TRUCK, CARGO, LIGHT AND TRUCK, CARGO, LIGHT, WINCH, MC2 - LAND ROVER 110 6X6

HEAVY GRADE REPAIR

This instruction is authorised for use by command of the Chief of Army. It provides direction, mandatory controls and procedures for the operation, maintenance and support of equipment. Personnel are to carry out any action required by this instruction in accordance with EMEI General A 001.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Blank Page

INTRODUCTION

1. This EMEl contains procedures for removing, dismantling, repairing, assembling and installing various components of the Truck, Cargo, Light including Winch models. Where applicable, instructions for the adjustment, lubrication and minor servicing of these items are included. This EMEl should be read in conjunction with EMEl Vehicle G 203 and EMEl Vehicle G 204-1.

CAUTION

Do not use adhesive tapes to seal fuel or oil openings. The adhesive tape is soluble in fuel or oil and can cause contamination. Remove temporary covers before assembling.

2. Prevent dirt and foreign objects from entering any component by placing clean temporary coverings over all exposed openings, including hoses, tubes and lines.

CAUTION

Before removing any electrical system components, disconnect the battery leads. Failure to comply may result in damage to the vehicle electrical system.

3. When disconnecting electrical connectors, hoses and fittings, remove clamps, as required, to gain slack and avoid damage to connectors and fittings.

4. Discard all used gaskets, seals, cotter pins, tab-washers, lock-pins, key-washers and lock-washers. Discard all contaminated fuel and lubricants drained from the vehicle in accordance with current local instructions.

5. Use only those fuels and lubricants specified in the Servicing Instruction, EMEI Vehicle G 209, the User Handbook and this instruction when replenishing fuel or lubricants.

6. Any fastenings or fittings being tightened to prescribed torques are to have dry, clean threads unless otherwise specified. When specified, thread sealants are to be applied to dry, clean, oil-free threads.

7. The engine cooling system contains Nalcool corrosion inhibitor, in water, at a ratio of 1:12.

Items Previously Known To Have Contained Asbestos

WARNING

Asbestos is a hazardous material and a carcinogen. Airborne asbestos fibre poses a serious danger to personnel and can lead to acute health concerns and eventual death.

The Land Rover Family of Vehicles (FOV) was originally fitted with a number of gaskets, seals and washers known to have contained asbestos.

Since 2009, all genuine Land Rover Australia supplied repair parts including; gaskets, seals and washers are asbestos free. If it is unknown as to whether the material contains asbestos, such items are to be removed, handled and disposed of IAW Defence WHSManual.

NOTE

Prior to the disruption, removal or replacement of items contained within Table 1, the vehicle logbook (GM120) should be reviewed. If the item has been replaced since 2009 and noted in Part 4 of the GM120 the item can safely be handled as being asbestos free.

8. The following table provides a list of all known, in-situ, items including; parts, gaskets, seals and washers found in Land Rover 6X6 FOV which may contain asbestos. If an item in Table 1 is to be replaced, the GM120, Part 4 should be reviewed. If the item in question has been replaced after 2009 and noted in Part 4 of the GM120 the item can safely be handled as being asbestos free. If no evidence can be found in Part 4 the item is to be considered contaminated with asbestos. The item is to be replaced IAW WHSManual Vo1 2, Part 3A, Chap 5, Asbestos Management in Defence and recorded in the GM120 Part 4.

Table 1 Items Previously Known To Have Contained Asbestos

Serial	ACM NIIN	NON-ACM NIIN	Item name	Description	RPS: 02185 ISSUE 3 MAR 00	Entry into GM120 Part 4 YES/NO
1	991373054	661566324	Gasket, transmission magnetic plug	Fibre washer for the transmission magnetic plug	FBA 016	
2	991373055	661566325	Gasket, transmission oil strainer plug	Filler plug fibre washer	FBA 021 / FBB 006	
3	661284266	661285409	Gasket, exhaust manifold	Exhaust manifold gasket	ABA 020	
4	998221518	661566345	Gasket, cover plate transfer casing reverse idler access	Transmission side plate gasket	FBA 012	
5	998221724	661566352	Gasket, transfer casing lower cover plate	Transfer case bottom plate gasket	FBB 001	
6	998221850	661566360	Gasket, transmission pneumatic valve	PTO actuator fibre washer	FEA 024	
7	998240915	661566354	Gasket, transmission oil pump cover	Transmission oil pump cover gasket	FC 019	
8	998498732	661566323	Gasket, transmission oil pump cover	Filler plug gasket for transfer case, front axle housing, rear / intermediate axle housing.	FBA 014 / FBC 012 / JA 903 / KA 006	
9	997980214	994957906	Brake shoe set, transmission handbrake	Handbrake brake shoes	MFB 001	
10	998221517	661566341	Gasket, transmission top cover plate	Transmission top plate gasket	FBA 010	
11	996666734	661566343	Gasket Housing Dog Clutch	PTO Actuator housing gasket	FBC 026	
12	998238297	661568461	Ring oil pick up	Transmission front cover plate oil pickup ring	FC 010	
13	661284264	661586333	Gasket	Oil cooler housing gasket	BE 009	
14	997628209	661566325	Joint washer	Filler plug fibre washer transfer case	FBA 021 / FBB 006	
15	998221722	661566353	Gasket Speedometer case	Speedo drive housing gasket	FBC 015	
16	997920835	661566324	Gasket Magnetic Plug	Filler plug fibre washer transfer case	FBA 016	

Paint

WARNING

This vehicle is painted with polyurethane (PUP). Precautions should be taken prior to carrying out repairs which include painting, sanding, scraping or welding. Fine PUP partials from sanding, filing or welding are eye and lung irritants. Refer to EMEI Workshop D 701 – Repair Policy for Equipment Painted in Polyurethane Paint.

WARNING

The primer used on this vehicle contains chromates. Precautions should be taken prior to carrying out repairs which include painting, sanding, scraping or welding. Fine partials from sanding, filing or welding the primer will contain traces of chromate which are skin, eye and lung irritants. PPE is as for PUP.

WARNING

Do not use compressed air to remove dust from areas which vehicle paint has been sanded, filed or drilled. Fine partials of dust will contain chromates and polyurethane which are skin, eye and lung irritants.

9. This vehicle is painted with polyurethane paint. The primer may contain chromium or zinc chromates. Both PUP and primer are most carcinogenic when in a liquid state but are still harmful if exposed to dust or fumes during repairs which include sanding, filing, welding or drilling through or removing paint layers. Wet sanding methods and / or local extract ventilation will minimise and control exposure from dust or fumes generated.

10. PPE Requirements. During repairs that involve sanding, filing, welding or drilling of the paint the following PPE must be worn:

- **a.** safety glasses,
- **b.** rubber or PVC gloves,
- **c.** overalls or full length clothing,
- **d.** fully enclosed foot wear, and
- **e.** a Class P1 (Particulate) respirator.

General Safety Warnings

WARNING

All industrial safety, work practices and equipment operating and maintenance instructions pertaining to this EMEI are to be adhered to.

The handling, storage and use of chemical substances are to be in accordance with WHSMnaual, ChemAlert and EMEI Workshop E series requirements.

Under no circumstances is compressed air to be used to remove dust from the clutch assembly and flywheel housing or the brake drums/discs and brake linings. Dust from the brake linings can be a health risk if inhaled.

Associated Publications

11. Reference may be necessary to the latest issue of the following documents:

a. Block Scale 2406/31 – Special Tools for RAEME – B Vehicles Truck Utility and Truck Light MC2 (Land Rover Model 110);

b. Complete Equipment Schedules (CES):

(1) Truck, Cargo, Light, MC2 – Land Rover 110 6 x 6:

(a) SCES 12044; and

(b) Equipment Kit SCES 12045;

c. Complete Equipment Schedules (CES):

(1) Truck, Cargo, Light, Winch, MC2 – Land Rover 110 6 x 6:

(a) SCES 12046; and

(b) Equipment Kit SCES 12045;

d. EMEI Vehicle G187-1 Truck, Lightweight and Truck, Light - All Types - Land Rover 110 4x4 and 6x6 – Fitting of Link Cable to Headlamp Electrical Circuit;

e. EMEI Vehicle G187-8 Truck, Lightweight and Truck, Light - All Types - Land Rover 110 4x4 and 6x6 – Rework of the Winch Drum Grooves and Replacement of the Winch Rope and Chain;

f. EMEI Vehicle G197-7 Truck, Utility, Lightweight, MC2, Land Rover 110 4x4 - All Types – Fusing of Additional Circuits;

g. EMEl Vehicle G 200 Truck, Cargo, Light and Truck, Cargo, Light, Winch, MC2 – Land Rover 110 6x6 - Data Summary;

h. EMEl Vehicle G 202 Truck, Cargo, Light and Truck, Cargo, Light, Winch, MC2 – Land Rover 110 6x6 – Technical Description;

i. EMEl Vehicle G 203 Truck, Cargo, Light and Truck, Cargo, Light, Winch, MC2 – Land Rover 110 6x6 – Light Grade Repair;

j. EMEl Vehicle G 204-1 Truck, Cargo, Light and Truck, Cargo, Light, Winch, MC2 – Land Rover 110 6x6 – Medium Grade Repair;

k. EMEl Vehicle G 209 Truck, Cargo, Light and Truck, Cargo, Light, Winch, MC2 – Land Rover 110 6x6 – Servicing Instruction;

l. EMEI Workshop D 180 – Flaw Detection – Non Destructive;

m. Defence Safety Manual (SAFETYMAN);

n. Defence Supply Chain Manual (DSCM);

o. Material Safety Data Sheet (MSDS);

p. Repair Parts Scale 02185; and

q. Repair Parts Scale 02186 (W/Winch).

12. A number of modifications and improvements have been made during the service life of the vehicle. Reference to the following publications may be required during repair activities:

NOTE

Any effect of these publications pertaining to the technical content of this document has been included in the text.

a. EMEI Vehicle G 187–1 – Truck, Utility, Lightweight, MC2, Land Rover 110 4X4 and Truck, Cargo, Light, MC2, Land Rover 110 6X6 – Fitting of Link Cable to the Headlamp Electrical Circuit;

b. EMEI Vehicle G 187–2 – Truck, Lightweight, MC2, Land Rover 110, All Types and Truck, Light, MC2, Land Rover 110, All Types – Fitting of Mudguard Reinforcement Plates;

c. EMEI Vehicle G 187–3 – Truck, Utility, Lightweight, MC2, Land Rover 110, All Types and Truck, Cargo, Light, MC2, Land Rover 110, All Types – Fitting of an Extra Earth Strap;

d. EMEI Vehicle G 187–4 – Truck, Utility, Lightweight, MC2, Land Rover 110, All Types and Truck, Cargo, Light, MC2, Land Rover 110, All Types – Fitting of Spot Mirrors;

e. EMEI Vehicle G 187–5 – Truck, Utility, Lightweight, MC2, Land Rover 110, All Types and Truck, Cargo, Light, MC2, Land Rover 110, All Types – Fitting of Instrument Blackout Cover;

f. EMEI Vehicle G 187–6 – Truck, Utility, Lightweight, MC2, All Types, Land Rover 4X4 and Truck, Cargo, Light, MC2, All Types, Land Rover 6X6 – Fitting of External Bonnet Release;

g. EMEI Vehicle G 187–7 – Truck, Utility, Lightweight, MC2, All Types, Land Rover 4X4 and Truck, Cargo, Light, MC2, All Types, Land Rover 6X6 – Air Cleaner Bracket Mounting;

h. EMEI Vehicle G 187–8 – Truck, Lightweight, MC2, Land Rover 110 4X4, All Types with Winch and Truck, Light, MC2, Land Rover 110 6X6, All Types with Winch – Rework of the Winch Drum Grooves and Replacement of the Winch Rope and Chain;

i. EMEI Vehicle G 187–9 – Truck, Lightweight, MC2, Land Rover 110 4X4, All Types not fitted with Snorkel and Truck, Light, MC2, Land Rover 110 6X6, All Types not fitted with Snorkel – Repositioning of the Air Inlet Hose and Rear Axle Breather;

j. EMEI Vehicle G 187–10 – Truck, Lightweight, MC2, All Types, Land Rover 4X4 and Truck, Light, MC2, All Types, Land Rover 6X6 – Fitting of Seat Belt Protector Sleeve;

k. EMEI Vehicle G 187–12 – Truck, Lightweight and Truck, Light, MC2, Land Rover 110 4X4 and 6X6, All Types – Strengthening of Bonnet Stay;

l. EMEI Vehicle G 187–13 – Truck, Lightweight and Truck, Light, All Types, Land Rover 110 4X4 and 6X6 – Fitting of Trailer Safety Chain Brackets;

m. EMEI Vehicle G 187–14 – Truck, Utility, Lightweight, FFR, MC2, Land Rover 110, All Types, Truck, Utility, Light, FFR, Land Rover Series 3, All Types and Truck, Cargo, Light, FFR, MC2, Land Rover 110, All Types – Rewiring of the 28V Voltmeter Circuit;

n. EMEI Vehicle G 187–15 – Truck, Lightweight and Truck, Light, All Types, Land Rover 110 4X4 and 6X6 – Replacement of 24V Power Distribution Box Cables Between Generator Input Plug and Battery Connections;

o. EMEI Vehicle G 187–16 – Truck, Lightweight, MC2, All Types, Land Rover 110 4X4 and Truck, Light, MC2, All Types, Land Rover 110 6X6 – Conversion From Oil Filled to Grease Filled Swivel Pin Housings;

p. EMEI Vehicle G 189–6 – Truck, Utility, Lightweight, MC2, All Variants, Land Rover 110 4X4 and Truck, Cargo, Light, MC2, All Variants, Land Rover 110 6X6 – Reclaiming Broken Indicator Switch;

q. EMEI Vehicle G 189–12 – Truck, Lightweight, MC2, All Types, Land Rover 110 4X4 and Truck, Light, MC2, All Types, Land Rover 110 6x6 – Fitting of Speedi Sleeves;

r. EMEI Vehicle G 189–15 – Truck, Lightweight and Truck, Light, All Types, Land Rover 110 4X4 and 6X6 – Chassis Repairs;

s. EMEI Vehicle G 207–1 – Truck, Cargo, Light and Truck, Cargo, Light, Winch, MC2 – Land Rover 110 6X6 – Fitting of Tailgate Upper Reinforcement and Steps, Tailgate Buffers, Seat Grab Handles and Lower Troop Footsteps;

t. EMEI Vehicle G 297–1 – Truck, Cargo, Light, MC2, Landrover (110) – All Types – Plate ‘U’ Bolt and fitting of modification record plate;

u. EMEI Vehicle G 297–2 – Truck, Light, MC2, Landrover (110) – All Types – Fitting of Transfer Case Caution Decal;

v. EMEI Vehicle G 297–3 – Truck, Cargo, Light, MC2, Landrover 110 – All Types – Fusing of Additional Circuits;

w. EMEI Vehicle G 297–4 – Truck, Cargo, Light, MC2, Landrover 110 – All Types – Replacement of the Securing Clip and securing of the Map light Wiring;

x. EMEI Vehicle G 297–5 – Truck, Cargo, Light, MC2, Landrover 110 – All Types – Fitting of the Steering Protection Plate and Improved Winch Fairlead Plate Mounting Bolts;

y. EMEI Vehicle G 297–6 – Truck, Cargo, Light, MC2, Landrover 110 – All Types – Fitting of Improved Steyr Weapon Mount;

z. EMEI Vehicle G 297–8 – Truck, Cargo, Light, MC2, Landrover 110 – All Types – Fitment of Centre Seat Back Rubber Block;

aa. EMEI Vehicle G 297–9 – Truck, Cargo, Light, MC2, Landrover 110, All Types W/Winch – Rework of the Winch Rear Driveshaft;

bb. EMEI Vehicle G 297–10 – Truck, Cargo, Light, MC2, Landrover 110 – All Types – Replacement of the Rear and Intermediate Axle Rebound Strap Retaining Clips and Rework of the Brake Pipe Protector Plate;

cc. EMEI Vehicle G 297–11 – Truck, Light, MC2, All Types – Landrover 110 6X6 – Fitment of a Securing Clip to the Turbocharger Oil Feed Pipe;

dd. EMEI Vehicle G 297–12 – Truck, Cargo, Light, MC2, Landrover 110 6X6 – All Types – Replacement of the Lower Throttle Linkage Lever;

ee. EMEI Vehicle G 297–13 – Truck, Light, MC2, Landrover 110 6X6 – All Types – Fitting of Rear Disc Brakes;

ff. EMEI Vehicle G 297–14 – Truck, Light, MC2, Landrover 110 6X6 – All Types – Fitting of Fuel Balance Pipe;

gg. EMEI Vehicle G 297–18 – Truck, Light, MC2, Landrover 110 6X6 – All Types – Upgrade of Rear Leaf Springs from seven to 11 Leaf;

hh. EMEI Vehicle G 297–19 – Truck, Light, MC2, Landrover 110 6X6 – All Types – Fitting of Front Coil Spring Retainers; and

ii. EMEI Vehicle G 297–20 – Truck, Light, MC2, Landrover 110 6X6 – All Types – Fuel Injector Unique Identifier.

Location of Identification Numbers

13. The location of identification numbers on components of the vehicle are described in Table 2.

Table 2 Location of Identification Numbers

Serial	Identification Number	Location
1	Chassis number	Right-hand side of the chassis, forward of the spring mounting turret
2	Chassis nameplate	Left-hand seat box, in the cab
3	Engine number	Left-hand side of the engine block
4	Injection pump identification	Side of the pump
5	Transmission and transfer case	Rear of the transfer case

HEAVY REPAIR

Special Tools and Gauges

14. The following special tools, gauges and apparatus, as listed in Block Scale 2406/31, are required as indicated to perform the tasks detailed in Table 3 and are illustrated in Figure 1.

NOTE

Items in Table 3 without an NSN were issued to units authorised to conduct Heavy Grade Repairs as part of the 'Introduction into Service' process.

NSN and Manufacturer’s part numbers and designations used in this EMEI were current at the date of issue. If twelve months or more have expired since issue, the NSN and Manufacturer’s part number should be checked for supersession.

Table 3 Special Tools

Serial	Part Number	NSN	Item Name	Intended Use
1	9-8523-1426-0		Spring Compressor	Valve spring compressor
2	1-8522-0001-0	5120-66-128-4340	Remover and Installer	Valve guide removal
3	1-8522-1005-0	5120-66-128-4341	Inserter, Seal	Installing valve stem oil seals
4	9-8521-0063-0		Puller	Removing crankshaft pulley
5	5-8840-0086-0		Puller	Removing timing gear and thrust plate
6	9-8521-0141-0	5120-66-128-4314	Remover, Gear	Removing crankshaft gear
7	9-8523-1169-0	5120-66-128-4318	Puller, Mechanical	Cylinder liner removal
8	9-8523-2557-0	5120-66-128-4319	Attachment, Puller, Mechanical	Cylinder liner removal
9	9-8523-2554-0	5120-66-128-4317	Inserter, Cylinder Liner	Cylinder liner installation
10	9-8523-1818-0	5120-66-128-4308	Inserter and Remover	Camshaft bearing removal
11	9-8522-0033-0	5120-66-128-4313	Inserter, Gear	Crankshaft drive gear installation
12	9-8522-1251-0		Ring Compressor	Piston ring compressor
13	18G79	5120-99-820-6912	Clutch Centraliser	Clutch plate installation
14	18GA092	5120-66-128-4312	Inserter, Seal	Installing timing cover oil seal
15	EYA3745		Engine Lifting Sling	Engine lifting
16	9-8521-0097-0			Water pump impeller removal
17	9-8522-1140-0			Installing water pump shaft
18	157842-4420			Camshaft coupling tool
19	157944-8720			Mounting bracket base
20	157944-8520			Universal vice
21	157944-7820			Injection pump mounting bracket
22	157916-5420			Coupling spanner
23	157914-0100			Wrench for camshaft coupling nuts
24	157931-2500			Tappet holder
25	157915-0100			Wrench for governor flyweight nuts
26	157910-1120			Lever
27	157926-5110			Extractor for flyweight removal
28	157914-2400			12 mm socket
29	157921-0120			Tappet inserter
30	157931-6120			Clamp
31	157921-5620			Inserter
32	157914-0500			Wrench for delivery valve removal
33	105782-4200			Measuring device
34	105782-6280			Dial indicator
35	105782-4330			Plunger pre-stroke measuring device
36	157954-3600			Dial indicator
37	105782-6170			Governor adjusting device
38	157976-3100			Control rack locking screw
39	157913-3620			Torque cam wrench
40	LST120			Worm adjuster locknut C-spanner
41	LST119			Worm adjuster socket
42	157926-5820			Timing device removal

Table 3 Special Tools (Continued)

Serial	Part Number	NSN	Item Name	Intended Use
43	157921-9820			Flyweight spring removal
44	MS47	5120-99-820-8044	Remover, Bearing	Hand press
45	18G47BA	5120-99-825-0835	Extractor	Adapter for bearing removal
46	18G1335	5120-99-725-6472	Puller, Mechanical	Reverse gear extractor
47	18GA081			Quill shaft nut socket
48	18GA091	5120-66-128-4344	Remover	Gear and spacer remover
49	18G284	5120-99-806-9013	Extractor Assembly	Impulse extractor
50	18G284AR	5120-99-825-0834	Extractor	Adapter for bearing removal
51	18G1426	5120-99-725-6473	Inserter, Seal	Adapter for oil seal installation
52	18G134	5120-99-874-1715	Replacer, Bearing	Bearing and oil seal remover
53	18G134DG	5120-99-825-0833	Replacement Adapter Ring	Adapter for front cover oil seal
54	18G1205A	5120-66-128-4300	Wrench, Adjustable	Adjustable flange holding wrench
55	18G47BB	5120-99-825-0838	Extractor	Adapter for differential bearing
56	18G131C	5120-99-825-0842	Axle Spreader	Axle casing spreader
57	18G131F	5120-99-825-0843	Adapter, Peg Set	Adapter pins for axle casing spreader
58	S123A	5120-99-825-1553	Extractor	Pinion bearing cup remover
59	18G47BK	5120-99-825-0840	Extractor	Adapter for pinion bearing removal
60	18G47BL	5120-99-825-0841	Extractor	Adapter for differential bearing removal
61	18G134DP	5120-99-825-0848	Differential Bearing Replacer	Adapter for differential bearing installation
62	18G1122	5120-99-825-0846	Screw Press	Hand press
63	18G1122G	5120-99-825-0847	Replace Set	Adapter for pinion bearing installation
64	18G191	5220-66-128-4306	Gauge, Setting	Dial gauge
65	18GA191-4	5120-66-128-4326	Block, Pinion Setting	Pinion setting block
66	RO1008A			Pinion oil seal installation
67	RO262757A			Extractor for pinion bearing cups
68	18G47-6	5120-66-128-4325	Inserter and Remover	Pinion head bearing removal
69	RO262757-1			Adapter for pinion bearing cups
70	RO262757-2			Adapter for pinion bearing cups
71	LST106	5120-66-128-4320	Inserter, Seal	Drift for pinion oil seal
72	18G1063	5120-66-128-4304	Separator, Ball Joint	Ball joint separator
73	18G284AAH	5120-99-725-6474	Adaptor, Removal	Adapter for stub axle bush and oil feed ring removal
74	MS252A			Steering arm removal
75	R01016			Torque setting tool
76	EYA 3737	2815-66-149-1913	Tool Kit, Seal Installation	Crankshaft rear oil seal installation
77	606602			Rotary valve ring expander
78	606603			Rotary valve ring compressor
79	R01015			Input shaft seal saver
80	606604			Sector shaft seal saver
81	JD10			Power steering test set

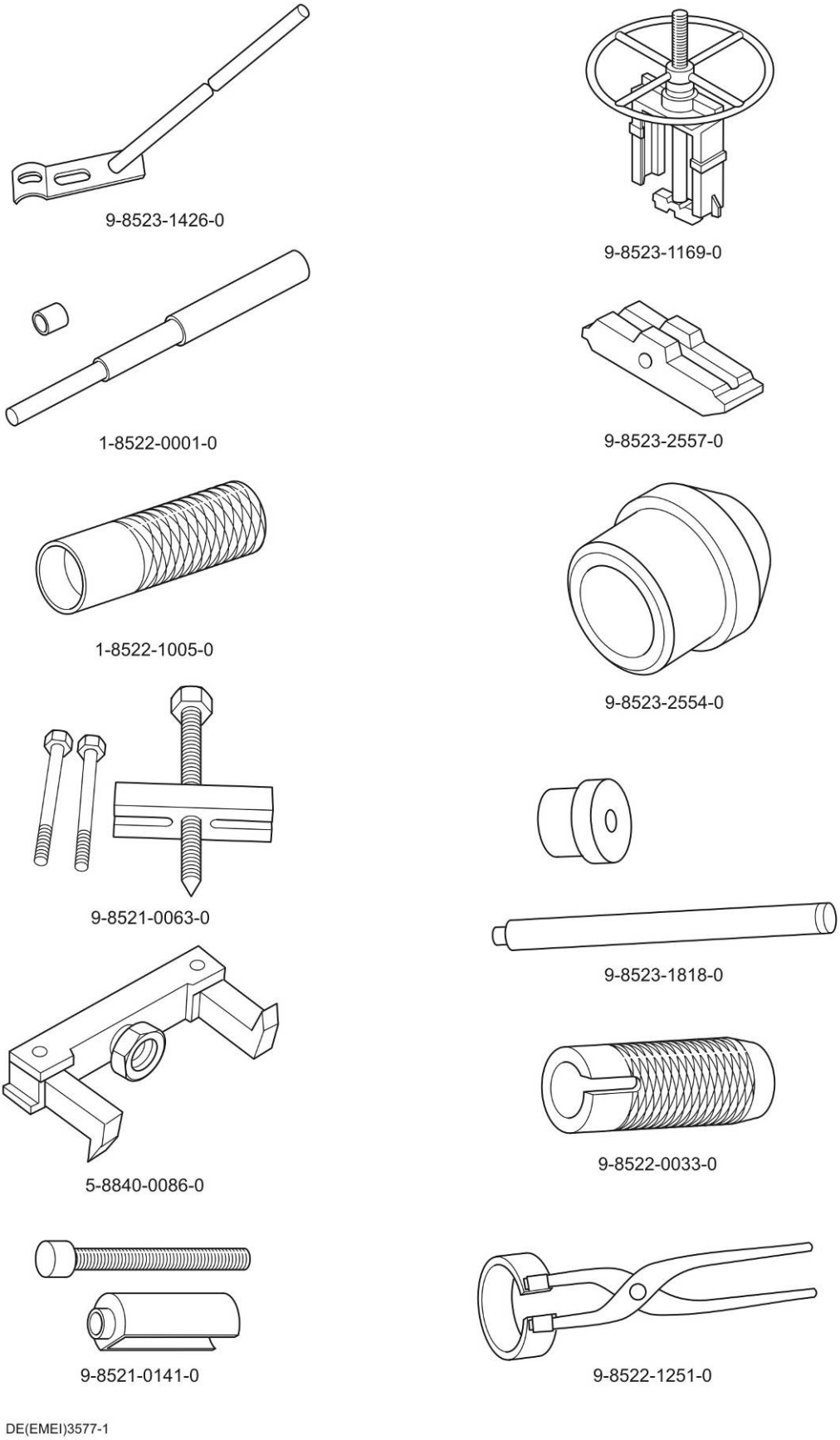


Figure 1 Special Tools (Sheet 1 of 7)

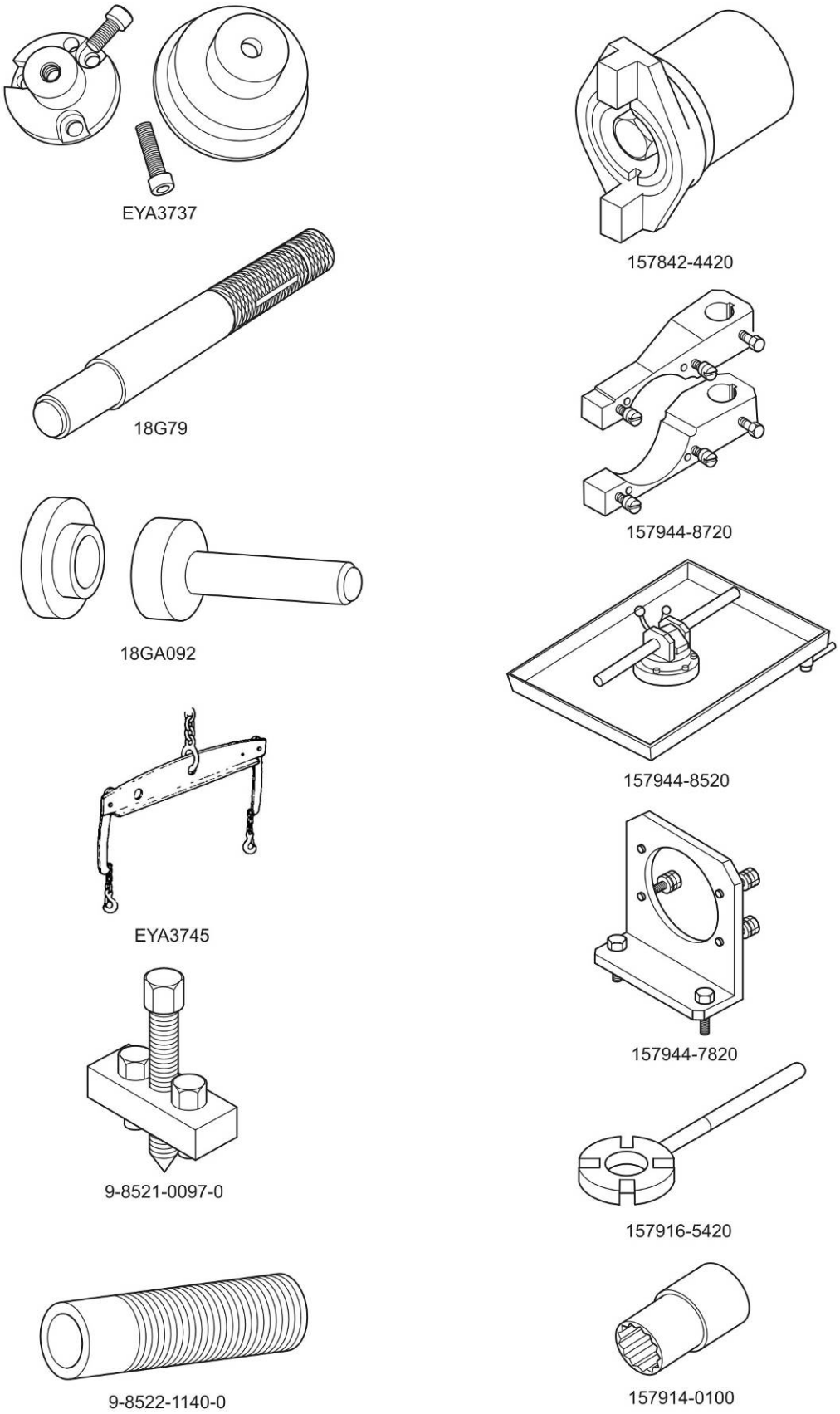
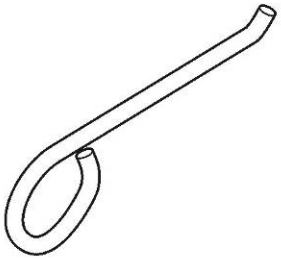
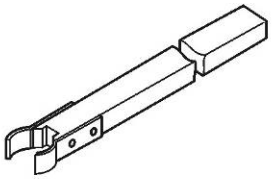


Figure 1 Special Tools (Sheet 2 of 7)

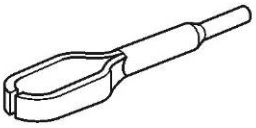


157931-2500

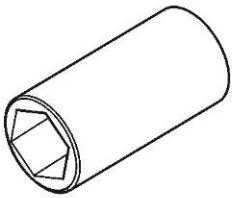


157931-6120

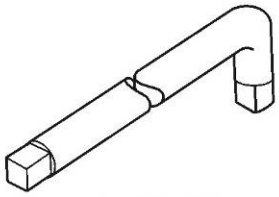
157915-0100



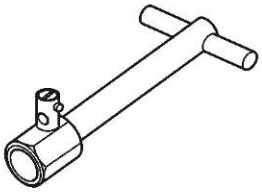
157921-5620



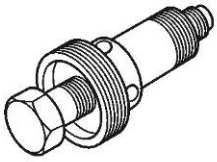
157914-0500



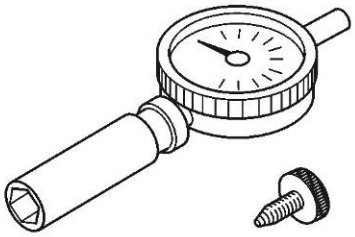
157910-1120



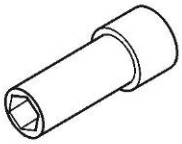
105782-4200



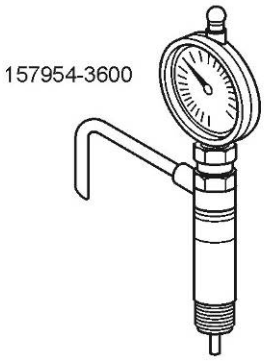
157926-5110



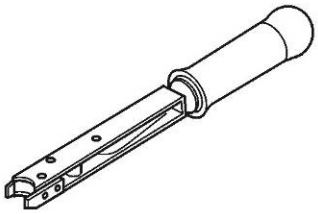
105782-6280



157914-2400



157954-3600



157921-0120

105782-4330

DE(EMEI)3577-3

Figure 1 Special Tools (Sheet 3 of 7)

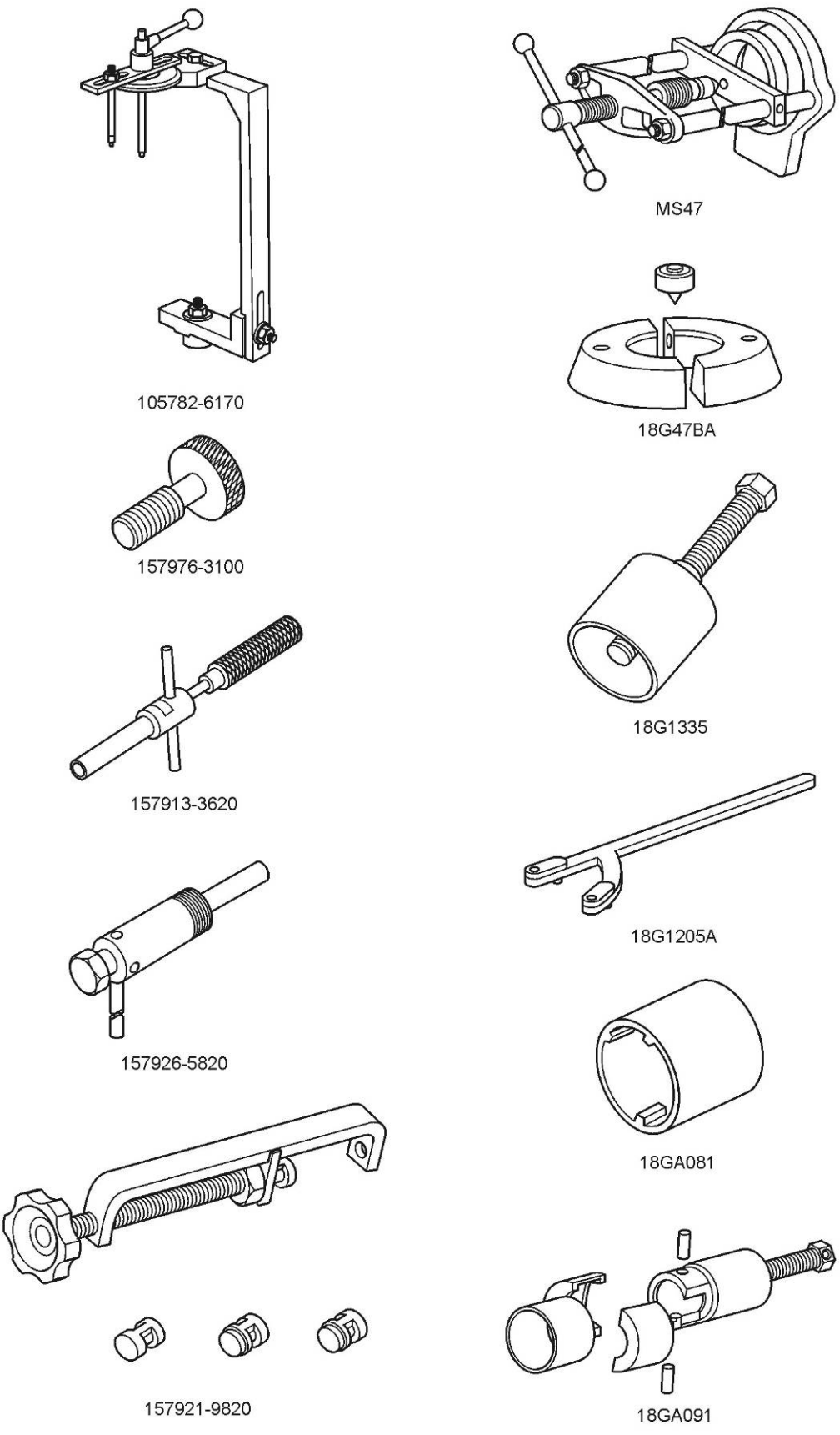


Figure 1 Special Tools (Sheet 4 of 7)

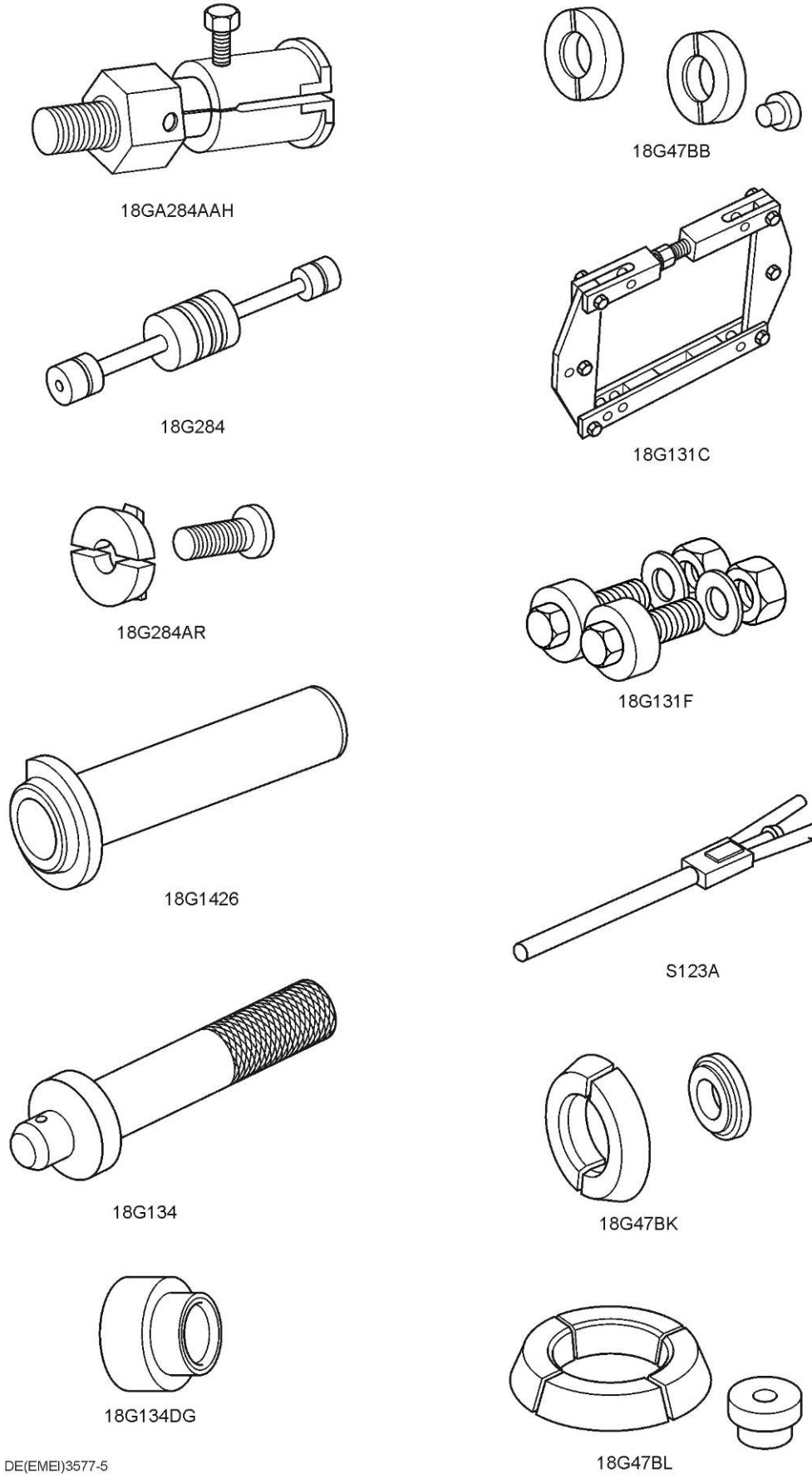
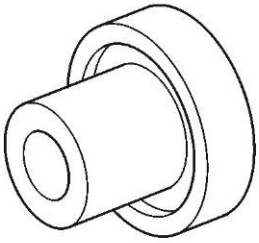
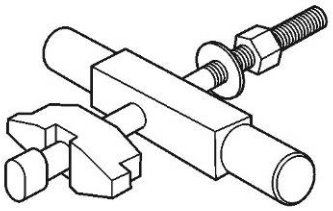


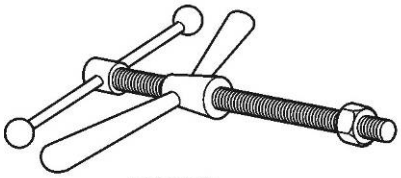
Figure 1 Special Tools (Sheet 5 of 7)



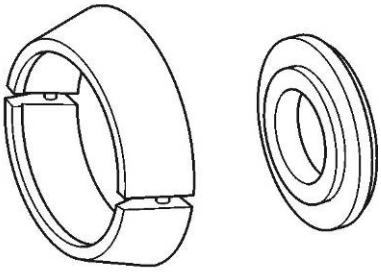
18G134DP



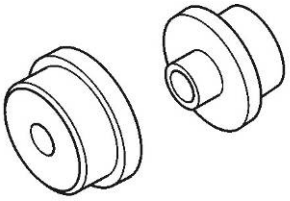
RO262757A



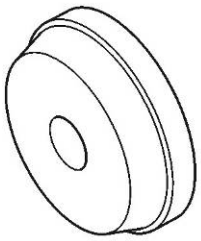
18G1122



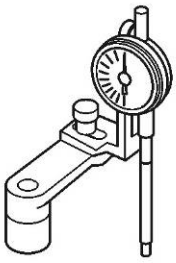
18G47-6



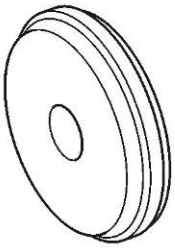
18G1122G



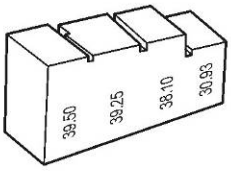
RO262757-1



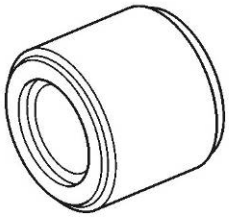
18G191



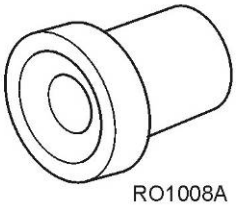
RO262757-2



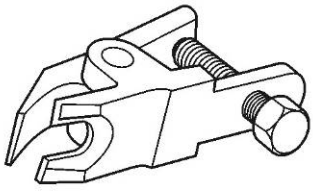
18GA191-4



LST106



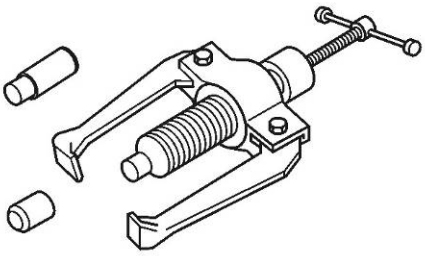
RO1008A



18G1063

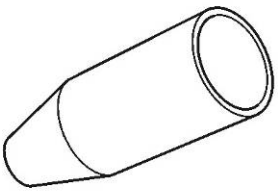
DE(EMEI)3577-6

Figure 1 Special Tools (Sheet 6 of 7)

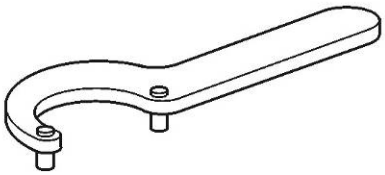


Jaw opening 3”

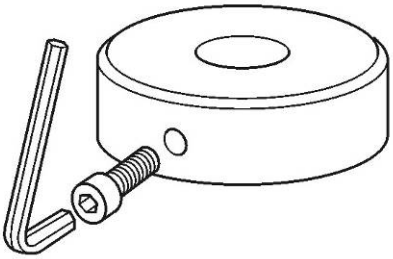
MS252A



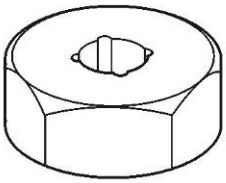
RO1015



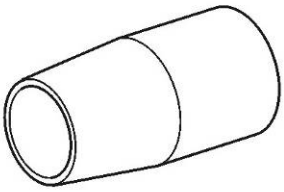
LST120



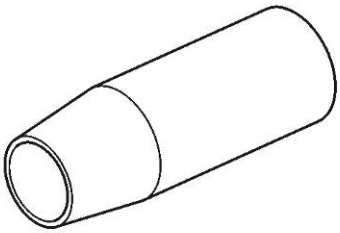
RO1016



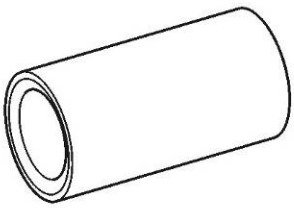
LST119



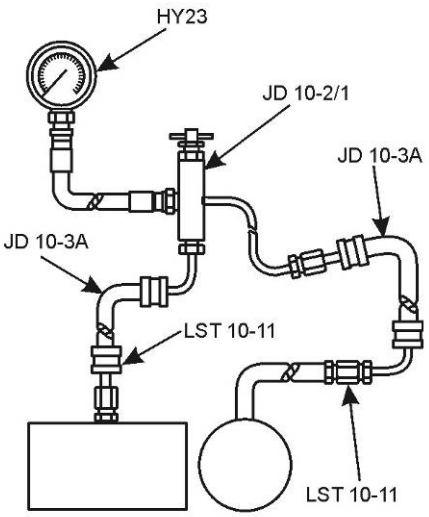
606604



606602



606603



JD10 MAIN TOOL

DE(EMEI)3577-7

Figure 1 Special Tools (Sheet 7 of 7)

15. The list of lubricants is detailed in Table 4.

Table 4 List of Lubricants

Serial	Equipment	Lubricant	Capacity (Litres)
1	Engine (including filters)	Lubricating oil: internal combustion engine, Combat/tactical service, SAE Grade 40	8.5
2	Transmission		2.7
3	Transfer case (without PTO)		3.2
4	Transfer case (with PTO)		5.8
5	Front differential	OEP-220	1.7
6	Intermediate differential	OEP-220	2.3
7	Rear differential	OEP-220	2.6
8	Swivel pin housings	Molytex grease	EP00 Sachet
9	Brake master cylinder	OX-8	Fill to level
10	Clutch master cylinder	OX-8	Fill to level
11	Power steering system reservoir	OX46	1.25
12	Wheel bearings	XG-291	As required
13	Winch rope	Rocol wire rope lube NSN 9150-99-337-1498	As required
14	Winch	OEP-220	2.1
15	Radiator inhibitor	NALCOOL	1:12 Ratio (8% solution)

ENGINE

Cylinder Head

16. To overhaul the cylinder head proceed as follows:

a. Remove the cylinder head in accordance with EMEl Vehicle G 204-1 – Group 1.

b. Install a valve spring compressor, special tool 9-8523-1426-0, over a valve, compress the valve springs and remove the two collets (Figure 2).

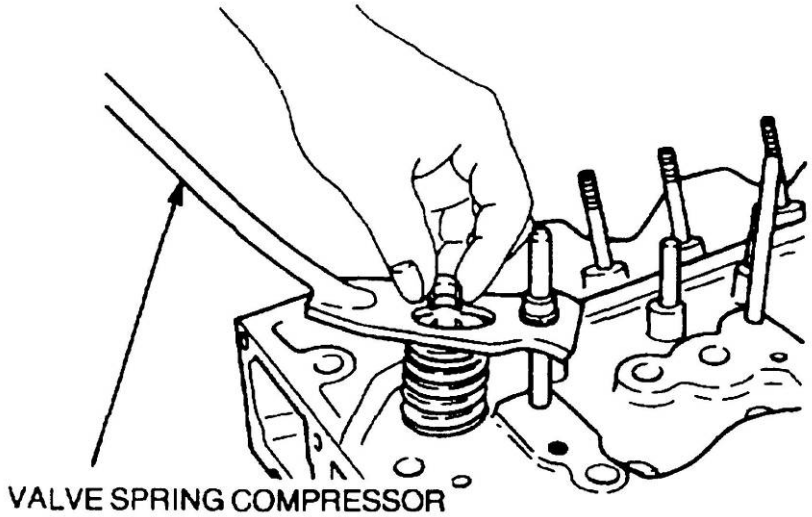


Figure 2 Valve Removal

c. Remove the valve spring compressor; remove the spring retainer, the valve springs and the valve.

d. Mark the cylinder number on each part after removal. Repeat the procedure for each valve.

17. Check the cylinder head for distortion, using a straight edge and a feeler gauge (Figure 3). If the distortion exceeds 0.2 mm (0.008 in) the cylinder head will require machining. Before machining the cylinder head, measure the thickness with a micrometer. The standard thickness is 89.95 to 90.05 mm (3.541 to 3.545 in). The head may be machined to 0.3 mm (0.012 in) under the standard minimum thickness. If the head is still not true after machining to the limit of 89.65 mm (3.530 in), replace the head.

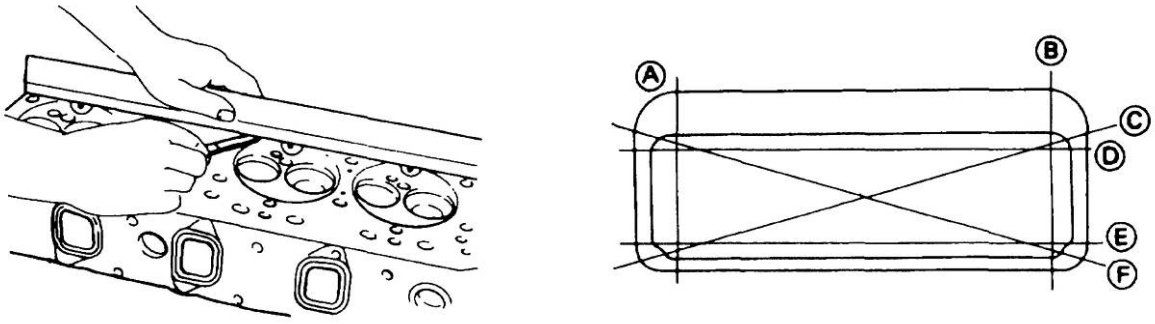


Figure 3 Checking the Cylinder Head Distortion

a. Check the condition of all studs, clean the threads with an appropriate die and replace any stud found to be bent or damaged. Run an appropriate tap into all threaded holes to dress the threads.

b. To replace the expansion plugs, pierce the plug with a sharp instrument, then prise the plug out. Install new plugs ensuring they are correctly seated.

NOTE

The small expansion plugs may be difficult to remove. If necessary, use a drill, but do not exceed the outer diameter of the expansion plug.

c. If the cylinder head is serviceable, clean the cylinder head thoroughly, removing all trace of carbon and metal cuttings.

d. Check the valve contact width of the valve seat. If the contact width exceeds the 2.0 mm (0.079 in) limit, insert the valve which was originally positioned in the port, ensuring that the valve head thickness (Figure 4) is not less than 1.0 mm (0.039 in), and measure the amount of depression between the cylinder head surface and the head of the valve (Figure 5). The standard dimension is 1.0 to 2.5 mm (0.039 to 0.098 in). If the dimension is within these limits, carefully grind or cut the valve to obtain the correct contact width and recheck the amount of depression. If the depression exceeds 2.5 mm (0.098 in) or if cracks or surface imperfections are evident, replace the valve seat. Repeat this procedure for each valve seat.

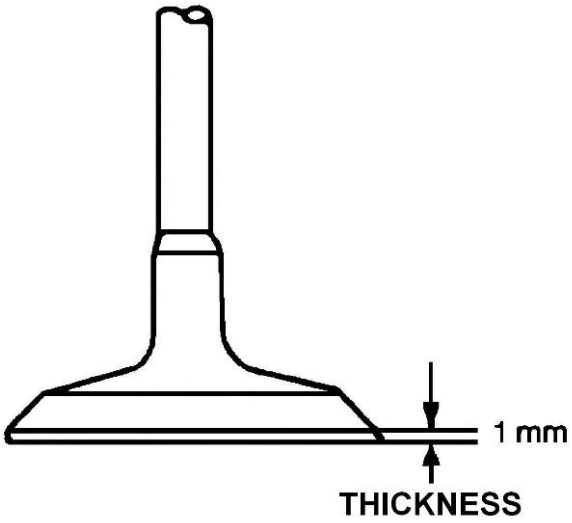


Figure 4 Measuring the Valve Head Thickness

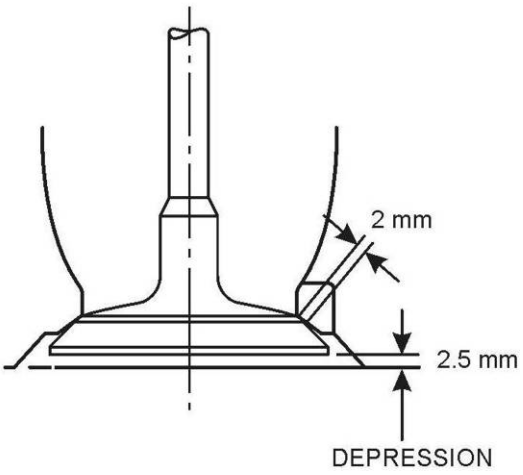


Figure 5 Measuring the Valve Depression

e. If the valve seats are to be removed, run a bead of weld on the angled face of the valve seat (Figure 6). As the weld cools, this will cause the valve seat to shrink, enabling easy removal of the valve seat.

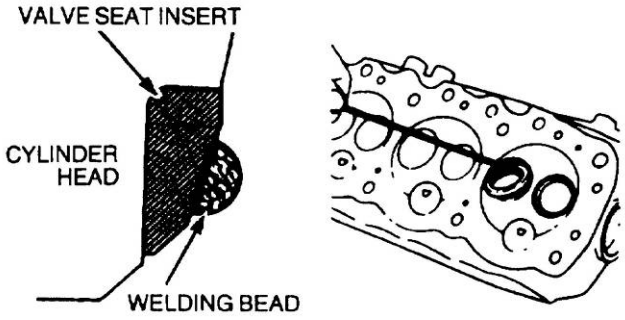


Figure 6 Removing the Valve Seat

NOTE

To assist with the installation of the valve seat insert, chill the insert in a freezer or dry ice.

f. Ensure that the counterbore is clean, position the new valve seat insert over the counterbore and press it into place using a bench press.

g. Carefully grind the valve seat to an angle of 45 degrees, ensuring that the contact width of the seating face is 1.5 mm (0.059 in). Repeat this procedure for each valve seat.

h. Before lapping the valves to the valve seats, check the valve stems for wear. Using a micrometer, measure the valve stems in three places (Figure 7). The standard diameters are:

(1) inlet valve - 8.88 to 8.961 mm (0.350 to 0.353 in); and

(2) exhaust valve - 8.88 to 8.936 mm (0.350 to 0.352 in).

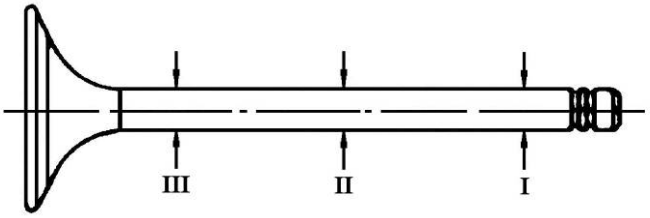


Figure 7 Valve Stem Measuring Points

i. Replace any valve that is worn below 8.88 mm (0.350 in).

j. Check the valve guides for wear by installing the valves in their respective guides and, using a dial indicator (Figure 8), push the valve stem back and forth against the micrometer plunger. The standard clearances are:

(1) inlet valve guides - 0.039 to 0.200 mm (0.0015 to 0.008 in); and

(2) exhaust valve guides - 0.064 to 0.250 mm (0.0025 to 0.010 in).

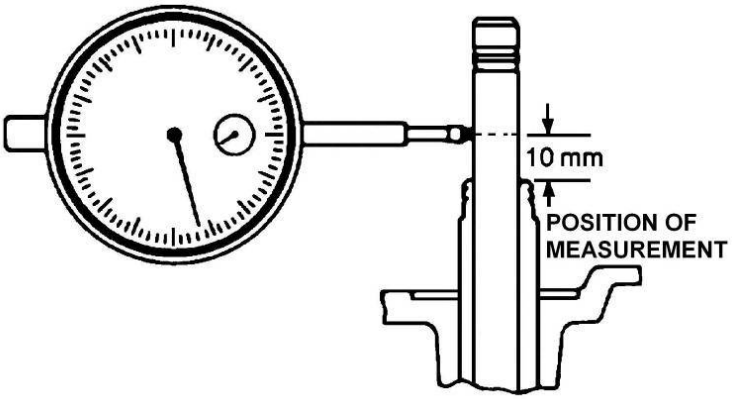


Figure 8 Measuring the Valve Guide Wear

k. Replace any valve guide if the clearance exceeds the limit.

l. Using special tool 1-8522-0001-0 and a hammer, remove the worn guide(s) from the cylinder head. Position the guide on the cylinder head and using the same tools knock the guide into the head, leaving the guide protruding 13.9 to 14.3 mm (0.547 to 0.563 in) above the cylinder head.

m. Lap the valves to their respective seats ensuring that both the valve and seat are lapped in evenly. Remove the valves and wipe all trace of lapping compound from the valves. Clean the cylinder head thoroughly ensuring that all cuttings and filings are removed and that the water jacket and oil galleries are clear.

n. Liberally coat the valve stems and guides with clean engine oil and install each valve into its respective port.

o. Position new valve stem seals over the top of each valve guide. Using a hammer and special tool 1-8522-1005-0, install each seal (Figure 9).

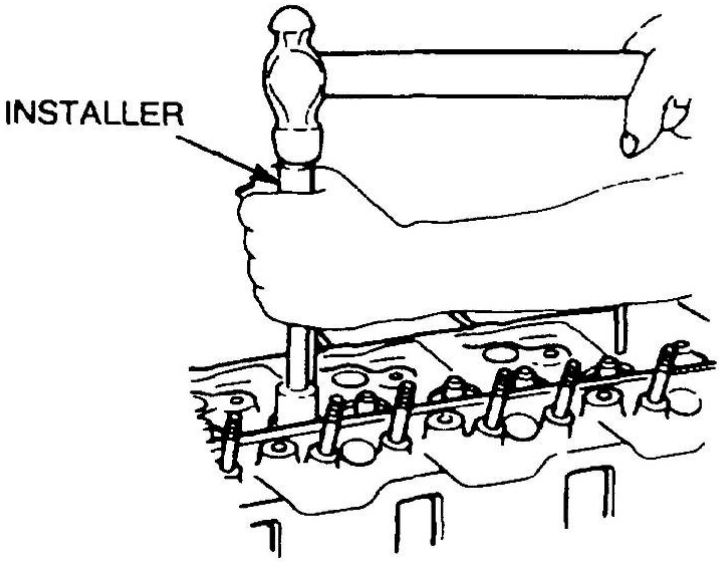


Figure 9 Installing the Valve Stem Oil Seal

p. Before installing the valve springs, check the condition of each spring. Check for cracks or damage and also check the free length, tension and inclination of the spring (Figure 10).

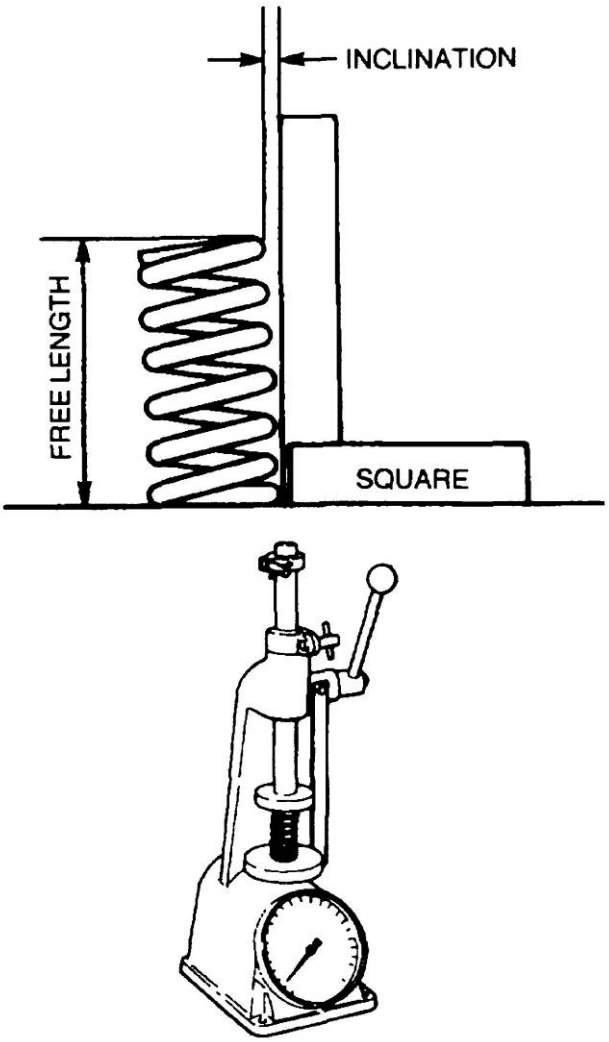


Figure 10 Checking the Free Length, Inclination and Tension of the Valve Springs

q. Replace any spring that is cracked or damaged or is below the limits listed in Table 5.

Table 5 Valve Spring Tolerances

Free Length and Inclination			
		mm (in)	
Free length	Inner	50.0 to 52.4 (1.970 to 2.063)	
	Outer	50.65 to 53 65 (1.994 to 2.112)	
Inclination	Inner		1.0 (0.039)
	Outer		1.0 (0.039)
Tension			
	Set length mm (in)	**kg (lb)**	
Inner	42.0 (1.65)	9.9 to 10.9	(21.83 to 24.03)
Outer	44.0 (1.73)	20.0 to 23.0	(44.10 to 50.71)

r. Position the inner and outer springs over their respective valve with the tighter wound coils of the springs towards the cylinder head (Figure 11).

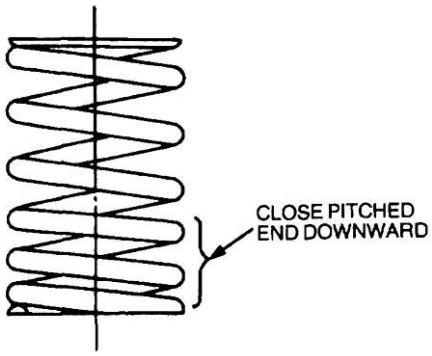


Figure 11 Valve Spring

s. Install a valve spring retainer over the valve springs, install a valve spring compressor (special tool 9-8523-1426-0) and compress the valve springs. Install the two collets ensuring that they are properly positioned and correctly seated on the valve stem (Figure 12) then release the spring compressor. Repeat this procedure for each valve and spring assembly.

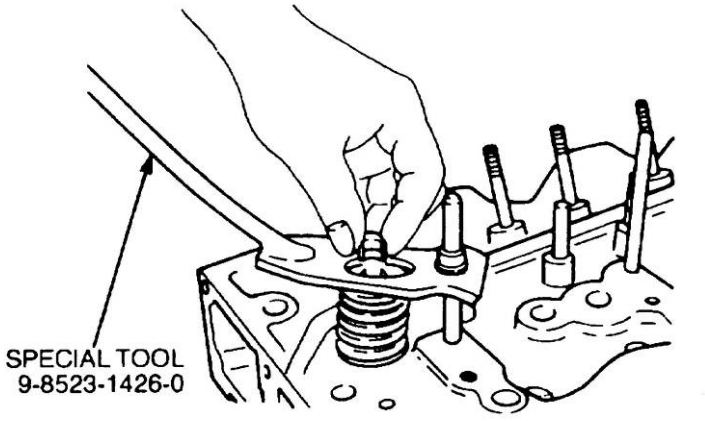


Figure 12 Valve Installation

t. Install the cylinder head in accordance with EMEl Vehicle G 204-1 – Group 1.

Engine

18. Disassembly. Disassemble the engine as follows:

WARNING

New gaskets provided by Land Rover do not contain asbestos. Older gaskets still fitted to vehicles may contain asbestos. During this task some parts may contain asbestos; refer and comply with procedures and warnings in the introduction section of this EMEI under paragraph heading: Items Previously Known To Have Contained Asbestos.

a. Refer to EMEl Vehicle G 204-1 – Group 1 for the removal of the following:

(1) the engine, and

(2) the cylinder head.

b. Remove the bolts and nuts securing the engine mounting brackets to the engine and remove the mounting brackets.

c. Replace the engine mountings if they are cracked or damaged.

d. Position the engine in a universal engine overhaul stand and secure the engine to the stand.

e. Position a suitable container beneath the engine, remove the drain plug from the oil pan and drain the oil from the engine. Reinstall the drain plug.

NOTE

The oil filter will contain some residual oil; care should be taken to avoid spillage.

f. Remove the oil filter, and the two bolts securing the oil feed pipe to the oil cooler.

g. Remove the four bolts securing the oil filter adapter to the engine and remove the adapter.

h. Disconnect the oil feed pipe from the injection pump and from the engine block. Plug the oil feed port in the injection pump to prevent the ingress of dust or dirt.

i. Remove the nut and washer securing the injection pump adapter to the rear mounting bracket (Figure 13).

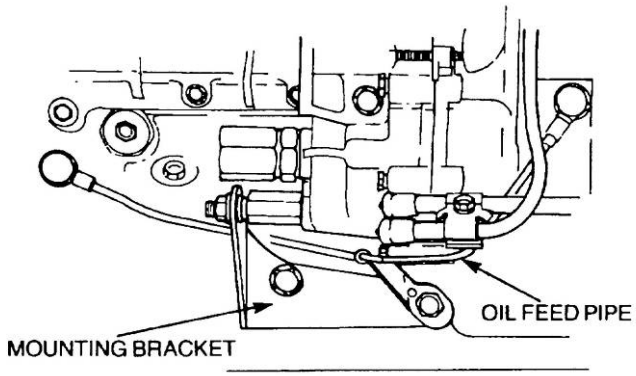


Figure 13 Removal of the Injection Pump Rear Mounting Bracket

j. Remove the two bolts securing the mounting bracket to the engine and remove the mounting bracket and the oil feed pipe from the engine.

k. Remove the plug from the timing cover (Figure 14) and remove the seven bolts (one is accessed from the rear of the timing case below the injection pump) securing the injection pump to the timing case.

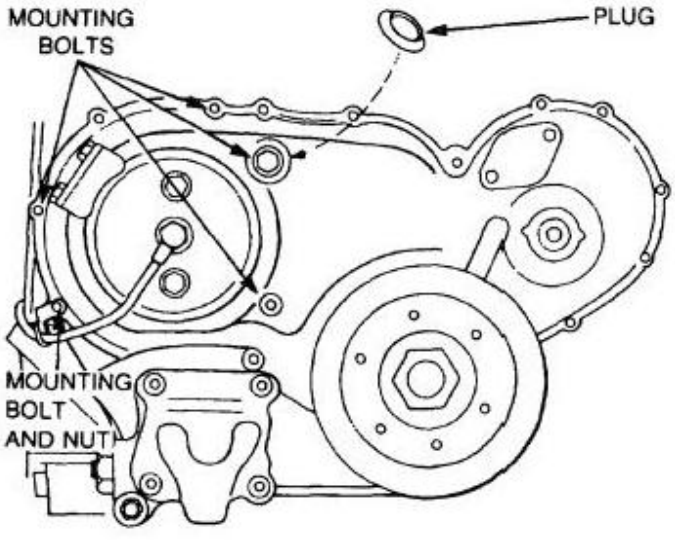


Figure 14 Removal of the Injection Pump

l. Remove the injection pump from the engine, place a protective cover over the injection pump and place the pump aside.

m. Disconnect the vacuum pump oil feed and return hoses from the engine block.

n. Disconnect the vacuum hose from the vacuum pump.

o. Remove the alternator adjusting bolt and mounting bolts and remove the alternator and fanbelt.

p. Remove the four bolts securing the cooling fan to the water pump drive flange; remove the fan, spacer and drive pulley.

q. Disconnect the heater hose from the water pump.

r. Remove the bolts securing the water pump to the engine block and remove the water pump.

s. Remove the two nuts and one bolt securing the starter motor to the flywheel housing and remove the starter motor.

WARNING

Under no circumstances is compressed air to be used to remove dust from the clutch assembly and flywheel housing. Dust from the clutch assembly and flywheel housing can be a health risk if inhaled.

t. Remove the clutch pressure plate and clutch plate by alternately slackening each of the twelve bolts to prevent distortion of the pressure plate housing.

u. Lock the flywheel to prevent it from turning and slacken the crankshaft pulley retaining nut.

v. Remove the six bolts securing the flywheel to the crankshaft and remove the flywheel.

w. Remove the side cover plates from the left-hand side of the engine and discard the gaskets and bolt seals.

x. Remove the bolts securing the oil cooler to the engine block and remove the oil cooler.

y. Remove the nut and washer securing the crankshaft pulley to the crankshaft, install special tool 9-8521 -0063-0 and remove the pulley.

z. Remove the bolts securing the timing cover to the timing case and remove the cover. Remove and discard the oil seal.

aa. Invert the engine and remove the nuts and bolts securing the oil pan to the engine block.

bb. Remove the oil pan, supporting plates and the gaskets. Discard the gaskets.

cc. Remove the two bolts securing the oil feed pipe to the engine block.

dd. Remove the two bolts securing the oil pump to the engine block and remove the oil pump.

ee. Remove the thirteen bolts and washers securing the flywheel housing to the engine block and remove the housing. Pry out and discard the oil seal.

ff. Prior to removing the pistons and connecting rods, turn the engine over (right way up) and remove all carbon deposits and/or ridging from the top of each cylinder. Invert the engine and remove the bearing caps from the connecting rods ensuring that each bearing cap, connecting rod and piston are match marked with the relevant cylinder number.

gg. Remove each piston and connecting rod assembly by pushing the assembly out through the cylinders.

hh. Before further removal of components from the engine, check the idle gear end-play with a feeler gauge (Figure 15). The standard end-play is 0.058 to 0.20 mm (0.002 to 0.008 in).

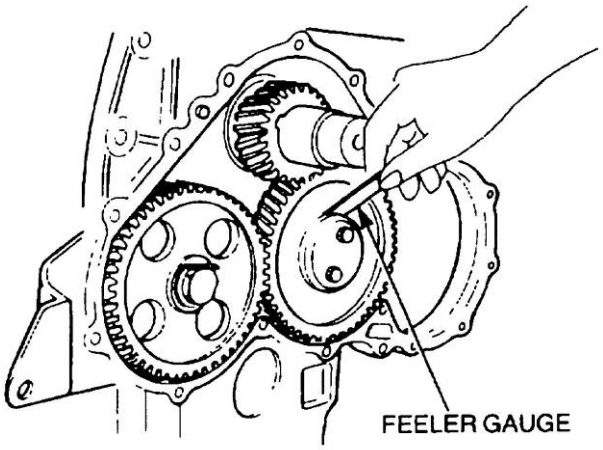


Figure 15 Checking the Idle Gear End-play

ii. Using a dial indicator check the backlash between the crankshaft, idle and camshaft gears (Figure 16). The standard backlash is 0.10 to 0.30 mm (0.004 to 0.012 in).

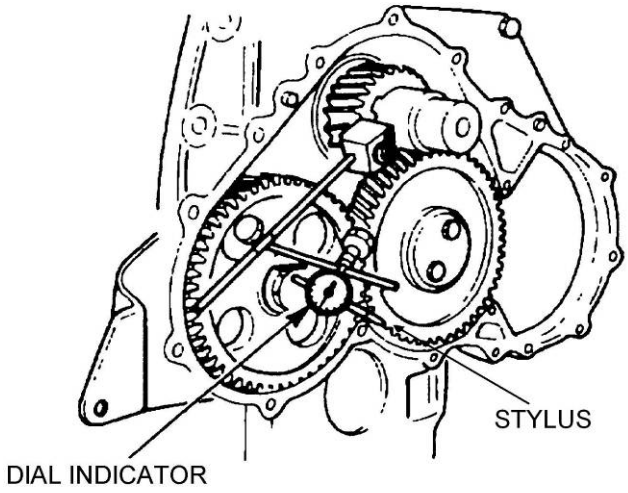


Figure 16 Checking the Timing Gear Backlash

jj. Using a feeler gauge, check the crankshaft end-play (Figure 17). The standard dimension is 0.15 to 0.45 mm (0.006 to 0.018 in).

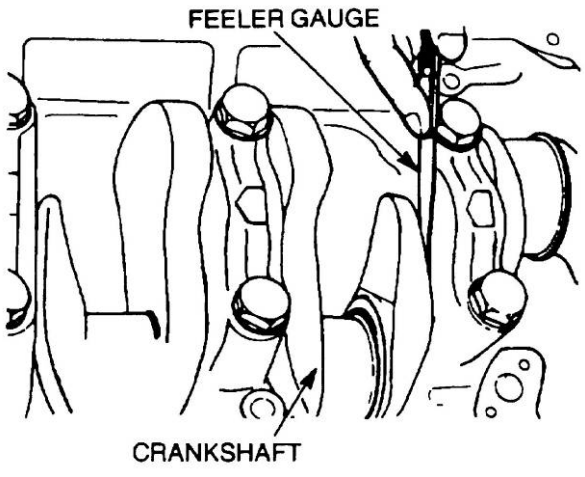


Figure 17 Checking the Crankshaft End-play

kk. Using the sequence shown in Figure 18, remove the crankshaft main bearing bolts and bearing caps, ensuring that each bearing cap is numbered. With the aid of a suitable piece of wire, push the thrust bearings out.

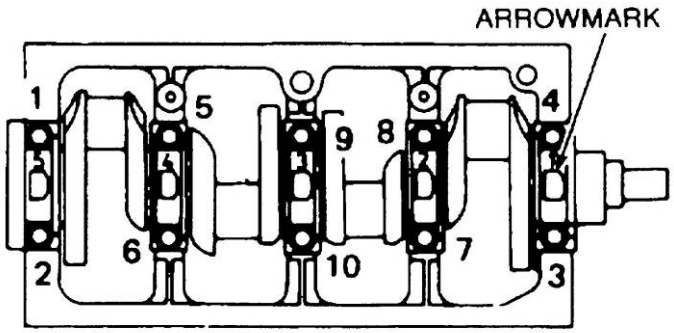


Figure 18 Main Bearing Bolt Removal Sequence

ll. Lift the camshaft followers from the camshaft lobes and support the followers in the raised position with suitable clips or tape, ensuring that there is sufficient clearance to remove the camshaft.

mm. Remove the oil pump cover from the left hand side of the engine block. Using an Allen key, remove the grub screw locating the thrust bearing.

nn. Remove the thrust bearing and the oil pump drive pinion.

oo. Rotate the camshaft drive gear to align the holes in the gear with the thrust plate retaining bolts.

pp. Remove the retaining bolts and carefully withdraw the camshaft from the engine block, ensuring that the camshaft lobes do not scratch or damage the camshaft bearings.

NOTE

The camshaft followers will drop from the engine when the support is removed.

qq. Match mark or number the camshaft followers to ensure correct location at installation. Remove the device supporting the followers and remove the followers.

rr. Remove the two bolts securing the idle gear thrust collar and shaft to the engine block and remove the idle gear assembly.

ss. Remove the bolts securing the timing case to the engine block and remove the timing case. Lift the crankshaft from the engine.

tt. Remove all the expansion plugs and threaded plugs from the engine block.

19. Cleaning and Inspection. Clean and inspect the engine as follows:

WARNING

New gaskets provided by Land Rover do not contain asbestos. Older gaskets still fitted to vehicles may contain asbestos. During this task some parts may contain asbestos; refer and comply with procedures and warnings in the introduction section of this EMEI under paragraph heading: Items Previously Known To Have Contained Asbestos.

a. Thoroughly clean the engine block and engine components with a recommended cleaning agent and blow them dry with compressed air.

b. Ensure all carbon deposits and gasket residues are removed and inspect the engine block for cracks, damage or wear. Repair or replace the engine block as necessary.

c. Inspect the camshaft followers for pitting, cracking or wear (Figure 19). If no fault is evident, measure the diameter of the follower with a micrometer. The standard dimension is 27.92 to 27.98 mm

(1.100 to 1.102 in). Replace any follower which is pitted, cracked or has irregular wear, or if the diameter is worn below the limit.

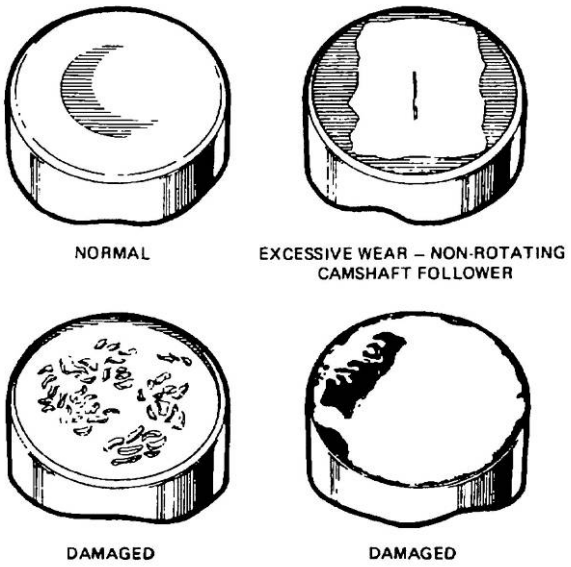


Figure 19 Camshaft Follower Wear Patterns

d. Check a camshaft follower bore in the engine block with an internal micrometer (Figure 20) and subtract the diameter of the follower, removed from that bore, from the dimension found. The standard clearance is 0.02 to 0.10 mm (0.0008 to 0.0039 in). Repeat this procedure for each bore and camshaft follower. Replace the engine block if any bore exceeds the limit.

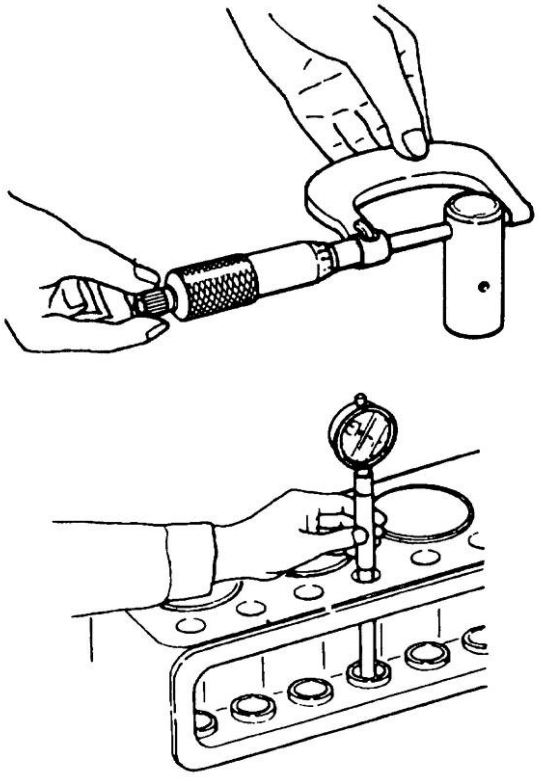


Figure 20 Measuring Camshaft Follower and Bore Wear

NOTE

Each cylinder liner and piston form a matched set and should not be interchanged. If a cylinder liner replacement is required the respective piston must also be replaced.

e. Measure the bore of each cylinder liner by inserting an inside diameter micrometer 20 mm down into the cylinder bore. Take a reading from two points approximately 90 degrees apart (Figure 21). The standard dimension of the bore is 102.021 to 102.20 mm (4.0166 to 4.0236 in). Replace the cylinder liners if they are worn beyond this limit in accordance with Para 20.

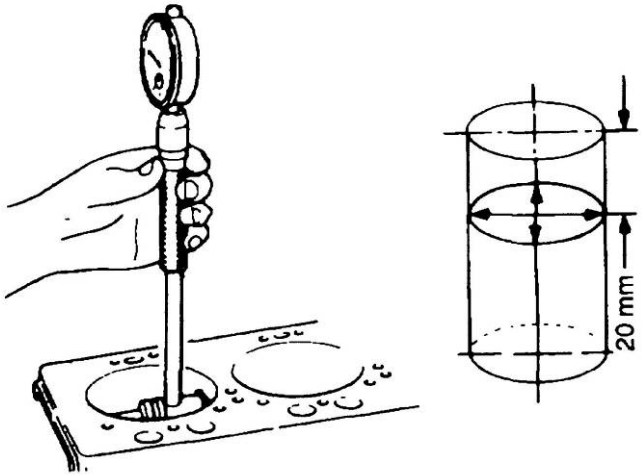


Figure 21 Measuring the Cylinder Bore

f. Position the camshaft in V-blocks and with a micrometer measure the diameter of the camshaft bearing journals (Figure 22). The standard dimension is 55.60 to 55.97 mm (2.1889 to 2.2035 in). Position a dial indicator on the centre bearing and check the camshaft run-out. If the run-out exceeds 0.1 mm (0.0039 in) or the journal wear is below the limit, replace the camshaft.

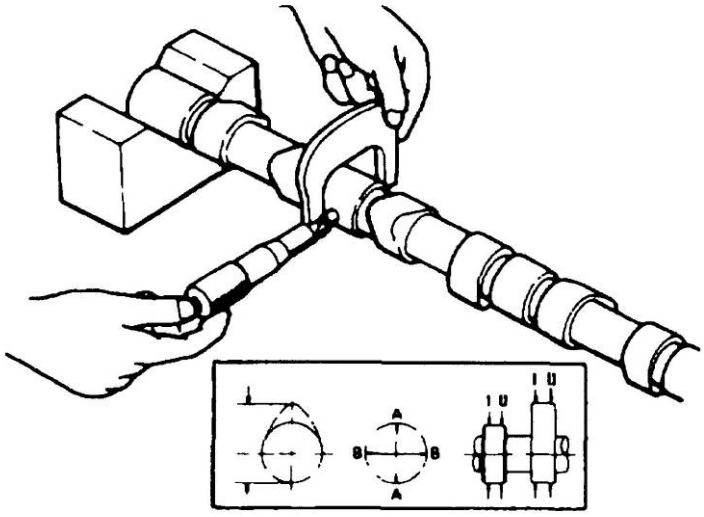


Figure 22 Measuring the Camshaft Bearing Journals

g. Using an internal micrometer, measure the internal diameter of the camshaft bearings (Figure 23). The standard diameter is 56.00 to 56.03 mm (2.2047 to 2.2059 in). If the camshaft is serviceable, subtract the camshaft bearing journal dimensions from the internal dimensions of the camshaft bearings. The standard clearance dimension is 0.03 to 0.l5 mm (0.0012 to 0.0059 in). If the clearance exceeds the limit, replace the camshaft bearings. Refer to Para 22. for the camshaft bearing removal procedure.

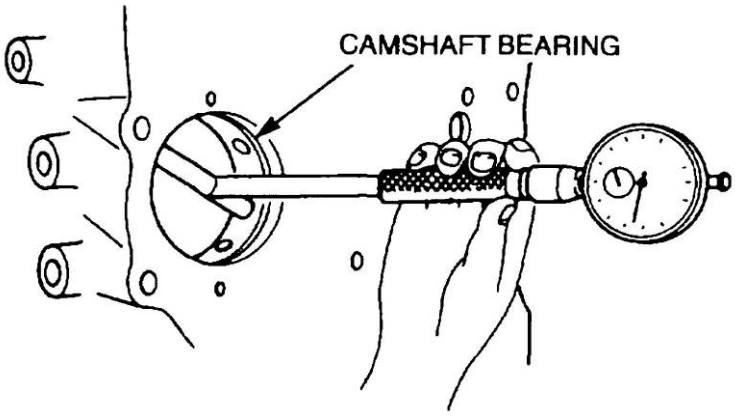


Figure 23 Measuring the Camshaft Bearings

h. Measure the height of the camshaft lobes with the micrometer. The standard height of the lobes is 47.7 mm (1.878 in) and the limit is 46.5 mm (1.830 in), also inspect the oil pump drive gear. Replace the camshaft if the lobes are worn below the limit or if the oil pump drive gear is cracked, damaged or excessively worn.

i. With a feeler gauge, measure the clearance between the camshaft Number one bearing journal and the thrust plate. The standard clearance is 0.050 to 0.200 mm (0.0020 to 0.0079 in).

j. If the thrust plate wear exceeds the limit or the timing gear backlash is excessive, clamp the camshaft securely in a soft-jawed vice and remove the timing gear retaining bolt. Using a puller (special tool 5-8840-0086-0), remove the timing gear and the thrust plate from the camshaft. Install a new thrust plate and, using a bench press, install the timing gear.

k. If the crankshaft gear backlash was excessive, remove the gear using special tool 9-8521-0141-0 and with an external micrometer measure the bearing journals on the crankshaft (Figure 24). For the main bearing journals, the standard dimension is 79.000 to 79.925 mm (3.1102 to 3.1467 in). The connecting rod bearing journal standard dimension is 63.000 to 63.944 mm (2.4803 to 2.5174 in). Check each journal for taper and ovality. Discard the crankshaft if the wear exceeds the limits.

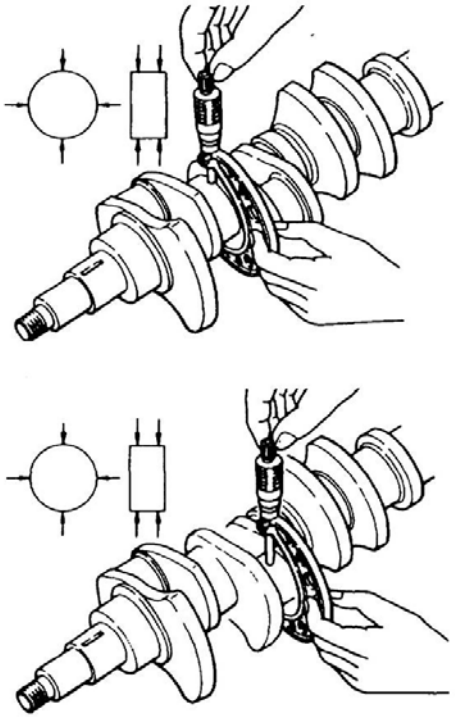


Figure 24 Measuring the Crankshaft Bearing Journals

l. With the crankshaft cradled on V-blocks, check for bend or run-out with a dial indicator positioned on the centre main bearing journal (Figure 25). The crankshaft should be supported on the main bearing journals at each end. Ensure that bearing journal wear is taken into consideration when measuring the run-out. Standard run-out is 0.05 mm (0.002 in) or less, and the limit is 0.30 mm (0.012 in). If the run-out exceeds the limit, replace the crankshaft.

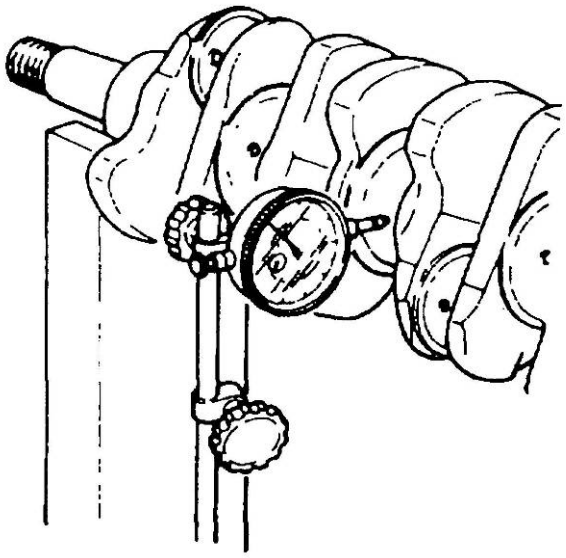


Figure 25 Measuring the Crankshaft Run-out

m. Inspect the crankshaft oil seal journals for any abrasion or scoring which may have been caused by previous oil seals. Carefully remove any burrs or rough areas with emery paper or a fine file.

n. Before installing new bearings, check the bearing spread (Figure 26). The spread limit for main bearings is 85.0 mm (3.35 in) and for the connecting rod big-end 68.0 mm (2.68 in). Install each half of each bearing into its respective position and check that a slight pressure is required to seat the bearing. Replace the set if the bearings are not to specification.

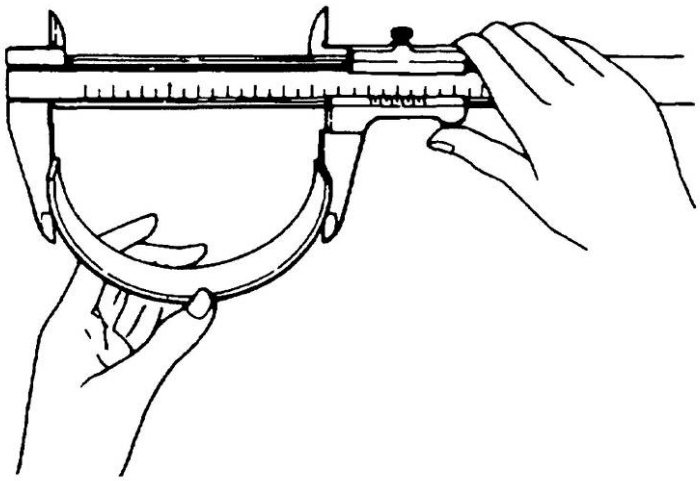


Figure 26 Measuring the Bearing Spread

o. Install the main bearing caps, together with the bearings, onto the engine block, ensuring that they are seated squarely and in their correct location. Torque the retaining bolts to 225 to 245 N.m (166 to 181 lbf.ft). Lubricate the bearing shells with clean engine oil and with an internal micrometer, measure the diameter of the bearings (Figure 27). The nominal diameter is 80.0 mm (3.15 in). Subtract the bearing journal diameter from the diameter of the bearing and check that the clearance falls within the standard dimension of 0.039 to 0.110 mm (0.0015 to 0.0043 in). If the clearance exceeds the limit, replace the crankshaft.

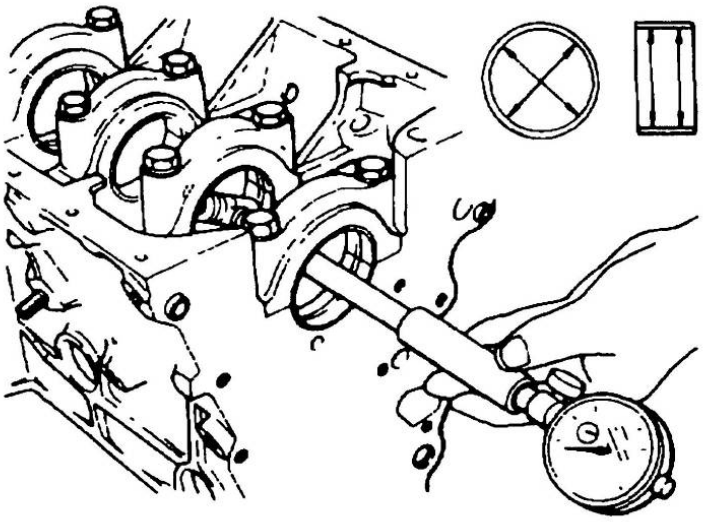


Figure 27 Measuring the Main Bearings

p. Install the new bearings into the connecting rod big-end cap. Install the cap and torque the retaining bolts to 39 N.m (29 lbf.ft), tighten each bolt a further 60 to 90 degrees. With an internal micrometer, measure the inside diameter of the bearing (Figure 28). The nominal diameter is 64 mm. Subtract the crankshaft bearing journal diameter from the diameter of the bearing to obtain the clearance. The standard clearance is 0.10 to 0.073 mm (0.004 to 0.0029 in). If the clearance exceeds the limit, replace the crankshaft.

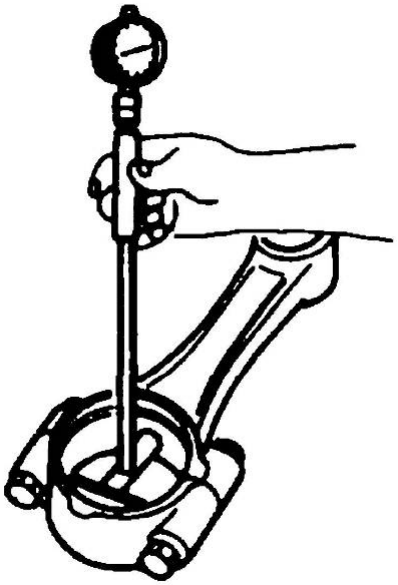


Figure 28 Measuring the Connecting Rod Bearing

q. Remove the piston rings from the pistons, then remove the gudgeon (piston) pin retaining snap-rings from each piston and push the gudgeon pin out.

r. Measure the diameter of the gudgeon pin with a micrometer (Figure 29). The nominal dimension is 35.00 mm (1.377 in) and the limit is 34.95 mm (1.375 in). Replace the gudgeon pin if the wear exceeds the limit.

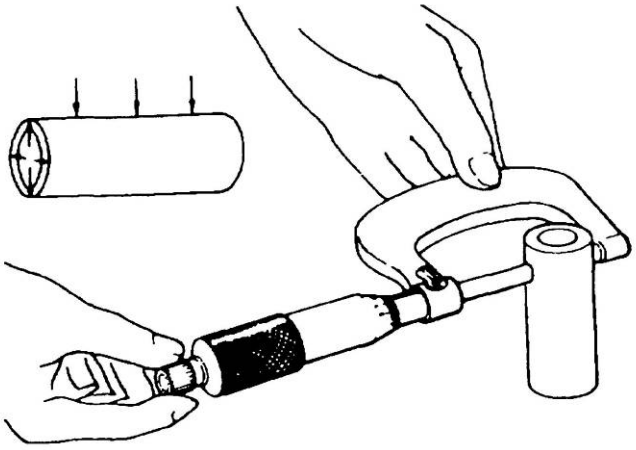


Figure 29 Measuring the Gudgeon Pin

NOTE

Each piston and cylinder liner form a matched set and should not be interchanged. If a piston replacement is required, the respective cylinder liner must also be replaced.

s. Using an internal micrometer, measure the diameter of the gudgeon pin bore in the piston. The diameter should be no more than 0.005 mm (0.0002 in) smaller than the diameter of the gudgeon pin, creating an interference fit between the pin and the piston. If the bore of the piston is worn so that an interference fit is no longer possible, replace the piston.

t. Before checking the small-end bush on the connecting rod for wear, ensure that the connecting rod is serviceable. Install the connecting rod on an alignment jig and check it for twisting or bending (Figure 30). The standard twist or bend is less than 0.05 mm (0.002 in) per 100 mm of the connecting rod length. Replace the connecting rod if twist or bend exceeds 0.200 mm (0.0079 in) per 100 mm.

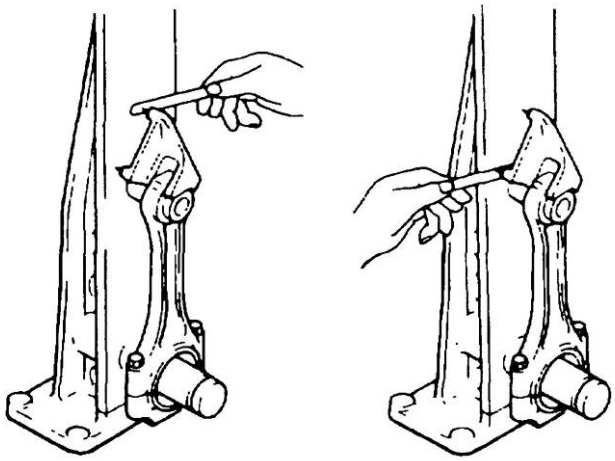


Figure 30 Checking the Connecting Rod Alignment

u. Using an inside micrometer, check the inside diameter of the connecting rod small-end bush. The standard dimension is 35.017 to 35.025 mm (1.3786 to 1.3789 in). Subtract the diameter of the gudgeon pin (Para 16. q.) from the diameter of the bush to obtain the amount of clearance. The standard clearance is 0.012 to 0.05 mm (0.0005 to 0.002 in). If the clearance limit is exceeded and the gudgeon pin is within the standard dimension, replace the connecting rod small-end bush.

v. Remove the small-end bush. With the aid of a press and a suitable adapter, install a new bush. Machine the bush out to obtain a clearance of 0.012 to 0.025 mm (0.0005 to 0.0010 in) between the gudgeon pin and the bush.

w. Using a micrometer, measure the diameter of the pistons. Place the pistons upside down on the work bench, position the micrometer 82 mm up from the crown of the piston and at 90 degrees to the

centreline of the gudgeon pin bore and measure the diameter (Figure 31). Subtract the diameter of the piston from the inside diameter of the cylinder liner (Para 16. e.) to obtain the piston-to-cylinder liner clearance. The standard clearance is 0.057 to 0.075 mm (0.0022 to 0.0030 in). If the dimension obtained exceeds the standard clearance, replace the piston and the cylinder liner.

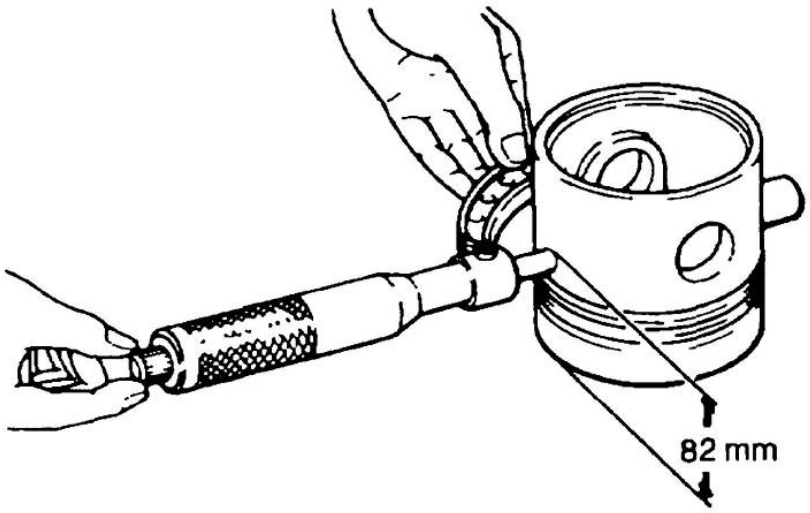


Figure 31 Measuring the Piston Diameter

NOTE

Each piston and cylinder liner forms a matched set and should not be interchanged. If a piston replacement is required, the corresponding cylinder liner must also be replaced.

x. Ensure that all trace of carbon is removed from the piston ring grooves. With the aid of a set of standard piston rings and feeler gauges, measure the clearance between the piston ring and the ring land (Figure 32). Refer to Table 6 for the standard clearances and limits. Replace any piston where the clearance exceeds the limits.

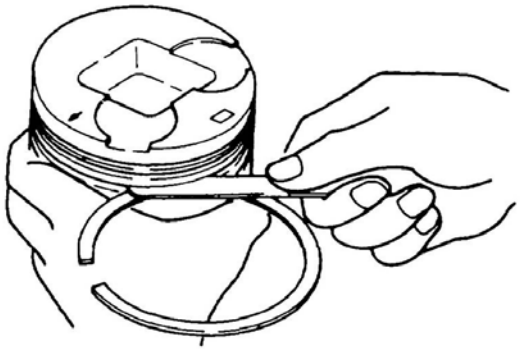


Figure 32 Measuring the Piston Ring Clearance

Table 6 Piston Ring Clearance

Piston Ring	Standard mm (in)	Limit mm (in)
First compression	0.085 to 0.11 (0.0033 to 0.0043)	0.2 (0.008)
Second compression	0.030 to 0.055 (0.0012 to 0.0022)	0.15 (0.006)
Oil	0.030 to 0.07 (0.0012 to 0.003)	0.15 (0.006)

y. Measure the diameter of the idle gear shaft with a micrometer (Figure 33). The standard dimension is 44.84 to 44.97 mm (1.765 to 1.770 in). Replace the idle gear shaft if the wear exceeds the limit.

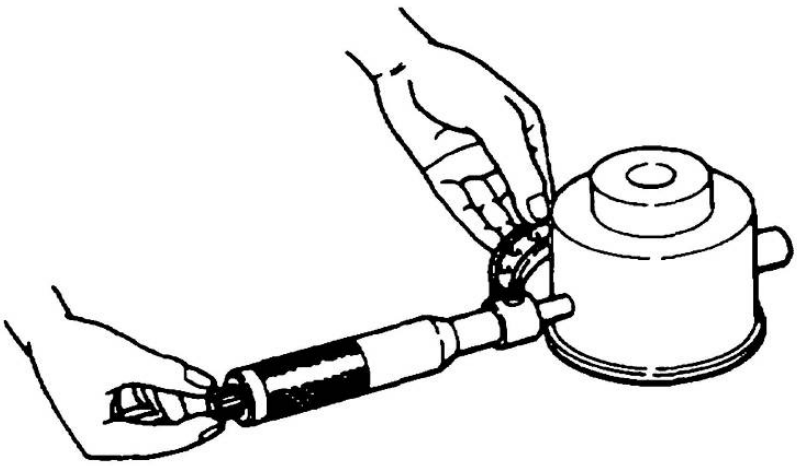


Figure 33 Measuring the Idle Gear Shaft

z. If the idle gear shaft is within specification, measure the internal diameter of the idle gear (Figure 34). Subtract the shaft diameter from the gear diameter to obtain the running clearance. The standard clearance is 0.009 to 0.060 mm (0.00035 to 0.0024 in). If the running clearance exceeds the limit, or if the gear backlash (measured at disassembly) exceeds the limit, replace the idle gear.

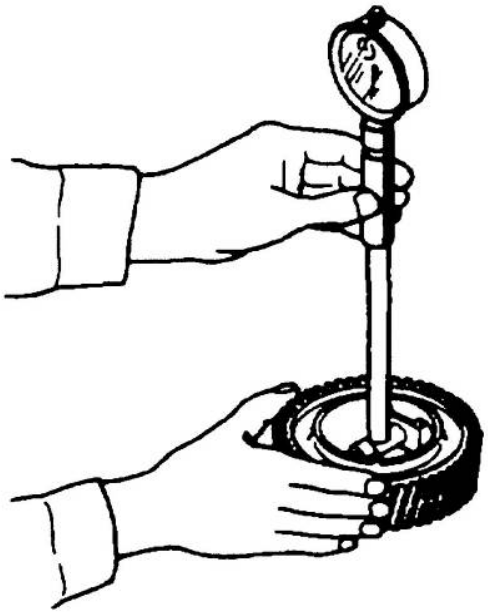


Figure 34 Measuring the Idle Gear

Cylinder Liners

20. Cylinder Liner Removal. Remove the cylinder liners as follows:

a. Position the cylinder liner remover, special tool 9-8523-1169-0, over the defective cylinder liner, ensuring that the tool is squarely seated and firmly supported on the engine block. Install the foot (ankle) of special tool 9-8523-2557-0 onto the leg of the remover, ensuring that the foot is correctly positioned on the liner. Operate the cylinder liner remover and withdraw the liner from the engine block (Figure 35). Remove other cylinder liners as necessary, in the same manner.

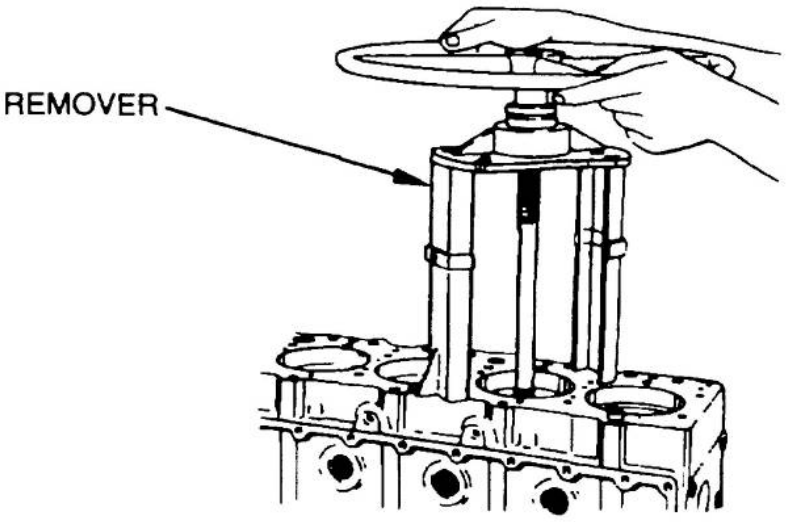


Figure 35 Removing the Cylinder Liners

b. After removing the cylinder liners, check the engine block deck for distortion using a straight edge and a feeler gauge (Figure 36). If the distortion exceeds 0.20 mm (0.008 in) the engine block deck will require machining. The maximum allowable amount of metal that can be removed is 0.3 mm (0.012 in). If distortion still exists after the maximum amount of metal has been removed, replace the engine block.

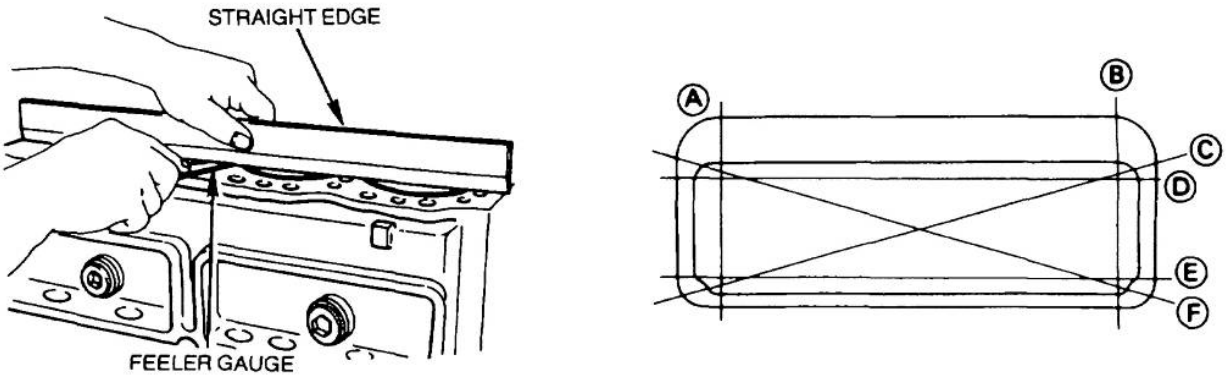


Figure 36 Checking the Engine Block Distortion

NOTE

The difference in the amount of protrusion from liner-to-liner should be less than 0.03 mm (0.0012 in).

c. If the engine block is serviceable after machining, it will be necessary to cut the cylinder liner lip counterbore the same amount to ensure that the protrusion of the cylinder liners (when installed) is between 0.03 to 0.10 mm (0.0012 to 0.0039 in) above the engine block deck.

d. Check the bores in the engine block for scoring, damage or wear, also measure the bore diameter. If the bore diameter exceeds the standard dimension of 105.001 to 105.010 mm (4.1339 to 4.1342 in) or if excessive scoring, damage or wear is evident, replace the engine block. Ensure that the bore is machined to allow for an interference fit of between 0.001 to 0.019 mm (0.00004 to 0.00075 in) when the cylinder liner is installed.

e. Overhaul the oil pump in accordance with EMEl Vehicle G 204-1 – Group 1.

f. Overhaul the water pump (Group 2).

21. Cylinder Liner Installation. Install the cylinder liners as follows:

NOTE

To assist with the installation of the cylinder liners, chill the liners in a freezer or with dry ice.

a. Ensure that the engine block is thoroughly clean and all trace of machine cuttings is removed from each of the cylinder liner bores. Position the engine block on a hydraulic press, then start a new cylinder liner into a bore. Position special tool 9-8523-2554-0 over the cylinder liner and press the liner into the block by initially applying a load of 500 kg (1100 lbs), apply a final load of 2500 kg (5500 lbs) to ensure that the cylinder liner is properly seated (Figure 37). Repeat this procedure for each cylinder liner being replaced.

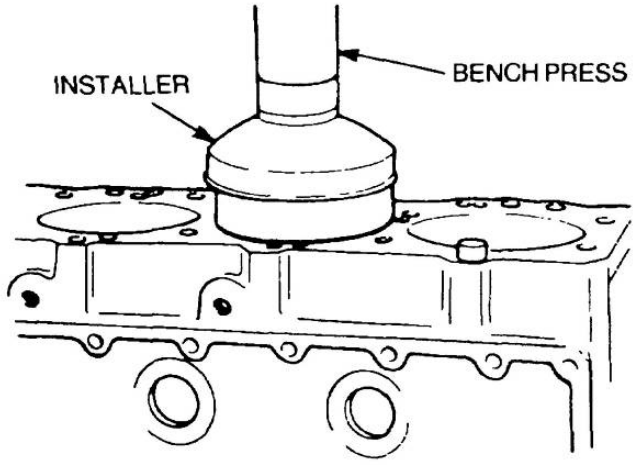


Figure 37 Installing the Cylinder Liners

b. After installing the cylinder liners, verify that each liner is protruding 0.03 to 0.10 mm (0.0012 to 0.0039 in) above the engine block deck and that the variation of the amount of protrusion between the cylinder liners is less than 0.03 mm (0.0012 in). Use a straight edge and a feeler gauge to check the amount of protrusion (Figure 38).

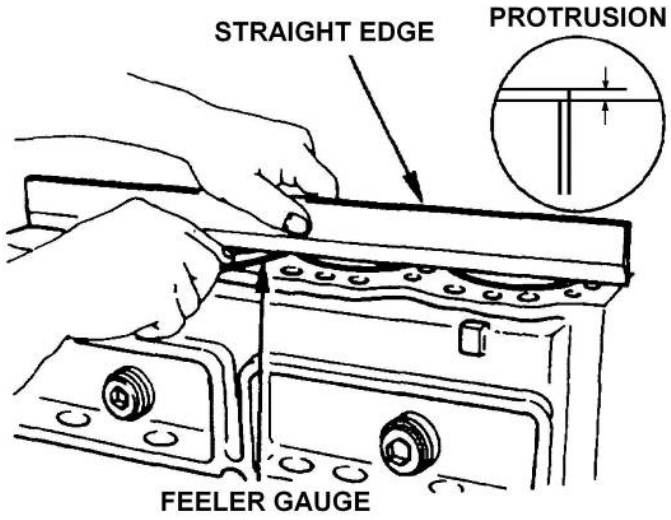


Figure 38 Checking the Cylinder Liner Protrusion

c. If one or more of the cylinder liners exceed the protrusion limit, carefully machine the liners down to the desired dimension. Clean the engine thoroughly to ensure that all metal filings or cuttings are removed.

Camshaft Bearings

22. Camshaft Bearing Removal. Remove the camshaft bearings as follows:

a. Position special tool 9-8523-1818-0 over the camshaft bearing and drive the bearing from the engine block by hitting the end of the special tool with a hammer (Figure 39). Repeat this procedure for each bearing.

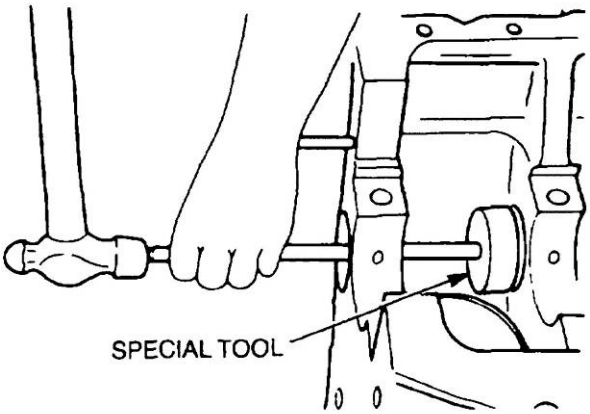


Figure 39 Removal of the Camshaft Bearing

b. Check the bearing bores in the engine block for burrs. Remove any burrs with a scraper or fine file and clean the bores ensuring that all metal filings are removed.

c. Check the camshaft bearing oil galleries for blockage and clear as necessary.

23. Camshaft Bearing Installation. Install the camshaft bearings as follows:

NOTE

The Number one camshaft bearing (timing case end) has two oil holes, while the other bearings have only one.

a. Position the new bearing over the bearing bore and align the oil hole with the port in the bearing bore. Using special tool 9-8523-1818-0 and the hammer, install the bearing. Ensure that the oil hole and the port are aligned. Repeat this procedure with the other bearings.

24. Engine Reassembly. Reassemble the engine as follows:

a. Position the engine block on a universal engine overhaul stand and secure the engine block to the stand.

b. Using special tool 9-8522-0033-0 and a hammer, install the drive gear onto the crankshaft (Figure 40). Install the main bearing shells and the main bearing caps into the engine block.

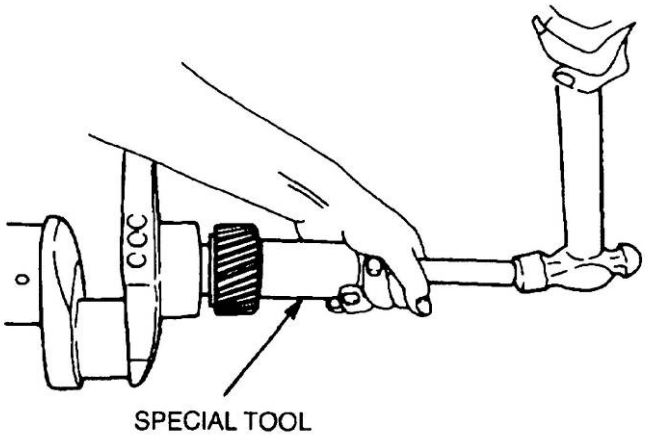


Figure 40 Installing the Drive Gear

c. Liberally coat the bearings with clean engine oil and position the crankshaft over the bearings in the engine block.

d. Install a new thrust bearing on the timing case side of the centre main bearing, with the oil grooves against the rotating face of the crankshaft.

e. Install the main bearing caps ensuring that each cap is correctly located in relation to the number placed on the cap during disassembly.

f. Smear the threads, shaft and head of the bearing cap retaining bolts with clean engine oil.

g. Install and torque the bolts to 225 to 245 N.m (166 to 181 lbf.ft) in the sequence shown (Figure 41), while tapping the bearing cap from side to side to centralize and seat the bearing correctly.

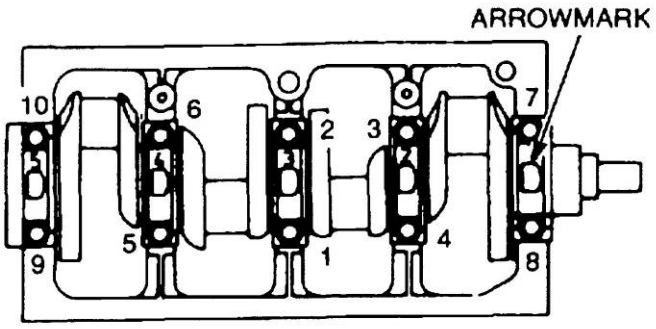


Figure 41 Crankshaft Bearing Bolt Tightening Sequence

h. Ensure that the crankshaft revolves freely without binding.

i. Position the timing case to engine block gasket on the back of the timing case and insert two retaining bolts through the timing case to hold the gasket in position.

j. Locate the timing case on the front of the engine block and screw in two retaining bolts. Install the four remaining bolts and torque all six bolts to 21 to 30 N.m (15 to 22 lbf.ft).

k. Lubricate the camshaft followers and each of the bores with clean engine oil. Position the camshaft followers in their corresponding bores and ensure that each follower moves freely within the bore. Secure each of the followers in the fully raised position using a suitable clip or tape.

l. Ensure that the camshaft bearings in the engine block are clean and lubricate each bearing with a liberal amount of clean engine oil.

m. Carefully install the camshaft ensuring that the lobes are not dragged across the bearings. Install and torque the thrust plate retaining bolts (Figure 42) to 21 to 30 N.m (15 to 22 lbf.ft).

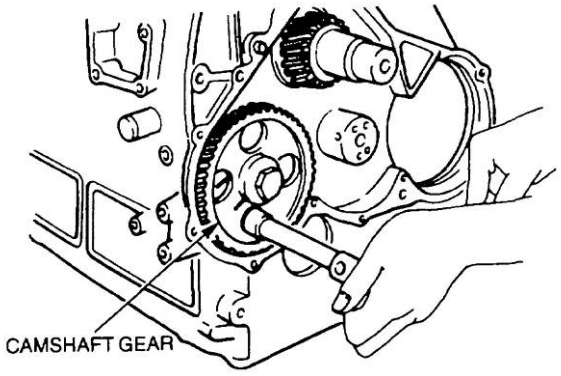


Figure 42 Installing the Camshaft

n. Invert the engine so that the engine block deck is uppermost.

WARNING

Use suitable personal protection equipment and mechanical aids to prevent personal injury when handling pistons heated to 60 degrees C. Burns will result in handling heated pistons without wearing personal protection equipment.

NOTE

Heating the pistons will facilitate installation of the gudgeon pin.

o. Place the pistons in a suitable heating device and heat them to approximately 60 degrees C to facilitate fitting the gudgeon pins.

p. Using suitable personal protection equipment and mechanical aids, position a piston over the small end of a connecting rod ensuring that both the piston and connecting rod are matched with their respective cylinder. Ensure the match marks on the connecting rod (Figure 43) are positioned towards the camshaft and the Front Mark on the piston is positioned toward the front of the engine block (Figure 44).

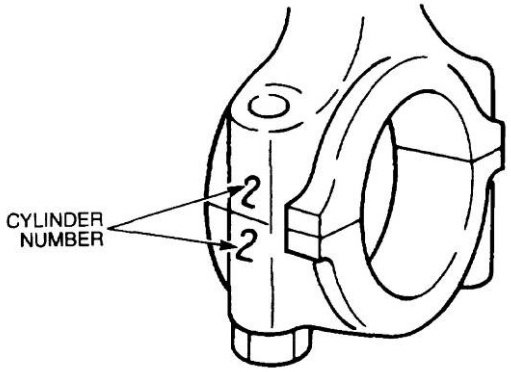


Figure 43 Connecting Rod Match Mark Location

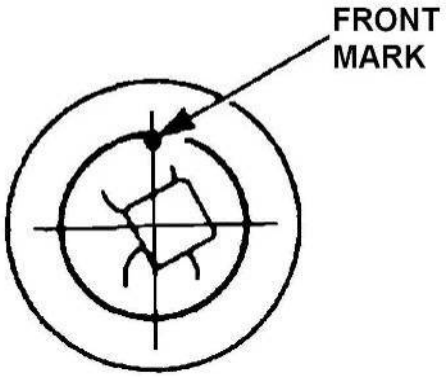


Figure 44 Piston Front Mark Location

q. Align the gudgeon pin holes in the piston and connecting rod. Coat the outer surface of the gudgeon pin with clean engine oil and push the gudgeon pin into position in the piston and connecting rod. Install the gudgeon pin retaining snap-rings into the grooves in the piston (Figure 45) ensuring that the snap-rings are correctly seated. Repeat the procedure for each piston and connecting rod set.

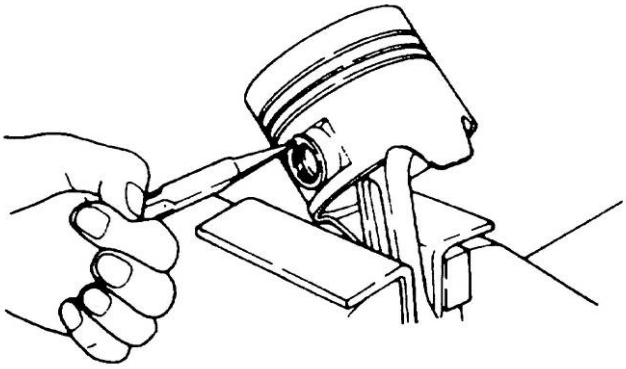


Figure 45 Installing the Snap-rings

r. Repeat the procedure detailed in sub-paragraphs p to q for each piston and connecting rod set.

s. Check the piston ring gap by installing the piston rings in the cylinders and measuring the gap with feeler gauges (Figure 46). Refer to Table 7 for the correct ring gap limits.

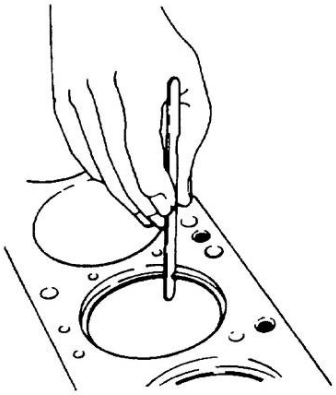


Figure 46 Checking the Piston Ring Gap

Table 7 Piston Ring Gap Clearance

Piston Ring	Standard mm (in)	Limit mm (in)
First compression	0.25 to 0.45 (0.010 to 0.018)	1.5 (0.059)
Second compression	0.2 to 0.4 (0.008 to 0.016)	1.5 (0.059)
Oil	0.2 to 0.4 (0.008 to 0.016)	1.5 (0.059)

t. If the piston ring gap is insufficient, clamp the piston ring securely in a soft-jawed vice and carefully file the end of the ring with a suitable fine file. Ensure that only a small portion of the ring end is protruding above the vice jaws to prevent ring distortion and/or breakage. Check the ring gap regularly to ensure that the tolerance is not exceeded.

u. Once the piston rings are correctly sized, install the rings onto each piston with the aid of a piston ring installer. Ensure that the first and second compression rings are installed with the face marked NPR or TOP uppermost, and the ring gaps positioned as shown (Figure 47).

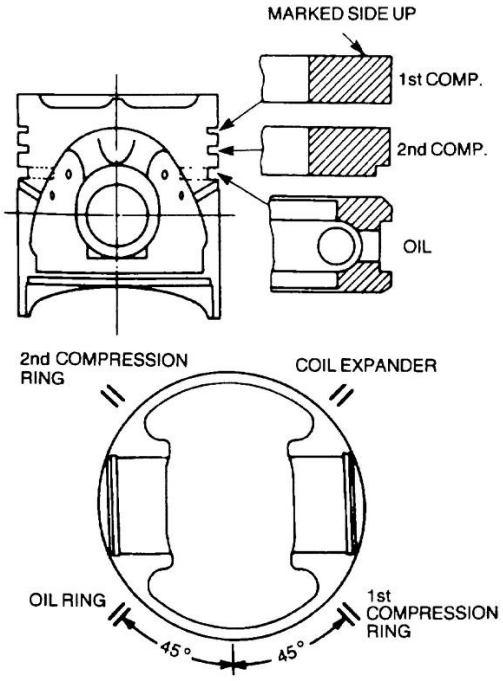


Figure 47 Installing the Piston Rings

v. Lubricate the piston rings, piston skirt and the connecting rod big-end bearing with a liberal amount of clean engine oil.

NOTE

Ensure that the piston and connecting rod assembly is correctly orientated.

w. Install a ring compressor, special tool 9-8522-1251-0, over the piston and compress the piston rings. Remove the connecting rod bearing cap (if not previously removed), lubricate both halves of the connecting rod bearing with clean engine oil and install the piston and connecting rod assembly into its respective cylinder. Ensure that the Front Mark on the piston is positioned toward the front of the engine block.

x. Guide the connecting rod big-end bearing over the connecting rod journal on the crankshaft while pushing the piston into the cylinder. Install the remaining pistons in the same manner.

y. Install the remaining pistons by repeating the procedure detailed in sub-para v to x.

z. Position the engine on its side.

aa. Lubricate a big-end cap bearing with a liberal amount of clean engine oil. Locating the connecting rod on the crank pin journal, install the big-end bearing cap to the appropriate connecting rod and install the retaining bolts.

bb. Tighten the retaining bolts to 39 N.m (29 lbf.ft), while tapping the bearing cap from side to side to centralise and seat the bearings correctly. Tighten the bolts a further 60 to 90 degrees.

cc. Install the remaining big end bearing caps by repeating the procedure detailed in sub-para z and bb.

dd. Position the engine with the sump face uppermost.

ee. Install the flywheel housing as follows:

(1) Apply a narrow bead of a suitable sealant to the mounting surface of the flywheel housing and install the housing ensuring that it is properly located over the dowel pins. Install the smaller retaining bolts, together with new lock-washers and tighten them to 21 to 30 N.m (15 to 22 lbf.ft).

(2) Install the large retaining bolts, together with new lock-washers and tighten them to 123 to 152 N.m (90 to 112 lbf.ft).

ff. Install the rear crankshaft oil seal (using special tool EYA 3737) as follows:

(1) Clean and inspect the crankshaft oil seal journal for any abrasion or scoring which may have been caused by previous oil seals.

(2) Carefully remove any burrs or rough areas with emery paper or a fine file. Thoroughly clean away any resulting filings or emery paper dust. If wear is greater than 0.1 mm deep or wide, fill the damaged area with Loctite 3805 to prevent oil seeping under the seal.

CAUTION

Emery dust or metal filings must not be allowed to enter the engine and must be completely removed before continuing.

(3) Inspect the seal installation, crank plate and push cone and carefully remove any burrs or sharp edges, particularly those on the outer diameter of the crank plate.

CAUTION

Handle the crank plate and push cone carefully during use to avoid causing burrs or sharp edges that may damage the seal during installation and cause early failure.

(4) Fit the crank plate to the crankshaft, with one hole positioned at the dowel pin and the other three holes aligned with the flywheel bolt holes (Figure 48). Secure the crank plate with the short screws ensuring the screws are evenly tightened.

Figure 48 Crank Plate Secured to the Crankshaft

NOTE

Before installation, apply only clean engine oil to the outside surface of the new type of seal. Do not apply any type of sealant in an attempt to improve the sealing between the housing and the outer surface of the new seal.

(5) Lubricate the outside surface of the seal with clean engine oil and do not apply any type of sealant in an attempt to improve the sealing between the housing and the outer surface of the seal.

(6) Position the seal over the crank plate so that the part number stamped on the flange of the green inner sleeve is visible. Push the seal, by hand, along the crank guide until it contacts the crankshaft (Figure 49).

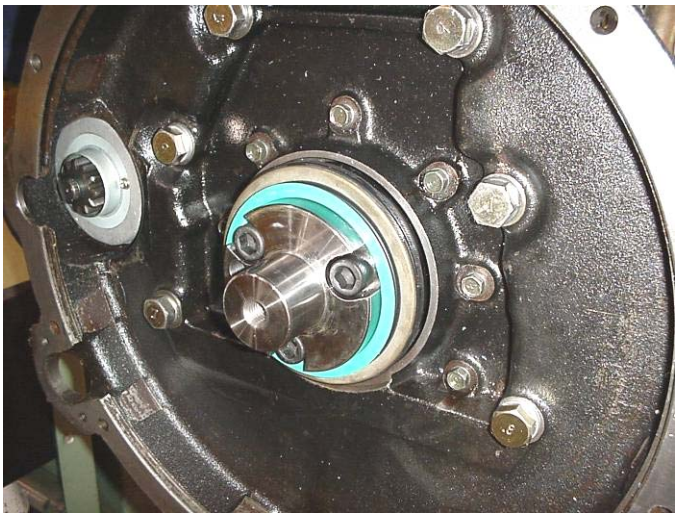


Figure 49 Rear Crankshaft Oil Seal Located on the Crank Plate Ready for Installation

(7) Position the push cone over the crank plate, locate it onto the seal and then engage the long screw into the crank plate (Figure 50).

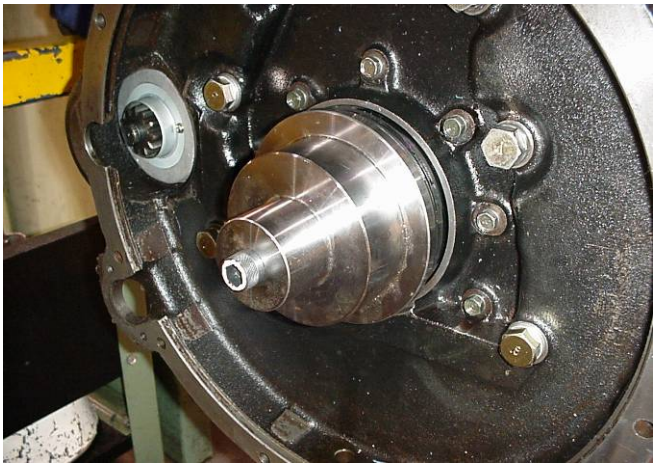


Figure 50 Push Cone Located on Crank Plate and Against Seal

CAUTION

To prevent the rubber seal from creeping back and to ensure the seal remains in the correct position during service, the push cone must be left tight against the seal for at least two minutes.

(8) Rotate the screw to push the seal into its housing, until hard resistance is felt. Leave the push cone in place for at least two minutes before loosening the screw.

NOTE

The presence of green bore sealant after the seal has been installed does not indicate there is a fault with the newly installed seal.

(9) Remove the push cone and crank guide and clean away any green bore sealant that may have been forced from inside the seal.

NOTE

The inner green flange on the seal will stand proud of the housing after installation.

(10) The inner green flange on the seal will stand proud of the housing after installation. This is intentional and no attempt should be made to alter the position of the seal as it is preset by the step on the push cone tool.

(11) Clean away any excess engine oil from the general area.

gg. Install the oil pump drive pinion, together with a new thrust bearing, into the engine block. Install and securely tighten the thrust bearing locating grub screw. Position a new gasket on the cover and install the cover. Install the two retaining bolts and tighten them securely.

hh. Pour clean engine oil into the oil pump intake to prime the oil pump, position the oil pump on the engine block ensuring that the drive shaft is properly engaged with the drive pinion. Install the two retaining bolts and torque them to 42 to 62 N.m (31 to 46 lbf.ft).

ii. Install the two bolts that secure the oil feed pipe to the engine block and tighten them securely.

jj. Fit new sealing sleeves to the oil pan retaining bolts and studs.

kk. Position a new gasket on the bottom of the engine block, place the oil pan over the gasket

ll. Position a new gasket and the supporting plates over the rim of the oil pan. Install the retaining bolts and nuts and torque them to 10 to 20 N.m (8 to 15 lbf.ft).

mm. Install a new sealing washer onto the drain plug and install and securely tighten the drain plug.

nn. Invert the engine.

oo. Install new expansion plugs into their appropriate positions on the engine block, (e.g. water jacket and camshaft rear bearing bore).

pp. Install the threaded plugs into the oil galleries ensuring that the plugs are tightened securely.

qq. Install the crankshaft extension, complete with a new spigot bush, into the crankshaft.

rr. Install the flywheel locating dowel pin if it was previously removed.

ss. Position the flywheel on the crankshaft, lock the flywheel to prevent it from turning, smear the threads of the retaining bolts with engine oil and install the bolts. Torque the bolts, in the sequence shown (Figure 51), to 142 to 172 N.m (105 to 127 lbf.ft).

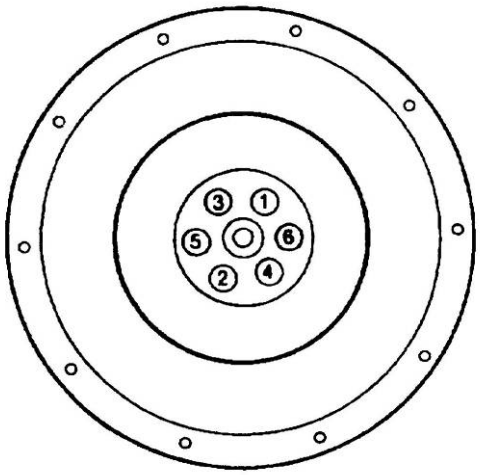


Figure 51 Flywheel Bolt - Tightening Sequence

tt. Position the clutch plate on the flywheel and install special tool 18G79 to hold the clutch plate in position. Install the pressure plate ensuring the dowel pins in the flywheel align with the respective holes in the pressure plate. Install the twelve retaining bolts and alternately tighten each of the bolts to prevent distortion of the pressure plate. Torque the bolts to 16 N.m (12 lbf.ft), remove the clutch aligning tool and the flywheel locking device.

uu. Install the idle gear shaft using the thrust collar retaining bolts as a guide and ensure that the oil port is facing toward the camshaft.

vv. Rotate the crankshaft to bring Number one cylinder onto Top Dead Centre (TDC), which also brings the timing mark on the gear toward the idle gear shaft. Rotate the camshaft to bring the timing mark on the gear toward the idle gear shaft (Figure 52).

ww. Lubricate the idle gear and the idle gear shaft with clean engine oil. Install the gear onto the idle shaft aligning the timing marks on the idle gear with the timing marks on both the crankshaft and camshaft gears (Figure 52). If necessary, remove the idle gear and rotate the camshaft to align the timing marks.

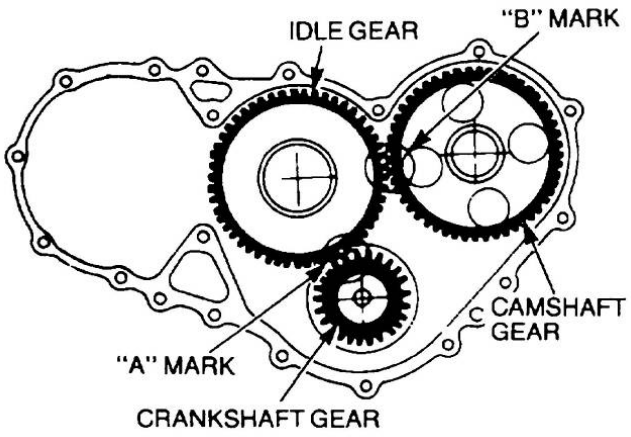


Figure 52 Aligning the Idle Gear Timing Marks

xx. Remove the thrust collar bolts and install the thrust collar with the chamfer away from the gear. Install and torque the bolts to 42 to 62 N.m (31 to 45 lbf.ft).

yy. Position a new gasket on the oil cooler cover and position the oil cooler on the engine block. Install and torque the retaining bolts to 21 to 30 N.m (15 to 22 lbf.ft) in the sequence shown (Figure 53).

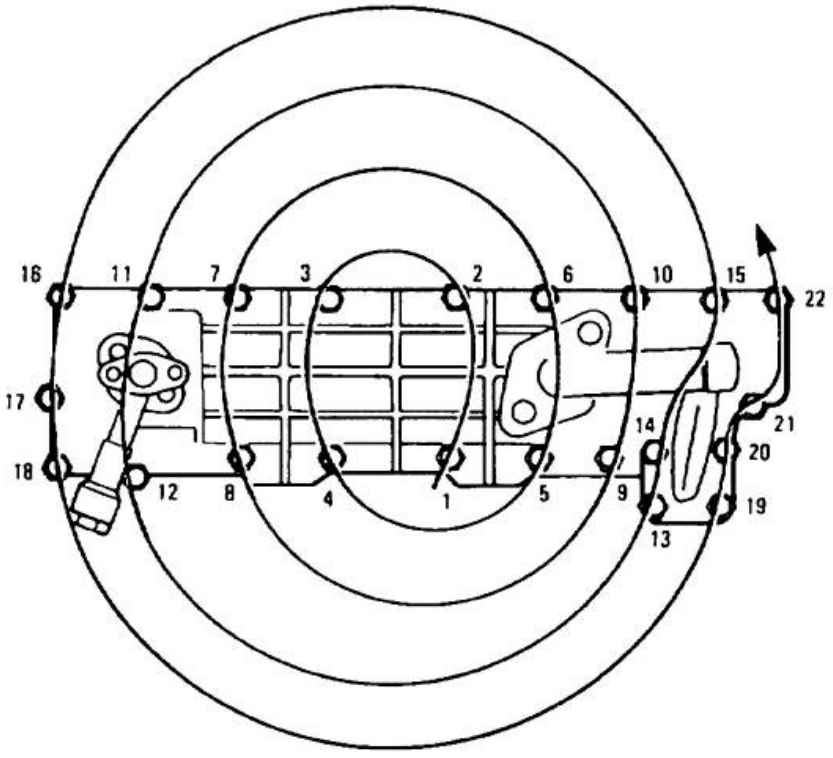


Figure 53 Oil Cooler – Bolt Tightening Sequence

zz. Place new gaskets on the side cover plates (if necessary use a suitable sealant to hold the gaskets in position). Position the cover plates on the engine block ensuring that the plate with the engine breather outlet is positioned to the rear of the engine (Figure 54). Install the retaining bolts and torque them to 16 to 25 N.m (12 to 19 lbf.ft).

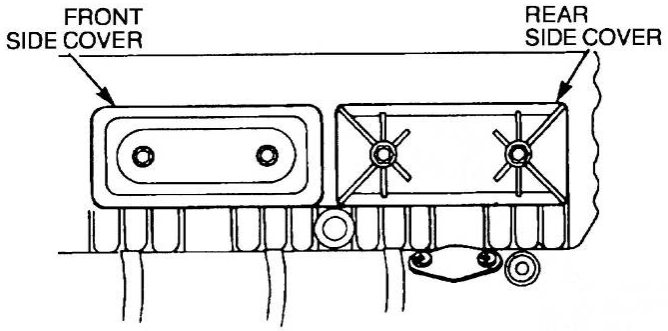


Figure 54 Installation of the Side Cover

aaa. Position the injection pump on the engine and align the timing mark on the pump drive gear with the mark on the idle gear. Install the seven injection pump-to-timing case retaining bolts, together with new lock-washers, but do not tighten them at this stage.

bbb. Install the injection pump rear mounting bracket over the injection pump mounting adapter and onto the engine block. Install the nut and the two retaining bolts together with new lock-washers (Figure 55). Torque the injection pump-to-timing case retaining bolts to 21 to 30 N.m (15 to 22 lbf.ft). Torque the adapter-to-mounting bracket retaining nut and the two bracket retaining bolts to 21 to 30 N.m (15 to 22 lbf.ft).

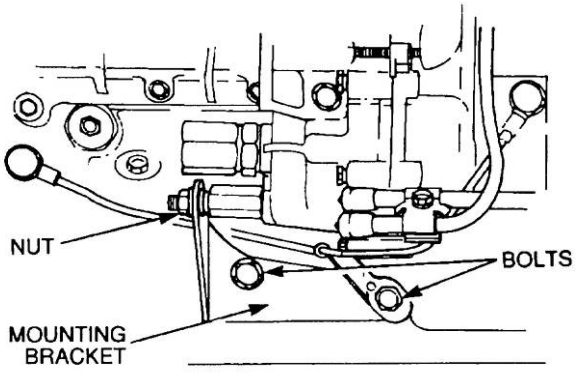


Figure 55 Installing the Injection Pump Rear Mounting Bracket

ccc. Install the injection pump oil feed pipe adapter onto the engine and tighten it securely. Connect the oil feed pipe to the adapter and tighten the pipe connector securely.

ddd. Ensure that the timing marks are aligned (Figure 56), lock the flywheel to prevent it from turning and torque the camshaft drive gear retaining bolt to 123 to 152 N.m (90 to 112 lbf.ft).

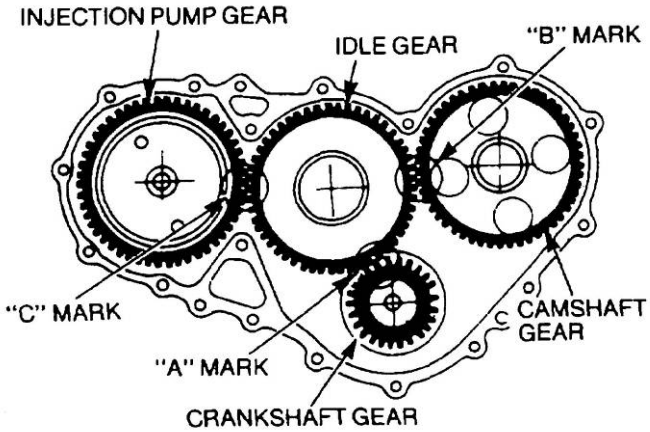


Figure 56 Aligning the Gear Timing Marks

eee. Using special tool 18GA092 and a hammer, install a new oil seal into the timing cover (Figure 57). Smear the sealing lip with rubber grease and position a new gasket on the timing cover using the timing cover retaining bolts to hold the gasket in place. Install the timing cover ensuring that the gasket is correctly aligned and the sealing lip on the seal is not distorted.

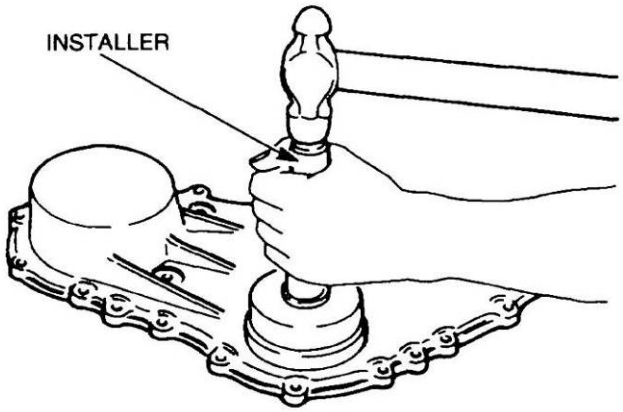


Figure 57 Installing the Timing Case Oil Seal

fff. Install the retaining bolts and torque them to 21 to 30 N.m (15 to 22 lbf.ft).

ggg. Install the two Woodruff keys onto the crankshaft and the dust thrower onto the back of the crankshaft pulley. Smear the seal rubbing surface on the crankshaft pulley with rubber grease.

hhh. Position the pulley over the end of the crankshaft, align the keyway with the keys and push the pulley onto the crankshaft. Install the retaining nut and washer and torque the nut to 382 to 480 N.m (282 to 354 1bf.ft). Remove the flywheel locking device.

NOTE

iii. Apply a suitable sealant to the gasket prior to installing the water pump.Position the water pump, together with a new gasket, onto the engine block. Install the retaining bolts and torque them to 42 to 62 N.m (31 to 45 1bf.ft).

jjj. Position the oil filter adapter, together with a gasket, on the engine block. Install and torque the four retaining bolts to 42 to 62 N.m (31 to 45 lbf.ft). Apply a film of clean engine oil on the rubber seal and install the filter until the seal contacts the adapter face, tighten the filter a further half a turn by hand only.

kkk. Position the alternator adjusting bracket on the thermostat housing, install the bolt but do not tighten it at this stage.

lll. Position the alternator mounting bracket on the engine, install the two retaining bolts together with new lock-washers, and torque them to 42 to 62 N.m (31 to 45 lbf.ft).

mmm. Position the alternator on the mounting bracket and install the two mounting bolts. Align the alternator adjusting bracket with the adjusting bolt hole on the alternator and install the adjusting bolt (Figure 58). Do not tighten the alternator adjusting and mounting bolts at this stage.

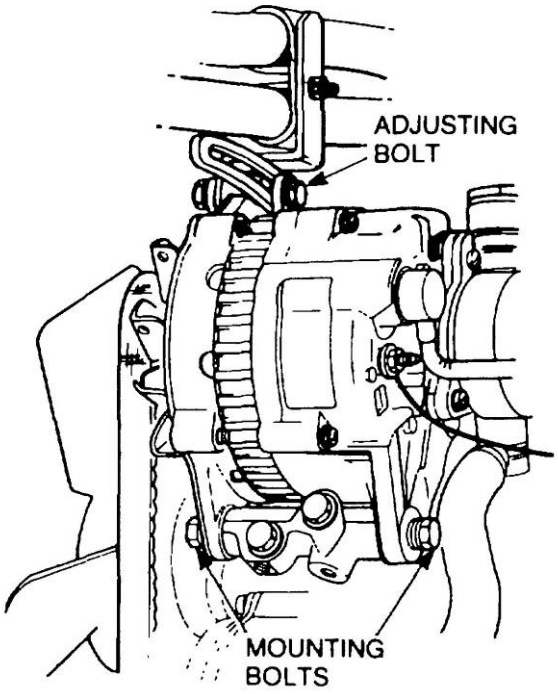


Figure 58 Installing the Alternator and Mounting Bracket

nnn. Install the vacuum pump oil feed and oil return hose adapters onto the engine block. Connect the oil feed and return hoses (Figure 59), ensuring that the hose connections are secure.

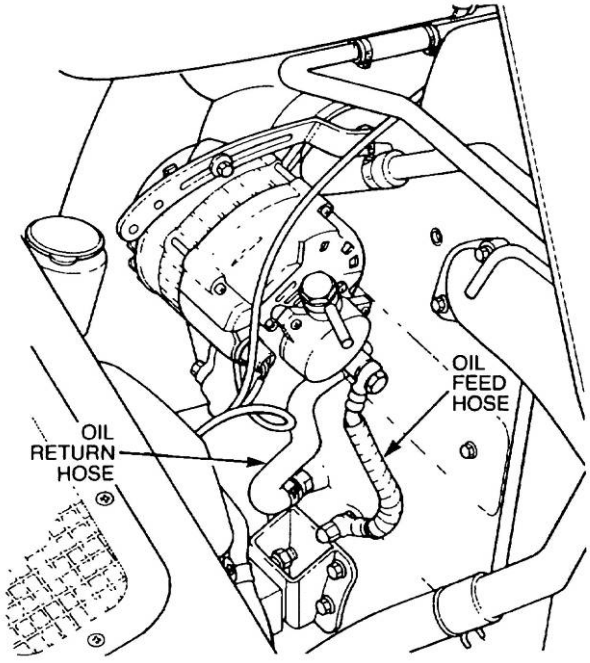


Figure 59 Installing the Vacuum Pump Oil Hoses

ooo. Position the starter motor on the flywheel housing. Install the retaining nuts and bolt and tighten them securely.

NOTE

A screwdriver slot in the top of the locating bolts will facilitate their removal once the cylinder head is in position.

ppp. Position a new cylinder head gasket on the engine block ensuring that the gasket is correctly orientated with the TOP mark facing up and the FRONT mark toward the front of the engine. Use two M 12 x 1.25 bolts, approximately 130 mm long with the bolt head removed to hold the gasket in position and to guide the cylinder head into place.

qqq. Install the dipstick tube into position on the engine block and install the cylinder head in accordance with EMEl Vehicle G 204-1 – Group 1.

rrr. Position the drive pulley, spacer and cooling fan on the water pump drive flange. Align the bolt holes, install and securely tighten the four retaining bolts.

sss. Position the fanbelt over the pulleys and adjust the tension of the fanbelt by moving the alternator outward. Remove the adjusting bolt if additional clearance is required. Check for a belt deflection of 10 to 15 mm between the water pump and the alternator pulleys. When the correct tension is obtained, securely tighten the alternator adjusting bolt and the alternator mounting bolts.

25. Engine Installation. Install the engine as follows:

WARNING

The overhead lifting equipment must have a minimum Safe Working Load (SWL) of 500 kg. Lifting equipment with a lower SWL may fail unexpectedly causing injury to personnel and damage to the equipment.

a. Secure special tool EYA3745 to the overhead lifting equipment.

b. Position the overhead lifting equipment above the engine (Figure 60) and secure the chains to the engine lifting brackets. Take up the weight of the engine with the overhead lifting equipment and remove the engine from the overhaul stand.

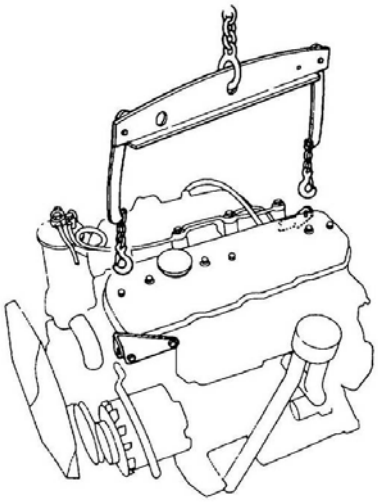


Figure 60 Attaching the Lifting Equipment

c. Position the engine mounting brackets on the engine, install the retaining nuts and bolts and tighten them securely.

CAUTION

During installation of the engine or transmission, DO NOT use the bell housing bolts to pull the assemblies together, if there is a gap evident. This will cause the transmission input bearing retaining plates to bend and allow excess end-float of the main shaft. If the plates are bent the transmission must be removed and returned for overhaul.

d. Install the engine in accordance with EMEl Vehicle G 204-1 – Group 1.

e. Fill the engine with 8.5 litres of clean engine oil. Disconnect the in-line fuse (blue wire) at the stop motor, rendering the stop motor inoperable. Using the starter motor, crank the engine over to circulate oil throughout the engine. Reconnect the fuse, then start and run the engine for several minutes, while checking for oil or coolant leaks.

f. Stop the engine, rectify any leaks and check the oil level. Top-up the engine with clean engine oil as necessary.

g. Road test the vehicle.

26. The engine specifications are detailed in Table 8.

Table 8 Engine Group Specifications

Serial	Item	Specification
	Cylinder head	
1	Distortion	Less than 0.2 mm (0.008 in)
2	Thickness	89.95 to 90.05 mm (3.541 to 3.545 in)
3	Machining limit	89.65 mm (3.530 in)
4	Head to valve depression	1.0 to 2.5 mm (0.039 to 0.098 in)
	Valves	
5	Seat contact width	1.5 to 2.0 mm (0.059 to 0.079 in)
6	Head thickness	Not less than 1.0 mm min. (0.039 in)
7	Seat angle	45°
8	Inlet valve stem diameter	8.88 to 8.961 mm (0.350 to 0.353 in)
9	Exhaust valve stem diameter	8.88 to 8.936 mm (0.350 to 0.352 in)
10	Valve stem wear limit	8.88 mm (0.350 in)
	Valve guides	
11	Inlet valve - clearance	0.039 to 0.2 mm (0.0015 to 0.0079 in)
12	Exhaust valve - clearance	0.064 to 0.25 mm (0.0025 to 0.010 in)
13	Protrusion above cylinder head	13.9 to 14.3 mm (0.547 to 0.563 in)
	Valve springs	
14	Free length - Inner	52.4 mm (2.063 in)
15	Limit	50.0 mm (1.970 in)
16	Free length - Outer	53.65mm (2.112in)
17	Limit	50.65 mm (1.994 in)
18	Inclination limit – Inner and Outer	1.0 mm (0.039 in)
19	Tension - Inner	9.9 kg at 42 mm (21.83 lb at 1.65 in)
20	Tension - Outer	20.0 kg at 44 mm (44.10 lb at 1.73 in)
	Idle gear	
21	End-play - clearance	0.058 to 0.2 mm (0.002 to 0.008 in)
22	Shaft diameter - standard	44.84 to 44.97 mm (1.765 to 1.770 in)
23	Limit	44.84 mm (1.765 in)
24	Shaft to gear clearance - standard	0.009 to 0.060 mm (0.00035 to 0.0024 in)
25	Limit	0.2 mm (0.0079 in)
26	Idle gear tightening torque	42 to 62 N.m (31 to 46 lbf.ft)
	Crankshaft, idle and camshaft gears	
27	Backlash - standard	0.10 to 0.3 mm (0.004 to 0.012 in)

Table 8 Engine Group Specifications (Continued)

Serial	Item	Specification
	Camshaft followers	
28	Diameter - standard	27.92 to 27.98mm (1.100 to 1.1016in)
29	Bore clearance	0.02 to 0.1 mm (0.0008 to 0.0039 in)
	Cylinder liners	
30	Bore l.D. - clearance	102.021 to 102.2 mm (4.0165 to 4.0236 in)
31	Interference fit	0.001 to 0.019 mm (0.00004 to 0.00075 in)
32	Protrusion – above engine block	0.03 to 0.10 mm (0.0012 to 0.0039 in)
33	Maximum variation	0.03 mm (0.0012 in)
	Camshaft	
34	Bearing journal O.D. - standard	55.60 to 55.97 mm (2.189 to 2.2035 in)
35	Run-out (ovality)	0.1 mm (0.0039 in)
36	Bearing journal l.D.	56.0 to 56.03 mm (2.2047 to 2.2059 in)
37	Bearing - clearance	0.03 to 0.15 mm (0.0012 to 0.0059 in)
38	Lobe height - standard	47.7 mm (1.878 in)
39	Wear limit	46.5 mm (1.830 in)
40	Journal to thrust plate - clearance	0.050 to 0.2 mm (0.002 to 0.0079 in)
41	Thrust plate tightening torque	21 to 30 N.m (15 to 22 lbf.ft)
42	Drive Gear tightening torque	123 to 152 N.m (90 to 112 lbf.ft)
	Crankshaft	
43	End-play - clearance	0.15 to 0.45 mm (0.006 to 0.018 in)
44	Main bearing journal O.D. - standard	79.0 to 79.925 mm (3.1102 to 3.1467 in)
45	Main bearing nominal I.D	80.00mm (3.15in)
46	Main bearing to journal - clearance	0.039 to 0.11 mm (0.0015 to 0.0043 in)
47	Con rod bearing journal O.D. - standard	63.0 to 63.944 mm (2.4803 to 2.5174 in)
48	Crankshaft run-out - standard	0.05 mm (0.002 in)
49	Limit	0.30 mm (0.012 in)
50	Flywheel tightening torque	142 to 172 N.m (105 to 127 lbf.ft)
51	Pulley tightening torque	382 to 480 N.m (282 to 354 lbf.ft)
	Main bearings	
52	Tightening torque	225 to 245 N.m (166 to 181 lbf.ft)
53	Bearing spread	85.0 mm (3.35 in)
	Connecting rods	
54	Big-end spread	68.0 mm (2.68 in)
55	Distortion – standard	Less than 0.05 mm (0.002 in) per 100 mm of connecting rod length
56	Limit	0.2 mm (0.0079 in) per 100 mm of connecting rod length
57	Small-end bush – standard	35.017 to 35.025 mm (1.3786 to 1.3789 in)
58	Gudgeon pin - clearance	0.012 to 0.05 mm (0.00047 to 0.002 in)
59	Big-end tightening torque	39 N.m (29 lbf.ft), then turn a further 60 to 90 degrees

Table 8 Engine Group Specifications (Continued)

Serial	Item	Specification
	Gudgeon pins	
60	Diameter - nominal	35.0 mm (1.377 in)
61	Limit	34.95 mm (1.375 in)
	Pistons	
62	Gudgeon pin bore	0.005 mm (0.0002 in) smaller than the diameter of the gudgeon pin
63	Piston to cylinder liner - clearance	0.057 to 0.075 mm (0.0022 to 0.0030 in)
	Piston ring clearance	
64	First compression – standard	0.085 to 0.11 mm (0.0033 to 0.0043 in)
65	Limit	0.2 mm (0.008 in)
66	Second compression – standard	0.030 to 0.055 mm (0.0012 to 0.0022 in)
67	Limit	0.15 mm (0.006 in)
68	Oil – standard	0.030 to 0.07 mm (0.0012 to 0.003 in)
69	Limit	0.15 mm (0.006 in)
	Piston ring gap tolerance	
70	First compression – standard	0.25 to 0.45 mm (0.010 to 0.018 in)
71	Limit	1.5 mm (0.059 in)
72	Second compression – standard	0.2 to 0.4mm (0.008 to 0.016in)
73	Limit	1.5 mm (0.059 in)
74	Oil - standard	0.2 to 0.4 mm (0.008 to 0.016 in)
75	Limit	1.5 mm (0.059 in)
	Engine block	
76	Distortion	Less than 0.2 mm (0.008 in)
77	Machining limit	0.3 mm (0.012 in)
78	Cylinder liner bore	105.001 to 105.010 mm (4.1339 to 4.1342 in)
79	Rear oil seal housing tightening torque	21 to 30 N.m (15 to 22 lbf.ft)
80	Oil pump tightening torque	42 to 62 N.m (31 to 46 lbf.ft)
81	Oil pan (sump) tightening torque	11 to 21 N.m (8 to 15 lbf.ft)
82	Flywheel housing tightening torque	123 to 152 N.m (90 to 112 lbf.ft)
83	Oil cooler tightening torque	21 to 30 N.m (15 to 22 lbf.ft)
84	Side cover plates tightening torque	16 to 25 N.m (12 to 19 lbf.ft)
85	Water pump tightening torque	42 to 62 N.m (31 to 45 lbf.ft)
86	Oil filter adapter tightening torque	42 to 62 N.m (31 to 45 lbf.ft)
87	Alternator mounting bracket tightening torque	42 to 62 N.m (31 to 45 lbf.ft)
88	Timing case tightening torque	21 to 30 N.m (15 to 22 lbf.ft)
89	Timing cover tightening torque	21 to 30 N.m (15 to 22 lbf.ft)
90	Injection pump to timing case tightening torque	21 to 30 N.m (15 to 22 lbf.ft)
91	Injection pump rear mounting tightening torque	21 to 30 N.m (15 to 22 lbf.ft)
	Clutch	
92	Pressure plate tightening torque	16 N.m (12 lbf.ft)

COOLING SYSTEM

Water Pump

27. Disassembly. Disassemble the water pump as follows:

a. Remove the water pump in accordance with EMEl Vehicle G 203 – Group 2.

b. Remove the three screws securing the rear cover to the water pump. Remove the cover and discard the gasket.

c. Using special tool 9-8521-0097-0, remove the impeller from the pump shaft (Figure 61).

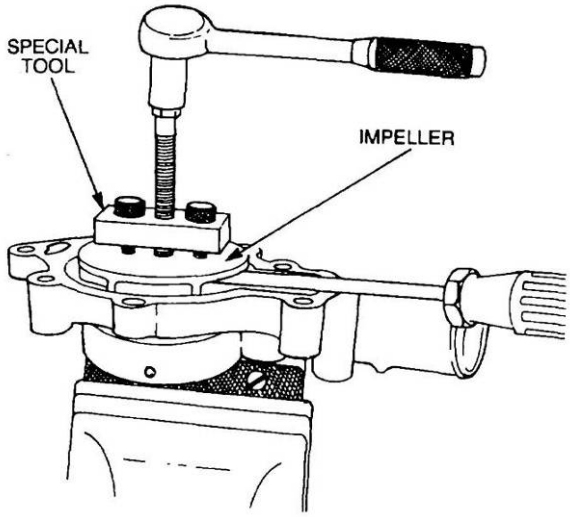


Figure 61 Removal of the Water Pump Impeller

d. Position the pump in a suitable press, press the drive flange from the shaft and remove the dust cover.

e. Remove the circlip from the front of the water pump housing (Figure 62).

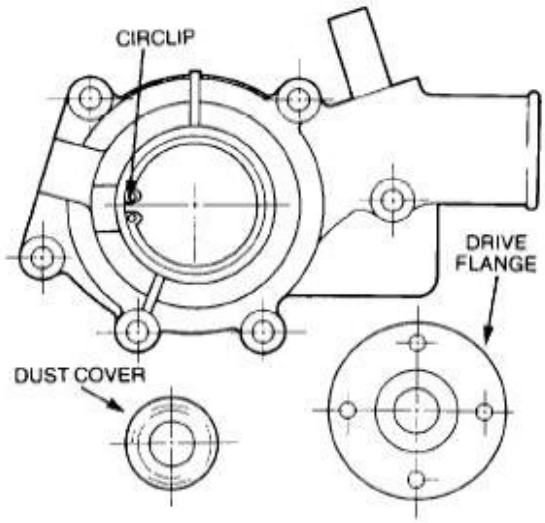


Figure 62 Removal of the Drive Flange

CAUTION

To avoid damaging the water pump housing the shaft must be pressed out from the impeller end of the housing.

f. Using the press, remove the shaft and bearing assembly from the housing.

g. Press out the two seals from the front of the housing and discard the seals.

h. Press the bearings and spacers from the shaft; do not remove the circlip (Figure 63) unless it is damaged.

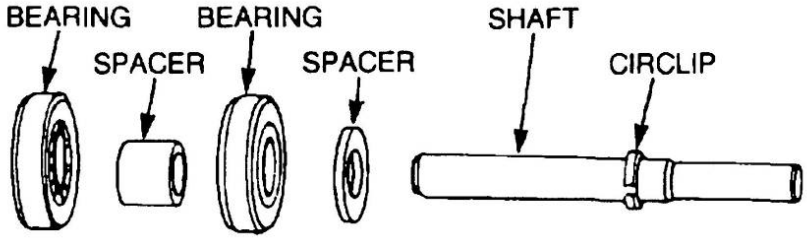


Figure 63 Removal of the Bearings and Spacers

28. Cleaning and Inspection. Clean and inspect the water pump as follows:

WARNING

DO NOT spin the bearings with compressed air as personal injury or damage to the bearings may result.

a. Clean all parts with a recommended cleaning agent and blow them dry with compressed air. Do not blow dry the bearings.

b. Remove all trace of gasket material from the water pump housing, rear cover and the engine block.

c. Check the water pump housing and impeller for cracks, excessive corrosion or damage and replace as necessary.

d. Check the bearings for smooth, noiseless operation. Replace them as necessary.

e. Check the shaft for straightness, excessive wear or damage and replace as necessary.

29. Reassembly. Reassemble the water pump as follows:

a. If the circlip was removed from the shaft during disassembly, fit a new circlip to the shaft.

NOTE

When installing the bearings, ensure that the bearing sealed surfaces face outward.

b. Pack the bearings with grease, in the sequence shown (Figure 63) fit the spacers and bearings to the shaft, use a suitable press for the bearings.

c. Apply liquid gasket to the contact surfaces of the new seals (Figure 64) and press the seals into the housing.

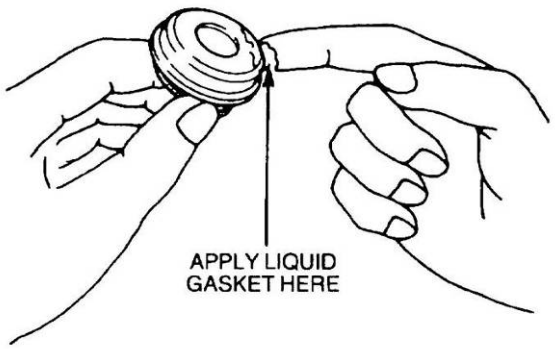


Figure 64 Installation of the Water Pump Housing Seals

d. Install the shaft and bearing assembly from the front of the water pump using the press and special tool 9-8522-1140-0.

e. Install the circlip in the front of the housing to retain the shaft and bearing assembly in position.

f. Position the dust cover on the shaft and press the drive flange onto the shaft.

g. Turn the water pump over and position the impeller on the shaft. Press the impeller onto the shaft until the clearance between the impeller and the pump housing (Figure 65) is 0.3 to 0.8 mm (0.012 to 0.031 in).

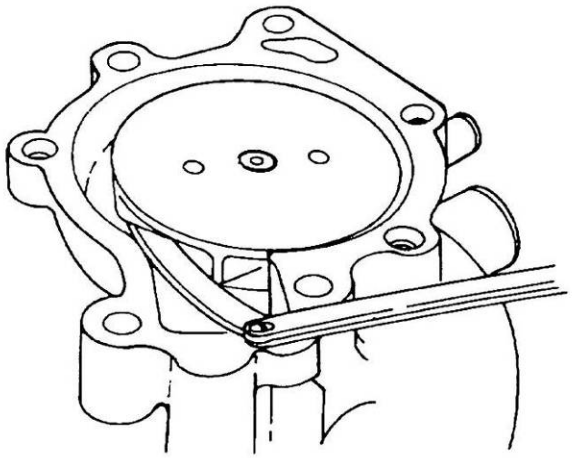


Figure 65 Checking the Impeller Clearance

h. Using a new gasket and a liquid sealer, secure the rear cover to the water pump. Tighten the screws securely.

i. Install the water pump in accordance with EMEl Vehicle G 203 – Group 2.

30. The water pump specification is detailed in Table 9.

Table 9 Water Pump Specifications

Serial	Item	Specification
1	Impeller clearance	0.3 to 0.8 mm (0.012 to 0.031 in)

FUEL

Fuel Injection Pump

31. Disassembly. Disassemble the fuel injection pump as follows:

CAUTION

All work on fuel injection equipment must be carried out in a clean, dust free environment. Dust or dirt could damage the internal components.

a. Remove the fuel injection pump in accordance with EMEl Vehicle G 203 – Group 4.

b. Lock the injection pump drive gear with a suitable locking device. Remove the nut and washer securing the drive gear and timing device to the injection pump camshaft and remove the drive gear and timing device.

c. Remove the four nuts and washers securing the injection pump-to-timing case mounting adapter to the injection pump. Remove the adapter by tapping it lightly with a soft faced hammer.

NOTE

The drive gear and timing device securing nut can be used in place of special tool 157842-4420 to facilitate the rotation of the camshaft.

d. Install the camshaft coupling tool, special tool 157842-4420, (Figure 66) on the camshaft and remove the control lever return spring.

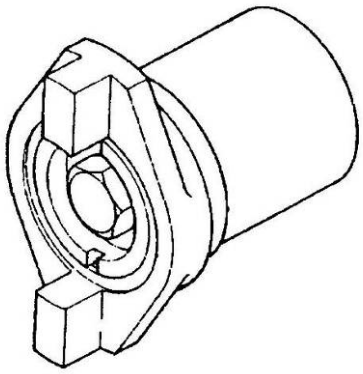


Figure 66 Camshaft Coupling Tool

NOTE

A suitable soft-jawed vice can be utilized in place of the universal vice and bracket assembly.

e. Install the mounting bracket base, special tool 157944-8720, onto the universal vice special tool 157944-8520. Attach the injection pump mounting bracket, special tool 157944-7820, onto the mounting bracket base and secure it with two bolts (Figure 67).

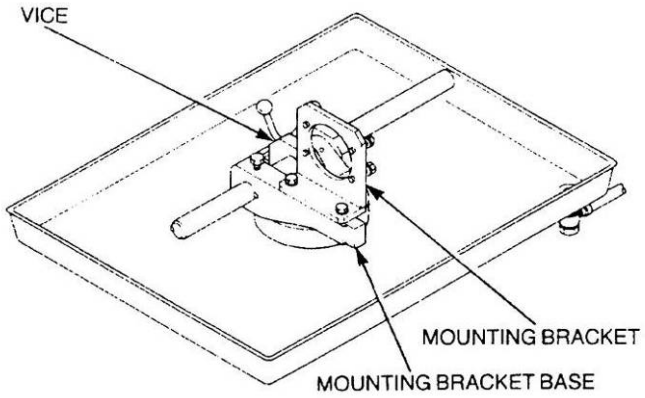


Figure 67 Universal Vice and Bracket Assembly

f. Position the injection pump on the vice and bracket assembly and secure the pump to the bracket using four bolts, tighten the bolts securely. Position the coupling spanner, special tool 157916-5420, onto the camshaft coupling, hold the coupling while tightening the coupling retaining nut with special tool 157914-0100.

g. With the injection pump secured to the vice, remove the three nuts securing the fuel transfer pump to the injection pump and remove the transfer pump.

WARNING

Ensure that the tappet holders (service pins) are properly installed, otherwise personal injury could result.

h. Remove the bolts securing the side cover plate to the injection pump and remove the cover plate. Using special tool 157916-5420, rotate the camshaft until a plunger return spring is compressed (the plunger is at TDC) and install the tappet holder, (special tool 157931-2500), into the hole. Secure the remaining tappets in the same manner.

i. Remove the seven bolts securing the cover to the governor housing and remove the cover by tapping the cover lightly with a soft faced hammer. Discard the gasket.

j. Position special tool 157916-5420 on the camshaft coupling to prevent the camshaft from turning. With special tool 157915-0100 and a lever, (special tool 157910-1120), remove the flyweight locknut (Figure 68).

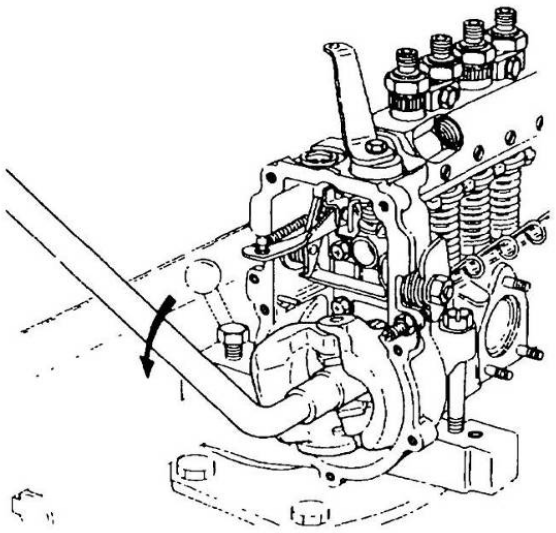


Figure 68 Removing the Flyweight Locknut

k. Position special tool 157926-5110 in the flyweights and remove the flyweights from the camshaft (Figure 69).

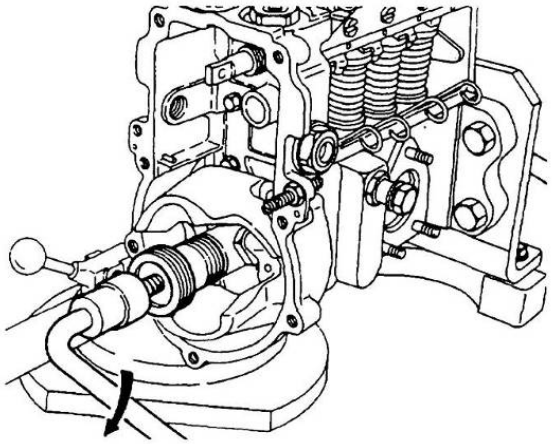


Figure 69 Removing the Flyweights

l. Using long nose pliers remove the start spring from the rack connecting link. Using two spanners (8 and 10 mm), remove the nut from the bolt securing the connecting link to the control rack and remove the connecting link complete with the bolt and plate (Figure 70).

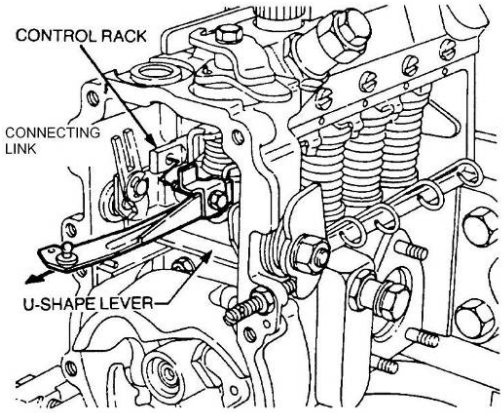


Figure 70 Removal of the Connecting Link

m. Remove the nut and spring washer securing the full-load set lever to the U-shaped lever and carefully remove the full-load set lever and spring. Remove the U-shaped lever pivot plug from the side of the governor housing, remove the U-shaped lever complete with the full-load set lever shaft and the sensor lever.

n. Using a Phillips screwdriver and a 12 mm socket (special tool 157914-2400 and a suitable lever), remove the six bolts, together with the start spring eye, securing the governor housing to the injection pump. With a soft faced hammer, lightly tap the governor housing to separate it from the injection pump.

o. Turn the injection pump on its side, using special tool 157910-1120, remove the four plugs from the base of the pump.

p. Position the pump upright, using special tools 157916-5420, 157914-0100 and 157910-1120, remove the coupling from the camshaft.

q. Rotate the injection pump camshaft until the key at the drive-end of the camshaft faces upward. Remove the key from the camshaft and the four bolts and spring washers securing the front bearing cover to the pump.

r. Tap the governor end of the camshaft with a soft faced hammer to unseat the bearing cover. Using two screwdrivers in the cut-aways provided in the bearing cover, pry the cover off.

s. Remove the camshaft from the drive end of the injection pump.

WARNING

Never place hands (fingers) inside the injection pump camshaft bore while the plunger return springs are held compressed as personal injury could result.

t. Position the injection pump with the plunger return springs uppermost. Install the plunger return spring compression tool 157921-0120. Compress each spring in turn, remove the tappet holders and slowly release the pressure on the springs (Figure 71).

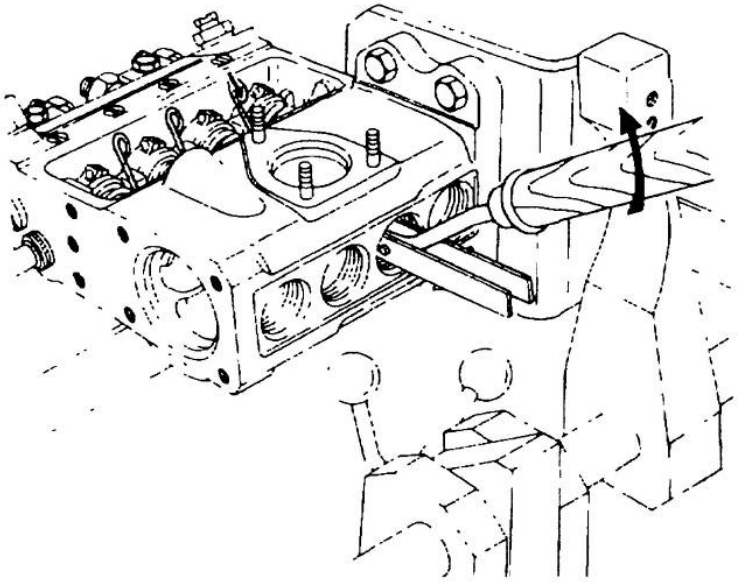


Figure 71 Removing the Tappet Holders

u. Using special tool 157931-6120, remove the tappet assemblies from the injection pump through the camshaft bore (Figure 72).

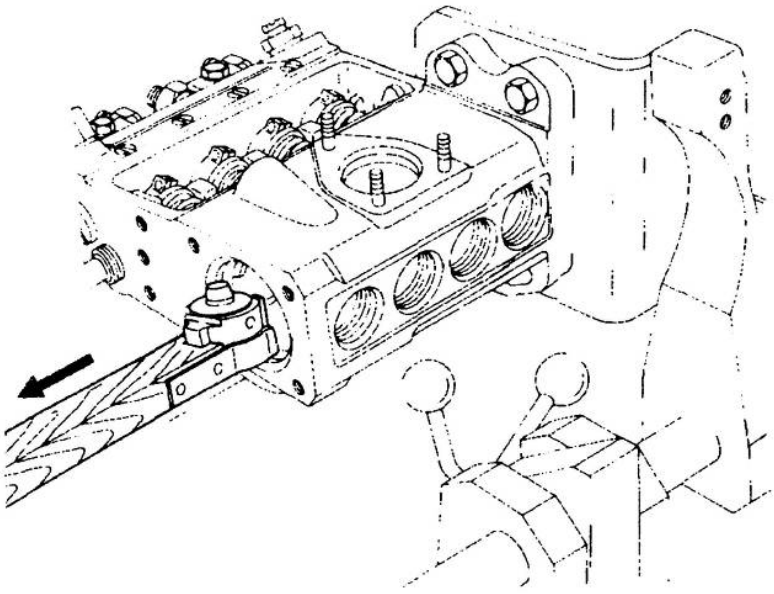


Figure 72 Removing the Tappet Assemblies

v. Using special tool 157921-5620, remove the lower spring seats and plungers through the holes in the base of the pump (Figure 73).

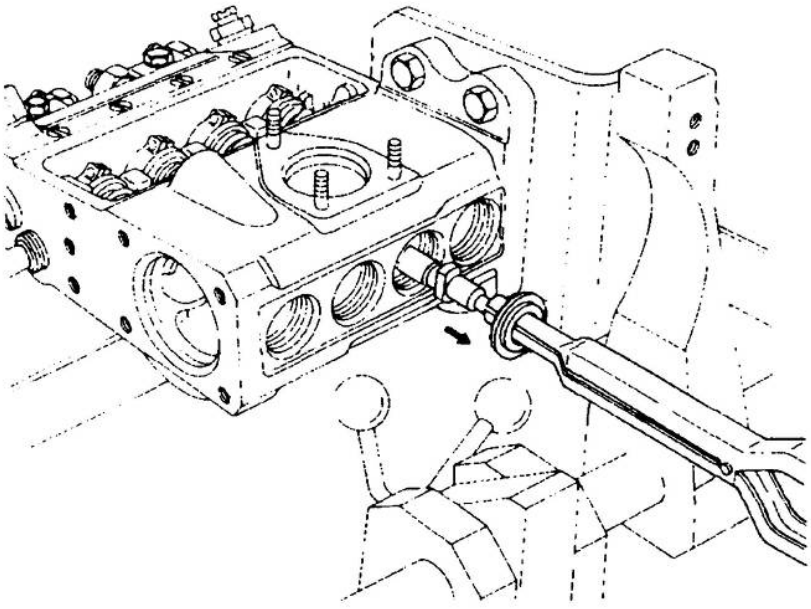


Figure 73 Removing the Spring Seat and Plunger

w. Remove the plunger return springs and the upper spring seats from the injection pump and remove the control sleeves from the barrel assemblies (Figure 74).

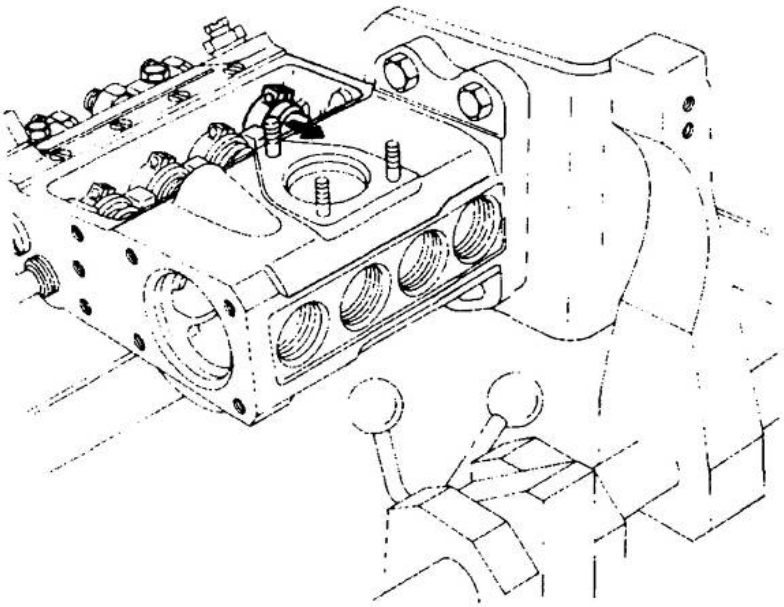


Figure 74 Removing the Control Sleeves

x. Remove the delivery valve holder locking plates and slacken the delivery valve holders using a suitable socket (special tool 157914-0500). Remove the delivery valve holders and the delivery valve springs (Figure 75).

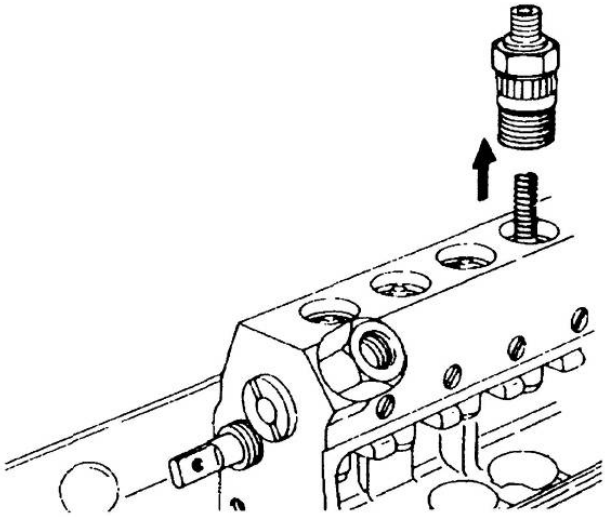


Figure 75 Removing the Delivery Valve Holders and Springs

y. Using a suitable pair of tweezers or tool, remove the delivery valve assemblies and gaskets from the top of the injection pump (Figure 76). Place each delivery valve assembly into clean diesel fuel in their order of removal.

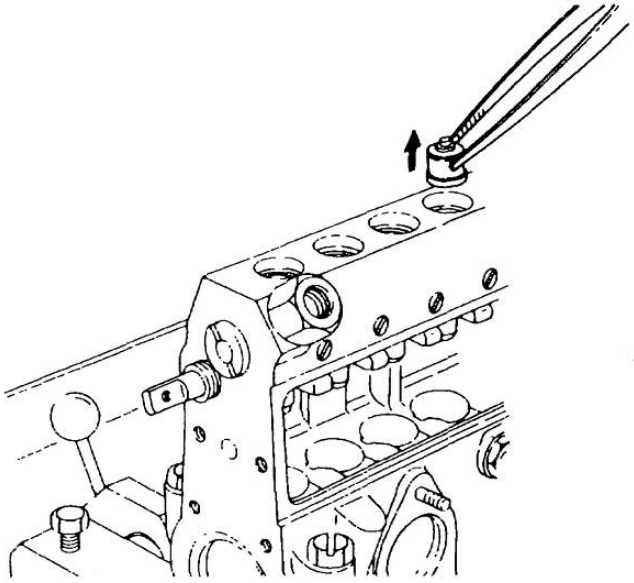


Figure 76 Removing the Delivery Valve Assemblies

CAUTION

The plungers and barrels form a matched pair and should not be intermixed.

z. Remove the plunger barrels from the injection pump and attach them to the corresponding plungers. Place the assemblies in the clean diesel fuel and align them with the corresponding delivery valve assemblies.

aa. Remove the control rack guide screw from the back of the injection pump and carefully withdraw the control rack from the injection pump.

bb. With the aid of a suitable puller, remove the bearing cones from the camshaft and retain the shims and spacers. With the aid of a suitable soft drift and a hammer, remove the bearing cups from the governor housing and the front bearing cover.

32. Cleaning and Inspection. Clean and inspect the fuel injection pump as follows:

a. Wash all parts except the barrel and plunger assemblies and the delivery valve assemblies, with a suitable cleaning agent and blow them dry with clean, moisture free compressed air.

b. Wash the delivery valve assemblies and the barrel and plunger assemblies in clean diesel fuel. Ensure that the matched barrels and plungers are kept together and are aligned with their corresponding delivery valve assemblies.

c. Remove all trace of gasket material from the mating surfaces of covers and housings. Ensure that the camshaft compartment is thoroughly clean and that the oil feed pipe and connections are clean and free from restrictions.

NOTE

Avoid excessive individual handling of the plungers or the barrel as body heat, through convection, can affect the fine tolerances between each barrel and plunger assembly.

d. Inspect each plunger and barrel assembly. Ensure that the helix and the inlet/spill port are not damaged, that neither the plunger nor the barrel are discoloured or scored and that the plunger moves smoothly in the barrel.

e. Lubricate each barrel and plunger assembly in clean diesel fuel. Check that when the assembly is inclined at 60 degrees each plunger slides smoothly into the barrel under its own weight (Figure 77). Rotate the plunger slightly several times and check that each time the plunger slides smoothly into the barrel. Replace the barrel and plunger assembly if the plunger fails to slide smoothly, or if it slides too quickly into the barrel.

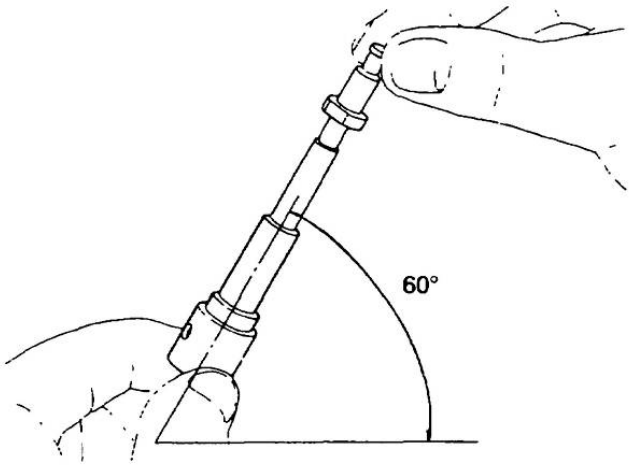


Figure 77 Checking the Plunger for Smooth Operation

f. Inspect the delivery valve and valve seat for nicks, dents or excessive wear. Hold the valve assembly and block off the fuel inlet port with a finger while pushing the valve into the valve body, then release the valve. Pressure of the air compressed in the bore of the valve body should cause the valve to rise when the valve is released. Replace the delivery valve assembly if the valve fails to rise when released or if damage or wear is evident.

g. Check the delivery valve return spring for damaged, broken or weakened coils (loss of tension) and replace it as necessary. Inspect the delivery valve holder for cracks or damage and for a scratched or scored sealing face. Replace the delivery valve holder as necessary.

h. Inspect the control rack bushes in the injection pump body for wear and replace the bushes as necessary. Inspect the control rack for bend, excessive wear on the bush sliding area of the rack and for excessive wear in the gear teeth (when checked with each control pinion). Also check the control pinion locking screw for damage (Figure 78) which may prevent the control pinion from being locked in position. Replace worn or damaged parts as necessary.

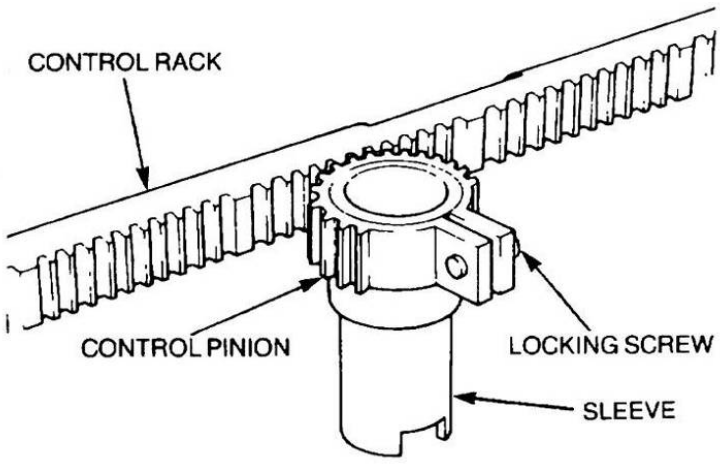


Figure 78 Checking the Control Rack and Pinion

i. Check the camshaft for damaged or worn lobes, damaged threads and key slots. Replace the camshaft if damage or wear is evident.

j. Inspect the camshaft roller bearings for scoring, wear or damage. Ensure that the bearings turn smoothly and freely and are a firm (press) fit onto the camshaft. Replace the bearings as necessary. Check the governor housing and the front bearing cover for evidence of bearing cup rotation. Replace the governor housing and/or the front bearing cover as necessary.

k. Inspect the injection pump housing for signs of cracks or damage, and check the tappet bores for wear, scoring or damage. Replace the injection pump housing if any of these faults are evident.

l. Check the injection pump housing for damaged gasket (mating) surfaces. If necessary, refinish the surfaces and ensure that they are smooth and flat. Check for damaged threads and loose or damaged studs. If necessary, clean the threads with an appropriate tap and replace any damaged stud.

m. Check the tappet rollers, bushes, guides and pins for excessive wear or damage. If wear or damage is apparent, replace the tappet assembly.

n. Inspect the plunger return springs and the upper and lower spring seats for wear or damage. Also check the control sleeves for damage and worn plunger slots. Replace any damaged or worn parts as necessary.

o. Overhaul the transfer pump (Para 42. to 45.).

33. Reassembly. Reassemble the fuel injection pump as follows:

a. Apply clean engine oil to the control rack and the bushes in the injection pump housing and install the control rack into the bushes. Centralize the control rack by aligning the setting marks, on the outer circumference of each end of the control rack, an equal distance from the injection pump housing. Install the control rack guide screw in the back of the injection pump housing and torque it to 4.9 to 6.9 N.m (43 to 61 lbf.in).

b. Install the plunger barrels into their respective bores. Ensure that each barrel is properly seated and try to rotate the barrel by hand. If the barrel can be rotated, the barrel locating pin is not entered far enough into the injection pump housing barrel bore. Remove the affected barrel and with the aid of a suitable drift (pin punch) and hammer, carefully drive the pin into the bore until there is a sufficient amount of the pin to effectively locate the barrel. Install the barrel.

c. Lubricate the delivery valves with clean diesel fuel and install the delivery valves into their respective bores together with new copper gaskets. Ensure that the gasket is installed as shown (Figure 79).

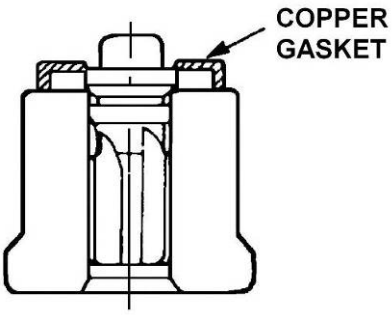


Figure 79 Delivery Valve and Gasket - Sectional View

d. Position the delivery valve springs over the delivery valves and install the delivery valve holders over their respective delivery valve. Tighten the delivery valve holders to a torque of 39 N.m (29 lbf.ft), slacken each holder off, again torque the holders to 39 N.m (29 lbf.ft) and slacken each holder off once more. Finally torque each holder to 44 N.m (32 lbf.ft). Install the delivery valve holder locking plates and torque the retaining bolts to 4.4 to 6.8 N.m (39 to 60 lbf.in).

e. If removed, position the control pinions onto the control sleeves with the slit in the control pinion aligned with one of the plunger slots in the control sleeve. Tighten the locking screws to secure the control pinion in position. Position the injection pump on its side and install the control sleeve assemblies with the slit in the control pinion uppermost.

f. When all control sleeve assemblies are installed, move the control rack back and forth and ensure that the control sleeves rotate equal amounts from the centre position as the control rack is moved in both directions (Figure 80).

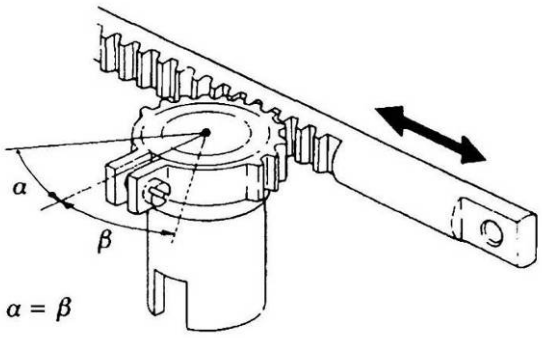


Figure 80 Control Sleeve Setting Position

g. Using a depth gauge or vernier caliper, check that the full stroke of the control rack is 21 mm from the position where the control rack is pushed fully toward the governor to the position where it is pulled fully toward the drive-end of the injection pump. If the stroke of the control rack is not within 21 mm, reposition the control pinions to obtain the correct stroke.

h. Position the upper spring seats over the control sleeves and install the plunger return springs. Assemble the lower spring seats onto their respective plungers and insert special tool 157921-5620 into the base of the spring seat. Dip each plunger into clean diesel fuel, and then carefully install each plunger into its respective barrel ensuring that the plunger helix is facing upward and the identification number is towards the slot in the control sleeve.

i. Lubricate each tappet assembly with clean engine oil and position a new shim, of equivalent thickness to the one removed, on each tappet assembly. Using special tool 157931-6120, position the tappet assemblies in their respective bores, align the tappet guide with the pump housing guide groove and insert the tappet.

WARNING

Never place hands (fingers) inside the injection pump camshaft bore while the plunger return springs are held compressed as personal injury could result.

j. Using special tool 157921-0120, slowly compress each plunger return spring while aligning the plunger control arms with the slots in the control sleeve. When each spring is fully compressed, install the tappet holders. Ensure that each tappet holder is positively installed into the hole in the tappet and slowly release the spring compressor (Figure 81).

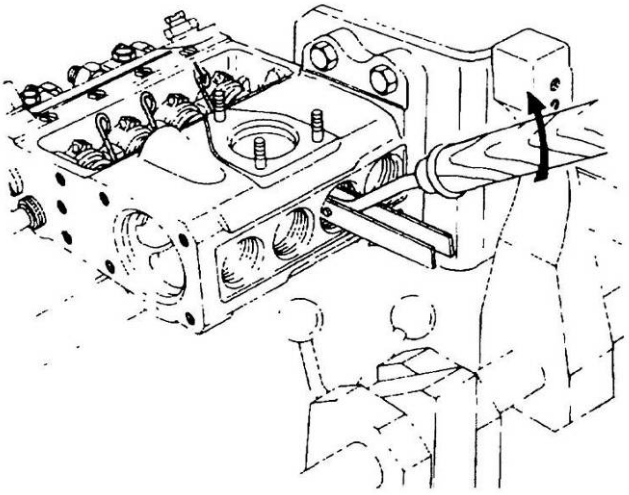


Figure 81 Installation of the Tappet Holders

k. Install the spacers and shims onto the camshaft. Using a suitable arbor and a press, press the bearings on with the tapers facing toward the ends of the camshaft. Ensure that the bearings butt firmly against the shims. Lubricate the bearings and camshaft lobes with clean engine oil. Insert the camshaft into the bore in the injection pump housing with the identification code (Figure 82) on the camshaft toward the front of the injection pump.

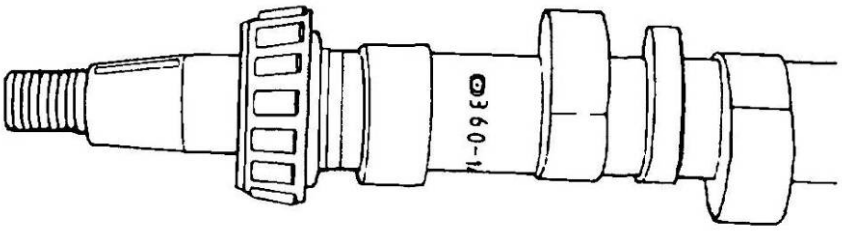


Figure 82 Camshaft Identification Number Location

l. Press the bearing cups into the governor housing and the front bearing cover, then position the governor housing together with a new gasket onto the injection pump. Install the six retaining bolts with new spring washers ensuring that the start spring eye is correctly positioned (Figure 83). Torque the bolts to 6.9 to 8.8 N.m (61 to 78 lbf.in).

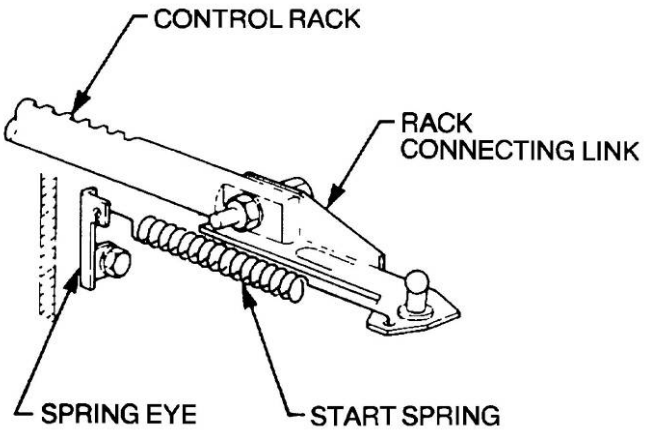


Figure 83 Connecting Link and Start Spring Location

m. Position the front bearing cover onto the front of the injection pump. Install the four retaining bolts together with new spring washers and torque the bolts to 6.9 to 8.8 N.m (61 to 78 lbf.in). Attach a dial indicator to the measuring device (special tool 105782-4200) and install the measuring device onto the drive-end of the camshaft. Pull the camshaft toward the drive-end of the injection pump and zero the dial indicator. Push the camshaft toward the governor housing and check for a reading of 0.03 mm (0.001 in). If the reading is not to specification, remove the camshaft and remove one of the camshaft bearings and the shims. Increase the thickness of the shims to reduce the camshaft end-play, or reduce the thickness of the shims to increase the end-play.

n. Press the bearing onto the camshaft, lubricate the bearing and camshaft lobes and install the camshaft and the bearing cover. Torque the retaining bolts and check the amount of end-play. Repeat this procedure as necessary to obtain the correct end-play, and then remove the measuring device.

o. Install the Woodruff keys onto both ends of the camshaft and install special tool 157842-4420 onto the drive-end of the camshaft. Using special tool 157916-5420, rotate the camshaft and remove the tappet holders as the camshaft lobes make contact with the tappets compressing the plunger return springs. Rotate the camshaft several times to ensure that there is no jamming and that the components operate smoothly.

p. Turn the pump on its side, apply a thin coating of Loctite 271 to the plug threads and install the four plugs into the injection pump base. Tighten the plugs to a torque of 54 to 74 N.m (40 to 55 lbf.ft).

q. Position the U-shaped lever in the governor housing. Apply a suitable liquid adhesive to the U-shaped lever pivot plug and install the pivot plug into the governor housing. Ensure that it is properly engaged with the U-shaped lever and tighten the plug securely. Carefully install the full-load set lever and spring onto the full-load set lever shaft and secure the set lever with the nut and spring washer. Torque the nut to 10 to 14 N.m (88 to 124 lbf.in).

r. Position the control rack connecting link, complete with bolt and plate, onto the control rack. Install the retaining nut and using two spanners (8 and 10 mm) tighten it securely. Install the start spring into the spring eye on the governor housing. With a pair of long-nose pliers, connect the spring to the control rack connecting link.

s. Position the flyweights onto the camshaft in the governor housing. Position the flyweight locknut and new spring washer on the camshaft. Install special tool 157916-5420 onto the camshaft coupling to prevent the camshaft from turning, then with special tool 157915-0100 and lever (special tool 157910-1120), torque the flyweight locknut to 49 to 59 N.m (36 to 43 lbf.ft).

t. Position a new gasket on the governor cover and hold the gasket in position with two of the cover's retaining bolts. Turn the free-end of the floating lever outward and position the governor cover on the governor housing, engaging the free-end of the floating lever with the ball joint on the connecting link. Install the remaining governor cover-to-housing retaining bolts and torque them to 6.9 to 8.8 N.m (61 to 78 lbf.in).

u. Install a new O ring onto the transfer pump flange and install the transfer pump onto the injection pump. Install the three retaining nuts, together with new spring washers, and torque the nuts to 4.9 to 6.9 N.m (43 to 61 lbf.in).

v. Connect special tool 157916-5420 onto the camshaft coupling and rotate the camshaft until the lobe on Number one cylinder raises the tappet. Remove the tappet holder and repeat the procedure for the remaining cylinders.

w. The injection pump is now ready to be timed, pressure tested and calibrated (Para 37., 38. and 39.).

Governor

34. Disassembly. Disassemble the governor as follows:

All work on fuel injection equipment must be carried out in a clean, dust free location. Dust or dirt could damage the internal components.

a. Remove the injection pump in accordance with EME1 Vehicle G 203 – Group 4.

b. Lock the injection pump drive gear with a suitable locking device. Remove the nut and washer securing the drive gear and timing device to the injection pump camshaft and remove the drive gear and timing device.

c. Remove the four nuts and washers securing the injection pump-to-timing case mounting adapter to the injection pump and remove the adapter by tapping it lightly with a soft faced hammer.

NOTE

The drive gear and timing device securing nut can be used in place of special tool 157842-4420 to facilitate the rotation of the camshaft.

d. Install the camshaft coupling tool 157842-4420 (Figure 84) on the camshaft and remove the control lever return spring.

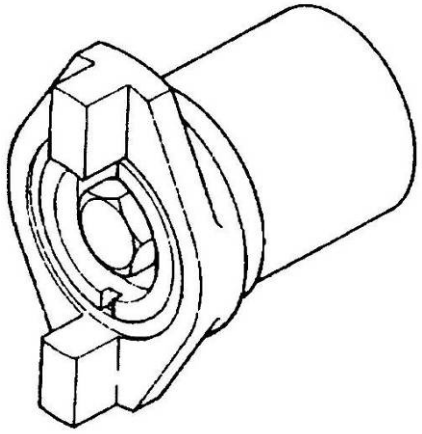


Figure 84 Camshaft Coupling Tool

NOTE

A suitable soft-jawed vice can be utilized in place of the universal vice and bracket assembly.

e. Install mounting bracket base, special tool 157944-8720, onto the universal vice, special tool 157944-8520. Attach the injection pump mounting bracket, special tool 157944-7820, onto the mounting bracket base and secure it with two bolts (Figure 85).

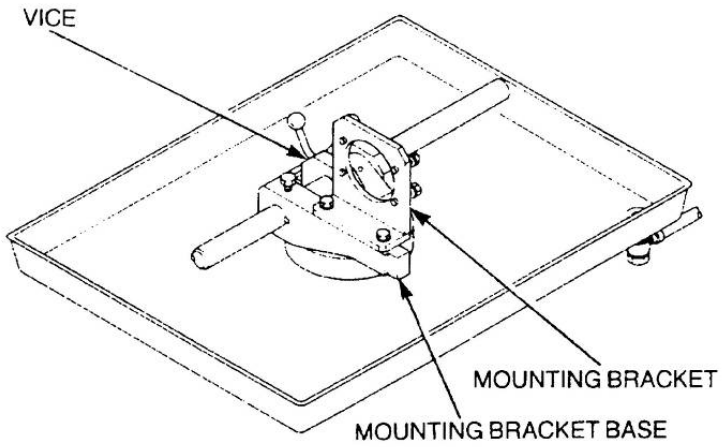


Figure 85 Universal Vice and Bracket Assembly

f. Position the injection pump on the vice and bracket assembly and secure the pump to the bracket using four bolts, tighten the bolts securely. Position the coupling spanner, special tool 157916-5420, onto the camshaft coupling and hold the coupling while tightening the coupling retaining nut with special tool 157914-0100.

g. With the injection pump secure to the vice, remove the three nuts securing the fuel transfer pump to the injection pump and remove the transfer pump.

WARNING

Ensure that the tappet holders (service pins) are properly installed otherwise personal injury could result.

h. Remove the bolts securing the side cover plate to the injection pump and remove the cover plate. Using special tool 157916-5420, rotate the camshaft until a plunger return spring is compressed (the plunger is at TDC), then install the tappet holder (service pin) special tool 157931-2500 into the hole. Secure the remaining tappets in the same manner (Figure 81).

i. Remove the cap-nut and gasket from the governor shaft (Figure 86), with two spanners (13 and 19 mm) remove the two locknuts from the governor shaft and slacken the guide screw locknut (27 mm) with a suitable spanner.

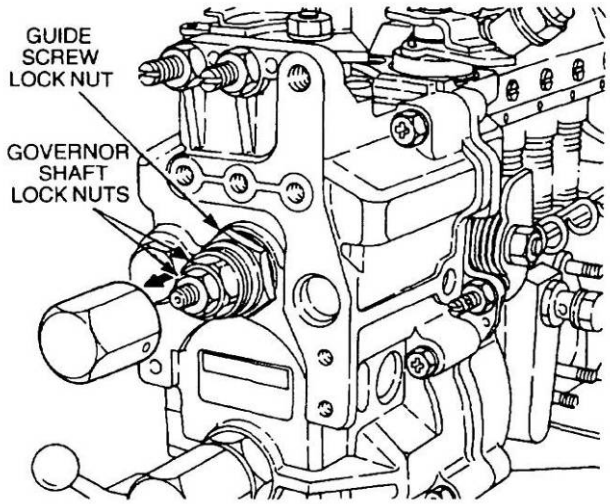


Figure 86 Governor Shaft Cap-nut and Locknuts

j. Remove the plug (19 mm) covering the torque cam rod adjuster (Figure 87).

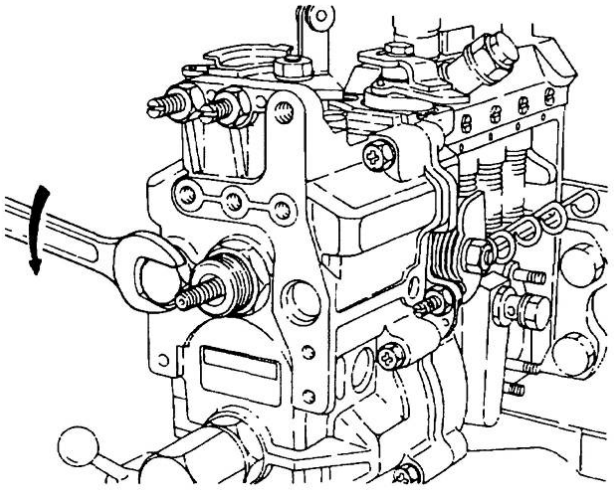


Figure 87 Removal of the Torque Cam Rod Adjuster Plug

k. Remove the cap-nut from the idling spring capsule, then slacken the locknut and remove the idling spring capsule (Figure 88).

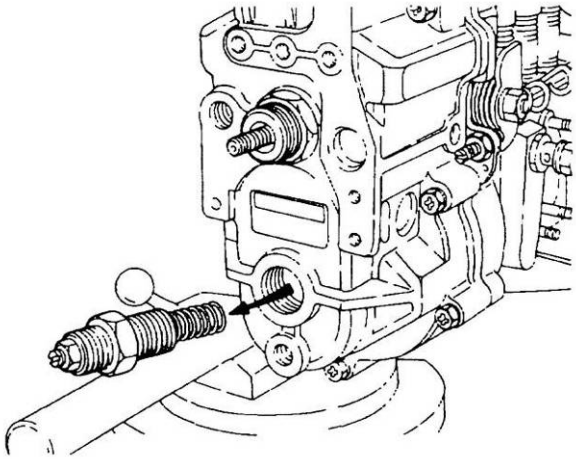


Figure 88 Removal of the Idling Spring Capsule

l. Remove the seven bolts securing the cover to the governor housing and remove the cover by tapping the cover lightly with a soft faced hammer (Figure 89). Discard the gasket.

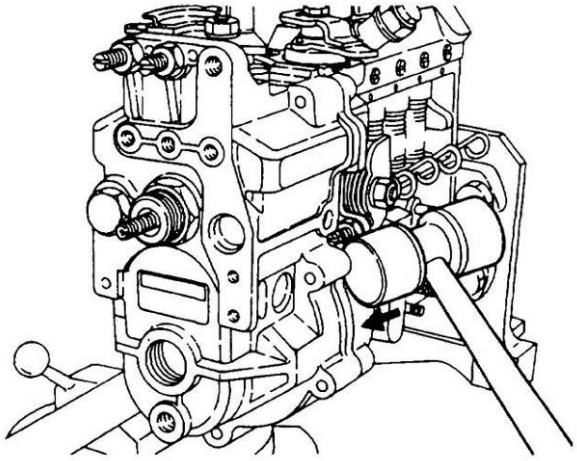


Figure 89 Removal of the Governor Cover

m. Remove the governor shaft, complete with springs and spring seat, from the housing (Figure 90). With a pair of long-nose pliers, disconnect the start spring from the rack connecting link.

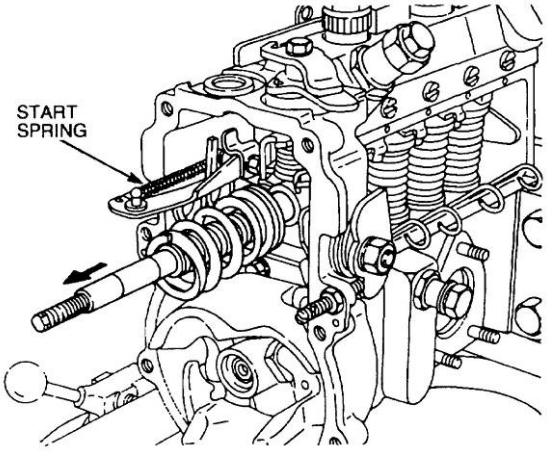


Figure 90 Removing the Governor Shaft and Start Spring

n. Using two spanners (8 and 10 mm), remove the nut securing the connecting link to the control rack, then remove the connecting link, complete with the bolt and plate (Figure 91).

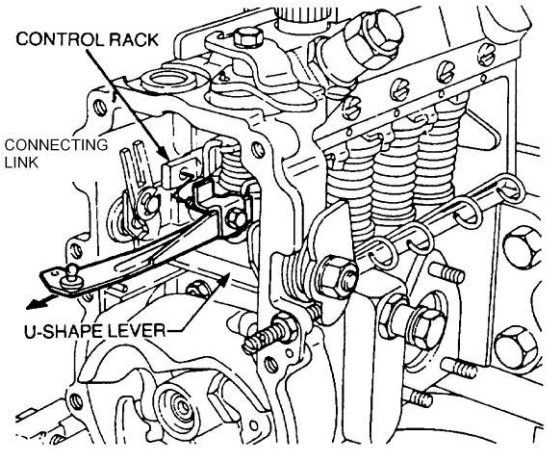


Figure 91 Removal of the Connecting Link

o. Remove the snap-ring securing the sensor lever to the U-shaped lever and remove the sensor lever (Figure 92).

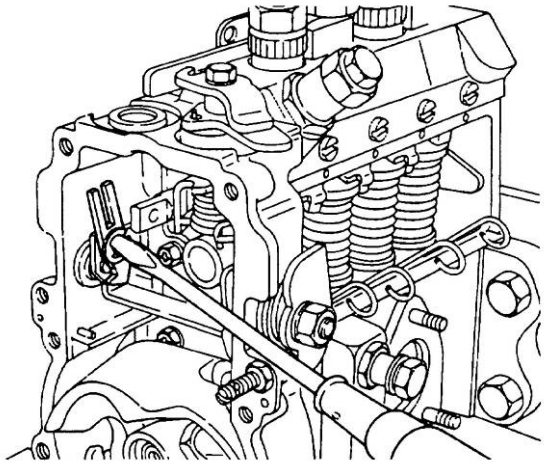


Figure 92 Removal of the Sensor Lever

p. Remove the nut securing the full-load setting lever to the U-shaped lever (Figure 93) and remove the full-load setting lever together with the return spring.

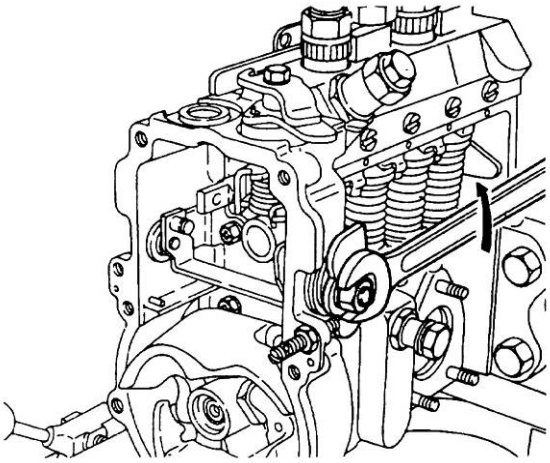


Figure 93 Full-load Setting Lever Retaining Nut

q. Remove the U-shaped lever guide plug from the side of the governor housing. Remove the U-shaped lever and the full-load setting lever shaft and cancel spring (Figure 94).

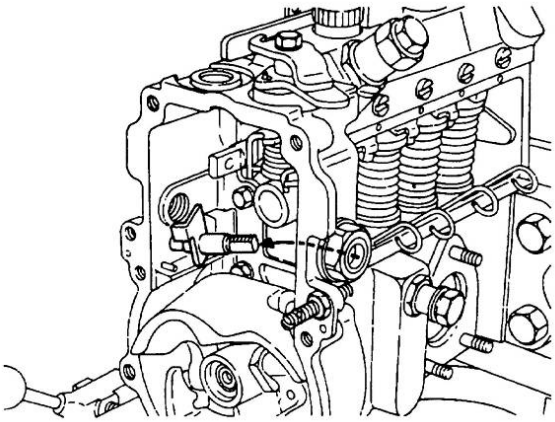


Figure 94 Removal of the Full-load Setting Lever Shaft

r. Remove the bolt securing the stop lever to the stop lever shaft and remove the stop lever, cap, return spring, O ring, shim and shaft from the governor housing (Figure 95).

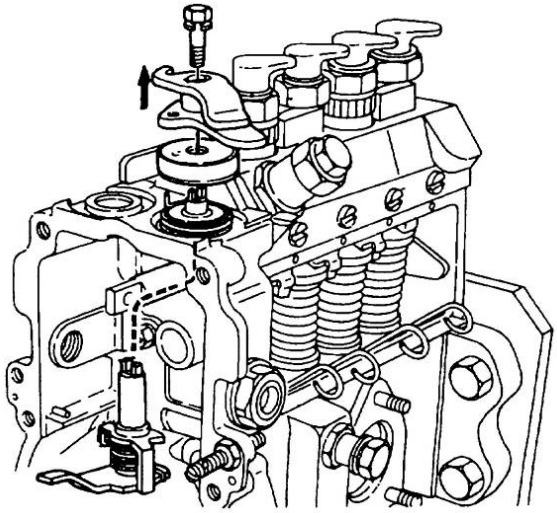


Figure 95 Removing the Stop Lever Assembly

s. Position special tool 157916-5420 on the camshaft coupling to prevent the camshaft from turning. Remove the flyweight retaining nut using special tool 157915-0100 and lever (special tool 157910-1120). Install special tool 157926-5110 into the flyweights and remove the flyweights (Figure 96).

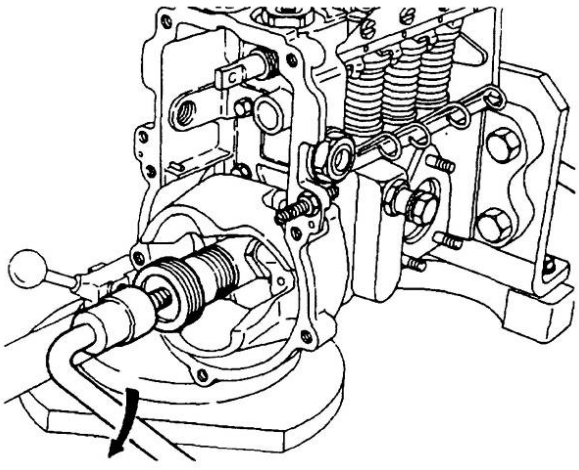


Figure 96 Removal of the Flyweights

t. Using a Phillips screwdriver and a 12 mm socket (special tool 157914-2400), remove the seven bolts and spring eye from the governor housing. Lightly tap the housing with a soft faced hammer to separate the housing from the injection pump (Figure 97).

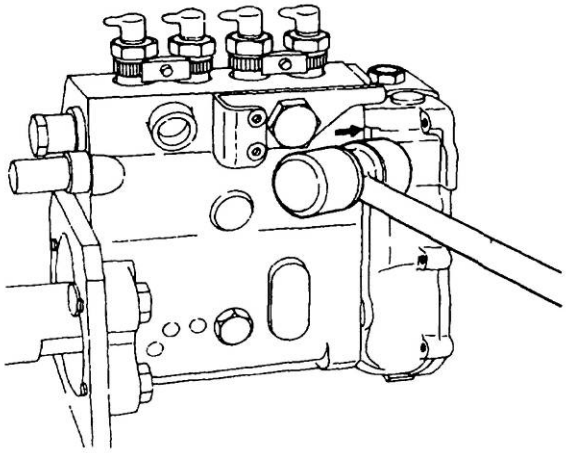


Figure 97 Removal of the Governor Housing

u. Remove the governor shaft guide screw and locknut from the governor housing. Remove the snap-ring securing the torque cam adjusting rod to the torque cam (Figure 98).

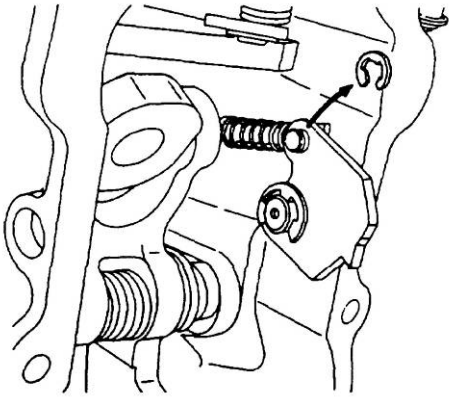


Figure 98 Removal of the Snap-ring

v. Using a suitable punch, remove the two plugs pressed into the sides of the governor cover. Unhook the cancel spring from the tension lever and push the tension lever pivot shaft out through the hole in the side of the governor housing (Figure 99).

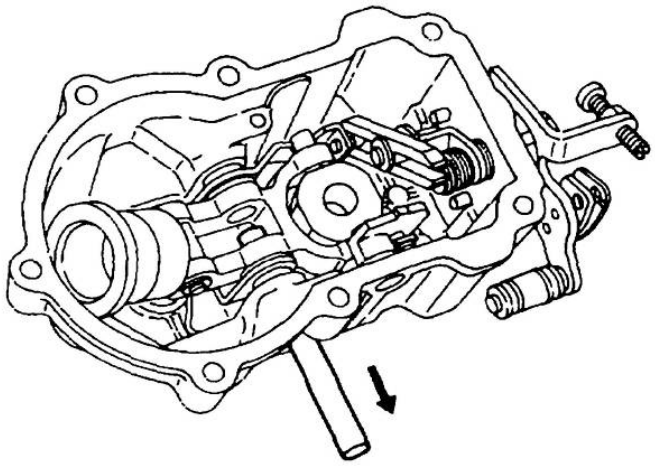


Figure 99 Removal of the Tension Lever Pivot Shaft

w. Remove the guide lever and cancel spring and the tension lever assembly from the governor cover. Remove the snap-ring securing the torque cam to the pivot pin and remove the torque cam (Figure 100).

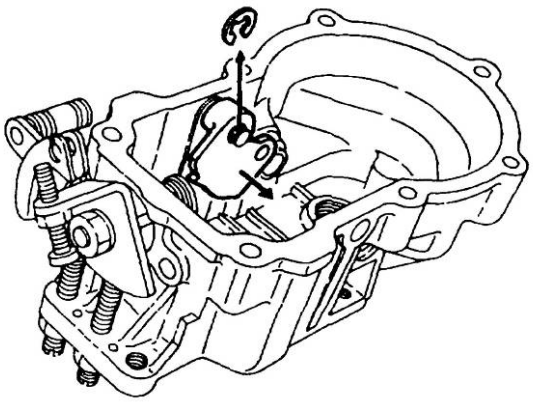


Figure 100 Removal of the Torque Cam

x. Remove the nut and spring washer securing the control lever to the control lever shaft and remove the control lever. Remove the control lever shaft and floating lever assembly from the governor cover (Figure 101).

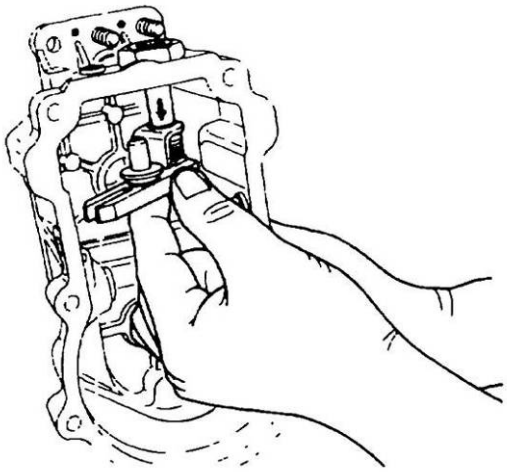


Figure 101 Removal of the Control Lever Shaft and Floating Lever Assembly

y. Remove the snap-ring from the pivot pin and separate the sleeve and shifter assembly from the tension lever (Figure 102).

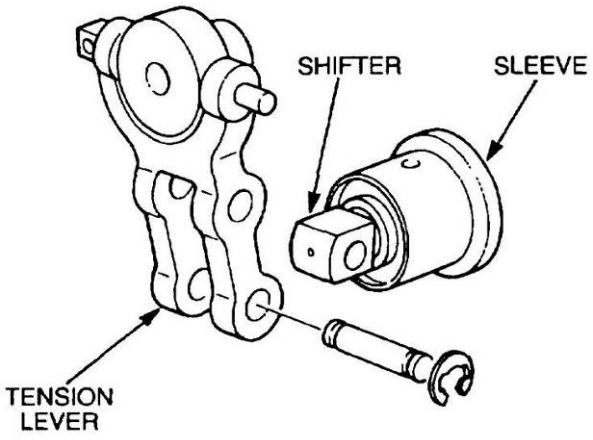


Figure 102 Removal of the Snap-ring and Pivot Pin

z. Remove the circlip securing the shifter to the sleeve, then remove the shifter and bearing assembly from the sleeve (Figure 103).

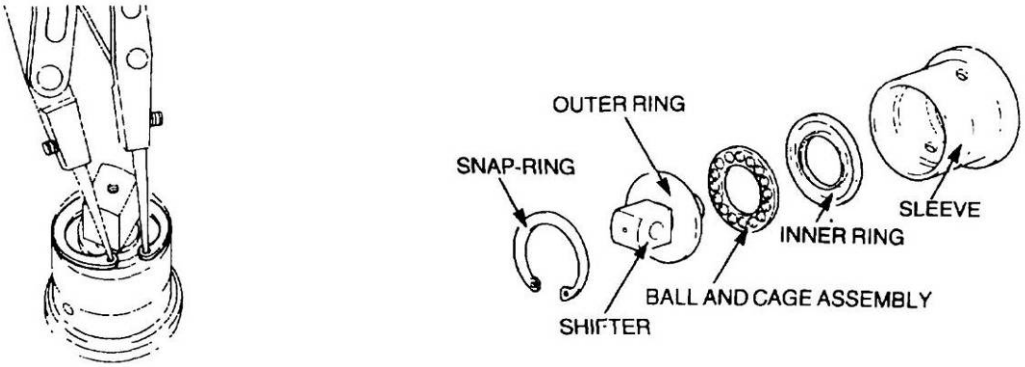


Figure 103 Removal of the Shifter and Bearing

35. Cleaning and Inspection. Clean and inspect the governor as follows:

WARNING

DO NOT spin the bearings with compressed air as personal injury or damage to the bearings may result.

a. Clean all components with a suitable cleaning agent and blow them dry with compressed air.

NOTE

If the governor housing is to be replaced, remove the camshaft bearing outer race from the housing.

b. Inspect the governor cover and housing for wear, damage, bent or damaged pivot pins or worn bushes. Replace the governor cover or housing if any of these faults are evident.

c. Inspect the flyweight assembly. Check for perceivable radial clearance between the flyweight and the pivot pin, and the slider and pivot pin on the contact surface of the slider (Figure 104). If any of these faults are evident, replace the flyweight assembly.

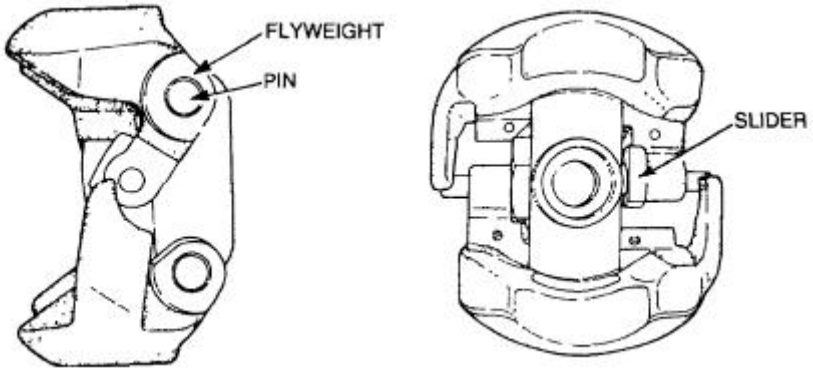


Figure 104 Flyweight Inspection

d. Inspect the pivot pin bores in the tension lever for wear and check for wear on the spring seat and the governor shaft bore in the spring seat. If excessive wear is evident in any of these locations, replace the tension lever.

e. Inspect the shifter for wear in the pivot pin bore and check the sleeve for excessive wear on the slider contact surface. Replace the shifter and/or the sleeve if excessive wear is evident.

f. Inspect the shifter/sleeve bearing for wear, pitting, cracks or damage. If replacement is required, press the bearing outer race from the shifter (Figure 105).

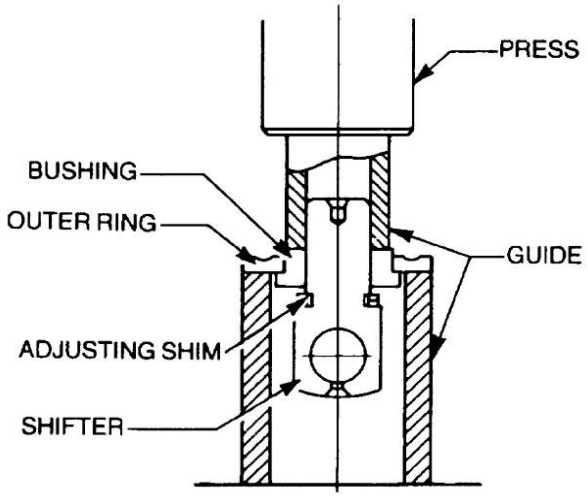


Figure 105 Removing the Bearing Race from the Shifter - Sectional View

g. Check the sensor lever and the torque cam for wear at the points shown (Figure 106). Replace either or both if excessive wear is evident.

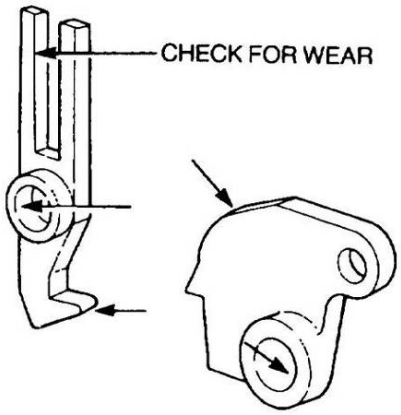


Figure 106 Sensor Lever and Torque Cam Wear Points

h. Inspect the control lever shaft assembly and the control rack connecting link for damage or wear (Figure 107). Replace any part showing excessive wear.

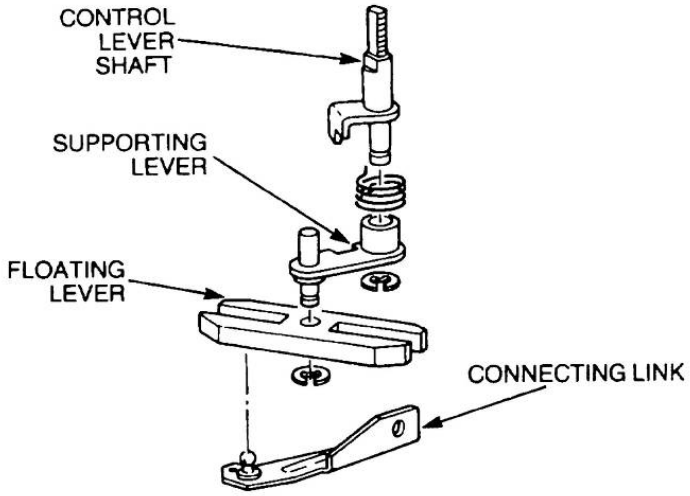


Figure 107 Control Lever Shaft Assembly and Connecting Link

i. Inspect all springs (Figure 108) for distortion, excessive wear, cracks or damage and replace as necessary.

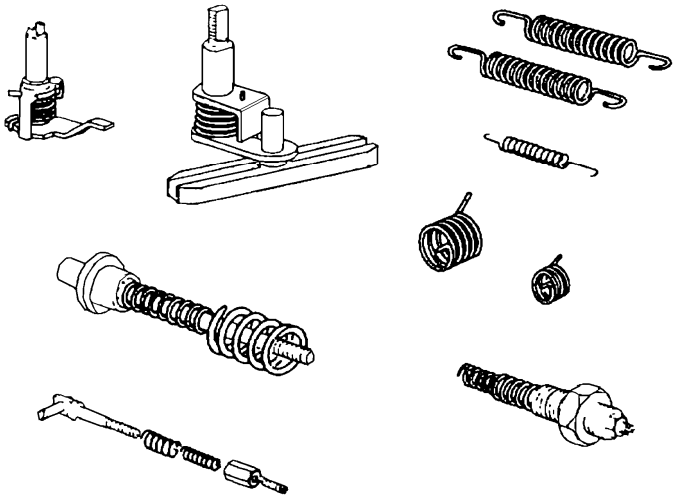


Figure 108 Governor Springs

j. Inspect the governor shaft and replace the shaft if wear or damage is evident.

36. Reassembly. Reassemble the governor as follows:

a. Install a new oil seal into the control lever shaft bore at the top of the governor housing. Install the camshaft bearing outer race into the governor housing. Position a new gasket and the governor housing on the injection pump and install the seven retaining bolts with new spring washers and the start spring eye. Ensure that the start spring eye is correctly positioned and torque the bolts to 6.9 to 8.8 N.m (61 to 78 lbf.in).

b. Align the keyway in the flyweight assembly with the key on the camshaft and install the flyweight assembly. Install the flyweight assembly retaining nut and toque the nut to 49 to 59 N.m (36 to 43 lbf.ft).

c. If the shifter/sleeve was replaced, press the new bearing outer race onto the shifter bush ensuring that the bearing running surface is facing away from the bush shoulder and that the bearing butts against the bush shoulder.

d. Smear the bearing cage, balls and both races with grease. Position the inner race, the cage and ball assembly and the outer race and shifter assembly into the sleeve. Install a new circlip ensuring that it is properly seated in the groove in the sleeve. Ensure that the sleeve rotates smoothly on the shifter.

e. Position the shifter and sleeve assembly in the flyweight assembly ensuring that the shifter and sleeve assembly contacts the flyweight holder. Hold the shifter and sleeve assembly against the flyweight holder to ensure that the flyweights are in the zero lift position. Measure the distance between the governor housing face and the centre of the pivot pin hole in the shifter (Figure 109). The dimension should be between 28.8 to 29.2 mm (1.134 to 1.149 in).

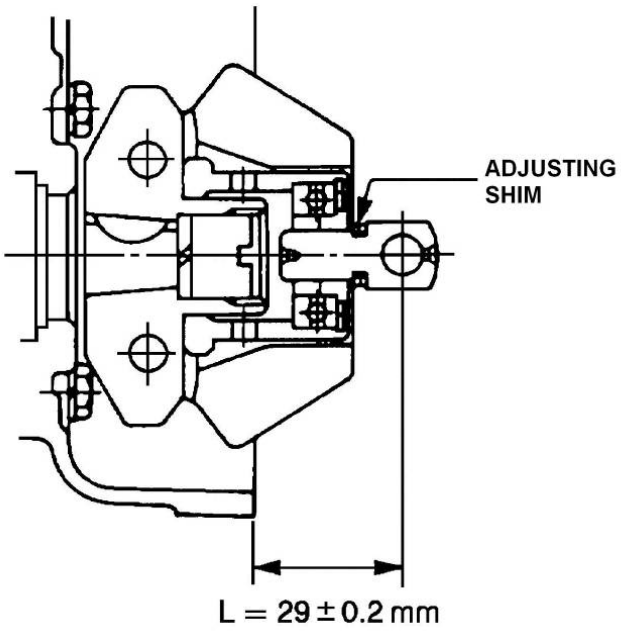


Figure 109 Shifter and Sleeve Assembly Setting Dimension - Sectional View

f. If the dimension is not to specification, disassemble the shifter and sleeve assembly, then press the bush and bearing outer race from the shifter to gain access to the adjusting shims. Either increase or decrease the thickness of the shims to obtain the correct dimension. Reassemble the shifter and sleeve assembly and verify that the dimension is correct. If necessary repeat this procedure until the correct dimension is obtained.

g. Position the tension lever over the shifter, align the pivot pin holes and install the pivot pin. Secure the pivot pin in place with new snap-rings (Figure 110). Install the torque cam control rod into the governor seat locating pin on the tension lever and adjust the nut until 3 to 6 mm of thread protrudes from the nut.

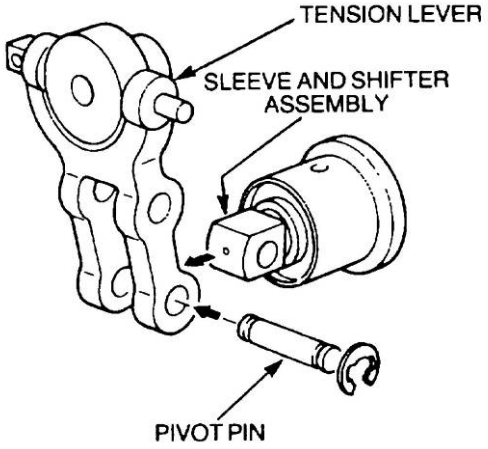


Figure 110 Connecting Sleeve and Shifter Assembly

h. Lubricate the sealing lip on the oil seal with grease and carefully install the control lever shaft assembly into the bore at the top of the governor cover (Figure 111). Position the control lever over the control lever shaft, install the retaining nut together with a new spring washer and tighten the nut securely.

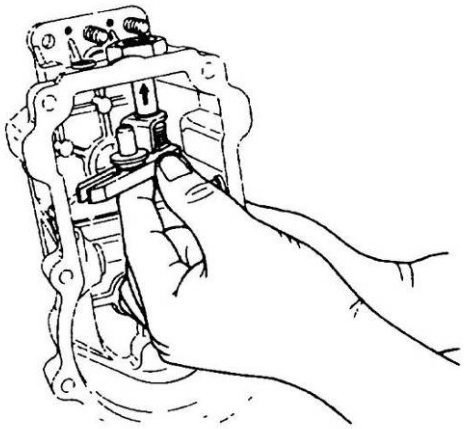


Figure 111 Installation of the Control Lever Shaft Assembly

i. Position the torque cam on the pivot pin in the governor cover (Figure 112) and secure the torque cam in place with a new snap-ring.

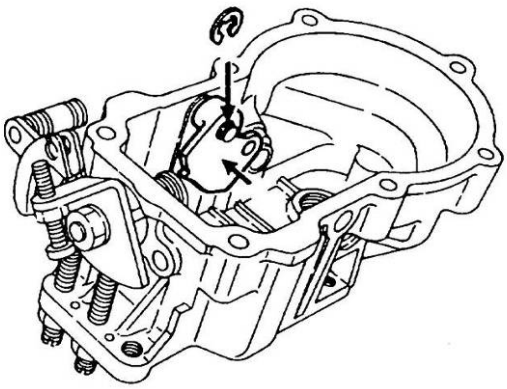


Figure 112 Installation of the Torque Cam

j. Install new bushes in the guide lever and position the guide lever in the governor cover ensuring that the ball joint is correctly engaged in the floating arm. Install the tension lever into the governor cover, positioning the lever between the bushes on the guide lever. Align the tension lever shaft holes in the guide lever and tension lever with those in the governor cover and start the tension lever shaft into the governor cover, guide lever and tension lever.

k. Install the cancel spring between the tension lever fork, align the bore of the spring with the tension lever shaft and push the shaft in until both ends of the shaft are supported by the governor cover. Using a suitable tool, e.g. a socket, install a new expansion plug into the governor cover at both ends of the tension lever shaft (Figure 113). Apply a liquid adhesive to the outside of each plug to prevent oil leakage.

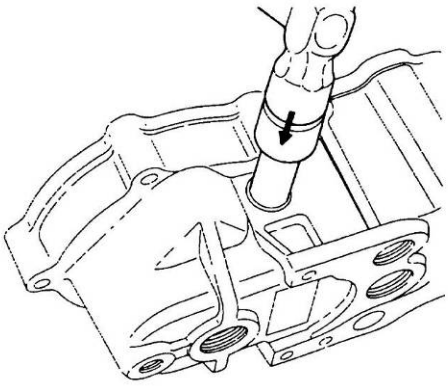


Figure 113 Installing the Expansion Plugs

l. Using a suitable tool, e.g. a Vee-notch screwdriver, attach the cancel spring to the tension lever (Figure 114).

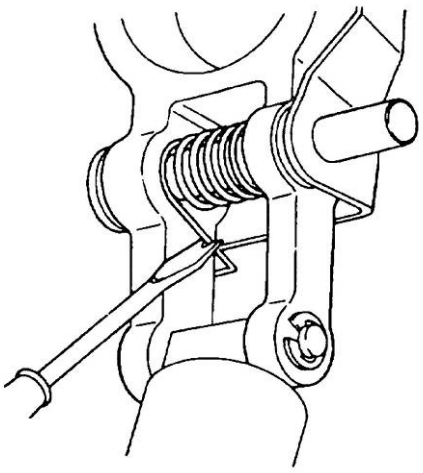


Figure 114 Attaching the Cancel Spring to the Tension Lever

m. Connect the torque cam control rod to the torque cam and secure it in place with a new snap-ring.

n. Install the stop control lever shaft through the aperture in the top of the governor housing and position a new O ring, the shims, return spring, cap and stop lever onto the shaft. Install the retaining bolt together with a new spring washer and torque the bolt to 10 to 14 N.m (7 to 10 lbf.ft).

o. Install the full-load setting lever shaft and cancel spring into the governor housing and position the full-load setting lever over the end of the shaft. Install the retaining nut together with a new spring washer and torque the nut to 10 to 14 N.m (7 to 10 lbf.ft).

p. Position the U-shaped lever onto the full-load setting lever shaft and link the end of the cancel spring over the U-shaped lever. Apply a suitable liquid adhesive to the threads of the U-shaped lever guide plug and install the guide plug into the governor housing, ensuring that the U-shaped lever is properly engaged with the guide plug. Torque the guide plug to 20 to 29 N.m (15 to 21 lbf.ft).

q. Position the sensor lever on the U-shaped lever and secure it in place with a new snap-ring.

r. Position the control rack connecting link, complete with bolt and plate, on the control rack with the end of the bolt positioned in the fork of the sensor lever. Install and securely tighten the retaining nut using two spanners (8 and 10 mm).

s. With the aid of long-nose pliers, install the start spring into the spring eye secured to the governor housing and to the control rack connecting link, (Figure 115).

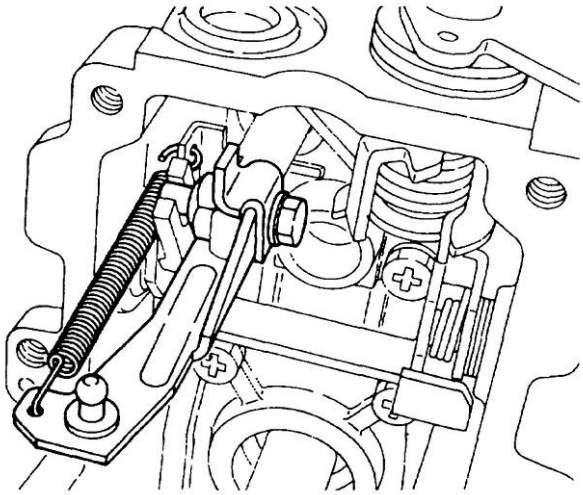


Figure 115 Installation of the Start Spring

t. If removed, install the spring seat and springs onto the governor shaft and insert the governor shaft into the bore in the governor housing (Figure 116).

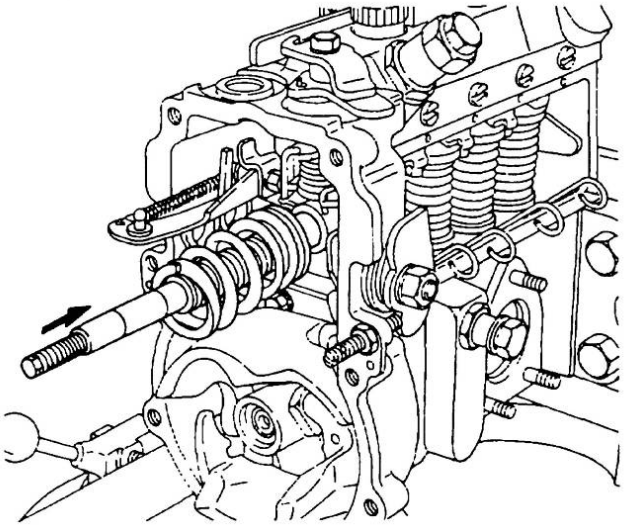


Figure 116 Installation of the Governor Shaft

u. Position a new gasket on the governor housing and install the governor cover. Align the ball joint on the connecting link with the fork in the floating lever and align the shifter and sleeve assembly with the flange on the flyweights. Install and torque the seven retaining bolts to 7 to 9 N.m (62 to 80 1bf.in).

v. Install the governor shaft guide screw complete with locknut. Install the idling spring capsule, together with the idling spring (Figure 117).

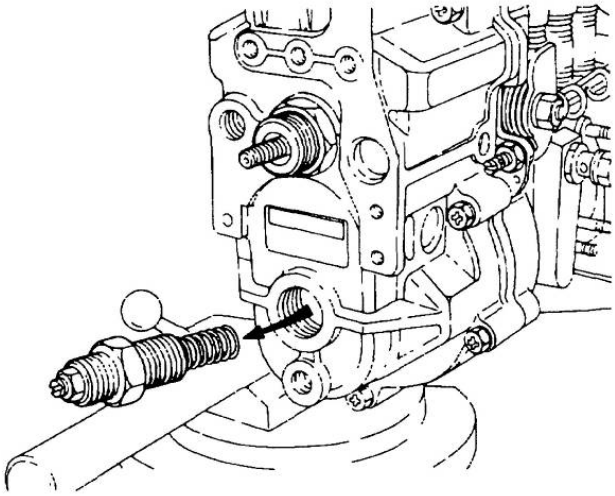


Figure 117 Installation of the Idling Spring Capsule

w. Connect special tool 157916-5420 onto the camshaft coupling and rotate the camshaft until the lobe on Number one cylinder raises the tappet. Remove the tappet holder and repeat the procedure for the remaining cylinders.

Injection Pump Timing

37. Adjustment. Adjust the injection pump timing as follows:

a. Remove the injection pump from the overhaul vice and install the pump on the calibration stand. Add approximately 180 ml of clean engine oil and install a suitable plug into the oil feed hole.

b. Connect the fuel feed hose directly to the injection pump fuel gallery and connect the high pressure fuel lines to the delivery valve holders. Install a dial indicator (special tool 105782-6280), over the end of the control rack.

c. Fully slacken off the governor shaft locknuts and set the pump rotating in a clockwise direction (as viewed from the drive-end of the injection pump) at a speed of 1000 to 1200 rpm. Push the governor shaft in until it contacts the wall of the injection pump housing, then set the control rack at the position where the dial indicator reads zero. Stop the injection pump.

d. Set the injection pump control lever to the full-load position and remove the high pressure fuel line from the injection pump Number one cylinder. Remove the delivery valve holder locking plate, the delivery valve holder, delivery valve return spring and the delivery valve assembly. Install the plunger pre-stroke measuring device (special tool 105782-4330), together with a dial indicator (special tool 157954-3600), into the bore of Number one cylinder (Figure 118).

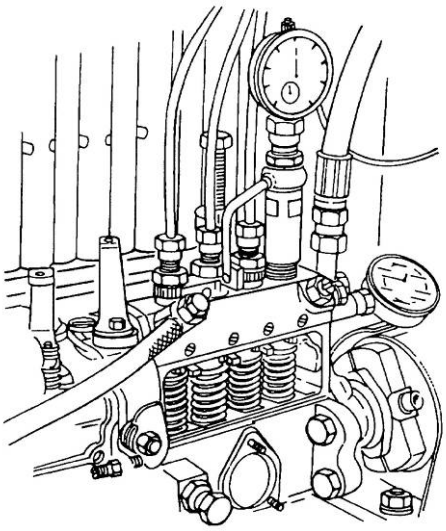


Figure 118 Installation of the Pre-stroke Measuring Device

e. Rotate the injection pump camshaft by hand to bring the camshaft lobe on Number one cylinder to BDC. Zero the dial indicator; continue rotating the camshaft and check that the reading of the dial indicator varies with the lift of the camshaft lobe.

WARNING

Do not place fingers near the plunger return spring while the spring is being held in compression otherwise personal injury could result.

f. Using a suitable calibration oil, set the test stand supply pump to 20 kPa (3 psi) and start the pump. Open the bleed screw on the injection pump to bleed off all the air from the injection pump fuel gallery. After bleeding close the bleed screw. With calibration oil flowing from the measuring device on Number one cylinder, rotate the camshaft in the clockwise direction until the calibration oil stops flowing. Check for a pre-stroke reading of 3.6 ± 0.05 mm on the dial indicator. If the reading is not to specification, stop the supply pump and rotate the camshaft until Number one camshaft lobe is at TDC. Install a plunger return spring holding tool and rotate the camshaft until the tappet is sufficiently clear of the spring seat to enable the shim to be replaced.

g. Using a suitable tool, e.g. magnetic pencil or similar, remove the shim from the top of the tappet and install a thicker shim to decrease the plunger lift-to-port closing or a thinner shim to increase the plunger lift-to-port closing. Rotate the camshaft until the Number one lobe is at TDC and remove the plunger return spring holding tool.

h. Start the supply pump and measure the pre-stroke again, replace the shim as necessary to obtain the correct pre-stroke specification. Once the correct setting has been obtained, stop the supply pump and set the test stand flywheel pointer to an arbitrary angle graduation and record the exact degree setting. Remove the plunger pre-stroke measuring device from Number one cylinder and install the delivery valve assembly, the delivery valve return spring and the delivery valve holder together with a new copper gasket. Torque the delivery valve holder to 39 N.m (29 lbf.ft), then slacken the holder, re-torque the delivery valve holder and slacken once more. Finally torque the holder to 44 N.m (32 lbf.ft).

i. Ensure that the port closing of each successive cylinder is 90 degrees ± 30 minutes from the previous cylinder. As the injection order is 1-3-4-2, the next cylinder to be checked is Number three. Open the bleed-off valve at the Number three fuel outlet on the test stand and start the supply pump. Adjust the pressure until a steady stream of calibration oil flows from the bleed-off valve. Rotate the camshaft (clockwise) by hand until the oil stops flowing and note the number of degrees on the test stand flywheel. If the degree of rotation is not to specification (90 degrees ± 30 minutes), stop the supply pump and replace the tappet shim as detailed in Paras 34. f. and g. Install a thicker shim to decrease the number of degrees of rotation or a thinner shim to increase the degrees of rotation. Repeat the test procedure until the correct reading is obtained, and then test the remaining cylinders in a like manner.

Injection Pump Pressure Test

38. Test Procedure. Test the injection pump pressure as follows:

NOTE

With the injection pump installed on the test stand and air bled from the fuel system, perform the following test to ensure that there is no fuel leakage from the injection pump.

a. Connect the test stand fuel supply hose to the injection pump fuel gallery and tighten the connection securely.

b. Start the test stand fuel supply pump and slowly supply fuel to the injection pump until a pressure of 1725 kPa (250 psi) is obtained. Stop the supply pump and check for signs of fuel leakage.

NOTE

A rapid drop in pressure indicates fuel leakage. A very gradual leak between the barrel and plunger is permissible.

c. Repair or replace parts as necessary to rectify any leakage.

Calibration

39. Preliminary Checks. Carry out the following preliminary checks:

a. Ensure that the pump is aligned, properly connected and secured to the test stand.

b. Check that the fuel supply hoses are correctly connected and secured to the transfer pump, and that an overflow valve is installed in place of the blanking plug in the injection pump fuel gallery.

c. Ensure that the fuel supply hoses to the transfer and injection pumps, and the fuel return hose from the overflow valve are correctly installed and free from restriction.

d. Check that each test nozzle is functioning correctly. Repair or replace any faulty nozzle as necessary.

e. Ensure that the high pressure fuel lines are in good condition and correctly installed, and that each of the injection pump cylinders is connected to its corresponding test nozzle on the calibration stand.

f. Check the temperature of the calibration oil (or test fuel) at the injection pump fuel inlet. The temperature should be 38 to 41 degrees C.

40. Preparation and Run-in. Prepare the injection pump as follows:

NOTE

As injection from each of the injection pump cylinders takes place in one revolution of the injection pump camshaft, set the test stand counter to the number of strokes in the pump calibration procedures.

a. Ensure that the fuel system is primed. Slacken the overflow valve connection on the injection pump and operate the hand primer plunger on the transfer pump. The system is primed when the calibration oil (or test fuel) flows from the overflow valve in a steady stream, free from air bubbles.

b. Remove the idling spring capsule assembly from the governor cover and slacken the maximum speed setting bolt and the full-load setting bolt.

c. Position special tool 105782-6170 (adjusting device) over the control lever, attach the adjusting device support bracket to the test stand and align the mark on the supporting bracket with one of the match marks on the scale plate (Figure 119).

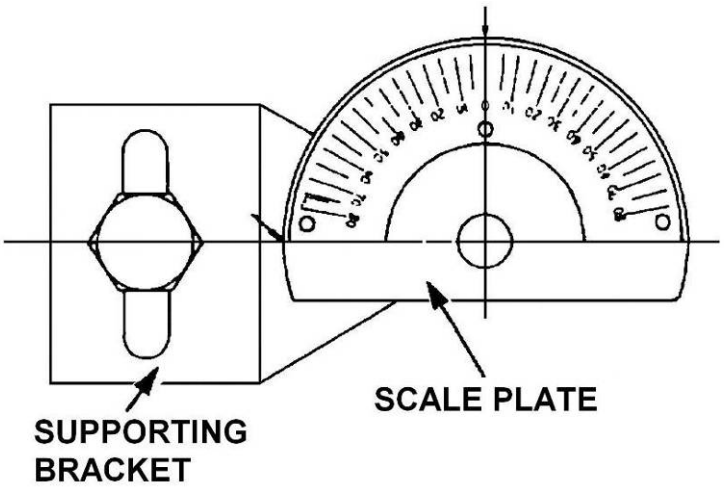


Figure 119 Aligning the Adjusting Device Match Marks

d. Move the support bracket of the adjusting device until pin A is over the centre hole of the control lever shaft (Figure 120). Secure the support bracket in place and insert pin B into the hole in the control lever.

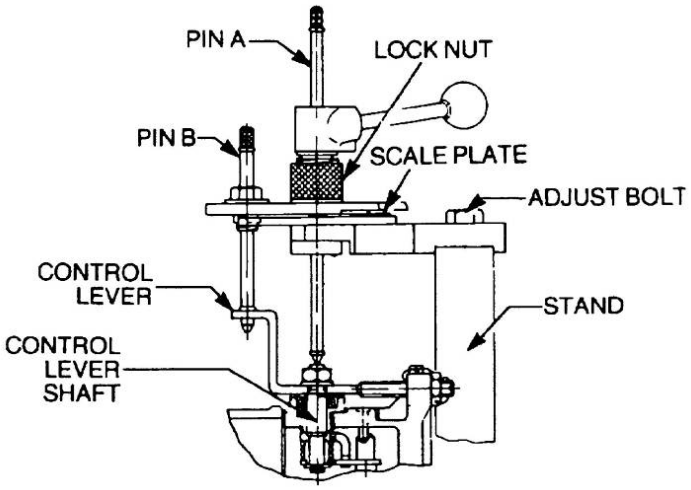


Figure 120 Positioning the Adjusting Device

e. Slacken the adjusting device locking handle and check that the injection pump control lever and pin B move smoothly.

f. Verify that there is sufficient lubricating oil in the injection pump and governor assembly (approximately 180 ml of clean engine oil).

g. Install the control rack travel measuring device, special tool 105782-6280, onto the end of the control rack. Lock the control lever in the idle position and push the governor shaft into the governor housing until it contacts the injection pump housing.

h. Start the test stand motor and run it at 1000 to 2000 rpm. Check the zero position as indicated on the dial indicator.

41. Calibration Procedure. Calibrate the injection pump using the following procedure:

a. Remove the control rack guide screw from the back of the injection pump and replace it with a locking screw (special tool 157976-3100). Using the dial indicator, set the control rack at 11.3 mm and lock the rack in position with the locking screw.

b. Set the calibration stand to 1000 strokes. Start and run the motor at 950 rpm. Fuel delivery should be 67.3 to 70.3 ml per cylinder, with a maximum variation of ± 2.5% between cylinders.

c. If the fuel injection quantity on any cylinder is not to specification, adjust the cylinder(s) by slackening the clamping screw on the control pinion. With the aid of a suitable tool inserted into one of the holes in the side of the control sleeve, rotate the sleeve to adjust the quantity of the fuel delivered by that cylinder. Rotating the control sleeve towards the governor increases the fuel quantity. Once the correct adjustment has been made, tighten the clamping screw and remove the adjusting tool. Repeat the procedure for the other cylinders as necessary.

NOTE

Fuel delivery figures are per 1000 rpm. Drain the calibrated containers after each fuel delivery reading.

d. Set the control rack to 9.6 mm and lock it in position. Start and run the motor at 290 rpm. Fuel delivery should be 6.7 to 9.3 ml per cylinder with a maximum variation of ± 14% between cylinders. Adjust the position of the control sleeves as necessary to achieve the correct fuel delivery at the cylinders.

e. Slacken the control rack locking screw and adjust the position of the control rack to 11.3 mm using the control lever. Lock the control lever in position. Start and run the motor at 950 rpm. Fuel delivery should be 67.8 to 69.8 ml without variation between cylinders. Adjust the cylinders as necessary to achieve the correct fuel delivery.

f. Using the control lever, adjust the control rack position to 10.95 mm and lock the control lever. Run the motor at 1600 rpm and check that the fuel delivery is 67.0 to 70.2 ml without variation between cylinders. Adjust the cylinders as necessary to achieve the correct fuel delivery.

g. Move the control lever to bring the control rack to 11.5 mm, lock the control lever, run the motor at 1300 rpm and check that the fuel delivery is 70.9 to 74.1 ml without variation between cylinders. Adjust the cylinders as necessary to achieve the correct fuel delivery.

h. Run the motor at 650 rpm and adjust the control lever to obtain a reading of 11.05 mm at the control rack. Check that the fuel delivery is 48.7 to 51.9 ml without variation between cylinders.

i. Move the control lever to bring the control rack to 11.4 mm, run the motor at 500 rpm and check that the fuel delivery is 49.9 to 53.9 ml without variation between cylinders.

j. After setting the fuel injection quantities, adjust the governor. Hold the control lever in the idling position and increase the pump speed to 500 to 600 rpm. Move the control lever to the maximum speed position and adjust the full-load setting bolt to set the control rack 3 mm beyond the maximum speed position.

k. Set the pump speed at 80 to 100 rpm and adjust the idle setting bolt (Figure 121) so that the control rack will be at 11.5 mm.

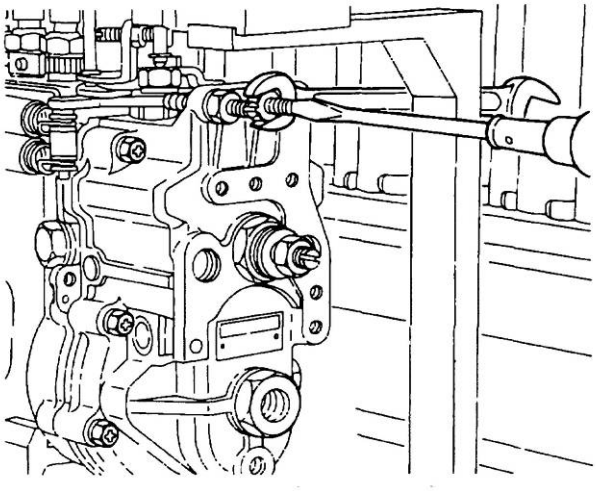


Figure 121 Adjustment of the Idle Setting Bolt

l. Increase the pump speed to 220 rpm and install the idling spring capsule together with a new gasket. Screw the capsule in until the control rack is at about 9.5 mm (Figure 122). The outer idling spring is now set. Torque the idling capsule locknut to 18 to 22 N.m (13 to 16 lbf.ft).

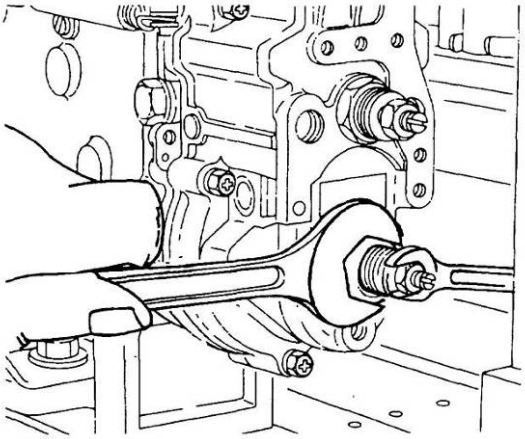


Figure 122 Adjustment of the Outer Idling Spring

m. Adjust the pump speed to 240 rpm and adjust the screw on the idling capsule until the control rack is at 9.5 mm (Figure 123). Tighten the locknut securely. The inner idling spring is now set. Install the cap-nut, together with a new gasket, and torque the cap-nut to 16 to 20 N.m (12 to 15 lbf.ft).

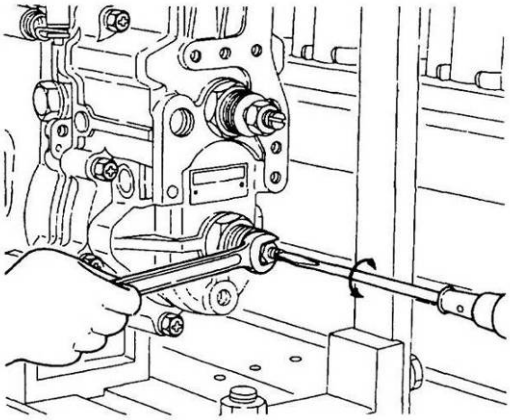


Figure 123 Adjustment of the Inner Idling Spring

n. Adjust the governor shaft guide screw so that it protrudes 13.5 to 14.5 mm from the governor cover (Figure 124). Torque the locknut to 39 to 49 N.m (29 to 36 lbf.ft).

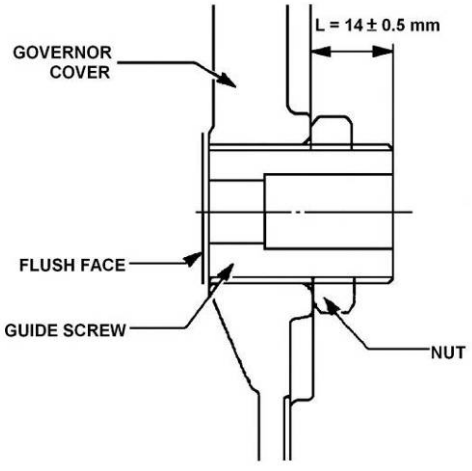


Figure 124 Adjustment of the Governor Shaft Guide Screw - Sectional View

o. Position and lock the control lever in the idling position and set the pump speed to 630 rpm. Turn the adjusting nut on the governor shaft to bring the control rack to 6.6 mm (Figure 125). Torque the locknut to 10 to 14 N.m (7 to 10 lbf.ft), increase the pump speed to bring the control rack to 3.5 mm and check that the pump speed is 1100 ± 50 rpm.

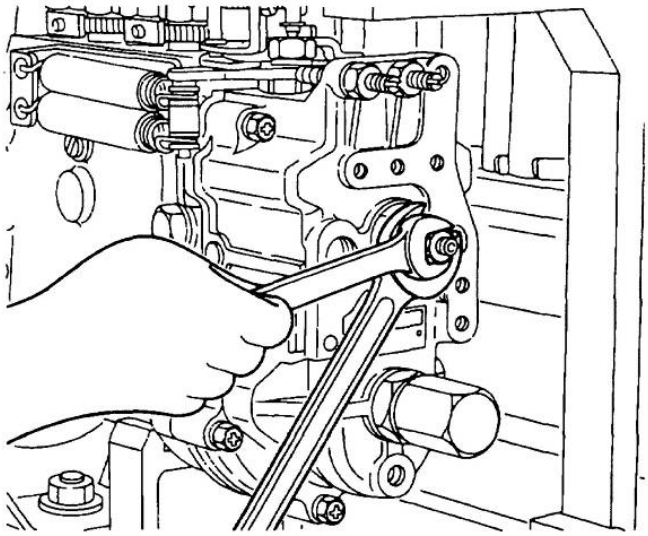


Figure 125 Adjustment of the Governor Shaft Spring

p. Increase the pump speed until the control rack reaches the zero position on the dial indicator and check that the pump speed is 1340 rpm. After the correct adjustment is made, install the cap-nut together with a new gasket and torque the cap-nut to 29 to 39 N.m (21 to 29 lbf.ft).

q. Decrease the pump speed to 240 rpm and adjust the idling setting bolt to bring the control rack to 9.5 mm. Tighten the locknut securely. Decrease the pump speed to 80 to 100 rpm and check that the control rack is at 11.5 mm.

r. Set the pump speed to 1120 rpm and set the control lever in the position where is makes contact with the maximum speed setting bolt. Adjust the maximum speed setting bolt (Figure 126) so that the control rack begins to move in the fuel decrease direction while the pump speed is 1575 to 1635 rpm. Tighten the locknut on the maximum speed setting bolt.

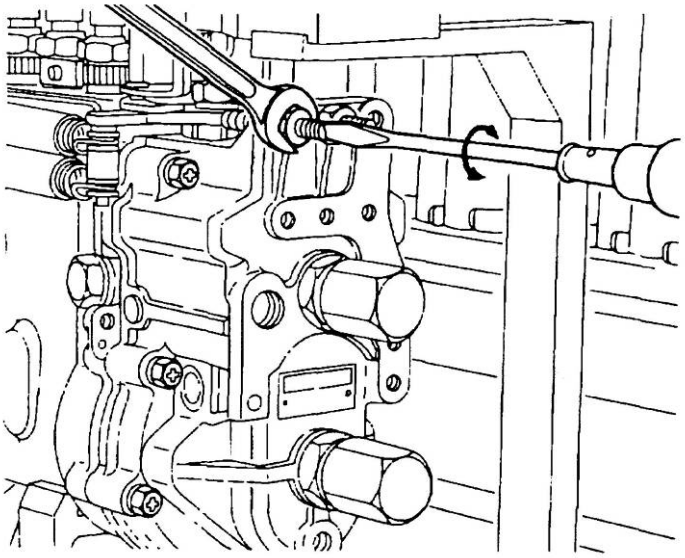


Figure 126 Adjustment of the Maximum Speed Setting Bolt

s. Decrease the pump speed to 1120 rpm and adjust the full-load setting bolt to bring the control rack to 11.3 mm, tighten the locknut securely (Figure 127).

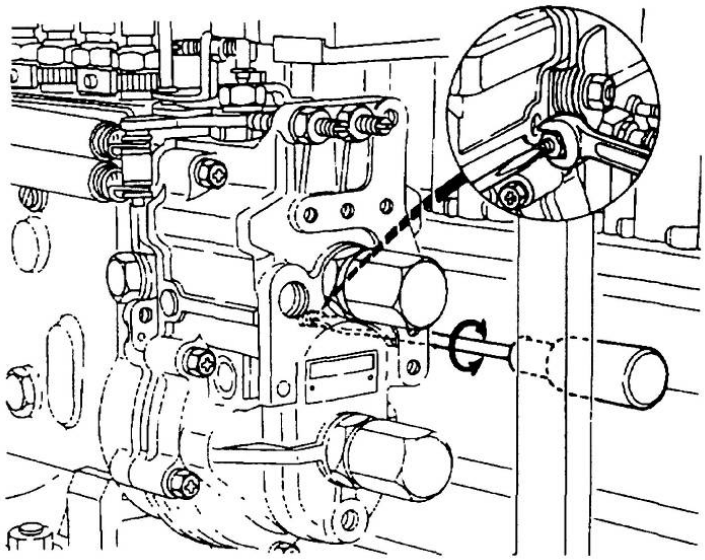


Figure 127 Adjustment of the Full-load Setting Bolt

t. Set the pump speed to 225 rpm and with special tool 157913-3620, adjust the nut on the torque cam control rod (Figure 128) to bring the control rack to 11.15 mm. Once the correct adjustment has been made, lock the adjusting nut with the lock screw.

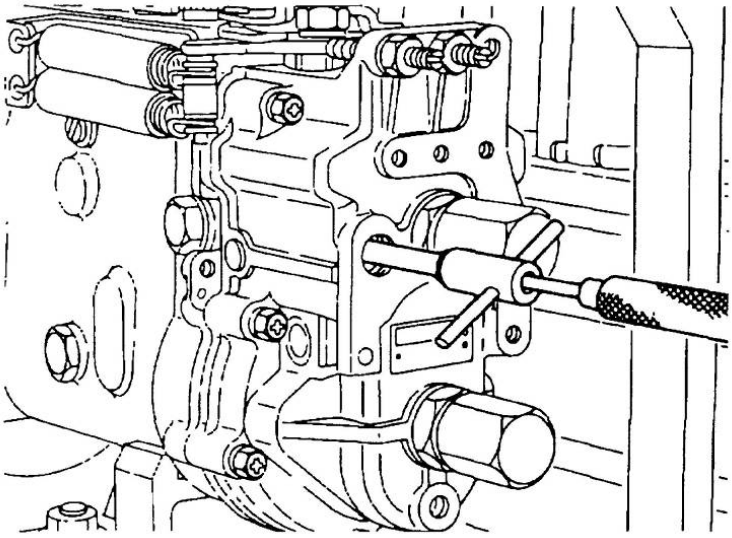


Figure 128 Adjustment of the Torque Cam Control Rod

u. Decrease the pump speed to 190 rpm and then increase the pump speed to 1575 to 1635 rpm. Ensure that the control rack position is to specification for the corresponding pump speeds. If not, adjust the torque cam control rod to obtain the correct settings. If adjustment cannot be made, replace the torque cam.

v. Check the fuel injection quantities as specified in Paras 38. e., f., g., h. and i. If necessary, adjust the full-load setting bolt and the torque cam adjusting nut to bring the quantities to specification.

w. Increase the pump speed to 1600 + 35 – 25 rpm, then move the control lever to maximum speed and lock the control lever when it makes contact with the maximum speed setting bolt. Adjust the maximum speed setting bolt until the control rack begins to move from 11.3 mm toward fuel decrease and tighten the setting bolt locknut.

x. Check the speed drop by gradually increasing the pump speed to 1780 ± 50 rpm and checking that the control rack reaches 9.5 mm. Increase the pump speed further to ensure that the control rack reaches zero mm.

y. After the governor adjustments have been made, stop the pump and install the plug and new gasket into the governor cover of the torque cam adjusting nut. Torque the plug to 20 to 29 N.m (15 to 21 lbf.ft).

z. Install lockwire and seals between the idle and maximum speed setting bolts, between the governor shaft and idling spring cap-nuts and into the full-load setting bolt.

aa. Disconnect the fuel lines from the fuel injection pump and the transfer pump and remove the injection pump from the calibration stand. Remove the coupling device from the injection pump camshaft and install the automatic timing device. Torque the timing retaining nut to 49 to 59 N.m (36 to 43 lbf.ft).

bb. Install the fuel injection pump in accordance with EMEl Vehicle G 203 – Group 4.

Transfer Pump

42. Disassembly. Disassemble the transfer pump as follows:

CAUTION

All work on the fuel transfer pump must be performed in a clean, dust free location. Dust or dirt could damage the internal components.

a. An exploded view of the transfer pump is shown in Figure 129.

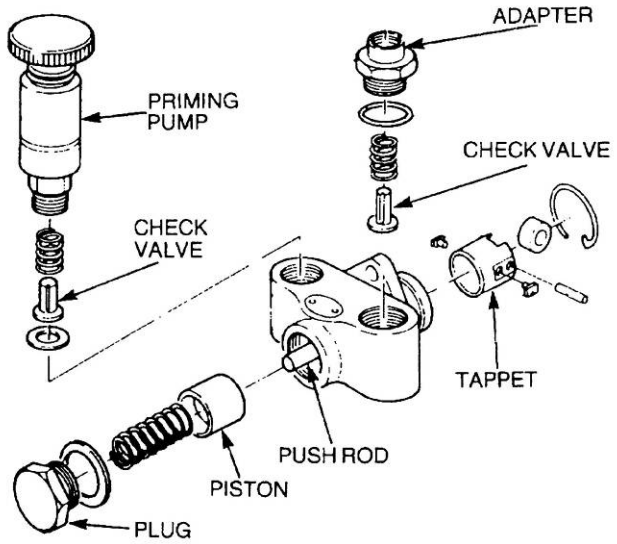


Figure 129 Transfer Pump - Exploded View

CAUTION

All work on the fuel transfer pump must be performed in a clean dust free environment. Dust or dirt could damage the internal components.

b. Clamp the pump in a suitable vice ensuring soft jaw covers are used. Remove the priming pump and discard the O ring (Figure 130).

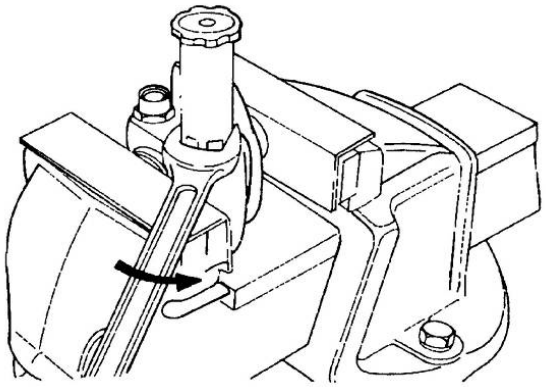


Figure 130 Removal of the Priming Pump

c. Remove the adapter and, using long-nose pliers, lift out both check valves and springs (Figure 131). Discard the O ring.

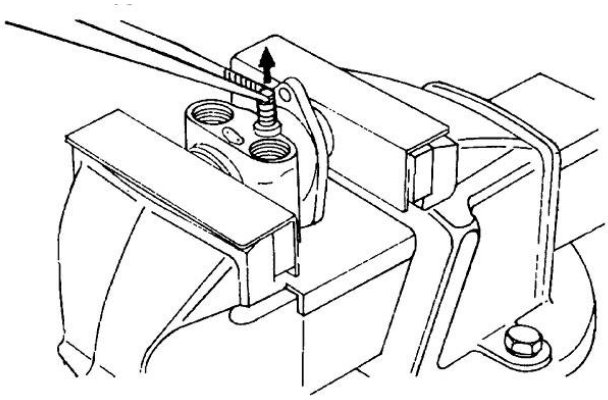


Figure 131 Removal of the Check Valve

d. Clamp the pump in the vice so that the plug faces upward and remove the plug (Figure 132). Discard the gasket.

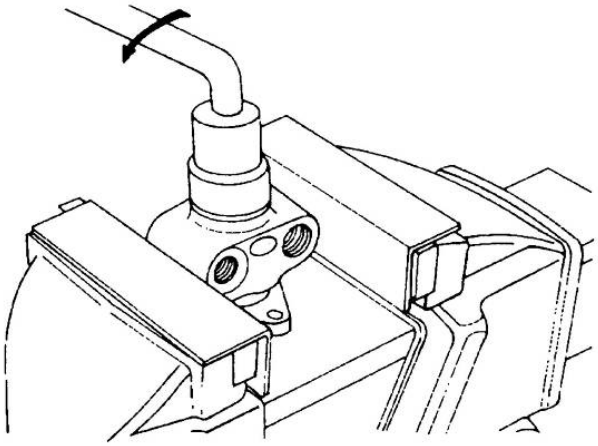


Figure 132 Removal of the Plug

e. Lift out the piston spring and, using long-nose pliers, remove the piston (Figure 133).

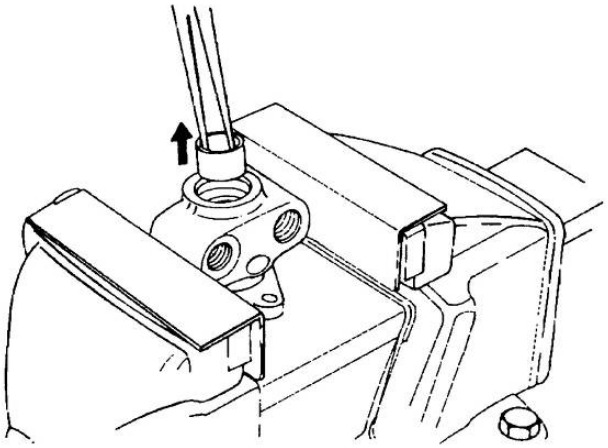


Figure 133 Removal of the Piston

f. Clamp the pump in the vice so that the tappet assembly faces upward. Using a screwdriver or a similar device, pry off the snap-ring that retains the tappet and remove the tappet assembly (Figure 134). Remove the push rod.

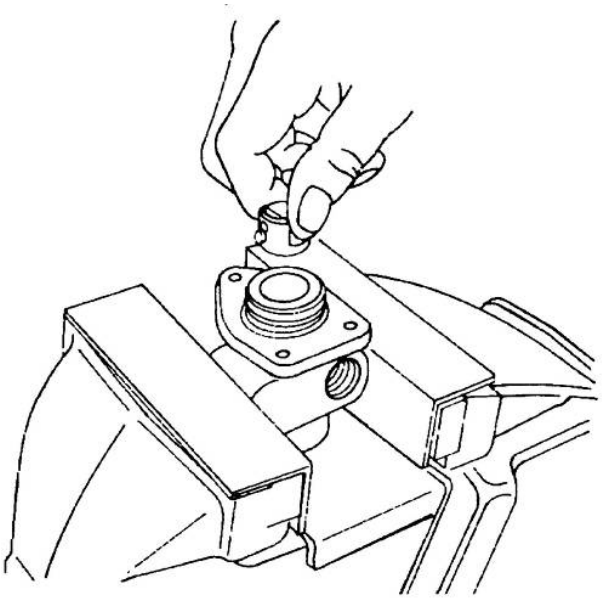


Figure 134 Removal of the Tappet

43. Cleaning and Inspection. Thoroughly clean all parts in clean diesel fuel and inspect the valve seats, piston and related parts for wear, cracks and scoring. Replace parts if necessary.

NOTE

Should the push rod or the pump body show any signs of wear, they must be replaced together as they are a matched pair.

44. Reassembly. Reassemble the transfer pump as follows:

a. Clamp the pump in a vice so that the mounting flange faces upwards and insert the tappet into the body.

b. Install the snap-ring to prevent the tappet dislodging.

c. Clamp the pump in a vice so that the tappet assembly faces downwards and insert the push rod, piston and piston spring.

d. Using a new gasket, install the plug and torque it to 78 to 88 N.m (57 to 64 lbf.ft).

e. Clamp the pump in a vice and install the two check valves and springs.

f. Using new O rings, install the transfer pump and adapter and torque them to 40 N.m (29 1bf.ft) and 12 N.m (8 lbf.ft) respectively.

45. Testing. Test the transfer pump by plugging the outlet (delivery) port. Use a plug with a thread of M17 x 1.5 mm, tighten the plug securely. Connect an air supply to the pump inlet port and tighten the connection securely. Immerse the transfer pump assembly in a container of clean diesel fuel and apply clean moisture free air at a pressure of approximately 200 kPa (29 psi) to the pump. Replace the transfer pump if air leakage is evident.

Automatic Timer

46. Removal. Remove the automatic timer as follows:

a. Remove the fuel injection pump in accordance with EMEl Vehicle G 203 – Group 4.

b. Position the injection pump in a soft-jawed vice and lock the injection pump drive gear with a suitable locking device. Remove the nut and washer securing the automatic timer assembly to the injection pump camshaft.

c. Install the outer piece of special tool 157926-5820 in the centre of the automatic timer. Insert the centre bolt and tighten it until the timer is withdrawn from the camshaft.

47. Disassembly. Disassemble the automatic timer as follows:

a. Secure the automatic timer in a soft-jawed vice and match mark the drive gear to the timing flange hub, or gauge and record the angle between the Z mark on the drive gear and the keyway in the timing flange hub (Figure 135).

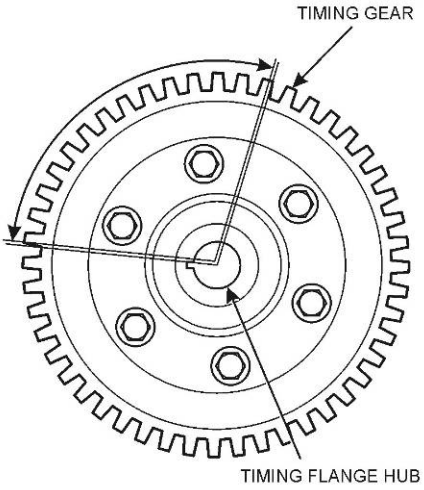


Figure 135 Z Mark-to-Keyway Angle

b. Remove the six bolts and lock-washers securing the drive gear to the drive flange and remove the drive gear.

c. Invert the assembly and using a suitable pair of circlip pliers, remove the circlip securing the cover to the timing flange hub and remove the cover.

d. Lift the flyweight and spring assembly from the timing flange, check and record the positions of the pivot pin holes in the cams in relation to the timing flange. Remove the cams from the timing flange.

e. Invert the assembly and using a suitable pair of circlip pliers, remove the circlip securing the timing flange to the drive flange. Remove the spacer and shim then separate the two flanges.

f. Position special tool 157921-9820 over the flyweight springs, compress the springs and remove the snap-rings securing the springs to the pilot pins (Figure 136). Remove the spring seats, shims and springs from the pilot pins.

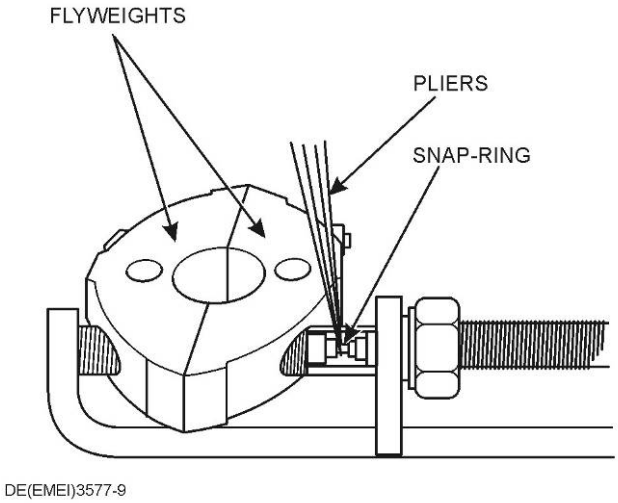


Figure 136 Removal of the Flyweight Spring Snap-ring

48. Cleaning and Inspection. Clean and inspect the automatic timer as follows:

a. Clean all parts with a suitable cleaning agent and then blow them dry with compressed air.

b. Inspect the drive gear for worn or damaged teeth and replace the gear if necessary.

NOTE

The springs and adjusting shims must always be replaced as a set.

c. Inspect the timing flange for signs of uneven wear, ridging or scoring in the cam bores and on the drive flange mounting surface of the hub. Replace the timing flange if damage is excessive.

d. Check the cams for uneven wear in the pivot pin bores and on the outer surfaces. Replace parts as necessary.

e. Check the pivot pins on both the drive flange and the flyweights for uneven wear and replace as necessary.

f. Check the flyweight springs and replace them if they are worn or bent.

g. Replace all circlips and snap-rings.

49. Reassembly. Reassemble the automatic timer as follows:

WARNING

Exercise care when installing the timer flange as the springs are compressed and could cause personal injury if they should dislodge.

CAUTION

The shims must be installed in their original positions.

a. Lubricate the drive and the timing flanges with clean engine oil. Position the drive flange over the timing flange hub, ensuring that the punch mark or the alignment mark on the drive flange is aligned with the keyway in the timing flange hub. Position the shim and spacer over the hub and secure the two flanges together with a new circlip. Check for a clearance of 0.02 to 0.1 mm (0.0008 to 0.004 in) between the shim and the drive flange. If necessary, replace the shim to achieve the specification.

b. Apply clean engine oil to the cams and assemble them into position, as previously noted, in the timing flange (Figure 137).

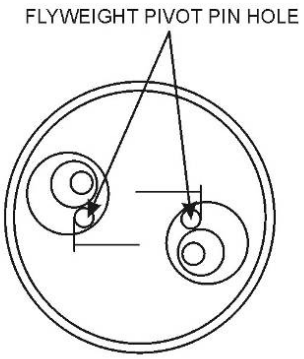


Figure 137 Installation of the Large and Small Cams

c. Using special tool 157921-9820, assemble the pilot pins, spring seats and springs on the flyweights and secure the springs with new snap-rings. Measure the distance between the outer edges of the pivot pins (Figure 138) and adjust the large cams to bring the pivot pin holes to the same dimension, while maintaining the pivot pin holes equidistant from the centre line of the timing flange hub (Figure 139).

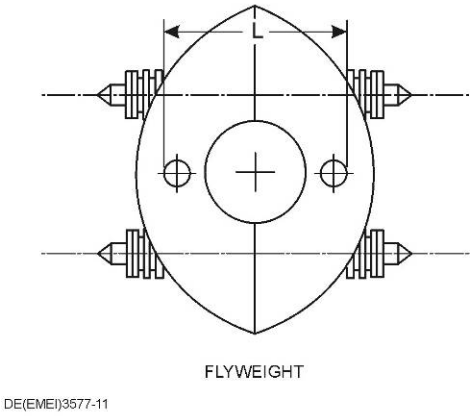


Figure 138 Measuring the Flyweight Pin Distance

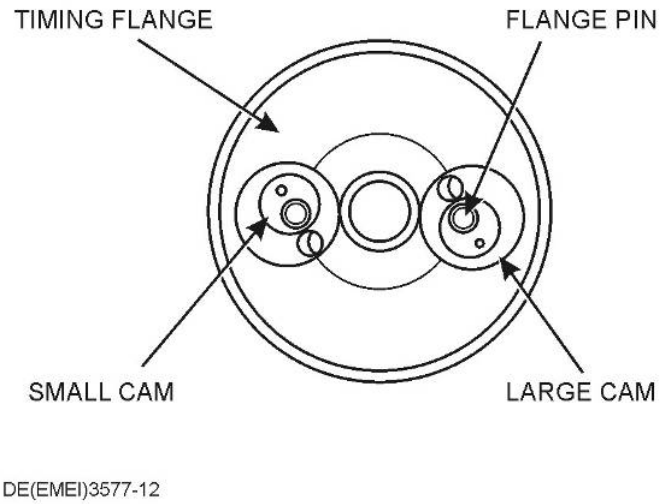


Figure 139 Cam Pivot Pin Holes to Hub Dimensions

d. Position the flyweight assembly above the timing flange, align the flyweight pivot pins with the pivot pin holes in the large cams and insert the flyweight assembly into the timing flange.

e. Install the cover over the flyweights and install a new circlip to secure the cover to the timing flange. Using a set of feeler gauges, check the clearance between the circlip and the cover. If necessary,

replace the cover with either a thicker or thinner cover to obtain a clearance of 0.05 to 0.2 mm (0.002 to 0.008 in).

f. Place the gear on the drive flange and set the Z mark on the gear at the correct angle (recorded previously) with the keyway in the timing flange hub, or align the match marks. Install and torque the six retaining bolts to 7.8 to 11.8 N.m (69 to 104 lbf.in).

50. Installation. Fit the automatic timer to the injection pump camshaft ensuring that the key aligns. Install the lock-washer and round nut and torque the nut to 59 to 69 N.m (43 to 51 lbf.ft).

51. Adjustment. Adjust the automatic timer as follows:

a. Install the fuel injection pump on a calibration test stand (Para 37.).

b. Operate the test stand and check, using a stroboscope, that at 1200 to 1300 rpm there is no advance and at 1500 rpm the advance finishes at 3 to 4 degrees.

c. If the advance is not within specification, adjustment can be made by replacing the timer springs and/or the shims.

Fuel Injectors

52. Disassembly. Disassemble the fuel injectors as follows:

CAUTION

All work on the fuel transfer pump must be performed in a clean, dust free environment. Dust or dirt could damage the internal components.

a. Secure the injector body in a soft-jawed vice and remove the end cap and gasket (Figure 140).

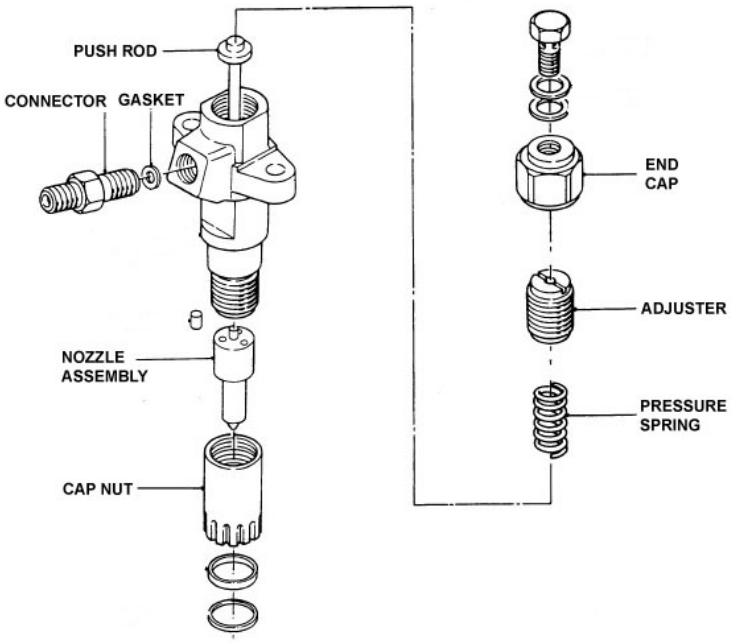


Figure 140 Fuel Injector- Exploded View

b. Remove the adjuster, washer, pressure spring and lift out the push rod. Unscrew the connector and remove and discard the gasket.

c. Invert the injector body in the vice and remove the cap-nut and nozzle assembly. Remove the injector body from the vice.

53. Cleaning and Inspection. Clean and inspect the fuel injectors as follows:

a. Soak all components in a suitable carbon removing and cleaning agent. Wash all external dirt, grease and carbon deposits from the body and cap-nut. Use a brass wire brush to assist in the removal of carbon deposits.

NOTE

When cleaning the needle valve and nozzle, take care not to scratch or score the valve seat.

b. Using a suitable diameter wire or drill, clean the fuel feed passages in the nozzle (Figure 141). Using an injector cleaning kit, remove the carbon from the recess in the nozzle.

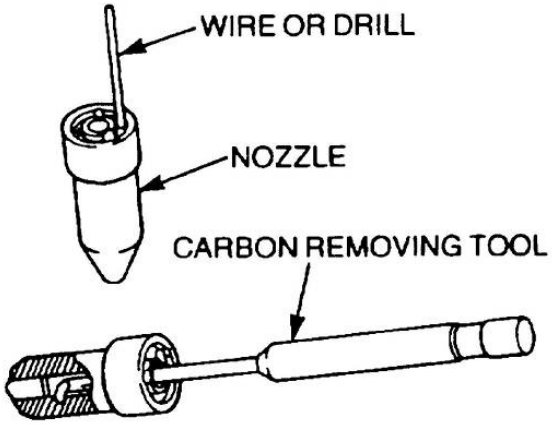


Figure 141 Cleaning the Nozzle

c. Using the tools provided in the cleaning kit, remove the carbon from the valve seat and the main fuel outlet (Figure 142).

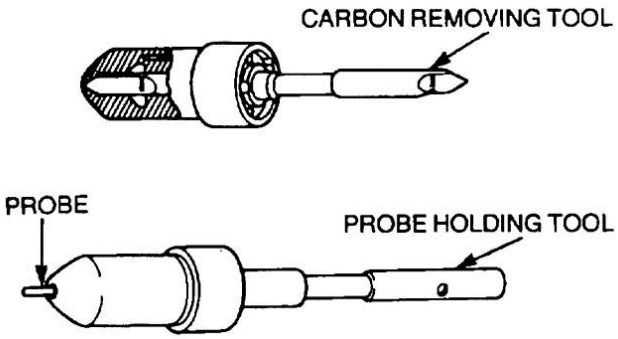


Figure 142 Cleaning the Nozzle Valve Seat

d. To prevent the wire bending or breaking in the nozzle ensure that no more than 1.5 mm (0.062 in) extends from the holder. Use the probe wire to clean out the carbon from the nozzle spray holes (Figure 143).

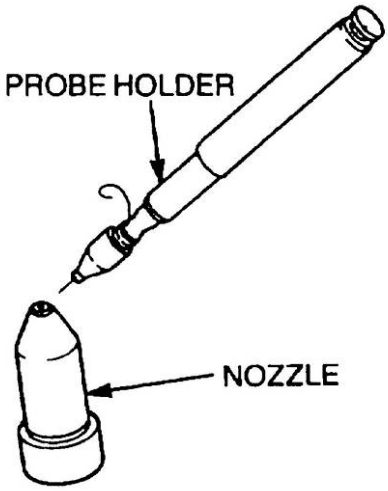


Figure 143 Cleaning the Nozzle Spray Holes

NOTE

If the needle valve is blued or has a dull appearance, this indicates wear. The valve and the nozzle must be replaced as a matched pair. Do not attempt to lap the valve in the nozzle.

e. Clean the needle valve and inspect it for wear or damage.

f. Inspect the mating faces of the nozzle and the body, these should be smooth and free of scratches or scores (Figure 144). Replace the injector assembly if these components are faulty.

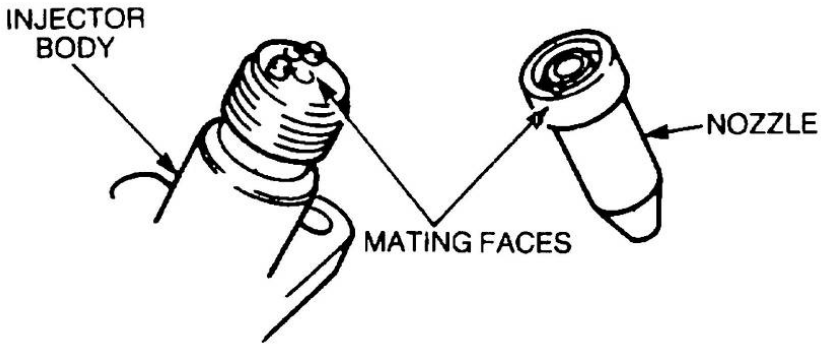


Figure 144 Inspection of the Injector Mating Faces

54. Reassembly. Reassemble the fuel injectors as follows:

NOTE

Do not hold the needle valve for too long as expansion due to body heat transfer will prevent valve installation.

a. Immerse the nozzle and needle valve in clean fuel and insert the valve in the nozzle. Ensure that the valve moves freely.

b. Ensure that the injector body is clean, fit the nozzle to the body and align the locating pegs. Install the cap-nut and tighten it securely. Secure the injector body in the vice and torque the cap-nut to 58 to 78 N.m (43 to 58 lbf.ft).

c. Insert the push rod in the body and fit the pressure spring, washer and adjuster. Install a new gasket and the end cap. Fit the connector together with a new gasket. Remove the injector from the vice.

55. Spray Pattern Test. Test the spray pattern of the fuel injectors using the following procedure:

WARNING

Due to the high pressures involved in the spray pattern test and the possibility of a defective injector spraying in any direction, keep hands away from the injector outlet to prevent personal injury.

CAUTION

Injector spray patterns should be checked by operating the pump lever at a rate of four to six strokes per second. Operating the lever too slowly will not generate sufficient test pressure and will cause the fuel to spray in coarse particles which will not give a true indication of the injector's condition.

a. Ensure that there is sufficient clean fuel in the reservoir. Install the injector on the test rig and close off the fuel supply to the gauge. Operate the handle two to three times while observing the fuel spray pattern (Figure 145).

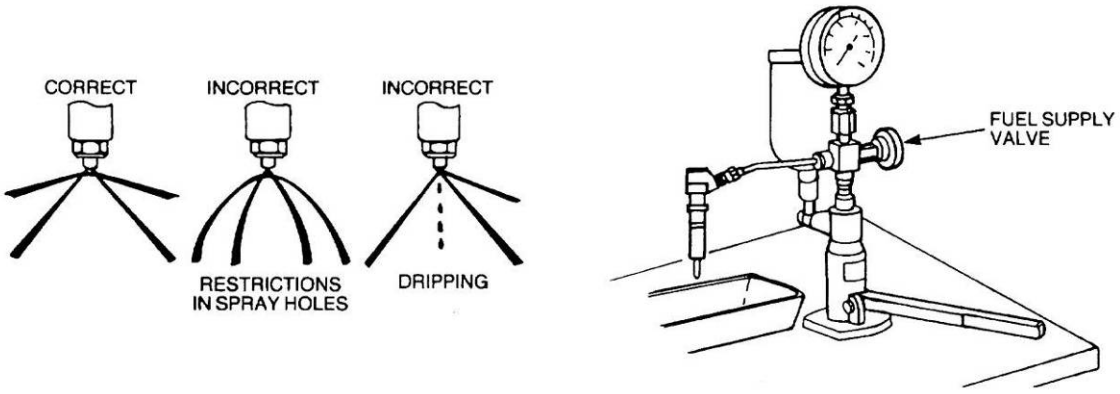


Figure 145 Injector Spray Pattern Test

b. Replace any injector that fails to spray correctly.

c. Open the fuel supply to the gauge and operate the handle to build up pressure, do not allow the injector to spray. Observe the starting pressure reading on the test rig gauge while holding the pressure with the handle as the injector sprays. The injection starting pressure must be 18 134 kPa (2630 psi). If it is not within specification, turn the adjuster with a screwdriver to increase or decrease the starting pressure as required (Figure 146).

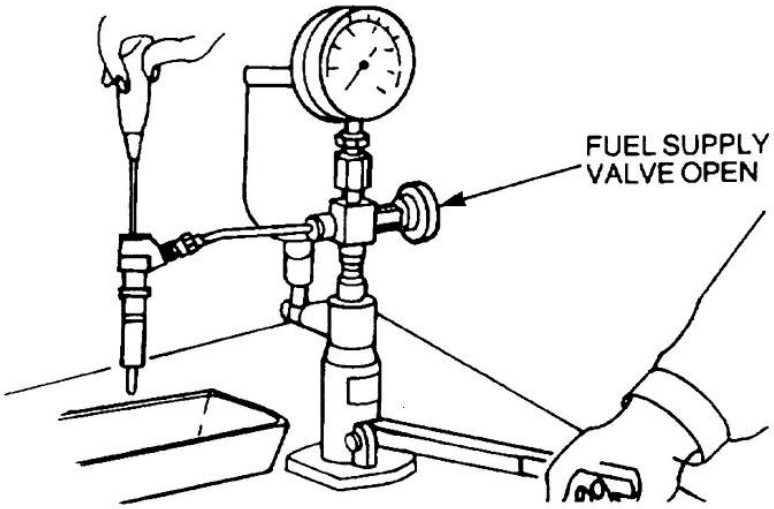


Figure 146 Adjustment of the Starting Pressure

d. Install the end-cap and gasket and torque the end-cap to 58 to 78 N.m (43 to 58 lbf.ft). Check that the starting pressure is correct and the leak down rate is not less than six seconds from 18134 kPa (2630 psi) to 10 132 kPa (1469 psi) when the handle is released and the pressure is allowed to fall naturally.

e. Check the end-cap and the cap-nut for any leaks and rectify them as necessary. If the leak down rate is less than six seconds, replace the nozzle assembly.

f. Replace the injector if it does not conform to specification.

Turbocharger

56. Disassembly. Disassemble the turbocharger as follows:

a. Remove the turbocharger in accordance with EMEI Vehicle G 203 – Group 4.

b. Remove the exhaust adaptor from the exhaust outlet on the turbine housing.

c. Clean the exterior of the turbocharger with a suitable non-caustic solvent and blow it dry with compressed air.

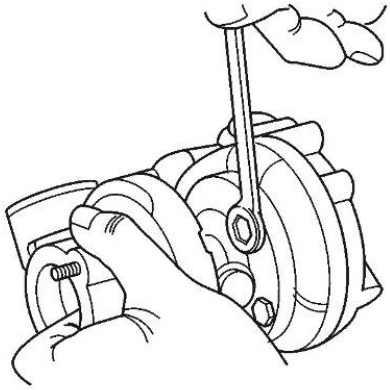
d. Using a scribe, match mark the relative positions of the turbine housing, the bearing housing and the compressor housing.

e. Remove the coolant inlet and outlet fittings from the bearing housing.

CAUTION

Use care when removing the turbine housing and the compressor housing. Do not tilt the housings during removal or damage to the turbine and/or compressor wheel blades could result.

f. Remove the bolts securing the turbine housing to the bearing housing (Figure 147). Remove the clamp-plates and carefully remove the turbine housing. If necessary, tap the turbine housing with a soft-headed hammer to free it from the bearing housing flange.



DE(EMEI)3577-13

Figure 147 Removal of the Turbine Housing

g. Using a suitable pair of circlip pliers, remove the circlip securing the compressor housing to the bearing housing and carefully remove the compressor housing.

57. Cleaning and Inspection. Clean and inspect the turbocharger as follows:

CAUTION

Damage to the turbocharger will result if:

It is cleaned with abrasives.

The bearing housing is immersed in the cleaning solvent.

Compressed air is blown under the compressor wheel.

The wheel and shaft assembly are spun when using compressed air to remove residue and solvent.

NOTE

Before cleaning the turbocharger inspect all components for burning, rubbing or impact damage which might not be evident after cleaning.

a. With the aid of a soft-bristle brush and a plastic blade scraper, clean all components with a suitable non-caustic solvent, then blow them dry with clean, dry, compressed air.

b. Inspect the compressor housing for the following:

(1) nicks, dents or warpage that could prevent sealing between the compressor housing and the bearing housing;

(2) a worn, broken or corroded circlip groove; and

(3) wheel-rub damage in the contour area.

c. If the wheel-rub damage cannot be polished out using an 80 grit silicone carbide abrasive cloth, or if any of the other faults are evident, replace the compressor housing.

d. Inspect the turbine housing for the following:

(1) nicks, dents or warpage that could prevent sealing between the turbine housing and the bearing housing;

(2) corroded or stripped threads in the mounting bolt holes;

(3) cracks or blow-by burns in the mounting flange; and

(4) wheel-rub damage in the contour area.

e. If the wheel-rub damage cannot be polished out using a 60 grit silicone carbide abrasive cloth or if any of the other faults are evident, replace the turbine housing.

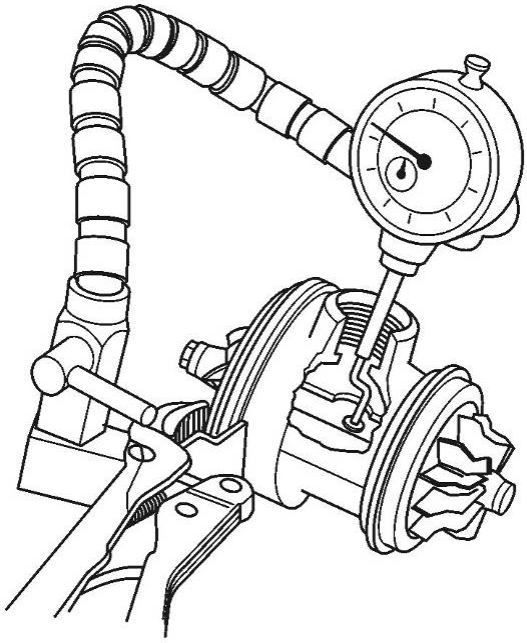
f. Check the condition of the compressor and turbine wheels. If wear or damage is evident, replace the bearing housing assembly.

CAUTION

Use care when installing the dial indicator assembly to avoid damaging the machined surface of the bearing housing.

Before installing a new bearing housing, ascertain and rectify the cause of the bearing failure.

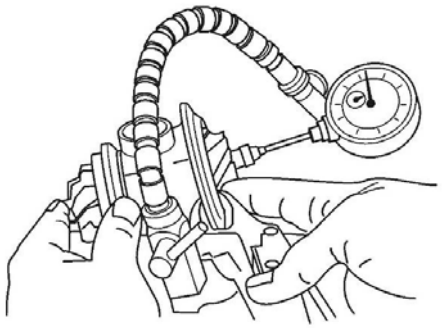
g. Suitably support the bearing housing in a soft-jawed vice. Install a dial indicator into the oil inlet port in the bearing housing with the cranked plunger resting on the shaft (Figure 148). Push the turbine wheel shaft away from the plunger by applying equal pressure simultaneously to both the turbine and compressor wheels. Zero the dial indicator and apply equal pressure simultaneously to both the wheels to move the shaft toward the plunger. Roll the shaft slightly in both directions while applying pressure to the wheels to ensure that the reading indicated is the maximum possible. Move the shaft away from the plunger using equal and simultaneous pressure to ensure that the indicator returns exactly to zero. Repeat the test procedure several times to ensure that the maximum radial clearance of the bearings has been obtained. If the clearance is not within 0.056 to 0.127 mm (0.0022 to 0.005 in), replace the bearing housing assembly.



DE(EMEI)3577-14

Figure 148 Checking the Journal Bearing Radial Clearance

h. Position the dial indicator assembly on the turbocharger so that the indicator plunger rests squarely on the end of the turbine wheel shaft at the compressor wheel end (Figure 149). Manually press on the compressor wheel to push the turbine shaft as far as it will go away from the indicator plunger. Zero the dial indicator, then push the shaft, at the turbine wheel end, as far as it will go toward the plunger and note the reading on the dial indicator. Push the shaft away from the plunger as far as it will go and check that the reading on the dial indicator returns exactly to zero. Repeat the clearance check several times to ensure that the maximum reading is obtained. If the axial clearance of the bearings is not within 0.025 to 0.084 mm (0.001 to 0.0033 in), replace the bearing housing assembly.



DE(EMEI)3577-15

Figure 149 Checking the Journal Bearing Axial Clearance

58. Reassembly. Reassemble the turbocharger as follows:

CAUTION

If any housing has been replaced, ensure that the scribed match marks have been transferred form the old to the new housing.

a. Position the turbine housing, on a flat level surface, with the discharge side down. Carefully insert the turbine wheel end of the bearing housing into the turbine housing. Ensure that the match marks are aligned and that the bearing housing enters the turbine housing squarely to avoid damaging the turbine wheel blades.

b. Install new clamp-plates over the flange on the bearing housing and align the bolt holes in the plates with the bolt holes in the turbine housing. Install new bolts and torque the bolts to 52 N.m (38 lbf.ft.).

c. Smear a new compressor housing retaining circlip with engine oil and install the circlip onto the bearing housing, ensuring that the bevelled side is toward the turbine housing. Position the bearing/turbine housing assembly and install a new O ring on the flange at the compressor end of the bearing housing (Figure 150). Carefully install the compressor housing onto the bearing housing and align the match marks. Without disturbing the turbocharger assembly, invert and position the assembly, compressor housing inlet down, on the base plate of the press. Position a suitable piece of flat steel plate on the turbine housing outlet and apply a uniform load of 159 to 182 kg (350 to 400 1bs) to the steel plate at a point directly above the wheel shaft centre-line. Install the oiled circlip, lug end first, into the groove in the compressor housing. Align the match marks and ensure that the circlip is correctly seated by tapping around the inner circumference of the circlip with a suitably sized drift and a hammer. Release the pressure from the turbocharger and remove it from the press.

DE(EMEI)3577-16

Figure 150 Installing the O ring

d. Install the coolant inlet and outlet fittings into position on the bearing housing and tighten the fittings securely.

e. Apply clean engine oil through the bearing housing oil inlet port and rotate the turbine wheel shaft several times to pre-oil the journal bearings, then refill the oil inlet hole with clean engine oil.

f. Install the turbocharger in accordance with EMEI Vehicle G 203 – Group 4.

59. The fuel system specifications are detailed in Table 10.

Table 10 Fuel System Specifications

Serial	Item	Specification
1	Control rack guide screw tightening torque	4.9 to 6.9 N.m (43 to 61 lbf.in)
	Delivery valve holders tightening torque	
2	Initial	39 N.m (29 lbf.ft)
3	Final	44 N.m (32 lbf.ft)
4	Delivery valve holder locking plates tightening torque	4.4 to 6.8 N.m (39 to 60 lbf.in)
5	Governor housing tightening torque	6.9 to 8.8 N.m (61 to 78 lbf.in)
	Front bearing cover	
6	Tightening torque	6.9 to 8.8 N.m (61 to 78 lbf.in)
7	Camshaft end-play	0.03 mm (0.001 in)
8	Injection pump base plugs tightening torque	54 to 74 N.m (40 to 55 lbf.ft)
9	Full-load set lever retaining nut tightening torque	10 to 14 N.m (88 to 124 lbf.in)
10	Transfer pump tightening torque	4.9 to 6.9 N.m (43 to 61 lbf.in)
11	Flyweight assembly retaining nut tightening torque	49 to 59 N.m (36 to 43 lbf.ft)
12	Governor housing face-to-pivot pin hole	28.8 to 29.2 mm (1.134 to 1.149 in)
13	Stop control lever tightening torque	10 to 14 N.m (7 to 10 lbf.ft)
14	U-shaped lever guide plug tightening torque	20 to 29 N.m (15 to 21 lbf.ft)
	Injection pump timing	
15	Plunger pre-stroke	3.6 $\pm$ 0.05 mm
	Pump cylinder port closure	
16	Cylinder 1	0°
17	Cylinder 3	90° $\pm$ 30'
18	Cylinder 4	180° $\pm$ 30'
19	Cylinder 2	270° $\pm$ 30'
20	Idling capsule locknut tightening torque	18 to 22 N.m (13 to 16 lbf.ft)
21	Inner idling spring cap-nut tightening torque	16 to 20 N.m (12 to 15 lbf.ft)
	Governor shaft guide screw protrusion	
22	Protrusion above governor cover	13.5 to 14.5 mm
23	Locknut tightening torque	39 to 49 N.m (29 to 36 lbf.ft)
	Governor shaft	
24	Locknut tightening torque	10 to 14 N.m (7 to 10 lbf.ft)
25	Cap-nut tightening torque	29 to 39 N.m (21 to 29 lbf.ft)
26	Governor cover tightening torque	20 to 29 N.m (15 to 21 lbf.ft)
27	Automatic timer tightening torque	49 to 59 N.m (36 to 43 lbf.ft)
28	Transfer pump piston plug tightening torque	78 to 88 N.m (57 to 64 lbf.ft)
29	Transfer pump tightening torque	40 N.m (29 lbf.ft)

Table 10 Fuel System Specifications (Continued)

Serial	Item	Specification
30	Transfer pump adapter tightening torque	12 N.m (8 lbf.ft)
	Automatic timer advance	
31	Pump speed and degrees advance - 1200 to 1300 rpm	No advance
32	1500 rpm	3 to 4 degrees
	Automatic timer	
33	Flange end-float	0.02 to 0.1 mm (0.0008 to 0.0039 in)
34	Locknut tightening torque	98 N.m (72 lbf.ft)
35	Timer flange tightening torque	43 N.m (32 lbf.ft)
36	Round nut tightening torque	59 to 69 N.m (43 to 51 lbf.ft)
	Fuel injectors	
37	Starting pressure	18 134 kPa (2630 psi)
38	Leak-down rate	Not less than six seconds from 18 134 kPa (2630 psi) to 10 132 kPa (1469 psi)
39	End-cap tightening torque	58 to 78 N.m (43 to 58 lbf.ft)
	Turbocharger bearing clearance	
40	Radial	0.056 to 0.127 mm (0.0022 to 0.005 in)
41	Axial	0.025 to 0.084 mm (0.001 to 0.0033 in)
42	Turbine housing retaining bolts tightening torque	52 N.m (38 lbf.ft)
43	Compressor housing	
44	Circlip installation pressure (Hydraulic press)	159 to 182 kg (350 to 400 lbs)

CLUTCH

Master Cylinder

60. Disassembly. Disassemble the master cylinder as follows:

a. Remove the master cylinder in accordance with EMEl Vehicle G 203 – Group 5.

b. Remove the circlip (Figure 151), the push rod and the retaining washer. The circlip may be reused if it is considered serviceable.

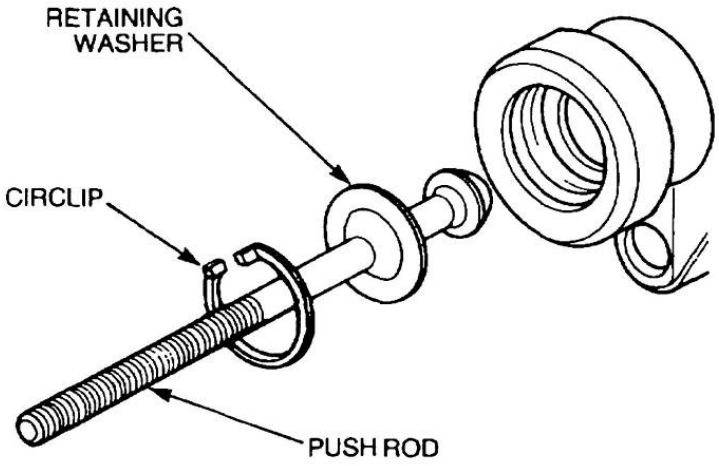


Figure 151 Removal of the Push Rod

c. Remove the piston assembly from the master cylinder (Figure 152). If necessary, apply a low air pressure to the outlet port to expel the piston.

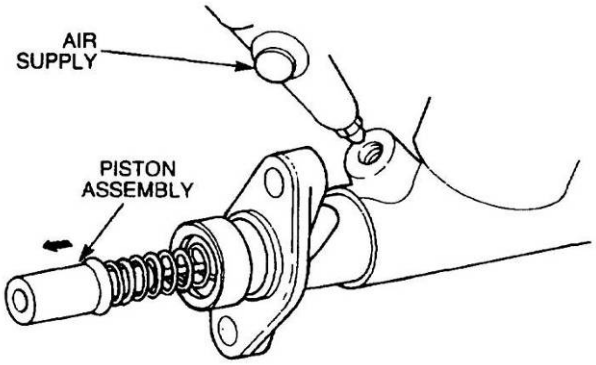


Figure 152 Removal of the Piston Assembly

d. Using a small screwdriver, prise the spring retainer locking prong clear of the piston shoulder, withdraw the piston (Figure 153), and the piston seal.

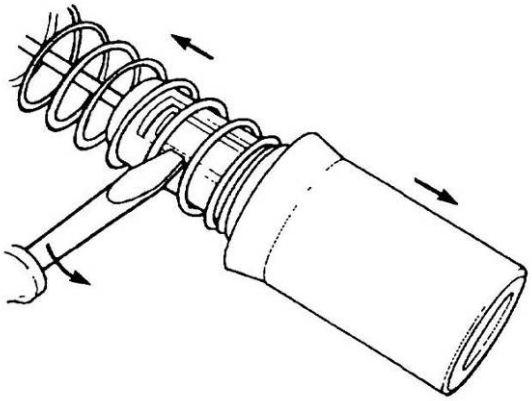


Figure 153 Removal of the Piston Seal

e. Compress the spring and position the valve stem to align with the larger hole in the spring retainer.

f. Remove the spring, retainer, valve spacer and spring washer from the valve stem. Remove the valve seal (Figure 154).

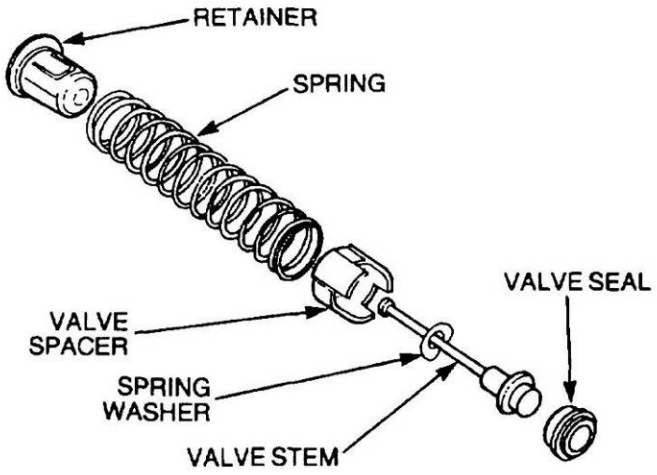


Figure 154 Disassembly of the Valve Stem

61. Cleaning and Inspection. Clean and inspect the master cylinder as follows:

a. Clean all components in a suitable solvent and allow them to dry.

b. Inspect the cylinder bore and piston. Check that they are smooth to touch and show no signs of corrosion, score marks or ridges. Replace parts as necessary.

62. Reassembly. Reassemble the master cylinder as follows:

a. Smear the new seals with a suitable rubber grease and the remaining internal components with clean brake fluid.

b. Install the valve seal, with the flat side first, onto the end of the valve stem (Figure 155).

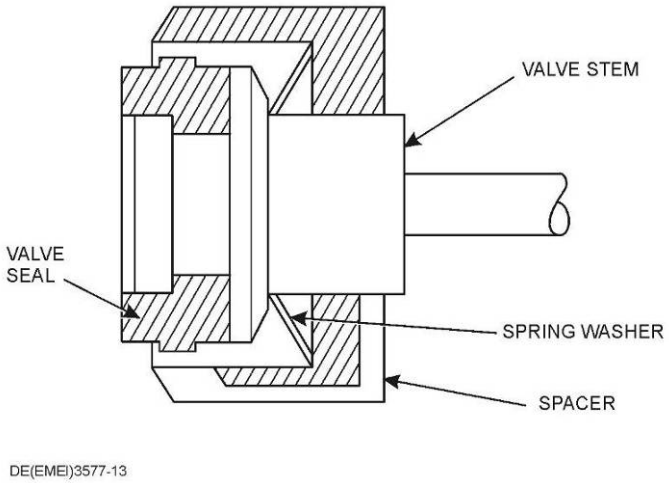


Figure 155 Valve Seal - Sectional View

c. Install the spring washer, domed side first, over the small end of the valve stem (Figure 155).

d. Install the spacer, with the legs entering the valve stem first.

e. Place the coil spring over the valve stem and insert the retainer into the spring.

f. Compress the spring and engage the valve stem in the keyhole slot provided in the retainer (Figure 156).

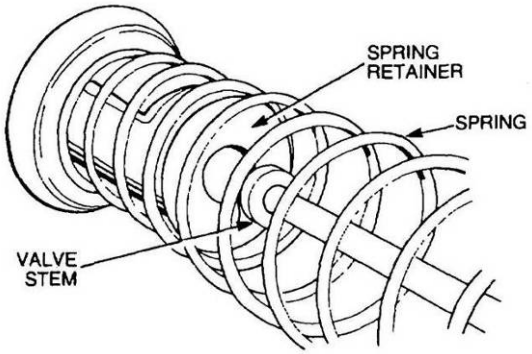


Figure 156 Reassembly of the Valve Stem

g. Install the seal, large diameter last, onto the piston.

h. Insert the piston into the spring retainer and engage the locking prong (Figure 157).

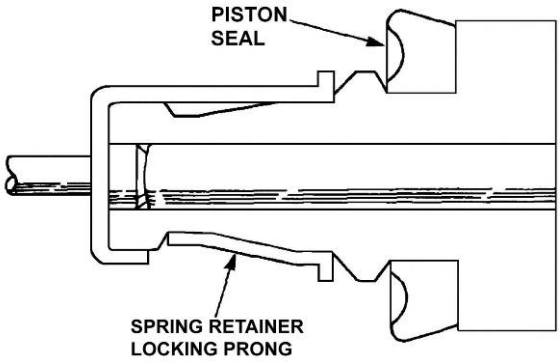


Figure 157 Installation of the Piston Seal

i. Smear the piston with a suitable rubber grease and insert the piston assembly, valve end first, into the cylinder.

j. Install the push rod, retaining washer and circlip (Figure 158).

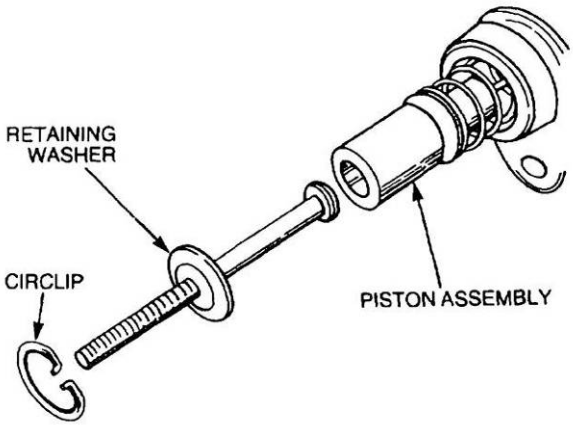


Figure 158 Installation of the Piston Assembly

k. Install the master cylinder in accordance with EMEl Vehicle G 203 – Group 5.

Slave Cylinder

63. Disassembly. Disassemble the slave cylinder as follows:

a. Remove the slave cylinder in accordance with EMEl Vehicle G 203 – Group 5.

b. Remove the dust cover and the piston assembly from the slave cylinder (Figure 159). If necessary, apply a low air pressure to the inlet port to expel the piston. Remove the seal from the piston and discard the seal.

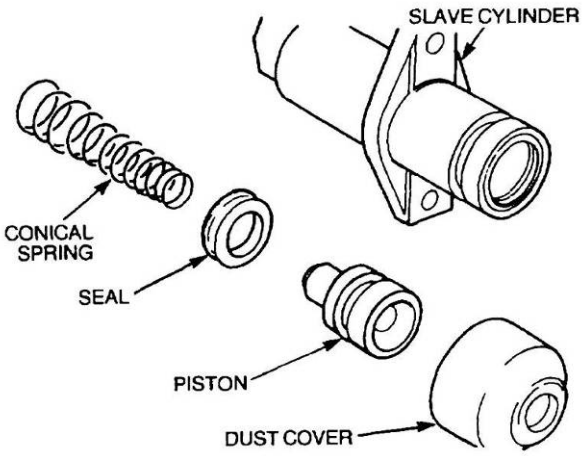


Figure 159 Slave Cylinder - Exploded View

c. Remove the conical spring.

64. Cleaning and Inspection. Clean and inspect the slave cylinder as follows:

a. Clean all components in a suitable solvent and allow them to dry.

b. Ensure that the cylinder bore and piston are smooth to touch and show no sign of corrosion, scale marks or ridges. Replace parts as necessary.

65. Reassembly. Reassemble the slave cylinder as follows:

a. Smear all internal components with clean brake fluid.

b. Assemble the conical spring, a new seal and the piston in the sequence shown (Figure 159).

c. Smear the cylinder bore with clean brake fluid and insert the piston assembly, spring end first, into the cylinder. Fit the dust cover.

d. Install the slave cylinder in accordance with EMEL Vehicle G 203 – Group 5.

TRANSMISSION

NOTE

If the transfer of oil between the gearbox and the transfer case is suspected, carry out the monitoring procedures detailed in EMEI Vehicle G 204-1 – Group 6 prior to changing the transmission.

If the transfer case is suffering continual disengagement (jump-out), the problem is to be rectified in accordance with the procedures detailed in EMEI Vehicle G 204-1 – Group 6 prior to changing the transmission assembly.

66. Disassembly. Disassemble the transmission as follows:

WARNING

New gaskets provided by Land Rover do not contain asbestos. Older gaskets still fitted to vehicles may contain asbestos. During this task some parts may contain asbestos; refer and comply with procedures and warnings in the introduction section of this EMEI under paragraph heading: Items Previously Known To Have Contained Asbestos.

a. Remove the PTO (if fitted) and transmission assembly in accordance with EMEl Vehicle G 204-1 – Group 6.

b. Remove the transmission and transfer case drain plugs and drain the oil into a suitable receptacle. Remove and clean the filter.

c. Remove the bolt and clip retaining the release lever to the pivot (Figure 160). Remove the lever and the release bearing.

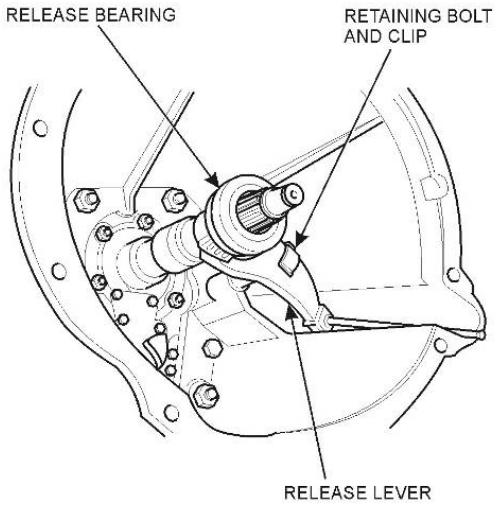


Figure 160 Removal of the Release Lever and Bearing

d. Remove the four bolts and nuts retaining the bell housing to the transmission. Remove the bell housing.

e. Move the gear and transfer levers to the neutral positions. Remove the reverse light switch.

f. Disconnect the transfer selector linkage at the lower ball joint. Remove the eight bolts retaining the top cover and transfer lever cross-shaft to the transmission case. Remove the top cover, ensuring that the detent springs do not fall into the case.

g. Remove the detent springs, taking note that the reverse spring is painted yellow (Figure 161). Using a small magnet remove the detent balls.

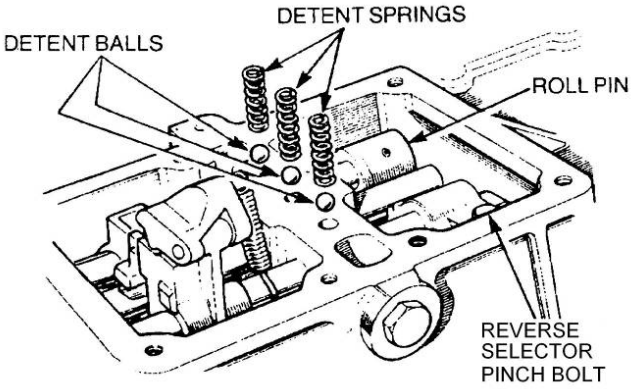


Figure 161 Removal of the Detent Springs

h. Slacken the pinch bolt securing the reverse selector finger. Using a suitable pin-punch, remove the four roll pins retaining the selectors on the shafts.

CAUTION

To prevent damage to the casing the selector shafts must be in the neutral position prior to removal.

i. Disconnect the reverse selector spring from the hinge stop plate and tap the selector shafts out through the front bearing plate. Remove the selectors and forks.

j. Remove the plug retaining the two interlock plungers in the cross drilling (Figure 162), and remove the plungers. Remove the lockwire and pivot bolt and lift out the reverse cross-over lever.

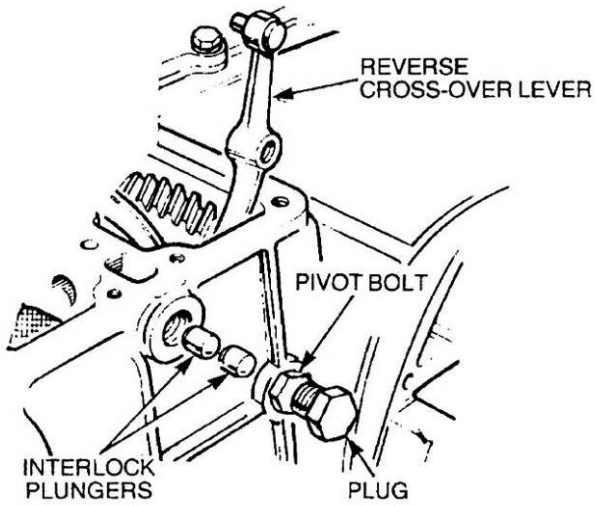


Figure 162 Removal of the Interlock Plungers and Reverse Cross-over Lever

k. Position the transmission with the front end uppermost. Remove the bolts, locknuts and washers retaining the front cover and oil pump. Remove the oil pump cover and gears, and remove the oil pump drive gear (Figure 163).

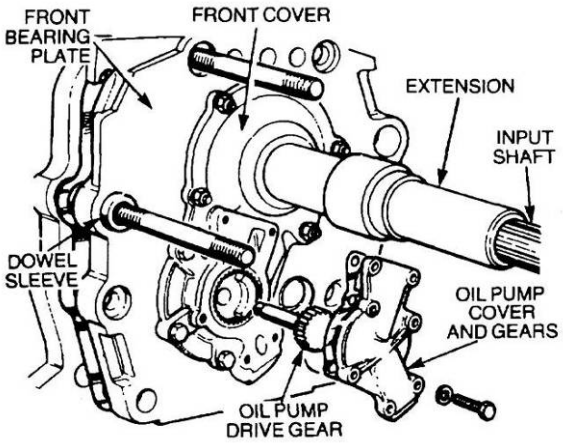


Figure 163 Removal of the Oil Pump and Drive Gear

l. Remove the plug retaining the ball and spring from the relief valve housing located in the front cover.

m. Remove the nuts and washers retaining the input shaft bearing and gently tap the shaft rearwards. Remove the four studs installed through the bearing plate and ease the plate away from the transmission.

n. Remove the two dowel sleeves which locate the bearing plate. Remove the plate complete with the input shaft and countershaft.

o. Remove the countershaft assembly from the bearing plate. Using special tools MS47 and 18G47BA remove and discard the bearing cones from the countershaft (Figure 164).

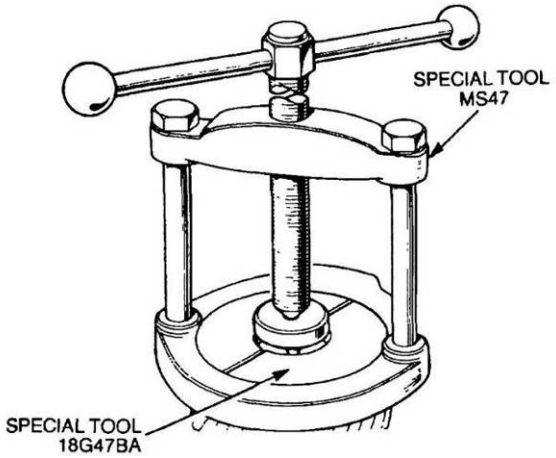


Figure 164 Removal of the Countershaft Bearing

p. Remove the bolts and washers retaining the side and bottom covers (if fitted). Remove the bolt retaining the reverse idler gear shaft in the transmission casing (Figure 165).

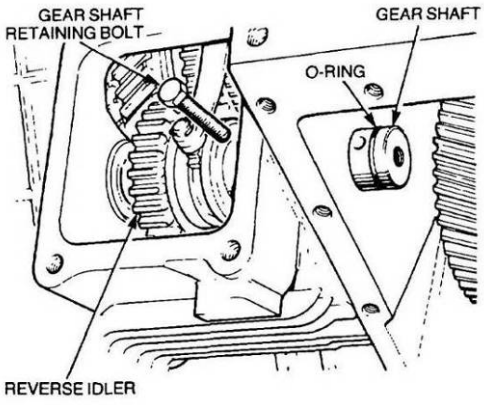


Figure 165 Removal of the Reverse Idler Gear and Shaft

q. Using special tool 18G1335, withdraw the gearshaft. Remove and discard the O ring and lift out the reverse idler assembly.

r. Remove the circlips retaining the needle roller bearings in the reverse idler. Remove the bearings and washer (Figure 166). Discard the circlips and bearings.

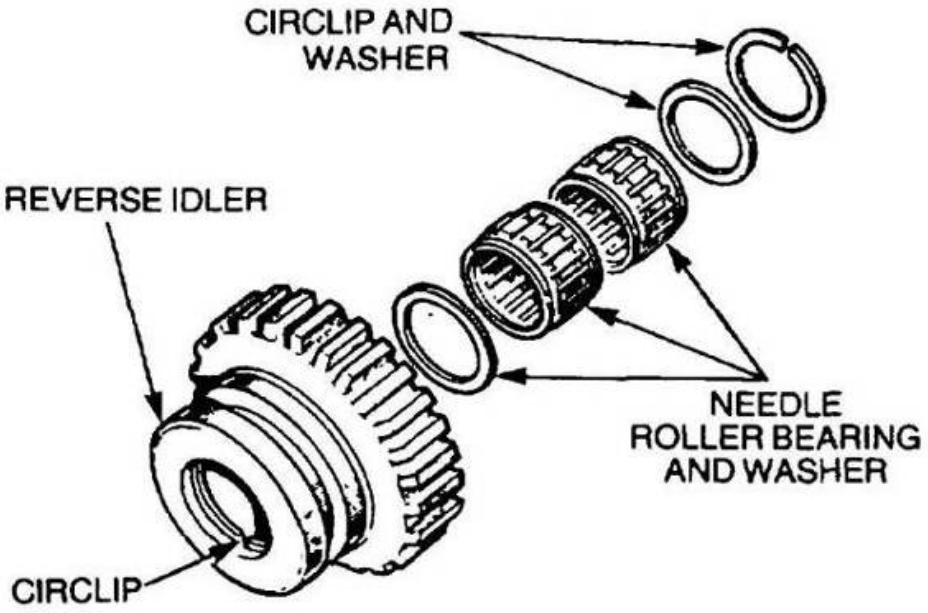


Figure 166 Reverse Idler - Exploded View

WARNING

The transfer gear is secured to the main shaft with Loctite 275 and requires considerable force to remove it. Ensure that special tool 18GA091 is correctly located on the transfer gear before using it to prevent it dislodging under force and causing injury.

s. Using special tool 18G1205A to prevent the rear axle output flange from rotating, remove the locknut securing the flange to the output shaft. Remove the flange and mud shield assembly.

WARNING

The transfer gear spacer is secured to the main shaft with Loctite 275 and requires considerable force to remove it. Ensure that special tool 18GA091 is correctly located on the transfer gear spacer and the extractor pins are securely installed before using it to prevent it dislodging under force and causing injury.

t. Remove the four bolts and lock-washers securing the rear axle output shaft lock vacuum chamber assembly (Figure 167). Remove the output shaft lock vacuum chamber assembly and discard the gasket and lock-washers. Take care not to lose the detent ball and spring during removal.

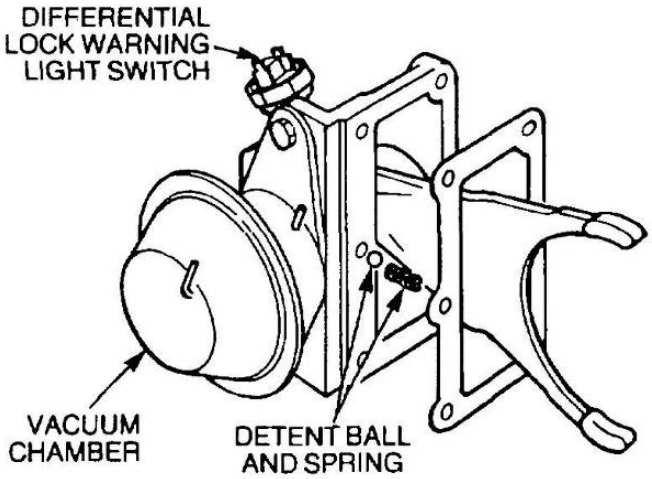


Figure 167 Removal of the Output Shaft Lock Vacuum Chamber Assembly

NOTE

If replacement of the output shaft lock diaphragm is necessary, the procedure is the same as used on the differential lock. Refer to EMEl Vehicle G 203 – Group 6 for the procedure.

u. Remove the six bolts and lock-washers securing the rear axle output shaft housing to the adapter. Withdraw the housing, complete with the output shaft, from the adapter and quill shaft (Figure 168).

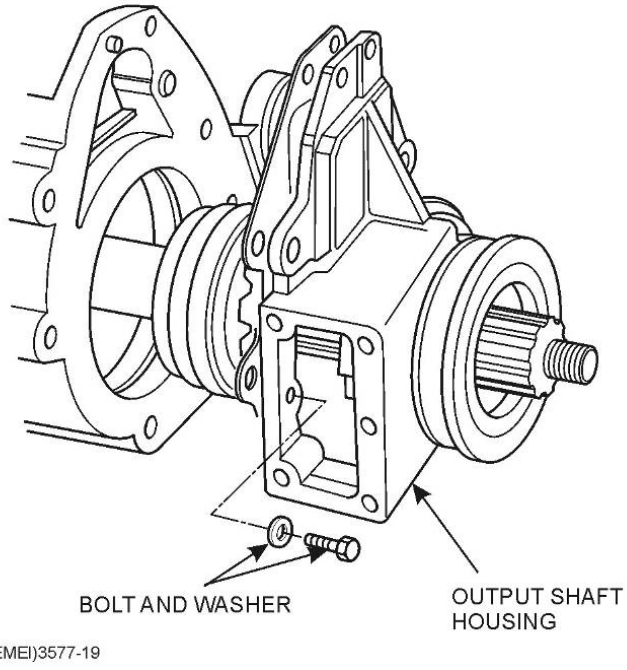


Figure 168 Removal of the Output Shaft Housing

v. Position the output shaft housing assembly in a press. Ensure that the mounting surface of the housing is properly supported on a suitable jig and press the output shaft from the housing.

w. Remove the oil seal from the rear of the output shaft housing and remove the large circlip retaining the bearing. Remove the bearing (Figure 169).

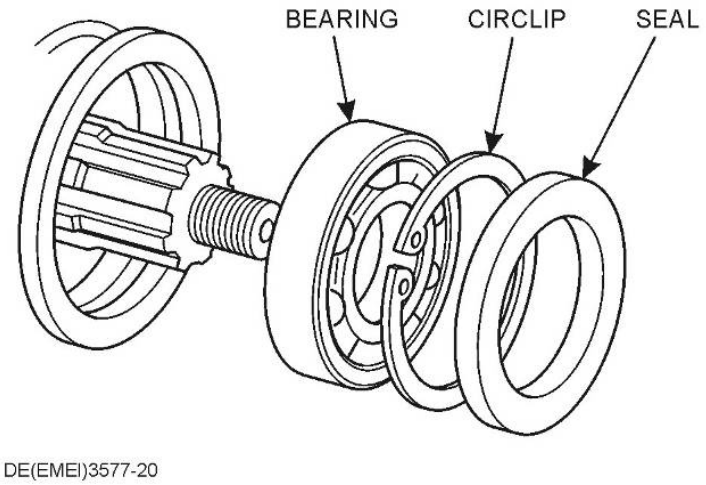


Figure 169 Removal of the Seal, Circlip and Bearing

x. Remove the eight bolts and washers securing the adapter to the transfer case, and remove the adapter, complete with gear, quill shaft and sliding clutch, from the transfer case.

y. Slide the sliding clutch off the quill shaft, bend back the lock-washer tang, then using special tool 18GA081 (socket) with a suitable bar, remove the nut from the quill shaft (Figure 170).

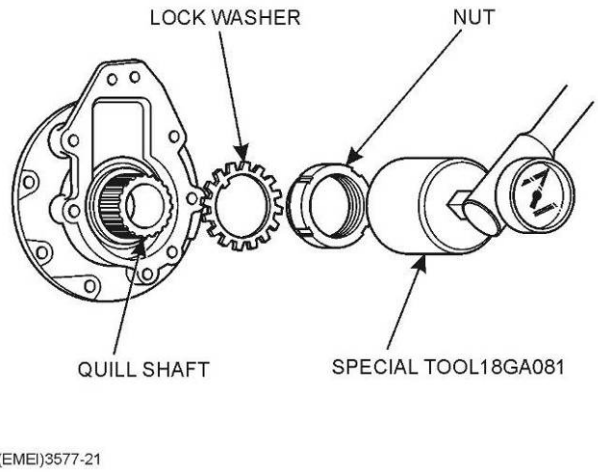


Figure 170 Removal of the Quill Shaft Retaining Nut

NOTE

Retain the selective thickness spacer to obtain the correct setting at reassembly.

z. Remove the quill shaft by positioning the adapter assembly (gear end down) on a suitable jig. Position the jig and adapter assembly in the press and, with the aid of a suitable arbor, press the quill shaft together with the inner bearing and selective spacer from the adapter.

aa. Invert the adapter in the press, and with the aid of a suitable arbor, press the outer bearing from the adapter.

bb. Remove the bolts and washers securing the gear to the quill shaft and remove the gear. Remove the spigot bearings, thrust washer and spacer from the bore of the quill shaft.

cc. Position a suitable collar between the bearing and the gear mounting flange on the quill shaft. Support the collar in the press and press the quill shaft from the bearing.

WARNING

The transfer gear is secured to the main shaft with Loctite 275 and requires considerable force to remove it. Ensure that special tool 18GA091 is correctly located on the transfer gear before using it to prevent it dislodging under force and causing injury.

dd. Remove the circlip and shim retaining the transfer gear to the mainshaft. Using special tool 18GA091, withdraw the transfer gear (Figure 171). Discard the circlip.

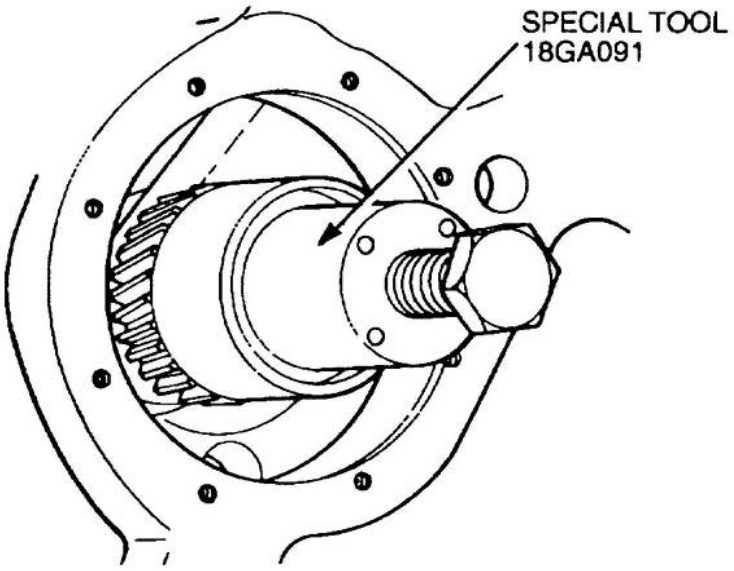


Figure 171 Removal of the Transfer Gear

ee. Using special tool 18GA091 (Figure 172), withdraw the transfer gear spacer along the mainshaft until the larger diameter on the spacer reaches the transfer gear lever cross-shaft. Remove the special tool when the spacer is loose on the mainshaft.

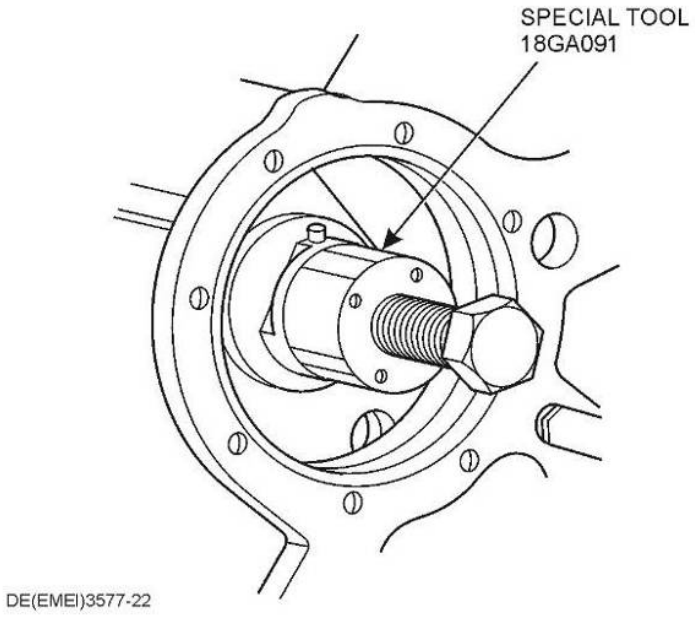


Figure 172 Removal of the Transfer Gear Spacer

ff. Carefully remove the mainshaft assembly while simultaneously removing the first speed gear from the shaft (Figure 173). Lift out the first speed gear.

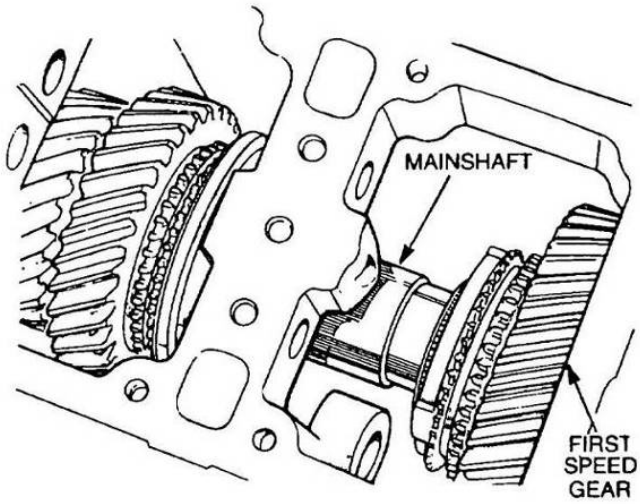


Figure 173 Removal of the Mainshaft

gg. Remove the thrust washers and roller bearings from the rear of the mainshaft. Remove the circlip and shim from the front of the mainshaft.

hh. Remove the third and fourth gear synchromesh assembly (Figure 174). Discard the circlip and bearing.

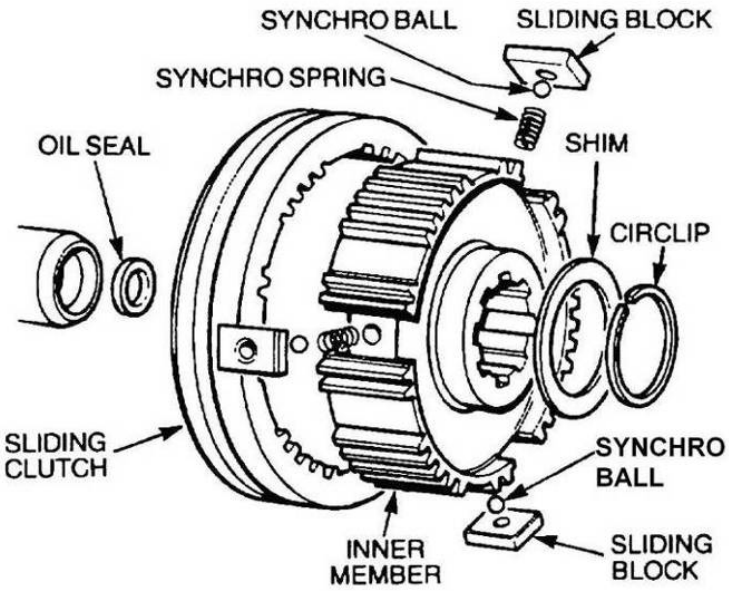


Figure 174 Third and Fourth Gear Synchromesh - Exploded View

ii. Remove the third and second speed gears together with the thrust washers and needle roller bearings, discard the bearings.

jj. Match mark the third and fourth gear synchromesh assembly, push down on the sliding blocks and remove the sliding clutch. Following the same procedure, dismantle the first and second gear synchromesh.

kk. Remove the oil seal fitted to the front end of the mainshaft. Discard the oil seal.

ll. Remove the circlip retaining the input shaft to the bearing (Figure 175). Remove the shim, and using a suitable press, remove the input shaft. Discard the needle roller bearing.

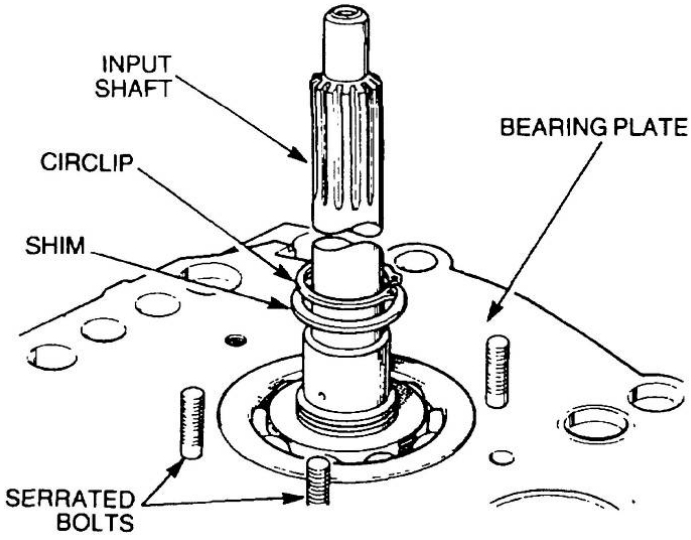


Figure 175 Removal of the Input Shaft

mm. Using special tool 18GA284AAH remove the oil feed ring and oil seal from the input shaft. Discard the oil seal.

nn. Remove the two input shaft bearing retaining plates and serrated bolts. Using a suitable press, remove the bearing from the transmission bearing plate. Discard the bearing.

oo. Using a suitable press, remove the countershaft front bearing cup from the transmission bearing plate. Using special tools 18G284 and 18G284AR, remove the countershaft rear bearing cup (Figure 176). Discard the bearing cups.

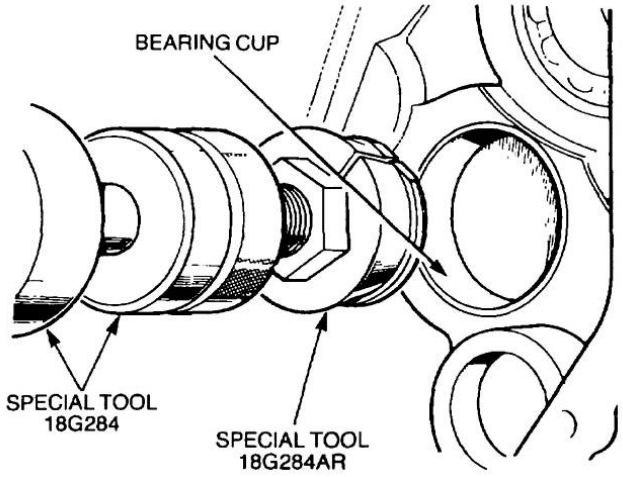


Figure 176 Removal of the Countershaft Rear Bearing Cup

pp. Using a suitable press, remove the mainshaft rear bearing and oil seal. Discard the bearing and the oil seal.

67. Cleaning and Inspection. Clean and inspect the transmission as follows:

WARNING

DO NOT spin the bearings with compressed air as personal injury or damage to the bearings may result.

Under no circumstances is compressed air to be used to remove dust from the clutch assembly, bell housing and flywheel housing. Dust from the brake linings can be a health risk if inhaled.

New gaskets provided by Land Rover do not contain asbestos. Older gaskets still fitted to vehicles may contain asbestos. During this task some parts may contain asbestos; refer and comply with procedures and warnings in the introduction section of this EMEI under paragraph heading: Items Previously Known To Have Contained Asbestos.

a. Clean the case, covers and all other parts of the transmission thoroughly with a suitable cleaning agent. Ensure all traces of old gaskets and sealer are removed and blow all parts dry with compressed air.

b. Inspect the gear teeth for wear, damage, scoring, surface fatigue, ridging or cracking. The gears may also be checked by Magnetic Particle Inspection or similar method for cracks which would not otherwise be visible.

c. Replace the selector forks and/or sliding clutches if the side clearance in the groove is excessive.

d. Replace the selector shaft if it is cracked in either the detent or locating roll pin holes.

NOTE

The front bearing plate and transmission case is supplied as a matched pair only.

e. Check the transmission case for cracks and replace it if necessary.

f. Inspect the detent springs for damage or loss of tension and replace them as necessary.

g. Check all other parts for wear or damage. Replace all parts as required.

h. Clean up any damaged threads.

i. Inspect the oil pump drive gear teeth and shaft for damage or wear. Replace parts as necessary.

68. Reassembly. Reassemble the transmission as follows:

NOTE

Do not degrease the thrust washers and roller bearings prior to assembly. Lubricate all items with clean engine oil and apply a suitable petroleum jelly on all bearing surfaces.

a. Using a suitable press, insert the new mainshaft rear bearing into the transmission case and secure it with the circlip. Using special tool 18G1426, press in the oil seal with the lip towards the front of the case (Figure 177).

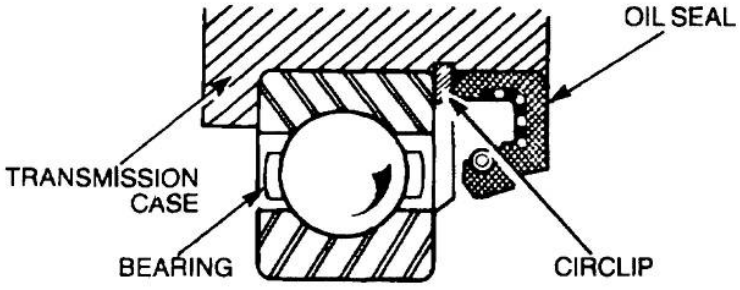


Figure 177 Installation of the Mainshaft Rear Bearing and Oil Seal

b. Fit the oil seal to the front end of the mainshaft.

c. Install the third and fourth gear synchromesh inner member into the sliding clutch. Ensure that the match marks are aligned and the sliding clutch coned face is fitted towards the plain face of the inner member.

d. Install the sliding blocks with the radius face outwards. Insert the springs through the sliding blocks and into the locating bores in the inner member. Position the balls on the spring ends and push them fully into the inner member. Move the sliding clutch over until the balls are engaged in the annular groove in the sliding clutch. Following the same procedure, assemble the first and second gear synchromesh, ensuring that the sliding clutch coned face is installed towards the front end of the mainshaft.

e. Install a synchromesh cone along the mainshaft and engage the cone teeth in the first and second synchromesh sliding clutch (Figure 178).

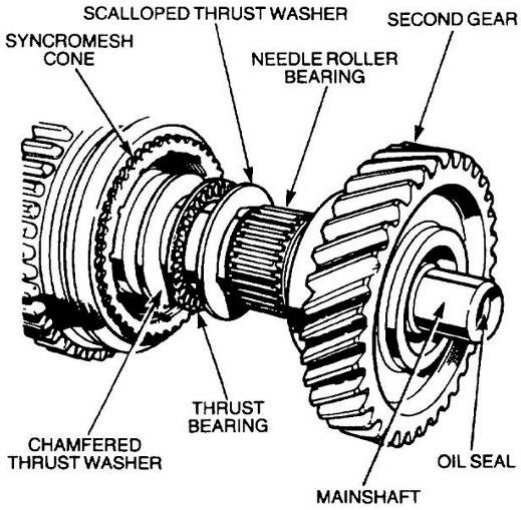


Figure 178 Installation of Second Gear

f. Install a chamfered thrust washer (with the chamfer towards the radius on the gear), the thrust bearing and a scalloped thrust washer on the rnainshaft. Fit a new needle roller bearing and the second gear.

g. Install a scalloped thrust washer, a thrust bearing and another scalloped washer on the mainshaft. Fit a new needle roller bearing and the third gear (Figure 179).

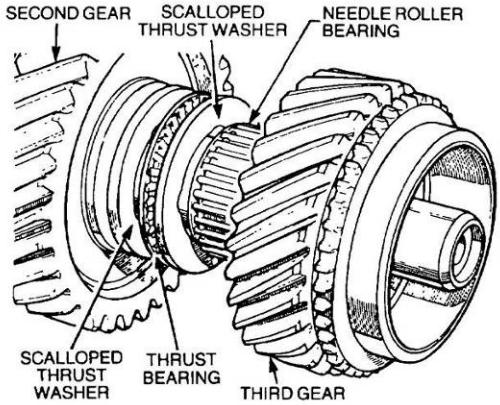


Figure 179 Installation of Third Gear

h. Install a scalloped thrust washer, a thrust bearing and another scalloped washer on the mainshaft. Position a synchromesh cone on the third gear and fit the third and fourth synchromesh assembly, ensure that the coned face is towards the rear of the mainshaft (Figure 180).

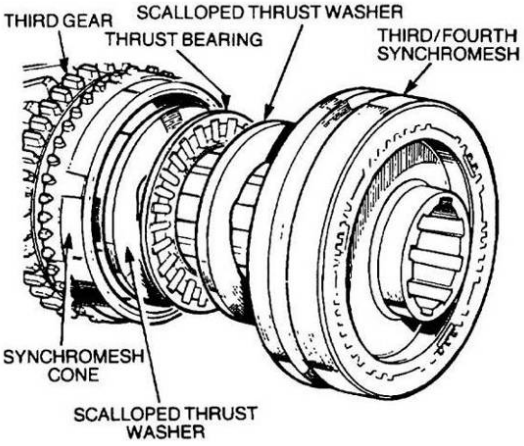


Figure 180 Installation of the Third and Fourth Synchromesh

NOTE

The shim range is from 1.55 mm (0.059 in) to 2.50 mm (0.098 in) in 0.05 mm (0.002 in) increments.

i. Position the mainshaft vertically with the front end uppermost and apply a light load on the gears to remove any end-play. Insert the circlip into the mainshaft groove and measure the distance between the circlip lower edge and the third and fourth synchromesh inner member (Figure 181). Install a suitable shim to obtain a clearance of between 0.025 to 0.150 mm (0.001 to 0.006 in.) and install the circlip.

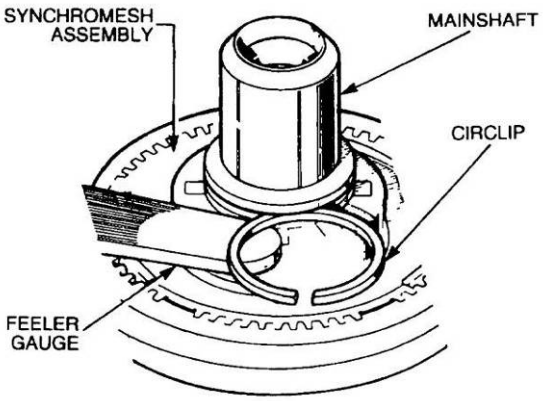


Figure 181 Adjustment of the Mainshaft End-play

NOTE

The countershaft bearing cones and cups are supplied as matched pairs only. The bearings must not be degreased prior to installation. Lubricate with clean engine oil.

j. Using a suitable press, install the countershaft bearing cones on the countershaft.

k. Using a suitable press, install the new countershaft rear bearing cup into the transmission case. Fit the new countershaft front bearing cup into the front bearing plate, but do not install it fully.

l. Position the countershaft into the transmission casing, ensuring that the oil pump drive end is at the front of the transmission.

m. Install the front bearing plate and gasket on the transmission case and insert the four studs. Using suitable spacers fit the bell housing retaining nuts, washers and bolts and tighten them securely (Figure 182).

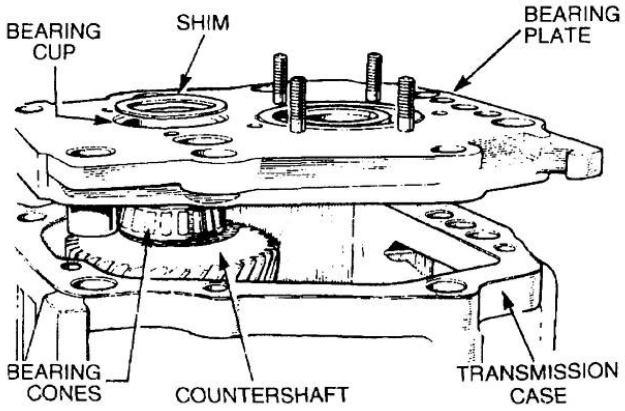


Figure 182 Adjustment of the Countershaft Bearing Pre-load

n. Press in the front bearing cup until all end-play is taken up and there is no load on the bearings. Install a suitable shim so that there is approximately 0.25 mm (0.010 in) standing proud of the bearing plate (Figure 182).

o. Install the oil pump cover and a new gasket, but do not include the pump drive gear. Ensuring the shim remains in position, secure the cover with the bolts and nuts and torque them to 30 N.m (22 lbf.ft).

NOTE

The shim range is from 1.55 mm (0.059 in) to 2.50 mm (0.098 in) in 0.05 mm (0.002 in) increments.

p. Using a spring balance and cord coiled around the larger diameter countershaft, measure the rolling resistance. With the bearings oiled, the rolling resistance must be 2.7 to 4.0 kg (6 to 8.8 lbs). To obtain the correct pre-load replace the shim as necessary with one of the correct thickness (Figure 183).

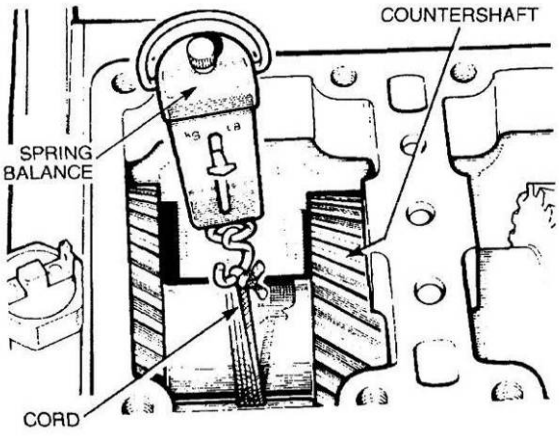


Figure 183 Countershaft Rolling Resistance

q. Remove the oil pump cover and bearing plate once the correct pre-load has been determined.

CAUTION

To prevent damage to the mainshaft, smear a suitable petroleum jelly onto the stepped washer to retain the washer in position during reassembly.

r. Install a synchromesh cone along the rear end of the mainshaft and engage the cone teeth in the first and second synchromesh sliding clutch. Position a chamfered thrust washer (with the chamfer towards the radius on the gear), a thrust bearing and a scalloped washer, then install the first gear and a new need1e roller bearing. Ensure that the gear synchromesh teeth are fitted towards the synchromesh assembly (Figure 184). Install a scalloped thrust washer, a thrust bearing and a stepped thrust washer with the stepped face outwards.

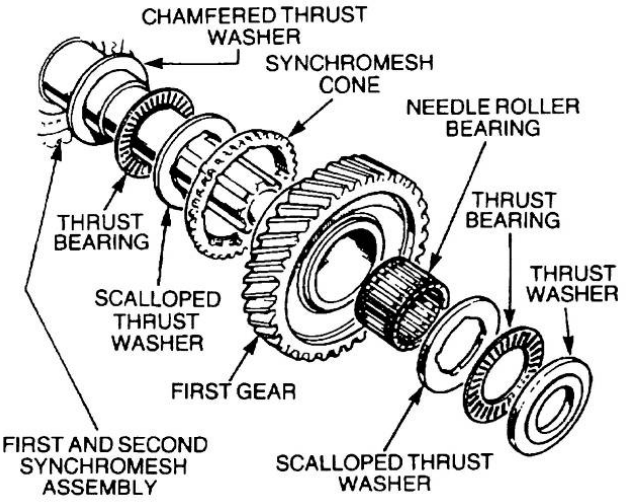


Figure 184 Installation of First Gear

s. Slide the first gear complete with the thrust washers and bearing to the end of the mainshaft. Install the mainshaft in the transmission and rear bearing.

t. Push the mainshaft fully into the bearing ensuring that the stepped washer bearings and thrust washers are correctly located. Install the mainshaft rear spacer on the shaft and positioned in the seal. Fit the transfer gear (Figure 185).

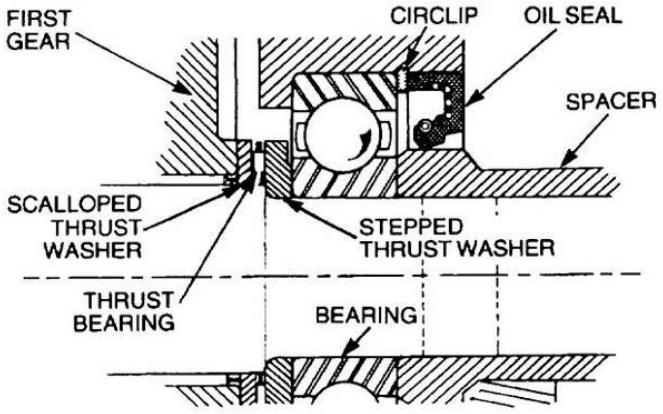


Figure 185 Installation of the Mainshaft and the Rear Spacer

u. Secure the transfer gear to the mainshaft with a new circlip. Push the mainshaft to the rear of the transmission and measure the clearance between the circlip and the transfer gear. The maximum clearance between the circlip and transfer gear is 0.050 mm (0.002 in). To obtain the correct pre-load on the mainshaft, insert a shim of the correct thickness (Figure 186).

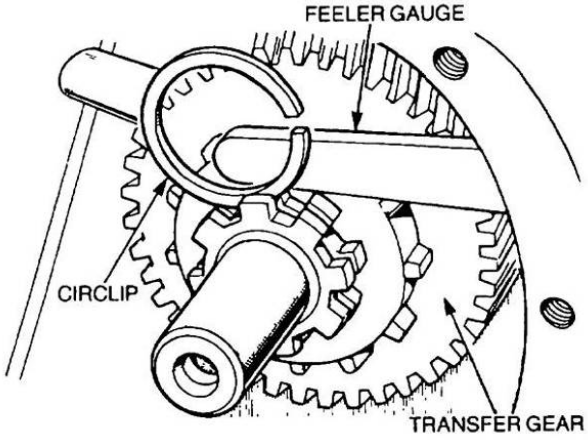


Figure 186 Adjustment of the Mainshaft Pre-Load

v. Remove the circlip and the transfer gear, and slide back the spacer as far as possible. Apply a thin coating of Loctite 275 to the exposed area of the shaft and push the spacer forward to contact the rear bearing. Apply Loctite 275 to the mainshaft rear splines, install the transfer gear and selected shim and secure them with the circlip.

NOTE

Prior to reassembly of the rear axle output shaft housing, place the quill shaft and new bearing cups in a refrigerator and allow them to cool overnight.

w. Using hot water, heat the output shaft adapter housing to 70 degrees C, then smear the bearing bores with molybdenum disulphide grease. Remove the bearing cups from the refrigerator and insert the cups (with the wide part of the taper innermost) into the housing. Ensure that the cups butt firmly against the housing and hold the cups in this position until the temperatures of the bearing cups and the housing return to ambient temperature.

x. Check that the bearing cups are held firmly in the housing and lubricate the bearing cages with oil. Position one bearing cage on the quill shaft (with the bearing rollers facing away from the gear flange) and with the aid of a suitable mandrel, press the bearing into place. Ensure that the bearing butts firmly against the flange.

y. Position the gear on the quill shaft flange ensuring that the countersunk ends of the tapped bolt holes of the gear are toward the flange on the shaft. Rotate the gear to align the bolt holes, apply Loctite 275 to the threads of the gear retaining bolts and install the bolts together with new lock-washers. Torque the retaining bolts to 60 to 64 N.m (44 to 47 lbf.ft).

z. Place the original selective thickness spacer (or a new spacer of equivalent thickness) on the quill shaft and against the bearing. Position the quill shaft in the adapter housing, using a press and a suitable mandrel; install the remaining bearing cage onto the quill shaft. Ensure that the bearing cage is firmly seated against the spacer.

aa. Install a new locking washer and the nut onto the quill shaft. Using special tool 18GA081 (socket) and a torque wrench, torque the nut to 61 N.m (45 lbf.ft) (Figure 187).

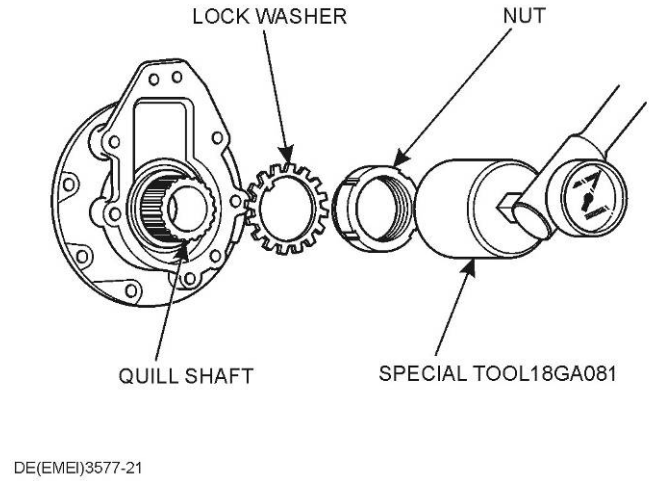


Figure 187 Installation of the Quill-shaft Lock-washer and Nut

bb. Mount a dial indicator on the adapter with the dial indicator plunger positioned at 90 degrees to, and resting against, the end of the quill shaft (Figure 188). Check the quill shaft end-float and if necessary, replace the selective thickness spacer to obtain a reading of 0.0063 to 0.0762 mm (0.00025 to 0.003 in).

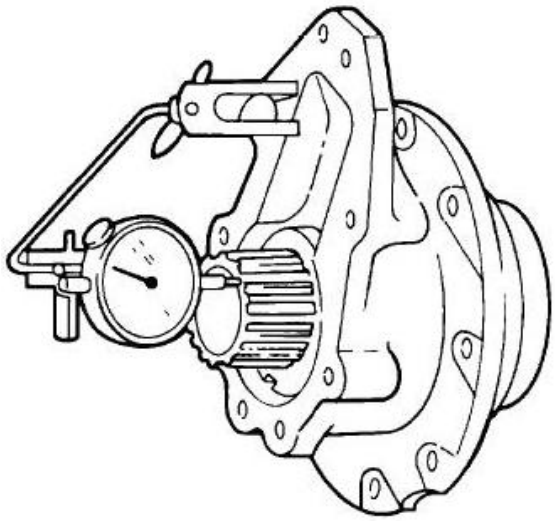


Figure 188 Checking the Quill-shaft End-float

cc. When the end-float is within specification, bend over the lock-washer tang to secure the nut.

dd. Install a new spacer washer, a new output shaft needle roller (pilot) bearing, bearing spacer and a new mainshaft needle roller (pilot) bearing into the bore of the quill shaft (Figure 189). Lubricate the needle roller bearings with clean oil. Position the adapter, together with a new gasket, on the transfer case while guiding the needle roller bearing over the end of the mainshaft. Install and torque the eight retaining bolts to 30 N.m (22 lbf.ft).

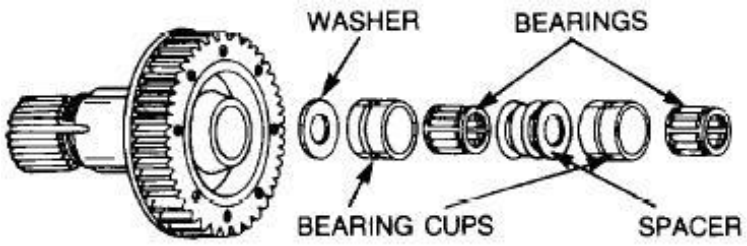


Figure 189 Installation of the Mainshaft and Output Shaft Pilot Bearing

ee. Lubricate the splines on the quill shaft and the sliding clutch collar with clean oil. Position the sliding clutch, concave surface toward the transfer case, on the quill shaft.

ff. Lubricate the output shaft bearing with clean oil and install the bearing in the output shaft housing. Secure the bearing in place with a new circlip (Figure 190). Invert the housing and support the bearing cone (inner race) on a suitable piece of tube steel. Position the assembly in the press and start the output shaft into the bearing. Press the shaft in until the shoulder of the shaft butts firmly against the bearing. Remove the assembly from the press, smear a new oil seal with clean oil and install the oil seal, with the open side toward the bearing, into the rear of the housing.

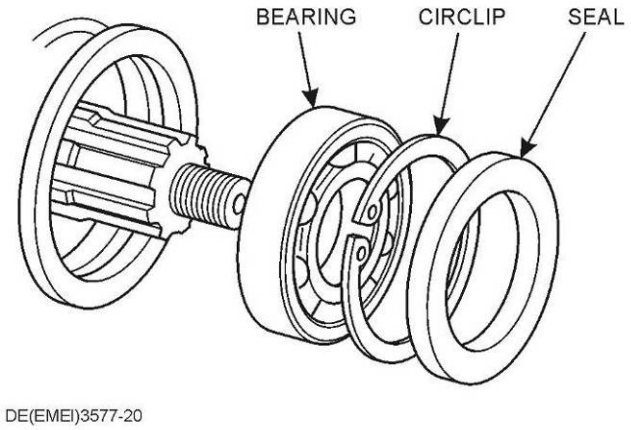


Figure 190 Installation of the Output Shaft Bearing, Circlip and Oil Seal

gg. Position the output shaft housing, together with a new gasket, on the adapter (Figure 191). Install the retaining bolts with new lock-washers and torque the bolts to 30 N.m (22 lbf.ft).

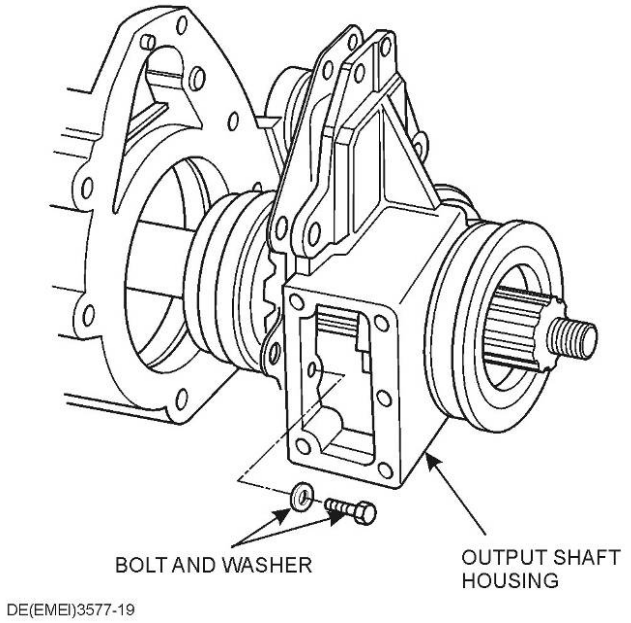


Figure 191 Installation of the Output Shaft Housing

hh. Insert the detent ball and spring into place in the output shaft lock vacuum chamber. Position the vacuum chamber assembly, complete with a new gasket, on the output shaft housing. Ensure that the tangs of the selector fork engage with the groove in the sliding clutch. Install the retaining bolts and washers and torque the bolts to 30 N.m (22 lbf.ft).

ii. If removed, install the propeller shaft retaining bolts and the mud shield on the output shaft flange. Lubricate the sealing surface of the flange with clean oil and install the flange onto the output shaft (Figure 192). Install a new locknut and washer onto the output shaft, using special tool 18G1205A to prevent the flange from rotating, torque the nut to 146 to 180 N.m (108 to 132 lbf.ft).

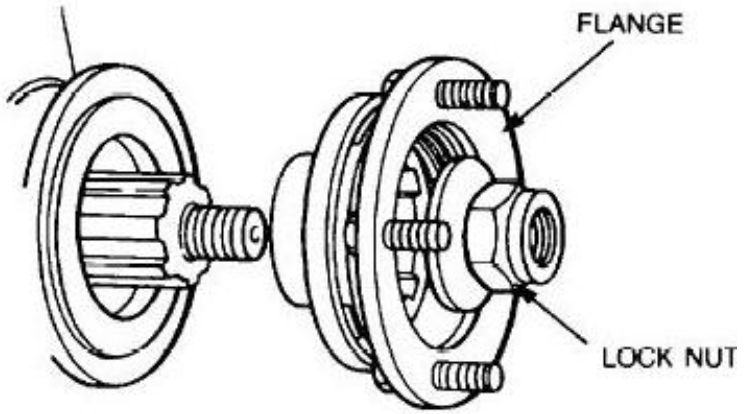


Figure 192 Installation of the Output Shaft Flange Assembly

NOTE

The shim range is 2.0 mm (0.079 in) to 2.15 mm (0.085 in) in 0.05 mm (0.002 in) increments.

jj. Using a suitable press, install the new input shaft bearing in the front bearing plate until the bearing is flush with the plate. Install the two bearing retaining plates with the studs towards the front of the transmission case. Press in the input shaft fully, install the shim and circlip, and measure the clearance between the circlip and the shim (Figure 193). The maximum clearance is 0.05 mm (0.002 in). To obtain the correct pre-load on the input shaft, replace the shim with one of the correct thickness.

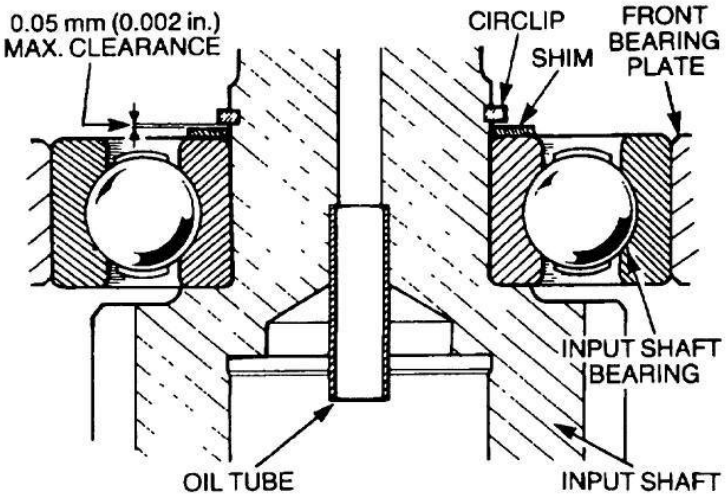


Figure 193 Installation of the Input Shaft

kk. Using special tools 18G134 and 18G134DG, press in the oil seal, plain face first (Figure 194), into the front cover.

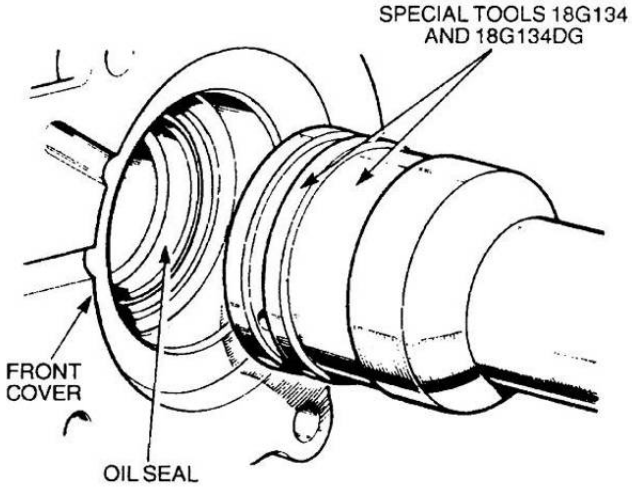


Figure 194 Installation of the Front Cover Oil Seal

CAUTION

Aligning the oil feed ring and the oil delivery hole is critical. A restricted oil supply to the mainshaft will result if the holes are not aligned.

ll. Align the centre oil hole on the oil feed ring with the oil delivery hole in the front cover. Using special tool 18G134 and 18G134DG, press in the oil feed ring (Figure 195).

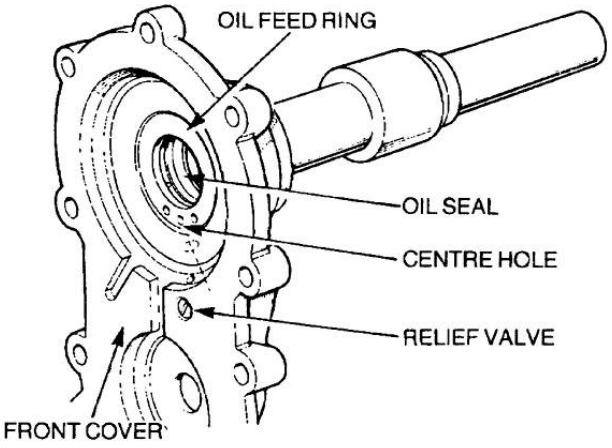


Figure 195 Installation of the Oil Feed Ring and Relief Valve

mm. Ensure that the relief valve ball and spring are serviceable. Check that the retaining plug is approximately one thread or 0.25 mm (0.010 in) below the front cover rear face.

nn. Install the countershaft in the front bearing plate. Insert a synchromesh cone into the mainshaft first and second synchromesh sliding clutch.

CAUTION

A restricted oil supply will result if the input shaft oil tube and mainshaft oil seal are not seated correctly. Severe transmission damage can be caused by restricted oil flow.

oo. Rotate the input shaft to ensure that the oil feed tube is central and smear the tube and the mainshaft oil seal with clean engine oil.

NOTE

The front bearing plate and the transmission case are supplied as a matched pair only.

pp. Carefully install the front bearing plate assembly and a new gasket onto the transmission case. Ensure that the oil feed tube does not damage the oil seal.

qq. Insert the two dowel sleeves in the front bearing cover and smear Loctite 242 on the threads of the upper studs. Install the front bearing plate retaining studs and tighten them securely.

rr. Ensuring that the selected shim (Para 65. n.) is installed on the countershaft front bearing, fit the oil pump front cover and a new gasket (Figure 196). Install the oil pump front cover retaining lock-washers, nuts and bolts, but do not tighten them at this stage.

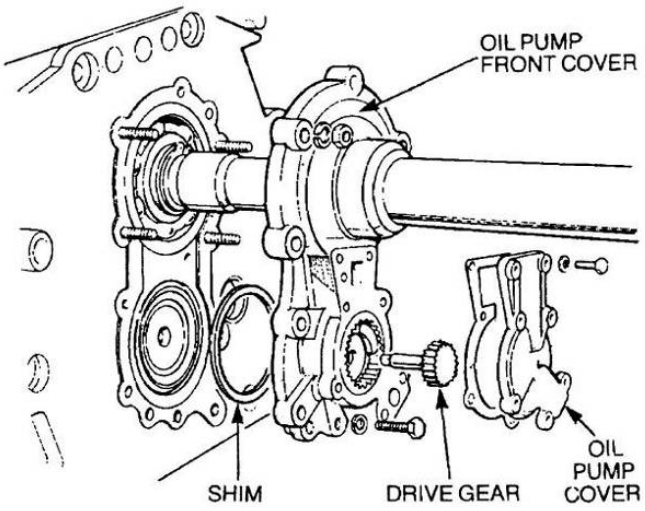


Figure 196 Installation of the Oil Pump Front Cover

CAUTION

The oil pump drive gear is of fibre construction. Damage will result if the gear teeth and the square drive are not correctly engaged.

ss. Smear the oil pump drive gear with clean engine oil and carefully insert the drive gear into the oil pump and countershaft drive square.

tt. Fit the oil pump cover and a new gasket and secure it with lock-washers and bolts. Torque the bolts to 10 N.m (8 lbf.ft).

uu. Ensure that the oil pump front cover is evenly fitted around the input shaft. Torque the nuts to 30 N.m (22 lbf.ft).

vv. Insert two new needle roller bearings in the reverse idler gear and fit the shim and two circlips.

ww. Check that the idler shaft support bush is serviceable. If not, replace the bush and secure it using Locquic grade T and Loctite 222.

xx. Instal1 a new O ring onto the idler shaft and smear the O ring with clean engine oil. Insert the shaft into the transmission case ensuring that the bolt hole aligns.

yy. Position the reverse idler in the transmission case and push in the shaft to support the idler ensuring that the bolt hole remains aligned. Prime the threads of the retaining bolt with Locquic grade T and allow it to dry, then smear the threads with Loctite 222 and install the bolt. Tighten the bolt securely.

zz. Install the bottom cover (if required), complete with a new gasket and fit the retaining bolts and lock-washers. Torque the bolts to 30 N.m (22 1bf.ft). Install the side cover with a new gasket and fit the retaining bolts and lock-washers. Torque the bolts to 58 N.m (43 lbf.ft).

CAUTION

Loctite must not be allowed to enter the transmission or run on the exposed pivot bolt threads.

NOTE

Ensure that the reverse cross-over lever pad is engaged in the reverse idler groove prior to tightening the pivot bolt.

aaa. Position the reverse cross-over lever in the transmission case and locate the selector pad in the reverse idler groove. Install the pivot bolt and engage the cross-over lever pivot hole. Apply Loctite 241 to the bolt threads only. Tighten the pivot bolt securely (Figure 197).

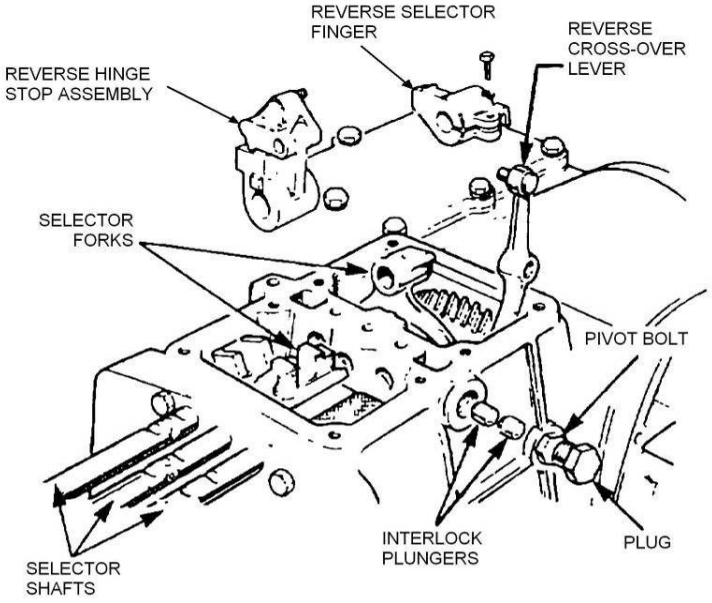


Figure 197 Installation of the Selectors

NOTE

Smear the selector fork slippers with petroleum jelly prior to fitting to the forks.

bbb. Locate the first and second gear selector fork in the sliding clutch groove with the boss on the fork facing towards the rear of the transmission (Figure 198). Position the boss on the right-hand side of the transmission.

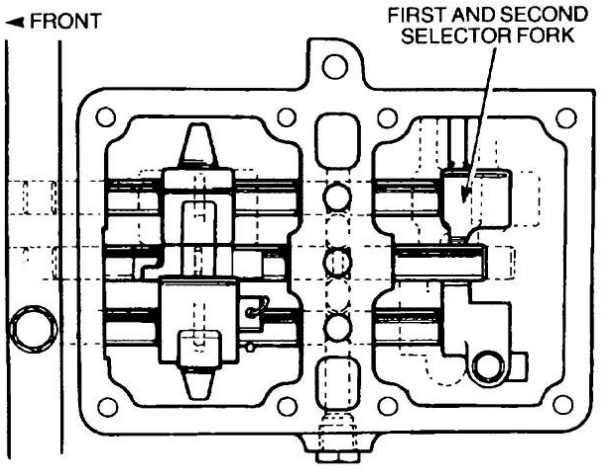


Figure 198 Installation of the First and Second Gear Selector Fork

ccc. Locate the third and fourth gear selector fork in the outer member groove and position the fork with the roll pin entry hole at the top right-hand side. Insert the third and fourth gear selector shaft and interlock pin assembly. Secure the shaft to the selector fork with a new roll pin (Figure 199).

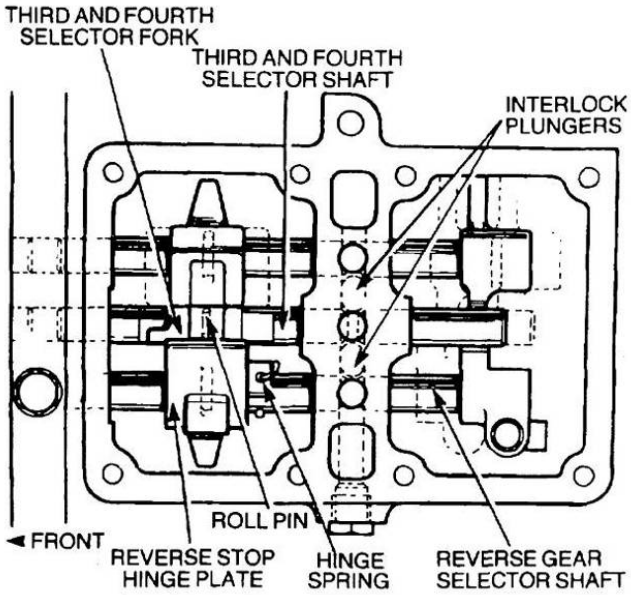


Figure 199 Installation of the Third and Fourth Gear Selector Fork

ddd. Insert an interlock plunger on either side of the third and forth selector shaft. Position the reverse stop hinge plate and selector in the transmission case adjacent to the third and fourth gear selector (Figure 199).

eee. Install the reverse gear selector shaft and engage the reverse stop hinge assembly and hinge spring (Figure 199). Push the shaft in fully and engage the reverse selector finger. Do not tighten the pinch bolt at this stage. Secure the reverse stop hinge assembly to the shaft with a new roll pin.

fff. Position the first and second gear selector in the transmission and install the first and second gear selector shaft engaging the selector and selector fork as the shaft is pushed in fully. Secure the first and second gear selector fork, and the first and second gear selector with new roll pins (Figure 200).

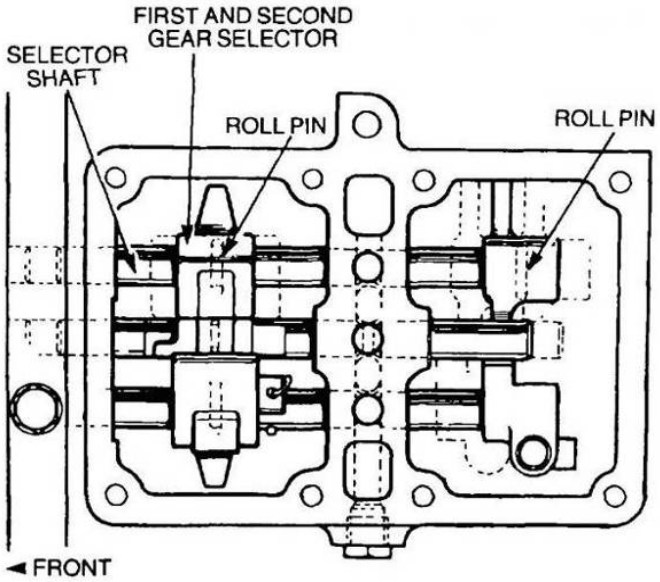


Figure 200 Installation of the First and Second Gear Selector

NOTE

Insert the feeler gauge between the upper edges of the selector as the jaws taper slightly.

ggg. Move the reverse selector shaft forward until the reverse stop hinge assembly is against the transmission casing. Holding the reverse stop hinge assembly in position, move the reverse selector finger forward on the shaft until it is against the casing, and then move it to the rear so it just clears the casing. Insert a 0.25 mm (0.010 in) feeler gauge between the upper edges of the reverse stop hinge assembly and the third and fourth selector (Figure 201).

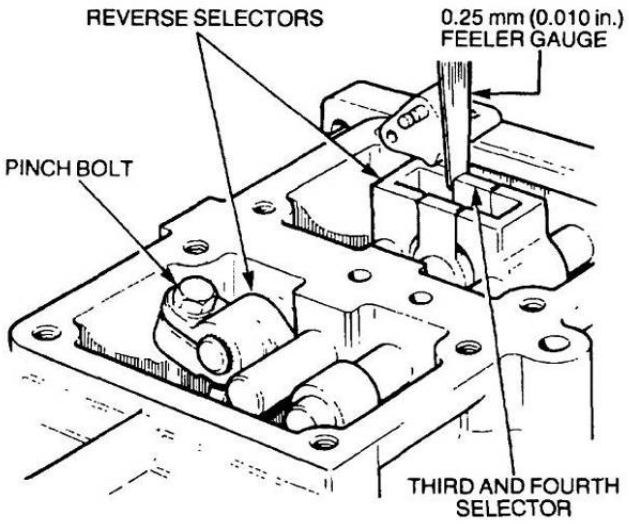


Figure 201 Adjustment of the Reverse Selectors

hhh. Hold the reverse stop hinge assembly and the third and fourth selectors together to retain the feeler gauge. Rotate the reverse selector finger until it is just touching the third and fourth selector shaft. Tighten the pinch bolt (Figure 201).

iii. Check the operation of the reverse gear selector and ensure there is sufficient clearance between the reverse cross-over lever and the reverse selector finger during operation. If necessary, increase the clearance between the upper edges of the reverse stop hinge assembly and the third and fourth selector by 0.5 mm (0.020 in) to provide a smooth selection. Ensure that second gear can be selected without interference with the reverse idler gear. If interference with the reverse idler gear does occur, adjust the position of the reverse selector finger along the reverse selector shaft to provide sufficient clearance for smooth operation.

jjj. Ensure the cross-over lever pivot bolt is secure and lockwire it to the side cover bolt. Connect the small hinge spring hook to the reverse stop hinge pin (Figure 202).

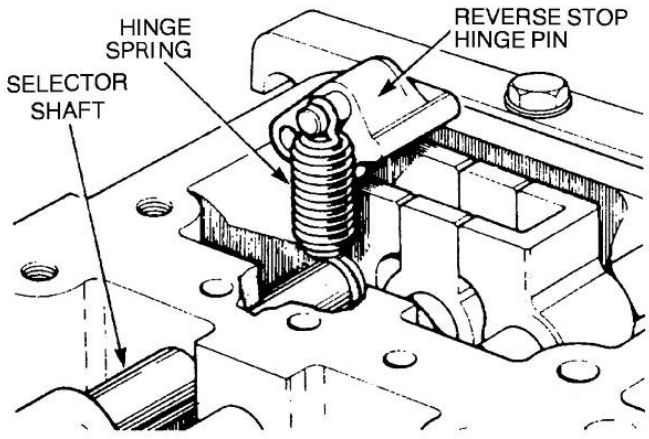


Figure 202 Installation of the Reverse Hinge Spring

kkk. Insert the detent balls and springs ensuring the spring painted yellow is installed on the reverse selector shaft. Fit the top cover, new gasket and transfer lever cross-shaft to the transmission case. Install the eight retaining bolts and new lock-washers and torque the bolts to 30 N.m (22 lbf.ft).

lll. Select neutral position on the transmission and install the reverse light switch in accordance with EMEl Vehicle G 203 – Group 6.

mmm. Apply a smear of suitable jointing compound around the three selector shaft holes in the bell housing rear face. Ensuring that the dowels are located, install the bell housing. Secure the bell housing with the nuts, bolts and new lock-washers. Torque the larger bolts and nuts to 163 N.m (120 lbf.ft), and the smaller bolts to 95 N.m (70 lbf.ft).

nnn. Smear a thin film of molybdenum disulphide base grease on the front cover extension sleeve and install the release bearing and lever. Secure the lever to the pivot with the clip and bolt.

ooo. Connect the transfer selector linkage at the lower ball joint and tighten the nut securely. Install the clutch push rod and secure it with the clip.

During installation of the engine or transmission, DO NOT use the bell housing bolts to pull the assemblies together if there is a gap evident. This will cause the input bearing retaining plates to bend, and allow excess end-float of the main shaft. If the plates are bent the transmission must be removed and returned for overhaul.

ppp. Install the PTO (if fitted) and transmission assembly in accordance with EMEl Vehicle G 204-1 – Group 6.

qqq. Fill the transmission with clean engine oil.

After installation, run the engine for ten minutes with the transmission in fourth gear and the transfer selector in neutral. This procedure will flush out any petroleum jelly used during reassembly and will ensure oil circulation to all bearings.

Transfer Case

69. Disassembly. Disassemble the transfer case as follows:

New gaskets provided by Land Rover do not contain asbestos. Older gaskets still fitted to vehicles may contain asbestos. During this task some parts may contain asbestos; refer and comply with procedures and warnings in the introduction section of this EMEI under paragraph heading: Items Previously Known To Have Contained Asbestos.

a. Remove the PTO (if fitted) and transmission assembly in accordance with EMEl Vehicle G 204-1 – Group 6.

b. Remove the transfer case drain plug and drain the oil into a suitable receptacle.

c. Remove the transmission brake drum retaining screws and remove the brake drum.

d. Using special tool 18G1205A, secure the rear output flange and remove the locknut. Remove the flange, washer and felt seal.

e. Disconnect the park brake draw link clevis and the four bolts securing the back plate to the speedometer housing. Remove the back plate.

f. Remove the locknut retaining the speedometer spindle housing. Remove the housing and the spindle from the transmission.

g. Remove the bolts and washers retaining the bottom cover (if fitted) and remove the cover.

h. Remove the lock-tab securing the intermediate gear retaining shaft, then while supporting the intermediate gear assembly, unscrew the shaft. The intermediate gear assembly can now be removed from the transmission as one unit.

i. Remove the shim installed on the end of the hollow sleeve and remove each gear complete with the bearing cups and cones. Using a suitable press, replace the bearings if required (Figure 203).

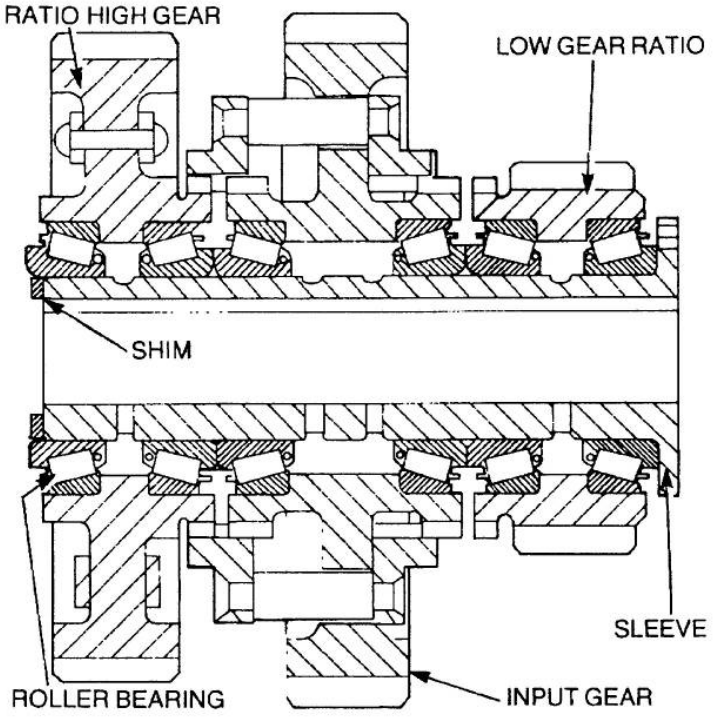


Figure 203 Intermediate Gears - Sectional View

j. Remove the intermediate gear shaft spacer from the rear of the transmission case and discard the two O rings.

k. Remove the pegged end-cap from inside the transmission case and check the security of the pegs. Replace the end-cap if necessary.

l. Using special tool 18G1205A to prevent the front output flange from rotating, remove the locknut retaining the flange to the output shaft and remove the flange.

m. Remove the four bolts and lock-washers retaining the differential lock vacuum chamber assembly (Figure 204). Remove the differential lock vacuum chamber assembly and discard the gasket and lock-washers. Take care not to lose the detent ball and spring during removal.

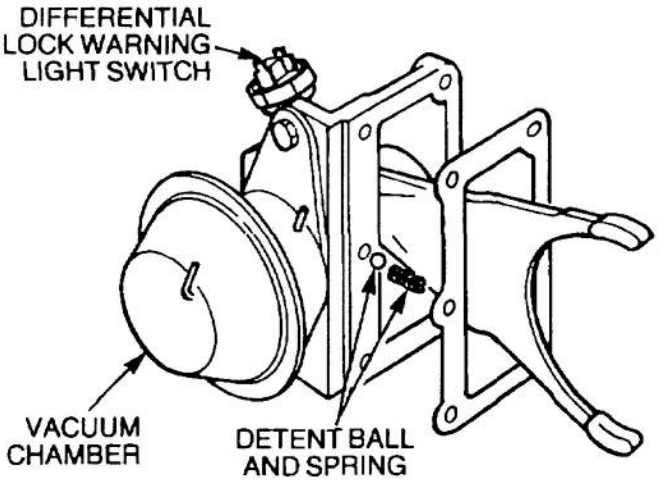


Figure 204 Removal of the Differential Lock Vacuum Chamber Assembly

n. Remove the six bolts and lock-washers securing the front output shaft housing to the transfer casing (Figure 205), withdraw the housing and output shaft. Remove the lock-up dog clutch, the output shaft and the oil seal. Remove the circlip and, using a suitable press, remove the bearing.

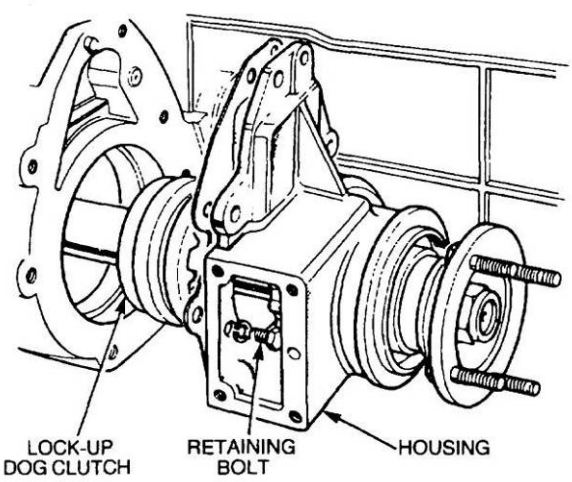


Figure 205 Removal of the Front Output Shaft and Housing

o. Remove the eight bolts and lock-washers retaining the speedometer drive housing to the transfer case, remove the housing complete with the output shaft. Remove the oil shield, oil seal, and circlip (Figure 206), using a suitable press, remove the output shaft and bearing.

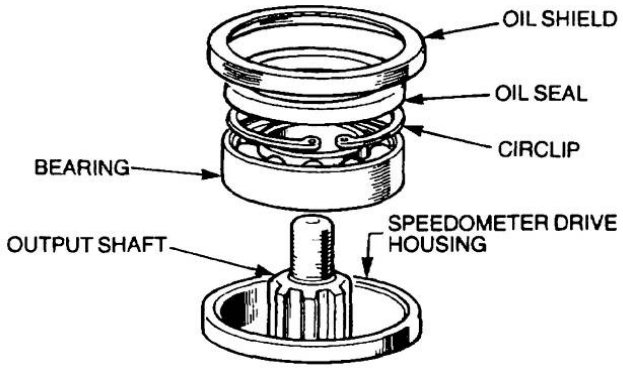


Figure 206 Removal of the Output Shaft

NOTE

All differential components must be match marked prior to removal to maintain their correct settings.

The output (high) gear is secured to the differential assembly with Loctite 648.

p. Remove the differential assembly complete with the output (high) gear (Figure 207).

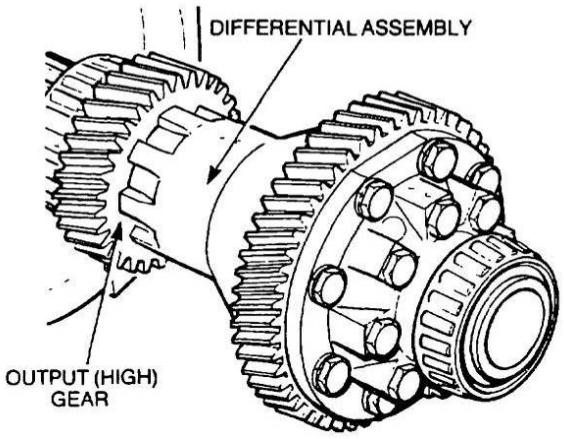


Figure 207 Removal of the Differential Assembly

q. Using special tool 18G47BB and a suitable press, remove the taper roller bearings. Remove the cups from the transfer casing and the speedometer drive housing.

r. Remove the eight bolts and lock-washers retaining the output (low) gear to the differential (Figure 208). Remove the gear and discard the lock-washers.

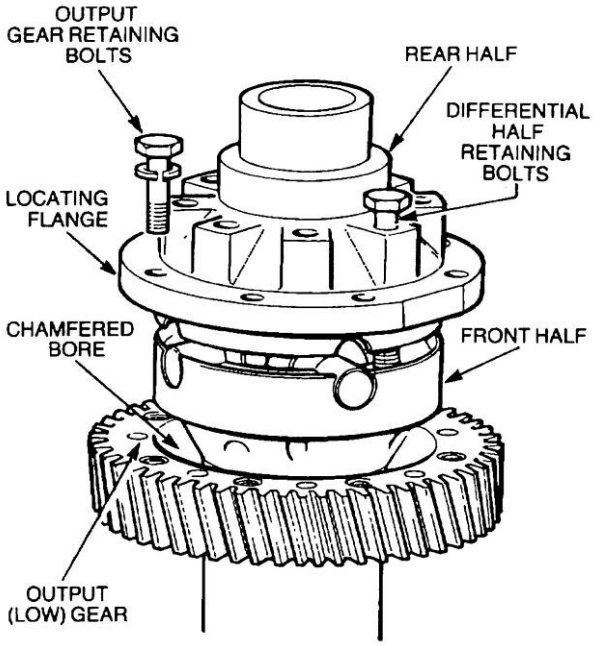


Figure 208 Removal of the Output (Low) Gear

s. Support the differential assembly in the vertical position with the rear half uppermost (Figure 208) and remove the eight bolts and lock-washers retaining the two differential halves together. Lift off the rear half and discard the lock-washers.

t. Lift off the upper side gear (Figure 209), slide out the pinion shafts and remove the bevel pinions and thrust washers. Remove the lower side gear.

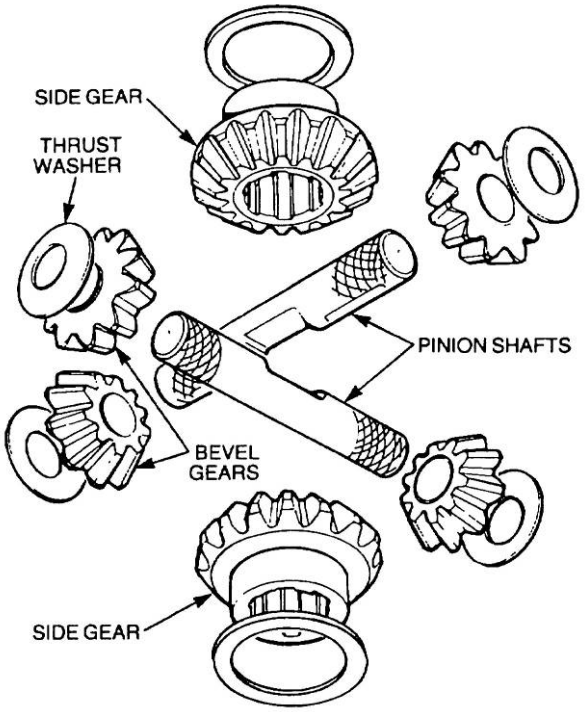


Figure 209 Removal of the Differential Gears

u. Remove the eight bolts and lock-washers retaining the transfer selector cover to the transfer casing and remove the cover.

v. Remove the roll pin securing the selector fork to the shaft (Figure 210) and move the selector to the front of the casing.

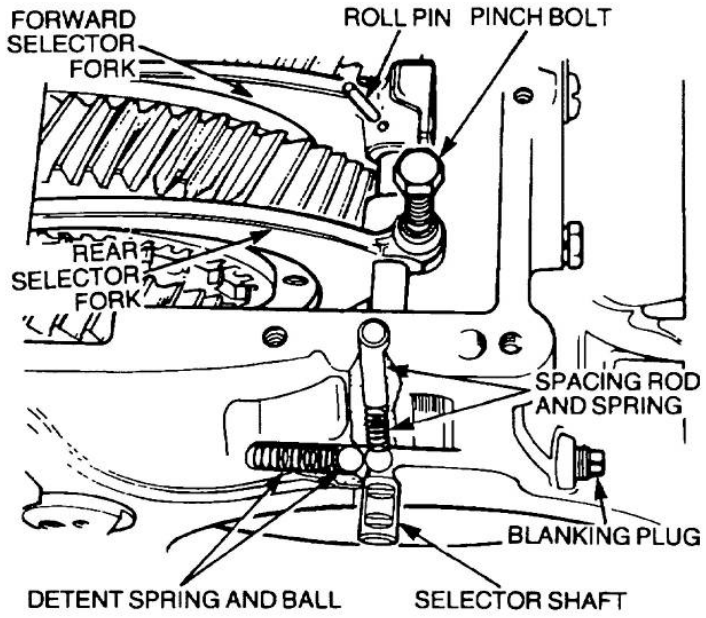


Figure 210 Removal of the Transfer Selectors

w. Pull the selector shaft to the rear to disengage the detent balls and remove the pinch bolt on the rear selector fork. Partially withdraw the selector shaft to enable the selector forks to be removed.

x. Carefully remove the selector shaft to allow the detent balls to be removed.

y. Lift out the spacing rod and spring, and then remove the blanking plug. Using a piece of hooked wire, remove the detent spring from the drilling.

z. Remove the roll pin securing the transfer selector lever to the internal cross-shaft and remove the lever.

aa. Slacken the pinch bolt securing the selector to the cross-shaft (Figure 211) and remove the two screws securing the retaining plates fitted to both ends of the cross-shaft. Remove the two plates and withdraw the shaft, selector and spacer. Discard the two seals.

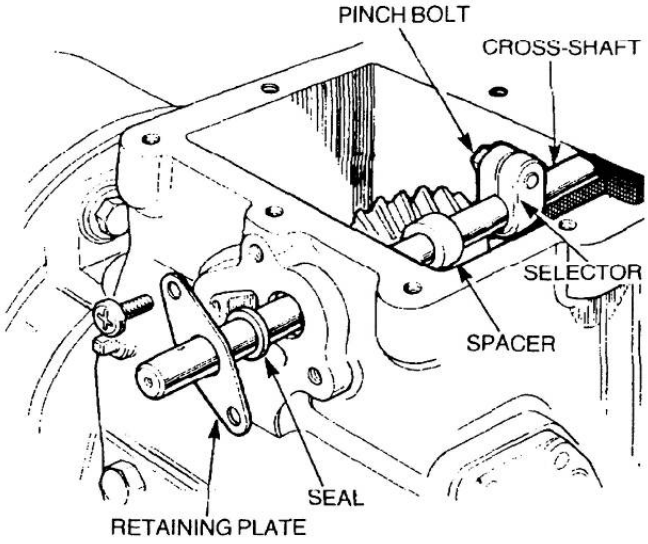


Figure 211 Removal of the Transfer Selector Cross-shaft

70. Cleaning and Inspection. Clean and inspect the transfer case as follows:

WARNING

DO NOT spin the bearings with compressed air as personal injury or damage to the bearings may result.

New gaskets provided by Land Rover do not contain asbestos. Older gaskets still fitted to vehicles may contain asbestos. During this task some parts may contain asbestos; refer and comply with procedures and warnings in the introduction section of this EMEI under paragraph heading: Items Previously Known To Have Contained Asbestos.

a. Clean the case, covers and all other parts of the transmission thoroughly with a suitable cleaning agent. Remove all trace of gasket material and sealer and blow the parts dry with compressed air.

b. Clean the bearings in a suitable cleaning agent and blow them dry with compressed air.

c. Check the bearings for damage or wear and replace them as necessary.

d. Inspect the gear teeth for wear, damage, scoring, surface fatigue, ridging or cracking. The gears may also be checked using Magnetic Particle Inspection or similar method for cracks which would not otherwise be visible.

e. Replace the selector forks and/or sliding clutches if the side clearance in the groove is excessive.

f. Replace the selector shaft if it is cracked in either the detent or locating roll pin holes.

g. Check the transmission case for cracks and replace it if necessary.

h. Inspect the detent springs for damage or loss of tension and replace them as necessary.

i. Check all other parts for wear or damage. Replace all parts as required.

j. Clean up any damaged threads.

CAUTION

The bevel pinions and side gears are supplied as a matched set of six and should not be interchanged. Replace as a set only.

k. Inspect the bevel pinions and side gears for wear, damage, scoring, surface fatigue, ridging or cracking. Replace all parts as required.

NOTE

The differential case halves and the pinion shafts are supplied as matched pairs only.

l. Inspect the differential case halves and pinion shafts for wear, damage scoring, surface fatigue, ridging or cracking. Replace all parts as required.

71. Reassembly. Reassemble the transfer case as follows:

a. General Instructions.

(1) It is important that the differential components are lubricated with clean oil during assembly All components must be lubricated with clean oil during assembly.

(2) Both the differential case halves and the pinion shafts are supplied as matched pairs only.

(3) The bevel pinions and side gears are supplied as a matched set of six and should not be interchanged. Replace them as a set only.

(4) The side gears must be adjusted to allow an end-float of 0.025 mm (0.010 in) and a pre-load of 0.025 mm (0.010 in).

(5) The range of shims available is from 1.05 to 1.45 mm (0.041 to 0.057 in) in 0.10 mm (0.004 in) increments.

b. Support the differential front half in the vertical position (Figure 212). Install a side gear and thrust washer into the front half of the differential. Fit the bevel pinions, thrust washers and pinion shafts onto the front half and side gear. Insert the remaining side gear and thrust washer into the rear half and fit the two halves together.

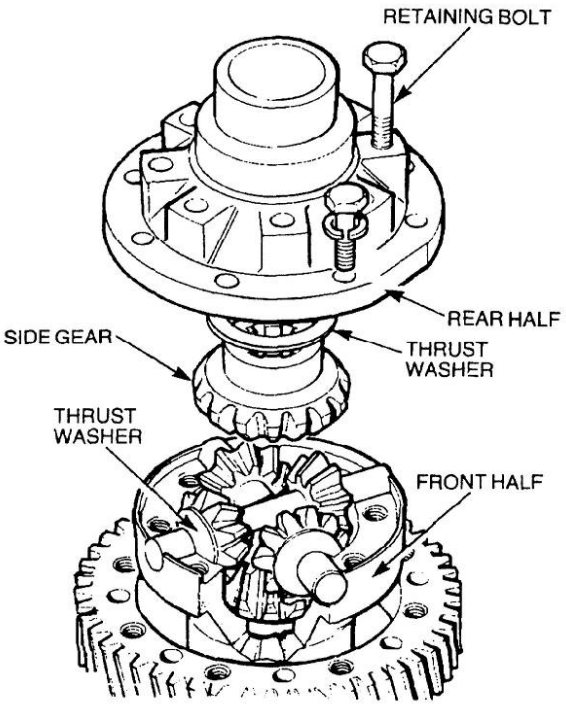


Figure 212 Reassembly of the Differential

c. Align the bolt holes and apply Loctite 241 to the threads of the bolts. Install and tighten the bolts in a diametrically opposed sequence and torque them to 54 to 68 N.m (40 to 50 lbf.ft).

NOTE

The bolt holes in the output (low) gear are not equally spaced to ensure the relationship between the differential and gear is maintained.

d. Install the output (low) gear over the front half of the differential, ensuring that the chamfered bore and countersunk ends of the tapped hole are towards the locating flange (Figure 208). Align the bolt holes and apply Loctite 241 to the threads of the bolts. Install the bolts and lock-washers. Tighten the bolts in a diametrically opposed sequence and torque them to 60 to 64 N.m (44 to 47 lbf.ft).

NOTE

If the differential assembly or bearings have been replaced, the differential bearing pre-load must be checked as described in Paras 68. u. to x.

e. Using a suitable press, install the new taper roller bearings on the differential front and rear halves.

f. Using a suitable press, install the bearing cup into the front of the transfer case.

g. Apply Loctite 648 to the splines of the output (high) gear. Using a suitable press, install the gear on the differential front half and insert the differential assembly in the transfer case.

NOTE

The bearings must be fully seated prior to torquing the nut.

h. Using a suitable press, install the bearing cups in the intermediate gears. Thoroughly lubricate the gears and taper roller bearings with clean oil and install the gears and bearings on the sleeve. Do not fit the shim washer at this stage. Using an 18 mm bolt and large flat washers (Figure 213), gradually tighten the nut to 130 N.m (96 lbf.ft) while rotating and tapping the gears.

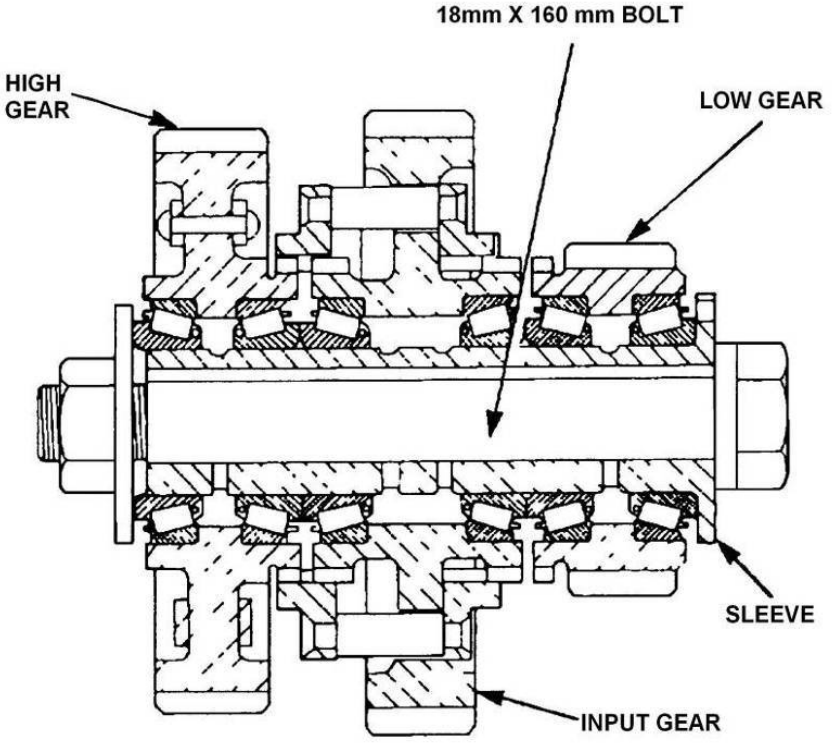


Figure 213 Intermediate Gear Assembly Pre-load Adjustment - Sectional View

i. Position the assembly vertically with the nut uppermost; remove the bolt, flat washers and nut, taking care not to disturb the gears and bearings.

j. Using a dial indicator, measure the gap between the shoulder of the sleeve and the face of the bearings (Figure 214). Select a shim washer to obtain a pre-load of 0.10 to 0.20 mm (0.004 to 0.008 in).

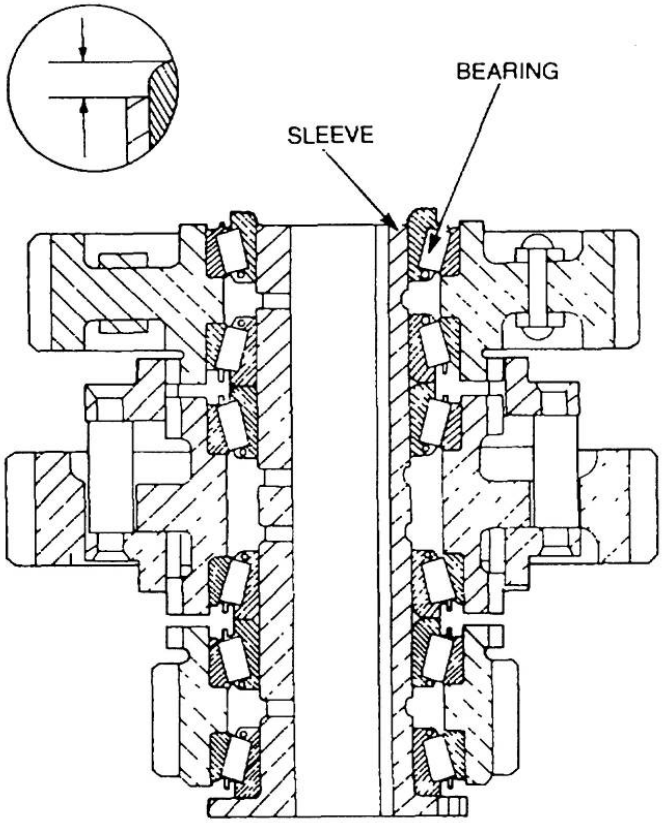


Figure 214 Intermediate Gear Assembly Pre-load Setting - Sectional View

NOTE

During the installation of the intermediate gear assembly, pour clean oil into both cast oil feed holes in the transfer case, to ensure the shaft and bearings are adequately lubricated.

k. Fit the pegged end-cap to the inside of the casing and carefully position the intermediate gear assembly and the selected shim washer into the casing. Ensure that the groove in the sleeve is towards the top of the transmission and aligns with the oil hole. Fit the new O rings to the end spacer and install the end spacer in the transmission case.

l. Insert the intermediate gear shaft and new lock-tab. Torque the shaft 170 to 190 N.m (125 to 140 lbf.ft) and check the gears rotate freely. The maximum resistance should be 0.5 N.m (0.36 lbf.ft). If the resistance is greater than specified the pre-load will require resetting. Bend the lock-tab to secure the shaft.

m. Position the cross-shaft selector in the transfer case and insert the cross-shaft and spacer engaging the selector (Figure 211). Fit a new seat on both ends of the shaft and secure it with the retaining plates. Tighten the retaining screws securely.

n. Align the hole in the transfer selector linkage lever with the hole in the cross-shaft and install a new roll pin.

o. Insert the detent spring in the transfer case drilling and install the detent ball (Figure 210). Push the ball against the spring and insert the selector shaft.

p. Position the rear selector, with the plain face to the rear, on the shaft, ensuring that the fork engages the rear side of the input gear. Push the shaft further, then position the front selector on the cross-shaft selector, with the extended boss to the rear and forks engaging the front side of the input gear. Insert the shaft fully, to allow the roll pin hole in the front selector to align with the hole in the shaft, and secure the selector with a new roll pin.

q. Install the detent ball, spring and spacing rod into the vertical drilling. Smear a suitable sealing compound on the blanking plug threads and fit the plug into the casing (Figure 210).

r. Select neutral on the transfer lever and check that the input gear on the intermediate gear assembly is in the neutral position, and the front fork is in contact with the input gear inner member.

s. Adjust the rear fork position on the selector shaft to allow a clearance of 0.12 to 0.25 mm (0.005 to 0.010 in) between the front face of the rear fork and the rear face of the input gear inner member (Figure 215). Tighten the pinch bolt securely.

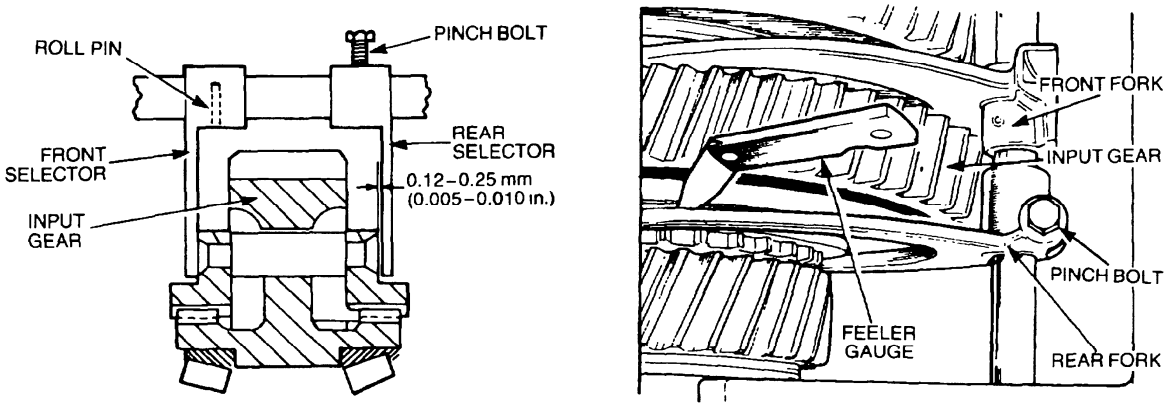


Figure 215 Adjustment of the Transfer Selectors

t. Position a new gasket on the selector housing and install the cover. Fit the eight bolts and new lock-washers and tighten them securely.

u. Using a micrometer, measure the thickness of the new gasket to be installed between the speedometer drive housing and the transfer case, and record the measurement.

v. Install the shim that was previously fitted in the speedometer drive housing and, using a suitable press, fit the bearing cup.

NOTE

The range of shims available is from 1.65 to 2.80 mm (0.065 to 0.110 in) in 0.5 mm (0.002 in) increments.

w. Position the speedometer drive housing, less the gasket, on the transfer case and measure the gap in at least four locations between the housing and transfer case joint faces. The measurement must be 0.1 mm (0.004 in) more than the thickness of the gasket measured in Para 68. u. The gap can be adjusted by replacing the shim installed behind the bearing (Figure 216).

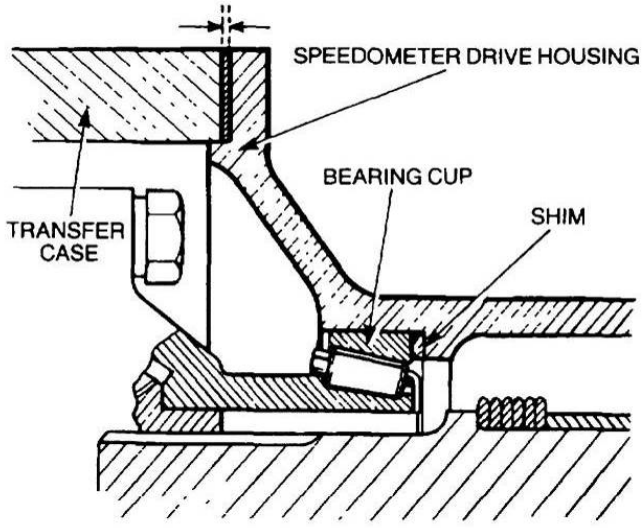


Figure 216 Differential Assembly Pre-load Adjustment - Sectional View

x. Remove the housing and install the selected gasket. Fit the eight bolts and new lock-washers and torque the bolts to 30 N.m (22 lbf.ft). With the differential lock disengaged and no oil seal fitted, the rolling resistance should be 6 to 7 kg (14 to 16 lbs). To obtain the rolling resistance replace the shim with one of the correct thickness (Figure 216).

y. Insert the rear output shaft, speedometer drive worm and spacer. Using a suitable press, install the output shaft bearing and secure it with the circlip. Press in the rear oil seal, open face first, until the seal plain face just clears the chamfer on the seal housing bore.

z. Install the parking brake backing plate and secure it with the four bolts and lock-washers. Using a suitable sealant, install and seal the oil catcher against the backing plate. Fit the coupling flange felt seal, plain washer and new locknut. Toque the locknut to 146 to 180 N.m (108 to 132 lbf.ft).

aa. Connect the park brake draw link and secure it with a new split pin. Install the brake drum and secure it with the two screws. Insert the speedometer drive spindle, new O ring and housing into the speedometer drive housing.

bb. Using a suitable press, install the bearing into the front output shaft housing and secure it with the circlip. Press in the front oil seal, open face first, until the seal plain face just clears the chamfer on the seal housing bore.

cc. Fit the lock-up dog clutch on the differential front half and insert the front output shaft. Locate a new gasket on the transfer case dowel and install the front output shaft housing (Figure 217). Secure the housing with the six bolts and new lock-washers, torque the bolts to 30 N.m (22 lbf.ft).

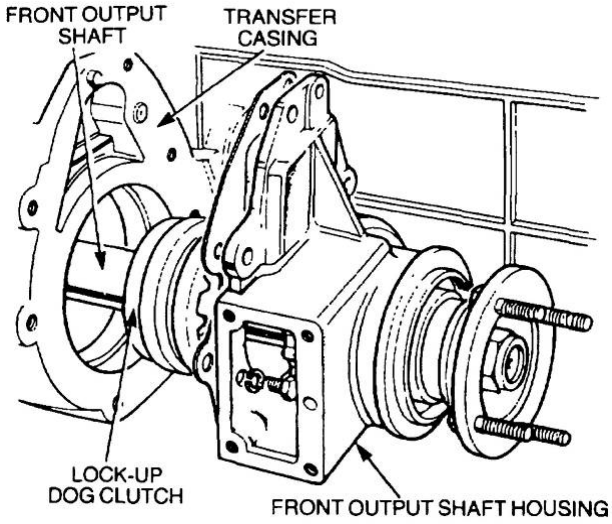


Figure 217 Installation of the Front Output Shaft Housing

dd. Fit the mud shield on the front output shaft flange; install the flange, plain washer and new locknut. Using special tool 18G1205A torque the locknut to 146 to 180 N.m (108 to 132 lbf.ft).

ee. Apply a suitable sealing compound to the differential lock vacuum chamber housing gasket and engage the selector fork in the lock-up dog clutch groove. Insert the four retaining bolts and new lock-washers. Torque the bolts to 30 N.m (22 lbf.ft).

CAUTION

During installation of the engine or transmission, DO NOT use the bell housing bolts to pull the assemblies together, if there is a gap evident. This will cause the input bearing retaining plates to bend, and allow excess end-float of the main shaft. If the plates are bent the transmission must be removed and returned for overhaul.

ff. Install the PTO (if fitted) and transmission assembly in accordance with EMEl Vehicle G 204-1 – Group 6.

gg. Fill the transfer case to the correct level with clean oil.

CAUTION

After installation, run the engine for ten minutes with the transmission in fourth gear and the transfer selector in neutral. This procedure will flush out any petroleum jelly used during reassembly and will ensure oil circulation to all bearings.

Power Take-off (PTO) and Torque Limiter

72. Disassembly. Disassemble the PTO and torque limiter as follows:

a. Remove the two split pins securing the selection lever clevis pins and remove the pins and the lever. Discard the split pins.

NOTE

The set screw is secured to the selector fork with Loctite 245.

b. Remove the two circlips and the flat washer from the selector shaft. Remove the set screw securing the selector fork to the shaft. Partially remove the shaft to allow the selector fork to be disengaged and removed. Remove the plug from the detent spring and ball drilling.

c. Remove the hexagonal cap from the housing, and using a suitable press and arbor, remove the PTO and torque limiter assembly from the housing (Figure 218).

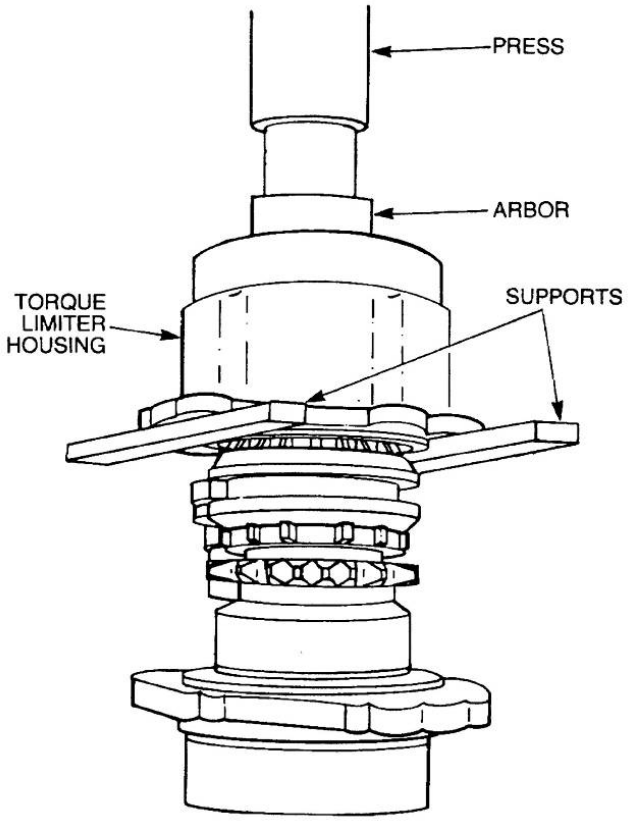


Figure 218 Removal of the Shaft Assembly

d. Support the torque limiter end of the shaft in a vice fitted with soft-jawed clamps ensuring that the locknut is not damaged. Remove the locknut and flat washer securing the winch drive shaft flange to the shaft, clamp the flange in the vice and carefully tap the end of the shaft. Remove the flange assembly and discard the locknut.

e. Remove the external circlip retaining the ball bearing on the flange, supporting the end plate, press the flange off the bearing (Figure 219). Support the end plate and press out the oil seal and ball bearing.

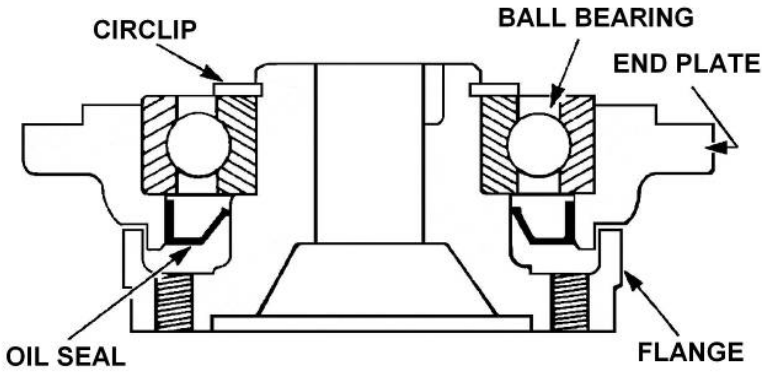


Figure 219 Removal of the Flange, End Plate and Bearing

f. Remove the internal circlip retaining the ball bearing to the chain driven sprocket, then carefully clamp the sprocket in the vice and tap the shaft to allow the sprocket and bearing to be removed (Figure 220). Using a suitable arbor, press out the needle roller and ball bearing.

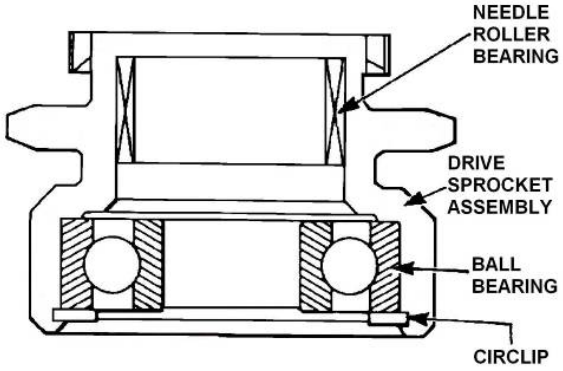


Figure 220 Removal of the Drive Sprocket Bearing

g. Slide off the sliding clutch, clamp the shaft in the vice and remove the locknut and flat washer securing the torque limiter to the shaft. Support the torque limiter on the jaws of the vice and carefully tap the shaft through the drive flange (Figure 221). Lift off the drive flange complete with the bearing, taking care not to lose the steel balls. Remove the spacer.

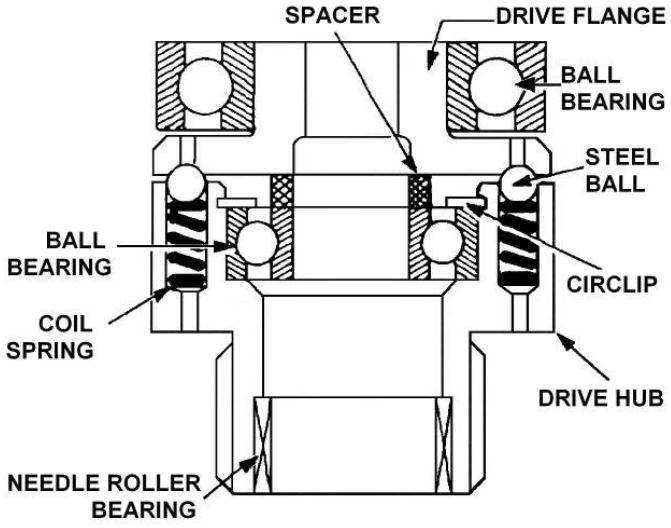


Figure 221 Removal of the Torque Limiter

h. Remove the steel balls and coil springs. Remove the internal circlip retaining the ball bearing in the drive hub.

i. Support the large ball bearing assembly and carefully tap out the drive flange.

j. Support the drive hub in the vice and carefully remove the needle roller bearing.

k. Remove the selector shaft oil seal if there are traces of oil leakage.

73. Cleaning and Inspection. Clean and inspect the PTO and torque limiter as follows:

WARNING

DO NOT spin the bearings with compressed air as personal injury or damage to the bearings may result.

a. Clean all components in a suitable cleaning agent and blow them dry with compressed air.

b. Inspect all components for excessive wear and replace parts as necessary.

c. Inspect the selector fork for excessive clearance in the sliding clutch groove.

d. Inspect the springs for wear, damage or loss of tension. Check that the spring heights are the same for all the springs. Replace them as necessary.

74. Reassembly and Resetting. Reassemble the PTO and torque limiter and reset the torque limiter settings as follows:

a. Support the drive hub and press in the ball bearing and needle roller bearing. Secure the bearing with the internal circlip (Figure 222).

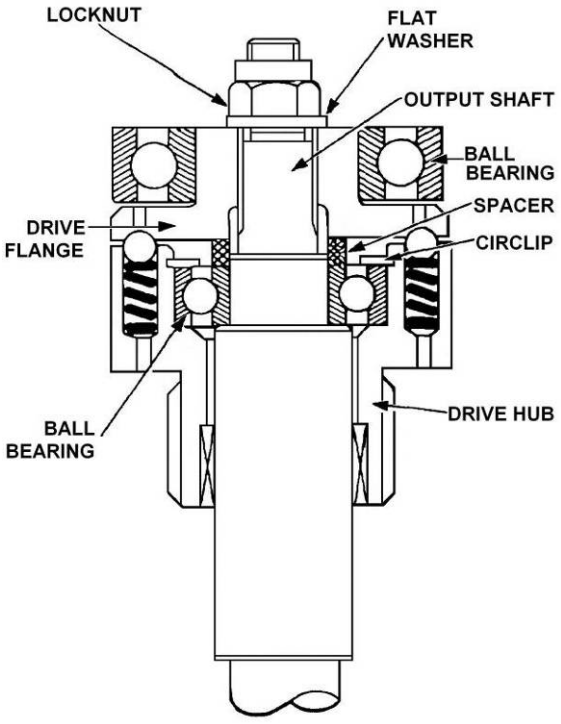


Figure 222 Installation of the Torque Limiter

b. Thoroughly lubricate the drive hub and bearings with clean oil. Clamp the shaft in the vice and install the drive hub.

NOTE

The torque limiter drive hub has sixteen holes but only twelve balls and springs are fitted in this version. Accordingly, the balls and springs are to be installed in four groups of three.

c. Install the springs and steel balls and fit the spacer and drive flange. Fit the flat washer and a new locknut, torque the nut to 60 N.m (44 lbf.ft). Using a suitable press install the ball bearing on the drive flange.

d. Press the needle roller and the ball bearing in the drive sprocket assembly and secure the bearing with the internal circlip (Figure 223).

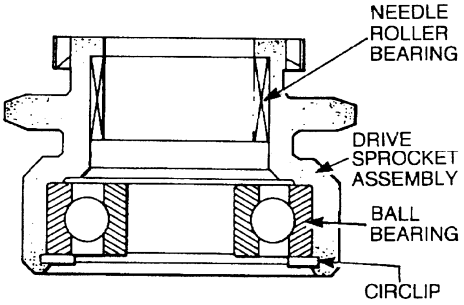


Figure 223 Installing Drive Sprocket Bearings

e. Thoroughly lubricate the bearings, install the sliding clutch and the drive sprocket assembly on the shaft.

f. Press the ball bearing in the end plate. Smear the oil seal with grease and fit the seal in the end plate with the open face towards the bearing.

g. Install the end plate assembly on the drive shaft coupling flange and secure the bearing with the external circlip.

NOTE

Ensure that the torque wrench is within calibration prior to use.

h. Fit the coupling flange on the output shaft and install the flat washer and a new locknut. Torque the nut to 61 N.m (45 lbf.ft).

NOTE

Ensure that the torque limiter is adequately lubricated with clean oil during the torque resetting procedure.

i. Clamp the drive hub in the vice, ensuring the soft-jawed clamps are fitted, then apply a torque wrench to the torque limiter retaining nut and check that the adjusting torque is set at 115 N.m (85 lbf.ft). To increase the torque setting, decrease the spacer thickness, and to decrease the torque setting, increase spacer thickness.

j. Support the torque limiter housing and carefully press the torque limiter and ball bearing assembly into the recess ensuring that the output shaft is centred in the mounting face (Figure 224).

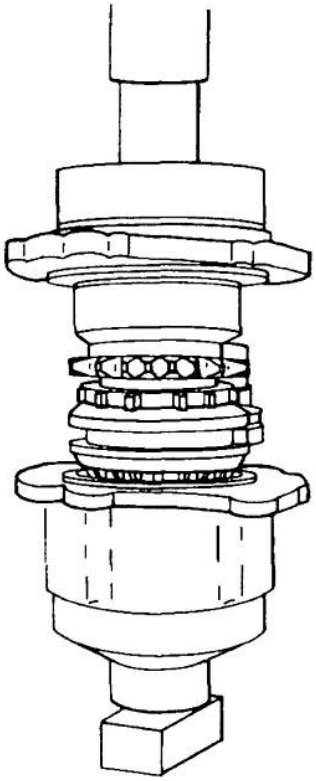


Figure 224 Installation of the Torque Limiter Housing

k. Push in a new selector shaft oil seal with the open face towards the selector fork. Insert the detent spring and ball in the drilling and smear the shaft with a suitable petroleum jelly. Push the shaft through the seal and housing.

l. Engage the selector fork in the sliding clutch groove and push the selector shaft into the fork. Clean the fork set screw and fork threads with Loctite T-primer, then apply Loctite 245 to the threads and tighten the screw securely ensuring that the point seats in the shaft indent.

m. Insert the detent spring and ball plug, and tighten the plug securely.

n. Fit the rubber boot over the selector shaft and install the two circlips and flat washer on the shaft.

o. Position the selector lever and fit the two clevis pins. Secure the clevis pins with new split pins and check the operation of the selector.

75. The transmission specifications are detailed in Table 11.

Table 11 Transmission Group Specifications

Serial	Item	Specification
1	Mainshaft end-play on gears	0.025 to 0.150 mm (0.001 to 0.006 in)
2	Countershaft rolling resistance	2.7 to 4.0 kg (6 to 8.5 lb)
3	Transfer gear end-play	0.050 mm (0.002 in) maximum
4	Oil pump front cover tightening torque	30 N.m (22 lbf.ft)
5	Rear bearing cover tightening torque	30 N.m (22 lbf.ft)
6	Input shaft end-play	0.05 mm (0.002 in)
7	Oil pump cover tightening torque	10 N.m (8 lbf.ft)
8	Bottom cover tightening torque	30 N.m (22 lbf.ft)
9	Side cover tightening torque	58 N.m (43 lbf.ft)
10	Top cover tightening torque	30 N.m (22 lbf.ft)
	Bell housing tightening torque	
11	Large bolts	163 N.m (120 lbf.ft)
12	Small bolts	95 N.m (70 lbf.ft)
13	Differential casing bolts tightening torque	54 to 68 N.m (40 to 50 lbf.ft)
14	Differential output (low) gear tightening torque	60 to 64 N.m (44 to 47 lbf.ft)
15	Intermediate gears shaft tightening torque	170 to 190 N.m (125 to 140 lbf.ft)
16	Intermediate gears rolling resistance	0.5 N.m (0.36 lbf.ft)
17	Transfer selector fork clearance	0.12 to 0.25 mm (0.005 to 0.010 in)
18	Speedometer drive housing tightening torque	30 N.m (22 lbf.ft)
19	Differential assembly rolling resistance	6 to 7 kg (14 to 16 lbs)
20	Propeller coupling flange (front and rear) tightening torque	146 to 180 N.m (108 to 132 lbf.ft)
21	Front output shaft housing tightening torque	30 N.m (22 lbf.ft)
22	Differential lock vacuum chamber housing tightening torque	30 N.m (22 lbf.ft)
23	Torque limiter to shaft tightening torque	60 N.m (44 lbf.ft)
24	Coupling flange to shaft tightening torque	61 N.m (45 lbf.ft)
25	Torque limiter adjusting torque	115 N.m (85 lbf.ft)
	Rear output shaft adapter housing	
26	Temperature for reassembly	70 degrees C (using hot water)
27	Gear to quill-shaft retaining bolts tightening torque	60 to 64 N.m (44 to 47 lbf.ft)
28	Quill-shaft retaining nut tightening torque	61 N.m (45 lbf.ft)
29	Quill-shaft end-float	0.0063 to 0.0762 mm (0.00025 to 0.003 in)
30	Adapter housing retaining bolts tightening bolts	30 N.m (22 lbf.ft)
31	Rear axle output shaft housing retaining bolts tightening torque	30 N.m (22 lbf.ft)
32	Vacuum chamber retaining bolts tightening torque	30 N.m (22 lbf.ft)
33	Rear axle output shaft flange nut tightening torque	146 to 180 N.m (108 to 132 lbf.ft)

REAR AXLE

NOTE

If the lower link mount on the axle housing is worn, it can be reclaimed using the procedures detailed in EMEI Vehicle G 204-1 – Group 9.

Differential Carrier

WARNING

New gaskets provided by Land Rover do not contain asbestos. Older gaskets still fitted to vehicles may contain asbestos. During this task some parts may contain asbestos; refer and comply with procedures and warnings in the introduction section of this EMEI under paragraph heading: Items Previously Known To Have Contained Asbestos.

76. Removal. Remove the differential carrier as follows:

a. Remove the rear axle in accordance with EMEl Vehicle G 204-1 – Group 9.

b. Remove the rear axle shafts from the axle in accordance with EMEl Vehicle G203 – Group 9.

c. Drain the oil from the axle casing.

d. Remove the bolts, lock-washers and support strip retaining the differential cover. Remove the cover and gasket (Figure 225).

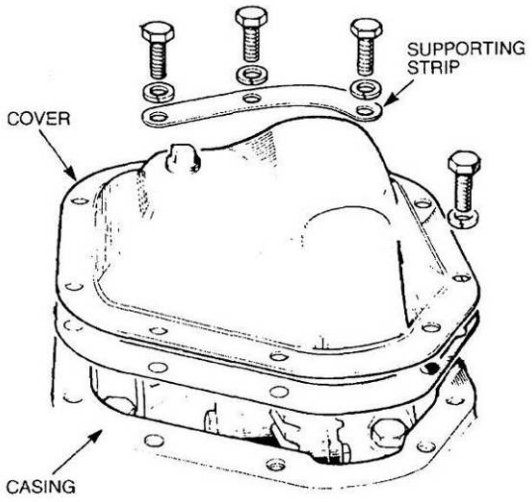


Figure 225 Removal of the Differential Cover

e. Inspect the differential oil level plug to ensure the threads in the cover plate are not stretched due to over tightening of the level plug during servicing. Rectify stretched threads in accordance with EMEI Vehicle G 203 – Group 9.

f. Match mark the two bearing caps (Figure 226), remove the retaining bolts and lift out the bearing caps.

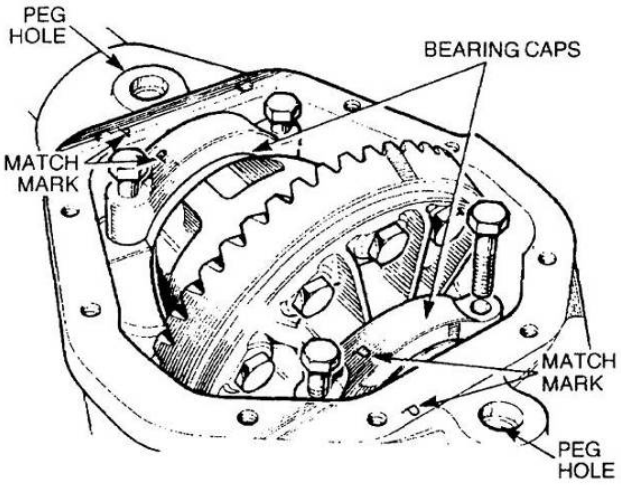


Figure 226 Match Marking the Bearing Caps

g. Ensure that the two peg holes are clear of debris and excess paint. Install special tool 18G131C and adapter pegs 18G131F (Figure 227).

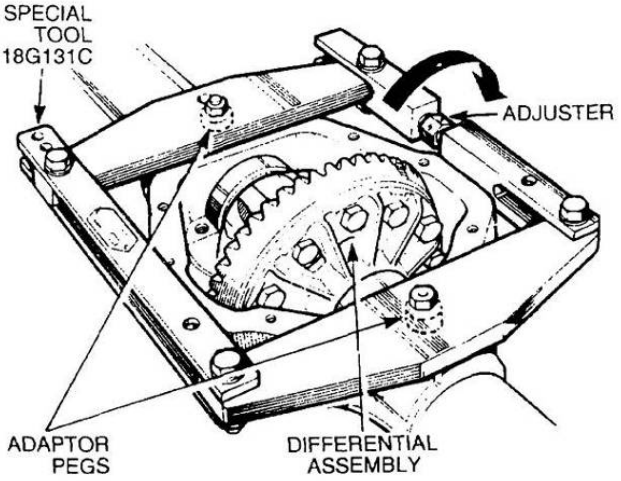


Figure 227 Removal of the Differential Assembly

NOTE

The adjuster on special tool 18G131C is provided with numbers to check on the amount turned. Ensure that the adjuster turns freely.

h. Turn the adjuster to take up the free play until the adjuster becomes stiff.

CAUTION

Do not overstretch the differential casing when removing the differential. Overstretching can permanently damage the casing.

i. Ensure that the side members of the special tool are not in contact with the casing and rotate the adjuster one flat at a time to spread the casing until the differential assembly can be removed. Do not overstretch the casing. The maximum stretch permissible is 0.30 mm (0.012 in) which is the equivalent of three flats on the adjuster barrel.

j. Slacken the adjuster and remove the special tool.

k. Using special tool 18G1205A to prevent the pinion flange from rotating, remove the locknut and flat washer (Figure 228). Using a soft hammer, tap the pinion shaft through the pinion flange. Remove the flange, then the pinion shaft assembly.

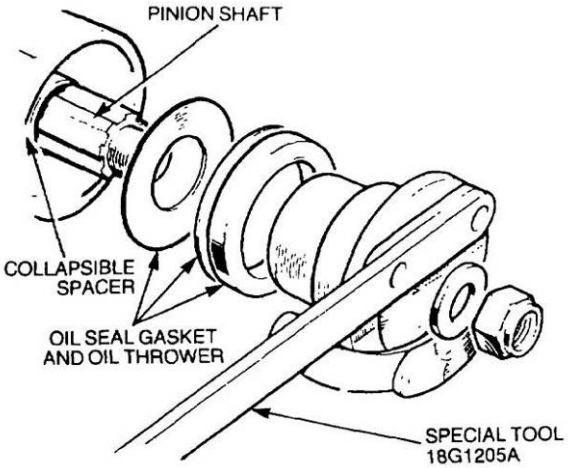


Figure 228 Removal of the Pinion Flange and Shaft

l. Remove the oil seal, gasket, oil thrower and outer bearing cone. Using special tool S123A, remove the inner and outer pinion shaft bearing cups from the casing. Remove the shims fitted behind the inner bearing cup (Figure 229) and record the shim thickness.

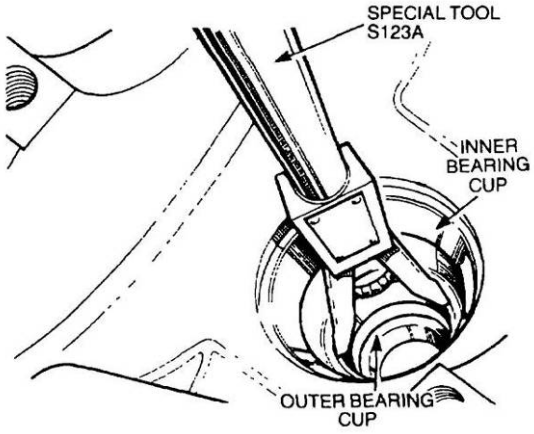


Figure 229 Removal of the Pinion Bearing Cup

m. Using special tool 18G47BK and press MS47, remove the inner bearing cone from the pinion (Figure 230).

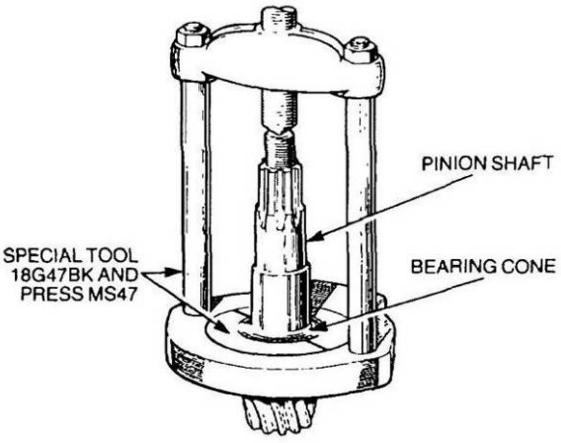


Figure 230 Removal of the Pinion Bearing Cone

77. Disassembly. Disassemble the differential as follows:

a. Match mark the crownwheel and the differential, remove the bolts and remove the crownwheel (Figure 231).

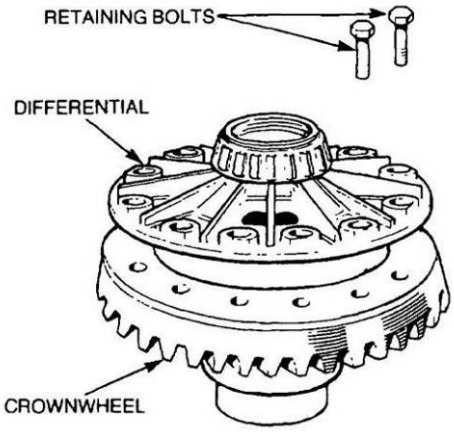


Figure 231 Removal of the Crownwheel

b. Match mark the two differential halves (if not already marked), remove the bolts securing the two halves together (Figure 232) and remove the upper half.

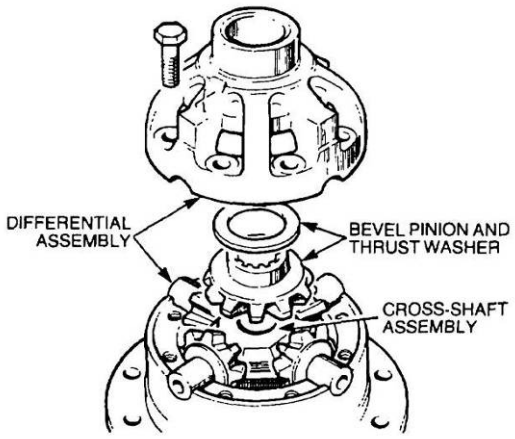


Figure 232 Disassembly of the Differential

c. Lift off the bevel pinion and thrust washer and remove the cross-shaft and pinions. Remove the four dished thrust washers and pinions from the cross-shaft (Figure 233). Lift out the remaining bevel pinion and discard the thrust washers.

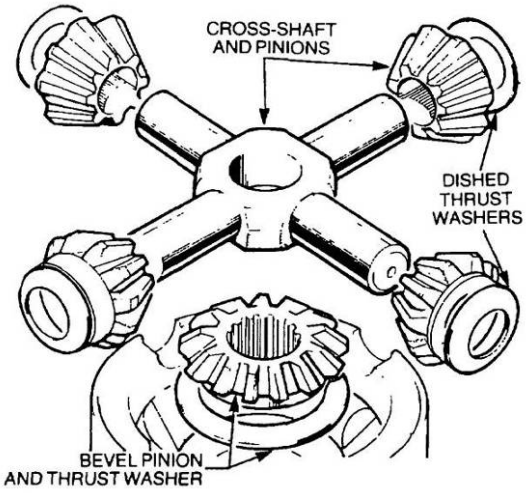


Figure 233 Disassembly of the Cross-shaft

d. Using special tools 18G134, 18G47BL, press MS47 and adapters 1 and 2, remove the differential bearing cones and shims (Figure 234).

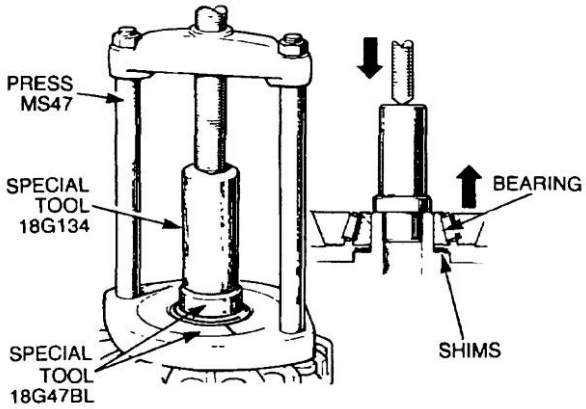


Figure 234 Removal of the Differential Bearing

78. Cleaning and Inspection. Clean and inspect the differential as follows:

WARNING

DO NOT spin the bearings with compressed air as personal injury or damage to the bearings may result.

New gaskets provided by Land Rover do not contain asbestos. Older gaskets still fitted to vehicles may contain asbestos. During this task some parts may contain asbestos; refer and comply with procedures and warnings in the introduction section of this EMEI under paragraph heading: Items Previously Known To Have Contained Asbestos.

a. Thoroughly clean all components using a suitable cleaning agent and blow them dry with compressed air.

b. Inspect all gear teeth for signs of abrasive wear, scratching, ridging, scoring, surface fatigue, pitting, corrosive wear, digging in or cracking and replace parts as necessary.

c. If either the crown wheel or pinion is defective, both components must be replaced as a set as they are only available as a matched pair.

d. Inspect the crown wheel and pinion and check that that the serial number etched on the pinion end face matches the serial number etched on the crown wheel (Figure 220). If the numbers do not match replace the crown wheel and pinion set.

e. Ensure the pinion end-face is free of any raised burrs around the etched markings.

f. Inspect all bearings for flaking, cracks, fractures, fretting and corrosion and replace as necessary.

g. Inspect the crown wheel-to-differential joint faces for signs of damage and replace parts as necessary.

h. If either of the differential halves is defective, they must be replaced as a set as they are only available as a matched pair.

i. Ensure that all bearings, except the outer pinion bearing cone, are an interference fit when reassembling.

CAUTION

Ensure that the threads in the differential oil level plug hole are not stretched.

j. Inspect the differential oil level plug opening to ensure the threads in the cover plate are not stretched due to over tightening of the level plug during servicing. Stretched threads may allow the oil level plug to contact the crown wheel causing severe damage. If necessary rectify stretched threads in accordance with EMEI Vehicle G 203.

79. Reassembly. Reassemble the differential as follows:

NOTE

Ensure that all bearings, except the outer pinion bearing, are an interference fit when reassembling.

a. Install a bevel pinion and thrust washer in the differential half, fit the four pinions and dished thrust washers on the cross-shaft. Position the cross-shaft assembly in the differential half, install the remaining bevel pinion, a new thrust washer and the remaining differential half, ensuring the match marks on the differential halves are aligned (Figure 235).

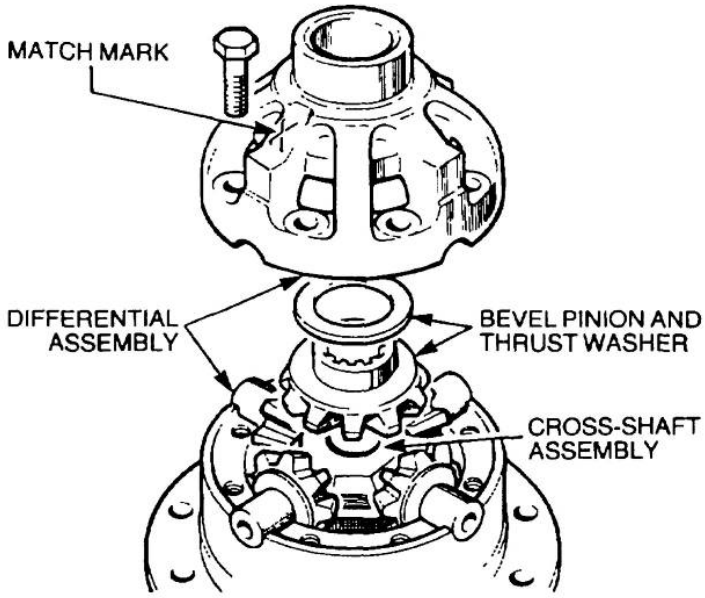


Figure 235 Reassembly of the Differential

b. Apply Loctite 271 to the retaining bolt threads, insert the bolts and tighten them evenly. Torque the bolts to 89 to 102 N.m (66 to 75 lbf.ft).

c. Using special tool 18G134DP and a suitable press, install the bearing cones onto the differential assembly (Figure 236). Do not install the shims at this stage.

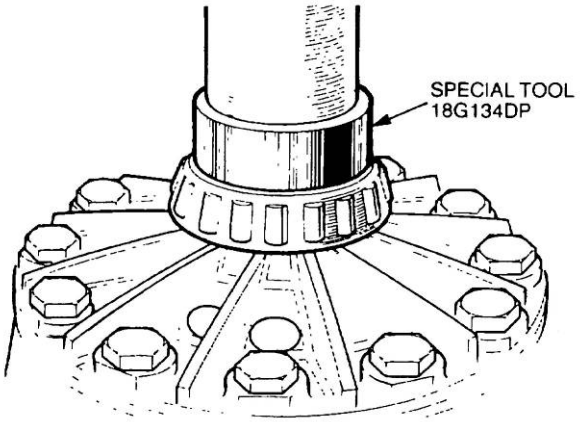


Figure 236 Installation of the Differential Bearing Cones

d. Install the crownwheel on the differential flange ensuring that the match marks are aligned, apply Loctite 271 to the retaining bolt threads, insert the bolts and tighten them evenly. Torque the bolts to 129 to 142 N.m (95 to 105 lbf.ft).

e. Fit the differential bearing cups onto the bearing cones and install the differential assembly in the axle casing. Rotate the differential to centralize the bearings.

f. Position a dial indicator on the axle casing with the stylus in contact with the rear face of the crownwheel (Figure 237), rotate the differential and check the total run-out. The run-out must not exceed 0.05 mm (0.002 in). If the run-out is excessive check the crownwheel-to-differential cage mating faces for dirt or signs of damage, and if necessary, select a new position for the stylus to contact until the amount of run-out is below that specified.

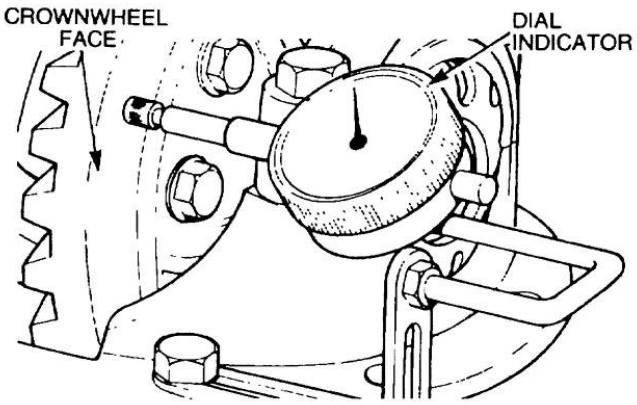


Figure 237 Measuring the Differential Run-out

g. Insert two levers between the axle casing and the differential assembly, move the differential fully to one side ensuring that the differential does not tilt. Rotate the differential to settle the bearings while continuing to apply pressure with the levers. Zero the dial indicator. While rotating the differential, lever the assembly fully to the opposite side and note the reading on the indicator.

NOTE

The shim dimensions are in thousandths of an inch, and the range is 0.003 in, 0.005 in, 0.010 in and 0.030 in.

Do not fit the shims to the bearings until the differential backlash check has been carried out.

h. To obtain the required pre-load, add 0.005 in to the reading noted in Para 76. g. The total is then equal to the nominal value of shims required for the differential bearings.

i. Remove the differential assembly from the axle casing.

80. Installation. Install the differential carrier as follows:

a. Select shims of the same thickness as those removed from the pinion inner bearing, as described in Para 73. l.

b. Position the outer bearing cup replacing tool 18G1122G and the outer bearing cup on the press tool 18G1122. Locate the assembly in the axle case pinion bearing nose (Figure 238).

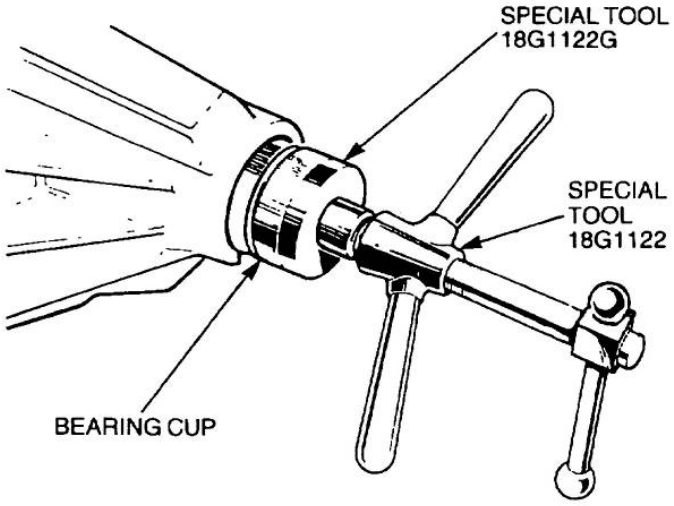


Figure 238 Installation of the Cup Replacing Tool

c. Insert the selected shims in the inner bearing cup seat and position the inner bearing cup in the casing. Fit the cup replacing tool onto the press tool and secure it with the nut (Figure 239). Hold the centre bolt lever and turn the butterfly lever to press in both bearing cups. Remove the nut and the special tools.

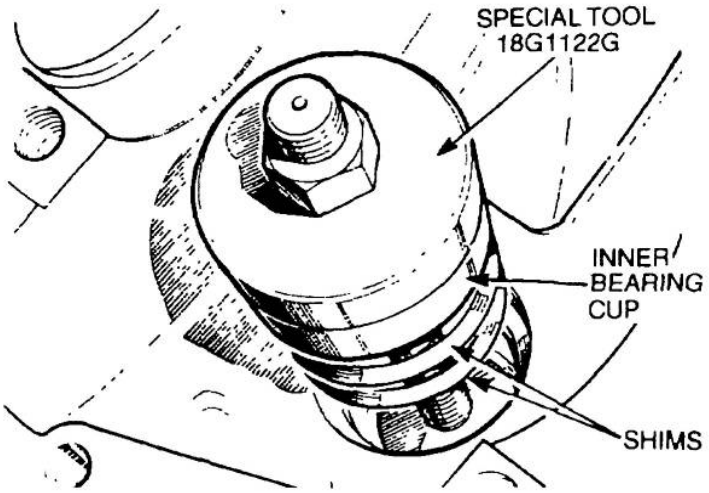


Figure 239 Installation of the Pinion Inner and Outer Bearing Cups

d. Using special tools 18G47BK and MS47, press the inner bearing cone on the pinion shaft (Figure 240) and position the shaft assembly in the case. Do not install the collapsible spacer at this stage.

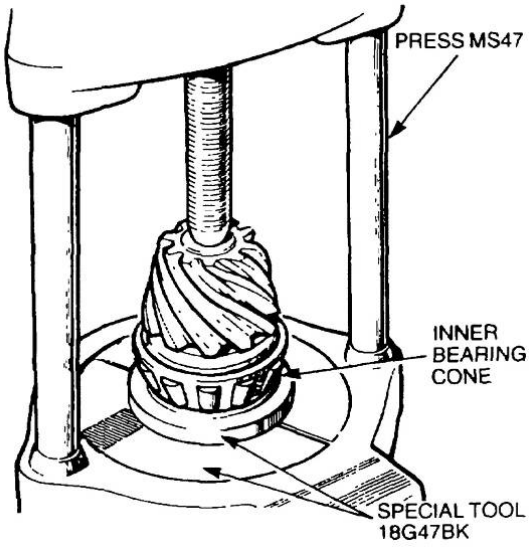


Figure 240 Installation of the Pinion Inner Bearing Cone

e. Fit the outer bearing cone on the pinion shaft and install the coupling flange flat washer and nut. Tighten the nut to remove all end-float. Rotate the pinion to settle the bearings and tighten the nut further until a torque resistance of 1.0 to 1.35 N.m (8.8 to 12 lbf.in) is required to rotate the pinion.

NOTE

Check that the serial number etched on the pinion end-face matches the serial number etched on the crownwheel (Figure 241).

The number etched on the pinion end-face opposite the serial number indicates, in thousandths of an inch, the deviation from nominal required to correctly set the pinion. A pinion marked plus (+) must be set below nominal, and a pinion marked minus (–) must be set above nominal. An unmarked pinion must be set at nominal.

The nominal setting dimension is represented by the setting gauge block (special tool 18GA191-4), which is referenced from the pinion end-face to the bottom radius of the differential bearing bore.

The shim dimensions are in thousandths of an inch. The range is 0.003 in, 0.005 in and 0.030 in.

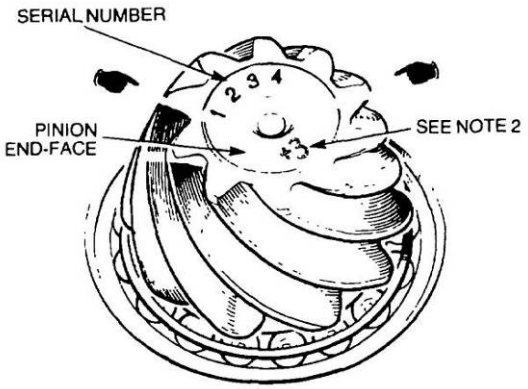


Figure 241 Pinion Shaft Markings

f. Ensure the pinion end-face is free of any raised burrs around the etched markings.

NOTE

The setting block 18GA191-4 is provided with four different heights. For this axle use the setting marked 30.93 mm.

g. Remove the keep-disc from the magnetized base of the dial indicator, special tool 18G191, and place the dial indicator and setting gauge, 18GA191-4, on a flat surface. Zero the dial indicator stylus onto the setting gauge (Figure 242).

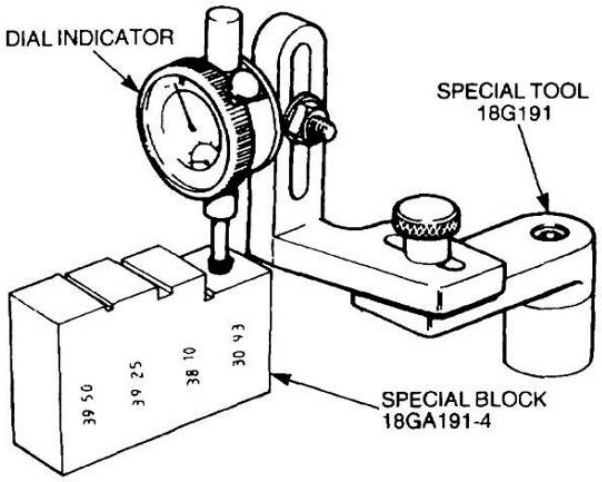


Figure 242 Zeroing the Dial Indicator

h. Position the magnetized base, of the dial indicator special tool, on the pinion shaft end-face and rest the stylus on the lowest point of one differential bearing cup bore (Figure 243). Note the dial indicator deviation from the zero setting.

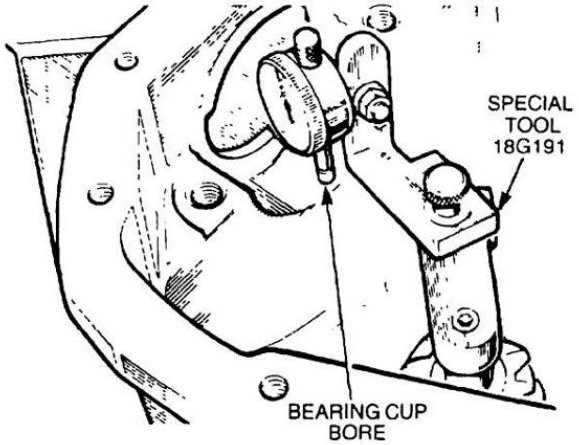


Figure 243 Measuring the Pinion Shaft Height

NOTE

If the stylus has moved down, the amount is equivalent to the thickness of shims that must be removed from under the pinion inner bearing cup to bring the pinion down to the nominal position (Figure 244).

If the stylus has moved up, the amount is equivalent to the additional thickness of shims required to bring the pinion up to the nominal position.

i. Repeat the procedure on the opposite bore and add together the two readings. Halve the total to obtain the mean reading and note whether the stylus has moved up or down from the zero setting (Table 12).

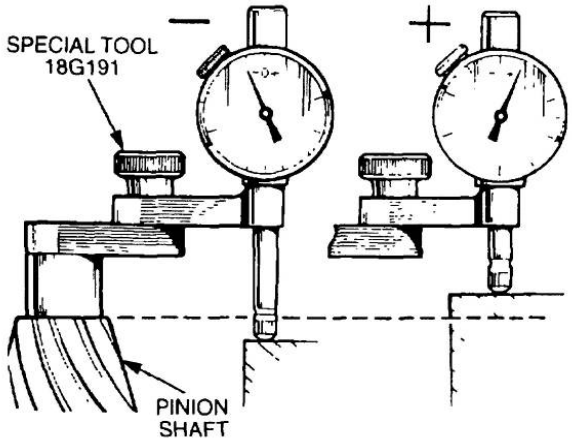


Figure 244 Measuring the Pinion Shaft Height Using the Setting Block

Table 12 Pinion Height Setting Examples

Example 1 – Readings		Example 2 – Readings	
Left-hand side	+ 0.006 in	Left-hand side	+ 0.006 in
Right-hand side	– 0.003 in	Right-hand side	– 0.008 in
	Add + 0.006 in		Add + 0.006 in
	– 0.003 in		– 0.008 in
Divide by 2	+ 0.003 in	Divide by 2	– 0.002 in
=	+ 0.0015 in	=	– 0.001 in
Therefore ***subtract*** 0.0015 in from the shim thickness behind the pinion inner bearing track.		Therefore ***add*** 0.001 in to the shim thickness behind the pinion inner bearing track.	

NOTE

Before adjusting the shim thickness, check the pinion end-face marking and if it has a plus (+) figure, subtract that amount, in thousandths of an inch, from the shim thickness figure obtained in Para 77. i. Alternatively if the pinion has a minus (–) figure, add the amount to the shim thickness figure.

j. Adjust the shim thickness behind the pinion inner bearing cup (Figure 245) as required, by the amount determined in Para 77. i., and recheck the pinion height settings as described in Paras 77. h. and i. If the setting is correct, the mean reading on the dial indicator will agree with the figure marked on the pinion end-face. For example, with an end-face marking of + 4, the dial indicator reading should indicate that the pinion is 0.004 in below nominal.

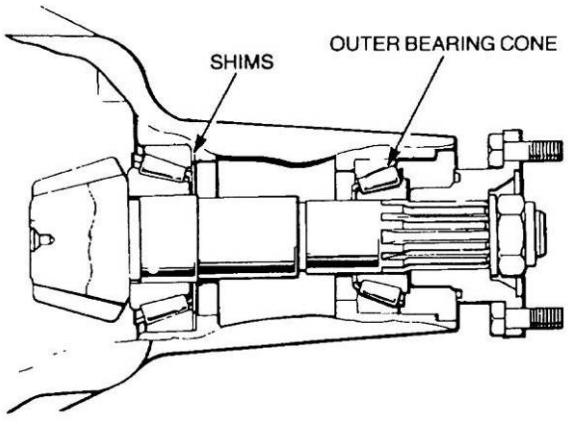


Figure 245 Installation of the Pinion Shaft

k. When the pinion shaft setting is satisfactory, remove the outer bearing cone and install a new collapsible spacer with the flared end towards the flange end. Fit the bearing, oil slinger and oil seal gasket (Figure 246).

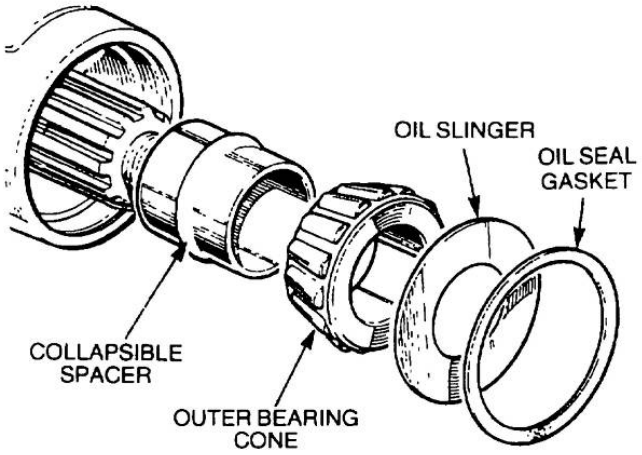


Figure 246 Installation of the Collapsible Spacer and Outer Bearing

l. Smear grease on the seal lip and using special tool RO1008A install the oil seal with the open face towards the bearing.

CAUTION

After the initial collapse, pinion shaft torque resistance build up is rapid. Frequent checks must be carried out, using a spring balance, to ensure the correct figures are not exceeded; otherwise a new collapsible bearing spacer will be required.

m. Fit the coupling flange and plain washer and loosely fit a new flange locknut. Using special tool 18G1205A to prevent the flange from rotating, tighten the nut and then check the resistance to rotation. A torque of approximately 339 N.m (250 lbf.ft) is required on the coupling flange nut to start collapsing the spacer. Torque resistance build up is rapid after the initial collapse of the spacer occurs and frequent checks are required to ensure the correct setting is not exceeded, otherwise a new collapsible spacer will be required. When using the original bearings, the resistance must be between 1.7 to 3.4 N.m (15 to 30 lbf.in). When using new bearings, the resistance must be between 3.4 to 4.5 N.m (30 to 40 lbf.in).

n. Install the differential in the axle casing and using two levers, move the assembly away from the pinion gear until the opposite bearing cup is seated against the axle casing (Figure 247). Do not tilt the differential assembly. Note the total reading on the dial indicator.

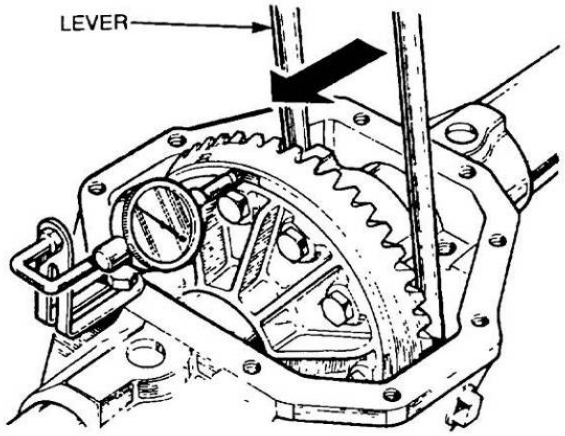


Figure 247 Checking the Differential Backlash

o. Position the dial indicator on the axle casing with the stylus in contact with the back face of the crownwheel and zero the gauge.

NOTE

The shim dimensions are in thousandths of an inch, and the range is 0.003 in, 0.005 in, 0.010 in and 0.030 in.

p. Lever the differential assembly to engage the crown wheel teeth in full mesh with the pinion teeth, ensuring the differential assembly is not tilted. Note the total reading on the gauge.

q. Subtract 0.010 in from the reading on the gauge to obtain the correct crownwheel backlash. This figure indicates the thickness of shims to be fitted between the axle case and the bearing cone on the crownwheel side of the differential. The shim thicknesses are in thousandths of an inch and are supplied in thicknesses of 0.003 in, 0.005 in, 0.010 in and 0.030 in.

r. Remove the differential assembly and using special tools 18G134, 18G47BL, press MS47 and adapters 1 and 2, remove the bearing cone on the crownwheel side.

s. From the shims, selected in reassembly Para 78. h., take the shim value selected in Para 77. p., and fit it to the crownwheel side bearing face. Using special tool l8Gl34DP, and a suitable press, install the bearing cone on the differential assembly.

t. Using special tool 18GI34, 18G47BL, press MS47 and adapters 1 and 2, remove the bearing cone from the opposite side of the differential assembly. Install the remaining shims determined in the reassembly procedure Para 77. p., then using special tool 18G134DP and a suitable press, install the bearing cone.

u. Using the axle case spreader, special tool 18G131C and adapter pegs 18G131F, install the differential assembly. Remove the spreader and install the two bearing caps ensuring that the match marks align. Insert the retaining bolts and torque them to 126 to 142 N.m (93 to I05 lbf.ft).

v. Position a dial indicator on the axle casing and place the stylus on a crownwheel tooth (Figure 248). Hold the pinion shaft flange and check the backlash between the crownwheel and pinion gear teeth. If the backlash is not between 0.15 to 0.27 mm (0.006 to 0.011 in) repeat the procedure described in Paras 77. n. to t.

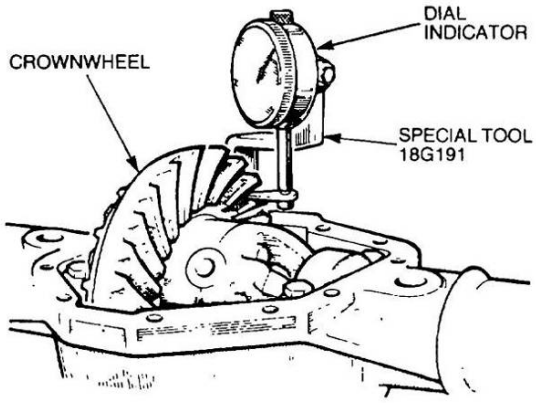


Figure 248 Final Check of the Differential Backlash

CAUTION

Ensure that the differential oil level plug threads are not stretched. Damaged threads may allow the oil level plug to contact the differential carrier causing severe damage. Rectify stretched threads in accordance with EMEI Vehicle G 203.

NOTE

Differential covers must not be interchanged.

w. Apply a suitable sealing compound to both sides of the differential cover gasket, install the cover and the supporting strip. Insert the bolts and new lock-washers and torque them to 27 to 34 N.m (20 to 25 lbf.ft).

x. Refill the axle casing with approximately 2.3 litres of clean oil.

y. Install the rear axle shafts and rear axle in accordance with EMEl Vehicle G 204-1 – Group 9.

NOTE

If the differential and pinion have been replaced, the axle should be allowed to run in, and high speeds and heavy loads must be avoided, when possible, during this period.

81. The rear axle specifications are detailed in Table 13.

Table 13 Rear Axle Specifications

Serial	Item	Specification
1	Crownwheel backlash	0.15 to 0.27 mm (0.006 to 0.011 in)
2	Differential bearings pre-load	0.127 mm (0.005 in)
3	Pinion height setting (using gauge 18GA191-4)	30.93 mm (1.218 in)
4	Pinion shaft and new bearings torque resistance	3.4 to 4.5 N.m (30 to 40 lbf.in)
5	Pinion shaft and original bearings torque resistance	1.7 to 3.4 N.m (15 to 30 lbf.in)
6	Crownwheel run-out	0.05 mm (0.002 in) Maximum
7	Differential casing bolts tightening torque	89 to 102 N.m (66 to 75 lbf.ft)
8	Crownwheel bolts tightening torque	129 to 142 N.m (95 to 105 lbf.ft)
9	Differential bearing caps tightening torque	126 to 142 N.m (93 to 105 lbf.ft)
10	Differential cover tightening torque	27 to 34 N.m (20 to 25 lbf.ft)

FRONT AXLE

Differential Carrier

82. Disassembly. Disassemble the differential carrier as follows:

WARNING

DO NOT spin the bearings with compressed air as personal injury or damage to the bearings may result.

New gaskets provided by Land Rover do not contain asbestos. Older gaskets still fitted to vehicles may contain asbestos. During this task some parts may contain asbestos; refer and comply with procedures and warnings in the introduction section of this EMEI under paragraph heading: Items Previously Known To Have Contained Asbestos.

NOTE

If the Panhard rod and radius arm mounts on the axle housing are worn, they can be reclaimed in accordance with EMEI Vehicle G 204-1 – Group 10.

a. Remove the front axle differential in accordance with EMEl Vehicle G 204-1 – Group 9.

b. Remove the roll pins securing the adjusting nut locking fingers to the side bearing caps (Figure 249). Remove the locking fingers and unscrew the adjusting nuts.

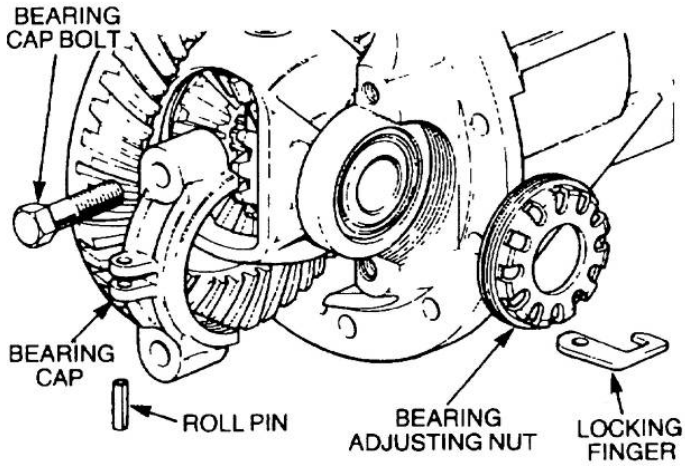


Figure 249 Removal of the Locking Finger and Adjusting Nut

NOTE

It is important that all components are marked in their original position, to maintain the initial settings, if they are not to be replaced.

c. Match mark the bearing caps and remove the four bolts. Remove the caps and lift the differential assembly out of the carrier.

d. Remove the split pin securing the coupling flange nut. Using special tool 18G1205A to prevent the flange from turning, remove the nut (Figure 250).

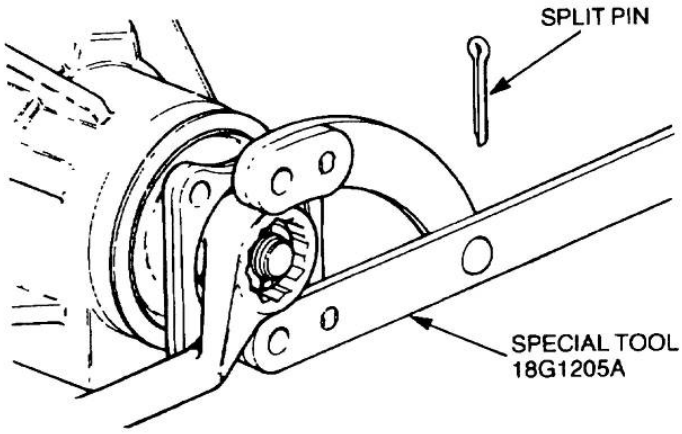


Figure 250 Removal of the Coupling Flange Nut

e. Remove the pinion shaft complete with the inner bearing cone and shims. Remove the oil seal, spacer and outer bearing cone (Figure 251). Do not discard the shims.

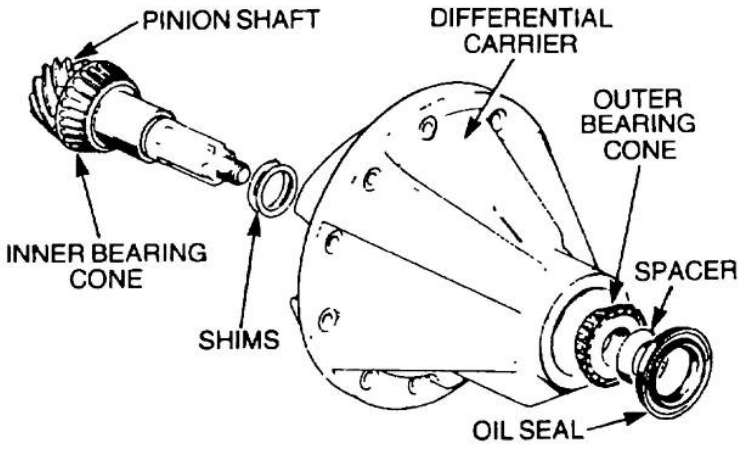


Figure 251 Removal of the Pinion Shaft and Bearings

f. Using special tool R0262757A, remove the inner bearing cup from the differential carrier (Figure 252). Using a suitable drift, remove the outer bearing cup.

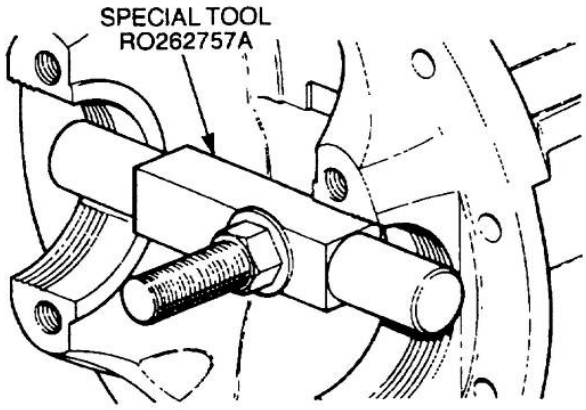


Figure 252 Removal of the Pinion Shaft Bearing Cups

g. Using special tools MS47 and 18G47-6, remove the pinion shaft inner bearing cone (Figure 253).

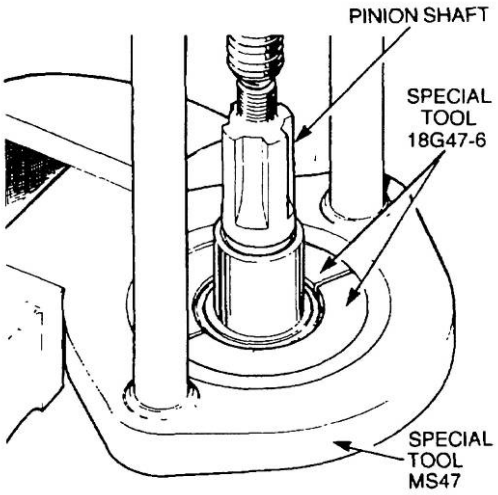


Figure 253 Removal of the Pinion Shaft Inner Bearing Cone

h. Remove the bolts and lock-washers securing the crownwheel to the differential flange (Figure 254), discard the lock-washers. Using a suitable collar and a press, remove the side bearings from the differential cage.

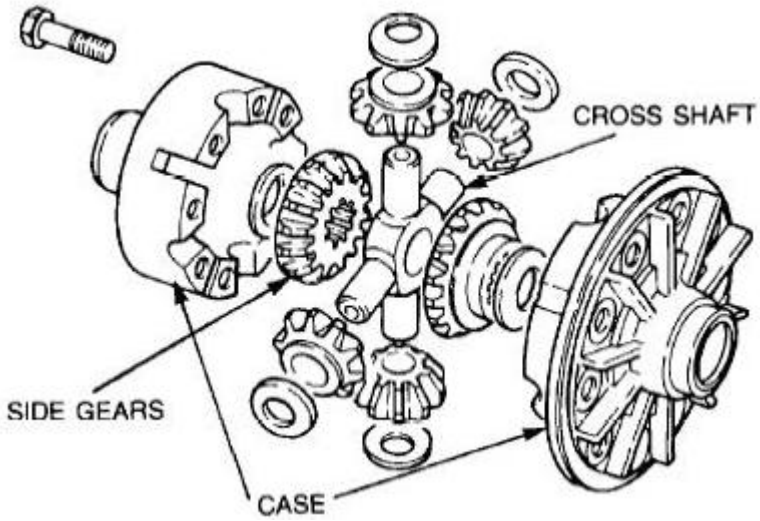


Figure 254 Front Differential Cage - Exploded View

i. Check for match marks on the two halves of the differential cage and if necessary, match mark the two halves. Place the cage on a side bearing mounting flange and remove the bolts securing the two halves of the cage together. Separate the two halves and remove the upper side gear and thrust washer. Lift out the cross-shaft, together with the four planetary bevel gears and thrust washers, then lift out the remaining side gear and thrust washer (Figure 254).

83. Cleaning and Inspection. Clean and inspect the differential as follows:

WARNING

DO NOT spin the bearings with compressed air as personal injury or damage to the bearings may result.

New gaskets provided by Land Rover do not contain asbestos. Older gaskets still fitted to vehicles may contain asbestos. During this task some parts may contain asbestos; refer and comply with procedures and warnings in the introduction section of this EMEI under paragraph heading: Items Previously Known To Have Contained Asbestos.

a. Thoroughly clean all components using a suitable cleaning agent and blow them dry with compressed air.

b. Inspect all gear teeth for signs of abrasive wear, scratching, ridging, scoring, surface fatigue, pitting, corrosive wear, digging in or cracking and replace parts as necessary.

NOTE

The crownwheel and pinion are supplied as a matched pair only, as is the differential carrier and bearing caps.

c. Inspect all bearings for flaking, fretting, corrosion, cracks and fractures, and replace parts as necessary.

d. Inspect the crownwheel-to-differential joint faces for signs of damage, and replace parts as necessary.

84. Reassembly. Reassemble the differential as follows:

a. Place half of the differential cage with the side bearing mounting flange down on a bench. Lubricate a side gear and a new thrust washer with clean oil and position the thrust washer and side gear in the cage.

b. Lubricate and assemble the cross-shaft, planetary gears and new thrust washers and position the cross-shaft assembly in the cage. Ensure that the bevel gears are in mesh with the side gear and that the cross-shaft is correctly seated in the cage.

c. Lubricate and assemble the remaining side gear and thrust washer. Position the side gear centrally over the bevel gears and ensure that the gears are in mesh.

d. Position the remaining half of the differential cage over the gears and align the match marks on the two halves of the cage. Apply Loctite 275 to the threads of the bolts securing the two halves together and install and torque the bolts to 30 to 36 N.m (22 to 27 lbf.ft).

NOTE

There is no provision for backlash adjustment.

e. Ensure that the differential cage flange and crownwheel faces are thoroughly clean and fit the crownwheel. Install the retaining bolts, with new lock-washers, and tighten the bolts evenly.

f. Using a suitable press, install the bearing cones on the differential cage and fit the bearing cups.

g. Insert the differential cage assembly in the carrier and install the bearing caps and retaining bolts (Figure 255). Do not tighten the bolts at this stage.

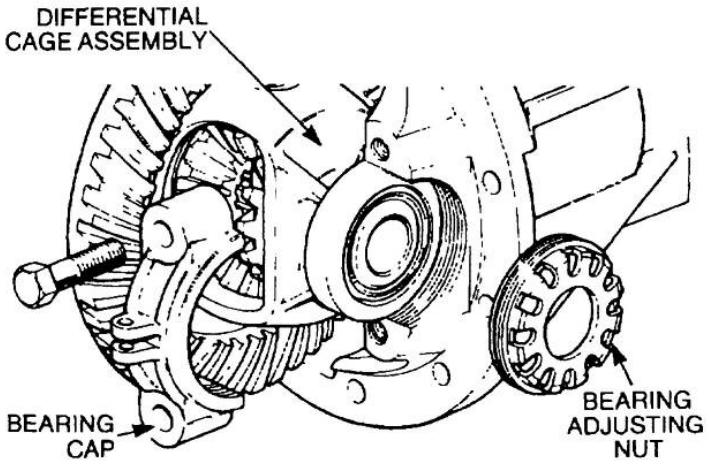


Figure 255 Installation of the Differential Cage

h. Install the two bearing adjusting nuts and tighten them until all end-float is taken up. Tighten the bearing cap bolts.

NOTE

Excessive run-out may be caused by a damaged differential cage flange, in which case, the cage must be replaced.

i. Mount a dial indicator on the differential carrier flange and rotate the differential to measure the run-out (Figure 256) which should not exceed 0.10 mm (0.004 in). If the run-out is excessive, remove the crownwheel and inspect the mating faces for signs of dirt or burrs. Install the crownwheel and recheck the run-out.

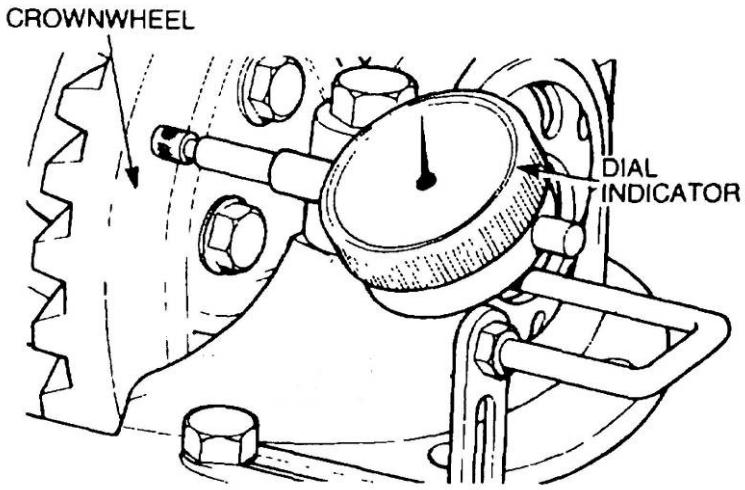


Figure 256 Checking the Crownwheel Run-out

j. If the run-out is within specifications, remove the differential assembly. Remove the bolts and lock-washers from the crownwheel, apply Loctite 275 to the threads of the bolts and insert the bolts and lock-washers. Torque the bolts evenly to 61 to 75 N.m (45 to 55 lbf.ft).

NOTE

If the original shims are damaged or lost use a shim of approximately 0.050 in thickness.

k. Using special tools RO262757A, RO262757-1 and RO262757-2, install the pinion shaft inner and outer bearing cups and shims in the differential carrier (Figure 257).

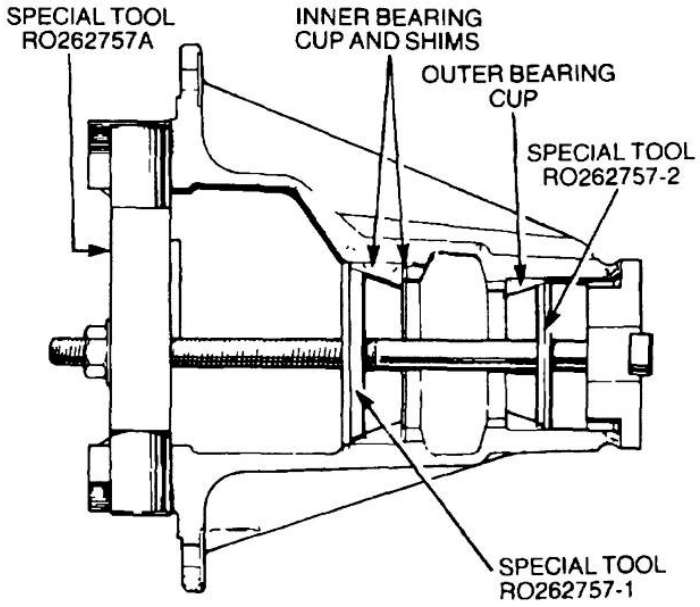


Figure 257 Installation of the Pinion Bearing Cups

NOTE

Ensure that the pinion shaft inner bearing cone is an interference fit on the shaft when reassembling.

l. Using special tools MS47 and 18G47-6, install the pinion shaft inner bearing cone (Figure 258).

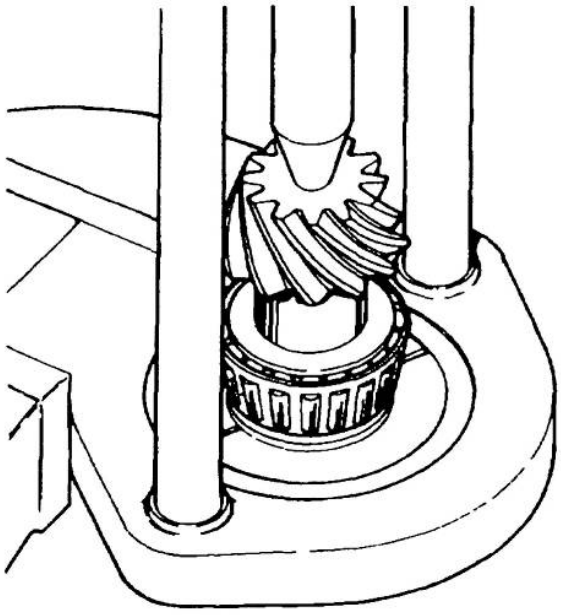


Figure 258 Installation of the Pinion Shaft Inner Bearing Cone

NOTE

If the original shims are damaged or lost, use a shim of approximately 0.160 in thickness.

m. Slide the original shims onto the pinion shaft and insert the shaft in the differential carrier. Install the outer bearing cone and spacer and fit the coupling flange and nut (Figure 259). Do not install the oil seal at this stage.

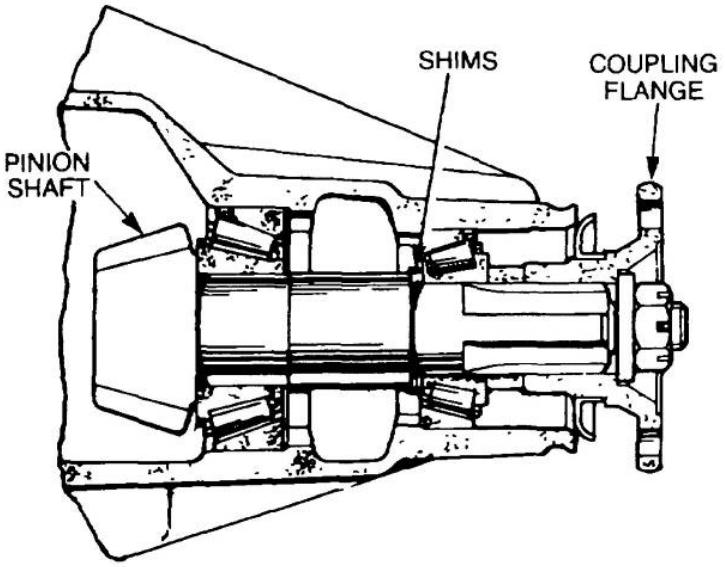


Figure 259 Adjustment of the Pinion Shaft Pre-load

n. Using special tool 18G1205A to prevent the coupling flange rotating, torque the flange nut to 95 to 163 N.m (70 to 120 lbf.ft). Remove the special tool and check that the torque required to rotate the shaft is 2.6 to 3.95 N.m (20 to 35 lbf.in) with new bearings, and 1.3 to 1.6 N.m (10 to 15 lbf.in) with the original bearings after the shaft has started to rotate. Replace the shims installed between the shaft and outer bearing cone to adjust the pre-load. A thicker shim will reduce pre-load and a thinner shim will increase pre-load.

NOTE

Check that the serial number etched on the pinion end-face matches the serial number etched on the crownwheel (Figure 260).

The number etched on the pinion end-face opposite the serial number indicates, in thousandths of an inch, the deviation from nominal required to correctly set the pinion. A pinion marked plus (+) must be set below nominal, and a pinion marked minus (-) must be set above nominal. An unmarked pinion must be set at nominal.

The nominal setting dimension is represented by the setting gauge block, special tool 18G191-4, which is referenced from the pinion end-face to the bottom radius of the differential bearing bore.

The pinion inner bearing shim dimensions are in thousandths of an inch, and range in increments of 0.002 in from 0.038 to 0.062 in and in increments of 0.001 in from 0.062 to 0.065 in.

The pinion outer bearing shim dimensions are in thousandths of an inch, and range in increments of 0.001 in from 0.060 to 0.070 in and in increments of 0.002 in from 0.072 to 0.078 in.

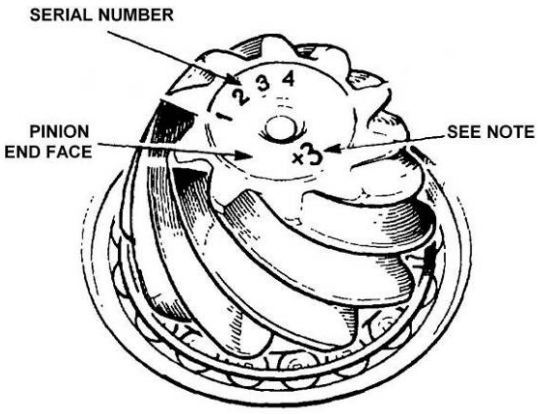


Figure 260 Pinion Shaft Markings

o. Ensure that the pinion end-face is free of any raised burrs around the etched markings.

NOTE

The setting block 18GA191-4 is provided with four different heights. For this axle, use the setting marked 39.50 mm.

p. Remove the keep-disc from the magnetized base of the dial indicator, special tool 18G191, place the dial indicator and setting gauge 18GA191-4 on a flat surface and zero the dial indicator stylus onto the setting gauge marked 39.50 mm (Figure 261).

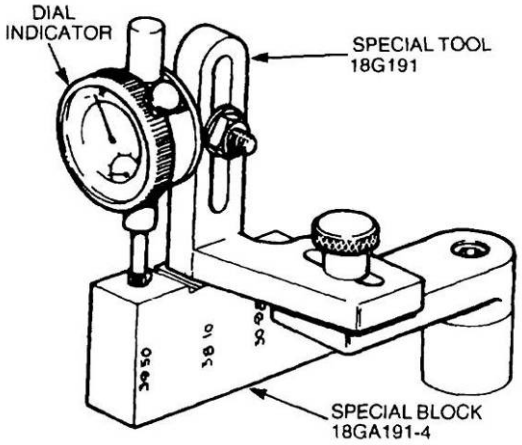


Figure 261 Zeroing the Dial Indicator

q. Position the magnetized base of the dial indicator on the pinion shaft end-face, and rest the stylus on the lowest point of one differential cup bore (Figure 262). Note the dial indicator deviation from the zero setting.

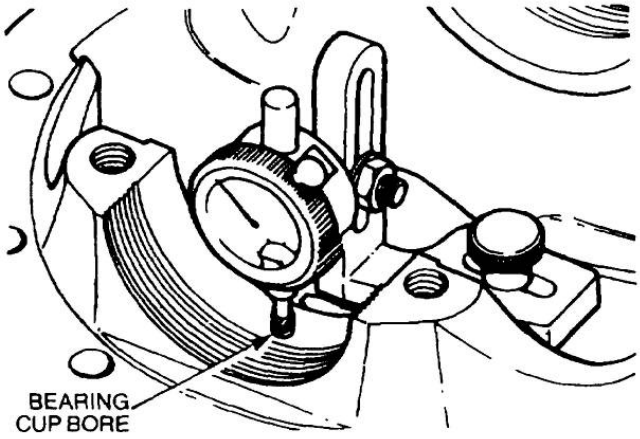


Figure 262 Measuring the Pinion Shaft Height

NOTE

If the stylus has moved down, the amount is equivalent to the thickness of shims that must be removed from under the pinion inner bearing cup to bring the pinion down to the nominal position (Figure 263).

If the stylus has moved up, the amount is equivalent to the additional thickness of shims required to bring the pinion up to the nominal position.

r. Repeat the procedure on the opposite bore and add together the two readings. Halve the total to obtain the mean reading and note whether the stylus has moved up or down from the zero setting (Table 12).

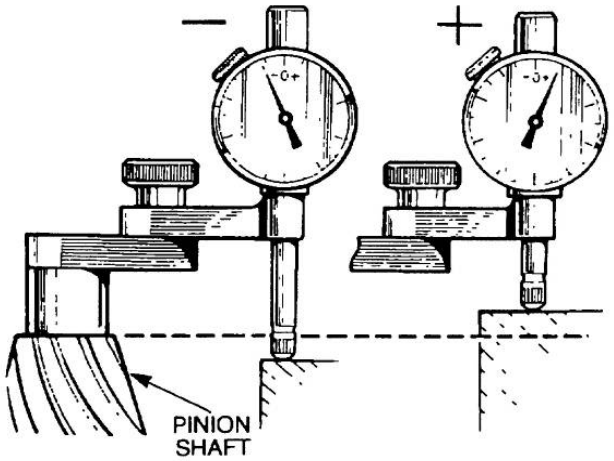


Figure 263 Measuring the Pinion Shaft Height Using the Setting Block

s. Before adjusting the shim thickness, check the pinion shaft end-face. If it has a plus (+) figure, subtract that amount in thousandths of an inch, from the shim thickness figure obtained in Paras 81. q. and r. Alternatively if the pinion has a minus (–) figure, add that amount to the shim thickness figure.

t. Adjust the shim thickness behind the pinion inner bearing cup as required by the amount determined and recheck the pinion height setting as described in Paras 81. p. to r. If the setting is correct, the mean reading on the dial indicator will agree with the figure marked on the pinion end-face. For example; with an end-face marking of + 4, the dial indicator reading should indicate that the pinion is 0.004 in.

u. Remove the coupling flange and nut and smear a suitable sealing compound on the outer periphery of the new pinion oil seal. Using special tool LST1O6, install the oil seal with the open face towards the bearing (Figure 264).

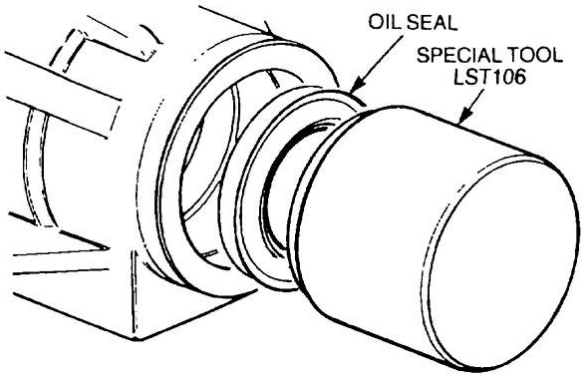


Figure 264 Installation of the Pinion Oil Seal

v. Apply grease to the seal lips and seal spring and insert the spacer and coupling flange (Figure 265). Fit the flat washer and nut and torque the nut to 95 to 163 N.m (70 to 120 lbf.ft). Lock the nut into position with a new split pin.

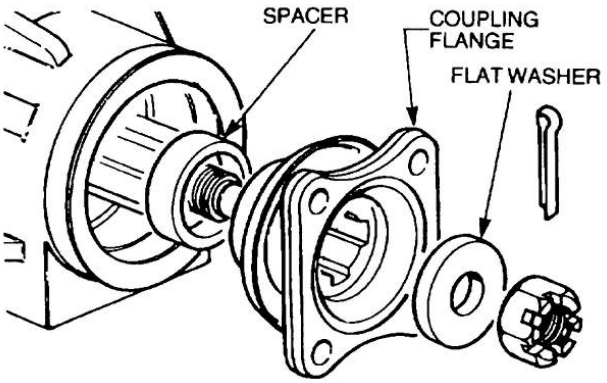


Figure 265 Installation of the Coupling Flange

w. Install the differential assembly in the differential carrier and fit the bearing caps and bolts, ensuring that the caps are correctly installed to their relative match marks. Do not fully tighten the bolts at this stage.

x. Install the bearing adjusting nuts and turn the nuts in direction A to reduce backlash, or in direction B to increase backlash (Figure 266). Finally, tighten the adjusting nuts one-half of a serration and torque the bearing cap bolts to 81 N.m (60 1bf.ft).

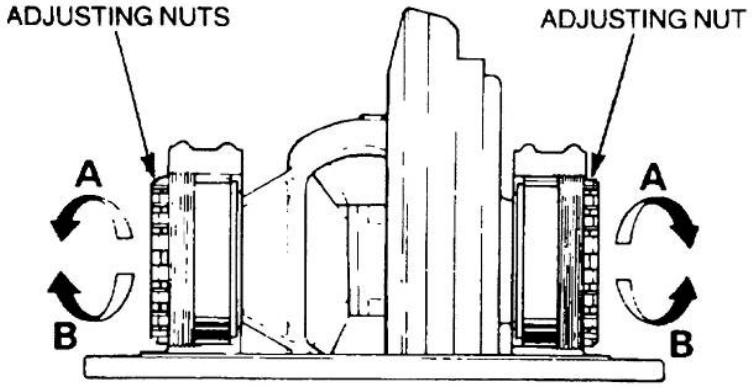


Figure 266 Adjustment of the Crownwheel Backlash

y. Position a dial indicator on the differential carrier flange (Figure 267) and place the stylus on a crownwheel tooth. Hold the pinion shaft flange and check the backlash between the crownwheel and pinion gear teeth. If the backlash is not between 0.20 to 0.25 mm (0.008 to 0.010 in), repeat the procedure (Para 81. x.).

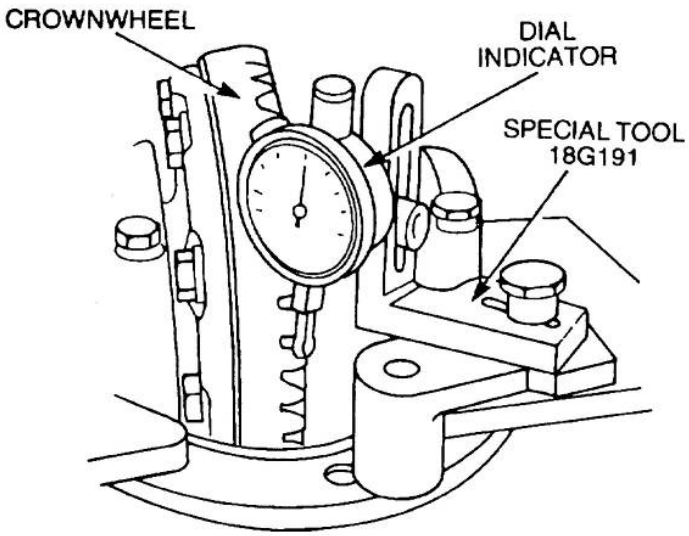


Figure 267 Final Check of the Differential Backlash

z. Fit the adjusting nut locking fingers bending the ends to engage the slots if necessary (Figure 268) and insert new roll pins. Do not alter the position of the adjusting nuts.

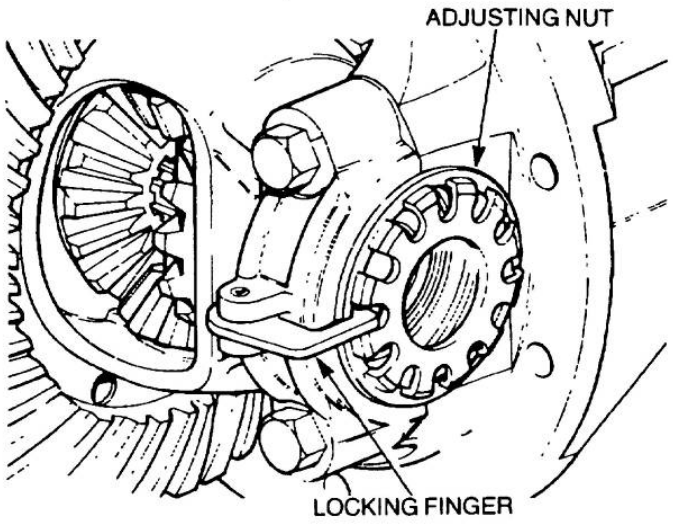


Figure 268 Installation of the Locking Finger

aa. Thoroughly lubricate all components with clean oil and install the differential carrier assembly in the front axle in accordance with EMEl Vehicle G 204-1 – Group 9.

Swivel Pin Housing

85. Removal. Remove the swivel pin housing as follows:

a. Remove the front hub assembly in accordance with EMEl Vehicle G203 – Group 10.

b. Drain the oil from the axle case into a suitable receptacle.

c. Using special tool 18G1063, disconnect the tie rod and drag link (left side only) ball joints from the swivel housing steering arms.

d. Remove the six bolts and locking plate retaining the hub stub axle to the swivel housing (Figure 269).

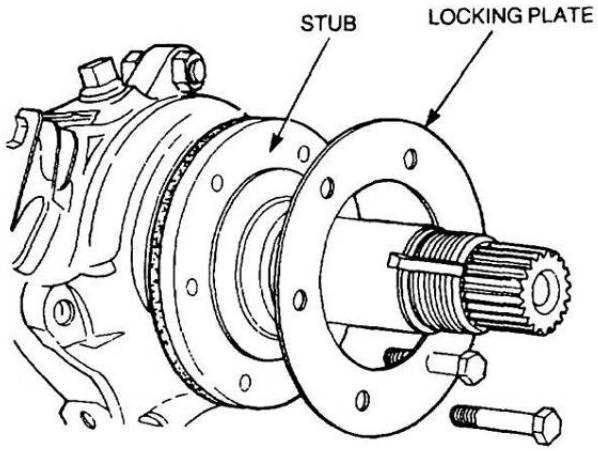


Figure 269 Removal of the Stub Axle

e. Remove the six bolts securing the seal retainer and seal to the swivel housing (Figure 270).

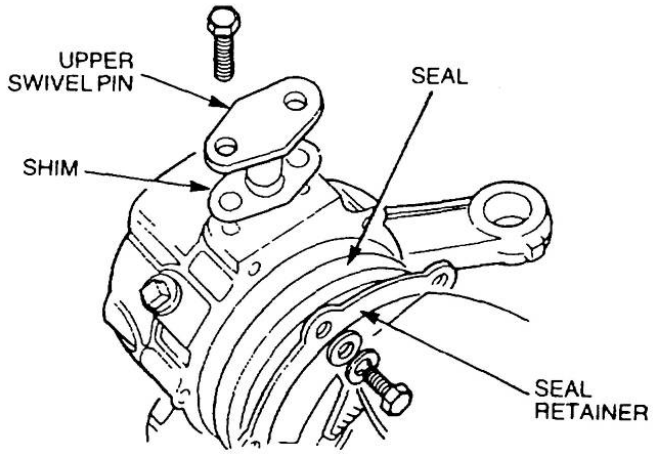


Figure 270 Removal of the Swivel Housing Oil Seal

f. Withdraw the drive shaft assembly from the axle.

g. Remove the two bolts and washers retaining the upper swivel pin, hose retaining bracket and shims (Figure 270).

h. Remove the bolt securing the backing plate to the lower retaining bracket. Remove the two bolts and washers retaining the lower swivel pin and shims. Remove the swivel pin housing.

i. Remove the six bolts retaining the bearing housing to the axle case (Figure 271).

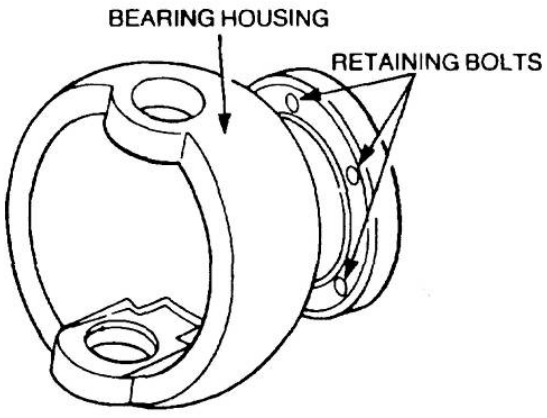


Figure 271 Removal of the Bearing Housing

86. Disassembly. Disassemble the swivel pin housing as follows:

a. Remove the oil seal from the bearing housing (Figure 272), then using a suitable press, remove the lower bearing cup, and upper bush housing.

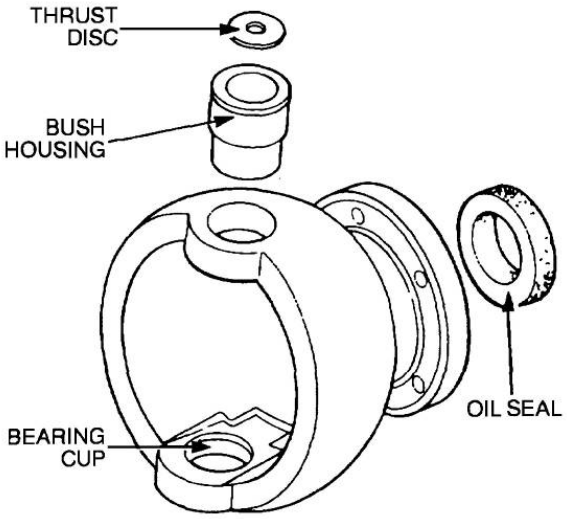


Figure 272 Disassembly of the Bearing Housing

b. Using special tool 18GA284AAH and 18G284, remove the oil seal and bronze bush from the stub axle (Figure 273).

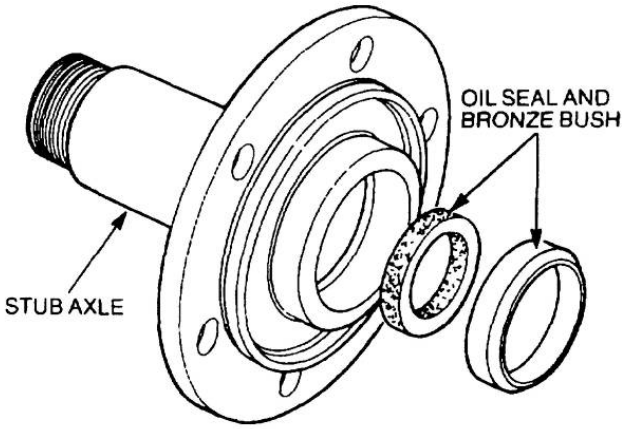


Figure 273 Removal of the Stub Axle Oil Seal

87. Cleaning and Inspection. Clean and inspect the swivel pin housing as follows:

WARNING

DO NOT spin the bearings with compressed air as personal injury or damage to the bearings may result.

CAUTION

Cleaning the upper swivel bush with a cleaning agent will destroy its lubrication characteristics and render it unusable for continued service.

a. Clean all other components in a suitable cleaning agent and blow them dry with compressed air.

b. Inspect the upper bush and housing and replace parts if they are excessively worn or pitted.

c. Ensure that the lower bearing is a push fit on the lower swivel pin, and inspect the bearing for pitting, corrosion or excessive wear. Replace the bearing as necessary.

d. Clean all trace of gasket material from the stub axle and bearing housing mating flanges.

88. Reassembly. Reassemble the swivel pin housing as follows:

a. Using a suitable press, install the oil seal and bronze bush in the stub axle, ensuring that the seal is positioned with the seal spring towards the wheel bearing side of the axle spindle.

b. Press the lower bearing cup, wide face first, into the bearing housing. Press in the upper swivel bush, with the machined flat towards the mounting flange, and thoroughly lubricate the bush with clean oil.

c. Press the oil seal into the bearing housing, plain side first (Figure 272), then smear grease around the seal lip.

89. Installation. Install the swivel pin housing as follows:

a. Fit the swivel housing oil seal and seal retainer over the bearing housing flange ensuring that the open face of the seal is towards the spherical face of the housing. Install the bearing housing and a new gasket onto the axle casing. Smear Loctite 275 on the threads of the bolts. Insert and torque the bolts to 65 to 80 N.m (48 to 59 lbf.ft).

b. Lubricate the lower roller bearing and thrust disc with oil. Install the bearing into the bearing housing cup and the thrust disc into the upper bush. Install the swivel pin housing onto the bearing housing.

c. Insert the lower swivel pin and a new gasket. Secure the swivel pin and the backing plate bracket with the two bolts and new lock-washers.

d. Insert the upper swivel pin and original shims. Secure the pin and brake hose bracket with the two bolts and new lock-washers. Torque the upper pin bolts to 60 to 70 N.m (44 to 52 lbf.ft), and the lower pin bolts to 22 to 28 N.m (16 to 21 lbf.ft).

NOTE

The shims range from 0.076, 0.127, 0.254 and 0.762 mm (0.003, 0.005, 0.010 and 0.030 in).

e. Connect a spring balance to the steering arm ball joint eye and measure the resistance to rotation after the initial movement (Figure 274). The resistance must be 3.64 to 4.55 kg (8 to 10 lbs). Adjustment can be achieved by adding or subtracting shims installed under the upper swivel pin.

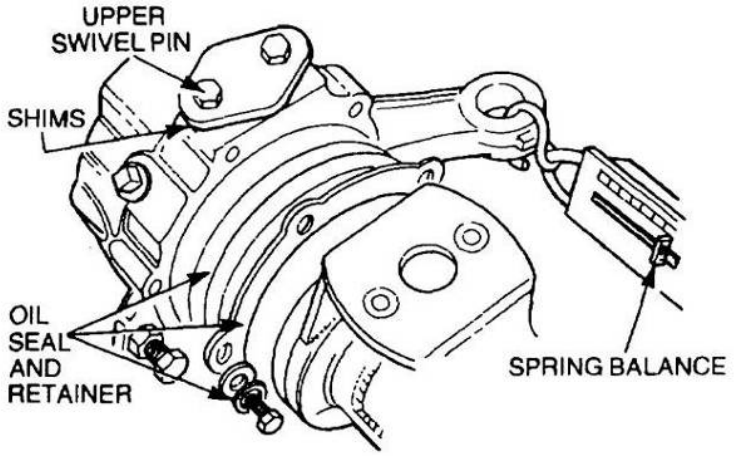


Figure 274 Measuring the Rotating Resistance

f. When the resistance is within specification, remove the upper and lower retaining bolts, apply Loctite 275 to the threads and install the bolts. Torque the upper pin bolts to 60 to 70 N.m (44 to 52 lbf.ft) and the lower pin bolts to 22 to 28 N.m (16 to 21 lbf.ft). Repeat the rolling resistance check.

g. Smear the swivel housing oil seal with grease, install the seal and seal retaining plate. Install the six bolts and new lock-washers (Figure 272). Torque the bolts to 7 to 10 N.m (5 to 7 lbf.ft) and check that the seal wipes the spherical surface of the bearing housing.

h. Install a new gasket and the stub axle onto the swivel pin housing. Apply Loctite 275 to the threads of the bolts and install the bolts and locking plate. Torque the bolts to 60 to 70 N.m (44 to 52 lbf.ft).

i. Connect the tie rod to the steering arm and while applying pressure on the ball joint, tighten the nut securely. Lock the nut in position with a new split pin.

CAUTION

Inserting excessive quantities of grease into the swivel pin housing can cause damage to seals, resulting in loss of grease and subsequent component damage.

j. Install the hub assembly in accordance with EMEI Vehicle G 203 - Group 10. Each swivel pin housing is to be greased using the entire contents of one Molytex grease EP00 sachet.

90. Wheel Alignment. Carry out the front wheel alignment in accordance with EMEI Vehicle G 203 – Group 14.

Drive Shaft

91. Removal. Remove the drive shaft as follows:

a. Remove the front hub assembly in accordance with EMEI Vehicle G 203 – Group 10.

b. Drain the oil from the axle case into a suitable receptacle.

c. Remove the six bolts and locking plate retaining the hub stub axle to the swivel housing (Figure 275).

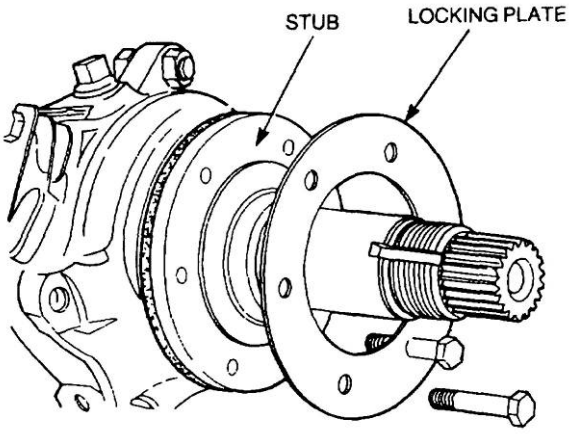


Figure 275 Removal of the Stub Axle

d. Withdraw the drive shaft from the axle case.

92. Disassembly. Disassemble the drive shaft as follows:

a. Clamp the axle end of the shaft firmly in a vice fitted with soft-jawed protectors. Using a soft-faced hammer remove the constant velocity joint from the shaft.

b. Remove the circlip and collar from the shaft and match mark the constant velocity joint inner and outer race to the cage.

c. To remove the steel balls, tilt and swivel the cage, then the inner race (Figure 276).

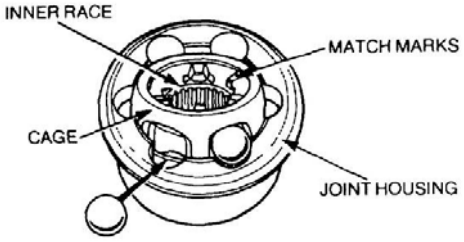


Figure 276 Removal of the Constant Velocity Joint Steel Balls

d. Swivel the cage to line up with the axis of the constant velocity joint (Figure 277), turn the cage until two opposite windows line up with two lands of the joint housing and then remove the cage.

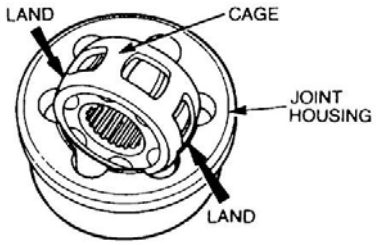


Figure 277 Removal of the Constant Velocity Joint Cage

e. Turn the inner race at right angles to the cage with two of the lands opposite the cage windows and remove the race (Figure 278).

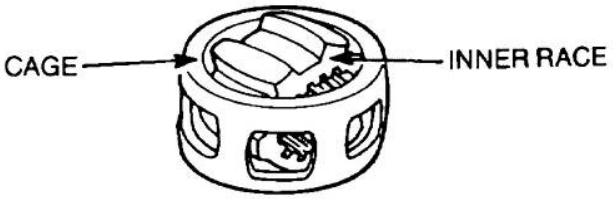


Figure 278 Removal of the Inner Race

93. Cleaning and Inspection. Clean and inspect the drive shaft as follows:

a. Thoroughly clean all components in a suitable cleaning agent and blow them dry with compressed air.

b. Inspect all components for wear and replace the complete assembly if any part is excessively worn.

NOTE

The maximum permissible end-float on the assembled constant velocity joint is 0.64 mm (0.025 in).

94. Reassembly. Reassemble the drive shaft as follows:

a. Turn the inner race at right angles to the cage with two of the lands opposite the cage windows and insert the race (Figure 278).

b. Position the cage on the constant velocity joint (Figure 277) and line up two opposite windows with two opposite lands, then fit the cage.

c. Align the match marks made on the joint inner and outer race and the cage, tilt and swivel the cage to allow the steel balls to be inserted (Figure 276).

d. Fit the collar and circlip on the shaft. Using a soft-faced hammer, install the constant velocity joint onto the shaft.

95. Installation. Install the drive shaft as follows:

a. Using a new gasket, install the stub axle and locking plate. Apply Loctite 275 to the bolt threads, install the bolts and torque them to 60 to 70 N.m (44 to 52 lbf.ft).

NOTE

A new circlip must be fitted to the drive shaft when installing the hub assembly.

b. Install the hub assembly in accordance with EMEl Vehicle G 203 – Group 10 and fill the axle housing with oil to the correct level.

Swivel Pin to Bush Clearance

96. Inspection and Adjustment. Inspect and adjust the swivel pin-to-bush clearance as follows:

a. Slacken the front wheel nuts.

WARNING

Do not work on the vehicle without the use of an axle stand beneath the axle. Place the axle stand as close to the raised wheel as possible. This procedure is required for all repairs and maintenance activities involving positioning of body parts in potential crush zones of the vehicle. Failure to comply may result in serious injury or death.

b. Jack up the vehicle, support the axle on axle stands and remove the wheel.

c. Disconnect the track rod and drag link from the swivel pin housing in accordance with EMEl Vehicle G 203 – Group 14. After removing the swivel housing oil seal, rotate the axle end from lock to lock five times.

NOTE

The shims range from 0.076, 0.127, 0.254 and 0.762 mm (0.003, 0.005, 0.010 and 0.030 in)

d. Connect a spring balance to the steering arm ball joint eye and measure the resistance to rotation after the initial movement (Figure 279). The resistance must be 4.5 to 9 kg (10 to 20 lbs). Adjustment can be achieved by adding or subtracting shims installed under the upper swivel pin.

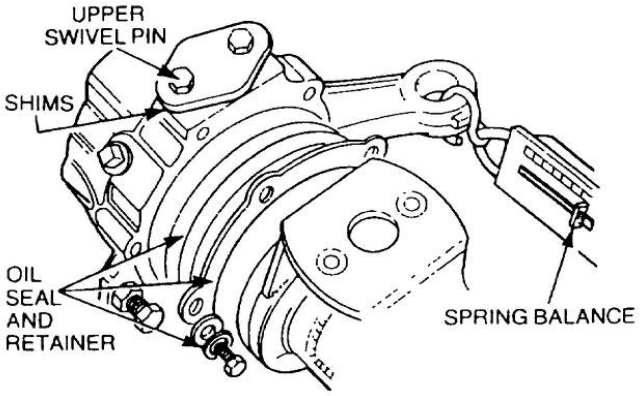


Figure 279 Measuring the Rotating Resistance

e. When the rotating resistance is correct, place a magnetic dial indicator on the outer face of the brake disc adjacent to the outer edge (Figure 280).

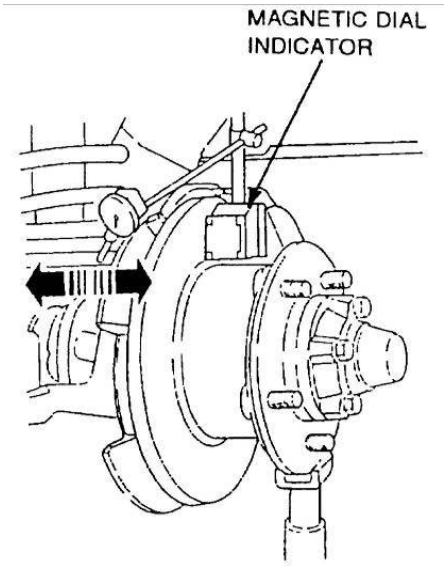


Figure 280 Measuring the Bush Clearance

f. Place the stylus on the bottom spring seat in line with the top of the axles, as near to horizontal as possible, and zero the pointer.

g. With an assistant depressing the brake pedal by hand, place a jack under the outer end of the hub and jack the axle just clear of the axle stands.

h. Note the dial indicator reading.

i. Lower the axle back onto the stand.

j. Apply a downward pressure to the outer end of the hub and ensure that the dial indicator returns to zero.

k. Repeat this operation a further nine times and record the readings.

l. Take an average of the readings. An average of 0.4 mm (0.015 in) or less indicates the bush to bearing clearance is within specification.

m. If the clearance is excessive overhaul the swivel pin housing as detailed in Paras 85. to 89.

n. Remove the dial indicator and the jack from the hub assembly.

o. Install the swivel housing oil seal, the drag link and the track rod in accordance with EMEl Vehicle G 203 – Group 14.

p. Remove the axle stands, refit the wheel and lower the vehicle.

97. The front axle specifications are detailed in Table 14.

Table 14 Front Axle Specifications

Serial	Item	Specification
1	Crownwheel backlash	0.20 to 0.25 mm (0.008 to 0.010 in)
2	Differential cage bolts tightening torque	30 to 36 N.m (22 to 27 lbf.ft)
3	Differential bearings pre-load	0.79 to 1.35 N.m (7 to 12 lbf.in)
4	Pinion height setting (using gauge 18GA191 - 4)	39.50 mm (1.55 in)
5	Pinion shaft torque resistance (new bearings)	3.4 to 4.5 N.m (30 to 40 lbf.in)
6	Crownwheel run-out	0.10 mm (0.004 in) Maximum
7	Crownwheel bolts tightening torque	61 to 75 N.m (45 to 55 lbf.ft)
8	Differential bearing caps tightening torque	81 N.m (60 lbf.ft)
9	Coupling flange tightening torque	95 to 163 N.m (70 to 120 lbf.ft)
10	Swivel bearing housing tightening torque	65 to 80 N.m (48 to 59 lbf.ft)
11	Swivel pin (upper) tightening torque	60 to 70 N.m (44 to 52 lbf.ft)
12	Swivel pin (lower) tightening torque	22 to 28 N.m (16 to 21 lbf.ft)
13	Swivel pin housing rotation resistance	4.5 to 9 kg (10 to 20 lb)
14	Swivel pin housing seal retainer tightening torque	7 to 10 N.m (5 to 7 lbf.ft)
15	Constant velocity joint maximum end-play	0.64 mm (0.025 in)

BRAKE SYSTEM

WARNING

Under no circumstances is compressed air to be used to remove dust from the brake drums or discs. Dust from the brake linings can be a health risk if inhaled.

Master Cylinder

98. Disassembly. Disassemble the brake master cylinder as follows:

a. Remove the brake master cylinder in accordance with EMEl Vehicle G 203 – Group 12.

NOTE

Unless otherwise stated, all item numbers in parenthesis refer to Figure 281.

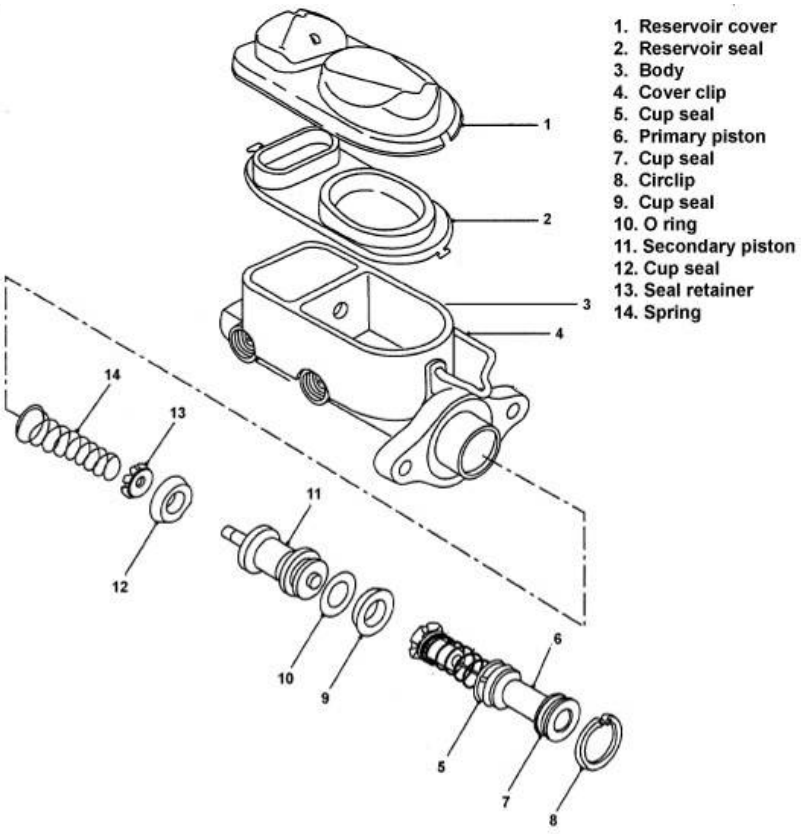


Figure 281 Brake Master Cylinder - Exploded View

b. Unclip and remove the reservoir cover (item 1) and the reservoir seal (item 2). Empty out the residual brake fluid.

c. Depress the primary piston (item 6) into the bore and, using circlip pliers, remove the circlip (item 8) from the retaining groove at the rear of the bore.

d. Remove the primary piston assembly (item 6) from the bore in the master cylinder body (item 3).

e. Remove the secondary piston assembly (item 11) from the bore in the master cylinder body (item 3).

f. Using pointed nose pliers remove the spring (item 14) from the master cylinder bore.

g. Remove the cup seals (items 5 and 7) from the primary piston (item 6) and discard them.

h. Remove the cup seals (items 9 and 12) and the O ring (item 10) from the secondary piston (item 11). Discard the cup seals and the O ring.

99. Cleaning and Inspection. Clean and inspect the brake master cylinder as follows:

a. Clean all components with a recommended cleaning agent and blow them dry with compressed air. Pay particular attention to the recesses, openings and internal passages of the cylinder body.

b. Inspect all components for nicks, burrs, corrosion, excessive wear or damage. Replace as necessary.

NOTE

The master cylinder is not to be honed. Replace it if machining is required.

100. Reassembly. Reassemble the brake master cylinder as follows:

a. Lubricate all internal components with clean brake fluid, including the cylinder bore.

b. Install a new O ring into the smaller of the two grooves at the end of the secondary piston. Install a new cup seal into the second groove ensuring that the seal lip faces away from the O ring.

c. Install a new cup seal into the shallow groove at the other end of the secondary piston ensuring that the seal lip faces away from the O ring.

d. Locate part of the cup seal retainer in the groove on the piston and hold the retainer in position (Figure 282). Using a small screwdriver, clip the retainer into the groove ensuring that the cup seal is not damaged.

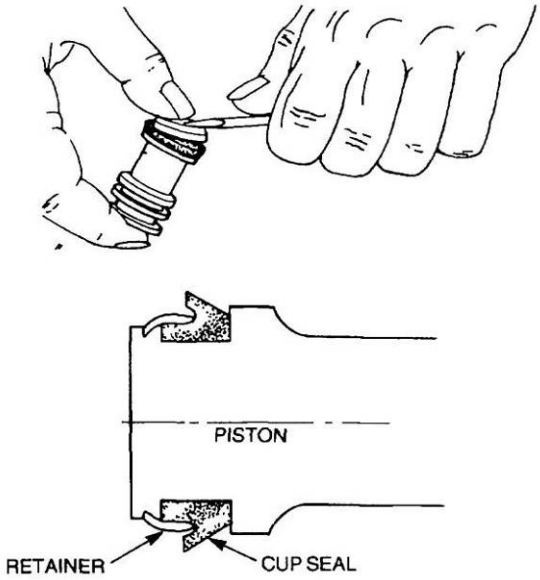


Figure 282 Installation of the Seal Retainer

e. Install a new cup seal into the shallow groove at the spring end of the primary piston ensuring that the seal lip faces towards the spring end. Locate part of the cup seal retainer in position (Figure 282). Using a small screwdriver, clip the retainer into the groove ensuring that the cup seal is not damaged.

f. Install a new secondary cup seal into the groove at the push rod end of the primary piston ensuring that the seal lip faces away from the push rod hole end of the piston.

g. Insert the secondary return spring into the secondary piston and insert the assembly, spring end first, into the master cylinder bore.

h. Fit the primary return spring to the primary piston. Insert the assembly, spring end first, into the bore. Depress the primary piston until the end of the piston clears the circlip groove, hold the piston in position and install the circlip in the groove.

i. Prime the master cylinder with clean brake fluid and check for smooth piston operation by pushing on the end of the primary piston with a screwdriver. Check for a spurt of fluid in the front secondary side of the reservoir as the pistons are slightly depressed. After bleeding, block the master cylinder outlet ports with suitable plastic plugs to prevent fluid escaping.

j. Install the master cylinder and bleed the brake system in accordance with EMEl Vehicle G 203 – Group 12.

Proportioning Valve

101. Disassembly. Disassemble the proportioning valve as follows:

NOTE

If a small screwdriver is required to assist in removal of components from the valve bore, care should be taken to avoid scratching the cylinder wall as this will decrease the function of the valve.

a. Disconnect the brake lines from the proportioning valve and allow the fluid to drain into a container. Disconnect the electrical lead from the pressure differential switch. Remove the bolt and nut securing the valve to the firewall and remove the valve.

b. Unscrew the pressure differential switch from the valve body and remove the brake pipe fittings (Figure 283).

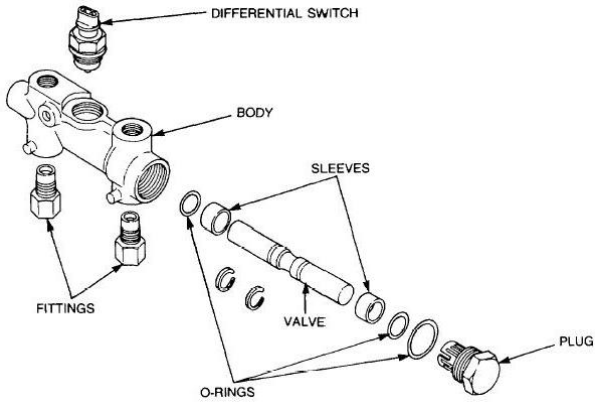


Figure 283 Proportioning Valve - Exploded View

c. Remove the hexagon plug from the end of the valve; remove the piston, the two metal sleeves and the two O rings. Discard the O rings. If the piston is providing resistance to removal, it may be necessary to tap the cylinder lightly or apply air pressure through the primary port to shift the valve.

102. Cleaning and Inspection. Clean and inspect the proportioning valve as follows:

a. Clean all components with a recommended cleaning agent and blow them dry with compressed air, paying particular attention to the recesses, openings and internal passages of the valve body.

b. Inspect all components for nicks, burrs, corrosion, excessive wear or damage. Replace all parts as required.

c. Bench test the differential switch using a test light to ensure that the sensitivity of the contact tip of the switch is operational.

NOTE

The valve body is not to be honed. Replace it if machining is required.

103. Reassembly. Reassemble the proportioning valve as follows:

a. Lubricate all internal components with clean brake fluid, including the valve bore.

NOTE

If a small screwdriver is required to position the inner O ring, care should be taken to avoid scratching the cylinder wall as this will decrease the function of the valve.

b. Install a new O ring into the far end of the bore ensuring that correct alignment is maintained.

c. Position the valve vertically and carefully insert the differential switch piston and sleeve.

d. Insert the second sleeve and a new O ring.

e. Using a screwdriver, depress the internal assembly down the valve bore past the threaded area to allow fitment of the plug. Install the hexagon plug and torque it to 12 N.m (8 lbf.ft).

f. Ensure that the valve is centrally located and install the differential switch and the brake line fittings into the valve body.

g. Install the proportioning valve and check that the master cylinder reservoir is full.

h. Loosen the brake pipe at the connection leading to the rear brakes.

i. Depress the brake pedal fully, pause then allow the pedal to return rapidly, pause then repeat the procedure until all air is expelled at the connection, tighten the connection.

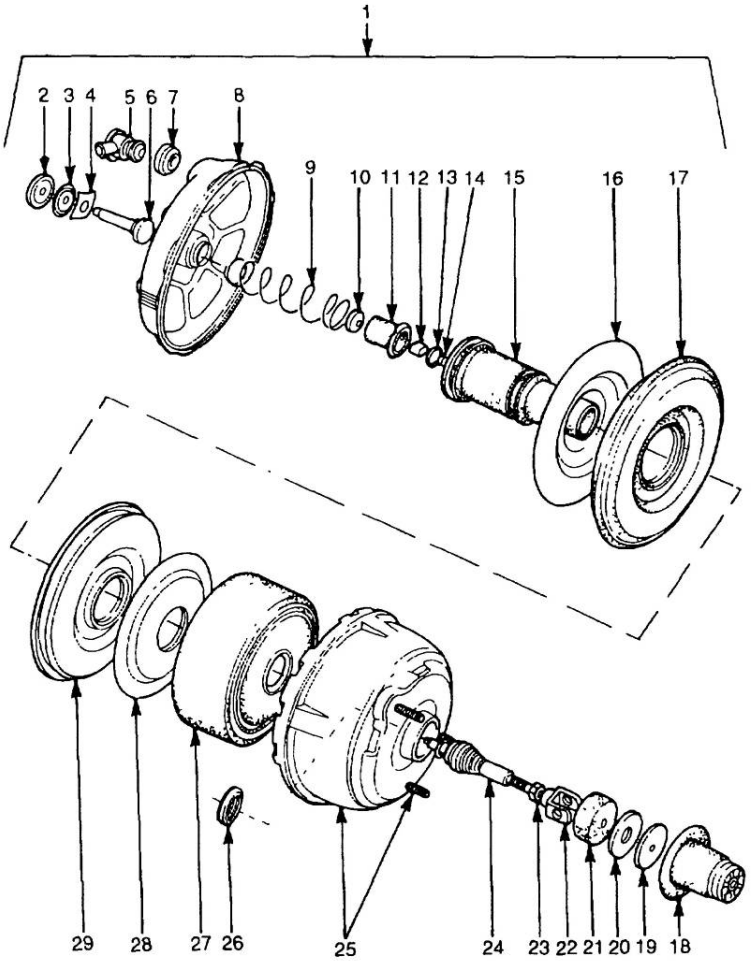
Servo Vacuum Chamber

104. Disassembly. Disassemble the servo vacuum chamber as follows:

a. Remove the servo vacuum chamber in accordance with EMEl Vehicle G 203 – Group 12.

NOTE

Unless otherwise stated, all item numbers in parentheses refer to Figure 284.



1. Brake servo assembly
2. Seal
3. Support plate
4. Retainer
5. Check valve
6. Front push rod
7. Grommet
8. Front cover
9. Return spring
10. Reaction disc
11. Reaction hub
12. Reaction plunger
13. Seal
14. Circlip
15. Valve body
16. Front pressure plate
17. Front diaphragm
18. Dust cover
19. Felt air filter
20. Protector
21. Foam air filter
22. Clevis
23. Nut
24. Rod and plunger
25. Rear cover
26. Seal
27. Rear diaphragm
28. Rear pressure plate
29. Centre plate and seal

Figure 284 Servo Vacuum Chamber - Exploded View

b. Match mark the front and rear covers (items 8 and 25) to ensure correct orientation on reassembly.

c. Remove the vacuum check valve (item 5) and grommet (item 7) from the front cover. Discard both components.

d. Remove the nut (item 23) and clevis (item 22) from the input rod and plunger (item 24). Discard the nut.

e. Remove the dust cover (item 18) and the felt air filter (item 19) from the input rod. Remove the protector (item 20) and the foam air filter (item 21). Discard all components.

f. Remove the front seal (item 2), the support plate (item 3) and the front push rod (item 6) with the retainer (item 4). Discard the seat and the retainer.

g. Place the vacuum chamber in a screw press or equivalent (Figure 285), with the rear cover studs in the holes in the base of the tool. Place the bar wrench and adapter over the studs in the front cover. Align the tool clamp with the base and attach the hook bolts to the base.

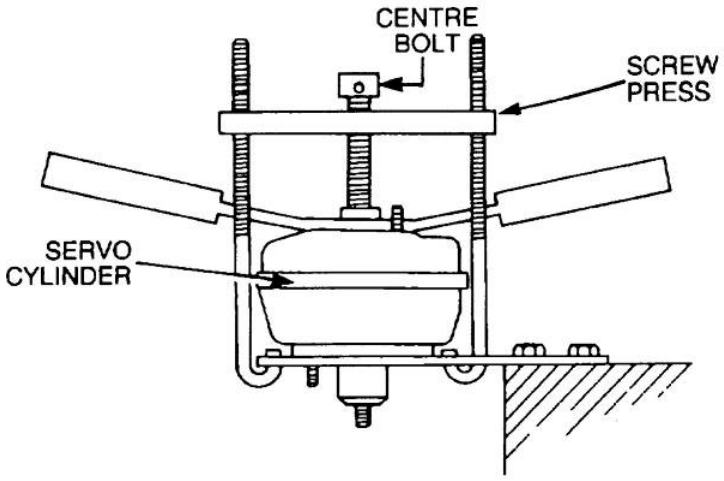


Figure 285 Disassembly of the Servo Vacuum Chamber

h. Tighten the centre bolt sufficiently to free the lock at the rim of the front cover.

i. Turn the bar wrench counterclockwise until the cut outs in the front cover align with the indentations of the rear cover, then loosen the centre bolt.

NOTE

The covers should begin to separate as the centre bolt is loosened. If not, check the alignment of the cut-outs and indentations. Tapping the front cover lightly with a soft-faced hammer will assist to break the seal.

j. Unscrew the centre bolt sufficiently to remove the front cover (item 8) and the return spring (item 9). Remove the vacuum chamber from the screw press.

k. Remove the reaction disc (item 10), reaction hub (item 11) and the reaction plunger and seal (items 12 and 13) from inside the valve body (item 15). Discard the reaction hub and the seal.

NOTE

A screwdriver may be needed to assist the centre plate removal.

l. Push on the input rod and plunger (item 24) to remove the valve body (item 15) and diaphragm assemblies (items 16, 17, 27, 28 and 29) from the rear cover (item 25).

m. Remove the circlip (item 14) from the plunger and withdraw the input rod and plunger assembly from the valve body. Discard both components.

n. Hold the valve body assembly firmly on a bench, with the front pressure plate (item 16) facing downward. Pull the rear diaphragm (item 27) upward to remove it from the valve body (Figure 286).

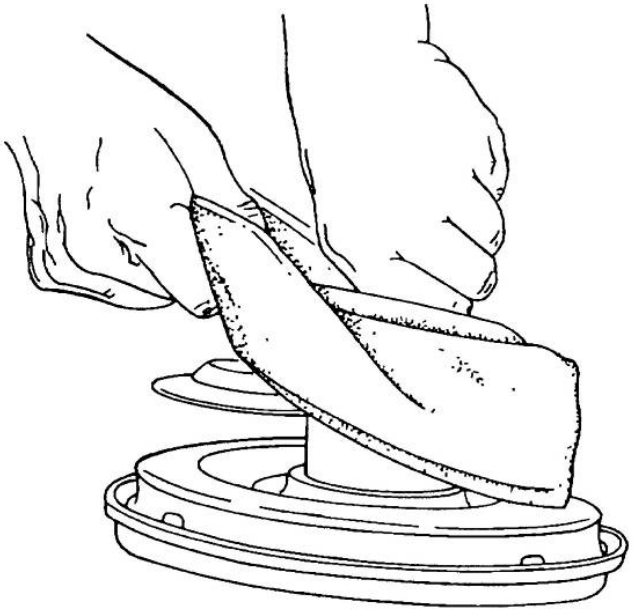


Figure 286 Removal of the Rear Diaphragm

o. Remove the rear pressure plate (item 28) and the centre plate (item 29) from the valve body.

p. Pull the front diaphragm (item 17) upward to remove it from the valve body. Remove the front pressure plate (item 16).

q. Pry the seal from the centre plate (item 29) and the rear cover (item 25). Discard the seals.

105. Cleaning and Inspection. Clean and inspect the servo vacuum chamber as follows:

a. Clean all components with a recommended cleaning agent and blow them dry with compressed air, paying particular attention to recesses, openings and valve holes.

b. Inspect all components for nicks, burrs, corrosion, excessive wear or damage and replace as necessary. Minor rust may be removed with fine emery cloth.

NOTE

Do not attempt to reclaim the covers by welding as excessive heat will distort the covers.

c. Inspect the front and rear covers for loose or damage studs. Replace the covers as necessary.

106. Reassembly. Reassemble the servo vacuum chamber as follows:

a. Support the rear cover on a wooden block. Lightly smear a new seal with rubber grease, using a suitable arbor, carefully install the seal, plastic bearing ring side first.

b. Support the centre plate on a wooden block with the seal lead-in edge of the hole facing upward. Lightly smear a new seal with rubber grease, using a suitable arbor, carefully install the seal, rubber side first.

c. Position the valve body on the bench with the wider end facing down. Install the front pressure plate on the valve body.

d. Lightly smear the front diaphragm inner bead and the diaphragm locating groove with rubber grease in the valve body. Install the front diaphragm on the valve body, ensuring that the inner bead seats correctly in the locating groove between the pressure plate and the valve body (Figure 287).

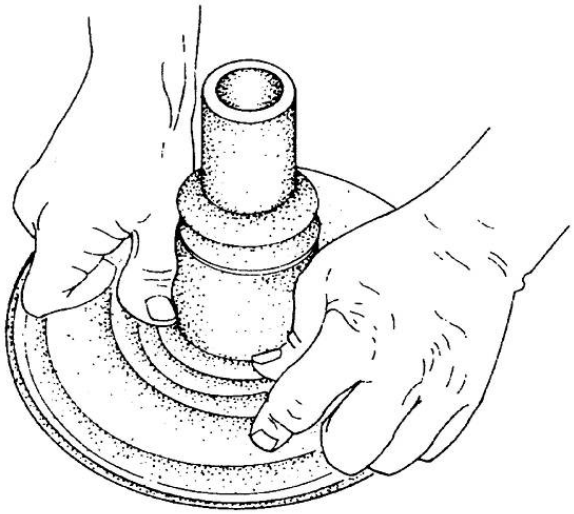


Figure 287 Installation of the Front Diaphragm

e. Lightly smear the larger bearing surface of the valve body with rubber grease and install the centre plate and seal.

CAUTION

Ensure that the rubber sealing lip of the large seal is not damaged or turned over when passing over the air holes in the valve body.

f. Install the rear pressure plate and the rear diaphragm, ensuring that the outer bead of the rear diaphragm seats correctly over the outer edge of the centre plate.

CAUTION

Ensure that the circlip seats correctly in the groove on the rod and plunger assembly.

g. Lightly smear a new rod and plunger assembly with rubber grease and insert the assembly into the bore of the valve body. Secure the rod and plunger with a new circlip from the other end of the valve body.

h. Lightly smear the smaller bearing surface of the valve body and the outside beads of the front and rear diaphragms with rubber grease. Carefully insert the valve body assembly into the rear cover and through the rear seal. Ensure that the rear diaphragm outer bead remains correctly located over the outer edge of the centre plate.

i. Position the rear cover in the screw press.

j. Lightly smear a new small square-sectioned seal and the reaction plunger with rubber grease. Insert the seal into the bore at the hexagon end of the reaction hub and insert the reaction plunger into the centre bore of the reaction hub. Carefully insert the reaction hub assembly, large end first, into the centre of the valve body, ensuring that the reaction plunger does not fall out.

k. Lightly smear the reaction disc with rubber grease and insert the disc into the reaction hub, ensuring that the small rubber protrusion of the disc faces the rear reaction plunger.

l. Position the return spring over the reaction hub and against the hub shoulder.

m. Position the front cover over the return spring, ensuring that the match marks are adjacent to each other. Place the bar wrench over the studs in the front cover. Align the cut-outs in the front cover with the indentations in the rear cover and tighten the centre bolt of the screw press. Turn the bar wrench clockwise to lock the two covers.

NOTE

Do not tip the servo chamber upside down as the reaction plunger and disc will fall out.

n. Loosen the centre bolt and remove the servo chamber from the screw press.

o. Lightly smear the front push rod with rubber grease and carefully lower the push rod through the front cover aperture and into the reaction hub, against the reaction disc. Slide a new push rod retainer over the push rod and push it firmly into position with a screwdriver.

p. Install the support plate and a new seal over the push rod and into the front cover recess.

q. Invert the vacuum chamber and install a new foam air filter over the rod and plunger and into the valve body. Fit a new protector, felt air filter and dust cover, respectively.

r. Install a new nut and the clevis on the rod and plunger. Adjust the nut and clevis to obtain the required distance from the centre of the clevis pin hole to the vacuum chamber rear cover (Figure 288), depending on the configuration (see Note).

NOTE

Ensure that the distance from the centre of the clevis fork to the servo cylinder face is 110 mm for the early pedal box and 120 mm for the late pedal box.

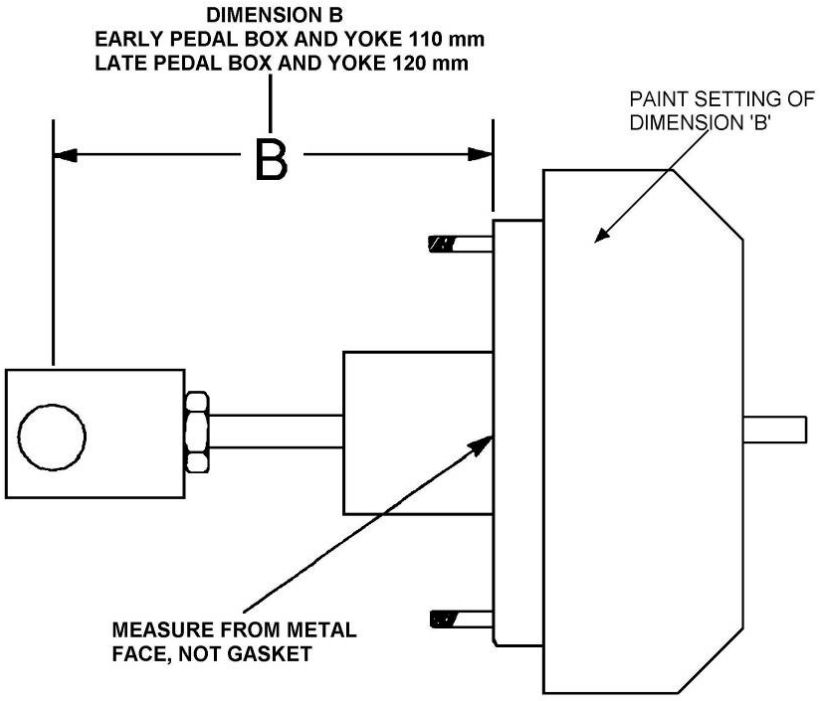


Figure 288 Clevis Adjustment

s. Install a new grommet into the aperture in the front cover and insert a new check valve into the grommet.

t. Install the vacuum chamber in accordance with EMEl Vehicle G 203 – Group 12.

107. The brake specifications are detailed in Table 15.

Table 15 Brake Specifications

Serial	Item	Specification
1	Proportioning valve hexagon plug tightening torque	12 N.m (8 lbf.ft)
2	Vacuum chamber clevis adjustment, clevis to rear cover	Early pedal box 110 mm (4.33 in) Late pedal box 120 mm (4.72 in)

STEERING

Power Steering Box

108. Disassembly. Disassemble the power steering box as follows:

a. Remove the power steering box in accordance with EMEl Vehicle G 204-1 – Group 14.

b. Centralize the sector shaft with the input shaft worm, match mark the drop arm to the sector shaft and, using special tool MS252A, remove the drop arm.

c. Rotate the retaining ring (if necessary), at the rack and piston bore in the housing, until one end is approximately 12 mm (0.5 in) from the extractor hole. Insert a suitable pointed drift into the extractor hole to unseat the retaining ring from the groove (Figure 289) and remove the retaining ring. Rotate the steering input shaft toward the right hand lock until the piston pushes the end cover out from the rack and piston bore.

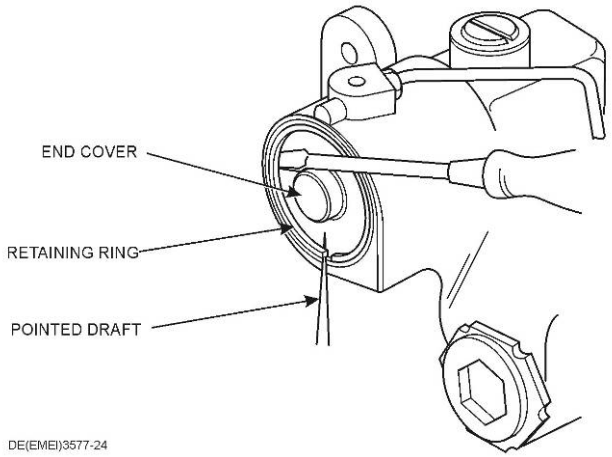


Figure 289 Removal of the Rack and Piston Retaining Ring

d. Remove the grub screw from the rack pad adjuster and with a suitable screwdriver, remove the rack pad adjuster (Figure 290). Remove and discard the sealing ring and the nylon rack pad.

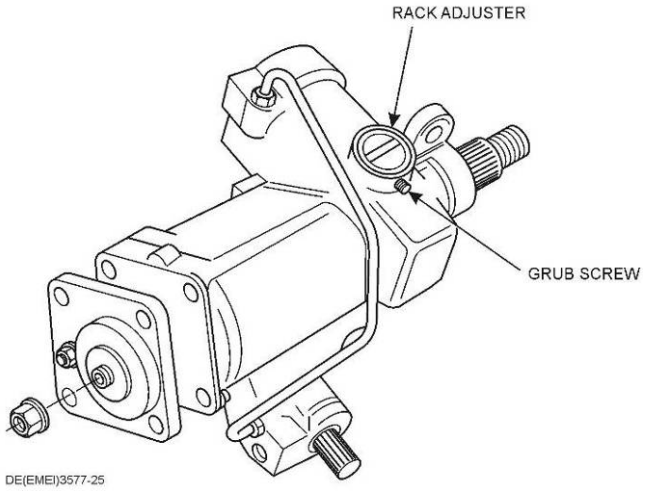


Figure 290 Removal of the Rack Pad Adjuster

e. Remove the sector shaft locknut from the top of the steering box. Remove the four bolts and washers securing the sector shaft cover to the top of the steering box. With the aid of a suitable screwdriver, screw the sector shaft adjuster in until the cover can be removed. Remove the cover and slide the sector shaft out from the steering box. Discard the O ring.

f. Remove the piston from the rack and piston bore by threading a suitable bolt into the tapped hole in the piston and pulling the piston from the bore.

g. Using a G-spanner, special tool LSTI20, remove the locknut from the worm adjuster and using special tool LST119 (socket) remove the worm adjuster.

NOTE

To remove the inner bearing cup and shims, jar the steering box housing on the work bench or use a suitable extractor, e.g. a bronze drift and a hammer.

h. Using a soft-headed hammer, tap the splined end of the input shaft to free the bearing from the housing. Remove the outer bearing cup and cage and withdraw the input (worm) shaft assembly together with the inner bearing cage from the housing (Figure 291). Remove the inner bearing cup together with the shims and retain the shims.

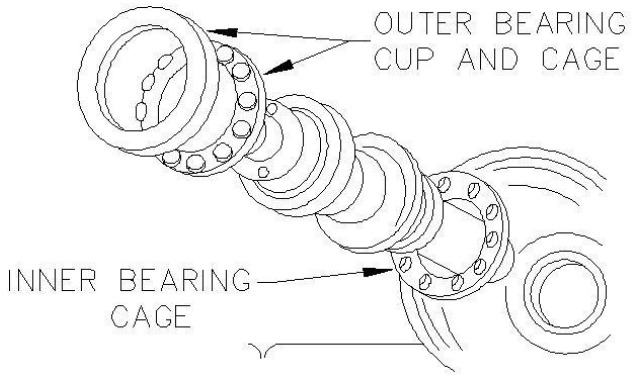


Figure 291 Removal of the Input Shaft and Bearings

i. Remove the circlips and seals from the sector shaft bore and the input shaft bore (Figure 292).

NOTE

Do not remove the sector shaft bushes from the shaft bore unless replacement is necessary.

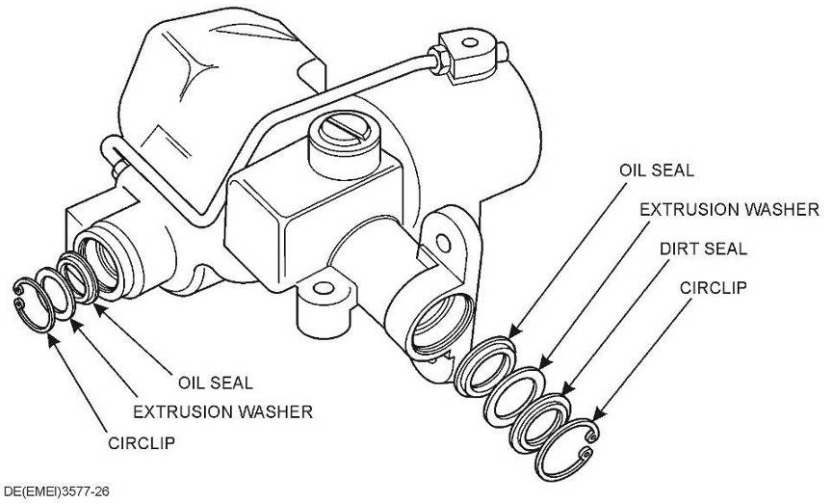


Figure 292 Removal of the Sector Shaft and Input Shaft Seals

109. Cleaning and Inspection. Clean and inspect the power steering box as follows:

a. Clean all parts with a suitable cleaning agent ensuring that all gasket material is removed. Blow the parts dry with compressed air.

b. Remove and discard the plastic ring and rubber seal from the piston, check the piston for scoring, wear or damage and check the teeth on the rack for wear or damage. Replace the rack and piston assembly if excessive wear or damage is evident.

NOTE

Ensure that the tubing used to remove the sector shaft bushes is a neat fit in the sector shaft bore and butts squarely against the bush.

c. Check the sector shaft bushes for ovality or damage and replace them as required. If replacement is necessary, use a suitable piece of tubing and a hammer (or press) to drive the bushes from the housing.

d. Inspect the piston bore for scoring, gouging or wear and replace the housing as necessary.

e. Inspect the transfer pipe for signs of cracking and replace as necessary.

f. Check all threaded holes, ports and bores for damaged threads. If necessary, use suitable taps to clean or dress the threads, or replace the housing if the thread damage is severe.

g. Inspect the sector shaft for uneven wear on the gear teeth, worn or badly damaged adjuster screw threads, obvious side play on the rollers and excessive wear on the bush running area of the shaft. Replace the sector shaft if any of these faults are evident.

h. Check the bush in the sector shaft cover for wear and replace the cover as an assembly if wear is evident.

i. Check the valve rings on the valve and worm assembly for cuts, scratches, grooves or other damage and replace them as necessary. If replacement is required, install the new rings using the ring expander, special tool 606602. If necessary, warm the valve rings and the expander with hot water to assist with installation, then install the ring compressor, special tool 606603, to cool the rings.

j. Check that the bearing running surfaces and the worm on the valve and worm assembly are smooth and without any sign of pitting, galling, indentations or uneven wear. Check for wear in the torsion bar assembly pins, no free movement should exist between the input shaft and the worm. Replace the valve and worm assembly if any wear or damage is evident.

k. Inspect the rack thrust pad adjuster and the adjuster grub screw for wear or damage and replace them as necessary. Replace the nylon thrust pad.

l. Inspect the rack and piston assembly for worn or damaged rack teeth, damage to the thrust pad bearing surface, damage to the outer diameter of the piston and scoring or damage to the seal and ring groove of the piston. Replace the rack and piston assembly if any of these faults are evident.

110. Reassembly. Reassemble power steering box as follows:

a. Install a new oil seal, with the open side toward the housing, into the input shaft bore. Ensure that the seal flange butts against the shoulder in the bore, install the extrusion washer and a new circlip (Figure 293).

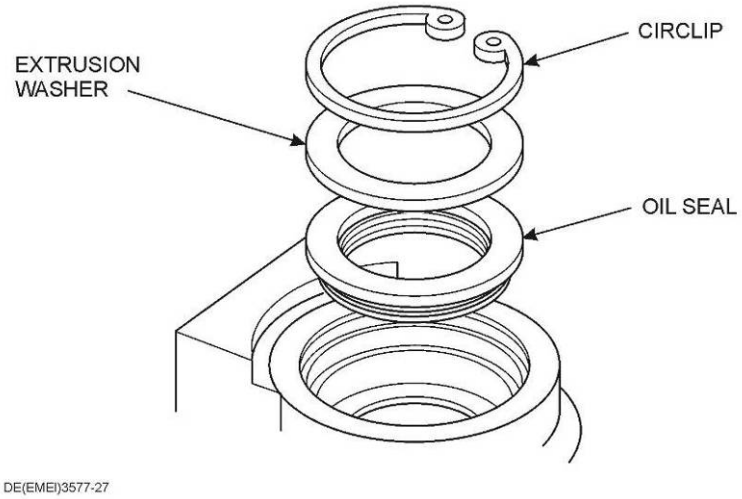


Figure 293 Installation of the Input Shaft Oil Seal

NOTE

Ensure that the tubing used to install the sector shaft bushes is a neat fit in the sector shaft bore and butts squarely against the bush.

b. If removed, install new bushes into the sector shaft bore in the housing. Align and start each bush into the housing, then with the aid of a press and a suitable piece of tubing, press the bushes into position.

c. Install a new oil seal, with the lip side in, into the sector shaft bore. Install the extrusion washer and a new dirt seal, with the lip side out. Install a new circlip to retain the seals in position (Figure 294).

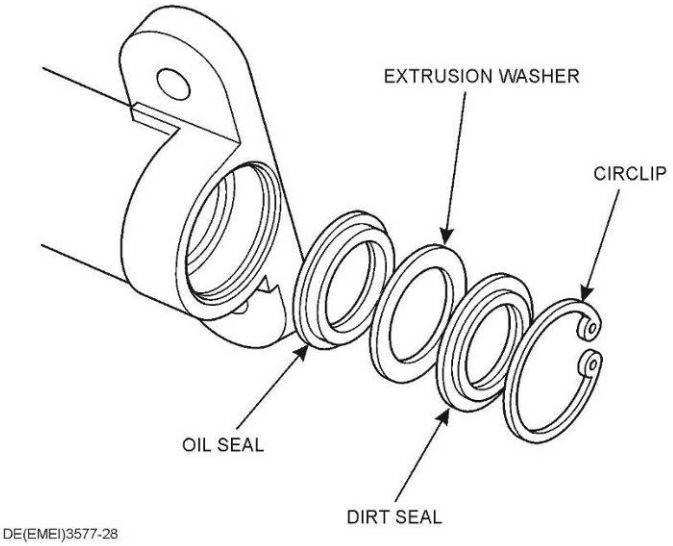


Figure 294 Installation of the Sector Shaft Oil Seals

NOTE

If the original shims are not available, install shims with a nominal thickness of 0.76 mm (0.030 in).

d. Lubricate new input shaft bearings with petroleum jelly and install the inner bearing cup together with the original shims, or shims of equivalent thickness, into the input shaft bore of the housing.

e. Position the inner bearing cage on the input shaft, then install a seal saver, special tool RO1015, over the splined end of the input shaft. Smear the sealing lip of the input shaft seal with petroleum jelly, install the input shaft into the housing and position the outer bearing cage and cup on the input shaft.

f. Install a new sealing ring on the worm adjuster and loosely screw the adjuster into the housing. Install the locknut, but do not tighten it. Screw the worm adjuster in until the input shaft end-float is almost eliminated. Install the torque setting tool RO1016 onto the input shaft, coil a length of cord several times around the tool and attach a suitable spring scale to one end of the cord. Pull on the scale with a slow and steady pull until the input shaft rotates (Figure 295). Record the load, indicated on the scale, required to keep the input shaft turning slowly and evenly.

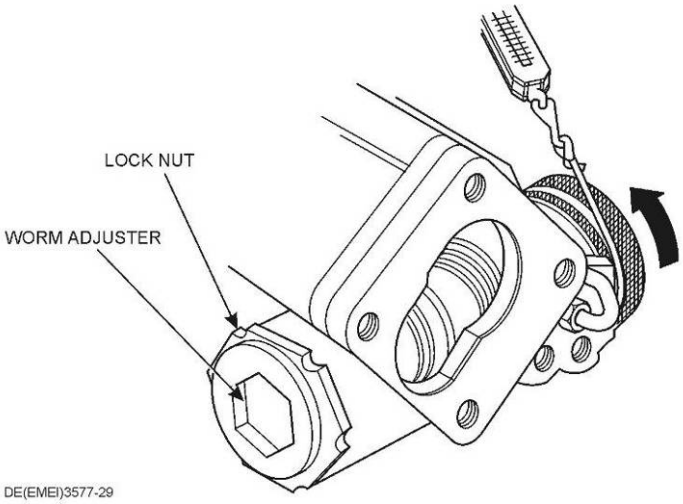


Figure 295 Adjustment of the Input Shaft

g. Using the worm adjusting socket (special tool LST119), screw in the worm adjuster to increase the previously recorded rolling resistance by 1.8 to 2.2 kg (4 to 5 lbs), on a setting tool radius of 31.7 mm (1.25 in), to settle the bearings. Back off the worm adjuster until the previously recorded rolling resistance is increased by only 0.9 to 1.3 kg (2 to 3 lbs), then tighten the locknut using the C-spanner (special tool LST120) and check that the rolling resistance has not altered.

h. Install a new rubber seal into the groove on the piston, ensure that the seal is not twisted, then smear the seal with petroleum jelly, Heat the nylon ring with hot water, then install the ring alongside the seal in the piston groove and allow the ring to cool.

i. Thread a suitable bolt into the tapped hole in the piston and insert the piston and rack assembly into the bore in the housing until the crown of the piston is 63.5 mm (2.5 in) from the outer end of the bore.

j. Install the seal saver (special tool 606604), onto the threaded end of the sector shaft, and liberally coat the sector shaft with clean power steering fluid. Smear the seal lips on both the oil seal and dirt seal, in the sector shaft bore, with petroleum jelly and liberally coat both the worm and the rack with clean power steering fluid. Start the sector shaft into the housing and align the pitch of the centre tooth of the rack with the centre tooth of sector shaft gear (Figure 296). Insert the sector shaft while simultaneously rotating the input shaft about a small arc to engage the sector shaft roller with the worm.

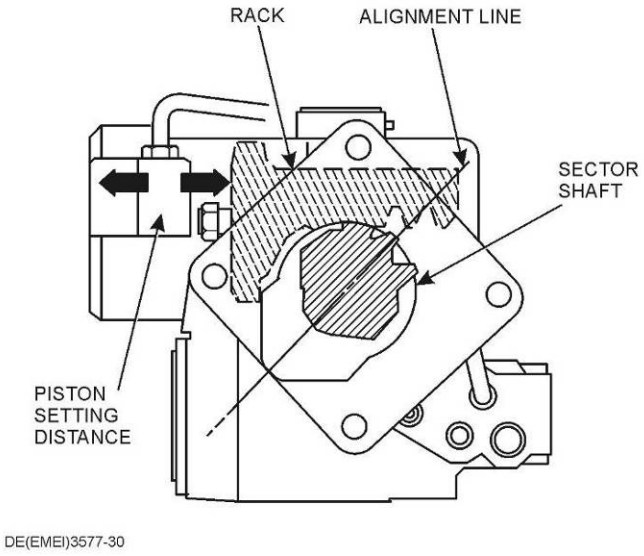


Figure 296 Installation of the Sector Shaft

k. Install a new sealing ring on the rack adjuster and install the adjuster, together with a new nylon thrust pad, into the housing. Screw in the adjuster until the thrust pad makes contact with the rack, then back the adjuster out half a turn. Screw in the grub screw until it contacts the rack adjuster, but do not tighten it.

NOTE

Before securing the cover to the housing, rotate the input shaft to ensure that the sector shaft roller moves freely on the input shaft worm.

l. Position a new O ring in the sector shaft cover, then screw the cover fully onto the sector shaft adjusting screw. Align the bolt holes in the cover with those in the housing and tap the cover with a soft-headed hammer to joint the cover fully with the housing. If necessary, back off the sector shaft adjusting screw to allow the cover to joint fully with the housing.

m. Install the sector shaft cover retaining bolts and torque the bolts to 22 to 27 N.m (16 to 20 lbf.ft).

n. Smear a new sealing ring with petroleum jelly and install it on the piston bore cover. Remove the bolt from the piston and install the cover into the piston bore. Press the cover into the bore sufficiently to clear the retaining ring groove and install a new retaining ring, ensuring that one end of the ring is approximately 12 mm (0.5 in) from the extractor hole.

o. Centralize the sector shaft on the worm by halving the number of turns of the input shaft when turned from lock-to-lock. Slacken the sector shaft adjusting screw to obtain backlash between the input shaft and the sector shaft, then screw the adjusting screw in until the backlash is just eliminated.

p. Using the spring scale and the torque setting tool (previously installed on the input shaft), measure and record the maximum rolling resistance of the input shaft (Figure 297). Loosely install a new locknut onto the sector shaft adjusting screw while holding the screw stationary. Screw the adjusting screw in until the recorded rolling resistance has been increased by 0.9 to 1.3 kg (2 to 3 lbs) when the locknut is tightened. Readjust as necessary.

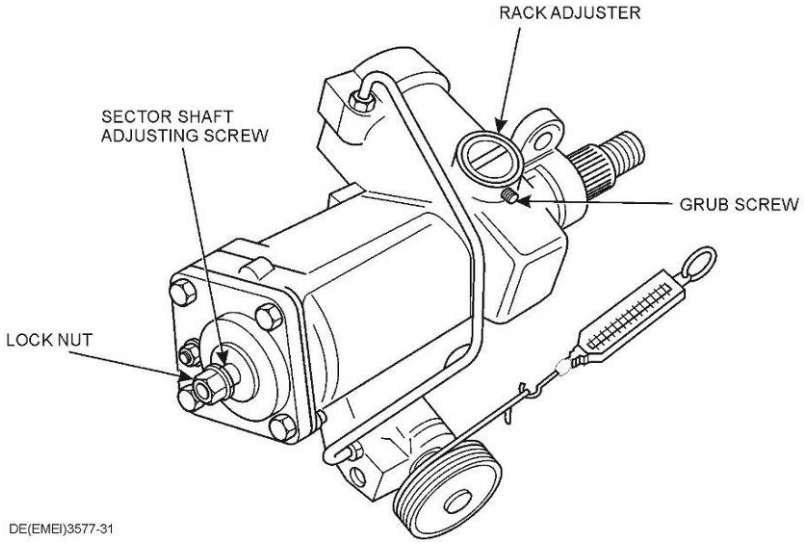


Figure 297 Adjustment of the Sector Shaft

q. With the spring scale and torque setting tool on the input shaft, adjust the rack adjuster until the rolling resistance is 0.9 to 1.3 kg (2 to 3 lbs.) above the final rolling resistance setting of the sector shaft. Ensure that the rolling resistance does not exceed 7.25 kg (16 lbs) and tighten the grub screw to lock the rack adjuster in position.

NOTE

An adjustment of 0.07 mm (0.003 in) to the thickness of the shims will move the position of the highest reading by approximately a quarter of a turn of the input shaft.

r. Using the torque setting tool and the spring scale, measure the rolling resistance of the worm and roller. Turn the input shaft to the left-hand full-lock position and attach the spring scale to the torque setting tool. Place a chalk mark on the torque setting tool (for reference purposes), then pull the spring scale with a slow and steady pull The highest reading on the spring scale should occur when the sector shaft roller travel across the centre of the worm (approximately one and a half turns from left full-lock position). If the highest reading occurs before reaching the centre of travel, reduce the thickness of the shims located between the input shaft inner bearing and the housing. If the highest reading occurs after the centre of travel, increase the thickness of the shims.

s. Once the correct shim adjustment has been made, reassemble the steering box and repeat the adjustment procedures (Para 107. e., f., g., j., l., m., o., q. and r.).

t. Centralize the sector shaft with the input shaft worm and position the drop arm on the sector shaft ensuring that the match marks are aligned. Install the retaining nut, together with a new tab washer, and torque the nut to 169 N.m (125 lbf.ft).

u. Install the steering box and bleed the power steering system in accordance with EMEl Vehicle G 204-1 – Group 14.

CAUTION

Do not hold the steering in full lock position for more than 30 seconds in any one minute, otherwise overheating of the steering fluid and possible seal damage could result.

v. Start and run the engine and check the steering system for leaks by turning and holding the steering in full lock position in both directions.

w. Shut down the engine and rectify any leaks as necessary.

Power Steering System

111. Test Procedure. Test the power steering system as follows:

a. Connect the components of the test equipment JD10 to the steering system (Figure 298).

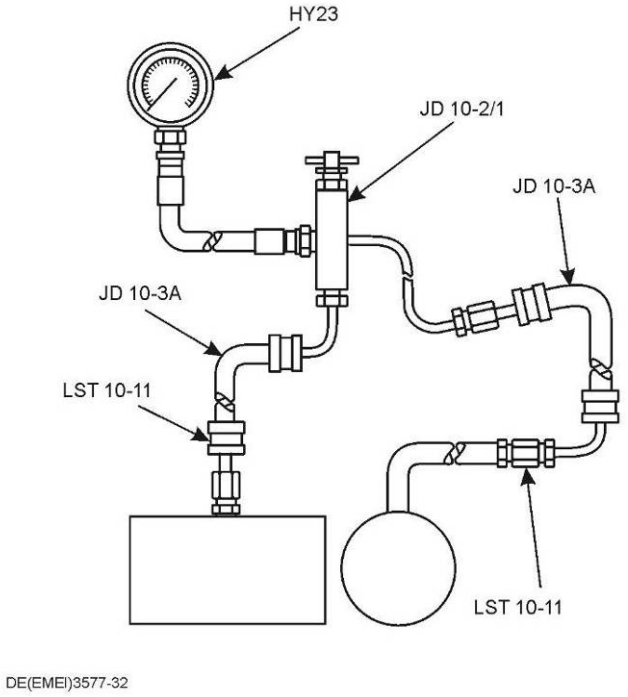


Figure 298 Installation of the Test Equipment

b. Ensure that the system is free from leaks and check that the power steering reservoir fluid is at the correct level. Top-up if necessary.

c. Open the tap in the adapter, start and run the engine and bleed the system, using care not to overload the pressure gauge.

CAUTION

Do not hold the steering in full lock position for more than 30 seconds in any one minute, otherwise overheating of the steering fluid and possible seal damage could result.

d. Run the engine at 1000 rpm, turn the steering on hard full lock and check for a reading of 5860 to 6550 kPa (850 to 950 psi) then repeat the test on the opposite lock.

e. Run the engine at idle, turn the steering on hard full lock and check for a reading of 2745 kPa (400 psi). Repeat the test on the opposite lock.

f. Release the steering wheel and with the engine idling, check for a pressure below 685 kPa (100 psi).

g. If the pressures registered are not to specification, close-off the valve tap, for no more than five seconds, and with the engine idling, check for a pressure of approximately 2745 kPa (400 psi). If the pressure fails to reach specification, repair or replace the pressure relief valve and retest the system. If the system pressure still fails to reach specification, repair or replace the power steering pump.

h. If the pressures shown are to specification, when the valve tap is closed-off, the fault is in the rotary valve on the steering box input shaft. Repair or replace the rotary valve (input shaft) as necessary.

112. The steering specifications are detailed in Table 16.

Table 16 Steering Specifications

Serial	Item	Specification
1	Input shaft shims nominal thickness	0.76 mm (0.030 in)
2	Input shaft bearing rolling resistance	Add 1.8 to 2.2 kg (4 to 5 lbs) to initial resistance obtained then back off the worm adjuster until the initial resistance is increased by only 0.9 to 1.3 kg (2 to 3 lbs)
3	Piston and rack assembly installation setting	Crown of piston 63.5 mm (2.5 in) from outer end of bore
4	Sector shaft cover bolts tightening torque	22 to 27 N.m (16 to 20 lbf.ft)
5	Piston bore cover retaining ring	End of ring to be 12 mm (0.5 in) from extractor hole
6	Sector shaft resistance adjustment	Input shaft rolling resistance to be increased by 0.9 to 1.3 kg (2 to 3 lbs) with sector shaft adjuster locknut tightened
7	Rack resistance adjustment	Input shaft rolling resistance to be increased by 0.9 to 1.3 kg (2 to 3 lbs) above the resistance setting for the sector shaft, but must not exceed 7.25 kg (16 lbs)
8	Sector shaft-to-input shaft resistance position	Alteration to the input shaft bearing shim thickness of 0.07 mm (0.003 in) alters the position of the highest resistance by a quarter of a turn of the input shaft
9	Drop-arm nut tightening torque	169 N.m (125 lbf.ft)
10	Power steering test pressures	
11	Full lock with engine at 1000 rpm	5860 to 6550 kPa (850 to 950 psi)
12	Full lock with engine at idle	2745 kPa (400 psi)
13	Steering wheel released with engine at idle	685 kPa (100 psi)
14	Valve tap closed with engine at idle	2745 kPa (400 psi)

ELECTRICAL

Starter Motor

113. Disassembly. Disassemble the starter motor as follows:

a. Remove the two nuts securing the two wires to the solenoid switch terminals and remove the two wires.

b. Remove the two screws and washers securing the switch to the housing and remove the switch (Figure 299).

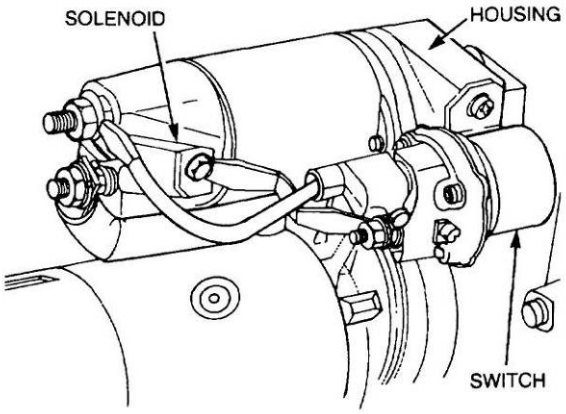


Figure 299 Removal of the Solenoid Switch

c. Remove the small hexagonal headed screw securing the field wire to the solenoid and match mark the solenoid to the housing.

d. Remove the two screws securing the solenoid to the starter motor housing and remove the solenoid by disengaging the plunger from the clutch lever (Figure 300). Remove the shim.

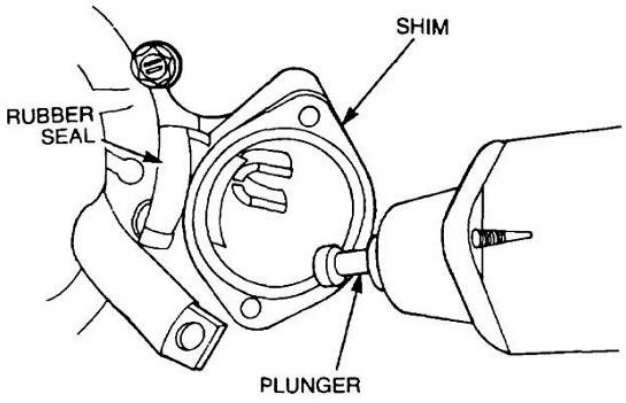


Figure 300 Removal of the Solenoid

e. Match mark the brush cover and field housing in relation to the starter motor housing. Remove the two screws securing the brush cover and the two long screws securing the field housing to the starter motor housing.

f. Remove the field housing and brush assembly from the starter motor housing (Figure 301) and discard the O ring. Disengage the brushes from the brush holder.

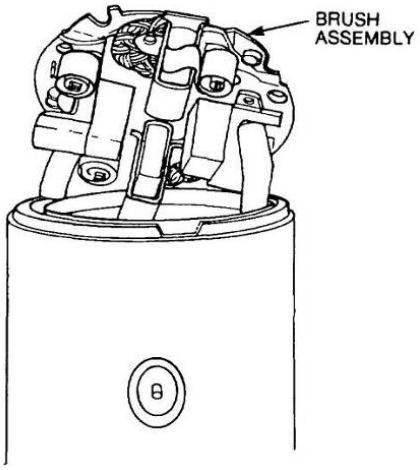


Figure 301 Removal of the Field Housing and Brush Assembly

g. Remove the armature and bearings from the housing.

h. Remove the single bolt securing the bearing plate to the housing and remove the two screws securing the cover to the plate (Figure 302). Remove the cover and C-clip from the end of the clutch then remove the washer and plate. Withdraw the bearing plate from the housing and remove the washers from the shaft.

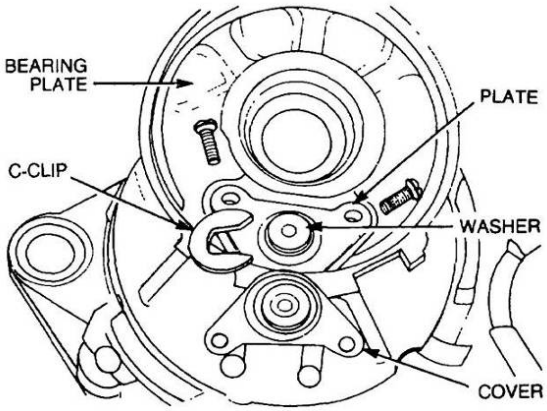


Figure 302 Removal of the Bearing Plate

NOTE

Prior to removing the pinion drive gear, note the position of the drive gear in relation to the clutch shaft.

i. Apply pressure on the pinion retaining collar and remove the circlip (Figure 303). Remove the collar, pinion and spring.

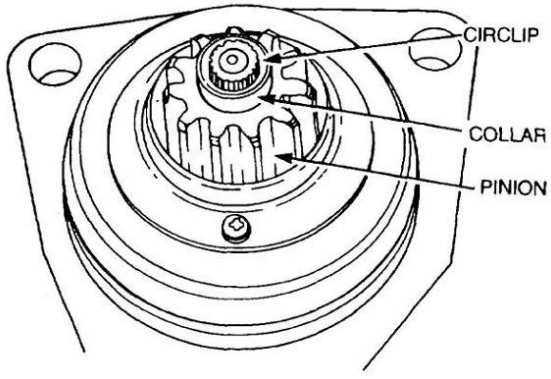


Figure 303 Removal of the Pinion Gear

j. Remove the two screws securing the pinion cover and plate to the housing (Figure 304). Remove the cover and plate.

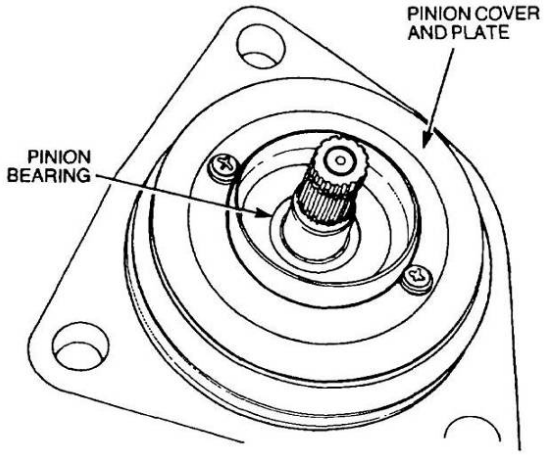


Figure 304 Removal of the Pinion Cover and Plate

k. Remove the rubber seal from the clutch pivot bore and remove the shims and plastic spacer (Figure 305). Remove the clutch assembly, lever and pivot bush.

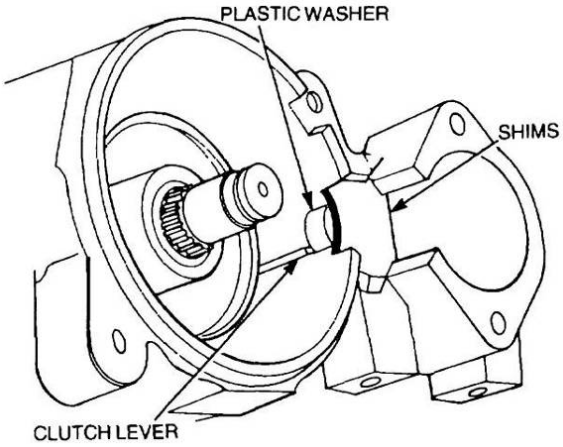


Figure 305 Removal of the Clutch Lever and Pivot Bush

l. Remove the lever pivot pin and pivot bush, taking note of the position of the bush halves (Figure 306).

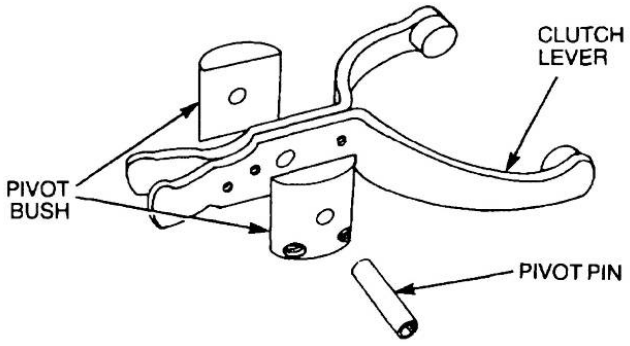


Figure 306 Removal of the Pivot Bush and Pin

m. Remove the bearing and the oil seal from the pinion housing (Figure 307).

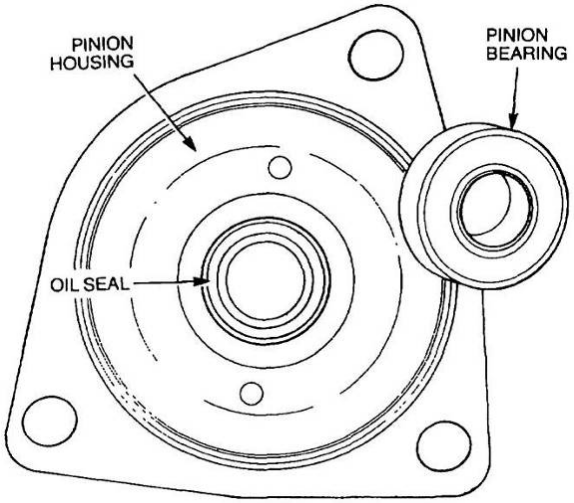


Figure 307 Removal of the Pinion Bearing and Seal

114. Cleaning and Inspection. Clean and inspect the starter motor as follows:

a. Clean all components in a suitable cleaning agent and blow them dry with compressed air.

b. Check that the bearings rotate smoothly without any noise.

c. Check the length of the brushes and replace them if they are below or approaching 9 mm (0.35 in). Replace the brush springs if the pressure is weak.

d. Inspect the commutator for excessive wear or scoring, and replace it if it is worn more than 1.0 mm (0.039 in) below the manufactured diameter.

e. The commutator under cut must not exceed 0.2 mm (0.007 in). Replace the commutator if the specification is exceeded.

NOTE

As the starter motor is a waterproof component, all gaskets and rubber seals must be replaced on reassembly.

115. Reassembly. Reassemble the starter motor as follows:

NOTE

The oil seal lips must face the pinion bearing.

a. Install the oil seal, plain face first. Using a suitable press, install the pinion bearing.

b. Install the pinion bearing retaining plate and cover and secure them in place with two screws and washers.

c. Position the clutch lever bush halves on the lever (Figure 308), smear the lever and bush halves with suitable grease and insert them in the pivot bore.

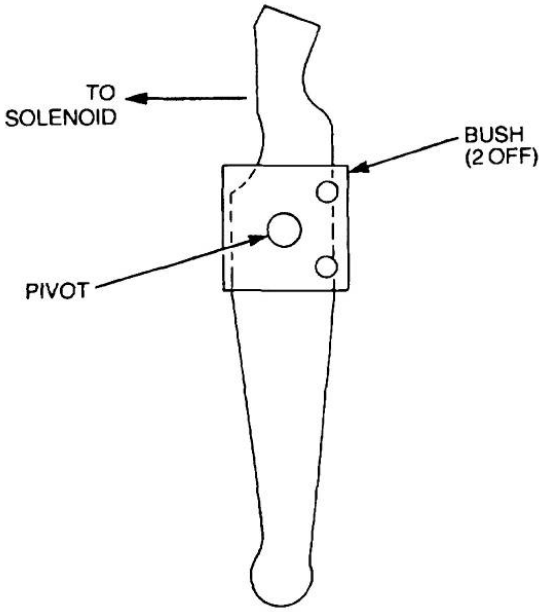


Figure 308 Installation of the Pivot Bush

d. Smear grease on the clutch shaft and clutch groove. Install the clutch assembly in the housing ensuring that the fork engages with the clutch groove.

e. Install the plastic bush, the shims and the rubber seal into the housing ensuring that the locating tab on the seal is positioned on the screw hole.

NOTE

Ensure that the pinion gear is fitted in the correct position as noted in the disassembly procedure.

f. Install the pinion spring, the pinion and retaining collar, apply pressure on the collar and install the circlip.

g. Install the clutch gear on the clutch shaft and fit the shim washers. Fit the bearing plate on the housing and secure it with the single bolt, tighten the bolt securely.

h. Fit the plate and washer on the bearing plate (Figure 302) and secure them with the C-clip. Install the cover and secure it with the two screws.

i. Apply grease to the armature shaft teeth. Install the armature and bearings in the bearing plate ensuring the shaft teeth engage with the clutch gear teeth. Press the bearing fully into the bearing plate.

j. Fit the O ring onto the bearing plate and install the field housing ensuring the match marks align. Install the O ring onto the field housing and engage the two tabs in the slots provided.

k. Position the brush holder on the field housing and install the two field brushes. Push back the four brushes into the holders and place the brush holder over the commutator. Fit the brush cover on the brush holder and secure it with the two screws. Align the match marks on the brush holder and field housing and secure it with the two long screws.

l. Install the solenoid and shim on the housing ensuring the plunger engages the clutch fork and the match marks align. Secure the solenoid and shim to the housing with the two screws. Connect the field wire to the solenoid lower terminal and tighten the nut securely.

m. Fit the solenoid switch to the housing and secure it with the two screws and washers. Connect the wire from the switch lower terminal to the solenoid side terminal and tighten the small hexagonal headed screw securely (Figure 299). Connect the wire from the switch upper terminal (with the protective boot), to the solenoid upper terminal and tighten the nut securely.

Alternator and Vacuum Pump

116. Disassembly. Disassemble the alternator and vacuum pump as follows:

a. Remove the alternator in accordance with EMEl Vehicle G 203 – Group 15.

b. Remove the three bolts securing the vacuum pump to the alternator. Securing the centre plate, remove the vacuum pump from the rotor shaft (Figure 309).

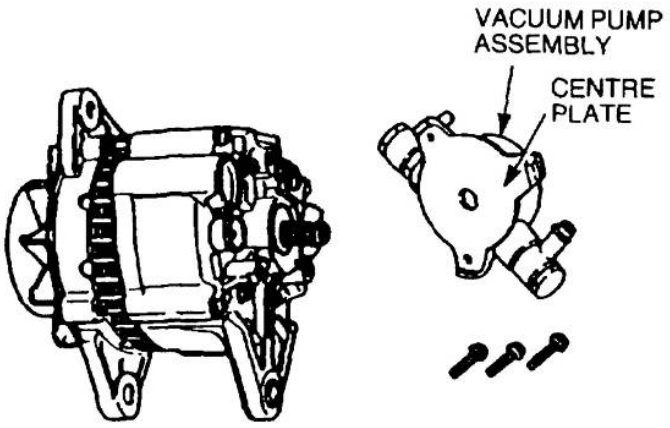


Figure 309 Removal of the Vacuum Pump

c. Turn the vacuum pump centre plate to release it from the three lugs. Remove the plate, rotor and vanes (Figure 310).

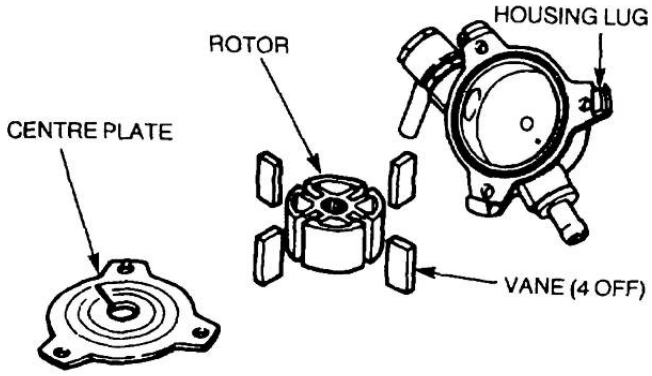


Figure 310 Disassembly of the Vacuum Pump

d. Apply a suitable tape to the rotor shaft splines. Taking care not to dislodge the stator coils and damage the rear seal, remove the four through bolts that secure the rear cover to the front cover (Figure 311).

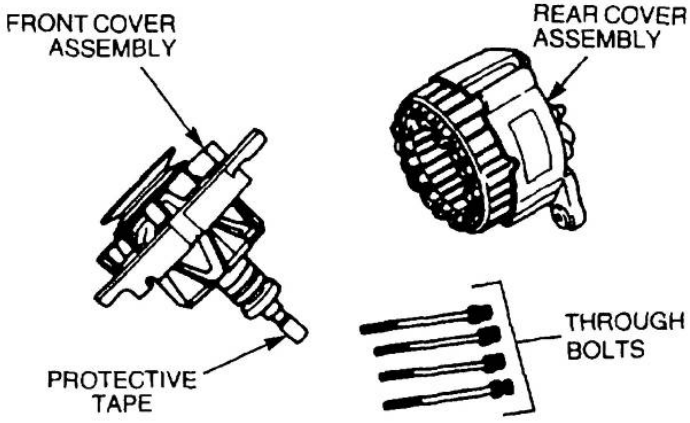


Figure 311 Removal of the Alternator Rear Cover

e. Carefully clamp the rotor in a vice fitted with soft-jaw protectors, remove the nut retaining the pulley (Figure 312), and remove the washer, pulley and cover from the rotor.

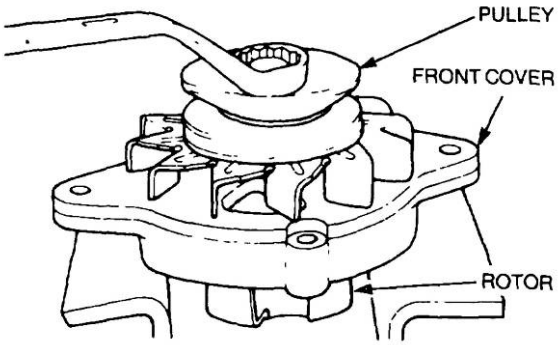


Figure 312 Removal of the Front Pulley and Cover

f. Remove the three screws and washers securing the bearing retaining plate to the front cover (Figure 313). Remove the plate, then using a suitable press and arbor, remove the bearing.

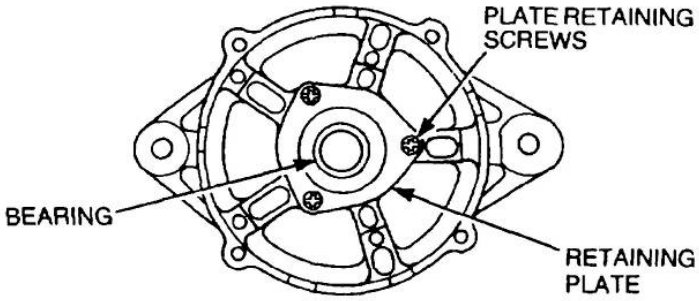


Figure 313 Removal of the Front Cover Bearing

g. Remove the nut retaining the B-terminal to the rear cover (Figure 314). Remove the five nuts retaining the diode holder taking note of the insulating washer positions.

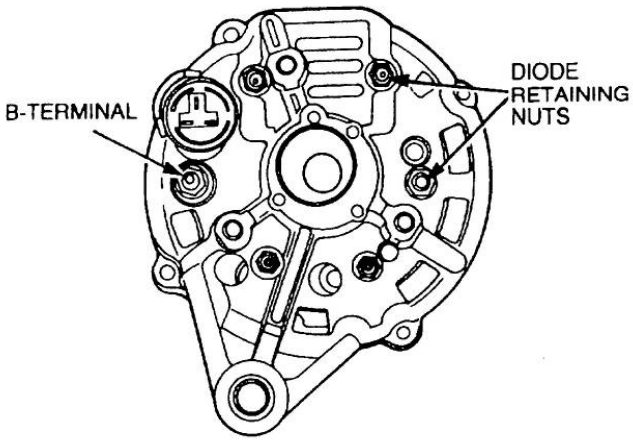


Figure 314 Removal of the Diode Assembly

NOTE

When using the soldering iron to separate the diodes from the stator coils, hold the lead wire with long-nose pliers to prevent heat being transferred to the diodes causing them to malfunction.

h. Hold the lead wire connecting the stator coil to the diode with long-nose pliers and melt the solder connection with a soldering iron (Figure 315). Repeat the procedure for the remaining connections and separate the coil from the diode holder.

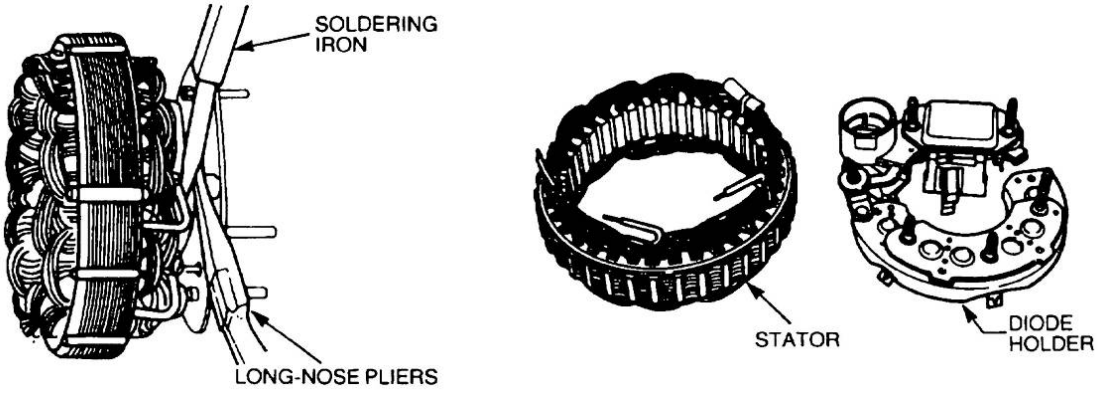


Figure 315 Removal of the Diode Holder

117. Cleaning and Inspection. Clean and inspect the alternator and vacuum pump as follows:

a. Clean all components in a suitable cleaning agent and blow them dry with compressed air.

b. Check the bearings and seals for damage or excessive wear and replace parts if necessary.

c. Using a vernier caliper, measure the outside diameter of the slip rings (Figure 316), the figure must be between 33.6 to 34.6 mm (1.31 to 1.36 in). If the dimension is not within specification, replace the rotor assembly.

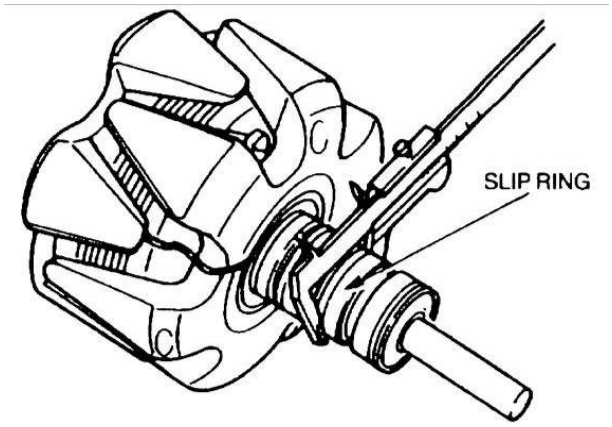


Figure 316 Measuring the Slip Rings

d. Using an ohmmeter, check the resistance across the slip rings. If continuity does not exist, replace the rotor assembly (Figure 317).

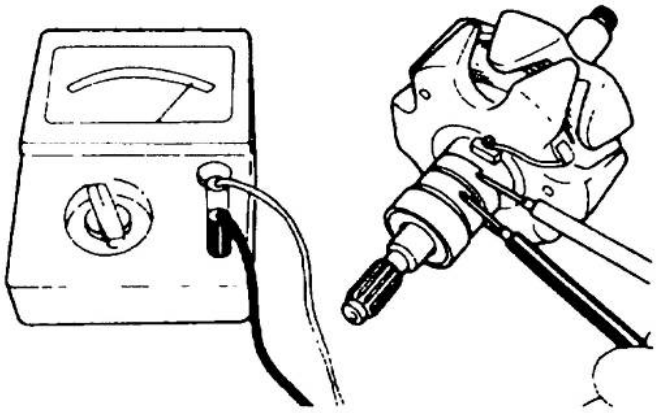


Figure 317 Continuity Test of the Rotor and Slip Ring

e. Check for continuity between the slip ring and rotor core (or shaft). If continuity exists, replace the rotor assembly (Figure 318).

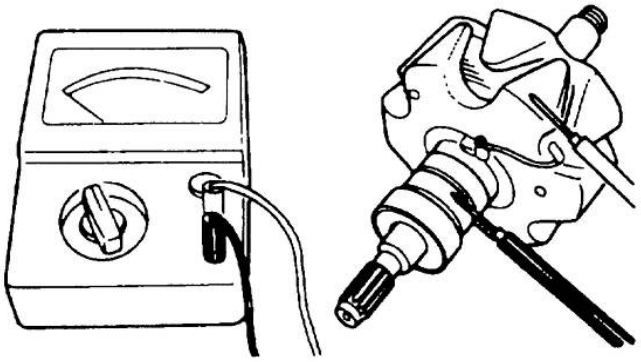


Figure 318 Earth Test of the Rotor and Slip Ring

f. Check for continuity across the stator coils (Figure 319). If continuity does not exist, replace the coil assembly.

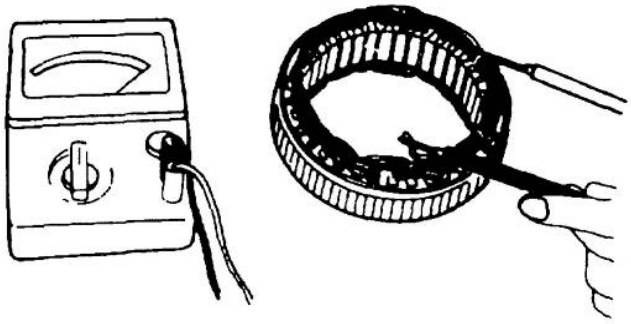


Figure 319 Continuity Test of the Stator Coil

g. Check for continuity across one of the stator coils and the stator core (Figure 320). If continuity exists, replace the coil assembly.

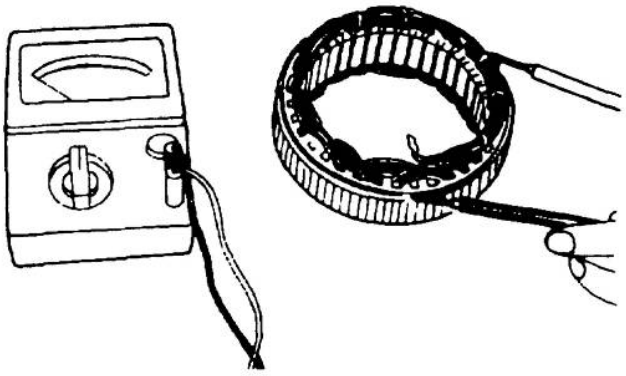


Figure 320 Earth Test of the Stator Coil

h. Ensure the brushes are between 5.5 to 12.5 mm (0.22 to 0.49 in). Replace the brushes if they are worn to (or near) the line scribed on the brush (Figure 321).

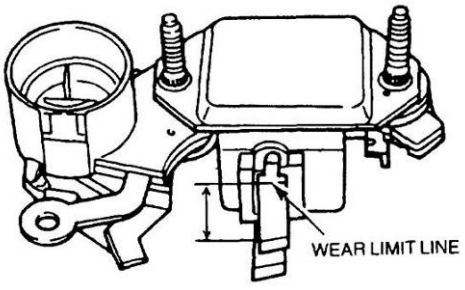


Figure 321 Inspection of Brush Length

i. Check each diode for continuity across the diode terminals and ensure that continuity exists in one direction and infinity in the opposite direction. Replace the diode assembly if any diode is suspected of being faulty.

j. Replace the regulator if it is suspected of being faulty.

k. Figure 322 is included as an aid to circuit tracing.

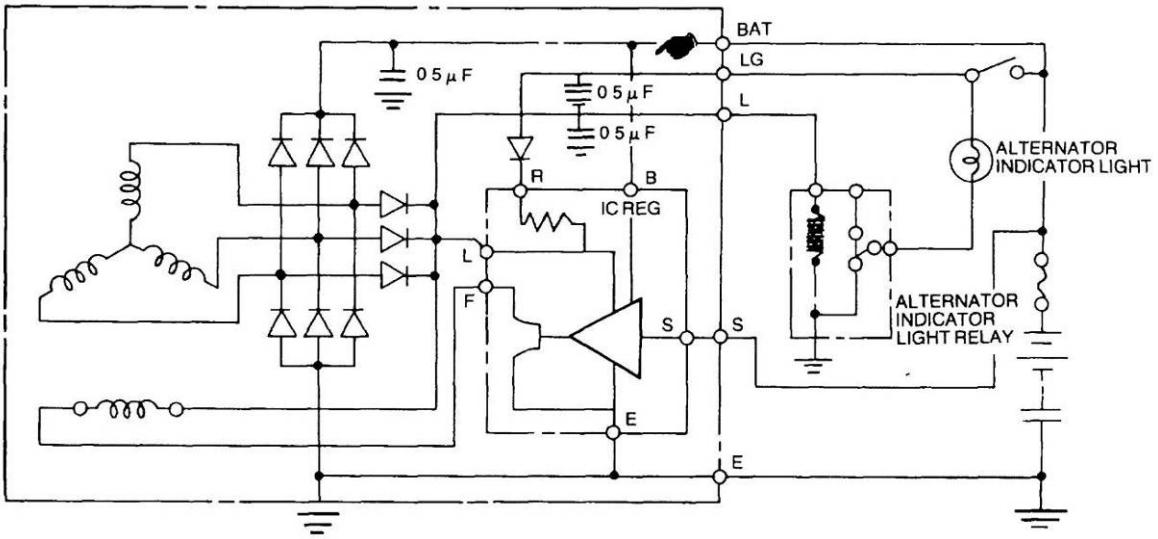


Figure 322 Alternator Circuit Diagram

l. Inspect the vacuum pump for damage or excessive wear and replace the vanes if the overall length is not between 12.5 to 13.5 mm (0.492 to 0.531 in) (Figure 323).

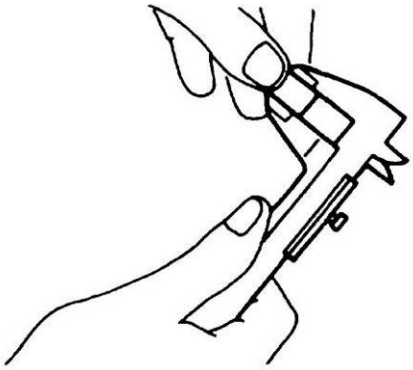


Figure 323 Measuring the Vacuum Pump Vanes

m. Measure the inside diameter of the pump housing and check that the dimension is between 57.0 to 57.1 mm (2.244 to 2.248 in). Replace the pump assembly if it is not within tolerance (Figure 324).

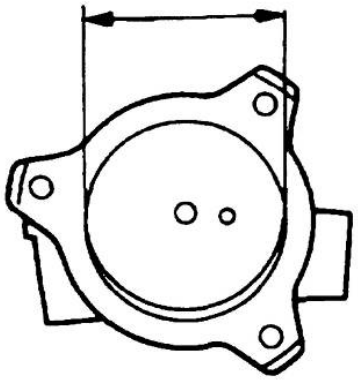


Figure 324 Measuring the Vacuum Pump Housing

n. Check the vacuum pump oil seal for signs of damage or excessive wear. If necessary, pry out the seal with a screwdriver, then using a suitable arbor, press in the new seal (Figure 325).

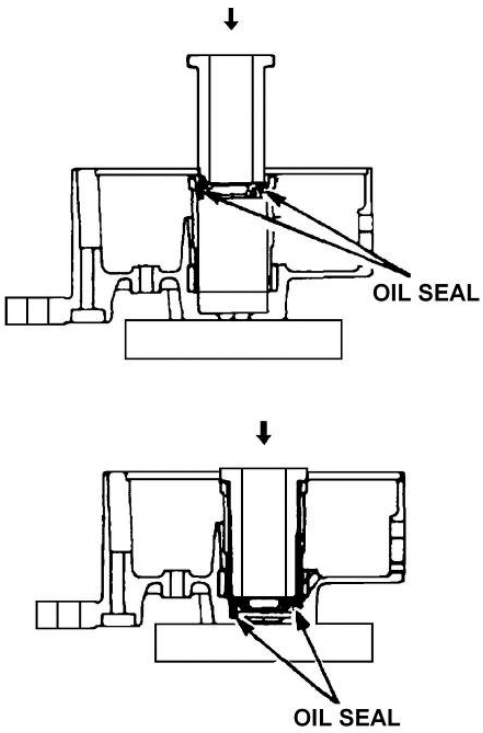


Figure 325 Installation of the Vacuum Pump Oil Seal

o. Check that the pump check valve operates smoothly.

118. Reassembly. Reassemble the alternator and vacuum pump as follows:

a. Position the diode holder on the stator coil assembly and solder each connection, ensuring the lead wires are held by long-nose pliers to prevent the heat damaging the diodes (Figure 326).

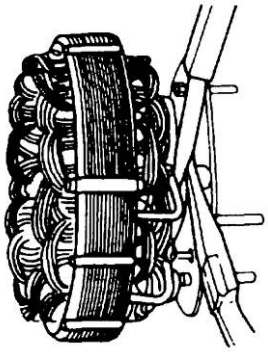


Figure 326 Reconnection of the Stator to the Diode Holder

b. Press the new bearing into the front cover. Install the retaining plate and secure it with the three screws and lock-washers.

c. Clamp the rotor in a vice fitted with soft-jaw protectors and install the front cover. Fit the pulley, a new lock-washer and the nut. Torque the nut to 45 to 58 N.m (33 to 43 lbf.ft).

d. Insert the diode holder and stator into the rear cover ensuring that the insulating washers are in the correct locations. Install the lock-washers and nuts and tighten the nuts securely.

e. Insert a piece of wire through the rear cover to hold the brushes back in the holder and install the rotor and front cover (Figure 327). Remove the wire when the rotor is fully installed. Check that the rear bearing and locking ring engage fully.

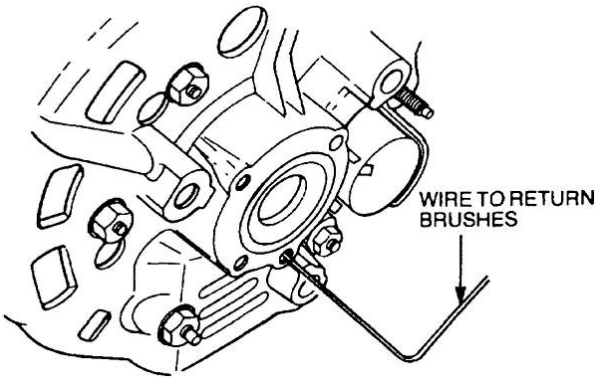


Figure 327 Installation of the Rear Cover

f. Insert a suitable bar or rod through the front and rear pivot holes and install the four through bolts (Figure 328). Tighten the bolts securely.

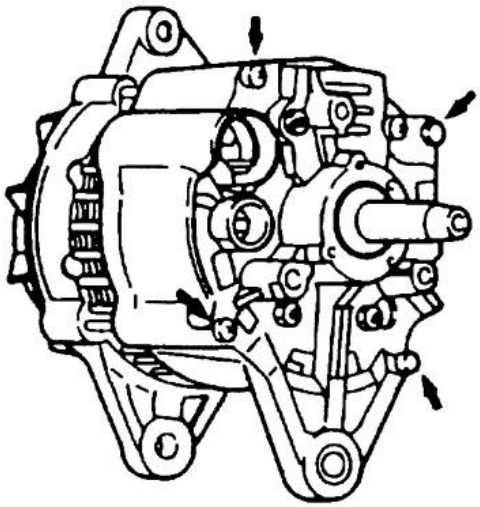


Figure 328 Installation of the Rear Cover Through Bolts

g. Remove the protective tape from the rotor shaft splines.

h. Insert the vacuum pump rotor in the housing with the serrated boss uppermost. Fit the vanes in the rotor with the round end towards the housing (Figure 329).

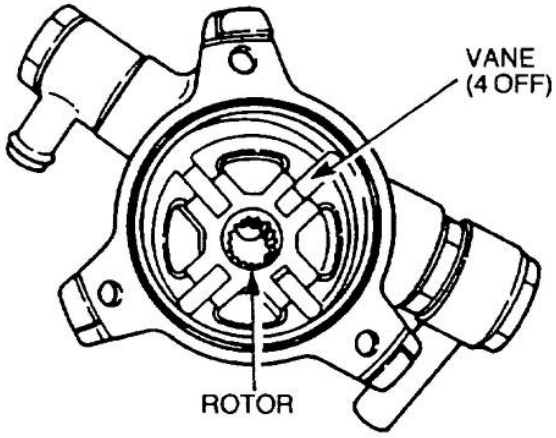


Figure 329 Installation of the Vacuum Pump Rotor and Vanes

i. Fit a new O ring on the pump housing and install the centre plate. Turn the plate to engage the three lugs in the housing (Figure 330). Position a new O ring on the alternator pump mounting face.

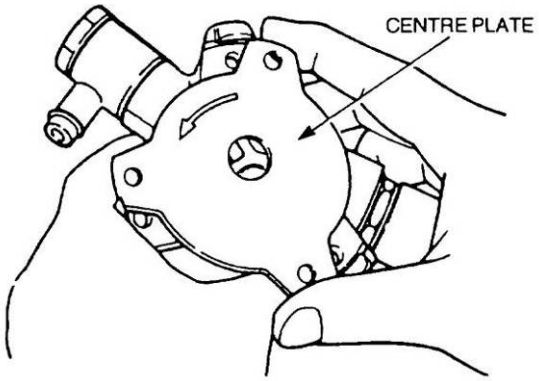


Figure 330 Installation of the Centre Plate

j. Align the rotor bore and the centre plate hole and install the pump on the alternator. If necessary turn the housing to align with the holes in the alternator rear cover (Figure 331). Insert and tighten the three bolts securely.

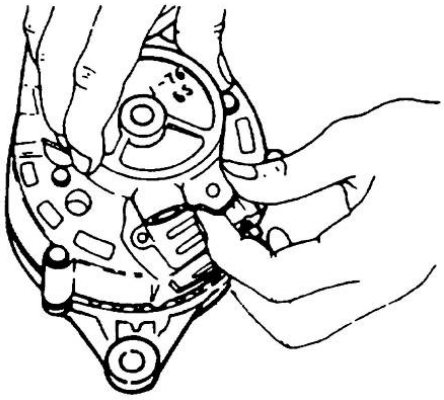


Figure 331 Installation of the Vacuum Pump

k. Apply a few drops of clean engine oil through the filler port and rotate the alternator pulley to ensure that the pump is adequately lubricated on initial start up. Check that the pulley rotates smoothly.

l. Install the alternator in accordance with EMEl Vehicle G 203 – Group 15.

Wiring Harness

NOTE

Ensure the link cable to the headlamp electrical circuit has been fitted in accordance with EMEI Vehicle G 187-1.

Ensure the instrument light and inspection light socket circuits are fused in accordance with EMEI Vehicle G 197-7.

CAUTION

Prior to commencing work on electrical systems, ensure all precautions are adhered to in order to avoid damage to equipment.

119. General Precautions. General precautions for working on the wiring harness are as follows:

a. Use suitable testing meters or circuit tester to trace or locate faults or check circuits. The practice of arcing wires to earth to determine if the wire is live, will destroy solid state components, and must not be used.

b. After tracing electrical faults, and before carrying out any electrical repairs, disconnect the battery, negative terminal first, and then the positive terminal.

c. Before carrying out any electrical arc welding on the vehicle, disconnect the battery and the alternator. Failure to disconnect the alternator will cause the transistors and diodes to fail as a result of current flow throughout the chassis when arc welding.

d. When installing the battery, ensure that the terminals are connected to the correct posts. Reversing battery polarity will cause serious damage.

120. Replacement. Replacement of wiring harnesses is carried out as follows:

a. Disconnect the battery, negative terminal first, then the positive terminal.

NOTE

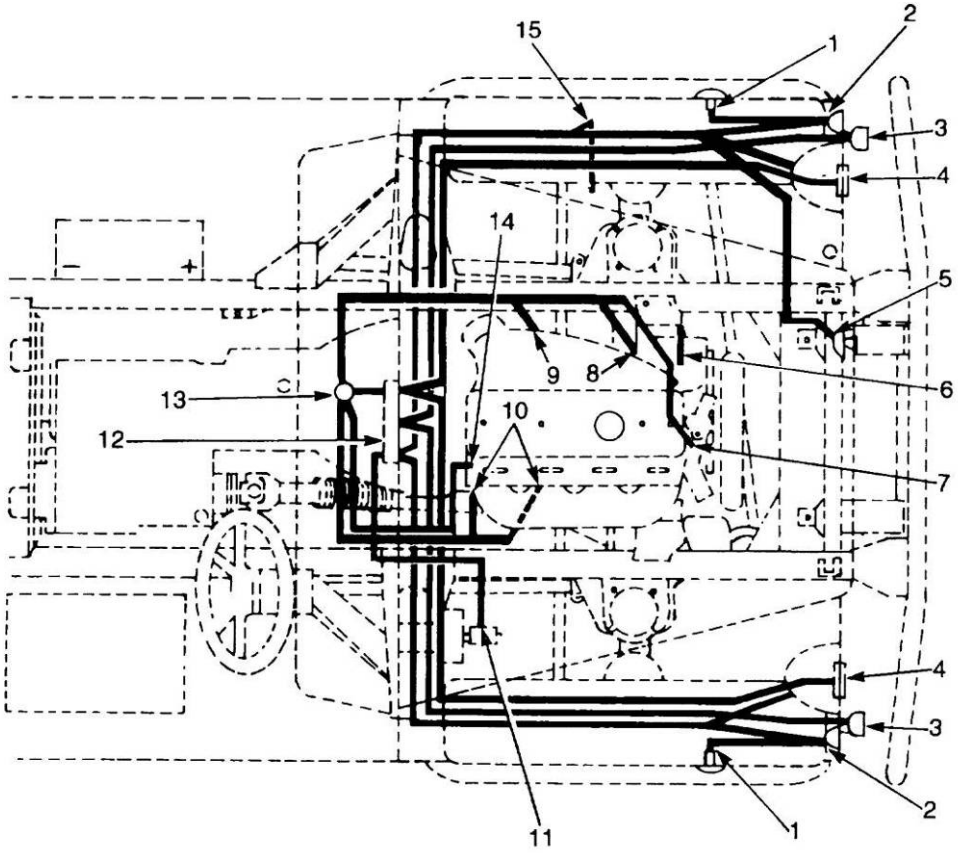
All electrical wiring in the vehicle is colour coded for identification and reference. If necessary, refer to the wiring diagram (EMEI Vehicle G 203), in conjunction with the relevant illustration when replacing a wiring harness.

b. After determining which harness is to be replaced (Figures 332, 333 and 334), disconnect the harness. As an added precaution and to assist in the installation of the replacement harness, tag each wire and terminal in turn as the wire is disconnected. Disconnect the zip clamps and brackets and remove the harness from the vehicle.

c. Ensure that the replacement harness is of the correct capacity and that the wires are correctly colour coded. Using the old harness and tags as a guide, connect the wires to the appropriate terminals.

d. Install and tighten the zip clamps and brackets, then connect the battery. Connect the positive terminal first, then the negative terminal.

e. Test the function of the components associated with the wiring harness that has been replaced to ensure correct function.



1. Repeater light.
2. Indicator/park light.
3. Reduced head lights.
4. Blackout lights
5. Horn.
6. Earth strap.
7. Water temperature sender unit.
8. Alternator.
9. Starter motor.
10. Oil pressure switches.
11. Brake master cylinder.
12. Fuse and relay panel.
13. Multi-pin connector.
14. Glow plugs.
15. Pad wear indicator

Figure 332 Front Wiring Harness

1. Warning light panel.
2. Switch panel.
3. Voltmeter.
4. Water temperature gauge.
5. Fuel gauge.
6. Speedometer.
7. Heater (blower) motor switch.
8. Ignition switch.
9. Light switch.
10. Combination switch.
11. Interior (dome) light.
12. Washer/wiper switch.
13. Dimmer switch.
14. Map reading light.
15. Blackout switch.
16. Fuse and relay panel.
17. Heater (blower) motor
18. Windscreen wiper motor

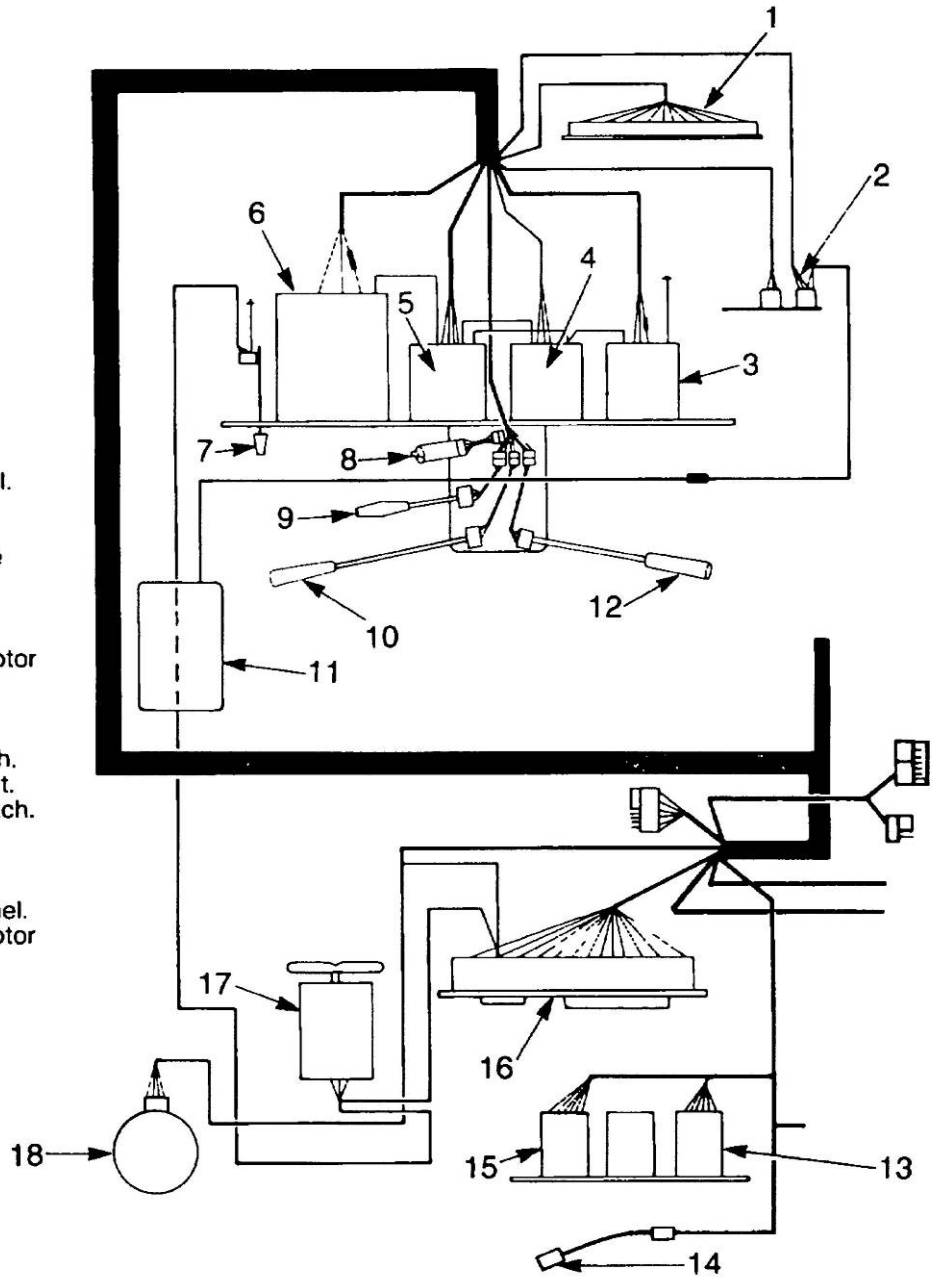
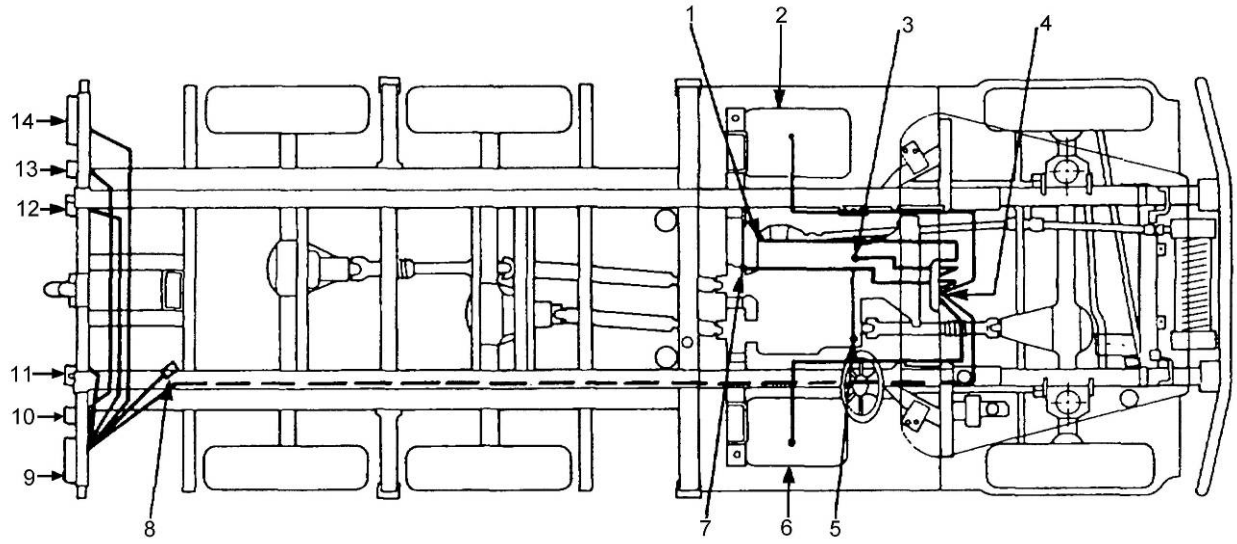


Figure 333 Cab Wiring



1. PTO warning light switch
2. Fuel tank
3. Reverse light switch
4. Fuse and relay panel
5. Diff lock warning light switch
6. Fuel tank
7. 6WD warning light switch
8. Convoy light
9. Tail light assembly right-hand side
10. Blackout light right-hand side
11. Power outlet socket
12. NATO socket
13. Blackout light left-hand side
14. Tail light assembly left-hand side

Figure 334 Rear Wiring Harnesses

121. The electrical specifications are detailed in Table 17.

Table 17 Electrical Specifications

Serial	Item	Specification
1	Starter motor brush length	9 mm (0.35 in)
2	Commutator maximum wear	1.0 mm (0.039 in)
3	Commutator maximum under-cut	0.2 mm (0.007 in)
4	Alternator slipring outer diameter	33.4 to 34.6 mm (1.31 to 1.36 in)
5	Alternator brush length (minimum)	To the scribed line on the brush
6	Vacuum pump vane length	12.50 to 13.50 mm (0.492 to 0.531 in)
7	Vacuum pump housing inner diameter	57.0 to 57.10 mm (2.244 to 2.248 in)
8	Fanbelt pulley tightening torque	45 to 58 N.m (33 to 43 lbf.ft)

FRAME

122. Inspection. Inspect the frame assembly for cracks and corrosion; replace the frame if the repairs are beyond standard workshop procedures.

123. Alignment. Check the frame alignment as follows:

NOTE

When measuring the diagonals, ensure that the exact opposition plumb line positions are used on both frame side rails.

a. Place the assembled vehicle on a level floor and hold a plumb line against one of the points shown in Figure 335. Mark the point with chalk directly below the plumb bob. Repeat the procedure for the remaining points to determine the frames squareness.

b. Move the vehicle forward away from the chalk marks and take the dimensions between the related diagonals. Each dimension must be within 9.5 mm (0.375 in).

c. Using a suitable measuring device, measure the distance between the front axle centre line and the spring equalizer centre line (dimension Y).

NOTE

When checking the frame for misalignment using the datum line, not all dimensions can be determined with the body and engine in position.

d. Side rail checks can be made while referring to Figure 335.

e. If the frame dimensions are not within the specification listed in Table 18, and cannot be aligned using standard workshop procedures, the frame assembly must be replaced.

Table 18 Frame Dimensions

Check Point and Dimension	Check Point and Dimension	Check Point and Dimension
A – 1701.8 mm	L – 108 mm	W – 372 mm
B – 197 mm	M – 89 mm	X – 32 mm
C – 878 mm	N – 453 mm	Y – 3490 mm
D – 835 mm	O – 1538 mm	Z – 2175 mm
E – 417.5 mm	P – 2623 mm	AA – 1052 mm
F – 458.5 mm	Q – 5028 mm	AB – 878 mm
G – 458.5 mm	R – 424 mm	AC – 173 mm
H – 555 mm	S – 424 mm	AD – 98 mm
I – 2547 mm	T – 5734 mm	AE – 791 mm
J – 3099 mm	U – 134 mm	AF – 268 mm
K – 3344.5 mm	V – 16 mm	

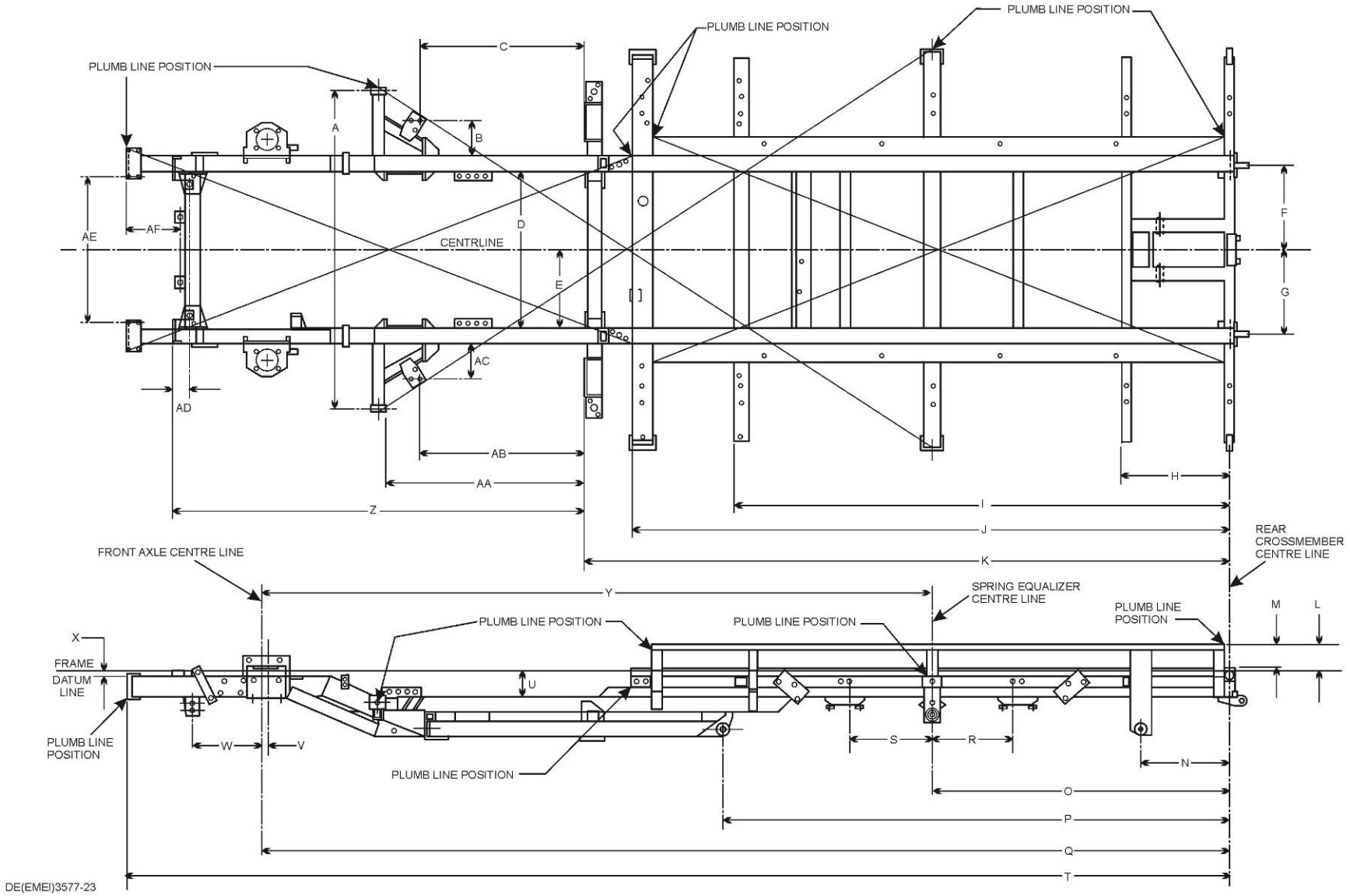


Figure 335 Frame Alignment

Blank Page

BODY

Dashboard

124. Removal. Remove the dashboard as follows:

a. Disconnect the battery.

b. Remove the steering wheel in accordance with EMEl Vehicle G 203 – Group 14.

c. Remove the instrument panel in accordance with EMEl Vehicle G 203 – Group 15. Tag and disconnect all wiring harnesses and connections. Disconnect the speedometer cable.

d. Remove the central switch panel in accordance with EMEl Vehicle G 203 – Group 15.

e. Remove the screws securing the driver's side end panel and heater control to the fascia and move the panel away from the fascia.

f. Remove the screws securing the upper crash pad to the firewall and the fascia support panel (Figure 336). Remove the support panel.

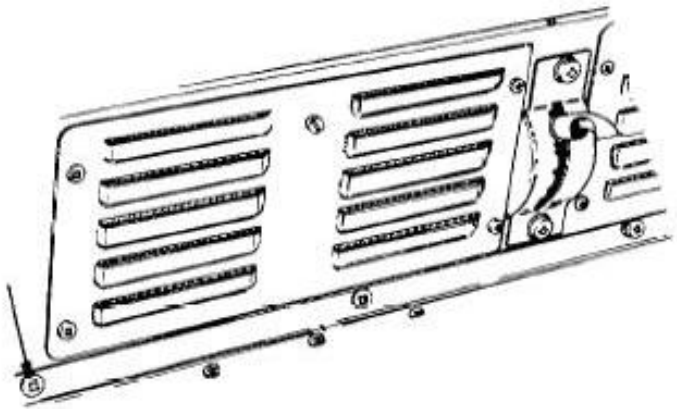


Figure 336 Removal of the Upper Crash Pad

g. Remove the two demister duct inserts secured to the top of the upper crash pad at the heater ducting outlet. Slightly lift the crash pad, adjacent to the windscreen, and move the crash pad to the rear end and out of the vehicle.

h. Remove the parcel tray and heater duct in accordance with EMEI Vehicle G 203 – Group 18.

125. Installation. Install the dashboard as follows:

a. Install the fascia support panel and secure it to the firewall.

b. Install the upper crash pad, ensuring that the support panel engages in the crash pad channel. Secure the pad with the screws.

c. Fit the parcel tray and heater duct in accordance with EMEl Vehicle G 203 – Group 18.

d. Install the heater control panel and secure it to the fascia.

e. Install the central switch panel in accordance with EMEl Vehicle G203 – Group 15, ensuring that all connections are secure.

f. Install the instrument panel in accordance with EMEl Vehicle G 203 – Group 15, ensuring that all connections are secure.

g. Install the steering wheel in accordance with EMEI Vehicle G 203 – Group 14.

h. Connect the battery.

Cab

126. Removal. Remove the cab as follows:

a. Chock the vehicle's wheels to prevent movement in either direction.

b. Remove the clip and pin securing the bonnet stay-bar to the bonnet and remove the bonnet from the vehicle.

c. Remove the mudguards in accordance with EMEl Vehicle G 204-1 – Group 17.

d. Disconnect the earth lead from the battery.

e. Disconnect the bottom radiator hose and drain the engine coolant into a suitable receptacle.

f. Loosen the heater hose clamps and disconnect the hoses from the engine.

g. Disconnect the accelerator linkage and the throttle cable from the injector pump.

h. Disconnect the brake pipes, running from the proportioning valve to the wheels, at the proportioning valve.

i. Remove the air cleaner assembly from the engine and disconnect the chassis wiring harness at the connectors on the firewall.

j. Disconnect the wiring from the alternator, the starter motor, the temperature sensor, the oil pressure sensor and the glow plugs and secure the ends to the cab.

k. Tag and disconnect the differential and the output shaft lock vacuum hoses at the vacuum chambers and disconnect the vacuum supply hose from the engine.

l. Disconnect the windscreen washer hose from the washer reservoir.

m. Disconnect the speedometer cable from the transmission together with the wiring from the reverse light switch, the differential lock and the output shaft lock indicator switches.

n. Remove the bolts securing the clutch slave cylinder to the transmission bell housing, then remove the slave cylinder from the bell housing and secure the cylinder to the firewall.

o. Ensure that the fuel level in the tanks is below the filler neck opening in the tanks. Slacken the clamps and remove the filler necks and the fuel tank breathers from the tanks. Plug all the openings in the fuel tanks.

p. Turn the steering wheel to the straight ahead position, match mark the upper steering shaft to the upper universal joint and disconnect the universal joint from the upper steering shaft.

q. Disconnect the parking brake cable at the draw link on the brake shoe expander and secure the end to the cab.

r. Disconnect the winch control cable from the power take-off (if fitted), and secure the end of the cable to the cab.

The cover over the transmission tunnel is fragile and can easily tear, use care when removing it.

s. Remove the transmission tunnel cover. Remove the knobs from the transmission and transfer case shift levers and remove the rubber boot from the tunnel.

t. Connect suitable lifting slings to the cab and attach the ends of the slings to suitable overhead lifting equipment and take-up the slack (Figure 337).

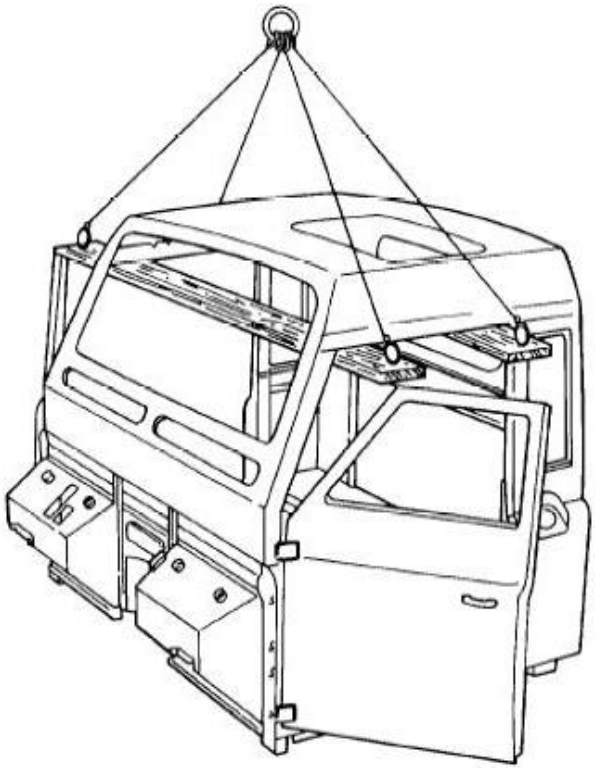


Figure 337 Removal of the Cab

u. Remove the bolts, nuts and washers securing the cab mounting brackets to the chassis outriggers.

v. Remove the bolts, nuts and washers securing the cab front mountings to the chassis brackets.

w. Remove the bolts, nuts and washers securing the cab front support brace to the chassis.

x. Remove the bolts, nuts and washers securing the cab rear support brace to the chassis.

y. Carefully raise the cab approximately 200 mm and check that all wiring, piping/hoses and cables have been disconnected and are not caught up. Continue to raise the cab while guiding the transmission and transfer case shift levers through the opening in the transmission tunnel and ensuring that the cab does not swing against the engine. Lift the cab clear of the vehicle, lower the cab to the ground and remove the lifting equipment.

127. Inspection. Inspect the cab for corrosion, dents, cracks and loose rivets. Repair or replace panels as necessary using standard workshop procedures.

128. Installation. Install the cab as follows:

a. Connect suitable lifting slings to the cab and attach the slings to suitable overhead lifting equipment.

b. Using the overhead lifting equipment, raise the cab above the chassis mounting points, ensuring that wiring, piping, hoses and linkages are clear and will not foul or jam when positioning the cab on the mounting points.

c. Manoeuvre, then lower the cab until it sits square on the mounting points. Install the nuts, washers and bolts securing the cab mounting brackets to the chassis mountings.

d. Securely tighten the nuts and bolts at all mounting points.

e. Remove the lifting slings from the cab body and retighten the nuts and bolts at all mounting points.

f. Connect the windscreen washer hose to the reservoir.

g. Remove the tags and connect the differential lock and output shaft vacuum hoses to the vacuum chambers. Connect the vacuum supply hose to the engine.

h. Install the transmission tunnel cover, the transmission and transfer case shift lever knobs and the rubber boot to the tunnel.

i. Connect the winch control cable to the power take-off (if fitted).

j. Connect the parking brake cable to the draw link on the brake shoe expanders.

k. Turn the steering wheel to the straight ahead position, align the match marks and connect the steering shaft to the upper universal joint.

l. Install the filler necks and breather to the fuel tanks and securely tighten the clamps.

m. Connect the speedometer cable to the transmission. Connect the wiring to the reverse light switch, the differential lock switch and the output shaft lock indicator switch.

n. Connect the wiring to the alternator, the starter motor, the temperature sensor, the oil pressure sensor and the glow plugs.

o. Position the air cleaner in the bracket and tighten the wing nuts firmly. Tighten the clamps securing the hoses to the air cleaner.

p. Connect the brake pipes from the wheels to the proportioning valve body.

q. Connect the accelerator linkage and the throttle cable to the injector pump.

r. Connect the heater hoses to the engine.

s. Install the bottom radiator hose and fill the coolant system with clean coolant.

t. Connect the earth lead to the battery.

u. Install the mudguards in accordance with EMEI Vehicle G 204-1 – Group 17.

v. Correctly position and install the bonnet, then install the clip and pin securing the bonnet stay bar to the bonnet.

w. Remove the chocks from the vehicle wheels and check that all items disturbed during removal and installation are fully functional.

Cargo Body

129. Removal. Remove the cargo body as follows:

a. Release the canopy straps and lashings and remove and stow the canopy.

b. Position suitable overhead lifting equipment above the cargo body. Attach suitable slings to the galvanized body support brackets and to the lifting equipment, then take up the slack in the slings.

c. Remove the bolts, nuts and washers securing the galvanized body support brackets to the vehicle's chassis outriggers and discard the nuts.

d. Remove the twelve bolts, nuts and washers securing the longitudinal body runners to the vehicle's chassis and discard the nuts.

e. Lift the cargo body from the vehicle, place the body on suitable stands and remove the lifting equipment.

130. Installation. Install the cargo body as follows:

a. Position suitable overhead lifting equipment above the cargo body; attach suitable slings to the galvanized body support brackets and to the lift equipment.

b. Lift the cargo body into position on the vehicle's chassis ensuring the cargo body headboard is positioned toward the front of the vehicle. Align the bolt holes in the cargo body longitudinal runners with the bolt holes in the vehicle's chassis. Install the bolts, washers and new nuts, but do not tighten them at this stage.

c. Align the bolt holes in the galvanized body support brackets with the bolt holes in the vehicle's chassis outriggers, install the bolts and washers together with new nuts, but do not tighten them at this stage.

d. Ensure that the cargo body is square with the vehicle's chassis, then tighten all of the retaining bolts and nuts securely and remove the lifting equipment. If required, install the canopy and secure it with the straps and lashings.

WINCH

131. Disassembly. Disassemble the winch as follows:

a. Remove the winch assembly in accordance with EME1 Vehicle G 204-1 – Group 19.

b. Remove the winch rope in accordance with EMEl Vehicle G 203 – Group 19.

c. Remove the breather banjo bolt, filler and drain plugs from the winch gear housing and drain the oil into a suitable receptacle.

d. Remove the four bolts and washers securing the fairlead frame to the winch housing.

e. Remove the four bolts and washers securing the winch rear mounting bracket to the winch housing.

f. Withdraw the dog clutch housing and lever (Figure 338).

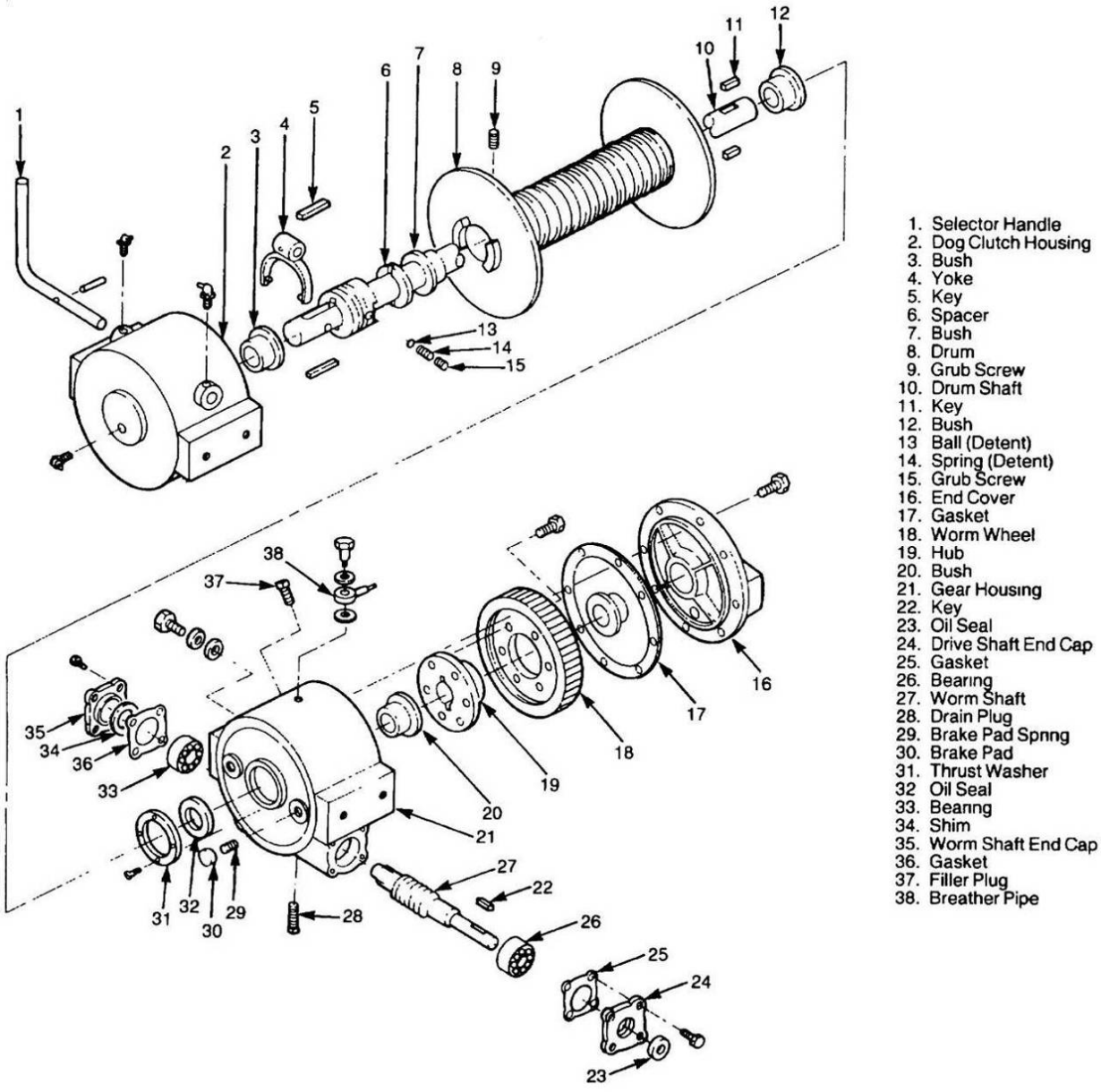


Figure 338 Winch Assembly - Exploded View

g. Remove the two drive keys from the shaft and slide the collar off the shaft (Figure 339). Withdraw the drum from the shaft, taking care not to lose the brake pads and springs.

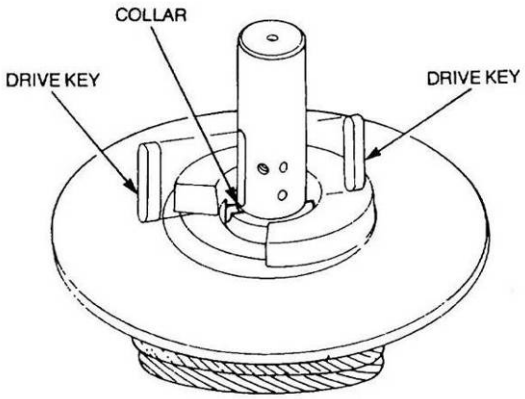


Figure 339 Removal of the Winch Drum

h. Remove the two brake pads and springs (Figure 340). Replace the pads if the overall thickness is 6 mm or less.

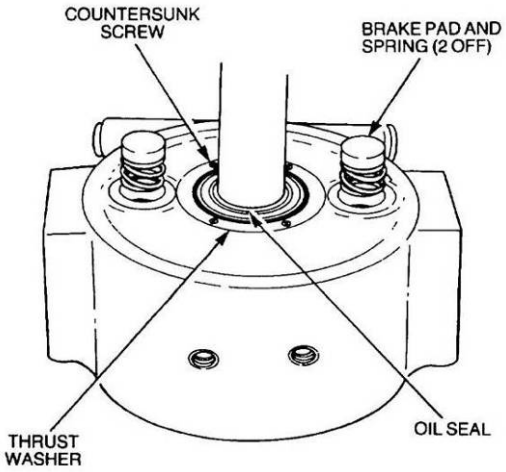


Figure 340 Removal of the Brake Pad

i. Remove the eight bolts that secure the end cover and gasket. Remove the cover and discard the gasket (Figure 341).

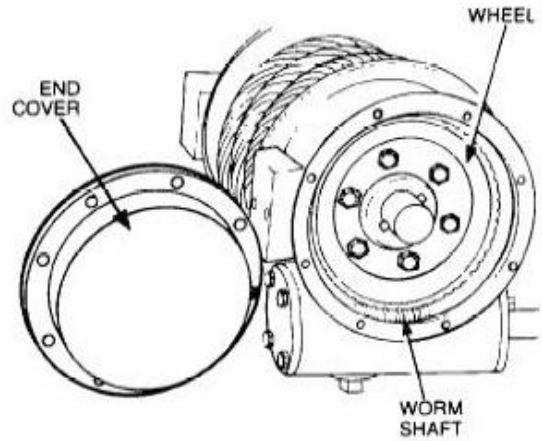


Figure 341 Removal of the End Cover

j. Remove the four bolts securing the worm shaft end-plate to the gear housing. Remove the plate and discard the gasket.

k. Remove the worm shaft drive key and remove the four bolts securing the drive shaft end-plate to the housing. Remove the end-plate and discard the gasket. Remove the oil seal from the end-plate and discard the oil seal.

l. Remove the plastic thrust washer from the worm shaft bearing. Using a suitable press, remove the worm shaft through the bearing and remove the worm shaft from the housing. Using a suitable puller, remove the remaining bearing from the worm shaft.

m. Remove the wheel and shaft assembly from the housing. Remove the six bolts securing the wheel to the hub and carefully press the wheel from the hub.

n. Using a 5/32 in Allen key, remove the two countersunk screws securing the nylon thrust washer to the winch gear housing (Figure 340) and carefully prise the thrust washer from the housing. Discard the thrust washer.

o. Using a suitable tool, carefully remove the oil seal from the winch gear housing ensuring that the main shaft bronze bush is not damaged.

132. Cleaning and Inspection. Clean and inspect the winch as follows:

a. Clean all components in a suitable cleaning agent and blow them dry with compressed air.

b. Check the internal diameter of the gear housing and clutch housing bushes, if the dimension exceeds 38.46 mm (1.514 in), replace the bush as necessary.

c. Check the drum shaft for run-out. Discard the drum shaft if the run-out is more than 0.250 mm (0.010 in). Check the overall condition of the shaft and keyways and replace them as necessary.

d. Measure the diameter of the winch drum in at least three places to check for distortion. Discard the drum if the diameters differ in excess of 0.500 mm (0.020 in) from each other.

e. Visually inspect the drive wheel and worm for any signs of abnormal wear and replace them as necessary.

133. Reassembly. Reassemble the winch as follows:

NOTE

Ensure the winch drum has been reworked in accordance with EMEI Vehicle G 187-8 prior to reassembling the winch.

a. Press the wheel onto the hub ensuring that the bolt holes are aligned. Apply oil to the threads of the bolts, insert the bolts and torque them to 40 N.m (30 lbf.ft). Fit the two drive keys to the shaft and using a suitable press install the hub.

NOTE

The oil seal must be lubricated as the main shaft is installed from the reservoir side of the seal.

b. Using a suitable tool, install the new oil seal into the winch gear housing. Install the new nylon thrust washer and align the two holes. Apply Loctite 262 on the threads of the countersunk screws, install the screws and torque them to 3.95 N.m (35 lbf.in). Apply a smear of grease onto the oil lip.

c. Fit the winch drum shaft and worm wheel assembly to the gear drive housing.

NOTE

Ensure the worm shaft keyed end is installed in the correct position on reassembly.

d. Using a suitable press, install a bearing to the keyed end of the worm shaft ensuring the thrust side of the bearing, when fitted, is towards the keyed end of the shaft.

e. Fit the worm shaft and bearing to the drive housing. Using a suitable press, press the remaining bearing on to the worm shaft ensuring the thrust side of the bearing is facing towards the outside of the housing.

f. Press a new oil seal into the drive shaft end-plate; install the plate and a new gasket.

g. Smear a suitable sealing compound on the threads of the bolts, install the bolts and tighten them securely.

h. Using plastic thrust washers between the worm shaft bearing and drive shaft end plate, adjust the worm shaft end-float until an end-float of zero ± 0.005 mm (0.0002 in) is achieved. Apply Loctite 261 to the end plate screws and tighten the screws securely.

i. Smear oil on the shaft and drum bushes and install the drum on the shaft. Ensure that the two brake pads and springs are located in the winch gear housing and push the drum towards the housing.

NOTE

The collar must be fitted with the machined end towards the keys, and aligned with the machined grooves on the main shaft.

j. Slide the collar along the shaft and fit the two keys on the shaft. Install the dog clutch and check that the keys do not restrict the sliding action of the clutch. Remove the clutch and insert the detent ball and spring in the drilling. Install the clutch on the shaft.

k. Apply Loctite 262 on the threads of the grub screw and the threads in the clutch drilling. Install and tighten the grub screw until the head is flush with the outer face of the clutch.

l. Check the operation of the clutch over the keys. If necessary, change the keys until the movement is satisfactory.

m. Install the dog clutch housing and lever ensuring that the selection fork engages the clutch groove.

n. Using a dial indicator on the periphery of the worm wheel, check that the worm to worm wheel clearance does not exceed 1.016 mm (0.040 in). If the clearance is excessive, the worm and wheel must be replaced.

o. Install the gear wheel housing end plate and gasket. Apply a sealing compound to the eight securing screws and torque them to 5.5 N.m (50 lbf.in).

p. Position the rear mounting bracket on the winch gear housing and smear a suitable sealing compound on the retaining bolts. Install the bolts and new washers and torque the bolts to 35 N.m (26 lbf.ft). Repeat the procedure for the fairlead frame installation.

q. Install the winch assembly in accordance with EMEI Vehicle G 204-1 – Group 19.

r. Remove the filler plug from the winch gear housing and fill the housing with approximately 2.1 litres of clean oil. Fit the plug and tighten it securely.

s. Grease the dog clutch operating linkage (three points) with grease.

t. Install the winch rope in accordance with EMEl Vehicle G 203 – Group 19.

134. The winch specifications are detailed in Table 19.

Table 19 Winch Specifications

Serial	Item	Specification
1	Drum shaft bush wear limit (maximum diameter)	38.46 mm (1.514 in)
2	Brake pad minimum thickness	6 mm
3	Drum shaft run-out (maximum)	0.250 mm (0.010 in)
4	Winch drum distortion (maximum)	0.500 mm (0.020 in)
5	Thrust washer wear limit (minimum thickness)	11.50 mm (0.453 in)
6	Wheel to shaft tightening torque (oiled)	40 N.m (30 lbf.ft)
7	Thrust bearing screws tightening torque	3.95 N.m (35 lbf.in)
8	Winch mountings tightening torque	35 N.m (26 lbf.ft)
9	Worm wheel to worm gear clearance (maximum)	
10	Standard	0.120 to 0.170 mm (0.005 to 0.007in)
11	Wear limit	1.016 mm (0.040 in)
12	Worm shaft end-float	0.005 mm (0.002 in)
13	Gear wheel housing end plate screws tightening torque	5.5 N.m (50 lbf.in)

END

Distribution List: **VEH G 20.0 – Code 2** (Maint Level)
(Sponsor: CGSVSPO, Light B Vehicles)
(Authority: EC-006639)