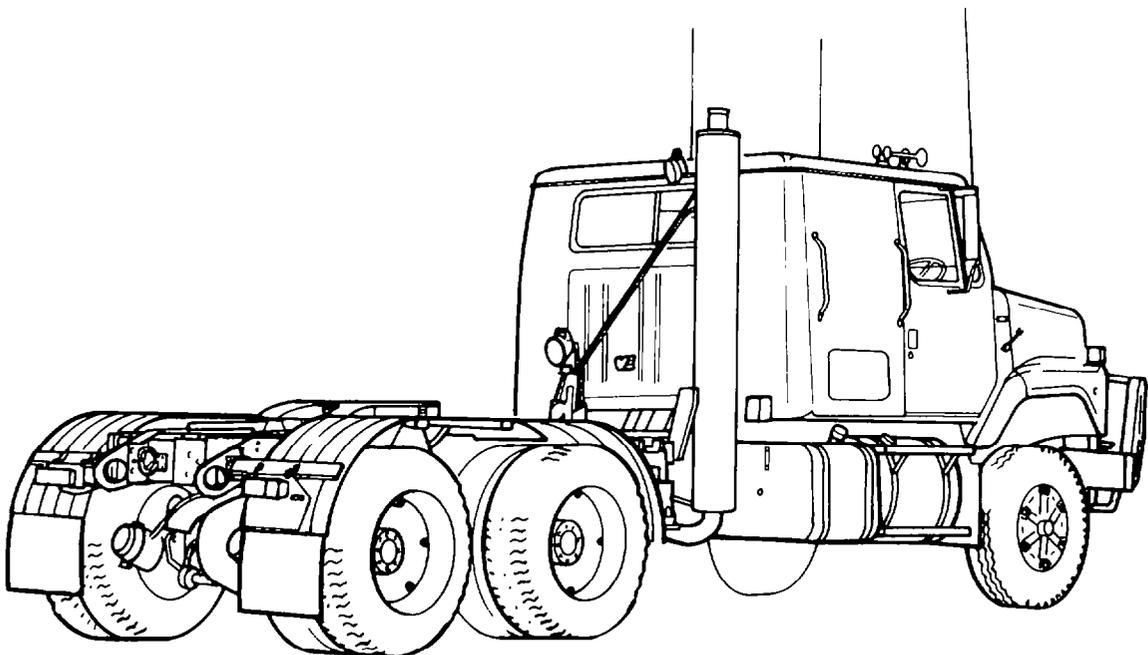
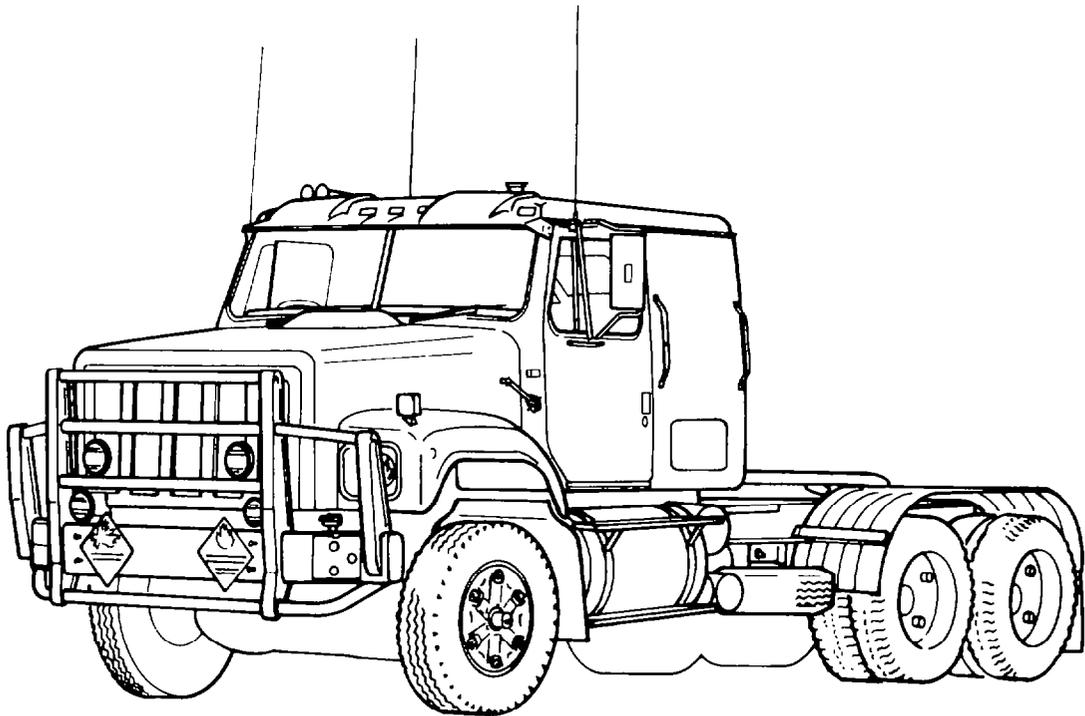


TRUCK, TRACTOR, HEAVY, MC4—
INTERNATIONAL SF2670 W/INTEGRAL SLEEPER

BASE REPAIR



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ASSOCIATED PUBLICATIONS

1. Standing Orders for Vehicle Operation and Servicing (Vol. 2 — B Vehicles)
2. Australian Army Books:
TGM 120 Record Book for Service Equipment — Army
3. Complete Equipment Schedules (CES):
 - (a) SCES 12074
 - (b) Equipment Kit SCES 12075 } Truck, Tractor, Heavy, MC4
4. EMEI VEH A119-24 — Repair of Vehicles Under Warranty Agreement — Policy Instruction
 - (a) Truck, Tractor, Heavy, MC4, International SF2670 W/Integral Sleeper
 - (b) Semi-trailer, Tank/Plant Transporter, MC4, Drake Expandable T2
 - (c) Semi-trailer, Cargo, 12.5 Metre, Heavy, MC4, Fruehauf Hefty Platform
 - (d) Semi-trailer, Tank, Water, Heavy, MC4, Fruehauf TAG 37 000 Litre
 - (e) Dolly, Semi-trailer, Converter, Heavy, MC4, Fruehauf EY-F2
5. EMEI VEH G 880 — Data Summary
6. EMEI VEH G 882 — Technical Description
7. EMEI VEH G 883 — Unit Repair
8. EMEI VEH G 884 — Field Repair
9. EMEI VEH G 889 — Servicing Instruction
10. Australian Change in War Materiel 31281
11. Repair Parts Scale 02197

MAINTENANCE SUPPLY ITEM (MSI) IDENTIFICATION

**Table 1 — Location of Identification Numbers on
Maintenance Supply Items**

Chassis — Left hand side of the chassis, forward of the
front axle

Engine — Left hand side of the engine block

Transmission — Above the output flange

Front Axle — Front centre of the axle

Rear Axle Bogie — Rear mounting flange, right hand side

Fifth Wheel — Front edge of the turntable

SPECIAL TOOLS

Many of the procedures described in this EMEI require the use of special tools, jigs or fixtures. The special tools are listed in Table 2 and illustrated in Fig. 1

Table 2 — Special Tools

Part No./Item Name	Para No.	Use
ST-448	1, 9	Valve spring compressor
ST-1179	3, 7	Injector sleeve holding tool
ST-1013	3	Water tester adapter plate
ST-1016	3	Adapter plate clamps
ST-1188	Table 4	Valve guide reamer
ST-1187	Table 4	Valve guide reamer
3375282	5	Valve guide driver
3376464	5	Valve guide reamer
ST-1124	6	Valve seat insert staking tool pilot
ST-1122	6	Valve seat insert staking tool driver
ST-663	6	Valve guide arbor set
ST-685-4	6	Eccentrimeter
ST-1244	7	Injector sleeve puller
ST-1227	7	Injector sleeve driver
ST-880	7	Injector sleeve expander
3376220	7, 11, 13	Gauge block
ST-884	7	Cutting tool
ST-1134	8, 18	Dowel pin extractor
ST-633	8	Crosshead guide spacer
3375594	10	Engine adapter plate
3375268	10, 14	Camshaft pilot
ST-1178	10	Main bearing cap remover
3376669	11, 13	Cylinder liner clamp
ST-560	11	Piston ring groove gauge
3375629	12	Cylinder liner remover
3377057	12	Puller plate (foot)
3376684	12, 13	Cylinder block counterbore tool
ST-1229	13	Cylinder liner driver
3375265	15	Water pump impeller puller
ST-1114	15	Bearing disassembly fixture
ST-658	17	Water pump bearing mandrel
3376091	17	Water pump seal mandrel
3375133	18	Fuel pump mounting bracket
ST-302	18, 39, 63	Ball joint vice
ST-709	18	Puller
3375599	18	AFC barrel puller
3376136	19	Barrel lock pin driver
ST-490	19	Drive shaft reaming fixture
3375148	20	AFC needle valve O-ring tool
3377449	20	Gear pump pressure valve tool
ST-419	20	Oil seal sleeve
ST-1241	20	Plunger protrusion tool
3375189	21	Fuel pump adjustment tool kit
3375014	21	Filter adapter
3375981	21	Idle adjustment tool
3375855	21	Throttle travel gauge
3375102	22, 25	Injector body wrench
3375166	22, 32	Wrench

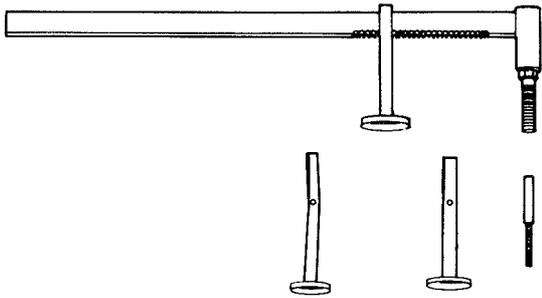
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Table 2 — Special Tools (Cont'd)

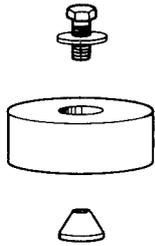
Part No./Item Name	Para No.	Use
ST-995	22, 25	Adapter nut
ST-1072	22, 25, 30, 32	Wrench
*Brass punch A	22	Injector cup removal
3376665	23	Ultrasonic cleaner
3375375	24, 27	Leakage tester
3376297	24	Testing fixture
3376350	24	Spray tester
3375317	24, 31	Injector test stand
STD PTD	24	Cup adapter
3376682	24	O-ring
ST-1298	25	Injector assembly stand
3375209	26	Plunger checking tool
3375395	27	Adapter pot
3822765	27, 28	Plunger extension
3375689	27	Injector link
3822696	30, 32	Top stop setting fixture
3822726	30, 32	Holding bracket
205462	30	Injector plunger link
3376170	31	Injector test stand cam
3375644	31	Injector pot adapter
3375488	31	Injector link
3376177	31	Injector orifice torque wrench
ST-1332	31	Injector orifice plug gauge
3376979	31	Burnishing tool
ST-708-1	31	Burnishing tool TIP
3052233	32	K-STC plunger link
ST-750	39	Mounting plate
*	42, 44	Clutch disassembly
*Support	47	Front countershaft support
*Support	47	Rear countershaft support
J-23667	47	Alignment tool
J-4550	59, 62	Pinion setting gauge
M14580	57, 59, 60, 62	Yoke removal tool
M14587	59, 62	Yoke installation tool
ST-749	63	Compressor mounting plate
3376663	63	Spline coupling puller
ST-1105	64	Bush mandrel
*Peg Spanner A	67, 69, 71, 73	Removing piston plug
*Peg Spanner B	67, 69	Removing bearing nut
TLN-1500	78	Lock tester
SE-2392-4	89, 90	Clutch spanner
SE-2392-5	89	Remover bolt
SE-2392-1	89	Seal removal tool
SE-2392-2	90	Seal installation tool

* To be manufactured

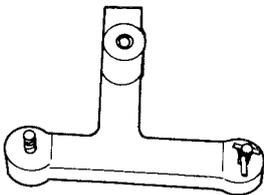
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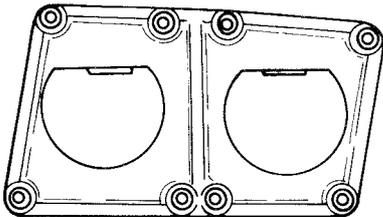
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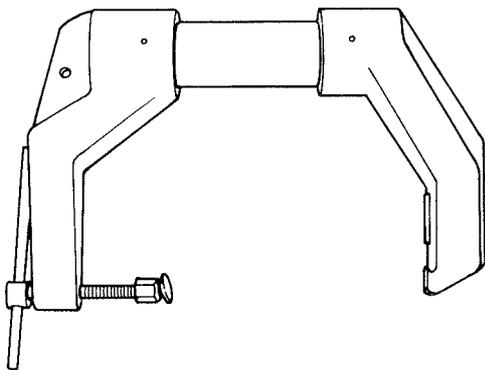
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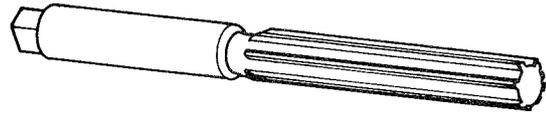
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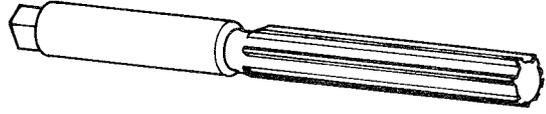
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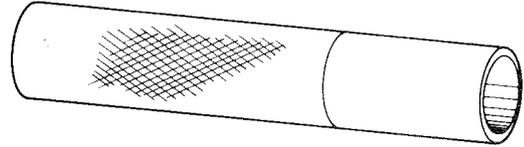
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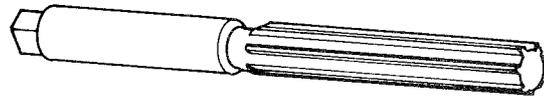
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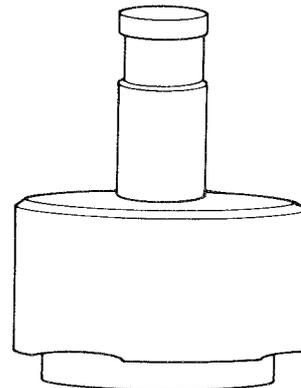
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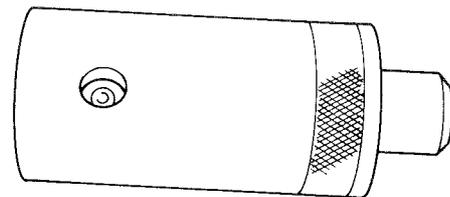
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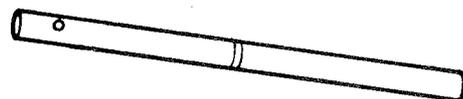
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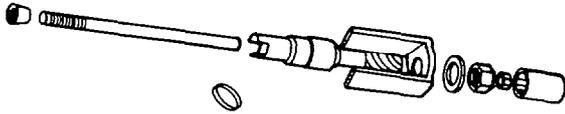
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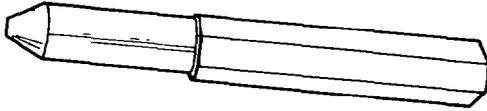
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Figure 1 — Special Tools — Continued

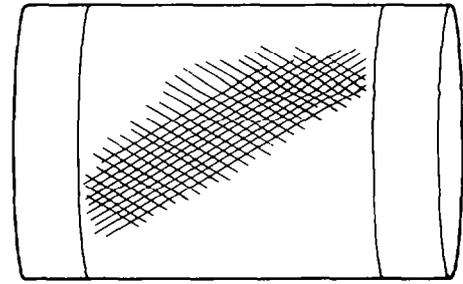
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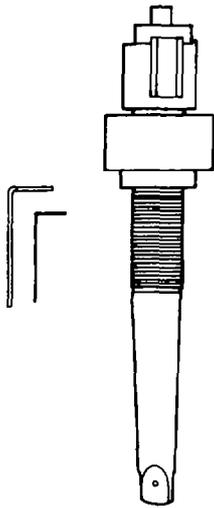
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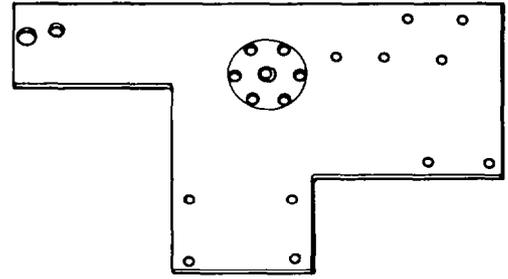
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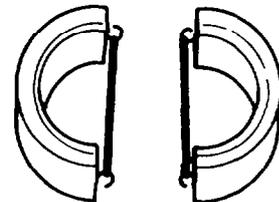
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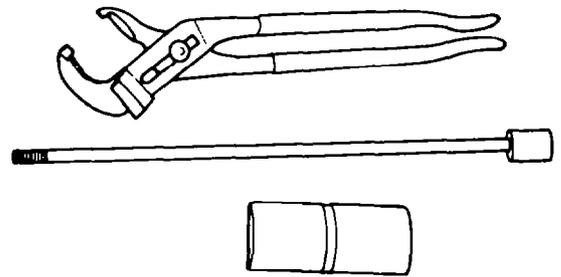
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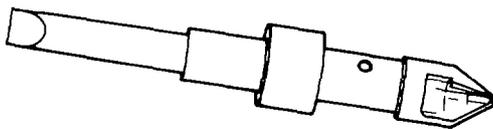
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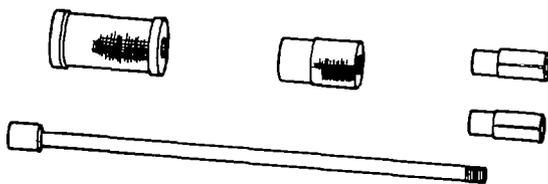
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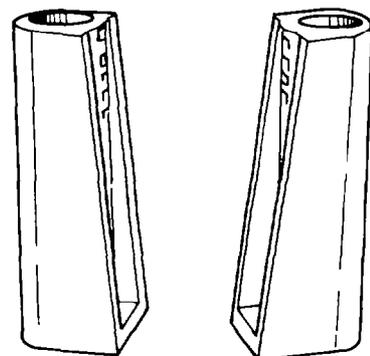
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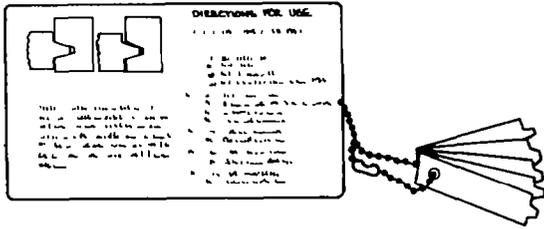
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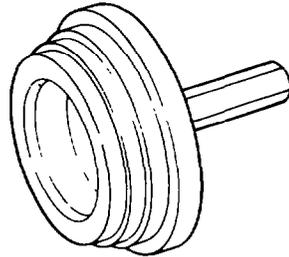
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Figure 1 — Special Tools — Continued

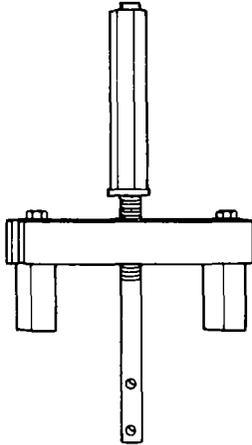
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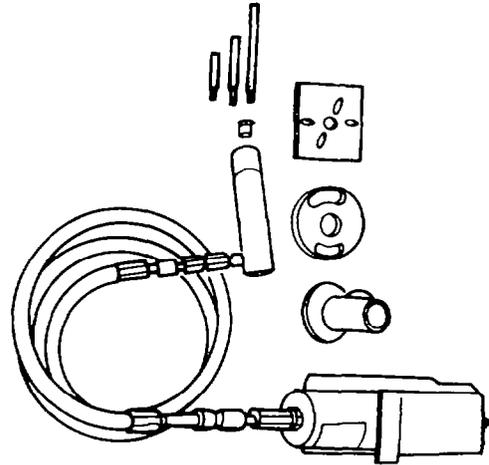
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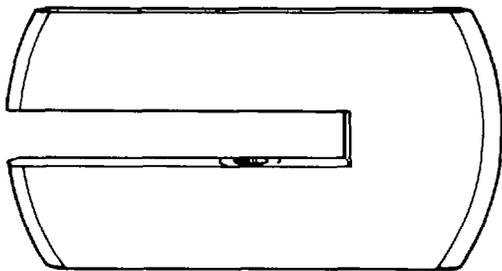
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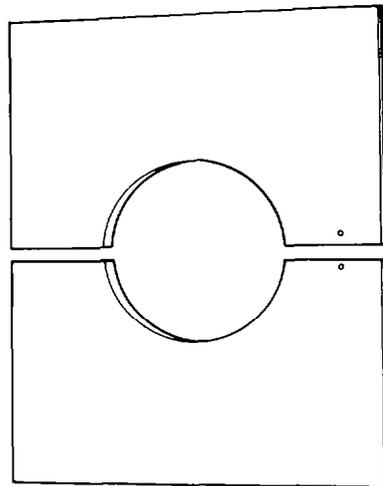
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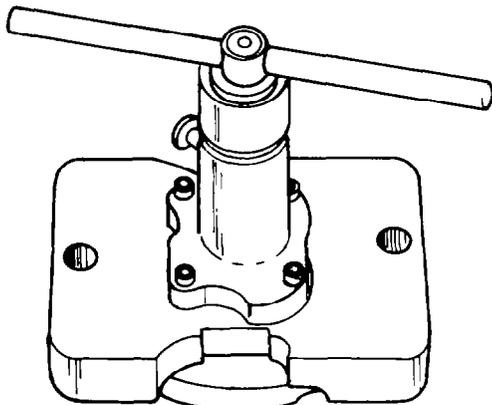
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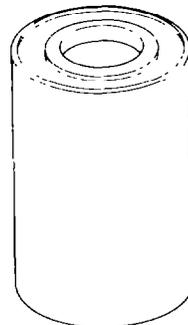
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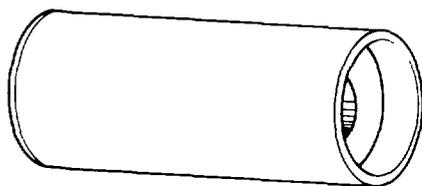
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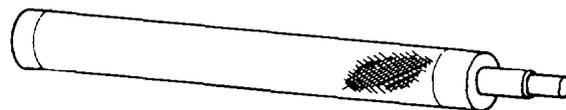
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Figure 1 — Special Tools — Continued

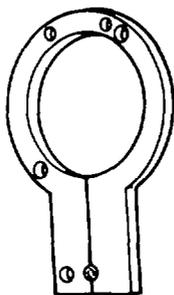
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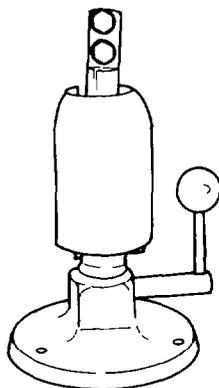
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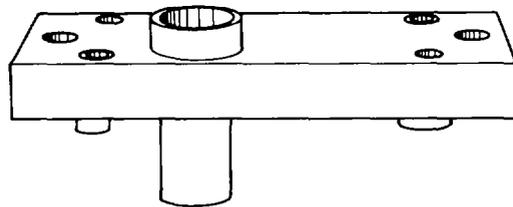
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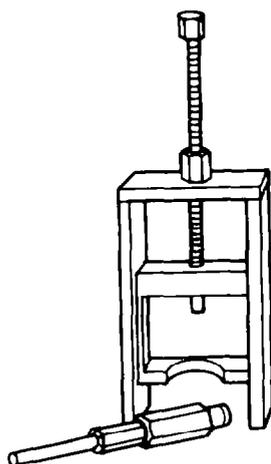
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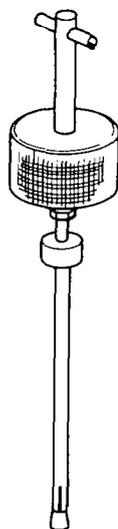
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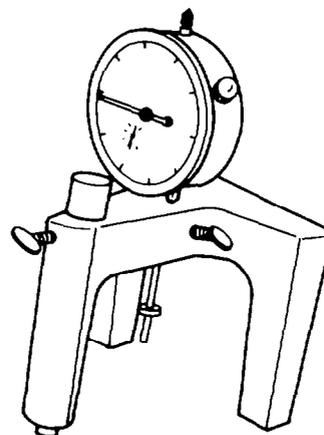
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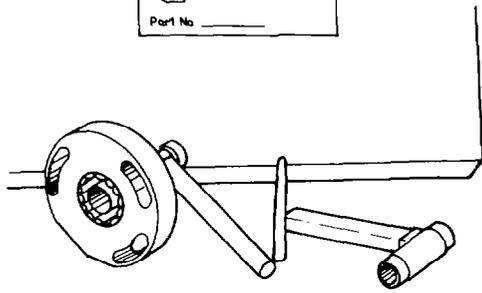
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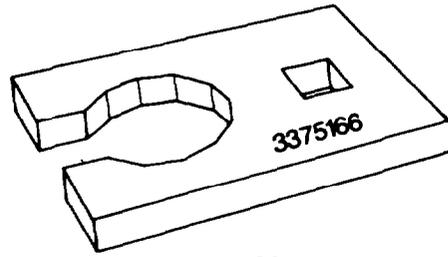
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Figure 1 — Special Tools — Continued

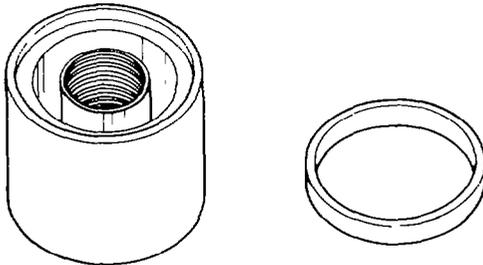
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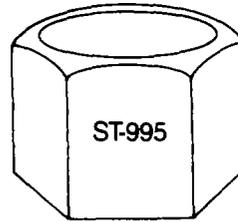
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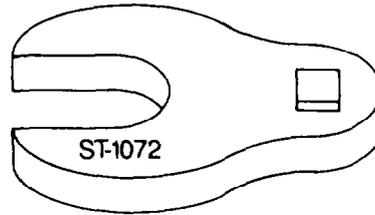
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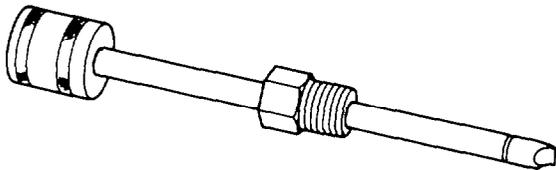
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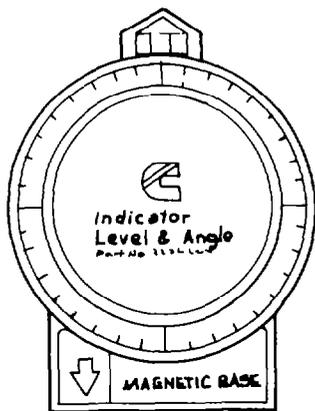
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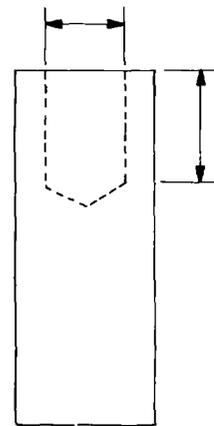
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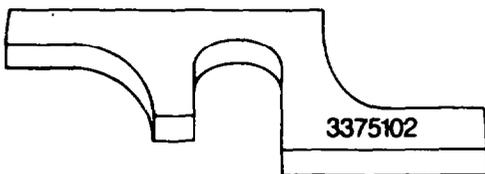
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3375855



*Brass punch A



3375102



3376665

Figure 1 — Special Tools — Continued

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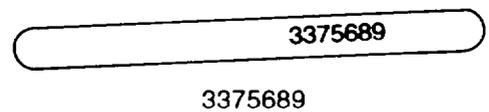
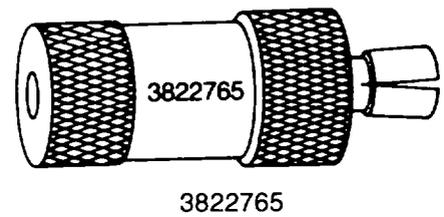
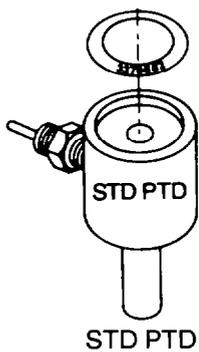
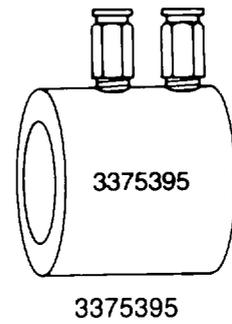
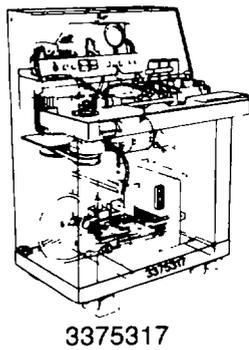
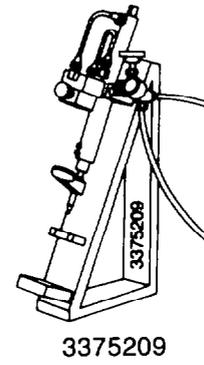
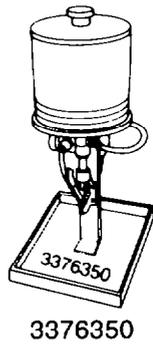
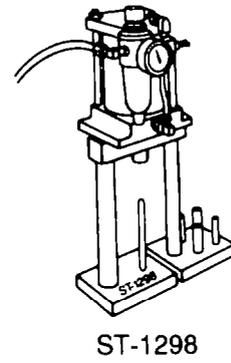
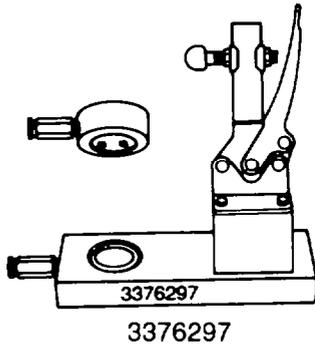
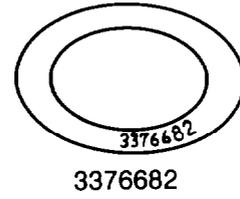
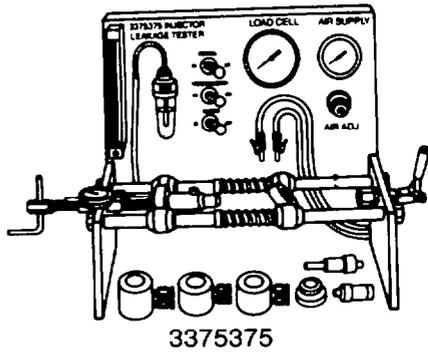
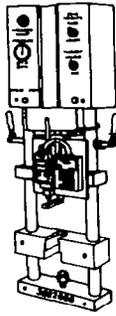


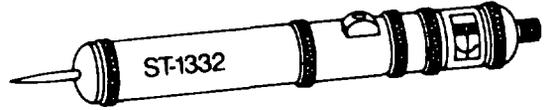
Figure 1 — Special Tools — Continued

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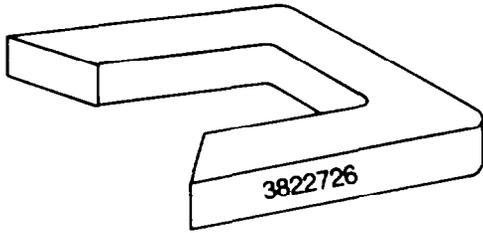
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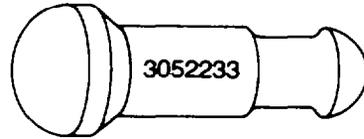
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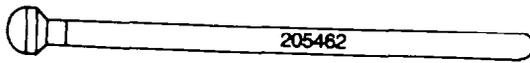
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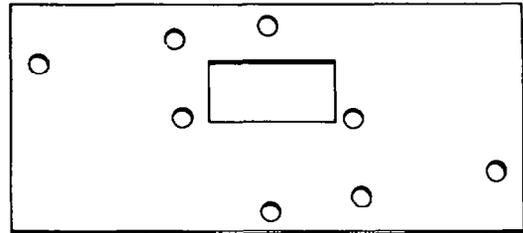
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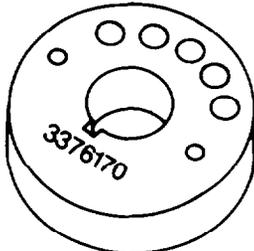
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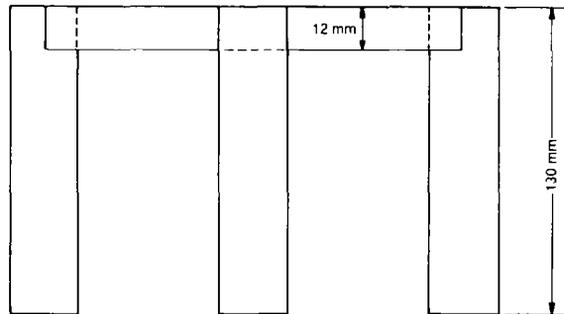
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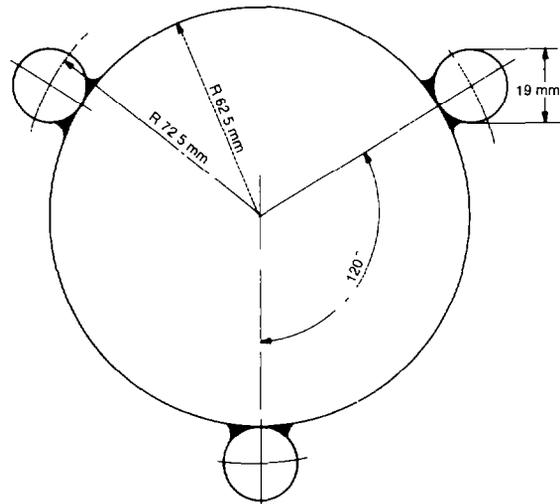
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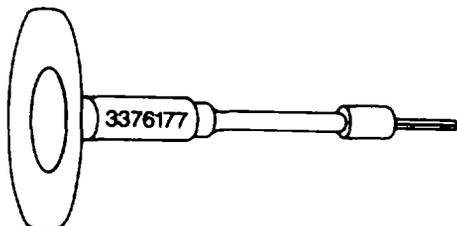
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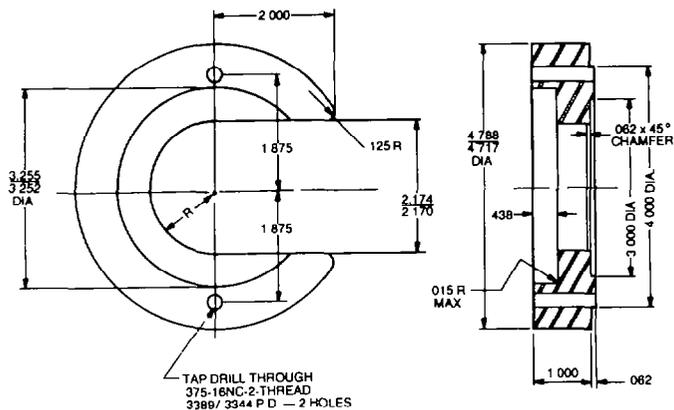


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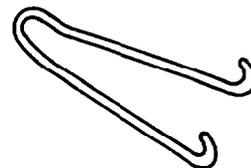


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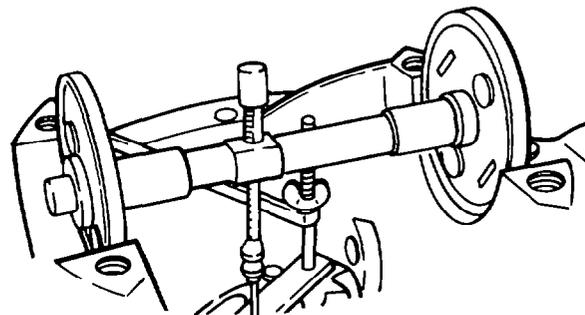
Figure 1 — Special Tools — Continued



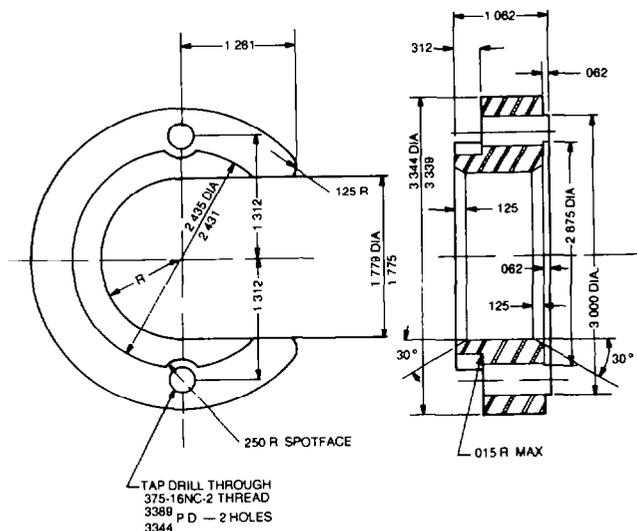
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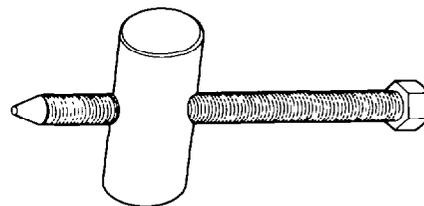
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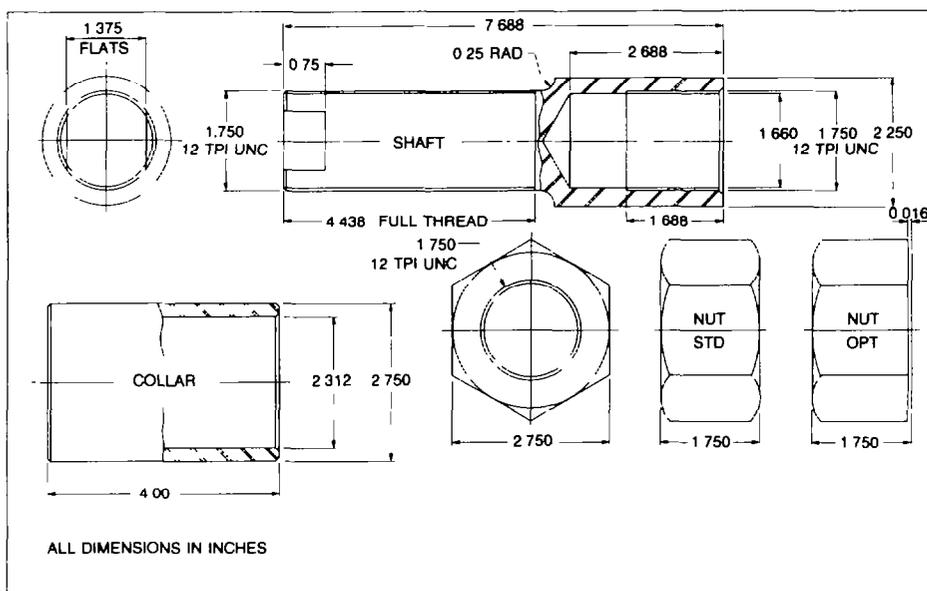
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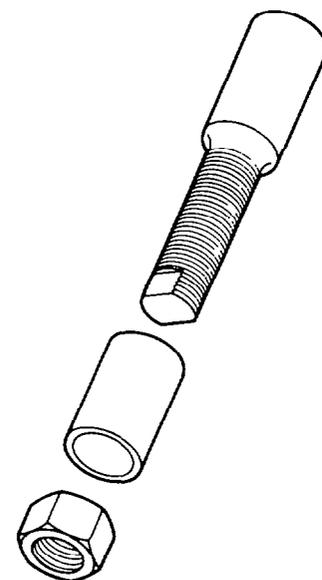
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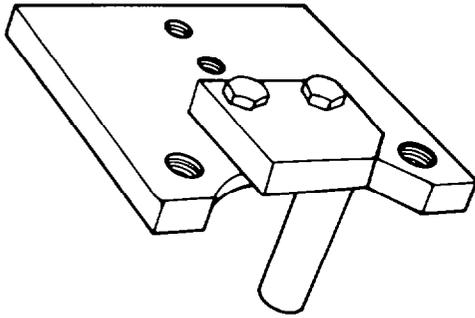
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Figure 1 — Special Tools — Continued

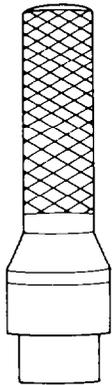
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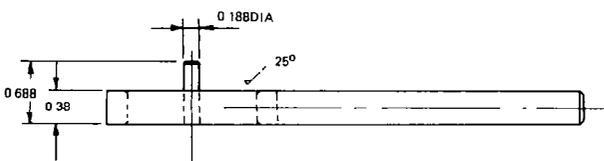
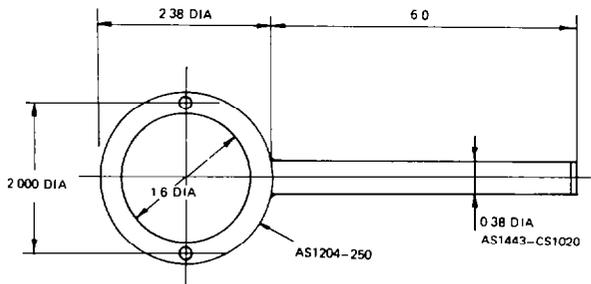
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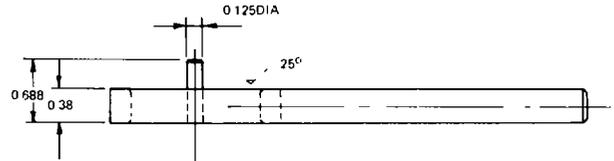
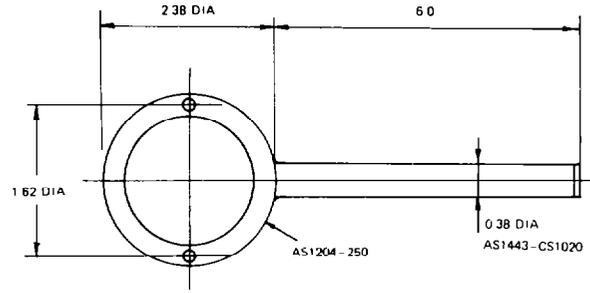


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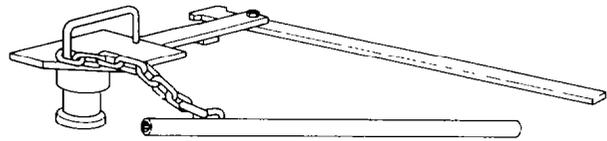
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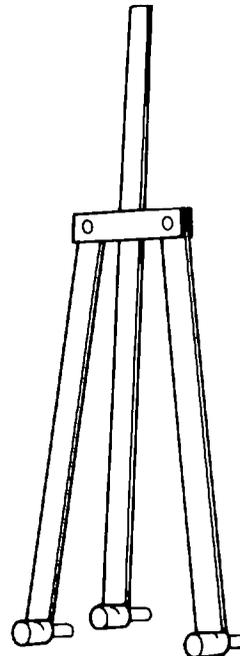


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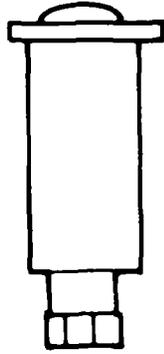
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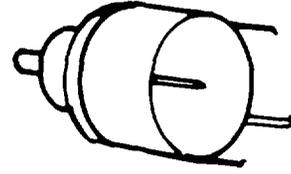
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Figure 1 — Special Tools — Continued

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Figure 1 — Special Tools — Continued

LIST OF LUBRICANTS

Table 3 — List of Lubricants

Equipment	Lubricant	Capacity (Litres)
Engine (including filters)	OMD-115	41
Transmission	OMD-115	14.2
Intermediate Differential	OEP-600	16
Rear Differential	OEP-600	13
Steering Box Input Shaft	XG-274	As required
Power Steering Reservoir	SAE 15W/40 (class CC/CD)	5
Front Wheel Hub	OEP-600	0.375
Radiator Inhibitor	DCA4	Cartridge
Radiator Antifreeze	Ethylene Glycol	9.2 (20% by volume)
Propeller Shaft	XG-276	As required
Hydraulic Reservoir	Hydraulic Fluid 68	227
Air Compressor	SUNISO No. 5 GS	As per dipstick
Refrigerant	FREON R12	1.83 kg (4 lb.)
Fifth Wheel	XG-274	As required

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TRUCK TRACTOR, HEAVY, MC4 — INTERNATIONAL SF2670 W/INTEGRAL SLEEPER

BASE REPAIR

INTRODUCTION

1. This EMEI contains procedures for removing, dismantling, repairing, assembling and installing various components of the truck, tractor, heavy, MC4 (see Fig. 2). Where applicable, instructions for the adjustment, lubrication and minor servicing of these items are included. This EMEI should be read in conjunction with EMEI VEH G 883 and EMEI VEH G 884.

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.

3. When disconnecting electrical connectors or 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 truck.

5. Use only those fuels and lubricants specified in the Servicing Instruction, EMEI VEH G 889 and the User Handbook when replenishing fuel or lubricants.

6. Any fastenings or fitting 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 Ethylene Glycol Antifreeze at a concentration of four parts water to one part Ethylene Glycol in addition to the additives from the coolant conditioner cartridge. When there is a need to drain the cooling system, use a suitable receptacle to collect the coolant mixture being drained. This will facilitate its reuse later and also eliminates the need to renew the conditioner cartridge out of the scheduled service period. Before reusing the coolant mixture, check and if necessary adjust the mixture concentration in accordance with the manufacturer's instructions.

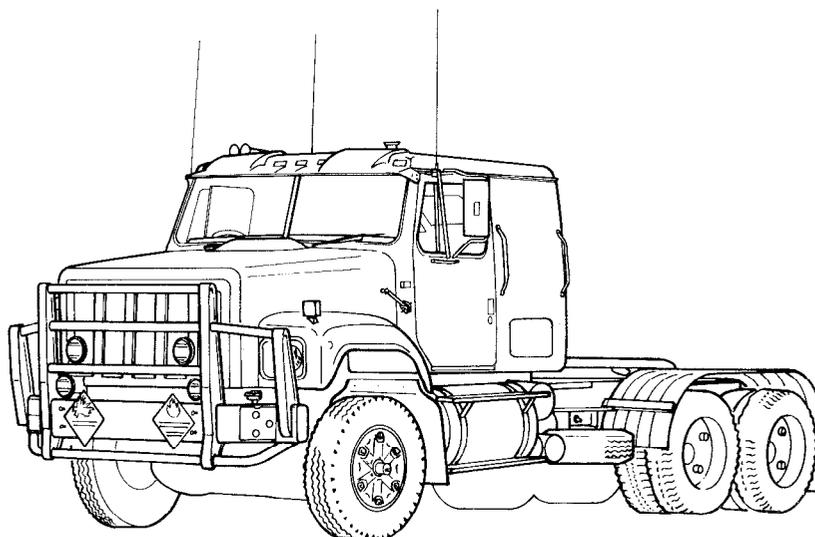


Figure 2 — Truck, Tractor, Heavy, MC4

ENGINE — GROUP 1

Cylinder Head Overhaul

1. Disassembly

- a. Clean the cylinder head and surrounding engine area using a suitable cleaning agent then blow dry with compressed air.
- b. Remove the fuel injector assembly (refer to EMEI VEH G 884 — GROUP 4).
- c. Remove the fuel crossover passage end plates from cylinder heads one and three, then discard the O-rings.
- d. Remove the cylinder head assembly (refer to EMEI VEH G 884 — GROUP 1).
- e. Install special tool ST-448 over the valve springs, and compress the valve spring and retainer, then remove and discard the valve collets, using a small magnet if necessary. Remove the valve spring compressor, then remove the spring retainer, valve spring, valve spring wear plate and valve. Mark the cylinder and location on each part after removal. Repeat the procedure for the remaining valves.

2. Cleaning and Inspection

- a. Clean the cylinder head assembly using a suitable cleaning agent and blow dry with compressed air.
- b. Clean all trace of gasket material from the cylinder head gasket mating surface using a suitable scraper tool, then polish the surface using an orbital sander with 80 grit emery cloth.
- c. Clean the combustion chambers with 80 grit emery cloth, and inspect the area for cracks, particularly between the valve and injector or adjacent valve apertures. Discard any cracked cylinder head.
- d. Check the cylinder head for distortion using a straight edge and feeler gauge (see Fig. 3), then measure the thickness of the cylinder head for parallel in several locations using a micrometer. If the distortion or out of parallel exceeds 0.076 mm (0.003 in.) the cylinder head will require machining. The standard cylinder head thickness is 111.00-111.25 mm (4.37-4.38 in.), the head may be machined to a minimum thickness of 110.24 mm (4.34 in.) if necessary. Discard any cylinder head that cannot be machined within specification.

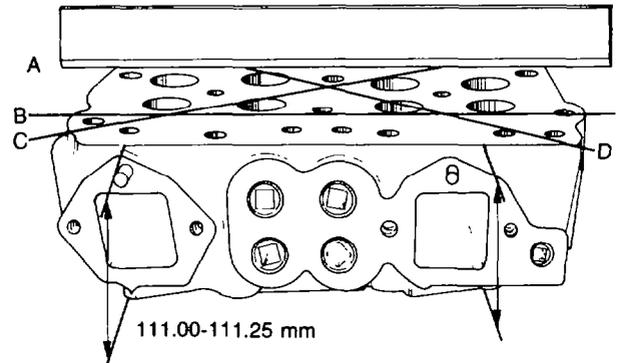


Figure 3 — Checking Cylinder Head Distortion

- e. Check the expansion plugs and replace as required (refer to EMEI VEH G 884 — GROUP 1).
- f. Check the condition of the threaded holes and dress all the threads using the appropriate size taps.
- g. Inspect the surface of the cylinder head around the water jacket holes for scratches, cracks or corrosion deeper than 0.076 mm (0.003 in.). There must not be any defect extending more than 2.38 mm (0.093 in.) from the edge of the water hole, repair any damaged water jacket holes as required.
- h. Inspect the intake and exhaust ports for damage and replace the cylinder head as required.
- i. Measure the crosshead guides in several places using a suitable micrometer, the diameter of the crosshead guide should be 11.011-10.970 mm (0.4335-0.4320 in.). Check that the crosshead guide is perpendicular to the cylinder head surface and straight, using a suitable square, then measure and check the height the crosshead guide projects from the cylinder head is 47.24-47.75 mm (1.86 - 1.88 in.). Replace any crosshead guide as required (refer to para. 8).
- j. Inspect the valve seat inserts for damaged or burnt areas then measure the valve seat width. Where the seat width is greater than 3.18 mm (0.125 in.) and cannot be cut narrower, it is unserviceable. Replace any valve seat insert found to be damaged or out of specification, as necessary (refer to para. 6).

- k. Measure the valve guide I.D. using a suitable bore gauge, the guide I.D. should be 11.494-11.560 mm (0.4525-0.4550 in.), check the valve guide I.D. at four points spaced 90° apart, over the full length of the guide, for out of round and taper. Remove and discard any damaged or out of specification valve guide (refer to para. 5).

NOTE

The valve spring specifications are identical for the inlet and exhaust valve springs.

- l. Compress the valve springs using a suitable valve spring tester to the working length of 43.79 mm (1.724 in.), then check that the force required to completely compress the spring is 655-724 N (147.25-162.75 lb.). Check that the valve spring is not cracked or damaged and replace any damaged or out of specification valve springs as necessary.
- m. Inspect the valves for cracked or burnt heads, then measure the O.D. of the valve stem using a suitable micrometer, the valve stem O.D. should be 11.46 - 11.41 mm (0.451-0.449 in.). Check the valve collet grooves for wear, new valve

collets must fit securely in the collet grooves.

3. Pressure Testing

- a. Install special tool ST-1179 into the injector sleeve, then tighten the injector sleeve holding tool retaining bolt.
- b. Install suitable new O-rings to the upper and lower plates of special tool ST-1013 to seal the water jacket holes. Place the cylinder head onto the lower plate of special tool ST-1013, ensure the locating pins engage in the water jacket holes, then position the upper plate over the water manifold holes, and secure the plates in position using special tool ST-1016 (see Fig. 4).

WARNING
When filling the cylinder head with hot water, use care to avoid personal injury.

- c. Fill the cylinder head with hot water 82-92°C (180-198°F) through the connector on the upper plate, and open the drain tap to expell the displaced air. When the cylinder head is full of water close the drain tap and disconnect the water supply from the connector.

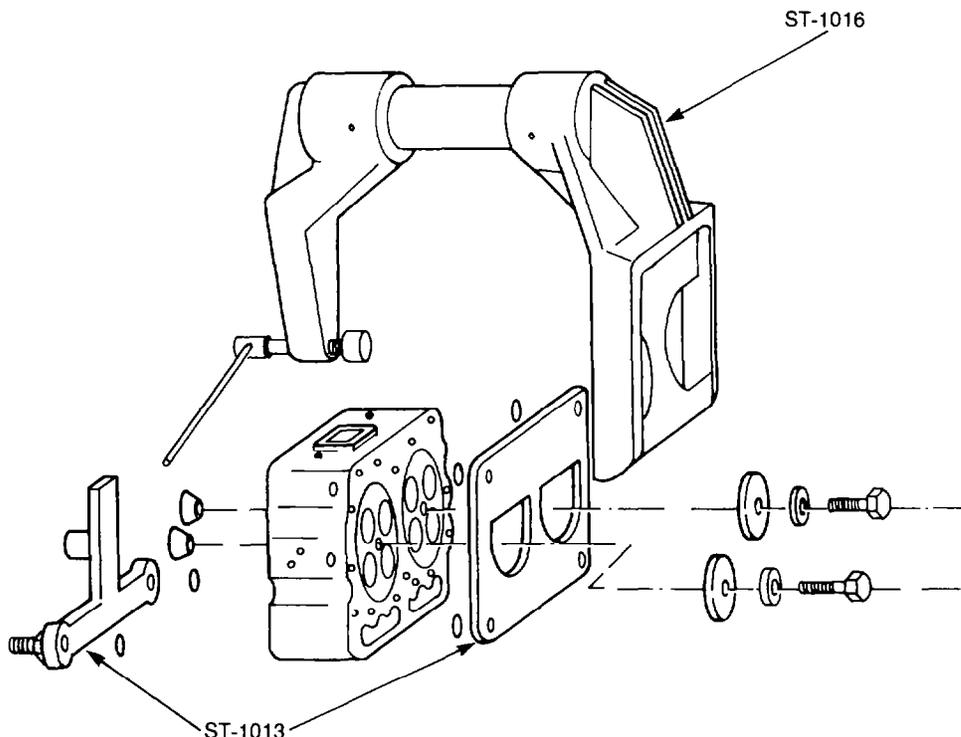


Figure 4 — Cylinder Head — Pressure Testing

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- d. Apply a 240-586 kPa (35-85 psi) regulated air supply to the upper plate connector.
 - e. Check the cylinder head for cracks, indicated by leaks, around the valve seats, combustion chambers and between the cylinder head and injector sleeve.
 - f. Replace the cylinder head where leaks are found in any area other than the injector sleeve. Replace the injector sleeve as required (refer to para. 7).
 - g. Disconnect the air supply from the connector, open the drain tap and drain the water from the cylinder head, loosen the retaining clamp on special tool ST-1016 then remove the cylinder head and special tools ST-1013 and ST-1179.
- 4. Machining the Cylinder Head**
- a. Remove and discard the injector sleeves (refer to para. 7).
 - b. Remove and discard the valve seat inserts (refer to para. 6).
 - c. Remove and discard the valve guides (refer to para. 5).
 - d. Remove and discard the valve crosshead guides (refer to para. 8).
 - e. Remove any burrs protruding from either cylinder head surface, using a suitable file.
 - f. Machine the cylinder head as necessary to obtain true and parallel surfaces. Do not machine the cylinder head below a height of 110.24 mm (4.340 in.). Clean all debris from the cylinder head using a suitable cleaning agent, then blow the cylinder head, oil and water galleries dry with compressed air.
 - g. Install new valve crosshead guides (refer to para. 8).
 - h. Install new valve guides (refer to para. 5).
 - i. Install new valve seat inserts (refer to para. 6).
 - j. Install new injector sleeves (refer to para. 7).
 - k. Install the valves (refer to para. 9).
 - l. Pressure test the cylinder head (refer to para. 3).
 - m. Install the cylinder head on the vehicle (refer to EMEI VEH G 884 — GROUP 1).
- 5. Valve Guide Replacement**
- a. Support the cylinder head, with the combustion chambers facing upward, on two suitable blocks of wood, then position a suitable drift into the valve aperture and locate the drift over the valve guide.
 - b. Drive the valve guide from the cylinder head using a suitable hammer and mandrel, then discard the valve guide.
 - c. Where the bore for the valve guide is damaged, select the next suitable over-size valve guide (see Table 4).
 - d. Ream the valve guide bore as necessary, using a suitable light oil to lubricate the ream while cutting and ensure the cuts are the entire length of the guide bore, then remove any sharp edges, with an oil stone.
 - e. Lubricate the valve guide bore with clean engine oil, install the valve guide into the cylinder head. Using special tool, mandrel 3375282 drive the valve guide in approximately 3 mm (0.125 in.) using a suitable hammer, then remove the special tool and check the valve guide is positioned squarely, correct the valve guide if necessary. Position the mandrel back over the valve guide and drive the valve guide into the bore until the mandrel bottoms on the cylinder head.
 - f. Repeat the procedure to install the remaining valve guides.

Table 4 — Valve Guide Dimensions

Valve Guide OD Details	Ream Size	Ream Part No.	Guide Part No.
Standard size	N/A	N/A	3050369
Oversize = 0.26 mm (0.010 in.)	19.30-19.33 mm (0.760-0.761 in.)	ST-1188	30066457
Oversize = 0.40 mm (0.015 in.)	19.43-19.46 mm (0.765-0.766 in.)	ST-1187	3006458

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- g. Use a new valve to check the inside diameter of the valve guide, where the valve fails to move smoothly, withdraw the valve and ream the valve guide using special tool 3376464 and a suitable light oil to lubricate the cutting action.
6. Valve Seat Insert Replacement
- a. To extract the valve seat inserts, apply a liberal coat of a suitable silicone based anti-splatter compound to the cylinder head and valve throats, then run a bead of weld around the angle of the valve seat insert, using an arc welder. This will cause the valve seat to shrink as the weld material cools, and relieve the interference fit, allowing easy removal of the valve seat inserts.
- b. Inspect the valve seat insert to determine its size (ie: standard or the dimension of oversize), then choose a valve seat insert of the next available oversize (see Table 5).
- c. Cut the valve seat insert counterbore to the appropriate diameter and depth to suit the new valve seat insert.
- d. Clean all debris and dirt from the valve seat insert counterbore, and position the new valve seat insert, with the chamfer against the cylinder head, in the counterbore, then install the valve seat insert driver and strike the driver using a large hammer until the insert is seated in the cylinder head counterbore.
- e. Stake the valve seat using special tools ST-1124 and ST-1122.
- f. Repeat the procedure to replace all the damaged or loose valve seat inserts in the cylinder head.
- g. Select and install a suitable arbor from special tool ST-663 into the valve guide, then position the eccentricmeter special tool ST-685-4. Check the alignment of the valve seat insert and the valve guide is within 0.05 mm (0.002 in.) per 360 deg. Remove the eccentricmeter from the arbor and replace the valve seat insert as necessary.
- h. Select a grinding wheel of suitable diameter and grinding angle (see Fig. 5). Grind the seat to the required angles and the seat area to 1.59-3.18 mm (0.063-0.125 in.) width using an up and down movement.

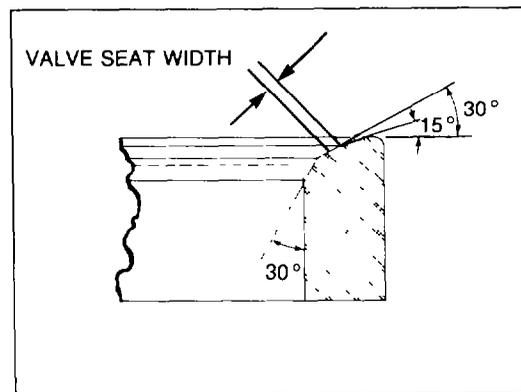


Figure 5 — Valve Seat Width

Table 5 — Valve Seat Insert — Oversize

Valve Seat Insert Service Part No.	Oversize Diameter mm (in.)	Oversize Depth mm (In.)	Insert OD min. mm (in.)	Cylinder Head ID max. mm (In.)	Insert Thickness max. mm (In.)
200354 (exhaust) 3017759 (inlet)	STD.	STD.	N/A	N/A	N/A
127931	0.25 (0.010)	STD.	51.118 (2.0125)	51.067 (2.0105)	7.16 (0.282)
127932	0.50 (0.020)	0.13 (0.005)	51.372 (2.0225)	51.321 (2.0205)	7.29 (0.287)
127933	0.76 (0.030)	0.25 (0.010)	51.626 (2.0325)	51.575 (2.0305)	7.42 (0.292)
127934	1.02 (0.040)	0.38 (0.0157)	51.880 (2.0425)	51.829 (2.0405)	7.54 (0.297)

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- i. Check the alignment of the valve seat insert and the valve seat (see para. g).
- j. Clean the cylinder head using a suitable cleaning agent and a bristle brush, then blow dry with compressed air.
- k. Install the valves (refer to para. 9).

CAUTION

Do not torque the small nut on special ST-1244 greater than 81 Nm (60 lb.ft) or damage may occur to the fuel injector sleeve, causing difficulties in removal.

Fuel Injector Sleeve

7. Replacement

- a. Remove the fuel injector sleeve from the cylinder head using special tool ST-1244. Screw the extractor tip approximately 10 mm onto the rod, then install the rod into the fuel injector sleeve until the extractor tip is seated against the injector sleeve.
- b. Position the support bridge over the upper surface of the cylinder head (see Fig. 6) and install the forming collar. Screw the small (9/16 in. UNC) nut onto the support bridge end of the rod, finger tight, then place the flat washer and the large (1 in. UNC) nut on the forming collar. Install the driver on top of the large nut and firmly strike the driver with a suitable hammer, to push the forming collar into the injector sleeve.

- c. Remove the driver and torque the small nut to 68-80 Nm (50-60 lb.ft), then turn the large nut clockwise using an air wrench or socket spanner to withdraw the fuel injector sleeve from the cylinder head.
- d. Remove and discard the O-ring from the fuel injector sleeve aperture in the cylinder head, using a suitable small screwdriver.
- e. Loosen the large and small nuts on special tool ST-1244, then lightly strike the fuel injector sleeve to free it from the forming collar. Turn the fuel injector sleeve 120°, then remove and discard the fuel injector sleeve from the tool.
- f. Clean the cylinder head fuel injector sleeve aperture with a wire chip removing brush, then clean all debris from the aperture using a lint free cloth.
- g. Apply a thin film of clean engine oil to a new fuel injector sleeve O-ring, then install the O-ring into the cylinder head fuel injector sleeve aperture O-ring groove.
- h. Place a new fuel injector sleeve on special tool ST-1227, apply Loctite 601 sealant to the fuel injector sleeve external tip area and a thin film of clean engine oil to the upper outside surfaces, then firmly push the fuel injector sleeve into the cylinder head aperture using hand pressure only.
- i. Withdraw special tool ST-1227 and install special tool ST-1179 to secure the fuel injector sleeve into the cylinder head (see Fig. 7), then torque the bolt to 47-54 Nm (35-40 lb.ft).
- j. Install special tool ST-1227 into the fuel injector sleeve and firmly strike the end of the tool using a suitable large hammer to seat the fuel injector sleeve against the bottom of the cylinder head aperture, then again torque the bolt on special tool ST-1179 to 47-54 Nm (35-40 lb.ft).

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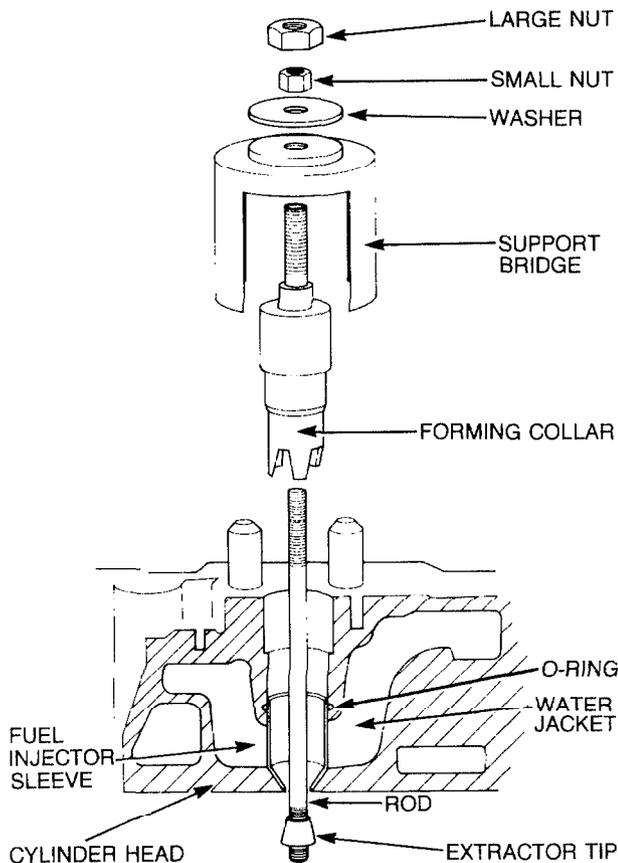


Figure 6 — Fuel Injector Sleeve — Removal

- k. Install special tool ST-880 into the fuel injector sleeve and torque the mandrel to 8.5 Nm (75 in.lb), then remove both tools from the fuel injector sleeve.

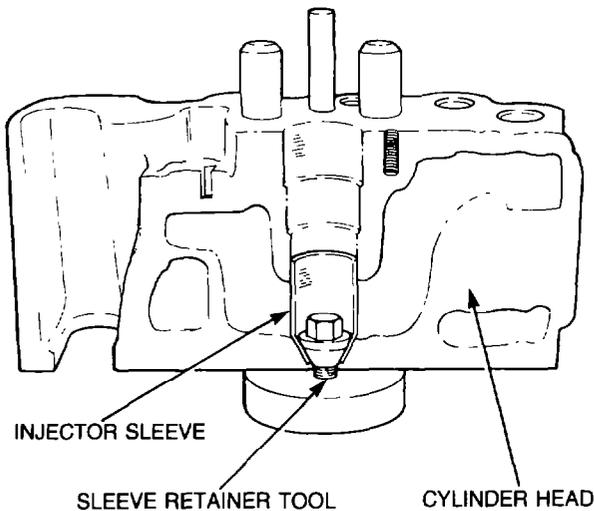


Figure 7 — Fuel Injector Sleeve Retainer — Installation

CAUTION
When expanding the fuel injector sleeve, use care not to damage the fuel injector sleeve O-ring, as damage to the engine may result.

- l. Install the fuel injector into the cylinder head, and torque the retaining clamp bolt to 14-16 Nm (10-12 lb.ft), then matchmark the fuel injector to the cylinder head. Measure and note the fuel injector tip protrusion from the cylinder head deck using special tool 3376220.
- m. The fuel injector tip should protrude 1.52-1.78 mm (0.060-0.070 in.) from the cylinder head deck. Determine the amount of material to be removed from the fuel injector sleeve by subtracting the actual protrusion noted from the specification, then remove the fuel injector.
- n. Secure the cylinder head deck down in a suitable drill press and use special tool ST-884 to cut the predetermined amount from the fuel injector sleeve, use an adequate amount of soluble oil to prevent the tool chattering, as the seat must be finished to a smooth surface.
- o. Remove the cylinder head from the drill press and clean the area of any debris using a suitable cleaning agent, then blow dry with compressed air.

- p. Apply a light coat of bluing compound to the fuel injector cup, then install the fuel injector into the cylinder head and torque the retaining clamp bolt to 14 - 16 Nm (10-12 lb.ft).
- q. Measure the fuel injector tip protrusion from the cylinder head deck using special tool 3376220 correct fuel injector tip protrusion is 1.52-1.78 mm (0.060-0.070 in.).
- r. Remove the fuel injector and inspect the pattern of the bluing compound around the injector cup, the pattern must be greater than 1.52 mm (0.060 in.) wide, smooth and unbroken to indicate a suitable sealing surface (see Fig. 8). Recut the fuel injector sleeve if necessary, but do not exceed fuel injector tip protrusion specification.

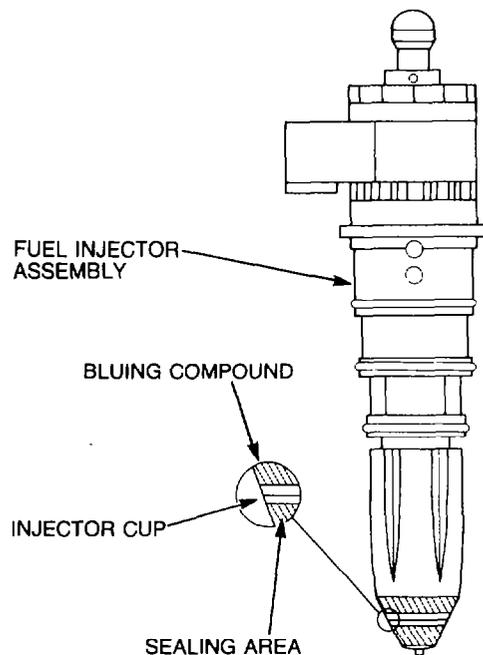


Figure 8 — Fuel Injector Cup — Sealing Surface

- s. Pressure test the cylinder head (refer to para. 3).
- 8. Crosshead Guide Replacement**
- a. Install special tool ST-1134 over the crosshead guide, then extract and discard the guide from the cylinder head, using repeated blows of the slide hammer.
 - b. Check the crosshead guide bore for damage. If the bore is damaged, or the crosshead guide is loose, carefully drill the bore out using a 29/64 in. drill, taking care to cut the bore to the same depth as the original bore. Ream the crosshead guide bore using a 15/32 in.

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reamer and a suitable light oil. When the crosshead guide bore has been reamed, use an oversize crosshead guide Part No. 161527.

- c. Place the crosshead guide into special tool ST-633, then position the guide into the crosshead guide bore, and drive the guide into the cylinder head using a suitable hammer, until the face of ST-633 is against the cylinder head.
- d. Remove special tool ST-633, then check that the assembled height of the crosshead guide is 47.24-47.75 mm (1.86-1.88 in.), and that the guide is perpendicular to the cylinder head. Replace any crosshead guide as necessary.

9. Valve Installation

- a. Clean the valves using a crocus cloth, then inspect all valves for damage or distortion. Measure the valve head rim thickness (see Fig. 9), which must be greater than 3.15 mm (0.124 in.). Discard any damaged or out of specification valves.

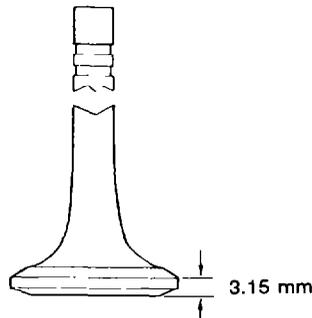


Figure 9 — Valve Head Rim Thickness

- b. Grind the valve faces to 30° from the horizontal position of the valve. However, do not grind any valves to below the valve head rim thickness specification. Replace any valve that cannot be correctly faced within specified tolerances.
- c. Lap the valves using a small amount of a suitable fine lapping compound, and matchmark each valve position to the cylinder head.
- d. Clean the cylinder head and valves using a suitable cleaning agent, clean the valve guides with a 13mm diameter bristle brush, then blow all components dry with compressed air.
- e. Apply a liberal coat of clean engine oil to the valve stems and guides, then install each valve into its respective position.

NOTE

It may be necessary to ream the spring wear plates to clear the valve guides, if oversize valve guides are used.

- f. Install new valve spring wear plates over each valve guide.
- g. Where the valve faces and seats have had greater than 0.76 mm (0.030 in.) of material removed, use spacers Part No. 68803-A under the valve springs.

NOTE

Do not use more than two spacers under each valve spring.

- h. Install the valve springs over the valve guides, then position the valve spring retainers over the valve springs.
- i. Secure special tool ST-448 to the cylinder head, compress the valve springs and install new valve spring collets to the valve stems, then slowly release the tension on the valve spring compressor.

NOTE

Only vacuum test the valve with the fuel injector removed.

- j. Vacuum test the valves to check the seal between the valve and valve seat with suitable vacuum testing equipment. Ensure that the cylinder head is clean and dry, then place the vacuum cup on the cylinder head around the valve. Open the shut-off valve and run the vacuum pump until the vacuum gauge indicates -60 to -85 kPa (18-25 in. Hg) of vacuum, then turn the shut-off valve to the closed position and stop the vacuum pump.
- k. Check the time required for the vacuum gauge to ascend from -60 to -27 kPa (18 to 8 in. Hg). The valve seal is suitable if the ascent take 10 seconds or longer. Rectify any faults found.
- l. Install new O-rings for the fuel crossover passage end plates in cylinder heads number one and three, then install and secure the end plates in position, and torque the retaining screws to 4 Nm (35 lb.in.).
- m. Install the cylinder heads on the engine (refer to EMEI VEH G 884 — GROUP 1).

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Engine Overhaul

10. Disassembly

- a. Clean the engine assembly using a suitable cleaning agent, then blow dry with compressed air.
- b. Apply the parking brake and chock the wheels, then turn the battery isolation switch to the OFF position.
- c. Drain the engine oil into a suitable container, then disconnect and remove the engine assembly (refer to EMEI VEH G 884 — GROUP 1).
- d. Remove the oil cooler assembly (refer to EMEI VEH G 884 — GROUP 1).
- e. Remove the exhaust manifold (refer to EMEI VEH G 883 — GROUP 1).
- f. Remove the alternator assembly (refer to EMEI VEH G 884 — GROUP 1).
- g. Remove the bolts securing the piston cooling nozzles to the cylinder block, then withdraw the cooling nozzles (see Fig. 10), and discard the O-rings.
- h. Remove the dipstick tube and housing (refer to EMEI VEH G 883 — GROUP 1).
- i. Secure the right hand side of the engine to a suitable engine stand, using the adapter plate 3375594 (if required).
- j. Remove the air conditioning compressor drive belt (refer to EMEI VEH G 883 — GROUP 2).
- k. Disconnect the air conditioning compressor low pressure switch from the harness, then remove the bolts securing the air conditioning compressor to the engine block and separate the air conditioning compressor from the engine.
- l. Remove the cylinder heads (refer to EMEI VEH G 884 — GROUP 1).
- m. Remove the fuel pump assembly (refer to EMEI VEH G 883 — GROUP 4).
- n. Remove the air compressor assembly (refer to EMEI VEH G 884 — GROUP 12).
- o. Remove the accessory drive assembly (refer to EMEI VEH G 884 — GROUP 1).
- p. Remove the power steering pump assembly (refer to EMEI VEH G 883 — GROUP 14).
- q. Remove the oil pump assembly (refer to EMEI VEH G 883 — GROUP 1).
- r. Remove the camshaft followers (refer to EMEI VEH G 884 — GROUP 1).
- s. Remove the engine oil pan (refer to EMEI VEH G 883 — GROUP 1).
- t. Remove the starter motor assembly (refer to EMEI VEH G 884 — GROUP 15).
- u. Remove the flywheel assembly (refer to EMEI VEH G 884 — GROUP 1).
- v. Remove and discard the rear crankshaft oil seal (refer to EMEI VEH G 884 — GROUP 1).
- w. Replace two of the flywheel housing retaining bolts with guide studs, then remove the remaining bolts. Lightly tap the flywheel housing using a rubber mallet to separate the housing from the cylinder block locating dowels, then remove the flywheel housing (see Fig. 11).

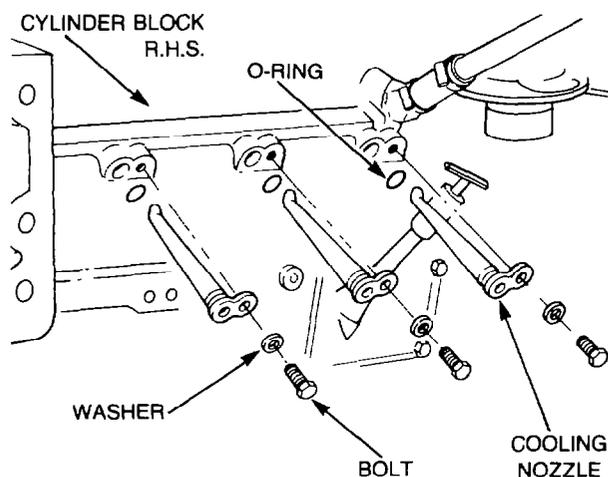


Figure 10 — Piston Cooling Nozzle — Removal

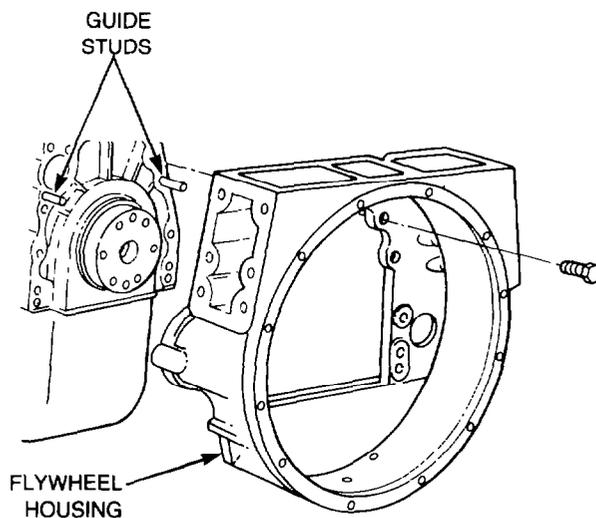


Figure 11 — Flywheel Housing — Removal

- x. Remove the front engine mounting bracket from the front gear case.
- y. Remove the three bolts securing the camshaft bearing support to the front gear case, rotate the bearing support approximately 60° using a suitable rubber or plastic tipped hammer. Lever the bearing support from the front gear cover, using a suitable pry bar, then remove and discard the O-ring (see Fig. 12). Remove the shims from the bearing support, then using a suitable micrometer measure and note the combined thickness of the shims.

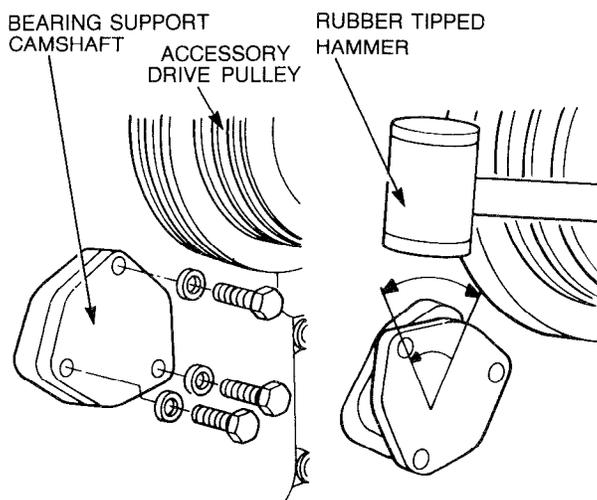


Figure 12 — Camshaft Bearing Support — Removal

- z. Replace two of the front gear case bolts with guide studs, then remove the remaining bolts securing the front gear case to the cylinder block, and remove the gear case. Drive the front crankshaft oil seal from the gear case using a hammer and a suitable drift, then discard the seal.
- aa. Remove the carbon deposits and/or ridging from the upper section of each cylinder liner.
- ab. Loosen the connecting rod bolts approximately 10 mm, then using a rubber or plastic tipped hammer, strike the connecting rod bolts to free the bearing cap from the connecting rod locating dowel.
- ac. Check to ensure that each connecting rod and bearing cap set have matching numbers stamped on them, and that they are in the correct cylinder locations, number and mark any set not stamped

or located incorrectly. Remove the connecting rod bolts and the bearing caps.

CAUTION

When removing the pistons, take care not to scratch or damage the crankshaft and cylinder liner bore with the free end of the connecting rod.

- ad. Push the piston upward until the piston crown is level with the top of the cylinder liner, then number the position of each piston in the cylinder block.
- ae. Withdraw each piston in turn from the cylinder block and place the pistons in a suitable stand to prevent any damage occurring, then remove and discard the bearing shells from the bearing caps and connecting rod. Remove and discard the piston rings from the pistons.
- af. Remove the internal circlips securing the piston pin in the piston, using a suitable pair of circlip pliers.

WARNING

Wear insulated gloves when handling pistons heated in boiling water, to prevent personal injury occurring.

- ag. Place the pistons in a suitable container of hot water, then heat the water until it boils. Maintain the piston in the boiling water for 15 minutes.

CAUTION

Do not use a hammer to remove the gudgeon pin, to do so may distort the piston causing the piston to seize in the cylinder liner, resulting in engine failure.

- ah. Using a suitable pair of insulated gloves remove a piston from the boiling water. Remove the gudgeon pin from the piston with a suitable blunt drift, then mark the piston number on the gudgeon pin with a suitable marking pen. Repeat this procedure until all the pistons are disassembled (see Fig. 13).

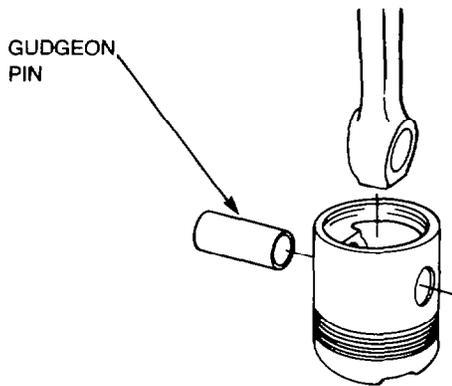


Figure 13 — Piston — Disassembly

- ai. Tag and remove the oil control hoses from the STC valve, then remove the mounting bolts and separate the STC valve from the cylinder block (see Fig. 14). Seal all apertures using suitable plastic plugs. Disconnect the hoses from the cylinder block.
- aj. Remove the PTO hydraulic throttle control from the front left hand side of the cylinder block.
- ak. Tag and remove all of the coolant transfer pipes attached to the engine.
- al. Tag and remove the fuel pipes from the left hand side of the engine.

am. Disconnect the engine wiring harness cable clamps and ties, then tag and remove the engine wiring harness.

an. Measure and note the backlash between the camshaft and crankshaft gears, using a suitable dial indicator on the camshaft gear. Mark the camshaft gear for replacement if required.

ao. Install the camshaft pilots Part Number 3375268 over the base of the camshaft between the journals (see Fig. 15), secure the camshaft pilots in place using a suitable rubber band straddling the camshaft lobe, then withdraw the camshaft from the cylinder block using a slow rotating action, balance the camshaft with one hand as it is removed. Remove and discard the thrust washer from the camshaft.

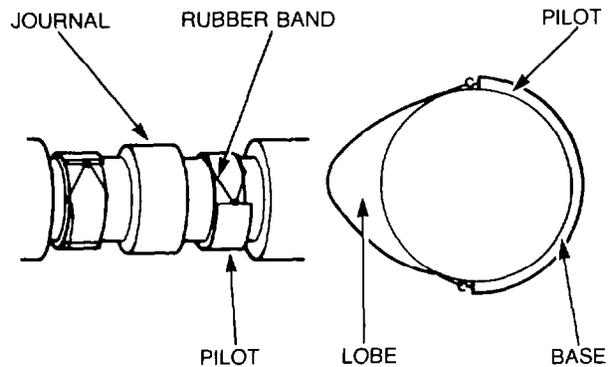


Figure 15 — Camshaft — Removal

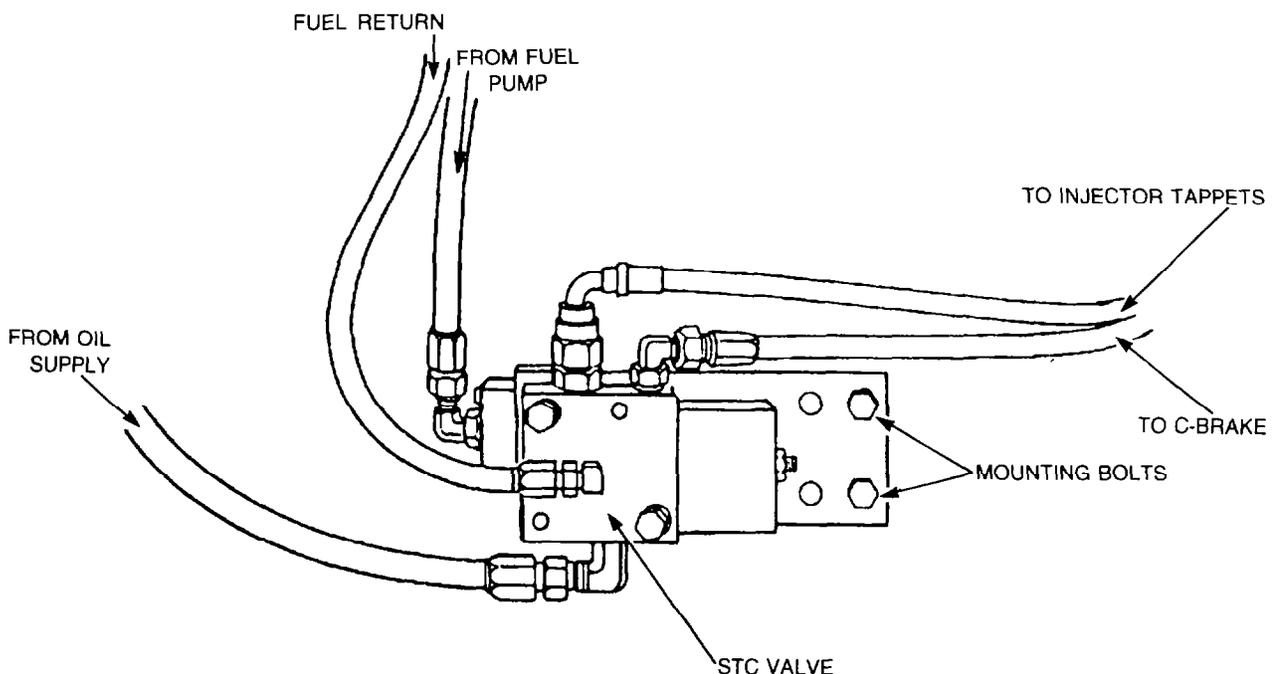


Figure 14 — STC Valve Hose — Locations

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- ap. Drive the camshaft bushes from the cylinder block using a suitable diameter stepped mandrel. Commence at number one camshaft bush and repeat the procedure using an appropriate extension shaft to remove the bearings from the front to the rear of the cylinder block, then discard the bushes.
- aq. Straighten the locking tabs on the main bearing caps, then loosen the bolts approximately 25 mm. Check to ensure that the main bearing caps are stamped on the camshaft side with the correct location number (see Fig. 16).

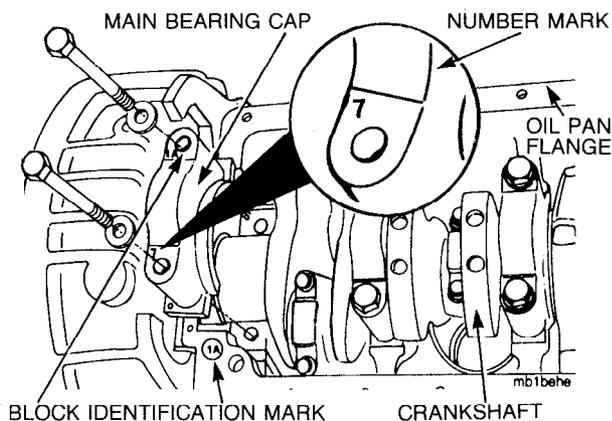


Figure 16 — Main Bearing Cap Identification

NOTE

The number seven main crankshaft bearing cap also retains the crankshaft thrust bearings.

- ar. Secure special tool ST-1178 to the centre of the main bearing cap, and strike the slide hammer to free the bearing cap from the dowel ring, then remove the bolts, bearing cap and the bearing shells. Discard the bearing shells.
- as. Attach a suitable lifting sling to each end of the crankshaft, then secure the sling to suitable overhead lifting equipment and remove the crankshaft from the cylinder block.
- at. Lower the crankshaft and rest it on suitable wooden V-blocks to prevent damage occurring to the journal surfaces.
- au. Remove and discard the upper main bearing shells from the cylinder block.
- 11. Cleaning and Inspection**
- a. Remove all trace of gasket material from the mating surfaces using a suitable gasket scraping tool.
- b. Clean all non-aluminium components using a suitable cleaning agent, then blow dry with compressed air.
- c. Clean the pistons and other aluminium components using a suitable aluminium cleaning solution, and use a stiff non-metallic bristle brush to remove carbon deposits from the piston ring grooves and the piston crown, then rinse the components in warm water and blow dry with compressed air.
- d. Clean the oil galleries in the cylinder block using a suitable thin brush, then use compressed air to blow the galleries clear of any obstruction.
- e. Check the cylinder block for damage, and repair or replace the cylinder block as necessary.
- f. Remove the pipe plug from the front of the camshaft, and clean the oil passages using a suitable cleaning agent. Blow the camshaft dry with compressed air, then apply a liberal coat of clean oil to the camshaft to prevent oxidation occurring.
- g. Clean the connecting rod oil drilling using a suitable bristle brush, then blow the drilling clear of any obstruction with compressed air.
- h. Clean the piston cooling nozzles using a suitable bristle brush, then blow the nozzles clear of any obstruction with compressed air.
- i. Measure the cylinder block camshaft bearing bore using a suitable bore gauge or inside micrometer, where one or more bores are larger than 68.26 mm (2.6875 in.) the bore will require resleeving.
- j. Inspect the cylinder block for cracks or damage around the cylinder liner area extending into the water jacket, oil galleries and cylinder head bolt holes. Check the mounting flanges and the remainder of the cylinder block for cracks or damage. Replace the cylinder block as necessary.

CAUTION

Do not clean any aluminium components with a steel wire brush, glass bead or sand blasting, as this may damage the surface finish and cause incorrect seating that may result in engine failure.

- k. Check the condition of the expansion plugs and replace as necessary (refer to EMEI VEH G 884 — GROUP 1).
- l. Inspect the surface of the cylinder block around the water jacket holes for scratches, cracks or corrosion deeper than 0.08 mm (0.003 in.). Defects may not extend more than 2.38 mm (0.093 in.) from the edge of the water jacket holes, repair any damaged water jacket holes as required.
- m. Clean all of the cylinder block oil galleries, using a small diameter bristle brush, then blow the galleries clear of any obstructions using compressed air.
- n. Check the condition of the threaded holes and studs, then dress all the threads using the appropriate size tap or die. Replace any bent or damaged studs as necessary.

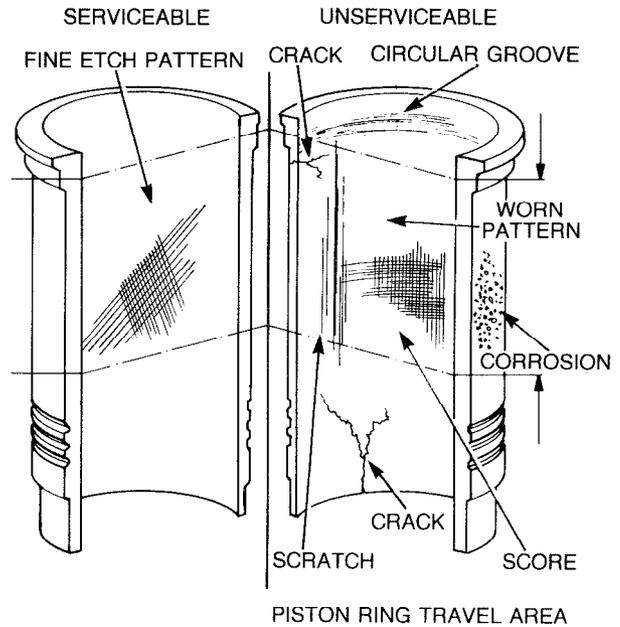


Figure 17 — Cylinder Liner Condition

CAUTION

Do not clean the cylinder liner bore with a hone, deglazer or prebrush, as the abrasives will damage the etch finished surface and can contaminate the cylinder liner, rendering it unserviceable.

- r. Measure and note the inside diameter of the cylinder liner, in four places 90 deg. apart at the top and bottom of the piston travel area, using a suitable inside micrometer or bore gauge (see Fig. 18). The cylinder liner bore should measure 139.694-139.827 mm (5.4998-5.5050 in.). Replace the cylinder liner as necessary (refer to para. 12).

- o. Clean the cylinder liner using a non-metallic stiff bristle brush, a suitable cleaning agent, and warm water, then blow dry with compressed air.
- p. Inspect the cylinder liner for cracks, scuffing, scoring, pitting or vertical scratches. Replace the cylinder liner as necessary (refer to para. 12).

NOTE

Oversize pistons and piston rings are not available, and therefore the cylinder liners cannot be honed or bored to correct any defective condition.

- q. Inspect the cylinder liners for indications of wear to the bore surface. Replace any cylinder liner, (refer to para. 12) where the cylinder liner etch pattern is worn away or only faintly visible in the piston ring travel area (see Fig. 17).

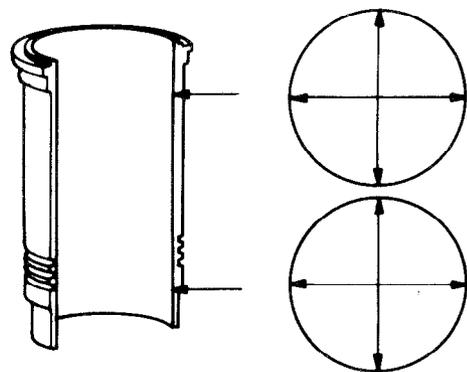


Figure 18 — Measuring Cylinder Liner

CAUTION

When installing special tool 3376669 (clamp set), do not torque the retaining bolts to greater than 70 Nm (50 lb.ft) as damage to the cylinder liner bead will result.

- s. Secure the two cylinder liner clamps, from special tool 3376669, 180° apart on the cylinder liner bead (see Fig. 19) using two cylinder head bolts torqued to 70 Nm (50 lb.ft).

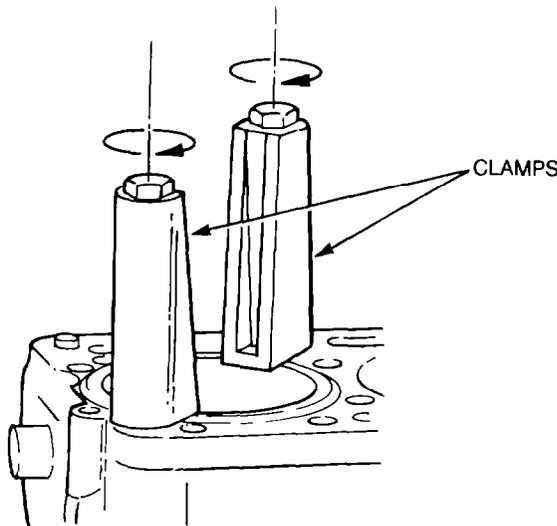


Figure 19 — Cylinder Liner Clamp — Installation

- t. Measure and note the cylinder liner out-of-round using a suitable inside micrometer or bore gauge at points C,D,E,F and G refer to Fig. 20, measure each point in two places 90° apart (A — A and B — B). The maximum allowable out-of-round is 0.08 mm (0.003 in.) at point C, and 0.005 mm (0.002 in.) at points D,E,F and G. Replace the cylinder liner as necessary (refer to para. 12).

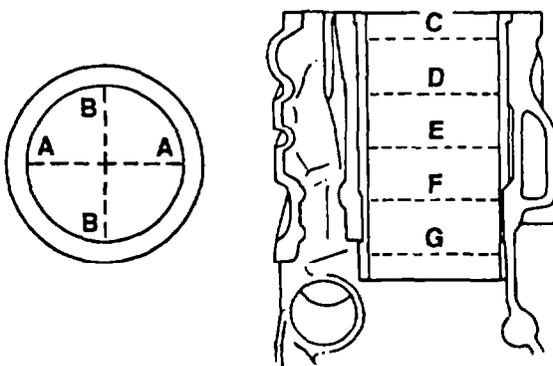


Figure 20— Measuring Cylinder Liner Out-of-Round

- u. Measure the cylinder liner protrusion, using special tool 3376220, at four points around the cylinder liner flange, 90° apart (see Fig. 21). Cylinder liner protrusion must be 0.08-0.15 mm

(0.003-0.006 in.). Where the cylinder liner protrusion is not within specification, remove the cylinder liner (refer to para. 12) and shim the cylinder liner to obtain the specified dimension.

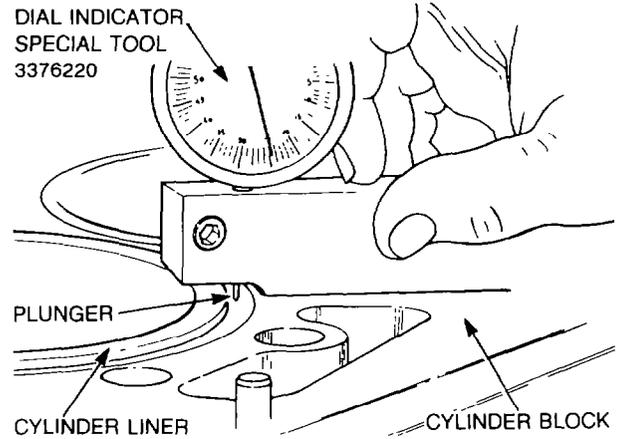


Figure 21 — Measuring Cylinder Liner Protrusion

- v. Measure and note the clearance between the cylinder liner and the lower cylinder block bore using a suitable feeler gauge (see Fig. 22). The maximum allowable clearance is 0.15 mm (0.006 in.), it is permissible for the cylinder liner to be in contact with the cylinder block lower bore, if it does not cause the cylinder liner to be out-of-round. Replace the cylinder liner as necessary.

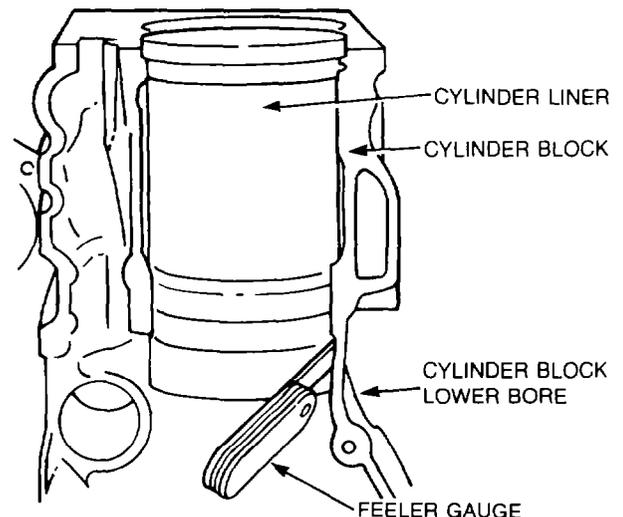


Figure 22 — Measuring Cylinder Liner to Lower Cylinder Block Clearance

- w. Inspect the piston for cracks or damage to the crown area, skirt, ring grooves and piston pin area. Replace any cracked or damaged pistons.

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- x. Check the top and second ring groove on each piston for wear, using ST-560. The piston is unserviceable where the shoulder of the tool touches the piston (see Fig. 23).

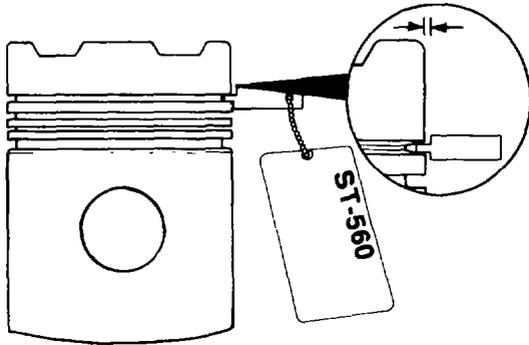


Figure 23 — Checking Piston Ring Grooves

NOTE

When measuring the O.D. of the pistons, take the measurements when the piston temperature is 21-32°C. (70-90°F.) to ensure an accurate reading.

- y. Measure and note the piston O.D., at right angles to the gudgeon pin bore using a suitable micrometer, the minimum allowable piston diameter is 139.27 mm (5.483 in.), then measure the I.D. of the gudgeon pin bore using a suitable inside micrometer. The gudgeon pin bore should be 50.762-50.800 mm (1.9985 - 2.000 in.). Replace any out of specification piston.
- z. Measure the O.D. of the gudgeon pin in two places 90° apart, in several places along the piston pin, using a suitable micrometer. Discard any gudgeon pin more than 0.03 mm (0.001 in.) out-of-round, or not 50.768-50.774 mm (1.99875-1.99900 in.) in diameter along the entire length of the pin.
 - aa. Inspect the connecting rod for cracks, damage or nicks on the I-beam or bush area, and replace the connecting rod as necessary.
 - ab. Check the gudgeon pin bush for scoring, scuffing, scratches or misalignment of the connecting rod oil passage and the gudgeon pin bush aperture (see Fig. 24).

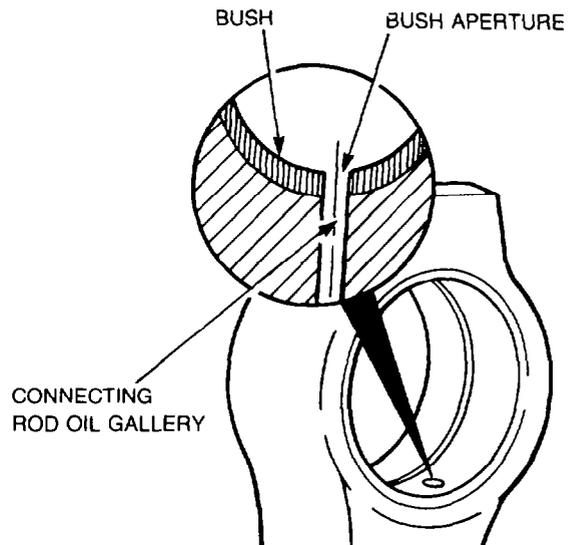


Figure 24 — Connecting Rod Bush — Alignment

- ac. Check the connecting rod bolts for damage, stretching, torn threads or corrosion, then measure the O.D. of the shank, the diameter should be 14.81-14.99 mm (0.583-0.590 in.). Discard any damaged or out of specification bolts.

CAUTION

When assembling the connecting rod, ensure the bearing cap and connecting rod identification numbers match, and are installed with the numbers adjacent, to prevent damage occurring to the crankshaft.

- ad. Assemble the connecting rod bearing cap to the connecting rod, and torque the bolts in two steps using an alternating sequence, first step 100 Nm (75 lb.ft), second step 230 Nm (170 lb.ft).
- ae. Measure and note the connecting rod crankshaft bearing bore using a suitable micrometer, in two places 90° apart, discard any connecting rod, where the inside diameter is not 84.219-84.244 mm (3.3157-3.3167 in.).
- af. Measure and note the inside diameter of the gudgeon pin bush, using a suitable inside micrometer or bore gauge, in two places 90° apart (see Fig. 25). The bush should measure 50.825-50.856 mm (2.0010-2.0022 in.), replace any out of specification bush.

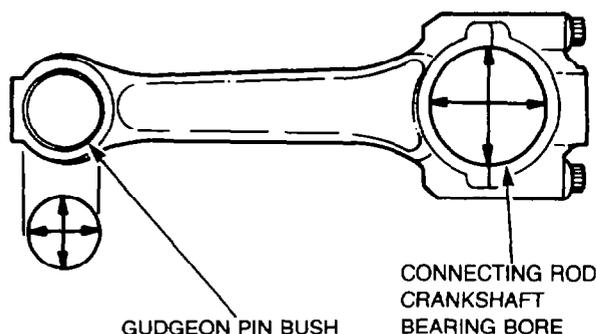


Figure 25 — Measuring Connecting Rod

- ag. Secure the connecting rod in a suitable alignment jig, and check for twist exceeding 0.25 mm (0.010 in.) or bending (out-of-alignment) greater than 0.10 mm (0.004 in.). Check the distance between the centre of the gudgeon pin bush and the crankshaft bearing bore centre, is 304.75-304.80 mm (11.998-12.000 in.). Replace any connecting rod not within specification.
- ah. Check the connecting rod bolt pad radius (see Fig. 26). The fillet radius must be 1.1-1.40 mm (0.045-0.055 in.), the radius may be repaired as required by cutting upto 1.587 mm (0.0625 in.) off the bolt pad.

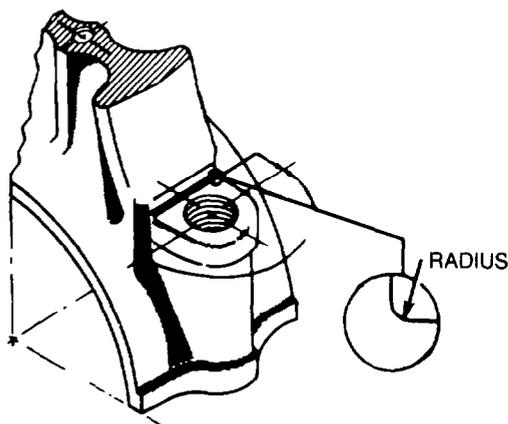


Figure 26 — Connecting Rod — Bolt Pad Radius

- ai. Measure the connecting rod bolt hole pilot bore, where the pilot bore exceeds 15.872 mm (0.6249 in.) discard the connecting rod assembly.
- aj. Measure the connecting rod bearing cap bolt hole pilot bore, where the pilot bore

exceeds 15.880 mm (0.6252 in.) discard the connecting rod bearing cap and the connecting rod.

- ak. Clean the crankshaft main and connecting rod bearing journals of any bearing material, copper, brass, carbon, babbitt or other deposits using a suitable tool and cleaning agent, then blow dry with compressed air.
- al. Remove any oxidation from the crankshaft counterweights using emery cloth.
- am. Remove the pipe plugs from the crankshaft bearing journal oil gallery cross drillings, then clean the oil galleries using a suitable small diameter, stiff bristle brush and an appropriate cleaning agent. Dry the area with compressed air.
- an. Inspect the crankshaft for bearing seizure, discolouration due to overheating, grooving, scoring, or any other indication of surface distress occurring.
- ao. Perform a magnetic crack detection test on the crankshaft, using Magnaflux test equipment or a suitable equivalent.
- ap. It is permissible for the crankshaft to be used without grinding or reconditioning where the crankshaft displays open longitudinal cracks less than six mm length, closed longitudinal cracks less than 22 mm length, or longitudinal indentations less than six mm length on the bearing journals (see Fig. 27). Any other cracks or conditions are unacceptable on the crankshaft, replace the crankshaft as required.

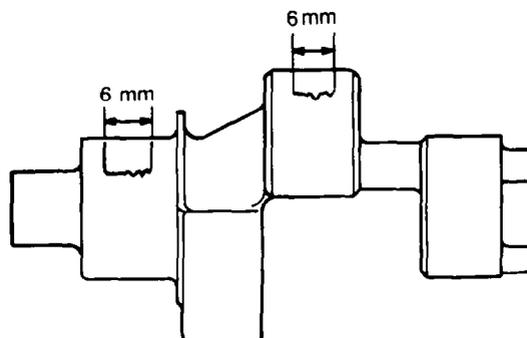


Figure 27 — Crack Testing — Crankshaft

- aq. After the magnetic inspection has been completed and any flaws in the crankshaft identified, demagnetize the crankshaft.

Table 6 — Crankshaft Journal Diameters

	Standard Size mm (in.)	Undersize = 0.25 mm (0.010 in.) mm (in.)	Undersize = 0.50 mm (0.020 in.) mm (in.)	Undersize = 0.76 mm (0.030 in.) mm (in.)	Undersize = 1.01 mm (0.040 in.) mm (in.)
Connecting rod	79.375-79.298 (3.1250-3.1220)	79.121-79.044 (3.1150-3.1120)	78.867-78.790 (3.105-3.102)	78.613-78.537 (3.095-3.092)	78.359-78.283 (3.085-3.082)
Main	114.300-114.326 (4.5000-4.4975)	114.046-113.982 (4.4900-4.4875)	113.792-113.728 (4.4800-4.4775)	113.538-113.474 (4.4700-4.4675)	113.284-113.220 (4.4600-4.4575)
Gear step	95.504-95.529 (3.7600-3.7607)	N/A —	N/A —	N/A —	N/A —
Front seal surface	92.08-92.10 (3.625-3.626)	N/A —	N/A —	N/A —	N/A —
Rear seal surface	152.35-152.40 (5.998-6.000)	N/A —	N/A —	N/A —	N/A —

NOTE

Do not remove the crankshaft gear unless it is worn, damaged or loose on the crankshaft.

- ar. Inspect the crankshaft gear for damage, cracks, broken or missing teeth and ensure it is a secure fit on the crankshaft. Remove and replace the crankshaft gear and Woodruff key as necessary.
- as. Measure and record the diameters of the crankshaft journals and the front and rear oil seal surfaces, in two places 90° apart at each end of the journal (see Fig. 28), using a suitable micrometer (refer to Table 6).

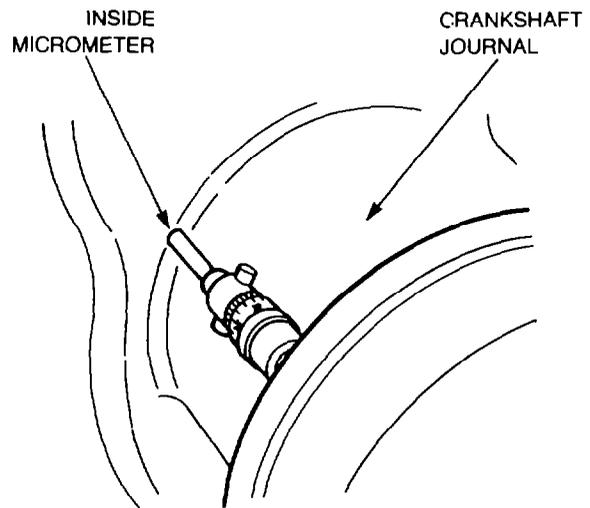


Figure 29 — Measuring Crankshaft Journal Width

- at. Measure and record the width of the crankshaft journals (see Fig. 29), using a suitable inside micrometer (refer to Table 7).

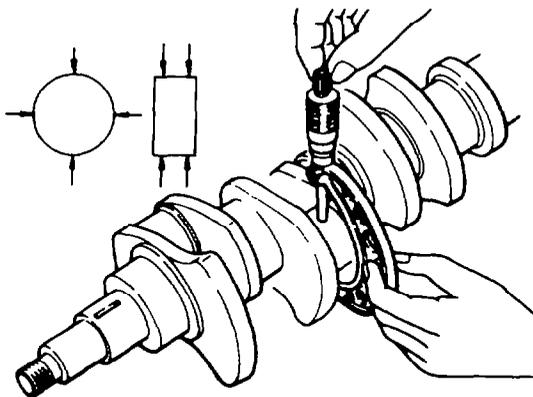


Figure 28 — Measuring Crankshaft Journals

Table 7 — Camshaft Journal Width

Journal	Dimensions	
	mm	(in.)
Connecting rod	53.98-54.05	(2.125-2.128)
Main number 1	61-72	(2.430-2.450)
Main number 2, 4, 6	50.55	(1.990-2.010)
Main number 3, 5	63.25-63.75	(2.490-2/510)
Main number 7	76.23-76.28	(3.001-3.003)

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- au. Measure the crankshaft thrust flange thickness (see Fig. 30), using a suitable micrometer the standard thickness is 12.65-12.75 mm (0.498-0.502 in.), then measure the distance from the flywheel mounting surface to the front thrust surface of the number seven main bearing journal. Where the distance is not 131.06-130.81 mm (5.160-5.150 in.) or the thrust flange is out of specification the crankshaft must be ground to accommodate undersize thrust bearings.

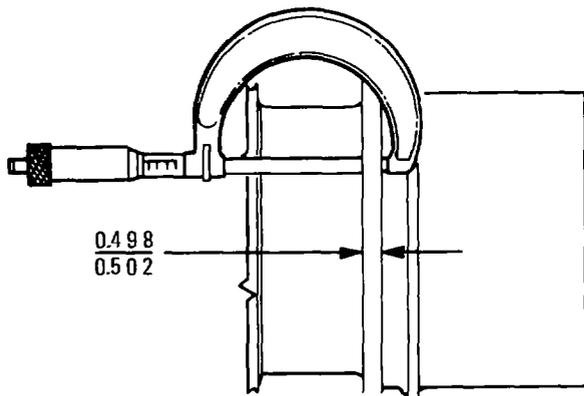


Figure 30 — Measuring Crankshaft Thrust Flange

- av. Support the crankshaft on the number one and the number seven main bearing journals in suitable wooden V-blocks, then install a dial indicator with the plunger on the side of the number four main bearing journal. Zero the dial indicator, then rotate the crankshaft one complete revolution, read the maximum movement of the dial indicator to obtain the Total Indicated Runout (T.I.R.). Where the T.I.R. exceeds 0.203 mm (0.008 in.) the crankshaft is unserviceable, some cases of excessive T.I.R. may be corrected by grinding the crankshaft to a suitable undersize.
- aw. Move the dial indicator to the front of the crankshaft with the plunger approximately six mm from the front face of the crankshaft (see Fig. 31). Zero the dial indicator, then rotate the crankshaft one complete revolution, read the maximum movement of the dial indicator to obtain the nose section T.I.R. Where the nose section T.I.R. exceeds 0.05 mm (0.002 in.) the crankshaft is not serviceable in this condition, it may be possible to recondition the crankshaft by hard chrome plating and grinding to specification (refer to Table 7).

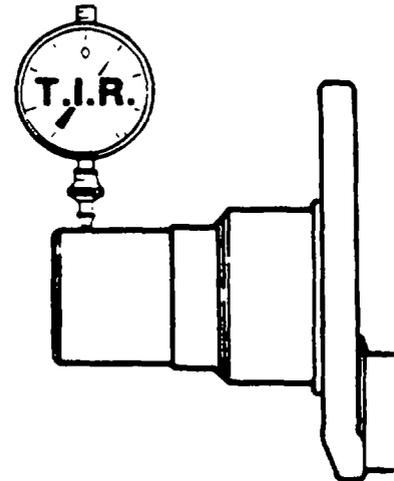


Figure 31 — Crankshaft Nose — Total Indicated Runout

- ax. Move the dial indicator to the front of the crankshaft with the plunger on the outer most point of the circumference (see Fig. 32). Zero the dial indicator, then rotate the crankshaft one complete revolution, read the maximum movement of the dial indicator to obtain the squareness of the crankshaft. Where the damper mounting surface is not perpendicular to the crankshaft axis within 0-0.05 mm (0-0.002 in.), the crankshaft is unserviceable in this condition, it may be possible to correct the fault, providing the crankshaft length remains 1298.73-1300.00 mm (51.131-51.181 in.).

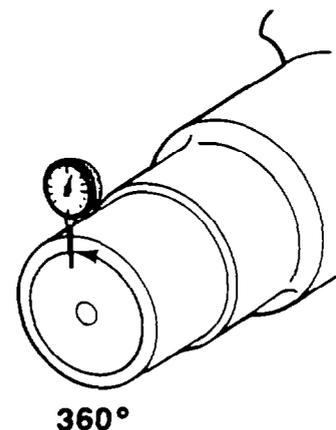


Figure 32 — Vibration Damper Mounting Flange Runout

- ay. Move the dial indicator to the rear of the crankshaft with the plunger positioned approximately six mm from the rear face of the crankshaft (see Fig. 33). Zero the dial indicator, then rotate the crankshaft one complete revolution,

read the maximum movement of the dial indicator to obtain the tail section T.I.R. Where the tail section T.I.R. exceeds 0.05 mm (0.002 in.) the crankshaft is not serviceable in this condition, it may be possible to recondition the crankshaft with hard chrome plating and grinding to the specified diameter (refer to Table 7).

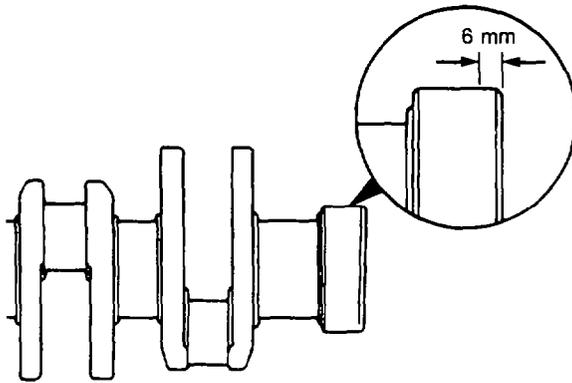


Figure 33 — Crankshaft Rear Seal Area Runout

- az. Inspect the front and rear crankshaft oil seal surfaces for wear caused by the oil seal. Install a suitable wear sleeve of the seal surface if required.
- ba. Check the face of the crankshaft and ensure the vibration damper mounting flange is flat or concave (see Fig. 34). It may be possible to correct a convex condition by grinding, providing the crankshaft length remains 1298.73-1300.00 mm (51.131 51.181 in.).

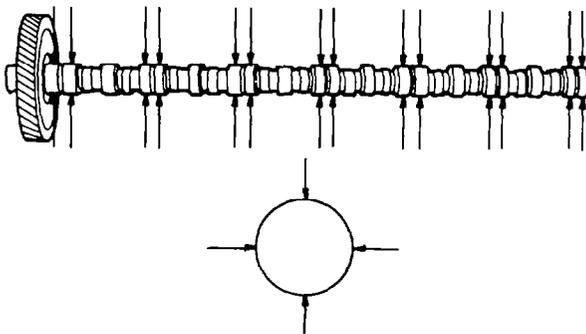


Figure 34 — Camshaft Journal Diameter

- bb. Dress the vibration damper mounting bolt hole threads, dress the threads using a suitable tap. Up to three of the threads may be repaired as necessary.
- bc. If the crankshaft is to be stored for any length of time, package it in a manner to prevent damage occurring to the journals, and stand the crankshaft vertically

to prevent any bow that may occur if laid horizontally.

- bd. Inspect the camshaft for damage to the lobes or bearing surfaces, discard any damaged camshaft.
- be. Measure and record the diameter of the camshaft bearing journals in two places 90° apart on each end of the journals. Discard any camshaft where one or more of the journals does not measure 63.37-63.42 mm (2.495-2.497 in.)

12. Cylinder Liner Removal

CAUTION

The puller plate (foot) must not overlap the outside diameter of the cylinder liner, or damage will occur to the cylinder block.

- a. Position the cylinder liner remover, special tool 3375629 over the defective cylinder liner, ensuring that the tool is seated square and firmly supported on the cylinder block top deck. Install the foot, special tool 3377057, onto the power rod of the remover, ensuring the foot is correctly positioned on the liner and parallel to the main bearing saddles (see Fig. 35), then install the retaining pin in the power rod and operate the remover using a suitable socket spanner to withdraw the liner from the cylinder block. Remove and discard the crevis seal and the O-rings, however, do not discard any shims that may be used under the cylinder flange.

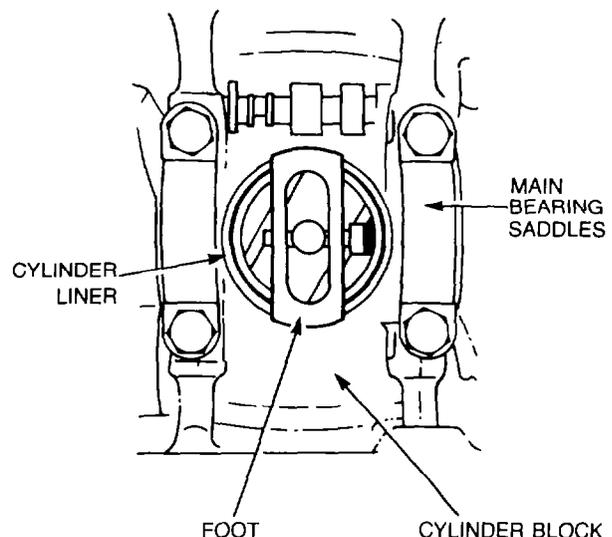


Figure 35 — Cylinder Liner — Removal

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- b. Use a suitable liquid metal marker to note the cylinder number on each liner as it is removed. Measure and record the thickness of the shims used in each cylinder.
- c. Clean the cylinder liner flange seating area using a rotary steel wire brush, then clean the inside diameter with a non-metallic bristle brush and warm soapy water. Rinse the cylinder liner thoroughly in clean fresh water and blow dry with compressed air

WARNING

Wear eye protection and ensure the wire brush is rated for the RPM being used, when cleaning the cylinder liner flange, to avoid personal injury.

- d. Inspect the liners for cracks on the inside or outside diameters and under the flange.
- e. Inspect the outside diameter for corrosion or pitting, greater than 1.6 mm (0.0625 in.) deep. Remove any shallow pitting using a fine emery cloth. Discard all cracked or excessively corroded cylinder liners.
- f. Clean the cylinder block counterbores using a suitable hydrocarbon solvent, then rinse the area using warm soapy water and blow dry with compressed air.
- g. Remove any sharp edges from the cylinder block deck around the counterbore area using a suitable oil stone.
- h. Where all of the cylinder liners have been removed, check the cylinder block top deck for distortion using a straight edge and a feeler gauge. If the distortion exceeds 0.05 mm (0.002 in.) the cylinder block will require machining. However, prior to machining the cylinder block, measure the height of the cylinder block from the centre line of the crankshaft to the top deck surface (see Fig. 36), the minimum permissible cylinder block height is 482.45 mm (18.994 in.), discard any cylinder block below specification or when the distortion cannot be rectified within the limit.
- i. Inspect the cylinder block counterbore for cracks around the counterbore ledge, or radial cracks extending from the counterbore area to the lubricant galleries, coolant passages or the cylinder

head bolt holes. Replace the cylinder block as required.

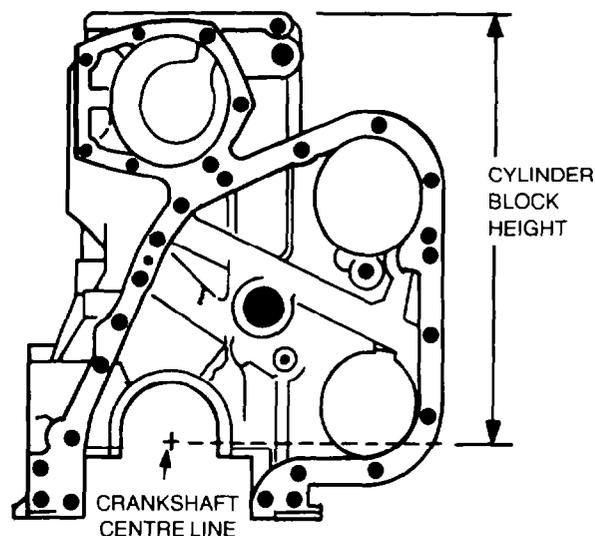


Figure 36 — Measuring Cylinder Block Height

- j. Measure and note the inside diameter of the cylinder block liner press fit area in two places equally spaced 90° apart around the circumference of the counterbore approximately 19 mm (0.75 in.) below the cylinder block deck surface. Where the dimension exceeds 160.909 mm (6.335 in.) or any out-of-round is greater than 0.03 mm (0.001 in.). Replace the cylinder block as necessary.

NOTE

The outside circumference depth must be taken as close to the counterbore wall as possible. The inside circumference depth must be taken as far from the counterbore wall as possible.

- k. Measure and record the counterbore ledge depth at four equally spaced locations around the inside and outside circumferences, using a suitable depth micrometer. Where the total difference in depth measurements around either circumference of the counterbore exceeds 0.03 mm (0.001 in.) or if the depth of the ledge is greater on the inside than the outside diameter (concave condition — see Fig. 37), machine the cylinder block counterbore ledge using special tool 3376684. If the counterbore depth exceeds 9.04 mm (0.356 in.), use a thicker shim below the cylinder liner flange (refer to Table 8) and machine the counterbore ledge as necessary.

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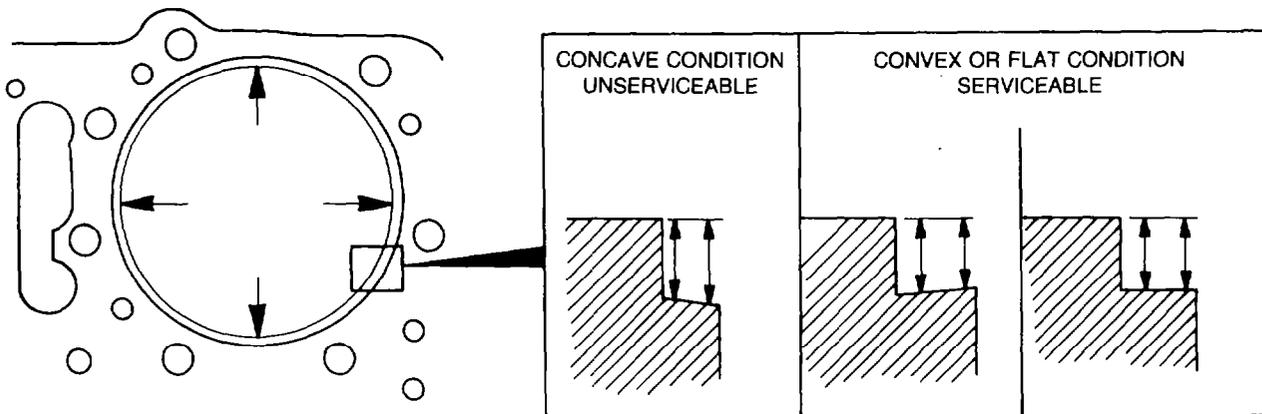


Figure 37 — Measuring Cylinder Block Counterbore

Table 8 — Cylinder Liner Flange Shims

Thickness		Size
mm	in.	
0.508	0.020	STD
0.686	0.027	O/S
0.889	0.035	O/S
1.016	0.040	O/S

- b. Apply a liberal coat of a suitable vegetable based oil to the crevis seal and the two O-rings, then install the shim sealing ring of equivalent thickness to that noted on disassembly, below the cylinder liner flange, the crevis seal in the top groove, then the O-rings in the centre and bottom grooves (see Fig. 38).

- i. Apply a thick film of clean engine oil to the entire surface of the cylinder liner bores, allow the liners to stand in this condition for five to ten minutes, then wipe the oil from the cylinder liner bores using clean, lint-free paper toweling (not cloth). Repeat the procedure until all the black and grey deposits are removed from the cylinder liner bores, then place the cylinder liners in a suitable clean container with a tight fitting lid, to keep them free from contamination until such time as they are reassembled into the cylinder block.

13. Cylinder Liner Installation

- a. Inspect the cylinder block counterbore and the cylinder liner flange for burrs, remove any burrs using a fine oil stone.

NOTE

Do not lubricate the O-rings or crevis seals with engine oil, use only a suitable vegetable based oil.

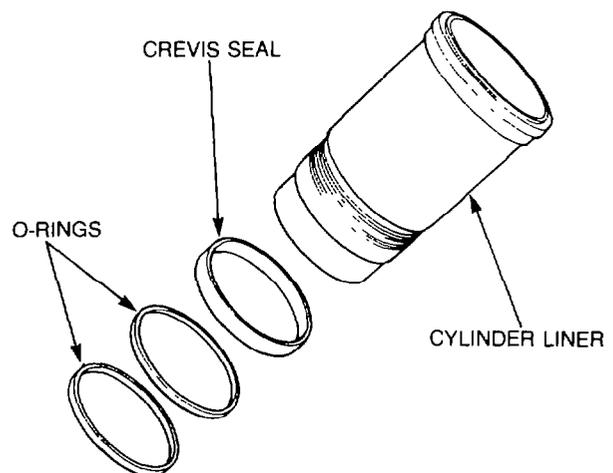


Figure 38 — Cylinder Liner Seals — Installation

NOTE

The cylinder liner must be installed within five minutes of applying the sealant.

CAUTION
Excessive use of sealant around the cylinder liner may result in a cooling system restriction and engine damage could occur due to overheating.

- c. Apply a bead of RTV sealant Part Number 33801048, 1.20-1.58 mm (0.0468-0.0625 in.) wide to the cylinder block counterbore ledge and the cylinder liner flange (see Fig. 39).

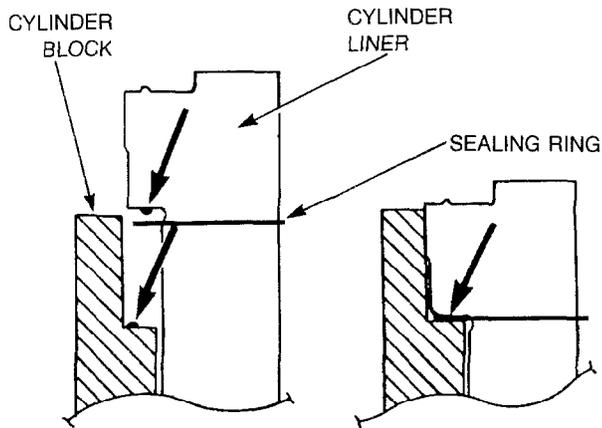


Figure 39 — Applying RTV Sealant to Cylinder Liner

- d. Lubricate the outside surfaces of the crevis seal and O-rings with a suitable vegetable based oil, then allow any excess oil to drain from the cylinder liner.

CAUTION
Ensure the oil from the O-rings does not contaminate the RTV sealant, or leaks in the cooling system may occur.

- e. Install the cylinder liner into the cylinder block with a quick push, then seat the cylinder liner in position, using special tool ST-1229 and a leather mallet.

CAUTION
When installing special tool 3376669 (clamp set), do not torque the retaining bolts to greater than 70 Nm (50 lb.ft) as damage to the cylinder liner bead will result.

- f. Secure the two cylinder liner clamps, from special tool 3376669, 180° apart on the cylinder liner bead, using two cylinder head bolts torqued alternately to 70 Nm (50 lb.ft).
- g. Measure and note the cylinder liner protrusion, using special tool 3376220, at four points around the cylinder liner bead 90° apart (see Fig. 40). Cylinder liner protrusion should be 0.08-0.15 mm (0.003-0.006 in.).

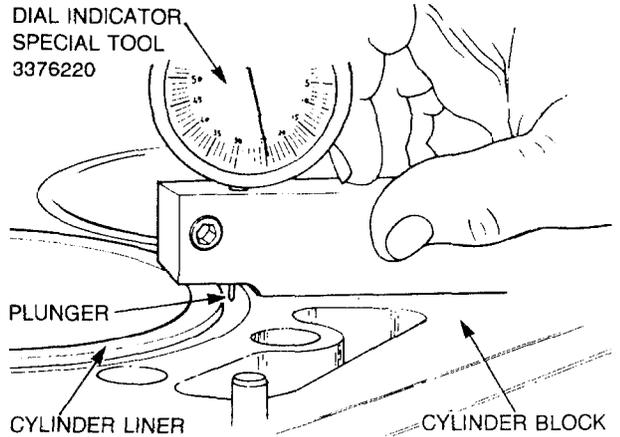


Figure 40 — Measuring Cylinder Liner Protrusion

- h. Measure and note the cylinder liner out-of-round using a suitable inside micrometer or bore gauge at points C, D, E, F and G (refer to Fig. 41), measure each point in two places 90° apart (A — A and B — B). The maximum allowable out-of-round is 0.08 mm (0.003 in.) at point C and 0.005 mm (0.002 in.) at the remaining points.

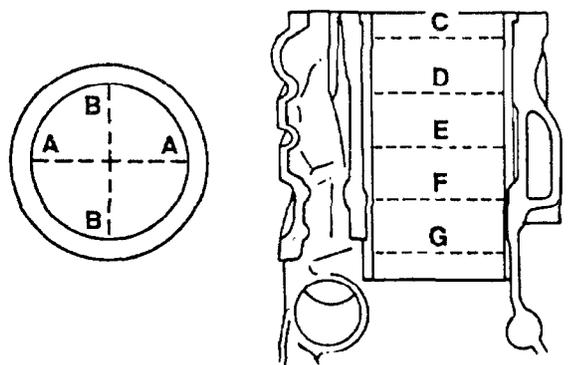


Figure 41 — Measuring Cylinder Liner Out-of-Round

- i. Measure and note the clearance between the cylinder liner and the lower cylinder block bore using a suitable feeler gauge (see Fig. 42). The maximum allowable

clearance is 0.15 mm (0.006 in.), it is permissible for the cylinder liner to be in contact with the cylinder block lower bore, providing it does not cause an out-of-round condition in the cylinder liner.

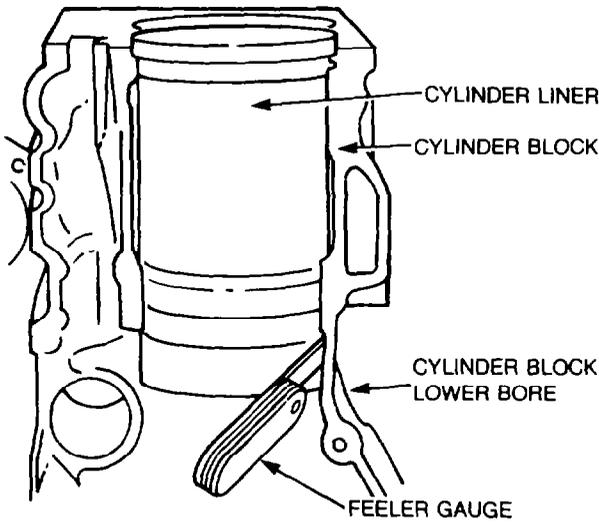


Figure 42 — Measuring Cylinder Liner to Lower Cylinder Block Clearance

- j. Where the cylinder liner protrusion, out-of-round or lower bore clearance is not within specification, remove the cylinder liner (refer to para. 12), cut the counter-bore ledge with special tool 3376684 (if required) and/or rectify any faults found as necessary. Replace the cylinder liner using an appropriate thickness shim below the cylinder liner flange.
- k. Loosen the cylinder liner clamps alternately, then remove the clamps from the cylinder block.

14. Reassembly

CAUTION
Incorrect installation of the camshaft bushes will result in engine failure. The numbers stamped on the camshaft bushes refer to the cylinder block location from front to back.

- a. Install a new set of camshaft bushes into the cylinder block, using a suitable diameter stepped mandrel and an appropriate length extension rod, commencing with number seven bush at the flywheel (rear) end of the cylinder block. Install the number seven bush with the locating notch toward the rear of the engine, aligned in the six o'clock posi-

tion (see Fig. 43) and the oil holes in the bush aligned with the galleries in the cylinder block.

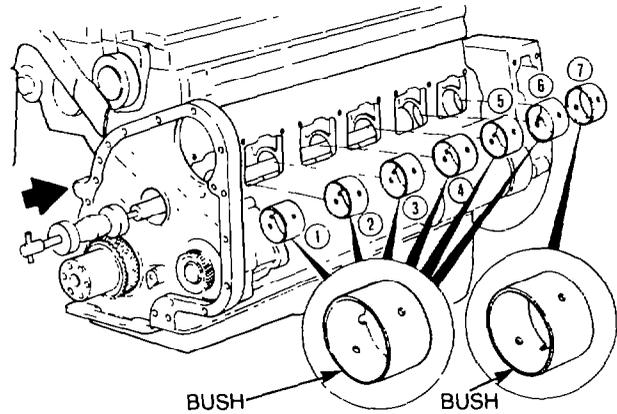


Figure 43 — Camshaft Bush Number Seven — Installation

- b. Check the alignment of the bush oil holes and the cylinder block oil galleries using a 2.39 mm (3/32 in.) diameter rod (see Fig. 44). The rod must pass through the oil holes in the bush and the cylinder block oil galleries, remove and realign any bush incorrectly located.

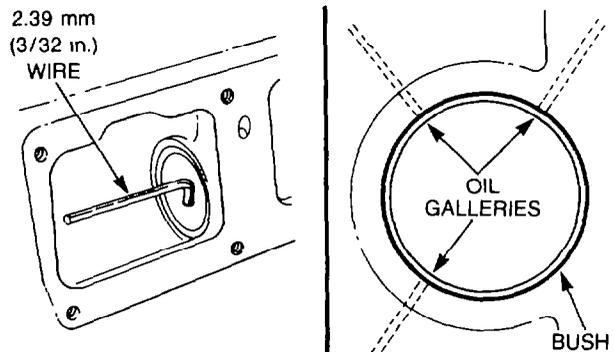


Figure 44 — Oil Gallery Hole — Alignment

- c. Install the number six through number two bushes with the locating notch toward the rear of the cylinder block, aligned in the nine o'clock position, drive the bushes in until the bush oil holes align with the cylinder block oil galleries.
- d. Check the alignment of the bush oil holes and the cylinder block oil galleries using a 2.39 mm (3/32 in.) diameter rod. The rod must pass through the bush oil holes and the cylinder block oil galleries, remove and realign any bush incorrectly located.
- e. Install the number one bush using the same procedure as outlined for bushes number six through two.

- f. Measure and note the installed diameter of the camshaft bushes, remove and discard the bushes where the inside diameter is not 63.457-63.558 mm (2.4983-2.5023 in.), then inspect the cylinder block for damage to the camshaft bush bore and rectify any faults found before reinstalling new camshaft bushes.

CAUTION

When installing the expansion plug into the cylinder block do not install the plug more than 2.29 mm (0.090 in.) below the cylinder block surface, or overheating of the camshaft will occur, resulting in engine damage.

- g. Install a new expansion plug with a suitable sealant into the rear of the camshaft bore, use a drift of suitable diameter to drive the plunger until it becomes level with the cylinder block.
- h. Clean the crankshaft bearing saddles using a lint free cloth, then clean and dry the bolt holes.

NOTE

The upper crankshaft bearing shells are identified by an oil hole and the oil groove around the inside circumference. The bearing shells are the same dimensions for locations two, four and six. The bearing shells are the same dimensions for locations one, three and five. The number seven bearing shell an individual size and configuration.

- i. Install a new set of appropriate size (undersize if necessary) crankshaft bearing shells into the correct cylinder block bearing saddle locations, commencing with number one location at the front of the cylinder block. The oil groove of the number seven bearing shell is not centralized, the wider part of the bearing shell must be installed toward the rear of the cylinder block (see Fig. 45), then check to ensure the bearing shell oil holes align with the cylinder block oil galleries.
- j. Apply a liberal coat of clean engine oil to the upper bearing shells, then install the main bearing cap dowel rings into the cylinder block saddle bolt holes.

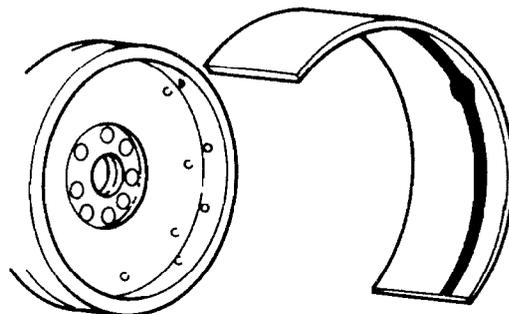


Figure 45 — Upper Main Bearing Shell — Installation

- k. Install new pipe plugs with a layer of Loctite 601 or equivalent in the crankshaft oil gallery cross drillings, and torque the plugs to 7-9 Nm (5-7 lb.ft).
- l. Install the crankshaft gear and Woodruff key onto the crankshaft using a suitable tool, where the gear has been removed.
- m. Clean the crankshaft using a lint free cloth, and ensure the bearing journals are not contaminated or damaged.
- n. Attach the crankshaft to suitable lifting equipment using a nylon sling capable of supporting 200 kg, then raise the crankshaft, apply a liberal coat of clean engine oil to the main bearing journals, and install the crankshaft in the cylinder block with the gear toward the front of the engine.
- o. Apply a liberal coat of clean engine oil to both sides of the upper thrust washer, then install the upper thrust washers in the number seven main bearing saddle with the grooved side of the thrust washer against the crankshaft flange.
- p. Apply a liberal coat of clean engine oil to the lower main bearing shells and install the shells in the correct locations on the crankshaft main bearing journals.
- q. Install the lower thrust washers onto each side of the number seven main bearing cap, with the grooved side of the thrust washer toward the crankshaft flange, then apply a liberal coat of clean engine oil to the thrust washers.
- r. Position the main bearing caps, according to the stamped location number, on the cylinder block with the location number toward the camshaft side of the engine (see Fig. 46).

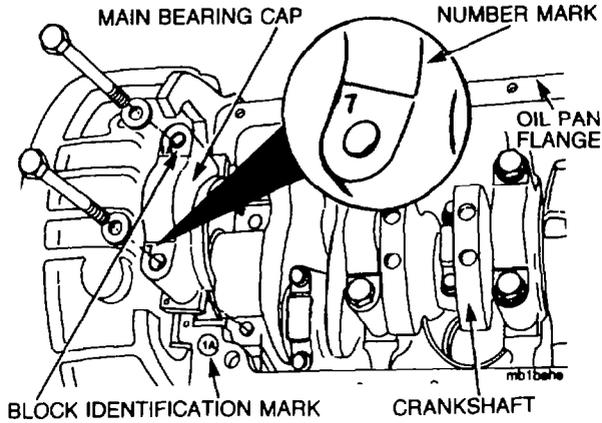


Figure 46 — Main Bearing Cap — Identification

- s. Align the bearing cap bolt holes with those in the cylinder block bearing saddles, then install new lockplates on the main bearing bolts and apply a film of clean engine oil to the threads and lockplates. Allow the excess oil to drain from the threads, before installing the bolts in the main bearing caps finger tight.

NOTE

When striking the main bearing caps, ensure the bearing shells or dowel rings do not move. Take care to align the dowel pins and dowel holes in the number seven cap and saddle.

- t. Strike the bearing caps using a suitable rubber mallet to seat the caps in the correct positions.
- u. Torque the main bearing cap bolts in seven steps using the sequence shown in Fig. 47.

- First Step — 120 Nm (90 lb.ft)
- Second Step — 230 Nm (170 lb.ft)
- Third Step — 345 Nm (255 lb.ft)
- Fourth Step — Loosen Completely
- Fifth Step — 120 Nm (90 lb.ft)
- Sixth Step — 230 Nm (170 lb.ft)
- Final Step — 345 Nm (255 lb.ft)

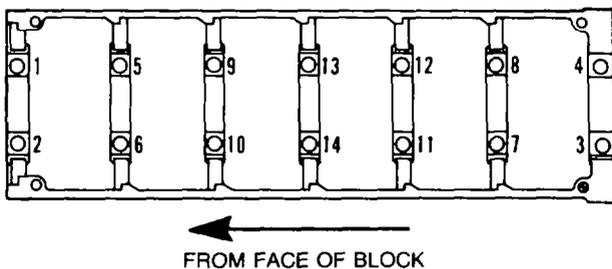


Figure 47 — Main Bearing Cap — Tightening Sequence

- v. Secure a dial indicator to the oil pan flange with the plunger against a convenient crankshaft counter weight.
- w. Push the crankshaft to the rear of the cylinder block using a suitable lever, then zero the dial indicator and push the crankshaft toward the front of the crankshaft. Read the end play measurement from the dial indicator.
- x. Where the end play is less than 0.18 mm (0.007 in.) loosen the main bearing cap bolts, move the crankshaft forward and back across the full range of deflection, then retorque the main bearing cap bolts (repeat para. u.) and re-measure the end play.
- y. The end play clearance should be 0.18 - 0.56 mm (0.007-0.022 in.). Where the end play is not within specification, remove the number seven main bearing cap and install new thrust washers of appropriate thickness to correct the end play, or remove the crankshaft and grind the crankshaft to accommodate oversize thickness thrust washers.
- z. Bend the tangs of the locking tabs against the main bearing cap bolt heads.
- aa. Install the cylinder liners, (refer to para. 13) where applicable.
- ab. Check the ring gap on a new set of piston rings in the cylinder liners. Use the crown of the piston to locate the piston rings in the cylinder liner, then measure the ring gap with a suitable feeler gauge, where the ring gap is not within the dimension shown in Table 9, replace the ring set.

Table 9 — Piston Ring Gap Dimensions

Ring Position	Ring Gap Dimensions	
	mm	in.
Top	0.430-1.034	(0.017-0.042)
Second	0.510-1.114	(0.020-0.045)
Third	0.480-1.094	(0.019-0.044)
Oil	0.250-0.994	(0.010-0.040)

- ac. Tag and remove the piston rings from the cylinder liner.
- ad. Install one internal circlip in each piston gudgeon pin bore groove using a suitable pair of circlip pliers.

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WARNING
Wear insulated gloves when handling pistons heated in boiling water, to prevent personal injury occurring.

- ae. Place the pistons in a suitable container of hot water, then heat the water until it boils. Maintain the pistons in boiling water for 15 minutes.

CAUTION
Do not use a hammer to install the gudgeon pin, to do so may distort the piston, causing the piston to seize in the liner resulting in engine failure

- af. Lubricate the connecting rod gudgeon pin bush bore and the piston pins using clean engine oil.
- ag. Using a suitable pair of insulated gloves remove a piston from the boiling water, position the connecting rod (as numbered) into the piston aligning the gudgeon pin holes, then push the gudgeon pin (as numbered) into the piston and through the connecting rod until seated, using a suitable blunt drift (see Fig. 48). Repeat this procedure until all the pistons are assembled.

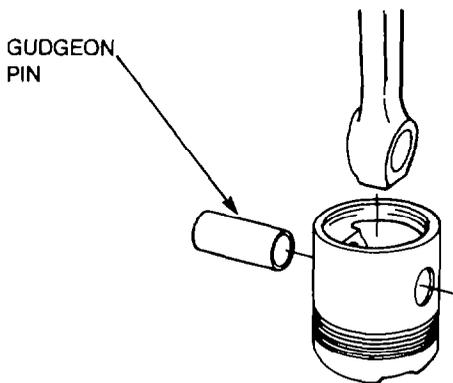


Figure 48 — Piston — Assembly

- ah. Install the remaining internal circlip in each piston gudgeon pin bore groove using a suitable pair of circlip pliers.
- ai. Install the piston rings to the pistons (as numbered) using a suitable piston ring expander. Commence with the oil control ring (see Fig. 49), ensure the side marked TOP on each piston ring

faces upward and the ring gap is not in alignment with the gudgeon pin or any other ring gap. Install the two piece oil control ring with the expander ring gap 180° from the control ring gap.

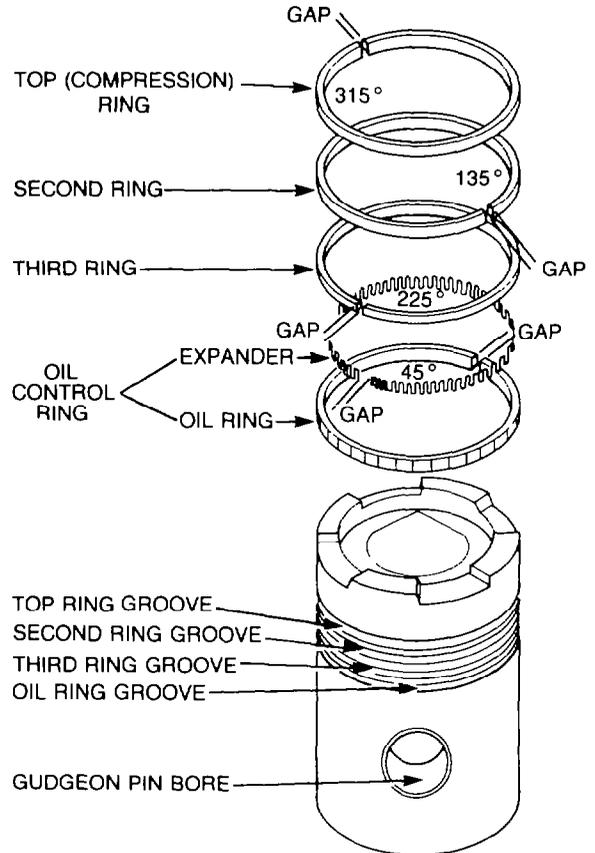


Figure 49 — Piston Ring — Installation

- aj. Apply a thick film of clean engine oil to the entire cylinder liner bore surface, allow the liners to stand in this condition for five to ten minutes, then wipe the oil from the cylinder liner bores using lint free paper toweling (not cloth). Repeat this procedure until all the black and grey deposits are removed from the cylinder liner bores.

NOTE

The connecting rod and bearing shell surfaces must be clean and dry prior to installing the bearing shells.

- ak. Install a new bearing shell of appropriate size (undersize if necessary) into each connecting rod, ensuring the bearing tang engages in the connecting rod slot.
- al. Install a new bearing shell of appropriate size (undersize if necessary) in each connecting rod bearing cap, ensuring the

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- bearing tang engages in the connecting rod cap slot.
- am. Apply a liberal coat of clean engine oil to the connecting rod bearing shells and cylinder liner bores, then place the piston assembly, crown first into a container of clean engine oil. Remove the piston from the container and allow the excess oil to drain from the piston.
- an. Compress the piston rings using a suitable piston ring compression tool.

CAUTION

When installing the pistons, prevent the free end of the connecting rod contacting the liner bores or the crankshaft journal, or damage may occur to these parts, resulting in premature engine failure.

- ao. Position the piston over the cylinder (as numbered) with the connecting rod bearing tang toward the camshaft side of the engine, then push on the piston crown using a blunt wooden implement (not metal) to move the piston into the cylinder liner (see Fig. 50).
- ap. Match the connecting rod bearing caps to the connecting rods (as numbered), and install the connecting rod bearing caps onto the connecting rods. Lubricate the connecting rod bolt threads and the washer face using clean engine oil, then secure the connecting rods caps in position with the bolts installed finger tight.

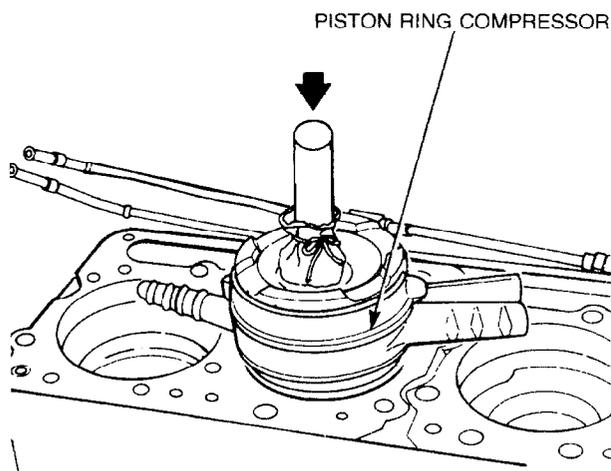


Figure 50 — Piston Assembly — Installation

- aq. Tighten the connecting rod bolts in an alternating sequence, then torque the bolts in two steps:
First step — 100 Nm (75 lb.ft)
Final step — 230 Nm (170 lb.ft)
- ar. Measure the side clearance of the connecting rods on the crankshaft journals, the side clearance must be 0.114-0.300 mm (0.0045-0.013 in.). Check to ensure the connecting rods move freely from side to side on the crankshaft journal. Disconnect any binding connecting rods and check for dirt or damage on the bearing shells or the mating surfaces, and rectify any faults found.
- as. Apply a liberal coat of clean engine oil to both sides of a new camshaft thrust washer.

CAUTION

The oil grooves on the camshaft thrust washer must face toward the camshaft gear, or failure of the thrust washer may occur.

- at. Install the camshaft thrust washer onto the camshaft, then install the camshaft pilots Part Number 3375268 over the base of the camshaft between the journals (see Fig. 51), secure the pilots in place using a suitable rubber band straddling the camshaft lobe.

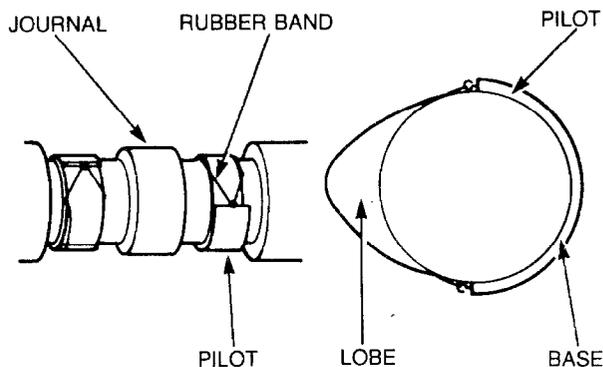


Figure 51 — Camshaft Pilot — Installation

- au. Apply a liberal coating of clean engine oil to the camshaft bearing journals, then install the camshaft into the cylinder block using a slow rotating action.
- av. Align the matchmark on the camshaft gear with the matchmark on the crankshaft gear (see Fig. 52), then push

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the camshaft into the cylinder block until the thrust washer is seated on the cylinder block.

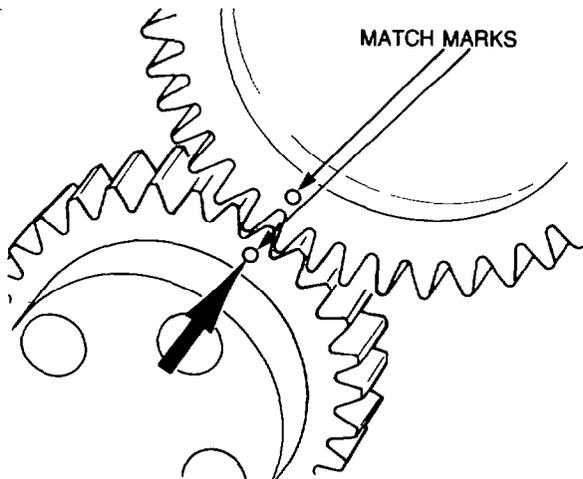


Figure 52 — Camshaft Timing Mark — Alignment

- aw. Remove the camshaft pilots and retrieve the rubber bands, ensuring no rubber bands remain trapped in the engine cavities.
- ax. Check the backlash between the camshaft and crankshaft gears, using a dial indicator. Replace the appropriate gear, where the backlash is not 0.05-0.50 mm (0.002-0.020 in.).
- ay. Install a guide stud in each side of the gear cover mounting flange, then position a new gear cover gasket over the guide studs and dowel pins, using a thin film of a suitable sealant to hold the gasket in place, if required.
- az. Install the gear cover over the guide studs and secure the mounting bolts finger tight, then replace the guide studs with the remaining mounting bolts and torque the bolts to 70 Nm (50 lb.ft). Cut the ends of the gear cover gasket level with the oil pan mounting flange, using a sharp knife.
- ba. Secure a dial indicator to the crankshaft face and place the plunger against the front crankshaft oil seal bore (see Fig. 53). Zero the dial indicator and rotate the crankshaft one complete revolution, while monitoring the movement of the dial indicator. Where total runout exceeds 0.25 mm (0.010 in.), check the bore surface for nicks and burrs, or loosen the gear cover mounting bolts and realign the gear cover, remove any burrs using a suitable oil stone.

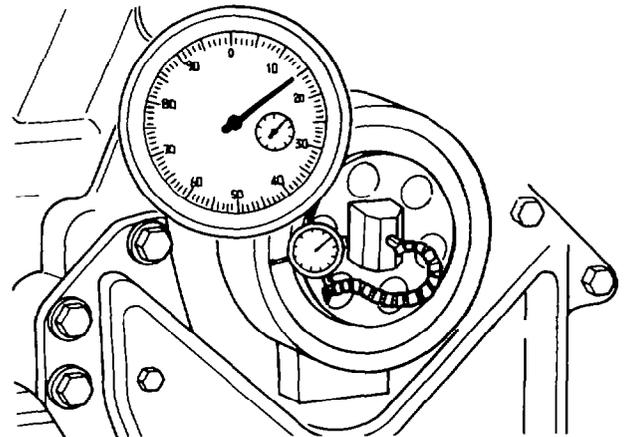


Figure 53 — Gear Cover Runout — Checking

NOTE

Do not install the O-ring onto the camshaft support bearing at this time.

- bb. Install the camshaft front support bearing into the gear cover, and push the support bearing in, until the camshaft is firmly seated.
- bc. Hold the camshaft support bearing against the camshaft using hand pressure only, then measure the distance between the gear cover and the support bearing (see Fig. 54), with a suitable thickness feeler gauge.

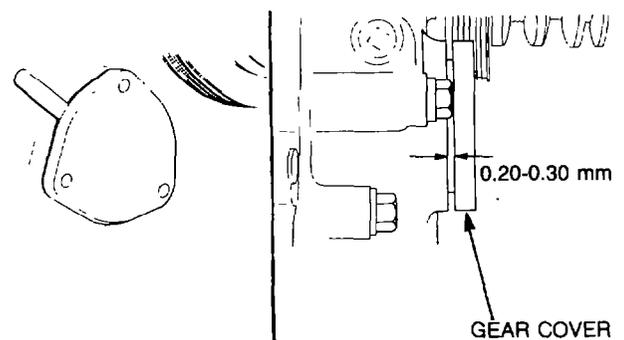


Figure 54 — Camshaft Support Bearing — Clearance

- bd. The required clearance between the camshaft and the support bearing is 0.20-0.33 mm (0.008-0.013 in.), after measuring the distance between the support bearing and gear cover, add an additional 0.20-0.33 mm (0.008-0.013 in.) to the distance measurement to determine the thickness of the shim pack required.
- be. Measure the thickness of the shim pack removed from the camshaft support dur-

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ing disassembly, using a suitable micrometer, then add (refer to Table 10 for available sizes) or delete shims as required to obtain the predetermined thickness of the shim pack.

Table 10 — Camshaft Support Bearing Shims

Part Number	Shim Thickness	
	mm	(In.)
65259-A	0.254	(0.010)
65259-C	0.508	(0.020)
185573	0.635	(0.025)
65259-B	1.270	(0.050)

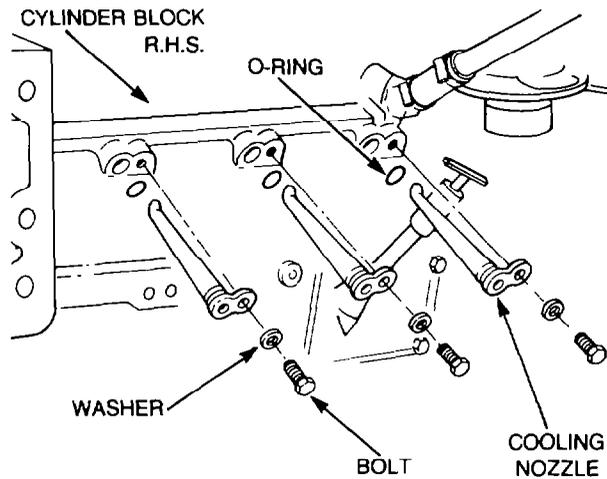


Figure 55 — Piston Cooling Nozzle — Installation

- bf. Remove the support bearing from the gear cover, then install the shim pack and a new O-ring. Apply a thin film of a suitable vegetable based oil to the O-ring and install the support bearing, secure the support bearing with the three bolts torqued to 25 Nm (20 lb.ft).
- bg. Secure the front engine mounting bracket to the gear cover and torque the bolts to 70 Nm (50 lb.ft).
- bh. Install the crankshaft front oil seal and vibration damper assembly (refer to EMEI VEH G 884 — GROUP 1).
- bi. Install the camshaft followers (refer to EMEI VEH G 884 — GROUP 1).
- bj. Install the accessory drive assembly (refer to EMEI VEH G 884 — GROUP 1).
- bk. Install the air compressor assembly (refer to EMEI VEH G 884 — GROUP 12).
- bl. Install the fuel pump assembly (refer to EMEI VEH G 883 — GROUP 4).
- bm. Place new O-rings on the piston cooling nozzles, grooves, lubricate the nozzles and O-rings using a vegetable based oil. Install the nozzles into the apertures in the right hand side of the cylinder block (see Fig. 55), torque the retaining bolts to 15 Nm (11 lb.ft).
- bn. Install and secure the engine wiring harness to the engine using the saddle clamps.
- bo. Install the waterpump and thermostat housing assembly (refer to EMEI VEH G 883 — GROUP 2).
- bp. Install the oil cooler assembly (refer to EMEI VEH G 884 — GROUP 1).

- bq. Install the engine oil pan (refer to EMEI VEH G 883 — GROUP 1).
- br. Install the alternator assembly (refer to EMEI VEH G 884 — GROUP 15).
- bs. Install the oil pump assembly (refer to EMEI VEH G 883 — GROUP 1).
- bt. Install the power steering pump assembly (refer to EMEI VEH G 883 — GROUP 14).
- bu. Install a guide stud in each side of the cylinder block flywheel housing mounting flange, then install the flywheel housing over the guide studs and install the retaining bolts. Tighten the retaining bolts to 7 Nm (5 lb.ft), then mount a dial indicator on the crankshaft and measure the concentricity of the flange internal diameter and the runout of the mounting flange.
- bv. Correct any run out or out of alignment as required, then replace the guide studs with retaining bolts and torque the bolts to 205 Nm (150 lb.ft) using the sequence shown in Fig. 56.

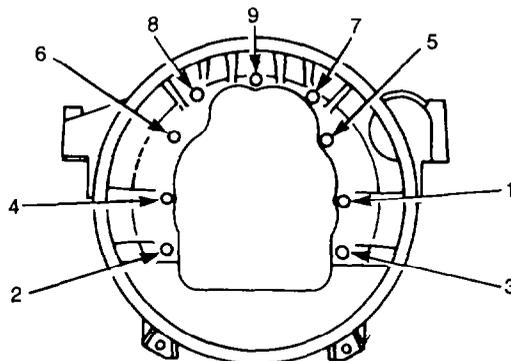


Figure 56 — Flywheel Housing Bolts — Tightening Sequence

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- bw. Install the crankshaft rear oil seal (refer to EMEI VEH G 884 — GROUP 1).
- bx. Install the flywheel assembly (refer to EMEI VEH G 884 — GROUP 1).
- by. Install the starter motor assembly (refer to EMEI VEH G 884 — GROUP 15).
- bz. Install the cylinder head assemblies (refer to EMEI VEH G 884 - 1).
- ca. Install the rocker lever housing and the push rods (refer to EMEI VEH G 884 — GROUP 1).
- cb. Install the C-brake assemblies (refer to EMEI VEH G 884 — GROUP 1).
- cc. Install the rocker covers (refer to EMEI VEH G 883 — GROUP 1).
- cd. Install the dipstick tube and housing (refer to EMEI VEH G 883 — GROUP 1).
- ce. Secure suitable lifting chains to the engine and attach the chains to suitable overhead lifting equipment, with a safe working capacity of 2000 Kg.
- cf. Raise the lifting equipment to support the weight of the engine, and disconnect the engine from the engine stand. Lower the engine onto a suitable floor stand, so as the accessories may be attached to the sides of the engine. Ensure the engine is stable and secure, then disconnect the overhead lifting equipment and chains.
- cg. Install the exhaust manifold (refer to EMEI VEH G 883 — GROUP 1).
- ch. Install the turbocharger assembly (refer to EMEI VEH G 883 — GROUP 4).
- ci. Install the aftercooler assembly (refer to EMEI VEH G 883 — GROUP 1).
- cj. Secure the air conditioning compressor to the engine, then connect the air conditioning low pressure switch to the engine harness.
- ck. Install the STC valve to the left hand side of the engine, remove the sealing plugs and connect the oil control hoses (as tagged) to the appropriate engine component.
- cl. Install the coolant transfer pipes, and connect the pipes (as tagged) to the appropriate engine component.

- cm. Install and connect the fuel pipes (as tagged) to the appropriate engine components.
- cn. Install and secure the PTO hydraulic throttle control to the left hand side of the cylinder block, then attach the operating cable to the fuel pump lever.
- co. Install and adjust the water pump drive belt (refer to EMEI VEH G 883 — GROUP 2).
- cp. Install and adjust the fanbelt (refer to EMEI VEH G 883 — GROUP 2).
- cq. Install and adjust the air conditioning compressor drive belt (refer to EMEI VEH G 883 — GROUP 2).
- cr. Seal all apertures with suitable plastic plugs.
- cs. Fill the engine oil pan with a suitable quantity of clean engine oil.
- ct. Remove the pipe plug from the oil pump cover (see Fig. 57), then install a suitable priming pump with a supply of clean engine oil and pressurize the oil crossover passage to 210 Kpa (30 psi).

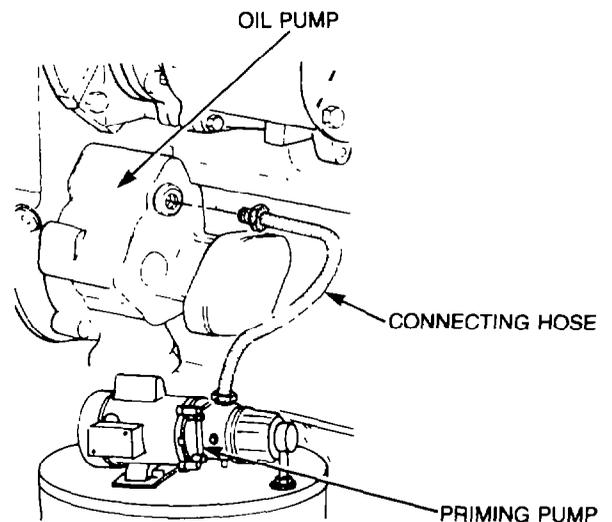


Figure 57 — Oil Crossover Passage — Priming

- cu. Disconnect the priming equipment and replace the pipe plug in the oil pump cover.
- cv. Secure all the pipes, hoses and wires to the engine using suitable clamps and cable tie down clips.

— SPECIFICATIONS —

Cylinder Head

Distortion	Less than 0.076 mm (.003 in.)
Out of Parallel	Less than 0.076 mm (0.003 in.)
Thickness	111.00 - 111.25 mm (4.37 - 4.38 in.)
Machining Limit	110.24 mm (4.34 in.)

Crosshead Guide

Diameter	11.011 - 10.970 mm (0.4335 - 0.4320 in.)
Assembled Height	47.24 - 47.75 mm (1.86 - 1.88 in.)

Valves

Seat Contact Width	1.59 - 3.18 mm (0.063 - 0.125 in.)
Stem Diameter	11.46 - 11.41 mm (0.451 - 0.449 in.)
Seat Angle	30°
Head Thickness	More than 3.15 mm (0.124 in.)

Valve Guides

Inside Diameter	11.494 - 11.560 mm (0.4525 - 0.4550 in.)
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Valve Springs

Tension	655 - 724 N at 43.79 mm (147.25 - 162.75 lb. at 1.724 in.)
---------------	--

Valve Seat Insert

Alignment	Less than 0.05 mm (0.002 in.) per 360°
-----------------	--

Fuel Injector

Tip Protrusion	1.52 - 1.78 mm (0.060 - 0.070 in.)
Seating Area	More than 1.52 mm (0.060 in.)

Cylinder Liner

Bore

Inside Diameter	139.694 - 139.827 mm (5.4998 - 5.5050 in.)
Out-of-Round	Refer to para. 11 t.

Flange

protrusion	0.08 - 0.15 mm (0.003 - 0.006 in.)
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Lower Cylinder Block

Clearance	0 - 0.15 mm (0 - 0.006 in.)
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Camshaft

Cylinder Block

Bearing Bore I.D.	Less than 68.26 mm (2.6875 in.)
------------------------	---------------------------------

Bearing Journals

Diameter	63.37 - 63.42 mm (2.495 - 2.497 in.)
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Bush

Inside Diameter (Installed)	63.457 - 63.558 mm (2.4983 - 2.5023 in.)
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Piston

Maximum Diameter	139.27 mm (5.483 in.)
Gudgeon Pin Bore Diameter	50.762 - 50.800 mm (1.9985 - 2.0000 in.)
Ring Gap	Refer to Table 9

Gudgeon Pin

Diameter	50.768 - 50.774 mm (1.99875 - 1.999000 in.)
Out-of-Round	Less than 0.03 mm (0.001 in.)

Connecting Rod

Bolt Shank Diameter	14.81 - 14.99 mm (0.583 - 0.590 in.)
Bearing Cap Bolt Hole Bore	Less than 15.880 mm (0.6252 in.)
Connecting Rod Bolt Hole Bore	Less than 15.872 mm (0.6249 in.)
Bolt Pad, Fillet Radius	1.14 - 1.40 mm (0.045 - 0.055 in.)

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Connecting Rod Bolt Tightening Torque

First Step	100 Nm (75 lb.ft)
Final Step	230 Nm (170 lb.ft)
Gudgeon Pin Bush I.D.	50.825 - 50.856 mm (2.0010 - 2.0022 in.)
Crankshaft Bearing Bore I.D.	84.219 - 84.244 mm (3.3157 - 3.3167 in.)
Twist	Less than 0.25 mm (0.010 in.)
Bend	Less than 0.10 mm (0.004 in.)
Length (at Bearing Centres)	304.75 - 304.80 mm (11.998 - 12.000 in.)
Side Clearance	0.114 - 0.300 mm (0.0045 - 0.0130 in.)

Crankshaft

Main Bearing Journal Diameter	Refer to Table 6
Connecting Rod Bearing Journal Diameter	Refer to Table 6
Bearing Journal Widths	Refer to Table 7
Thrust Flange Thickness	12.65 - 12.75 mm (0.498 - 0.502 in.)
Distance to Thrust Face	131.06 - 130.81 mm (5.160 - 5.150 in.)
Bend (T.I.R.)	Less than 0.203 mm (0.008 in.)
Nose Total Runout	Less than 0.05 mm (0.002 in.)
Damper Mounting Surface Total Runout	0 - 0.05 mm (0 - 0.002 in.)
Rear Surface Total Runout	Less than 0.05 mm (0.002 in.)
Length	1298.73 - 1300.00 mm (51.131 - 51.181 in.)
End Play	0.18 - 0.56 mm (0.007 - 0.022 in.)

Cylinder Block

Height	482.45 mm (18.994 in.)
Distortion	Less than 0.05 mm (0.002 in.)
Liner Press Fit Area	160.909 mm (6.335 in.)
Liner Press Fit Out-of-Round	Less than 0.03 mm (0.001 in.)
Counterbore Depth	Less than 9.04 mm (0.356 in.)

Crankshaft Plugs

Tightening Torque	7 - 9 Nm (5 - 7 lb.ft)
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Main Bearing Cap Bolts

Tightening Torque

First Step	120 Nm (90 lb.ft)
Second Step	230 Nm (170 lb.ft)
Third Step	345 Nm (255 lb.ft)
Fourth Step	Loosen Completely
Fifth Step	120 Nm (90 lb.ft)
Sixth Step	230 Nm (170 lb.ft)
Final Step	345 Nm (255 lb.ft)

Crankshaft to Camshaft Gears

Backlash	0.05 - 0.50 mm (0.002 - 0.020 in.)
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Gear Cover

Retaining Bolts

Tightening Torque	70 Nm (50 lb.ft)
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Alignment

.....	Less than 0.25 mm (0.010 in.)
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Camshaft Support Bearing

Clearance	0.20 - 0.33 mm (0.008 - 0.013 in.)
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Retaining Bolts

Tightening Torque	25 Nm (20 lb.ft)
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Front Engine Mounting Bracket Bolts

Tightening Torque	70 Nm (50 lb.ft)
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Piston Cooling Nozzle Bolts	
Tightening Torque	15 Nm (11 lb.ft)
Flywheel Housing Bolts	
Tightening Torque	205 Nm (150 lb.ft)

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COOLING SYSTEM — GROUP 2

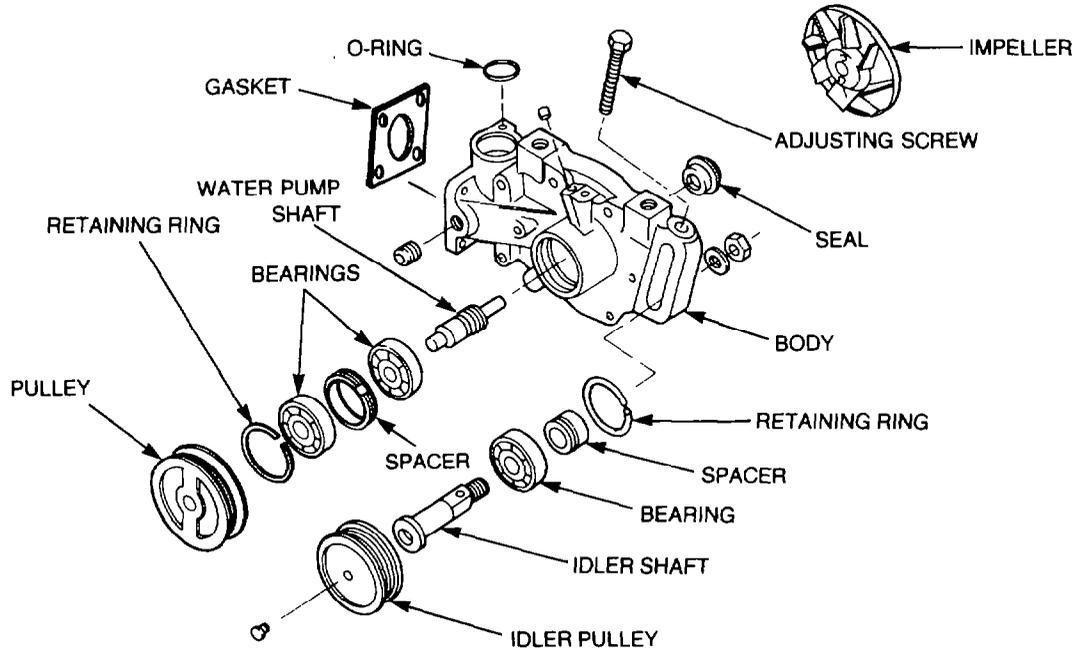


Figure 58 — Water Pump — Exploded View

Water Pump

15. Disassembly

- a. Remove the water pump from the vehicle (refer to EMEI VEH G 883 — GROUP 2).
- b. Remove the nut and washer securing the idler pulley shaft into the water pump body (see Fig. 58), then remove the idler pulley adjusting screw and the idler pulley assembly from the body.
- c. Using special tool 3375265 as shown in Fig. 59, remove the pulley and the impeller from the water pump shaft.
- d. Using a suitable pair of circlip pliers, remove the retaining ring securing the water pump shaft and bearings into the pump body. Then using a suitable press, support the water pump housing on the pulley side and press the bearing and shaft assembly from the body.
- e. Using a suitable pin punch and hammer remove and discard the seal from the pump body.

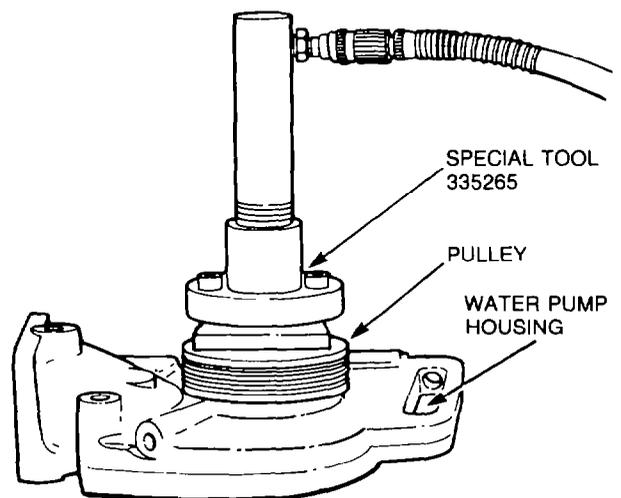


Figure 59 — Water Pump Pulley — Removal

- f. Support the inner bearing, spacer and outer bearing on the water pump shaft with special tool ST-1114 (see Fig. 60) then using a suitable press, remove the shaft from the bearings and spacer.

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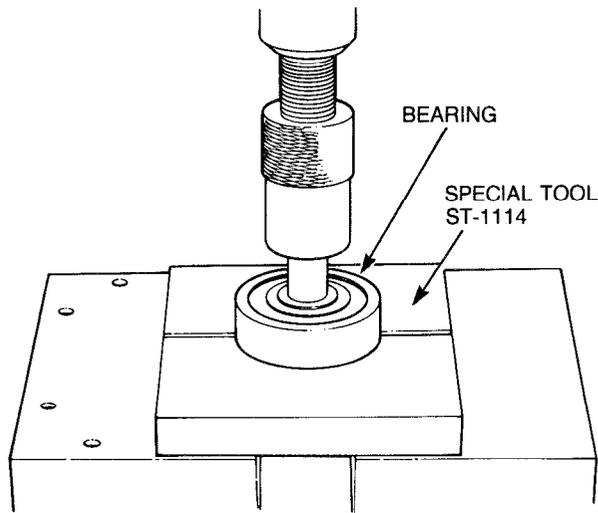


Figure 60 — Water Pump Bearing — Removal

- g. Secure the idler pulley spacer in a soft-jawed vice, then using a soft faced hammer remove the shaft and idler pulley from the spacer (see Fig. 61).

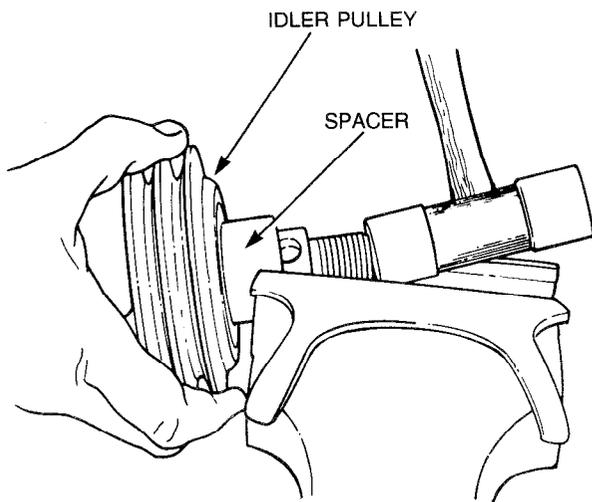


Figure 61 — Idler Shaft and Pulley — Removal

- h. Using a suitable pair of circlip pliers, remove the retaining ring securing the bearing and idler pulley shaft into the idler pulley.
- i. Remove the plug from the face of the idler pulley, then support the pulley in a vice and using a suitable drift and hammer, tap the bearing and shaft from the pulley (see Fig. 62).
- j. Using a suitable press and mandrel, remove the idler shaft from the bearing.

16. Cleaning and Inspection

- a. Thoroughly clean the water pump housing and all the components with a suit-

able cleaning agent, then blow dry with moisture free compressed air.

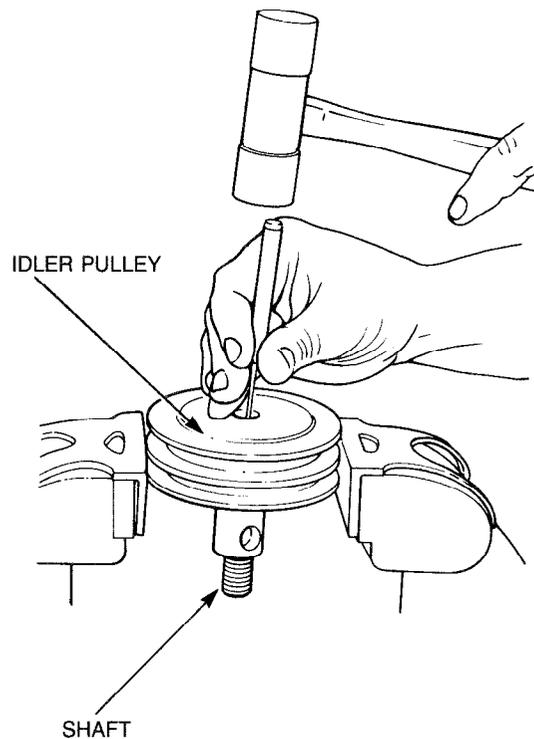


Figure 62 — Bearing and Shaft — Removal

- b. Inspect the water pump and idler pulley bearings for rough or worn races and discard the bearings if wear is evident.
- c. Inspect the water pump impeller for cracks or erosion and replace the impeller if damage is evident.
- d. Using an outside micrometer measure the impeller shaft at the locations indicated in Fig. 63, and replace the shaft if the measurements exceed the dimensions listed in Table 11.

Table 11 — Water Pump Shaft Dimensions

Position	Minimum mm (in.)	Maximum mm (in.)
1. Impeller end	0.6262 (15.905)	0.6267 (15.918)
2. Seat location	0.6262 (15.905)	0.6267 (15.918)
3. Inner bearing	0.9843 (25.001)	0.9847 (25.011)
4. Outer bearing	0.9843 (25.001)	0.9847 (25.011)
5. Pulley end	0.6693 (17.000)	0.6696 (17.008)

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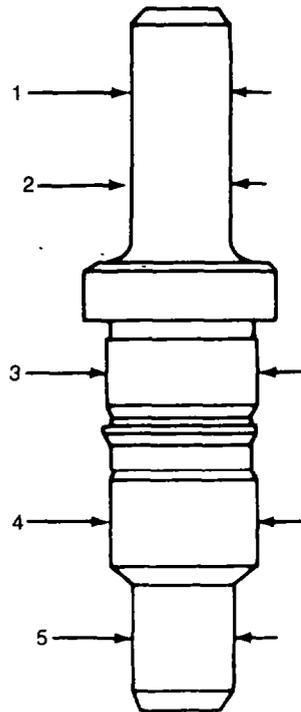


Figure 63 — Water Pump Impeller Shaft

- e. Measure the impeller bore as shown in Fig. 64 and replace the impeller if the measurement exceeds the minimum of 15.85 mm (0.624 in.) or the maximum of 15.88 (0.625 in.) .

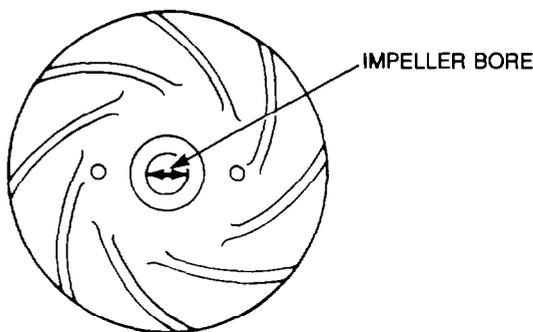


Figure 64 — Measuring Impeller Bore

- f. Inspect the shafts for straightness and galling on the press-fit diameter surfaces, then inspect the pulley grooves for wear, chips or cracks. Replace the shafts or pulleys as necessary.
- g. Measure the drive end of the idler pulley shaft and the idler pulley bore. A press-fit of 0.03 mm (0.001 in.) is required between the shaft and the pulley, replace the shaft or pulley as necessary.
- h. Inspect the water pump housing for cracks or damage caused by a bearing spinning in the housing and ensure that the weep hole is open. Measure the housing bore as shown in Fig. 65 and

replace the housing if the bore diameter exceeds the maximum dimension. The minimum dimension is 61.996 mm (2.4408 in.) and the maximum dimension is 62.012 mm (2.4414 in.).

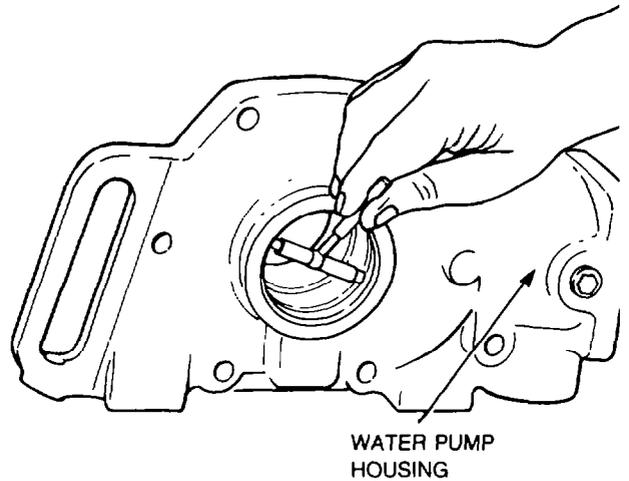


Figure 65 — Measuring Housing Bore

17. Reassembly

- a. Lubricate the idler shaft bearing surface with a thin coat of clean lubricating oil, then using special tool ST-658 to support the inner bearing race, press the shaft into the bearing (see Fig. 66) using a suitable press.

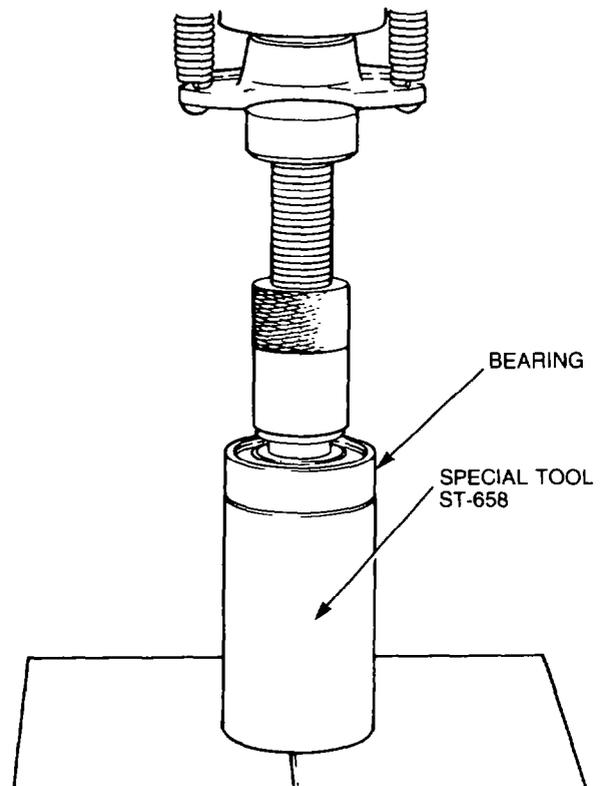


Figure 66 — Installing Idler Shaft Bearing

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- b. Apply a thin coat of Loctite 601 to the bearing outer race, then install the shaft and the bearing into the idler pulley using a suitable press, until the bearing bottoms in the bore of the pulley.
- c. Install the retaining ring into the groove in the pulley with the bevelled side up.
- d. Install the plug into the end of the idler pulley, then place the spacer on the idler shaft and tap the spacer until it seats against the bearing (see Fig. 67).

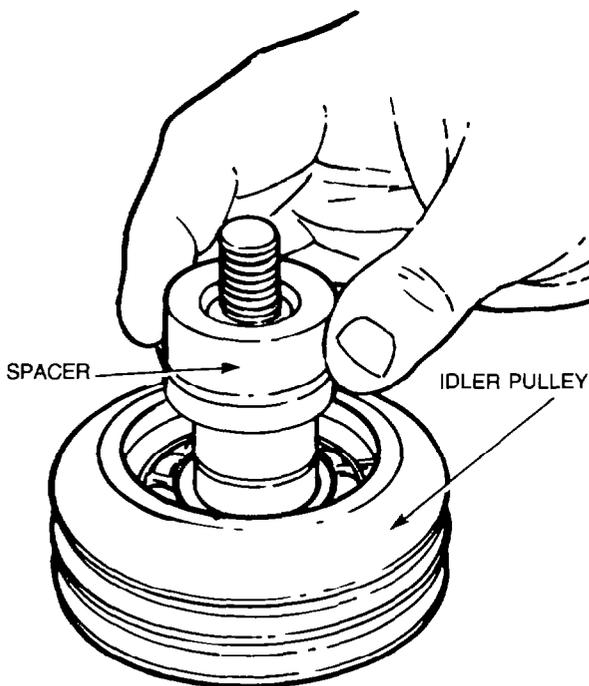


Figure 67 — Water Pump Spacer — Installation

- e. Lubricate the water pump shafts bearing surface with a thin coat of clean lubricating oil, then using special tool ST-658 to support the inner bearing, press the pulley end of the shaft through the bearing until the shoulder of the shaft seats against the bearing race (see Fig. 68)
- f. Support the outer bearing on the special tool ST-658, then position the bearing spacer on the shaft and press the shaft through the bearing until the spacer seats firmly against the bearings. Ensure that both bearings rotate freely.
- g. Apply a thin coat of Loctite 601 to the outer race of both bearings, then support the water pump body on a suitable press and using special tool ST-658

install the bearing and shaft assembly into the water pump body.

- h. Install the retaining ring with the bevelled side up, into the pump body to secure the shaft and bearing assembly.
- i. Support the pulley side of the pump body, then apply Loctite pipe sealant to the outer diameter of the seal. Install the seal into the pump body using special tool 3376091.

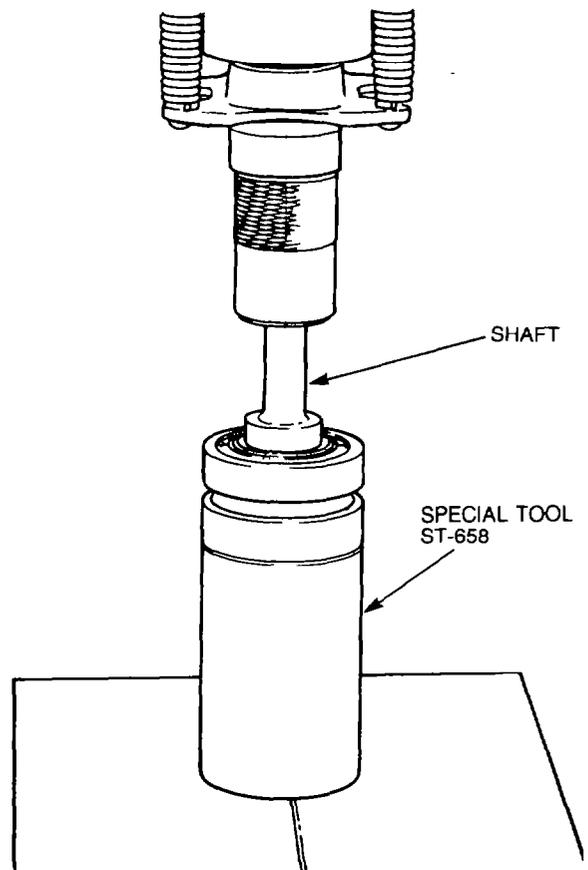


Figure 68 — Water Pump Bearing — Installation

- j. Apply a thin coat of Loctite 601 in the pulley bore and place the pulley face down on the press. Align the shaft with the bore in the pulley and press the shaft into the pulley until the pulley bottoms out on the shoulder of the shaft.
- k. Apply a thin coat of Loctite 601 in the impeller bore, then press the impeller onto the shaft ensuring that a clearance of between 0.51-1.02 mm (0.020 - 0.040 in.) is maintained between the impeller vanes and the housing (see Fig. 69).

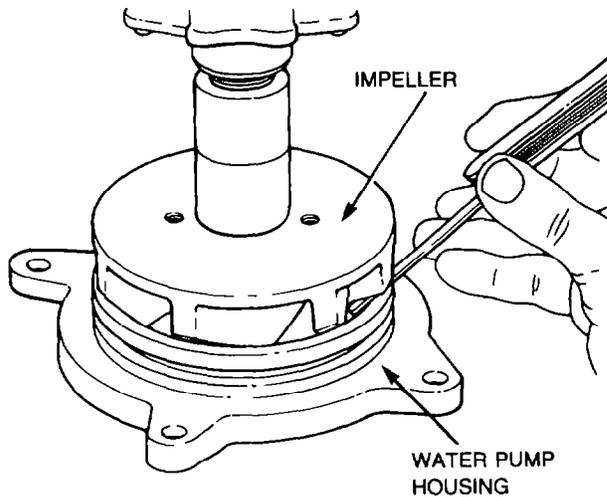


Figure 69 — Measuring Impeller Clearance

- I. Install the water pump on the engine (refer to EMEI VEH G 883 — GROUP 2).

— SPECIFICATIONS —

Impeller Shaft Diameter	
Impeller End.....	15.905 - 15.918 mm (0.6262 - 0.6267 in.)
Seat Location	15.905 - 15.918 mm (0.6262 - 0.6267 in.)
Inner Bearing	25.001 - 25.011 mm (0.9843 - 0.9847 in.)
Outer Bearing	25.001 - 25.011 mm (0.9843 - 0.9847 in.)
Pulley End	17.000 - 17.008 mm (0.6693 - 0.6696 in.)
Impeller Bore.....	15.85 - 15.88 mm (0.624 - 0.625 in.)
Minimum Press-Fit	
Shaft and Impeller.....	0.03 mm (0.001 in.)
Shaft and Pulley	0.03 mm (0.001 in.)
Water Pump Housing Bore.....	61.996 - 62.012 mm (2.4408 - 2.4414 in.)

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FUEL SYSTEM — GROUP 4

Fuel Pump

18. Disassembly

- a. Remove the fuel pump (refer to EMEI VEH G 884 — GROUP 4).
 - b. Clean the exterior of the fuel pump assembly with a suitable cleaning agent, then blow dry with compressed air.
 - c. Position the mounting bracket, special tool 3375133, on the fuel pump front cover and secure the bracket to the cover using the front cover-to-air compressor retaining bolts.
 - d. Secure the fuel pump, via the mounting plate to the ball joint vice special tool ST-302.
 - e. Remove the tachometer connector from the top of the fuel pump front cover.
 - f. With the aid of two pry-bars or special tool ST-709, remove the fuel pump drive coupling from the drive shaft.
 - g. Using a suitable brass drift and a hammer or special tool ST-1134 (dowel puller), remove the tachometer shaft, complete with the gear, bush and seal, from the fuel pump front cover.
 - h. Using a suitable small drift, remove the Woodruff key from the drive shaft, then remove the tachometer drive gear.
 - i. Remove the bolts securing the front cover to the fuel pump housing, hit the edge of the cover with a soft (plastic) headed hammer to loosen the cover, then lift the cover from the pump housing and remove and discard the gasket.
 - j. Before removing the governor weight assembly, check the backlash between the drive gear and the weight shaft gear, using a dial indicator. If the backlash exceeds 0.13-0.23 mm (0.005 - 0.009 in.), check for worn gear teeth or a worn weight shaft bush. Any side to side movement of the weight shaft indicates excessive wear of the bush.
- NOTE**
- The hexagon headed front cover retaining bolt, located at the top left hand side, is fitted with a captive nylon washer to prevent oil leakage. Discard the bolt after removal.
- k. Remove the governor weight assembly from the front cover, and remove and retain the weight assist plunger, spring and shims from the weight carrier assembly, then using a pair of long-nose pliers, unseat the large retaining ring, located between the drive gear and the front cover. Support the front cover in one hand, then drive the drive shaft from the cover with the aid of a copper headed hammer. If the governor weight shaft bush requires replacement, use special tool ST-709 with the inside puller attachment to remove the bush.
 - l. Check the clearance between the driver and the thrust bearing, then remove the driver, thrust bearing, shim, torque control spring and spacer bearing from the governor plunger and remove the governor plunger from the barrel. Replace the drive and thrust bearing if the clearance is outside 0.05-0.13 mm (0.002-0.005 in.).
 - m. Position the front cover on a bench, then with a suitable drift and a hammer, remove the two seals from the cover.
 - n. Place the drive shaft in an hydraulic press, with the splined coupling uppermost. Support the drive gear, then using the splined end of a used gear pump drive shaft (gear removed), press the drive shaft out from the drive gear and the splined coupling.
 - o. Slacken the lock nut on the air/fuel control (AFC) fuel adjustment screw, then remove the fuel adjustment screw and discard the O-ring.
 - p. Unscrew the check valve from the AFC cover plate, then remove the bolts securing the AFC cover plate to the fuel pump housing and remove the cover.
 - q. Carefully lift the diaphragm from the sealing surface, then pull the diaphragm (complete with the piston and plunger assembly) from the AFC barrel.
 - r. Remove the diaphragm return spring and washer, and remove the barrel retaining ring, then using special tool 3375599, remove the AFC barrel from the fuel pump housing and discard the barrel O-rings.
 - s. Remove the screws securing the coil housing to the shutoff valve housing and remove the coil housing, the fuel shield, the spring washer and the plate valve, then remove and discard the O-ring located in the valve housing.

Remove the shutoff valve manual opening knob, by turning the knob in a clockwise direction until it bottoms, then with the aid of a pair of pliers, continue turning the knob until the knob separates from the shaft. Remove the shaft and discard the shaft O-ring.

- t. Using an Allen key, remove the bolts securing the shutoff valve housing to the fuel pump housing. Remove the shutoff valve housing and discard the sealing ring.
 - u. Using an Allen key, remove the bolts securing the pulsation damper and the fuel filter adapter assembly to the rear of the gear pump, then remove the pulsation damper and discard the sealing ring.
 - v. Remove the bolts securing the cover plate to the head (fuel filter adapter), separate the cover plate from the head and remove the spring steel diaphragm, the nylon washer and the O-rings. Discard the O-rings.
 - w. Remove the check valve assembly (elbow) from the top of the gear pump and discard the valve assembly.
 - x. Using an Allen key, slacken the bolts securing the two sections of the gear pump together, then remove the four bolts securing the gear pump to the fuel pump housing. Remove the gear pump by hitting the side of the gear pump with a soft (plastic) headed hammer to loosen the pump from the ring dowel. Remove the gear pump and discard the gasket.
 - y. Before separating the two sections of the gear pump assembly, insert a suitable drift into the dowel holes in the gear pump housing and hit the drift with a hammer to drive the dowels from the housing, until they protrude approximately 19 mm (3/4 in.) from the gear pump cover. Remove the bolts securing the two sections then separate the housing from the cover, note the position of the driven gear in relation to the location notches on the gear pump body, then remove the gears from the housing. Remove the pressure regulator from the gear pump cover.
 - z. Using an Allen key, remove the four bolts securing the governor spring pack cover to the fuel pump housing. Remove the cover and discard the gasket.
- aa. Remove the circlip retaining the governor spring and remove the spring seat, shims, spring and the idle plunger guide assembly. Remove the driver, thrust bearing, shim, spring, spacer bearing and plunger from the barrel.
 - ab. Using a screwdriver, remove the filter screen cover from the top of the fuel pump housing, then remove the spring and the filter screen. Remove and discard the cover O-ring.
 - ac. Remove the rivets securing the throttle shaft cover to the fuel pump housing and remove the cover.
 - ad. Remove the no air adjusting screw from the throttle housing and discard the O-ring.
 - ae. Remove the throttle shaft retaining ring from inside the fuel pump housing, accessed at the front cover end of the housing, then remove the throttle shaft and remove and discard the O-ring.
 - af. Secure the throttle shaft in a soft-jawed vice, then with the aid of a suitable drill, remove the ball plug from the end of the throttle shaft and remove the fuel adjusting screw, noting the number of turns taken to remove the adjusting screw. Remove and discard the O-ring.

19. Cleaning and Inspection

CAUTION

The governor springs are colour coded to assist in the calibration of the fuel pump. Do not clean the springs in a hot (acid) bath or the reference colour will be removed creating difficulties in identification should the springs require replacement at a later date.

- a. Clean the fuel pump components in a suitable cleaning agent, then blow dry with clean, moisture free compressed air.
- b. Inspect the governor plunger, the AFC plunger and the throttle shaft for rounded edges, scoring, wear or damage and replace as necessary.
- c. Check the sealing surface on the drive shaft for grooves. If grooves are evident, replace the shaft complete with the bearing. If grooving is not evident, inspect the bearing for damage or wear and replace the bearing as necessary.

- d. Inspect the pulsation damper cover and head for damage and replace as necessary, then check the pulsation damper spring steel diaphragm for hidden cracks, by dropping the diaphragm (from a small height) onto a hard surface. A clean ringing sound indicates the diaphragm is serviceable. If necessary compare with the sound of a new diaphragm.
- e. Check the drive gear and the weight shaft gear teeth for wear or damage and replace the gears as necessary.
- f. Check the governor weight pins for wear by placing either two 6.0 mm (0.25 in.) drill bits or two new weight pins under the weight feet, then try to insert an 11/64 in. (4.365 mm) drill bit down between the weight feet. If the drill bit can be inserted, remove the weight pins, using a suitable brass drift and hammer, and discard the pins, inspect the weights for wear or damage and replace both weights (as a set) if either weight is worn or damaged.
- g. Clean the pump body and cover with a suitable cleaning agent, then blow dry with compressed air. Remove the pressure valve and check that all fuel parts and galleries are clean.
- h. Inspect the gear pump shafts for wear or damage and replace the shafts if damaged or if the diameter of the shaft is worn to less than 12.695-12.703 mm (0.4998-0.5001 in.). Press the shaft from the gears with the aid of a suitable mandrel and a hydraulic press.
- i. Check the width of the gears and replace the gears if the width is worn to less than 19.006-19.014 mm (0.7483-0.7486 in.)
- j. Using a depth micrometer, check the depth of the gear recess in the pump body. If the depth exceeds 18.994-19.002 mm (0.7478-0.7481 in.) or if the recess is badly scored or grooved, replace the pump body.
- k. Check the gear pump cover for excessive scoring or grooving and check the shaft bore in both the pump cover and body for wear. The bore diameter should be 12.733-12.740 mm (0.5013-0.5016 in.) when measured with an inside micrometer. Replace the cover if scoring or grooving is excessive or replace either or both the cover and the pump body if the shaft bore diameter exceeds the upper limit.
- l. Inspect the AFC diaphragm and replace if split, perished or damaged. Inspect the AFC check valve, ensure that the hole near the bottom of the valve is not plugged and that the check ball moves freely. Replace the valve as necessary.
- m. Clean all parts of the shut off valve (except the coil) with mineral sprits and blow dry with compressed air. Clean the coil with a clean dry cloth and polish the coil face with a 200 grit emery cloth on a flat surface. Check the valve and valve seat for dirt, metal particles, wear, bonding separation or corrosion and replace as necessary. Check that the valve set has a minimum width of 0.38 mm (0.015 in.).
- n. Using an ohmmeter, check for a coil resistance of 7.5 ± 0.5 Ohms. Replace the coil if the reading is less than specified.
- o. Replace the governor weight assist spring, the idle spring and the high speed spring with springs of matching colour codes.
- p. Inspect the fuel pump body and the front cover for cracks or damage and replace as required.
- q. Inspect the governor plunger barrel for scoring and replace as necessary.

NOTE

If the governor plunger is damaged, replace the governor plunger barrel.

- r. To replace the plunger barrel, remove the pipe plug from the bottom of the pump housing, then pull the spring dowel, locating the barrel, from the housing with the aid of a wire hook. Heat the pump housing (evenly) in an oven to a temperature of 149°C (300°F), to expand the aluminium housing, then position the housing in a press and press the barrel from the housing with the aid of a suitable mandrel, and remove the governor spring housing.
- s. Inspect the barrel bore in the housing for score marks. If deeply scored, replace the housing.
- t. Allow the housing to cool, then check for a 0.05 mm (0.002 in.) interference fit between the barrel and the housing. If there is no difference between the

diameter of the barrel and the bore in the housing, replace the housing.

- u. Scribe a centre line on both the pump housing and the face of the barrel to align the fuel passages, then heat the housing in an oven to a temperature of 149°C (300°F). Install the governor spring housing, then coat the barrel with a high pressure lubricant and position the governor barrel in the bore (chamfered end first and with the locating pin hole toward the bottom of the housing). Align the centre lines on both the barrel and the housing, then press the barrel into the housing, using an arbor press, until it bottoms against the governor spring housing.
- v. Select a new plunger (class 2 or green colour code) and try to install the plunger into the barrel. If the plunger enters the barrel try the next size up (class 3, yellow). Keep trying larger sizes until a plunger will not enter the barrel, then select a plunger two sizes smaller than the last plunger that did enter the barrel. Lubricate the plunger with test oil, then start the plunger in the barrel bore. When released, the plunger should slowly drop into the barrel. When the correct barrel size is selected, mark the governor barrel with the class size of the plunger.
- w. Install the spring dowel into the bottom of the barrel with the aid of special tool 3376136. Ensure that the slot of the dowel is facing the front of the pump.
- x. Check the drive shaft bush for wear or damage. Measure the inside diameter of the drive shaft bush with an inside micrometer. If the diameter exceeds 19.11 mm (0.7525 in.), replace the bush with the aid of a 0.5 in. pipe tap. Thread the pipe tap into the bush, then insert a suitable brass drift through the rear of the pump housing and drive the tap and bush from the housing by hitting the drift with a hammer.
- y. Apply a thin coating of high pressure lubricant to a new bush and position the bush over the drive shaft bore in the housing. Place the housing in an arbor press, align the bush with the housing bore then press the bush into the housing bore.
- z. Using special tool ST-490 and a well oiled 19.05 mm (0.750 in.) reamer (see

Fig. 70) line ream the bush to 19.04-19.06 mm (0.7495-0.7505 in.).

- aa. Inspect the throttle sleeve for wear or damage. If wear or damage is evident the pump housing must be sent out (to Cummins) for replacement of the throttle sleeve.

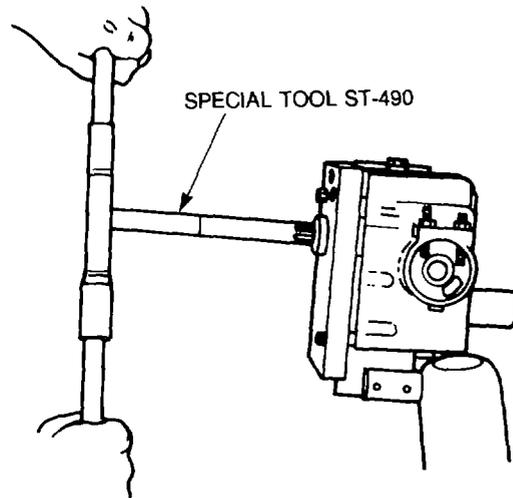


Figure 70 — Reaming the Drive Shaft Bush

20. Reassembly

- a. Lubricate the fuel adjusting screw and a new O-ring with clean diesel fuel and install the O-ring onto the adjusting screw.
- b. Secure the throttle shaft in a soft-jawed vice and install the fuel adjusting screw into the throttle shaft, the same number of turns noted at disassembly or approximately six turns. Ensure that the fuel hole in the throttle shaft is fully open.
- c. If the throttle shaft stop lever was removed, position the stop lever on the throttle shaft, as shown in Fig. 71. Install and torque both set screws to 8-10 Nm (70-90 lb.in.)

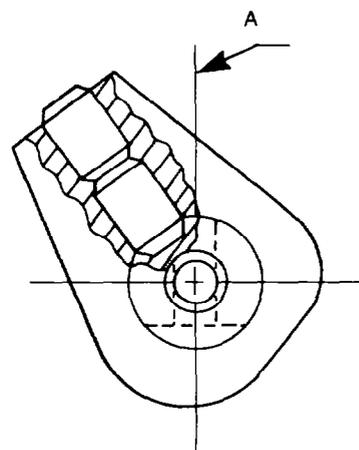


Figure 71 — Throttle Shaft Stop Lever Location

- d. Remove the throttle shaft from the vice, then lubricate the throttle shaft and a new O-ring and install the O-ring onto the throttle shaft.
- e. Lubricate the throttle shaft bore in the fuel pump housing with clean diesel fuel, then insert the throttle shaft into the housing, ensuring that the fuel port counterbore is facing toward the bottom of the fuel pump housing. Secure the throttle shaft in the fuel pump housing with a new retaining ring, installed through the front cover end of the fuel pump housing.
- f. Lubricate the no-air needle valve and a new O-ring with clean diesel fuel and install the O-ring onto the needle valve using special tool 3375148, then install the needle valve into the fuel pump housing and install the lock nuts, but do not tighten the lock nut at this stage.
- g. Install a new filter screen in the top of the fuel pump housing and position the spring on top of the filter screen. Install a new O-ring in the filter screen cover, then install the cover and tighten securely.
- h. Assemble the idle speed adjusting screw, washer, idle spring and the idle plunger (button) into the idle plunger guide, lubricate the assembly with clean diesel fuel, then install the assembly into the governor spring housing. Install the governor spring, the shim(s) and the spring seat into the spring housing and secure in place with a new circlip.
- i. If either the gears or the shafts of the gear pump were replaced, coat the shafts with clean diesel fuel, then press the gears onto the shafts until the gears are 17.27-17.53 mm (0.5013-0.5016 in.) from the body end of the shaft.
- j. Install a new pressure valve in the gear pump cover using special tool 3377449. Ensure that the valve is seated evenly and 0.38 mm (0.015 in.) below the cover face, then lubricate the shafts and gears with clean diesel fuel and install the shafts and gears into the gear pump body in the positions noted at disassembly.
- k. Lightly tap the dowel pins back through the gear pump cover until the pins are flush with the fuel pump housing mounting face of the gear pump cover. Position a new cover-to-pump body gasket over the dowel pins, then install the cover on the pump body, ensuring that the location notches on both the cover and the pump body are aligned. Install the four socket head retaining bolts and screw the bolts in evenly and alternately until the cover is seated against the pump body, then torque the bolts to 15-18 Nm (11-13 lb.ft).
- l. Check that the gear pump drive shaft end-play does not exceed 0.038 mm (0.0015 in.) and that the drive shaft protrusion is within 60.2-61.3 mm (2.370-2.412 in.).
- m. Lubricate the gear pump drive shaft ring dowel with clean diesel fuel, then install the ring dowel over the drive shaft and into the recess in the gear pump cover.
- n. Install a new gasket on the gear pump cover, then position the gear pump assembly on the fuel pump housing. Align the ring dowel with the recess in the fuel pump housing, then install and screw the socket head retaining bolts into the fuel pump housing, evenly and alternately, to ensure that the ring dowel is properly aligned and seated in the fuel pump housing. Torque the retaining bolts to 15-18 Nm (11-13 lb.ft).
- o. Assemble a new nylon washer and a new O-ring in the pulsation damper cover plate and install a new O-ring in the head (fuel filter adapter) of the pulsation damper. Lubricate the diaphragm with a 20 W grade oil, then position the diaphragm in the head. Assemble the cover plate on the head, then install and torque the retaining bolts to 15-18 Nm (11-13 lb.ft).
- p. Install new sealing rings in the recesses in the pulsation damper head, then position the pulsation damper on the rear of the gear pump, then install the four socket head retaining bolts and torque the bolts to 15-18 Nm (11-13 lb.ft).
- q. Lubricate the shut off valve manual opening shaft and a new O-ring with a suitable grease, then screw the shaft into the shut off valve housing until it bottoms in the housing. Using a depth micrometer set at 2.997 mm (0.118 in.), check the distance from the face of the valve housing to the tip of the shaft. If necessary, screw the shaft out until it touches against the end of the depth gauge, then without altering the position of the shaft, press the knob onto the shaft until it touches the valve housing.

- r. Place the valve in the housing with the rubber side toward the housing, then smear a new O-ring with a suitable grease and install the O-ring in the groove in the valve housing. Install the spring washer onto the valve, with the cavity side up, and positioned around the valve locator, then place the fuel shield and the coil housing over the spring washer and secure the coil housing with the retaining screw. Torque the screw to 2.8-3.4 Nm (25-30 lb.in.)
- s. Install a new sealing ring in the top of the fuel pump housing, then position the shut off valve assembly over the sealing ring. Install the socket head retaining bolts and torque the bolt to 7-11 Nm (5-8 lb.ft).
- t. Apply a light coating of a 50/50 mixture of lubricating oil additive and a clean lubricating oil on the AFC barrel O-rings, then install the O-rings onto the barrel. Install the barrel spring into the barrel bore in the fuel pump housing, then install the barrel, taking care not to damage to O-rings. Apply pressure to the end of the barrel to compress the barrel spring, then install the barrel retaining ring. Ensure that the retaining ring is properly seated in the groove in the housing.
- u. Smear the plunger O-ring with engine oil, then install the O-ring into the groove on the plunger just below the thread.
- piston lock nut to 3.4-4.5 Nm (30-40 lb.in.). Ensure that the parts are correctly aligned and that the diaphragm is not twisted.
- y. Install the diaphragm assembly over the threaded end of the AFC plunger, then install the plunger lock nut and tighten the lock nut finger tight.
- z. Install the plunger and piston assembly into the AFC barrel and position the tab on the diaphragm uppermost, then carefully push the diaphragm down between the piston and the housing, and ensure that the diaphragm is sitting flat at the cover mounting surface.
- aa. Position the cover over the diaphragm, align the bolt holes, then install the three retaining bolts and tighten the bolts finger tight.
- ab. Install the check valve into the AFC cover and torque the valve to 7 Nm (5 lb.ft).
- ac. If not assembled, press a new bearing on the new drive shaft, then position the fuel pump drive shaft gear with the flanged side up in a press. Suitably support the gear, place the large retaining ring over the gear flange, then start the drive shaft and bearing assembly into the bore of the drive gear. Press the drive shaft into the gear until the bearing butts against the flange of the gear. Remove the shaft and gear assembly from the press, then position and suitably support the splined coupling in the press. Start the gear end of the drive shaft into the splined coupling, then press the drive shaft into the coupling until the coupling butts against the gear.
- ad. Position the fuel pump front cover (front down) in an arbor press, ensure that the cover is suitably supported, then install the drive shaft, bearing end first, into the cover. Press the shaft in until the bearing butts against the shoulder in the cover. Remove the cover and shaft assembly from the press and install the large retaining ring into the groove in the cover, using long nose pliers. Look through the holes in the drive gear to ensure that the retaining ring is correctly located in the groove.
- ae. Position the front cover and drive shaft assembly in the press, with the drive shaft splined coupling down, and position special tool ST-419 over the end of
- v. Remove all trace of oil from the piston, then assemble the sealing washer, the flat washer, the diaphragm, the piston, the piston retaining washer and the piston lock nut onto the air/fuel insert (centre bolt).
- w. Position the spring shim in the seat groove of the diaphragm return spring, then install the spring (shim first) into position in the fuel pump housing.
- x. Align the washers and piston with the diaphragm, then hold the air/fuel insert with a suitable spanner and torque the

CAUTION

Ensure that the rounded edge of the flat washer is toward the diaphragm, and if the diaphragm has a part number, position the part number toward the piston.

the drive shaft. Position the drive shaft inner seal (with the sealing lip down) over the special tool, then with the aid of a suitable mandrel, press the seal into the front cover, until it butts against the inner race of the bearing. Position the outer seal (with the sealing lip up) on the special tool, then press the seal into the front cover, until it butts against the inner seal. Remove the assembly from the press and remove the special tool from the drive shaft.

- af. Start the tachometer shaft, bush and gear assembly into the tachometer drive shaft bore in the front cover, align the oil groove in the top of the bush with the drive shaft, then press the assembly into the front cover until the bush bottoms.

CAUTION

Do not apply excessive pressure, otherwise the spacer will be pressed flat, destroying its efficiency.

- ag. Install the spacer (slotted edge down) on top of the bush and ensure that the spacer is seated on the bush. Position a new seal, (spring side down) over the tachometer shaft, then press the seal into place using a suitable drift. Cover the top of the oil seal with a thin coating of oil, then install the tachometer housing and torque the housing to 47-61 Nm (35-45 lb.ft)
- ah. Install the tachometer drive gear into position on the fuel pump drive shaft. Ensure that the tachometer gears are meshing and the Woodruff key recess is aligned with the key slot in the shaft, then install the Woodruff key.
- ai. Position the front cover assembly in an arbor press and start the drive shaft coupling onto the drive shaft, ensuring that the keyway is aligned with the Woodruff key, then support the cover assembly on the splined coupling and press the drive coupling onto the shaft with the aid of a suitable mandrel.
- aj. Lubricate the outer circumference of the governor shaft bush with a suitable grease, then press the bush into the recess in the front cover until the bush seats against the cover.
- ak. Position the governor weights in the governor weight carrier, align the pivot

pin holes, then with the aid of an arbor press, install the new pivot pins. If the governor weight shaft gear was replaced, press the new gear onto the weight shaft, using the press and a suitable mandrel.

- al. Lubricate the governor weight shaft assembly with clean diesel fuel, then slide the carrier assembly into the bush in the front cover. Open the governor weights out and rotate the governor shaft, to ensure that the shaft will rotate without the weights fouling.

NOTE

Install the weight assist plunger with the smallest end towards the weights.

- am. Lubricate with clean diesel fuel, then install the weight assist spring, shim and plunger into the bore of the governor weight shaft. Using special tool ST-1241 check the plunger protrusion. Add or remove shims as necessary to obtain a plunger protrusion of 20.3 mm (0.8 in.), with a tolerance of ± 0.254 mm (0.010 in.).
- an. Lubricate the governor plunger with clean diesel fuel and install the plunger, drilled end first, into the governor barrel.
- ao. Lubricate with clean diesel fuel, then install the spacer bearing, the torque control spring, the shim, thrust bearing and the driver on the governor plunger.
- ap. Position a new front cover-to-fuel pump housing gasket over the ring dowels on the fuel pump housing, then position the front cover over the gasket. Ensure that the splines in the drive shaft coupling are meshed with the splines on the gear pump drive shaft, and that the ring dowel recesses in the front cover are aligned with the ring dowels in the pump housing. Install the socket head retaining bolts and a new hexagon head retaining bolt, with a captive nylon washer, Ensure that the hexagon head bolt is positioned at the top left hand side of the cover, then torque the retaining bolts to 15-18 Nm (11-13 lb.ft).
- aq. Remove the pump assembly from the vice and position the governor spring pack cover, together with a new gasket, over the spring pack. Install and torque the retaining bolts to 12-15 Nm (9-11 lb.ft).

21. Calibration

- a. Liberally coat the tachometer drive gears with clean engine oil, then install the fuel pump on the test bench and tighten the retaining bolts securely.
- b. Remove the AFC cover plate and install the AFC adjusting tool, from special tool kit 3375189, then connect a 0-207 kPa (0-30 psi) regulated air supply to the adjusting tool port.
- c. Prime the gear pump by pouring clean test oil (No. 3375364) through the inlet port of the pump.
- d. Remove the plug from the top of the pump housing and fill the fuel pump housing with clean test fuel, then install the plug.
- e. Connect the fuel outlet line to the fuel pump shut off valve and tighten the connection securely.
- f. Connect a hose to the drain line check valve on the gear pump, then remove the fuel filter (if fitted) and install a fuel filter adapter and gasket special 3375014.
- g. Turn the manual opening knob on the shut off valve in a clockwise direction to open the shut off valve, then open the flow control valve on the test stand. Move the throttle lever to the full open position and hold the throttle open with a spring. Do not use hand pressure to hold the throttle open.

CAUTION

Do not run the fuel pump at speeds above 1,000 rpm until all the air has been purged from the pump (check the flow meter), or damage to the pump may occur.

- h. Start and run the test bench at 500 rpm, then check the suction of the gear pump to ensure that the pump is pumping fluid and no air is evident. At 500 rpm close the fuel suction valve to obtain 8-10 in./Hg of vacuum.
- i. Open the suction valve and increase the test bench speed to 2000 rpm and allow the pump to run at this speed for two or three minutes to bring the pump to operating temperature and to ensure that all the air is removed.
- j. Check that the test oil has reached a temperature of 32-38° C (90-100° F),

then set the suction restriction of the fuel pump to 178 mm/Hg (7.0 in./Hg) of vacuum during the run-in period.

- k. To set the governor cut off speed, close the test bench idle orifice and leakage valves and open the flow control valve. Increase the pump speed to 2100 rpm (rated speed) and apply an air pressure of 169 kPa (24.5 psi) to the AFC.
- l. Adjust the flow control valve until the flow meter indicates 516 lb. per hour. Ensure that there is no air in the fuel flow meter, and check that the fuel pressure is a minimum of 1092 kPa (159 psi), then adjust the vacuum valve on the fuel inlet line to obtain a reading of 178 mm/Hg (7.0 in./Hg) on the vacuum gauge. If the correct vacuum setting cannot be obtained, check for restrictions in the fuel supply line filter on the test bench and rectify as necessary.
- m. If the flow rate cannot be obtained and held, check the idle plunger (button) and, check the governor has not exceeded the cut off speed. Replace the idle plunger (button) with a new number 15 idle plunger part No. 139894, if required.
- n. To set the governor cut off speed, open the fuel pressure gauge valve on the test bench and ensure that the throttle lever is in the full fuel position, then increase the pump speed to the point where the fuel pressure decreases by one psi. The pump stand speed should be 2130 to 2150 rpm. If the speed is not within specification either add or remove shims, from between the governor spring and the spring retainer, to increase or decrease the cut off speed respectively (see Fig. 72).

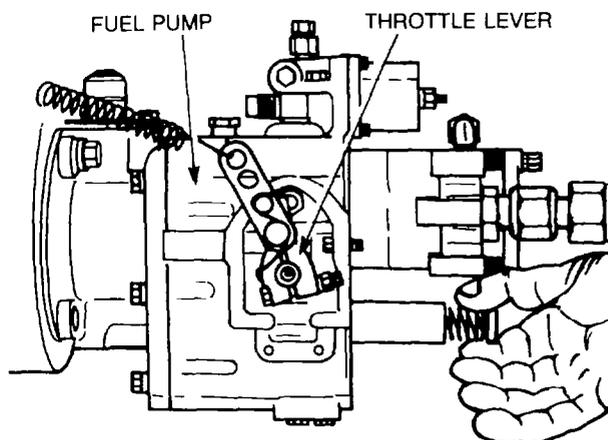


Figure 72 — Governor Cut Off Speed — Adjustment

NOTE

The cut off speed will change approximately two rpm for every 0.001 in. of shim thickness either added or removed. If more than 0.150 in. of shim thickness is required, replace the governor spring.

- o. After altering the governor spring shims, run the pump and move the throttle lever from the front to the rear several times to expell the air from the pump, then repeat para. l. to ensure that the governor cut off speed is to specification.
- p. Decrease the test bench speed to 2100 rpm. Open the throttle leakage valve, on the test bench, and close the main fuel flow and idle orifice valves, then move the throttle lever toward the gear pump and hold it using a suitable spring.

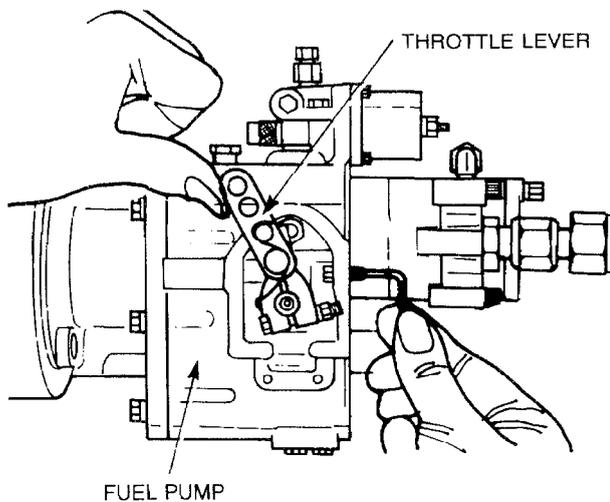


Figure 73 — Setting the Throttle Leakage

CAUTION

This test procedure will cause the temperature of the test oil to rise substantially. Avoid running the fuel pump longer than one minute with the throttle closed.

- q. Check the throttle leakage with the throttle leakage flow meter on the test bench (if equipped), or by using a 200 cm³ container. Move the throttle lever toward the rear throttle stop screw and check the leakage, when a light load is applied to the lever, and when a heavy

load is applied to the lever. If the leakage decreased when the heavy load was applied, set the leakage under these conditions. Adjust the stop screw to obtain the correct setting of 110 cm³ per minute, then tighten the lock nut and recheck the leakage and readjust as necessary. Do not overheat the gear pump.

- r. Open the main flow valve, then close the throttle leakage valve and check the temperature of the test oil.
- s. To set the idle speed, with the throttle leakage valve closed, run the test bench at 500 rpm and ensure that the idle orifice valve is open, then close the main flow control valve.
- t. Move the throttle lever to the idle position and hold it tightly against the rear stop screw using a spring, then check the idle pressure on the fuel pressure gauge. If the reading on the fuel pressure gauge is not 254 kPa (37 psi) adjust the idle adjusting screw, located in the governor spring housing, using special tool 3375981 idle adjustment screw. Turn the adjusting screw into increase the readings and out to decrease the readings. Install and torque the plug in the governor spring pack cover to 4.5-5.6 Nm (40-50 lb.in.)
- u. To adjust the throttle lever travel position the throttle lever against the rear stop screw, then position special tool 3375855 on the throttle lever. Move the throttle lever to the full fuel position and check the number of degrees of travel from the rear stop screw to the full fuel position. If necessary, adjust the full fuel stop screw to obtain a total travel of 28 degrees from stop to stop.

NOTE

Ensure that there is 172 kPa (24.5 psi) air pressure applied to the AFC.

- v. To adjust the calibration pressure open the main flow valve, then close the idle orifice and leakage flow meter valves on the test bench. Move the throttle to the full fuel position, then run the test bench up to 2100 rpm and adjust the flow meter 516 lb. per hour. Check that the reading on the fuel manifold pressure gauge is greater than 1092 kPa (159 psi), then set the suction restriction of the fuel pump to 178 mm./Hg (7.0 in./Hg). Adjust the fuel adjusting screw (located in the bore of the throttle

shaft) to obtain readings of 1092 kPa (159 psi) at 516 lb. per hour, then check that the fuel pump suction restriction is set at 178 mm.Hg (7.0 in.Hg). If not, adjust as necessary. Readjust the fuel adjusting screw to obtain all three values simultaneously.

NOTE

If the torque requirement to turn the fuel adjusting screw is less than 0.17 Nm (1.5 lb.in.), replace the fuel adjusting screw.

- w. Lower the test bench (speed) to 1300 rpm adjust the flow meter to 461 lb.per hour. Fuel pressure should be between 882- 923 kPa (128-134 psi) if the pressure is not within specification check the governor plunger torque spring for incorrect seating incorrectly shimed or the wrong spring. Seat the spring or install the correct shims or replace the spring as necessary. If the thickness of the shims exceeds 1.52 mm (0.060 in.) replace the spring. Recalibrate the fuel pump and check the governor cut off speed (refer to para l.) and the fuel manifold pressure (refer to para. v.).

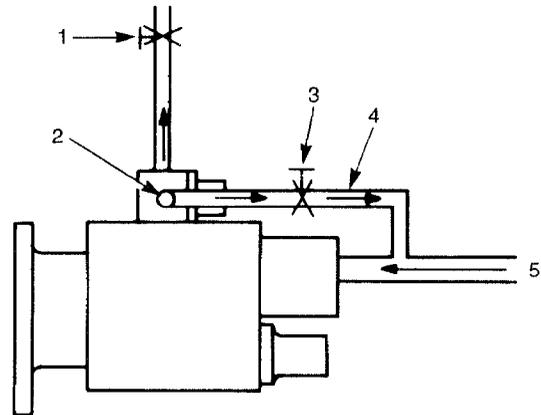
NOTE

To remove and/or install the governor plunger torque spring, it will be necessary to rotate the spring to expand the inside diameter.

CAUTION

Ensure that the weight assist plunger is installed with the smallest end toward the governor weights.

- x. Install a 0.25 in. needle valve and two pieces of No.4 (3/16 in. I.D.) flexible wire hose between the shut off valve and the gear pump inlet port or the test bench fuel tank (see Fig. 74). Install a female quick connect fitting to one end of a hose, no more than 150 mm (6 in.) long, then connect the quick connect fitting to the fuel pump shut off valve and the other end to the 0.25 in. needle valve. Connect the other short piece of hose between the needle valve and fuel inlet pipe or drain back to the tank.
- y. Set the test bench speed at the AFC calibrating speed at 1600 rpm, then move the throttle lever to the open position.



- 1. Flow valve in the test stand
- 2. Quick connect
- 3. Needle valve 0.25 in.
- 4. No. 4 flexible hose
- 5. Fuel inlet

Figure 74 — No Air Setting and Checking Plumbing

- z. Set the AFC diaphragm air pressure at 172 kPa (25 psi), close the idle and leakage valves on the test bench, then adjust the main flow valve and the 0.25 in. needle valve to obtain an AFC plunger setting flow of 454 kPa (66 psi) at the 306 lb. per hour.

CAUTION

Do not change the flow valve setting of the test bench during the remainder of the test.

- aa. Slacken the no-air screw lock nut, then using the AFC no-air adjusting tool from special tool kit 3375185, turn the no-air screw in until it bottoms. Close the 0.25 in. needle valve completely, then lower the air pressure on the AFC diaphragm to zero and allow the flow meter and fuel pressure readings drop to zero, then increase the air pressure on the AFC diaphragm to 27 kPa (3.9 psi).

CAUTION

The plunger setting must always be reached while increasing the air pressure on the AFC diaphragm. If the diaphragm pressure is adjusted too high, lower the air pressure to zero and wait until the fuel flow returns to or near to zero before applying the correct air pressure to the diaphragm.

ab. Using special tool 3375137 (previously installed) slacken the AFC plunger lock nut, then lower the air pressure on the AFC diaphragm to zero and adjust the AFC plunger either in or out to obtain a fuel pressure of 453 kPa (66 psi). Ensure that both of the sockets of the special tool are fully retracted before taking a pressure reading, otherwise the wrong pressure reading will be indicated.

NOTE

If the position of the AFC piston changes while adjusting the plunger, repeat the procedures detailed in paras. ad and ae.

CAUTION

Carefully tighten the AFC plunger lock nut to the specified torque as the plunger can easily be broken.

ac. Torque the plunger lock nut to 2.8-4.0 Nm (25-35 lb.in.), then check the fuel pressure and the fuel flow rate to ensure they are correct.

ad. Lower the AFC diaphragm air pressure to zero and remove the AFC plunger adjustment tool. Position the AFC cover plate on the fuel pump housing and install the retaining bolts, ensuring that the bolt with the lockwire drilling is positioned at the bottom. Torque the retaining bolts to 3.4-4.0 Nm (30-35 lb.in.) Check the AFC plunger setting is 453 kPa (66 psi) at 1600 rpm with 27 kPa (3.9 psi) applied to AFC diaphragm.

NOTE

The fuel pump no air adjusting screw must be closed when setting the AFC plunger.

ae. Set the test bench speed to 1600 rpm and move the throttle lever to the open position. Apply an air pressure of 172 kPa (25 psi) to the AFC diaphragm and adjust both the main flow valve, on the test bench, and the 0.25 in. needle valve at the fuel pump.

NOTE

Do not change the flow valve setting of the test bench during the remainder of this test.

af. Close the 0.25 in. needle valve completely and lower the AFC diaphragm air pressure to zero. Using the tool from special tool kit 3375137 to adjust the no air screw to obtain the no air flow and pressure readings of 413 lb. per hour flow and 800 kPa (116 psi) respectively. Tighten the lock nut securely using the adjusting tool, then recheck the settings.

ag. Remove the plug from the tap of the fuel pump housing and install a 200 kPa (30 psi) pressure gauge in the port. Run the fuel pump at 600 rpm then close the throttle and check the pressure reading, if the pressure inside the housing exceeds 103 kPa (15 psi), replace the pressure valve in the gear pump cover and recheck the pressure. Remove the pressure gauge, then install the plug into the pump housing and tighten the plug securely.

ah. Shut the test bench down, remove the hoses and connections from the fuel pump assembly, then remove the fuel pump assembly from the test bench.

ai. Drain the test fuel from the fuel pump housing and the governor spring pack cover. Install the plug in the spring pack cover and torque the plug to 4.5-5.6 Nm (40-50 lb.in.). Replenish the fuel pump housing with clean diesel fuel, then install and securely tighten the fuel pump housing plug.

aj. Install the fuel pump (refer to EMEI VEH G 883 — GROUP 4).

Fuel Injector

22. Disassembly

a. Remove the fuel injector from the vehicle (refer to EMEI VEHICLE G 884 — GROUP 4).

b. Install the injector body wrench 3375102 in a vice.

c. Using a suitable cleaning solvent, clean the outside of the injector assembly, then blow dry with compressed air.

NOTE

If more than one injector is being disassembled, mark or tag removed components to assist during reassembly.

d. Using a pair of needle nose pliers remove the injector plunger link (see Fig. 75) from the injector assembly.

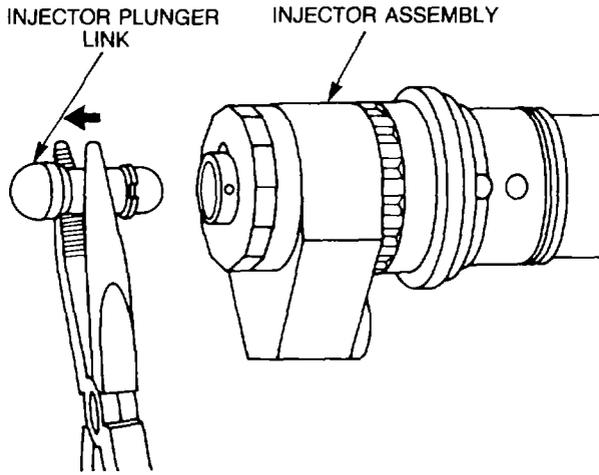


Figure 75 — Injector Plunger Link — Removal

- e. Position the injector assembly in the injector body wrench 3375102, then using the top stop injector crowsfoot wrench 3375166 loosen the tappet to top stop cap (see Fig. 76, item 1).

- f. Remove the tappet top stop cap, tappet top stop lock nut, STC tappet and the washer (items 1, 2, 3 and 6) from the stop screw (item 7).
- g. Using the top stop crowsfoot wrench 3375166 loosen the lock nut (item 5), then using a pin punch remove the stop screw (item 7) from the injector adapter (item 12).

NOTE

The injector plunger and barrel are a matched set, do not mix plungers and barrels.

- h. Remove the injector from the injector body wrench 3375102, then remove the injector link and the injector plunger (items 4 and 8) from the injector adapter and barrel (items 12 and 20).
- i. Remove the injector spring retainer (item 9) and the two compression

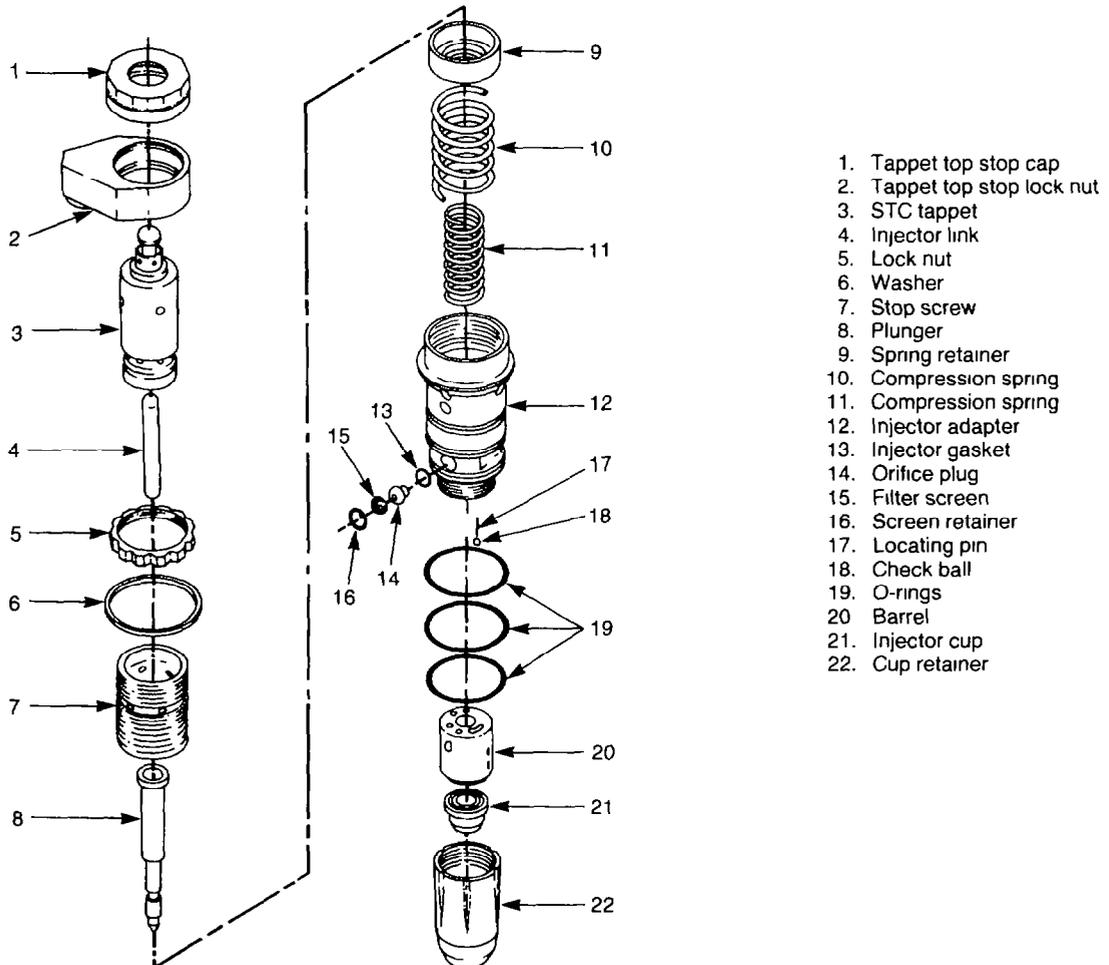


Figure 76 — Injector — Exploded View

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springs (items 10 and 11) from the injector adapter (item 12).

- j. Place the injector into the injector body wrench 3375102 with the injector cup (item 21) uppermost, then position special tool ST-995 on the injector cup retainer (item 22). Using special tool ST-1072 on special tool ST-995, loosen the cup retainer (see Fig. 77), then remove the retainer.

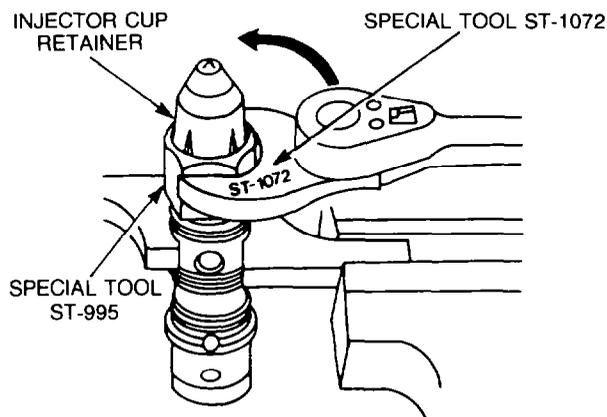


Figure 77 — Injector Cup Retainer — Removal

- k. Place the injector cup retainer on a flat bench top, then using the manufactured brass punch A and a hammer, remove the injector cup from the cup retainer (see Fig. 78).

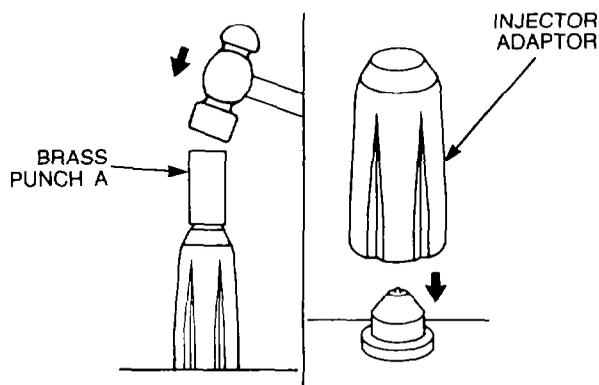


Figure 78 — Injector Cup — Removal

- l. Remove the injector from the body wrench while holding the injector barrel (item 20) against the injector adapter (item 12), then invert the injector and remove the barrel (item 20) from the adapter (item 12).
- m. Invert the barrel (item 20) and remove the check ball (item 18).

NOTE

Mark or tag the injector plunger and barrel to ensure they are retained as a matched set.

- n. Remove the screen retainer and the filter screen (items 16 and 15) from the injector adapter (item 12), then remove and discard the three O-rings (item 19).
- o. Remove the tappet plunger and compression spring from the tappet sleeve (see Fig. 79).

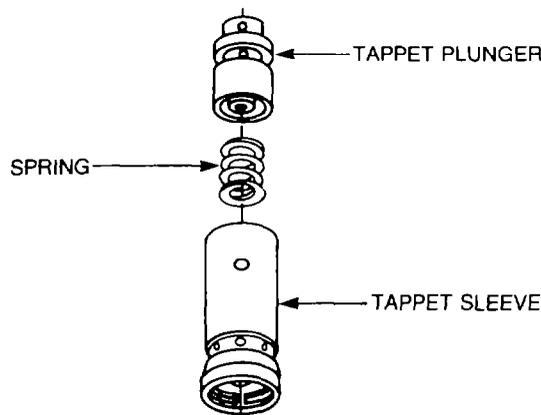


Figure 79 — Tappet Plunger and Spring — Removal

- p. Remove the spring guide, compression spring and the check ball from the tappet plunger (see Fig. 80).

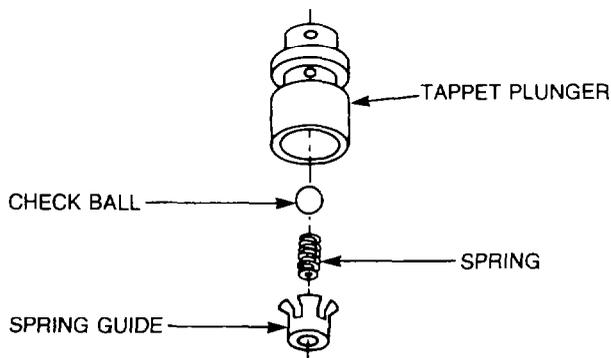


Figure 80 — Tappet Plunger — Disassembly

- q. Using a suitable pair of circlip pliers, remove the retaining ring from the tappet sleeve (see Fig. 81), then remove the tappet socket, compression spring, ball guide retainer and the check ball.

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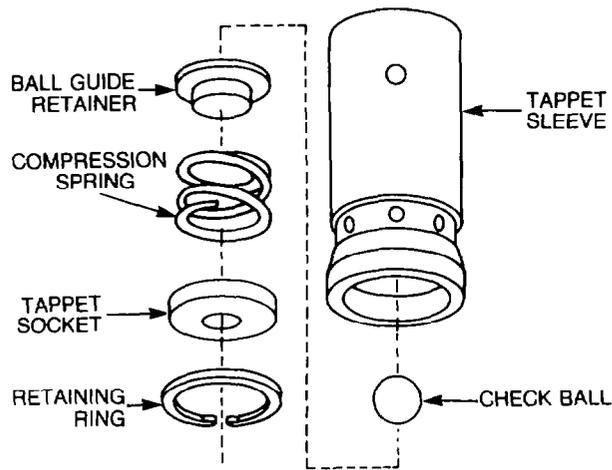


Figure 81 — Tappet Sleeve — Disassembly

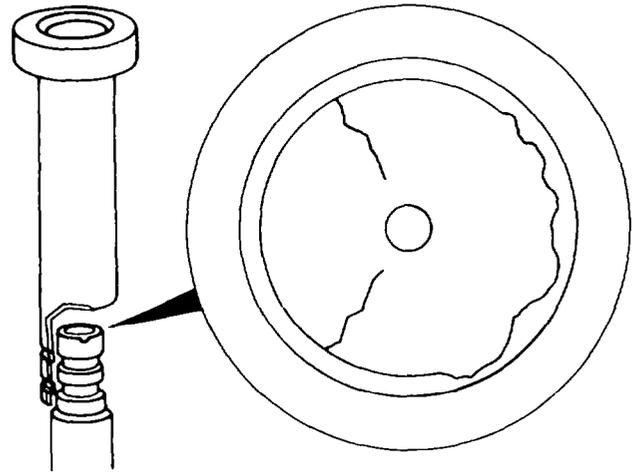


Figure 82 — Link Socket Seat — Inspection

23. Cleaning

CAUTION
Do not use drills, other metal instruments or brushes of any type to clean injector components

- a. Using an ultrasonic cleaner 3376665, cleaning solution 3375003 or cleaning powder 3376666, clean the injector components until all traces of carbon, varnish, and dirt are removed.

WARNING
When using solvents as a cleaning agent, care must be taken to avoid personal injury.

- b. Wash the injector components in mineral spirits to neutralize the ultrasonic cleaning solution, then blow dry with compressed air.

24. Inspection and Testing

NOTE

The plunger and barrel are a matched set and must be replaced as a set.

- a. Inspect the plunger link socket seat as shown in Fig. 82 for cracking or broken walls. If the seat is cracked or broken, replace the plunger and barrel.

- b. Inspect the plunger for loose crimps, cracked coupling or wear spots in the spring and retainer coupling area (see Fig. 83).

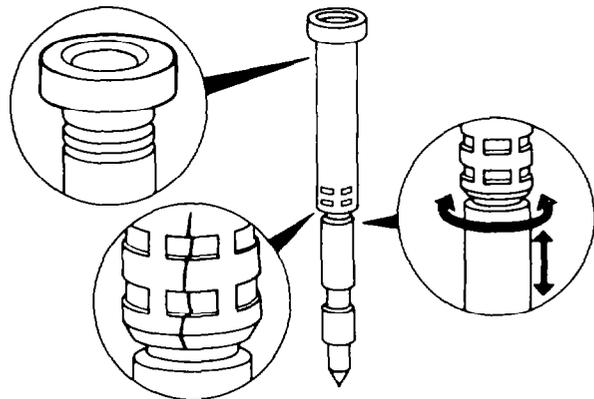


Figure 83 — Injector Plunger — Inspection

- c. Inspect the plunger barrel for deep scratches, cracks or loose plugs and replace the plunger and barrel if wear is evident.
- d. Apply bluing to the barrel to injector cup mating surface, then rotate the barrel 90° on a lapping plate and check for surface flatness.
- e. If the surface is not flat use a grade A280 grit lapping paste on a lapping plate and lap the barrel mating surface using a figure eight pattern.
- f. Remove all trace of the lapping paste by cleaning the barrel as detailed in para. 23.

- g. Inspect the check ball for nicks or flat spots and replace as necessary.
- h. Install the check ball into the barrel and using a depth gauge measure the distance from the top of the barrel to the check ball (see Fig. 84). If the measurement exceeds 1.40 mm (0.055 in.) replace the plunger and barrel.

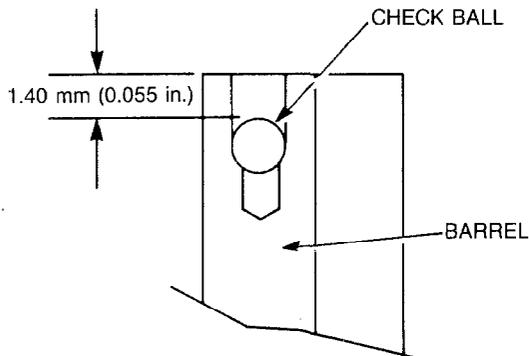


Figure 84 — Measuring Check Ball Depth

- i. Inspect the barrel check ball seat for damage and if damage is evident weld a new check ball to a small rod and using a 600 grade lapping paste on the ball lap the seat.
- j. Remove all trace of the lapping paste by cleaning the barrel as detailed in para 23.
- k. Recheck the depth of the check ball in the barrel and if the measurement exceeds 1.40 mm (0.055 in.) replace the barrel and plunger.

NOTE

Ensure that a fibre ball and not a steel ball is used in the leakage flow meter.

- l. Ensure that the switches on the injector leakage tester 3375375 are in the OFF position, then install the injector barrel test fixture 3376297 onto the injector leakage tester. Connect the black hose from the leakage tester to the fixture and the white hose to the adapter.
- m. Using clean calibration fluid 3375364 lubricate the barrel check ball and seat, then install the barrel into the test fixture with the check ball uppermost (see Fig. 85). Align the dowel pins on the adapter with the holes in the barrel, then clamp the barrel into the tester.

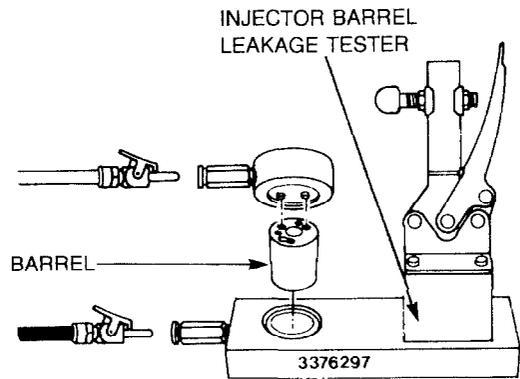


Figure 85 — Barrel and Test Fixture

CAUTION

The air supply switch must be in the OFF position whenever the other valves are switched to the ON position to prevent air pressure from blowing the oil from the bubble checker.

- n. Move the air supply switch to the ON position and adjust the air pressure to 414 kPa (60 psi).
- o. Switch the air supply switch to the OFF position, then turn the check ball leakage switch ON. Move the air supply switch to the ON position and observe the flow meter for check ball leakage. The maximum check ball leakage is 8.5 units at 414 kPa (60 psi).
- p. If the leakage is high, move the air supply switch ON and OFF several times to ensure that the check ball seats. If the reading remains too high, remove the barrel and ball valve and repeat the cleaning procedure as detailed in para. 23.
- q. Lubricate the check ball and seat with clean calibration fluid, then reinstall the barrel in the test fixture. Test the check ball for leakage again, and if the reading still exceeds the specification, remove the barrel from the test fixture.
- r. Lap the check ball into the barrel seat, then clean all trace of the lapping paste from the barrel seat using the cleaning procedure detailed in para. 23.
- s. Install the barrel in the test fixture and test for leakage again. If the barrel leakage still exceeds specifications replace the barrel and plunger.

- t. Switch the air supply and the check ball leakage switch to the OFF position, then remove the barrel from the test fixture.
- u. Remove the injector barrel test fixture from the injector leakage tester.

NOTE

The cup can be re-used if minor erosion is present, but the hole size has not changed.

- v. Using a microscope of at least a 30 power magnification, inspect the spray holes and tip of the injector cup and compare them with a new cup. Replace the cup if pitting, corrosion or erosion is evident either internally or externally.
- w. Using a new injector plunger, apply bluing to the plunger tip, then insert the plunger into the injector cup and rotate the plunger 90°.
- x. Remove the plunger and check the seating pattern. If the seating pattern is not continuous or seats in less than one quarter of the cup cone, replace the cup.
- y. Apply bluing to the cup-to-barrel mating surface of the cup, then rotate the cup 90° on a lapping plate and check for surface flatness.
- z. If the surface is not flat use a grade A280 grit lapping paste on the surface of the cup and lap the surface on a lapping plate until the surface is flat.
- aa. Remove all trace of lapping paste by cleaning the barrel as detailed in para. 23.

NOTE

The injector cup spray tester 3376350 is connected to the injector test stand 3375317 as shown in Fig. 86.

CAUTION
Do not attempt to calibrate injectors at the same time as the spray tester is in operation. The injector test stand clamping control handle must be in the unlocked position for the spray tester to operate.

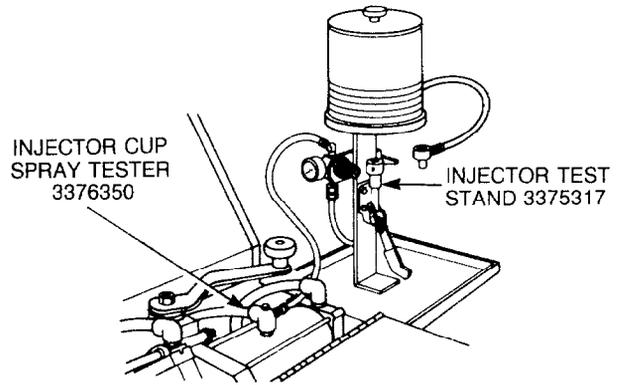


Figure 86 — Injector Cup Spray Tester

- ab. Install the cup adapter STD PTD and O-ring onto the tester oil supply hose and position the oil ring 3376682 into the cup adapter, then install the injector cup into the adapter (see Fig. 87).

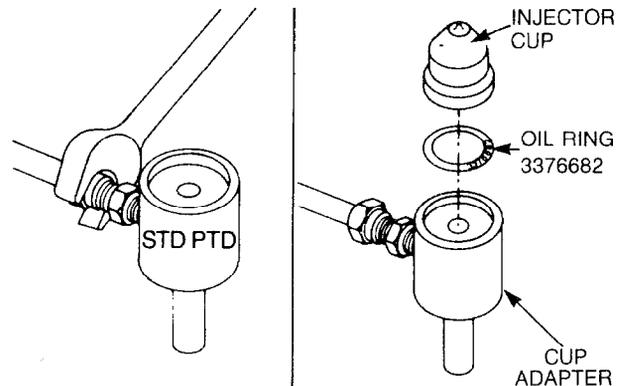


Figure 87 — Injector Cup Adapter

- ac. Install the cup adapter into the spray tester clamp adapter (see Fig. 88) and secure in position with the set screw.

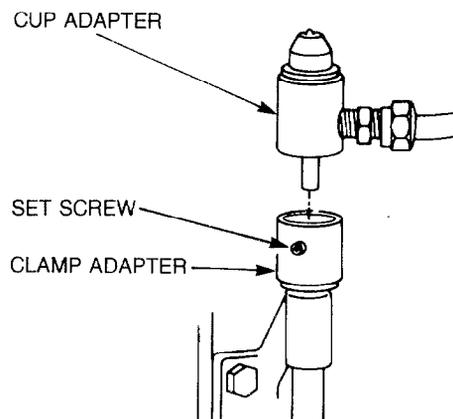


Figure 88 — Cup Adapter to Clamp Adapter — Installation

- ad. Loosen the four clamp adapter mounting bolts and position the injector cup

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against the tester O-ring so that only a moderate clamping force is necessary to seal the cup and O-ring. Tighten the mounting bolts and move the clamping lever to the clamped position (see Fig. 89).

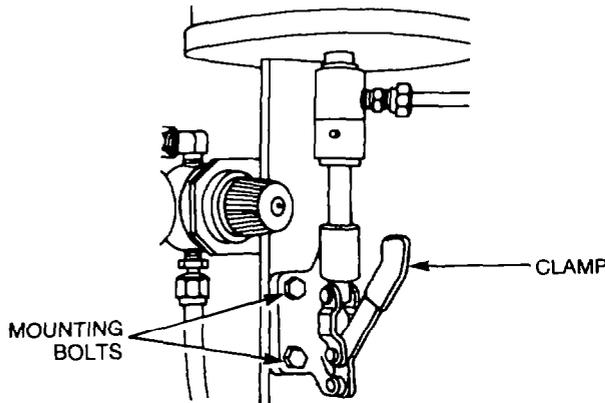


Figure 89 — Injector Cup — Clamping

- ae. Ensure that the injector cup spray tester's supply valve is in the OFF position and that the injector fuel supply handle on the injector test stand is in the ON position.
- af. Turn the injector test stand mains switch to the ON position, then press the fuel system ON button.
- ag. Adjust the fuel pressure regulator to 55-69 kPa (8-10 psi), then set the spray tester ON-OFF valve to the ON position.
- ah. Observe the spray pattern of the cup and record which mark on the tester the spray pattern is nearest to. The correct spray angle is 18° from each of the nine injector cup orifices. The scribed marks represent an angle of approximately 5° between one another. The limit for used cups is plus or minus 2°. All the spray holes should produce the same spray pattern and obtain the same height (see Fig. 90).

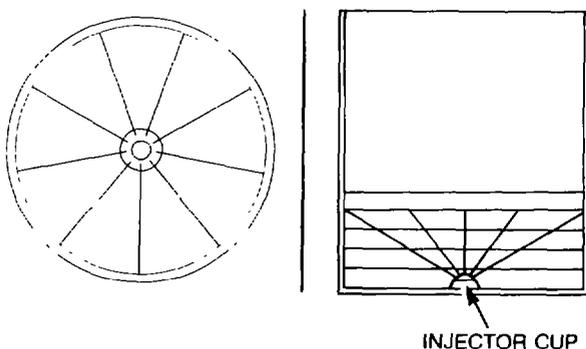


Figure 90 — Injector Cup Spray Pattern

- ai. If the spray pattern is poor, set the spray tester ON-OFF valve to the OFF position and remove the injector cup from the tester.
- aj. With a suitable piece of plastic hose fitted to an air gun nozzle, place the plastic hose over the injector cup tip and blow out any restriction in the spray holes.
- ak. Install the injector cup in the spray tester and check the spray pattern. If the spray pattern is still poor, remove the injector cup from the spray tester and clean the cup as detailed in para. 23.
- al. Retest the injector cup and if the spray pattern is still poor, discard the cup.
- am. Inspect the injector adapter for damage to the threads, O-ring grooves and the barrel mating surface for nicks or burrs (see Fig. 91). Replace the adapter if damage is evident.

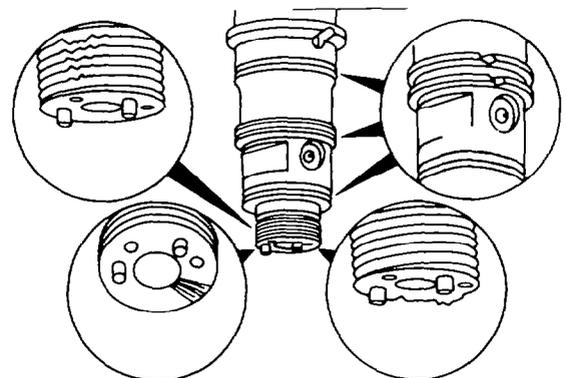


Figure 91 — Injector Adapter — Inspection

- an. Inspect the stop screw, lock nut and injector adapter threads for damage (see Fig. 92) and replace as necessary.

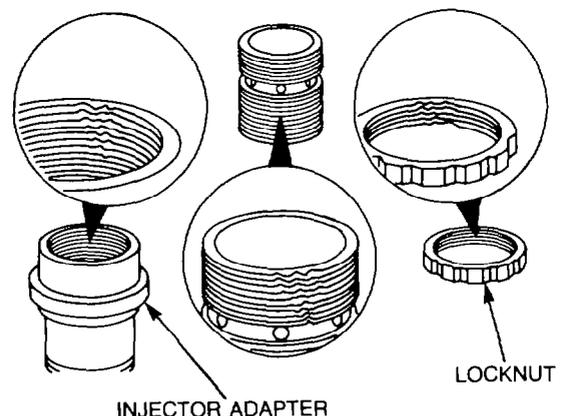


Figure 92 — Stop Screw, Lock Nut and Injector Adapter — Inspection

- ao. Inspect the tappet top stop cap and the tappet top stop lock nut for internal

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thread damage (see Fig. 93) and replace as necessary.

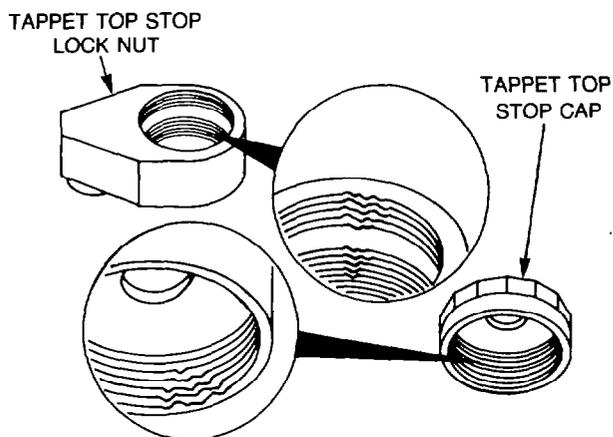


Figure 93 — Tappet Top Stop Cap and Lock Nut — Inspection

ap. Using an air gun at the orifice plug check for any air leakage in the internal bore of the injector adapter. If air leakage is evident replace the injector adapter (see Fig. 94).

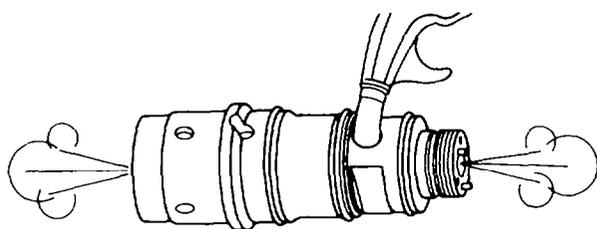


Figure 94 — Injector Adapter — Leakage Test

aq. Inspect the injector cup retainer for any thread damage and for any excessive wear on the inside or outside surface of the cone area caused by contact with

the cylinder sleeve or injector cup (see Fig. 95).

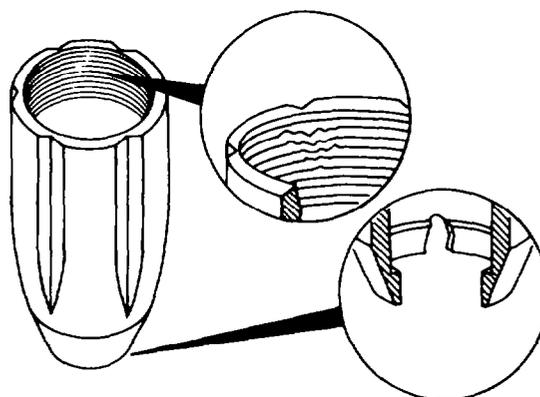


Figure 95 — Injector Cup Retainer — Inspection

ar. Inspect the two compression springs for excessive wear or damage, then using a V-block, dial indicator and a flat surface, check the springs for squareness. Place the spring in the V-block with the dial indicator plunger resting on the spring (see Fig. 96) then set the dial indicator to zero and rotate the spring through approximately 270 deg. while maintaining contact with the spring, V-block and dial indicator plunger.

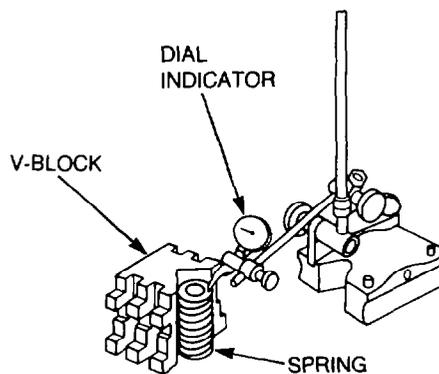


Figure 96 — Compression Spring — Testing

Table 12 — Injector Spring Tolerances

Part No	Free Length mm (in.)	Min. Load kg (lb.)	Max. Load kg (lb.)	Length mm (in.)
3034167	37.8460 (1.490)	38.8 (85.70)	43.4 (95.70)	26.80 (1.055)
3023478	38.2524 (1.506)	49.8 (110.0)		57.1 (126.0)

- as. Invert the spring and carry out the same procedure and if the spring is out of square in excess of 0.41 mm (0.016 in.) or damaged, replace the spring.
- at. Using a suitable valve spring tester (see Fig. 97), test the springs to the lengths detailed in Table 12 and discard the springs if the length is achieved at less than the minimum load detailed in Table 12.

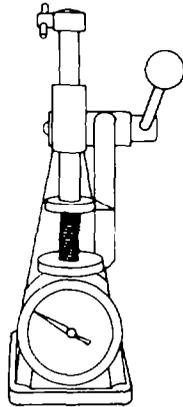


Figure 97 — Injector Spring Free Length and Tension — Checking

- au. Using a suitable depth gauge measure the spring retainer for wear as shown in Fig. 98. If wear exceeds 0.076 mm (0.003 in.) replace the spring retainer.

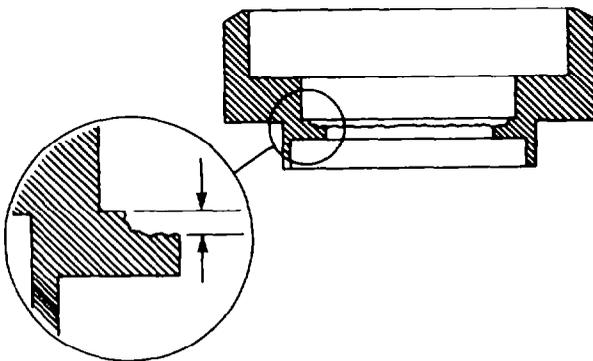


Figure 98 — Measuring Spring Retainer

- av. Inspect the injector link for wear and replace the link if wear is evident.
- aw. Inspect the STC tappet components (see Fig. 99) for damage or wear and replace as necessary.

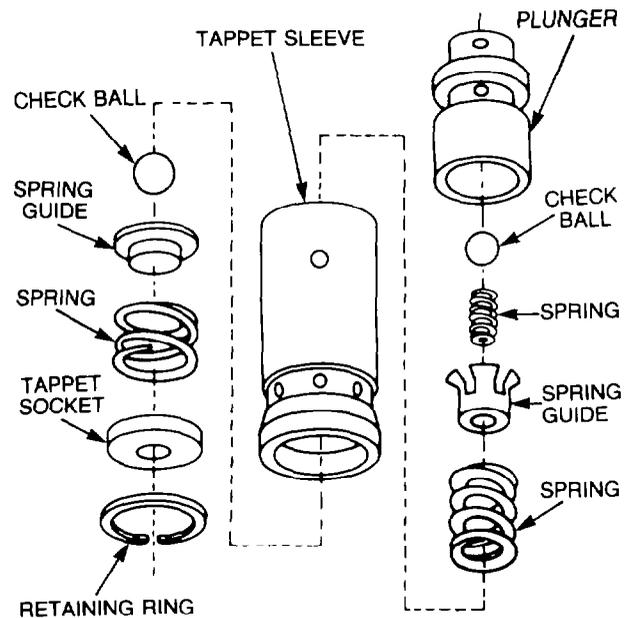


Figure 99 — STC Tappet — Components

25. Reassembly and Testing

- a. Install the injector body wrench 3375102 in a vice.

NOTE

If more than one injector is to be assembled, ensure that corresponding marked or tagged components are used.

- b. Install the check ball (see Fig. 100 item 18) into the barrel (item 20), then using clean calibration fluid 3375364 lubricate the check ball and seat.
- c. Hold the barrel (item 20) with the check ball (item 18) uppermost, then install the injector adapter (item 12) ensuring that the locating pins (item 17) in the adapter correctly locate into the barrel.
- d. Invert the adapter and barrel (items 12 and 20), then using clean calibration fluid lubricate the injector cup to barrel mating surface and position the injector cup (item 21) on the barrel (item 20).
- e. Lubricate the thread of the cup retainer (item 22) and the injector cup (item 21) with clean calibration fluid, then install the cup retainer onto the injector adapter (item 12) finger tight.

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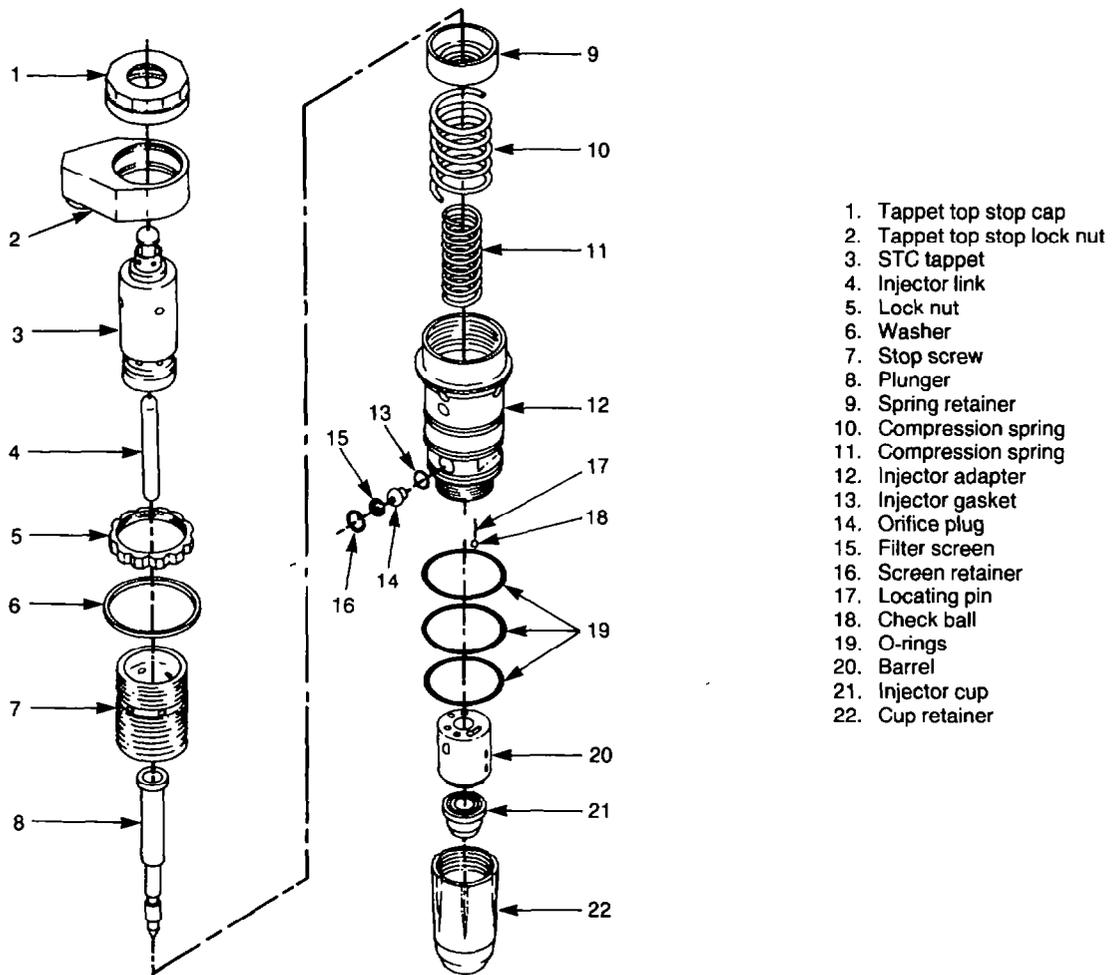


Figure 100 — Injector — Exploded View

NOTE

The springs (items 10 and 11) and spring retainer (item 9) are not installed at this time.

NOTE

The retaining ring is bowed and should be installed with the convex side toward the tappet socket.

- f. Lubricate the injector plunger (item 8) with clean calibration fluid, then install the plunger into the adapter (item 12).

NOTE

This completes the sub-assembly ready for testing. Refer to para. j. for the test procedure.

- g. Install the check ball, ball guide retainer, compression spring and tappet socket into the tappet sleeve and secure in position with the retaining ring (see Fig. 101).

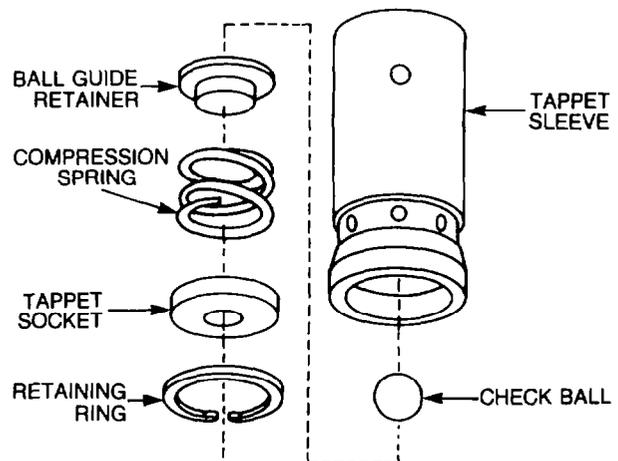


Figure 101 — Tappet Sleeve — Assembly

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- h. Install the check ball, spring and spring guide into the tappet plunger (see Fig. 102).

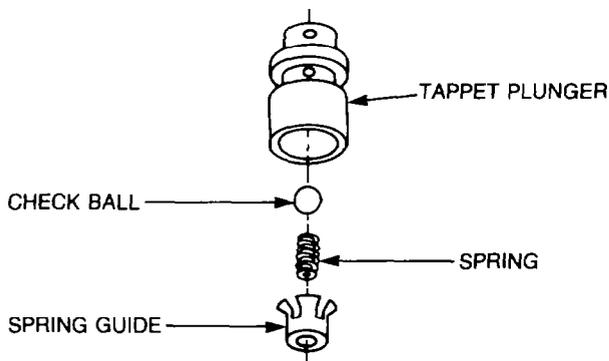


Figure 102 — Tappet Plunger — Assembly

- i. Install the compression spring and tappet plunger into the tappet sleeve (see Fig. 103).

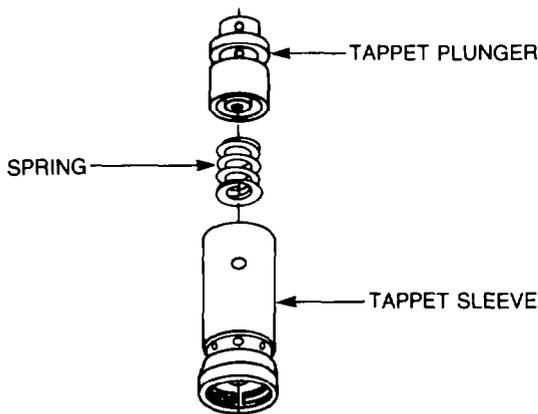


Figure 103 — Tappet Plunger and Spring — Installation

CAUTION
Care must be taken when installing the injector onto the injector assembly stand ST-1298 to prevent damaging the injector cups tip.

- j. Install the injector onto the injector assembly stand ST-1298 locating plate (see Fig. 104).
- k. Install the injector body wrench 3375102 onto the flats of the injector adapter (see Fig. 105), then position the injector cup wrench ST-995 on the cup retainer and pull the air switch knob down.

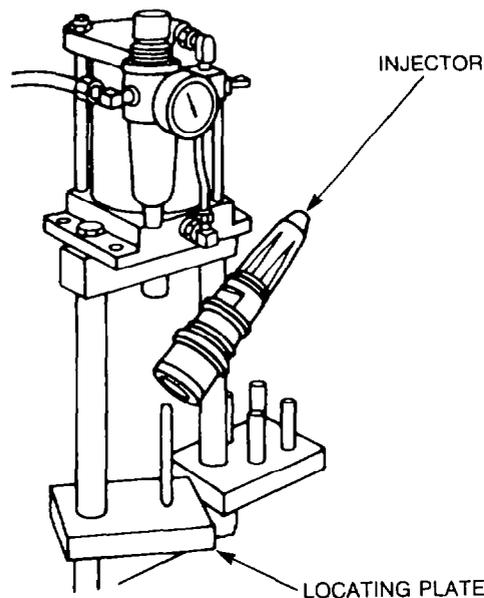


Figure 104 — Injector Assembly Stand

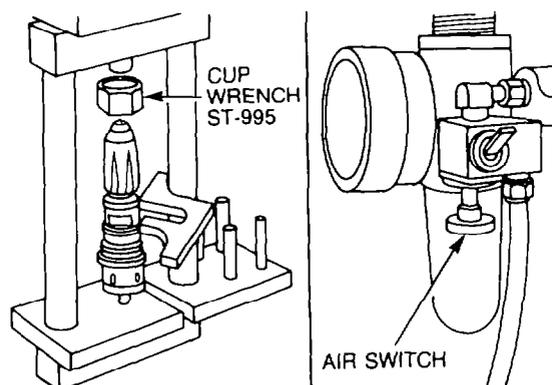


Figure 105 — Injector Body Wrench and Cup Wrench — Installation

- l. Adjust the air pressure on the air cylinder to 483 kPa (70 psi) to align the cup and plunger, then using the crows foot wrench ST-1072 and a suitable tension wrench, torque the cup retainer to 77 Nm (57 lb.ft).

CAUTION
Care must be taken when removing the injector from the injector assembly stand ST-1298 to prevent damaging the injector cups tip.

- m. Push the air switch knob up, then remove the injector body wrench and the injector cup wrench. Remove the injector from the assembly stand.

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26. Injector Plunger — Testing

- a. Install the injector without the springs into the injector sticking plunger checking tool 3375209 with the injector cup end in the lower bearing (see Fig. 106).

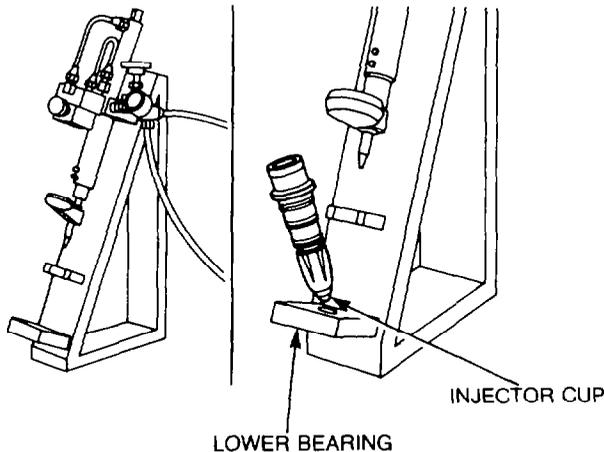


Figure 106 — Injector Plunger Checking Tool

- b. Loosen the setscrews in the torque wrench stem (see Fig. 107)
- c. Loosen the setscrews in the torque wrench stem (see Fig. 107), then set the torque wrench plunger cone 25.4 mm (1.0 in.) above the injector plunger surface and tighten the setscrews.

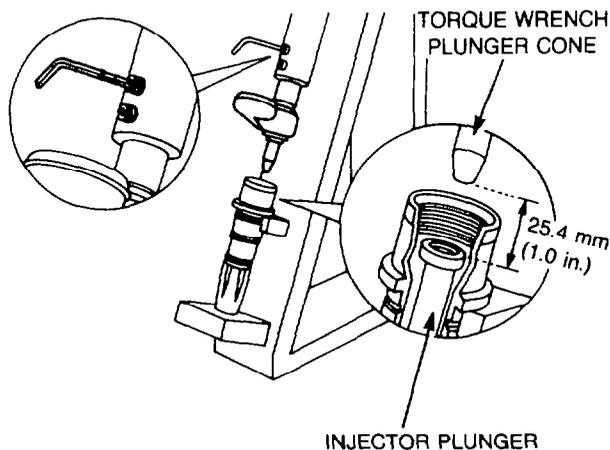


Figure 107 — Torque Wrench Plunger Cone

- c. Push the air actuator valve in, then adjust the air pressure on the air cylinder to 107 ± 14 kPa (30 ± 2 psi).
- d. Rotate the injector adapter and observe the reading on the gauge. If the reading is greater than 0.266 Nm (2 lb.in.) remove the injector and retorque the

cup retainer on the injector assembly stand.

- e. Install the injector into the injector sticking plunger checking tool again and recheck the reading. If the reading is still greater than 0.266 Nm (2 lb.in.) replace the barrel and plungers as a matched set.

27. Cup Leakage

- a. Install three new O-rings on the injector adapter and lubricate the O-rings with clean calibration fluid, then install the injector into the adapter pot 3375395 (see Fig. 108).

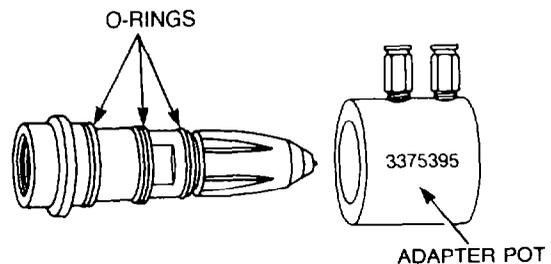


Figure 108 — Injector and Adapter Pot

- b. Install the plunger extension 3822765 into the injector plunger, followed by the injector link 3375689 (see Fig. 109).

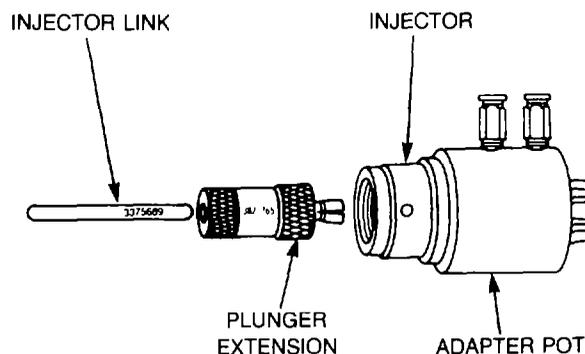


Figure 109 — Plunger Extension and Injector Link

- c. Turn the hand crank on the injector leakage tester 3375375 two turns counter-clockwise, then install the adapter pot and injector into the guide of the leakage tester (see Fig. 110) ensuring that the locking lever on the tester is in the unlocked position.

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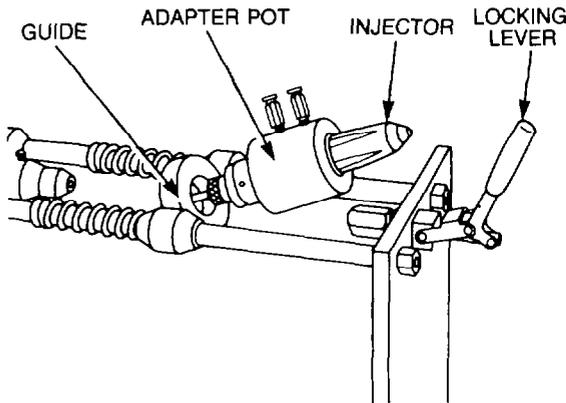


Figure 110 — Injector Leakage Tester

- d. Lock the injector and adapter pot assembly into the leakage tester, then connect the supply and drain hoses to the adapter pot with the white hose at the cup retainer end.
- e. Set the three leakage tester switches in the OFF position, then switch the air supply switch ON and adjust the air pressure to 414 kPa (60 psi). Turn the air supply switch OFF.

CAUTION
Do not allow the tester load cell gauge dial pointer hit the gauge stop as accuracy will be lost

- f. Turn the tester hand crank in a clockwise direction until the load cell gauge (see Fig. 111) reads 1379 kPa (200 psi).

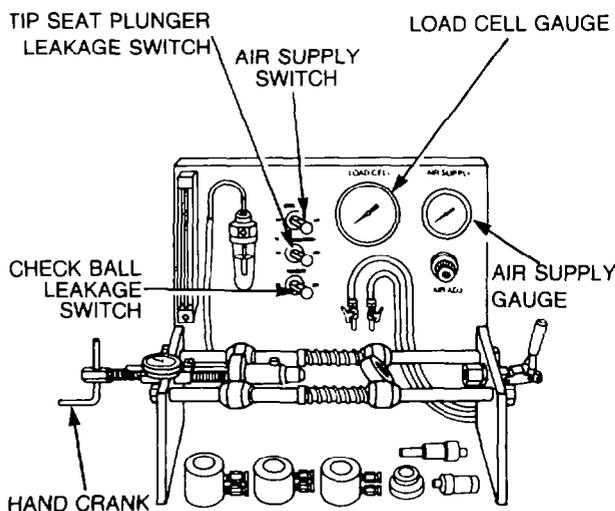


Figure 111 — Load Cell Gauge

CAUTION

The air supply switch must be in the OFF position whenever the other valves are switched to the ON position to prevent air pressure from blowing the oil from the bubble checker.

- g. Move the tip seat plunger leakage switch to the ON position, then move the air supply switch to the ON position and check for bubbles in the bubble checker.
- h. If one bubble appears after 10 seconds, or if the time between bubbles is more than 5 seconds, the cup to plunger seat is serviceable.
- i. If one bubble appears before 10 seconds, or if the time between bubbles is less than 10 seconds, the cup to plunger seat is unserviceable.
- j. Remove the injector from the leakage tester and retorque the injector cup retainer on the injector assembly stand.
- k. Install the injector on the leakage tester and retest. If the test shows the cup to plunger seat is still unserviceable, replace the injector cup.

28. Barrel to Plunger Leakage Test

NOTE

Ensure that fibre ball and not a steel ball is used in the leakage tester flow meter.

- a. Set the three leakage tester switches in the OFF position, then turn the air supply switch ON and adjust the air pressure to 414 kPa (60 psi).

CAUTION
Do not allow the tester load cell gauge dial pointer hit the gauge stop as accuracy will be lost

- b. Turn the tester hand crank clockwise until the load cell gauge reads 1379 kPa (200 psi) then set the tester dial indicator to zero (see Fig. 112).

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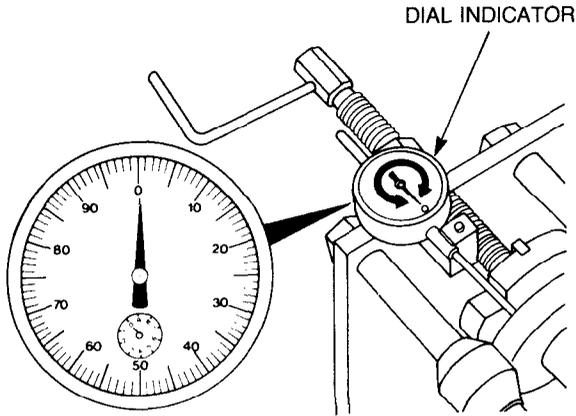


Figure 112 — Tester Dial Indicator

- c. While maintaining light pressure on the injector link turn the hand crank counter-clockwise until a reading of 1.22 mm (0.048 in.) is indicated on the dial indicator.
- d. Turn the air pressure switch to the OFF position, then turn the tip seat plunger leakage switch ON. Turn the air supply switch ON.

NOTE

Do not hold the plunger extension 3822765 while checking for plunger leakage. The lowest reading on the tester flowmeter is considered one unit ie. If the lowest reading is one, that is one unit, or if the lowest reading is ten, that is one unit.

- e. Slowly rotate the plunger extension 3822765 in small increments and record the highest reading on the tester flowmeter. If the reading exceeds 4.5 units, replace the barrel and plunger as a matched set.

29. Check Ball Leakage Test

- a. Set the three leakage tester switches in the OFF position, then turn the air supply switch ON and adjust the air pressure to 414 kPa (60 psi).

CAUTION

Do not allow the tester load cell gauge dial pointer hit the stop as accuracy will be lost.

- b. Turn the tester hand crank clockwise until the load cell gauge reads 1379 kPa (200 psi), then set the tester dial indicator to zero.
- c. While maintaining light pressure on the injector link turn the hand crank counter-clockwise until a reading of 1.22 mm (0.048 in.) is indicated on the dial indicator.
- d. Turn the air supply switch to the OFF position, then turn the check ball leakage switch ON. Turn the air supply switch ON and record the reading on the flowmeter. Maximum check ball leakage is 8.4 units at 414 kPa (60 psi).
- e. If the leakage reading exceeds 8.4 units, switch the air supply switch ON and OFF several times to ensure the check ball in the barrel is correctly seated.
- f. If the reading still exceeds 8.4 units the check ball seat and check ball require inspection.

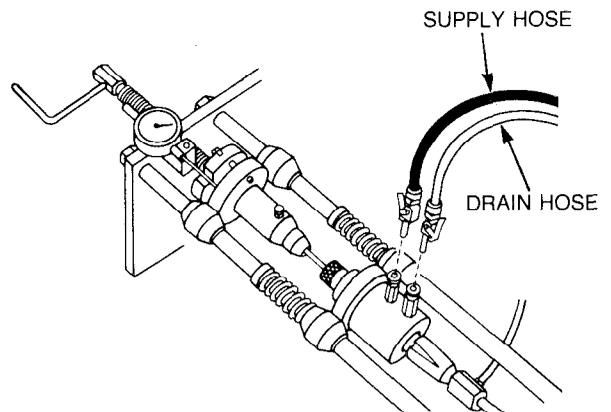


Figure 113 — Supply and Drain Hoses

- g. If the leakage is less than 8.4 units, switch the air supply and the check ball leakage switches OFF, then turn the hand crank counter-clockwise two turns and disconnect the supply and drain hoses (see Fig. 113).
- h. Unclamp and remove the injector and adapter pot from the injector leakage tester, then remove the link and plunger extension from the injector. Remove the injector from the adapter pot (see Fig. 114).

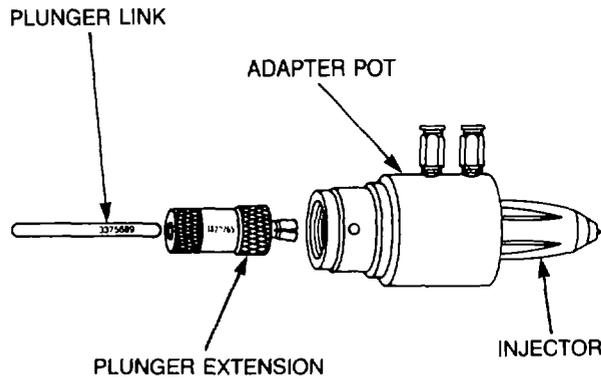


Figure 114 — Plunger Link, Extension, Adapter Pot and Injector

- i. Remove the plunger from the injector, then install the outer and inner compression springs, spring retainer and plunger into the injector adapter (see Fig. 115).

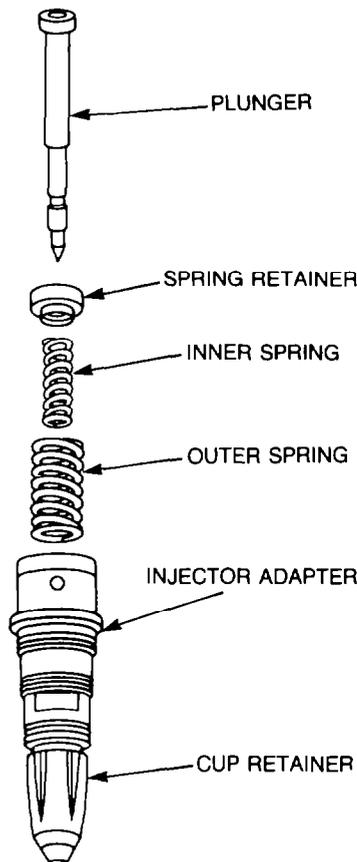


Figure 115 — Assembly of Injector for Top Stop Travel Adjustment

30. Top Stop Plunger Travel — Adjustment

- a. Set the deadweight switch to the RAISE position and the plunger switch to the UNLOAD position on the top stop setting fixture 3822696 (see Fig.

116), then adjust the air pressure to 550 ± 20 kPa (80 ± 3 psi).

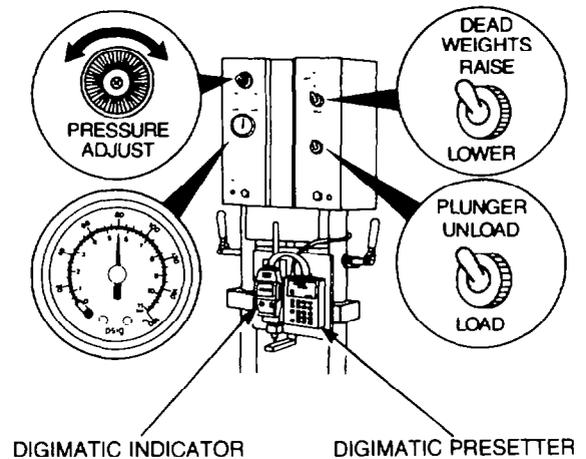


Figure 116 — Top Stop Setting Fixture 3822696 — Controls

- b. Set the digimatic indicator and the digimatic presetter power switches to the ON position.
- c. Install the stop screw and lock nut assembly into the injector adapter, then position the holding bracket 3822726 over the flat machined areas of the fuel supply groove. Install the injector plunger link 205462 into the injector (see Fig. 117).

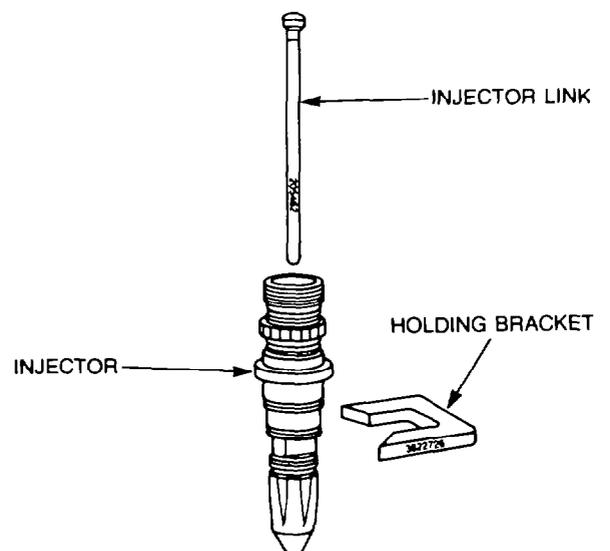


Figure 117 — Holding Bracket and Injector Link

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- d. Install the injector and holding bracket into the top stop setting fixture ensuring that the injector is central over the fixture stop nut (see Fig. 118). Then using crowsfoot wrench ST-1072 and a suitable tension wrench, torque the fixture stop nut to 13 Nm (115 lb.in.).

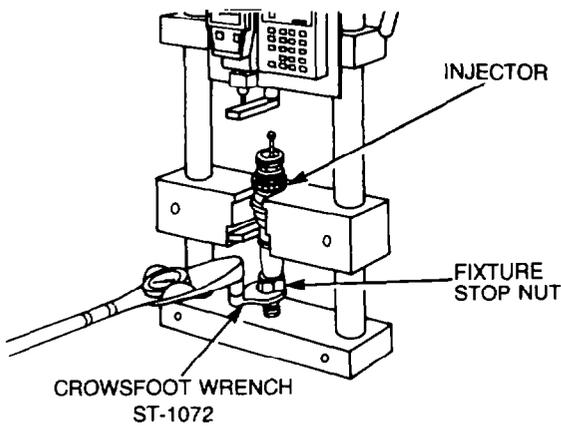


Figure 118 — Fixture Stop Nut — Tensioning

- e. Clamp the fixture clamp handles in the DOWN position, then move the dead-weights switch to the LOWER position which will lower the centre plunger down against the injector link. Move the plunger switch to the LOAD position which will activate the air cylinder and bottom out the plunger in the injector cup.
- f. Push the I/M (inch/millimeter) selector button on the digimatic indicator so that the in. symbol is shown, then push the \uparrow/\downarrow (up/down) selector button so that \downarrow is shown (see Fig. 119).

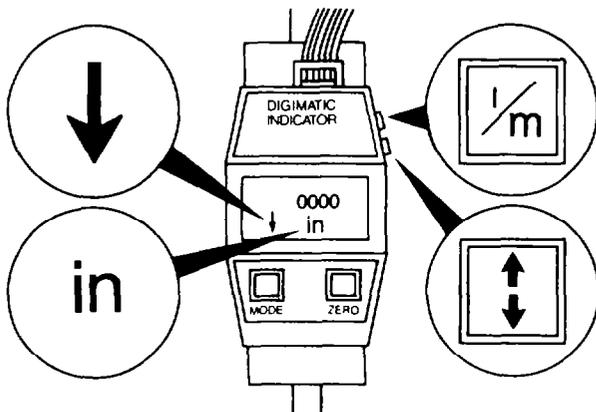


Figure 119 — Digimatic Indicator — Setting

- g. Press the preset button on the digimatic presetter and enter the fixture preset value in inches using the number keys on the presetter. The digimatic indicator will now show the preset value and the letter P (see Fig. 120).

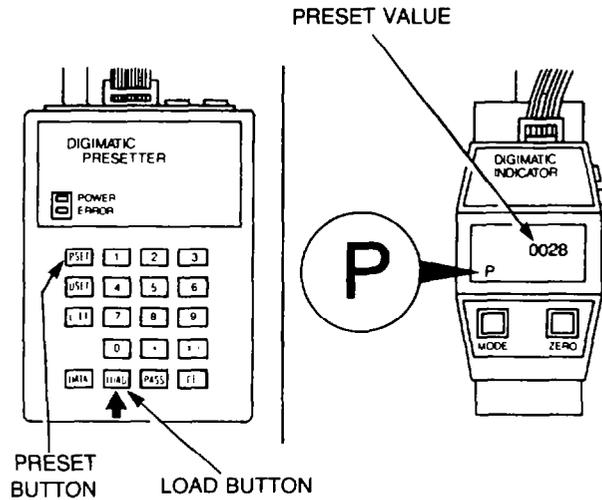


Figure 120 — Digimatic Presetter

NOTE

The \downarrow and in. symbols must be shown before proceeding with the setting or the travel readings will be incorrect.

- h. Press the LOAD button on the presetter and wait five seconds or until the digimatic indicator shows the \downarrow and in. symbols.
- i. Move the plunger switch to the UNLOAD position and record the plunger travel, which will be shown as a negative reading on the indicator. The correct plunger travel is 5.6896 ± 0.013 mm (0.224 ± 0.0005 in.)
- j. If the plunger travel is incorrect, insert an allen key into the oil feed holes in the stop screw and turn the screw until the indicator shows the correct travel reading.
- k. Using the top stop injector crowsfoot wrench 3375166 and a suitable tension wrench, torque the locknut to 75 Nm (55 lb.ft).
- l. Recheck the plunger travel to ensure that it did not change when the lock nut was torqued, then move the plunger switch to the LOAD position.
- m. Press the PSET button on the digimatic presetter. The preset value and the letter P will be shown on the indicator. If the

preset value is now shown, enter the preset value again.

- n. Press the LOAD button on the presetter. The symbols ↓ and in. will be shown on the indicator.
- o. Move the plunger switch to the UNLOAD position and record the plunger travel shown on the indicator. If the travel is incorrect, adjust the stop screw again.
- p. Move the deadweights switch to the RAISE position, then using a suitable wrench and the crowsfoot wrench ST-1072 loosen the fixture stop nut from the injector cup.
- q. Remove the injector from the top stop setting fixture, then remove the link and the bracket (see Fig. 121).

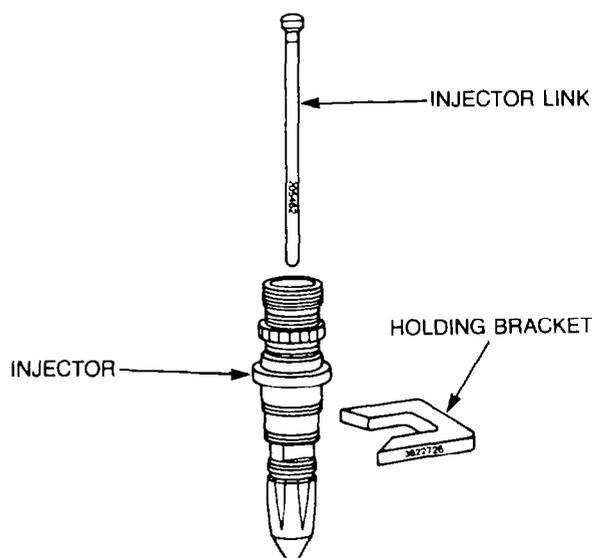


Figure 121 — Holding Bracket and Injector Link

31. Flow Testing/Calibration

NOTE

Prior to using the injector test stand 3375317 ensure that the calibration fluid level is 13 mm (0.50 in.) below the top of the sight glass.

- a. Move the injector fuel supply handle to the ON position, then turn the mains switch and the fuel system ON.
- b. Ensure that the correct cam 3376170 is fitted in the test stands cam box. If the cam is incorrect, remove the transparent cam box lid and using a suitable box wrench and T-bar turn the tappet adjust-

ing nut clockwise to move the tappet away from the cam (see Fig.122) .

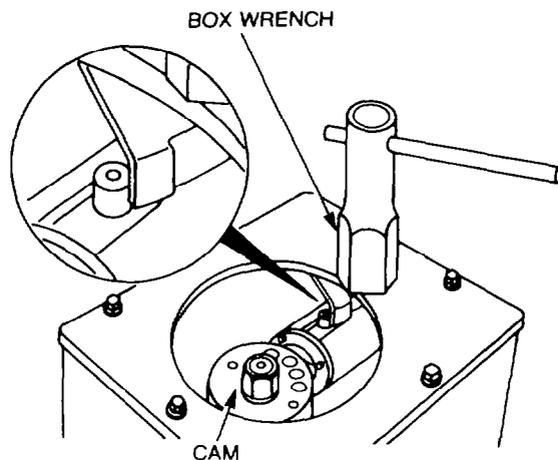


Figure 122 — Injector Test Stand Cam Box

- c. Using the box wrench and the T-bar remove the nut and washer securing the cam onto the shaft.
- d. Remove the cam from the keyed shaft then install the correct cam 3376170, the washer and nut, then using the box wrench and T-bar tighten the nut until the cam begins to turn.
- e. Using the box wrench and the T-bar turn the tappet adjusting nut in an anti-clockwise direction until the tappet strikes the cam. Install the lid onto the cam box.
- f. Install the injector pot adapter 3375644 onto the injector adapter and insert the pot locating pin through the pot adapter into the hole in the injector adapter (see Fig. 123).

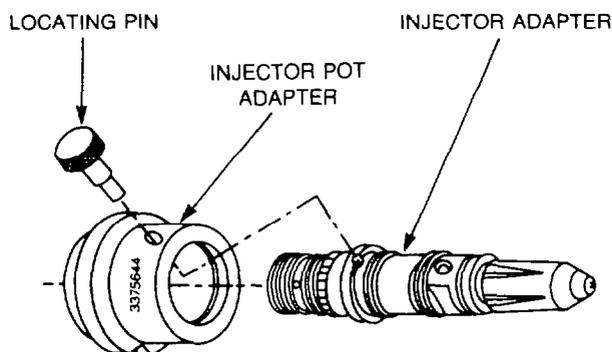


Figure 123 — Injector Pot Adapter — Installation

- g. Install the injector link 3375488 into the injector.
- h. Ensure that the test stands clamping control handle is in the unclamped posi-

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tion, then raise the guard on the test stand.

- i. Install the injector, pot adapter and injector link into the test stand ensuring that the cut outs on the pot locate on the two rods protruding from the clamp plate (see Fig. 124).

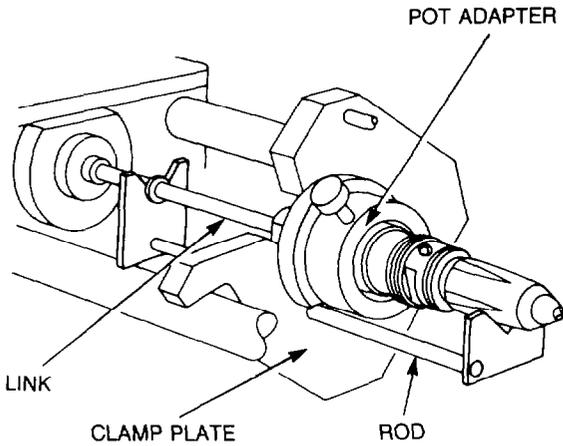


Figure 124 — Test Stand — Injector Installation

- j. Close the test stands guard, then ensure that the clamp pressure lever is in the PT position (see Fig. 125) and move the clamping control handle to the clamped position.

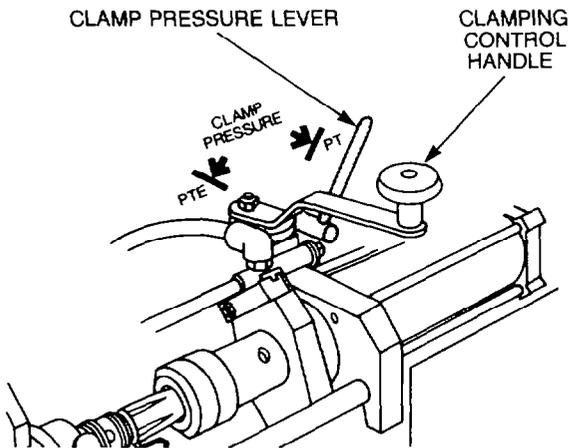


Figure 125 — Clamp Pressure Lever and Clamping Control Handle — Locked Position

- k. Ensure that the assembly to test stand alignment is correct. If the stamped line on the seal cylinder flange is not positioned between the notch in the alignment strip (see Fig. 126), the combination of cam, link and pot adapter is incorrect. Install the correct cam, link and pot adapter.

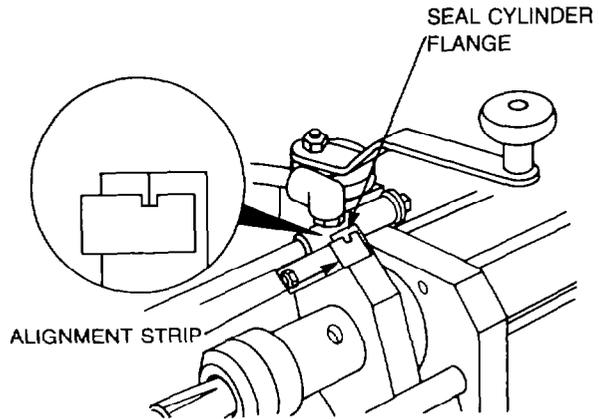


Figure 126 — Alignment of Assembly and Test Stand

WARNING
If the test stands self sealing valve does not align with the injector orifice personal injury may occur.

- l. Adjust the alignment of the self sealing valve by loosening the two allen head screws and align the valve with the injector orifice.

NOTE

When the locking lever handle is locked in position test oil will flow from the injector drain port.

- m. Lower the locking lever handle in position, then press the main drive START button. Bring the metering head temperature to the correct operating temperature by running the injector to be calibrated for a continuous five minute cycling period.
- n. If the small hand on the test stands dial indicator has made less than one revolution (see Fig. 127), use the inner ring figures (2-24) and multiply by ten, then add the reading of the large hand.

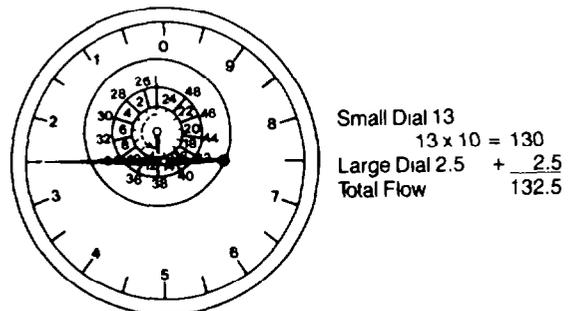


Figure 127 — Dial Indicator — Example of Lower Reading

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- o. If the small hand on the test stands dial indicator has made more than one revolution (see Fig. 128), use the outer ring of figures (26-48) and multiply by ten, then add the reading of the large hand.

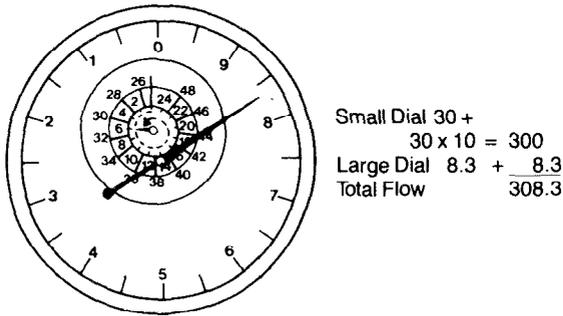


Figure 128 — Dial Indicator — Example of Upper Reading

- p. Press and release the metering button several times to warm up the test equipment and observe the flow readings on the dial indicator.

CAUTION

To avoid damage occurring to the test stand, do not allow the injector to be in the clamped position for more than one minute after stopping the main drive.

- q. When the readings stabilize, raise the locking lever handle to stop the main drive.
- r. After the motor has stopped, press and hold the metering button, then using a suitable screwdriver set the dial indicator to zero by turning the set zero screw (see Fig. 129).

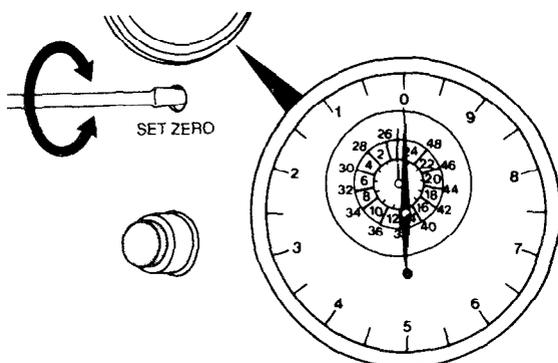


Figure 129 — Dial Indicator — Adjustment

- s. Lower the locking lever handle, then press the start main drive and the metering button. Observe the flow reading on the dial indicator and if the reading is greater than 191-193 cm³/stroke replace the orifice plug.
- t. Raise the locking lever handle to stop the main drive, then using the injector orifice torque wrench 3376177 (see Fig. 130) loosen and remove the orifice plug.

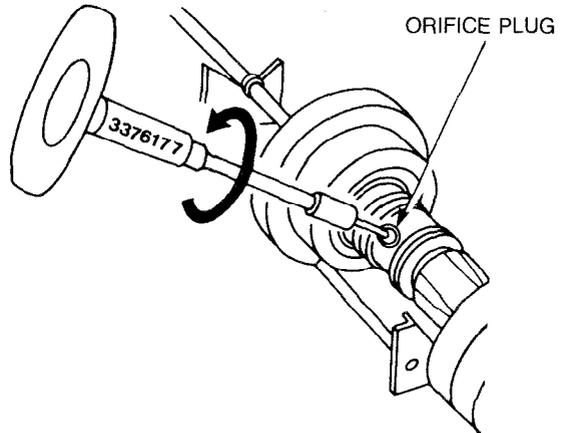


Figure 130 — Orifice Plug — Removal

- u. Use the injector orifice plug gauge ST-1332 to measure the approximate inside diameter of the old plug, then install the new gasket and smaller I.D. orifice plug into the injector. Using the injector orifice torque wrench 3376177 torque the orifice plug to 1 Nm (9 lb.in.).
- v. Lower the locking lever handle, then press the start main drive and the metering button. Observe the flow reading on the dial indicator and if the reading is less than 191-193 cm³/stroke use the burnishing tool 3376979 to adjust the inside diameter of the plug.

NOTE

The test is designed to permit burnishing of the orifice plug without removing the injector from the stand.

CAUTION

If the orifice plug is 0.66 mm (0.026 in.) or larger, 0.794 mm (0.031 in.) must be ground of the tip of the burnishing tool ST-708-1 to prevent damaging the injector adapter.

- w. Insert the burnishing tool into the orifice plug and push the tool until the spring tension is overcome. Remove the tool, lower the locking lever handle, then press the start main drive and the metering button. Observe the flow reading on the dial indicator.
- x. Continue burnishing the orifice plug until a flow reading of 191-193 mm³/stroke is obtained.

CAUTION

Do not unclamp the injector from the test stand until the main drive has stopped.

- y. Raise the locking lever handle to stop the main drive, then unclamp the clamping control handle. Raise the guard and remove the injector, pot adapter and link from the test stand.
- z. Press the fuel system OFF button and turn the mains switch OFF.
- aa. Remove the link and the injector pot adapter from the injector, then install the filter screen and the screen retainer (see Fig. 131).

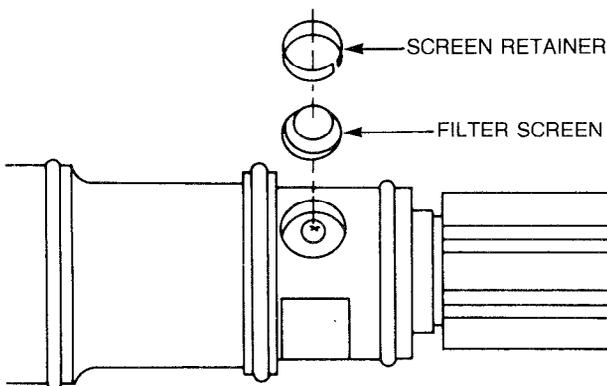


Figure 131 — Filter Screen and Screen Retainer — Installation

32. Top Stop Total Travel — Adjustment

NOTE

Top stop total travel consists of the plunger travel and top stop tappet travel settings.

- a. Install the injector link, washer, STC tappet, tappet top stop lock nut and the tappet top stop cap.
- b. Position the holding bracket 3822726 over the flat machined areas of the fuel supply groove.

- c. Ensure that the deadweights switch is in the RAISE position on the top stop setting fixture 3822696, then install the injector and holding bracket into the fixture ensuring that the injector is central over the fixture stop nut.
- d. Using crowsfoot wrench ST-1072 and a suitable tension wrench, torque the fixture stop nut to 13 Nm (115 lb.in.).
- e. Install the K-STC plunger link 3052233 into the top of the injector, then move the test stand clamp handles to the UP position.
- f. Move the deadweights switch to the lower position which will lower the centre plunger down against the injector link. Move the plunger switch to the LOAD position which will activate the air cylinder and bottom out the plunger in the injector cup.
- g. Push the I/M (inch/millimeter) selector button on the digimatic indicator so that the in. symbol is shown then push the \uparrow/\downarrow (down/up) selector button so that the \downarrow symbol is shown.
- h. If the indicator readout changes slowly, oil is trapped in the STC tappet and must be removed.
- i. Move the plunger switch to the UNLOAD position, then move the deadweights switch to the raise position. Using crowsfoot wrench ST-1072 and a suitable wrench loosen the fixture stop nut and remove the injector from the test fixture.
- j. Remove the holding bracket and the tappet link from the injector, then remove the tappet top stop cap and the STC tappet.
- k. Remove the tappet plunger and spring from the tappet and drain any oil in the tappet, then reassemble the tappet.
- l. Install the STC tappet in the injector and secure with the tappet top stop cap. Install the holding bracket on the injector, then install the tappet link and install the injector in the setting fixture.
- m. Using crowsfoot wrench ST-1072 and a suitable tension wrench torque the fixture stop nut to 13 Nm (115 lb.in.).
- n. Move the deadweights switch to the lower position and the plunger switch to the load position.
- o. Press the PSET button on the digimatic presetter. The preset value and the letter

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- P will be shown. If the preset value is not shown, enter the preset value again.
- p. Press the LOAD button on the presetter and wait five seconds or until the indicator shows the ↓ and the in. symbols.

NOTE

The ↓ and in. symbols must be shown before proceeding with the setting or the travel readings will be incorrect.

- q. Move the plunger switch to the UNLOAD position and record the plunger travel, which will be shown as a negative reading on the indicator. The correct plunger travel is 7.4676 ± 0.013 mm (0.2940 ± 0.0005 in.).
- r. If the travel is incorrect, adjustment is carried out by turning the tappet top stop cap until the correct reading is obtained (see Fig. 132).

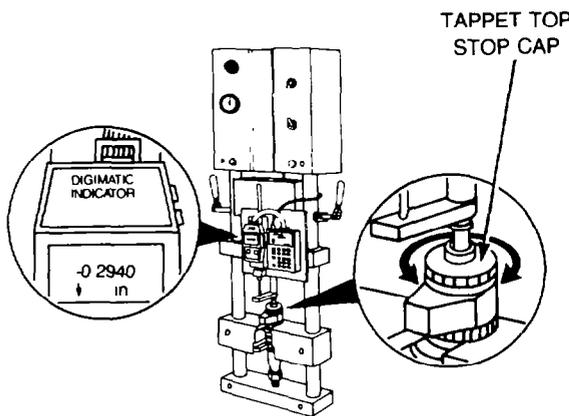


Figure 132 — Plunger Travel — Adjustment

- s. Using crowsfoot wrench 3375166 hold the top stop cap, then using a suitable crowsfoot wrench and tension wrench, torque the lock nut to 75 Nm (55 lb.ft).
- t. Move the plunger switch to the LOAD position, then press the preset button on the presetter. If the preset value is not shown, enter the preset value.
- u. Press the LOAD button on the presetter and wait five seconds or until the indicator shows the ↓ and the in. symbols.

NOTE

The ↓ and in. symbols must be shown before proceeding with the setting or the travel readings will be incorrect.

- v. Move the plunger switch to the UNLOAD position and record the plunger travel. If the travel is incorrect, readjust the tappet top stop cap.
- w. Move the deadweights switch to the raise position, then using a suitable wrench and crowsfoot wrench ST-1072 loosen the fixture stop nut (see Fig. 133) and remove the injector from the fixture.

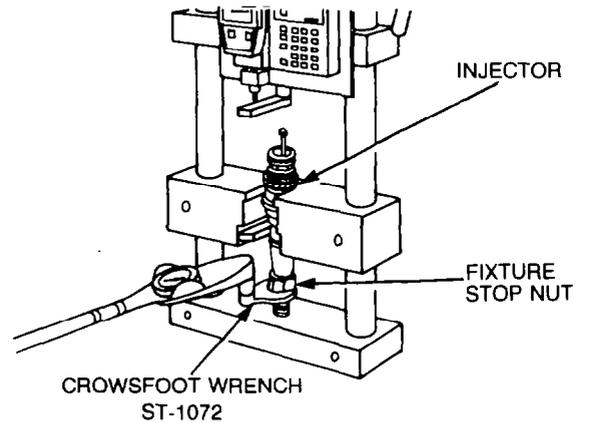


Figure 133 — Injector — Removal

- x. Remove the link and the holding bracket from the injector, then install the original or replacement link.

STC Control Valve

33. Removal

- a. Clean the area around the control valve with a suitable cleaning agent, then blow dry with compressed air.
- b. Tag and remove the oil lines from the STC control valve unions (see Fig. 134).

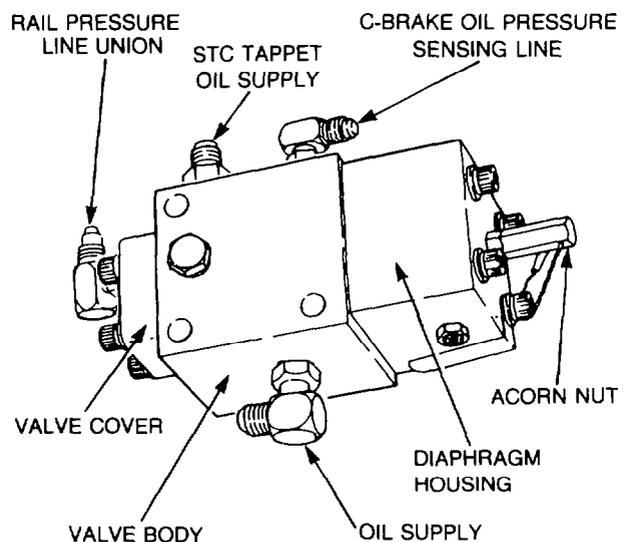


Figure 134 — STC Control Valve

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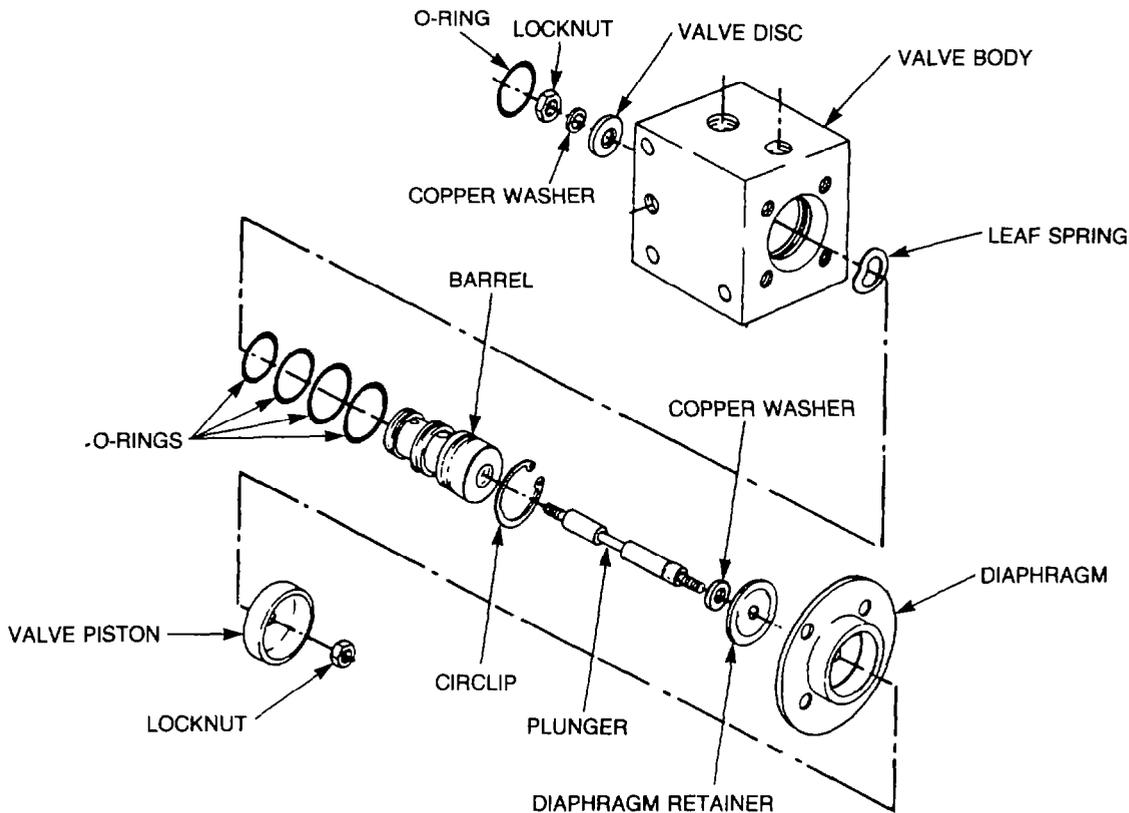


Figure 135 — Valve Body — Exploded View

- c. Remove the two bolts securing the control valve to the engine and remove the valve.

34. Disassembly

- a. Remove the unions from the control valve, then using a scribe remove the screen retainer and the filter screen from the oil supply orifice in the valve body.
- b. Remove the four bolts and washers securing the valve cover to the valve body, then remove the valve cover.
- c. Remove the four bolts and washers securing the diaphragm housing to the valve body, then remove the housing, the spring retainer and the spring from the valve body.
- d. Remove and discard the O-ring from the valve body (see Fig. 135).
- e. Loosen the two lock nuts on the plunger, and remove the lock nut, copper washer and the valve disc from the plunger. Withdraw the plunger and diaphragm from the valve body.

- f. Remove the lock nut, valve piston, diaphragm, diaphragm retainer and copper washer from the plunger.

- g. Using a suitable pair of circlip pliers remove the circlip securing the barrel into the valve body, then using a suitable drift or a 7 mm (0.2812 in.) socket and a soft-faced hammer, remove the barrel from the valve body, then remove the leaf spring.

- h. Remove and discard the four O-rings from the barrel.

35. Cleaning and Inspection

- a. Wash the STC control valve components in a suitable cleaning agent, then blow dry with compressed air.

NOTE

The plunger and barrel are a matched set and must be replaced as such.

- b. Inspect the plunger and barrel for evidence of scoring or pitting and replace as necessary.
- c. Inspect the diaphragm for cracks or holes and replace if damaged.

- d. Inspect the compression spring for cracked or broken coils and replace as necessary.

36. Reassembly

- a. Install the four new O-rings on the barrel, then lubricate the barrel and O-rings with clean engine oil.
- b. Install the leaf spring in the valve body, then position the barrel in the valve body and using a suitable drift or socket and a soft-faced hammer, install the barrel into the valve body until the O-ring groove is exposed.
- c. Using a suitable pair of circlip pliers install the circlip, with the bevelled side toward the barrel, into the groove in the valve body.
- d. Install the filter screen in the oil supply orifice in the valve body and secure in position with the screen retainer.
- e. Install the copper washer, diaphragm retainer, diaphragm, valve piston and lock nut on the plunger, then install the plunger in the valve body.
- f. Install the valve disc, copper washer and lock nut on the plunger, then using a suitable tension wrench and socket wrench, torque the plunger lock nuts to 4 Nm (35 lb.in.).
- g. Position a new O-ring in the valve body, then install the valve cover and secure with the four bolts and washers. Torque the bolts to 6.8 Nm (60 lb.in.).
- h. Position the spring retainer and spring in the diaphragm housing, then secure the housing to the valve body with the four bolts and washers. Torque the bolts to 6.8 Nm (60 lb.in.).
- i. Install the unions in the STC control valve (see Fig. 134) ensuring that the unions are aligned correctly.

37. Installation

- a. Position the control valve on the engine and secure with the two washers and bolts, then tighten the bolts securely.
- b. Install the oil lines onto the control valve unions and tighten securely.

38. On Engine Calibration

- a. Disconnect the rail pressure line from the union in the STC control valve and install a plug in the line (see Fig. 136).

NOTE

The air pressure regulator must be capable of bleeding off air pressure

when inlet pressure is reduced and with a gauge reading from 0-418 kPa (0-60 psi).

- b. Install an air pressure regulator between an external air supply and the rail pressure line union on the end of the STC control valve.
- c. Install an oil pressure gauge between the STC tappet oil supply union and the oil line.
- d. Adjust the air pressure regulator to zero, then start and run the engine at idle. The reading on the oil pressure gauge should be slightly less than the engine oil pressure.
- e. If no pressure is registered on the oil pressure gauge, ensure that the air pressure regulator is set at zero. If the oil pressure gauge still fails to register oil pressure, remove and inspect the STC control valve for plugged fittings or a binding plunger.

NOTE

The air pressure on the rail in union simulates fuel rail pressure. By varying the air pressure the STC control valve will cycle between the advanced and normal timing modes. In the advanced mode the engine overhead gear will sound noisy, while in the normal timing mode the engine will sound quieter.

- f. Adjust the air pressure regulator up and down several times to become familiar with the change in engine noise, while at the same time observing the change in oil pressure as the air pressure is raised and lowered.

NOTE

The lower shiftpoint (i.e. shift to advanced timing) must occur at a pressure below the upper shiftpoint (i.e. shift to normal timing). If it does not occur the engine advanced timing mode will not be achieved. The lower shiftpoint is not directly adjustable, but is dependent on the upper shiftpoint.

- g. Adjust the air pressure regulator to zero, then adjust the regulator slowly to raise the air pressure. Record the air pressure at which the oil pressure falls below 55 kPa (8 psi), or when the engine noise level changes from noisy to quiet (the

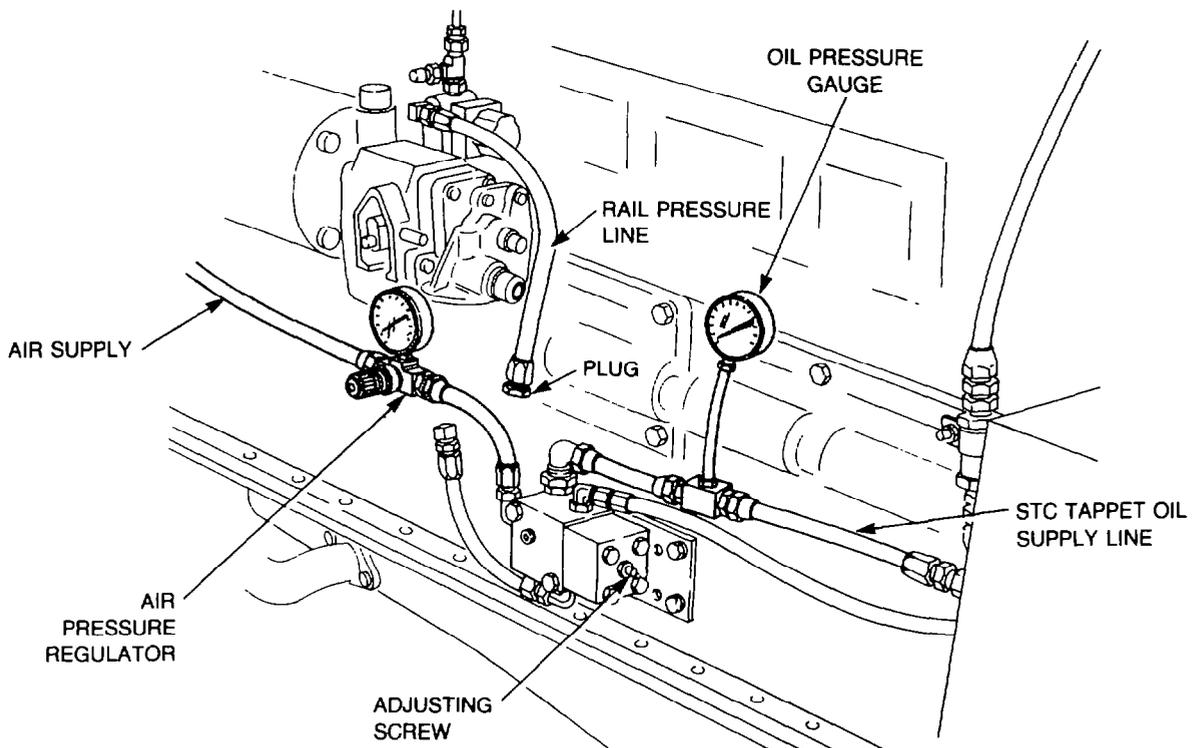


Figure 136 — STC Control Valve — Test Equipment

upper shiftpoint) and which should occur at 103 ± 21 kPa (15 ± 3 psi).

- h. Continue to raise the air pressure to 480 kPa (70 psi) then slowly lower the pressure. Record the air pressure at which the oil pressure raises above 55 kPa (8 psi), or when the engine noise level changes from quiet to noisy (the lower shiftpoint).
- i. If the upper shift point is incorrect, remove the lockwire and the acorn nut (see Fig. 137) from the valve adjusting screw, then loosen the adjusting screw lock nut.

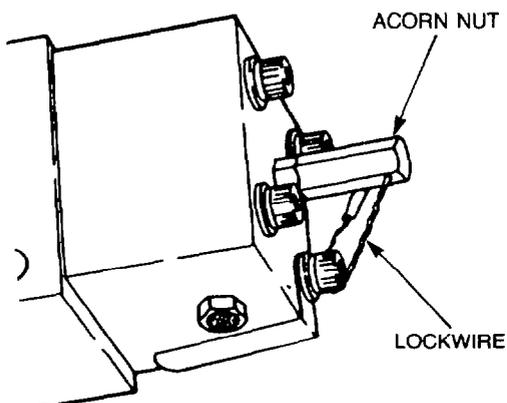


Figure 137 — Lockwire and Acorn Nut

- j. To raise or lower the upper shiftpoint, turn the adjusting screw clockwise or counter-clockwise then, recheck the upper and lower shiftpoints.
- k. When the upper shiftpoint is adjusted correctly, hold the adjusting screw and tighten the lock nut, then install the acorn nut and the lockwire.
- l. Remove the air pressure regulator from the rail pressure line union on the end of the STC control valve, then remove the plug from the rail pressure line and install the line on the union.
- m. Remove the oil pressure gauge from between the STC tappet oil supply union and the oil line, then connect the oil line to the union.

Turbocharger

39. Disassembly

NOTE

Prior to disassembly, match mark the turbocharger components as shown in Fig. 138 to assist during reassembly.

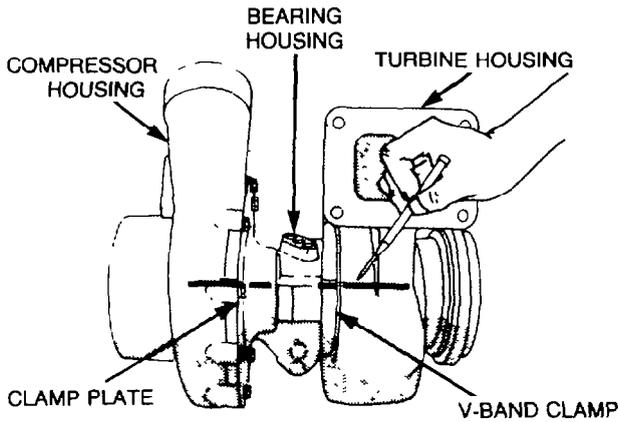


Figure 138 — Component Match Marks

CAUTION

Care must be taken when removing the compressor housing to prevent damaging the compressor impeller blades

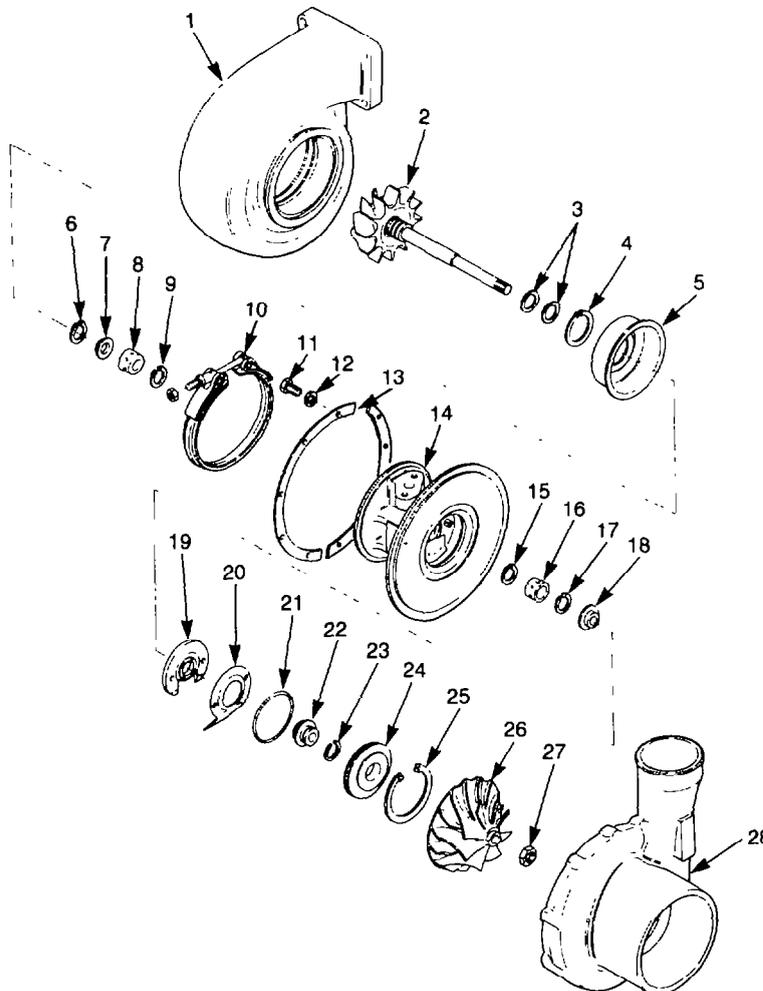
- c. Separate the compressor housing (item 28) from the bearing housing (item 14).
- d. Loosen the V-band clamp (item 10) securing the turbine housing (item 1) to the bearing housing (item 14), then slide the clamp onto the bearing housing.

CAUTION

Care must be taken when removing the turbine housing to prevent damaging the turbine blades.

- a. Remove the bolts, washers and clamp plates (see Fig. 139 items 11, 12 and 13) securing the compressor housing (item 28) to the bearing housing (item 14).
- b. Secure the turbocharger to the mounting plate ST-750, then secure the mounting plate to the ball joint vice ST-302.

- e. Remove the turbine housing (item 1) from the bearing housing (item 14),



- 1. Turbine housing
- 2. Shaft and turbine wheel
- 3. Split ring seal
- 4. Retaining ring
- 5. Heat shield
- 6. Retaining ring
- 7. Oil control sleeve
- 8. Bearing
- 9. Retaining ring
- 10. V-band clamp
- 11. Bolt
- 12. Washer
- 13. Clamp plate
- 14. Bearing housing
- 15. Retaining ring
- 16. Bearing
- 17. Retaining ring
- 18. Thrust collar
- 19. Thrust bearing
- 20. Oil baffle
- 21. O-ring
- 22. Oil slinger
- 23. Split ring seal
- 24. Insert
- 25. Retaining ring
- 26. Compressor impeller
- 27. Impeller nut
- 28. Compressor housing

Figure 139 — Turbocharger — Exploded View

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then remove the V-band clamp (item 10) from the housing.

- f. Secure the turbine wheel and shaft (item 2) with a socket (see Fig. 140) at the turbine wheel end of the shaft, then remove the impeller nut (see Fig. 139, item 27) from the turbine shaft.
- g. Remove the compressor impeller (item 26) from the turbine wheel and shaft (item 2), then remove the turbine wheel and shaft (item 2) from the bearing housing (item 14). Remove and discard the two split ring seals (item 3) from the shaft.

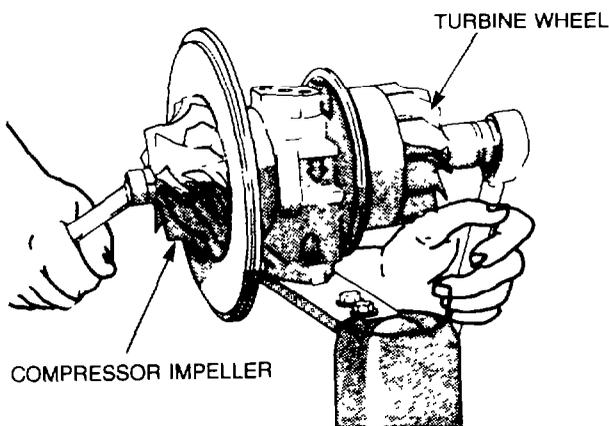


Figure 140 — Impeller Nut — Removal

- h. Using a suitable pair of circlip pliers remove the retaining ring (item 25) securing the insert (item 24) into the bearing housing (item 14), then using two screwdrivers, pry the insert from the bearing housing (see Fig. 141).

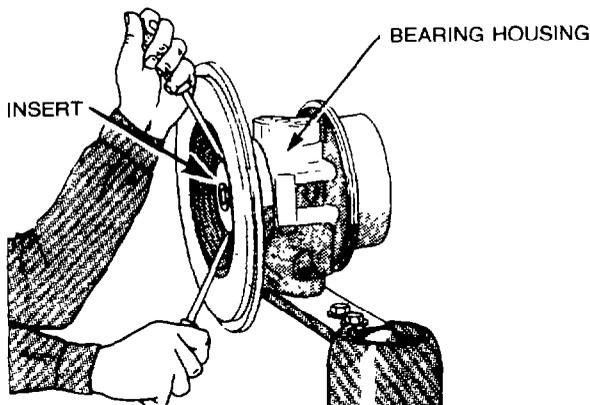


Figure 141 — Insert — Removal

- i. Remove and discard the O-ring (see Fig. 139, item 21) from the insert (item 24),

then remove the oil slinger (item 22) from the insert. Remove and discard the split ring seal (item 23) from the oil slinger.

- j. Remove the oil baffle, thrust bearing and the thrust collar (items 20, 19 and 18) from the bearing housing (item 14).
- k. Using a suitable pair of circlip pliers, remove the retaining ring (item 17) securing the bearing (item 16) into the bearing housing (item 14), and remove the bearing. Remove the inner retaining ring (item 15), then rotate the bearing housing so that the turbine end is uppermost as shown in Fig. 142. Remove the retaining ring (see Fig. 139, item 4) securing the heat shield (item 5) to the bearing housing (item 14), then remove the heat shield.
- l. Using a suitable pair of circlip pliers, remove the retaining ring (see Fig. 139, item 6), securing the oil control sleeve and the bearing (items 7 and 8) into the bearing housing (item 14), then remove the oil control sleeve and the bearing.

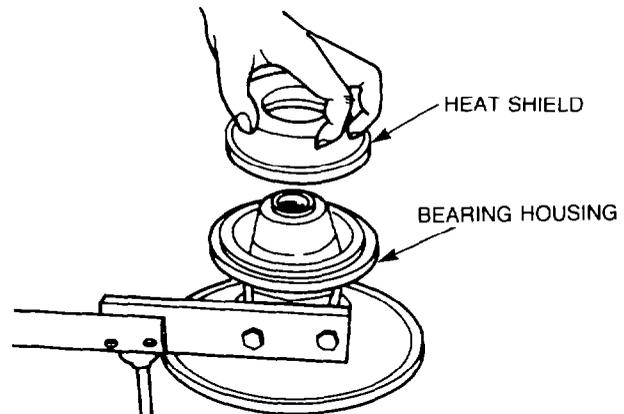


Figure 142 — Heat Shield — Removal

- m. Remove the retaining ring (item 9) from the bearing housing (item 14).

40. Cleaning and Inspection

- a. Thoroughly wash all the components of the turbocharger in a suitable cleaning agent, then blow dry with compressed air.
- b. Using a 600 grit emery cloth clean the split ring seal grooves in the turbine wheel shaft.
- c. Inspect the turbine wheel for cracks, bent or damaged blades and replace the shaft and wheel as necessary.

- d. Using an outside micrometer, measure the turbine shaft bearing journals (see Fig. 143). The standard journal measurements are 14.254-14.262 mm (0.5612-0.5615 in.), replace the turbine wheel and shaft if the dimension is less than 14.252 mm (0.5611 in.).

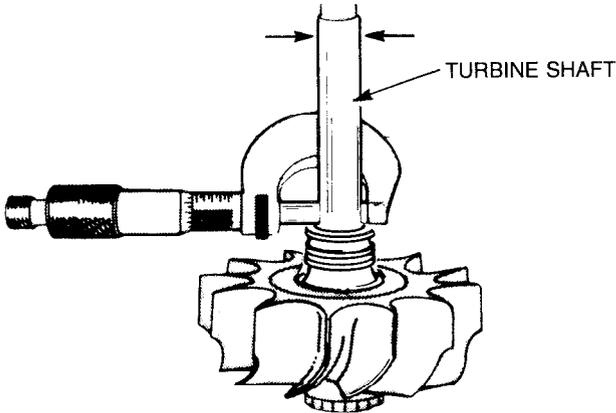


Figure 143 — Measuring Turbine Shaft Bearing Journals

- e. Install new split ring seals into the grooves in the turbine shaft, then using a set of feeler gauges measure the side clearance between the split rings and the grooves (see Fig. 144). The standard clearance is 0.038-0.08 mm (0.0015-0.003 in.) replace the turbine wheel and shaft if the clearance exceeds 0.13 mm (0.005 in.).

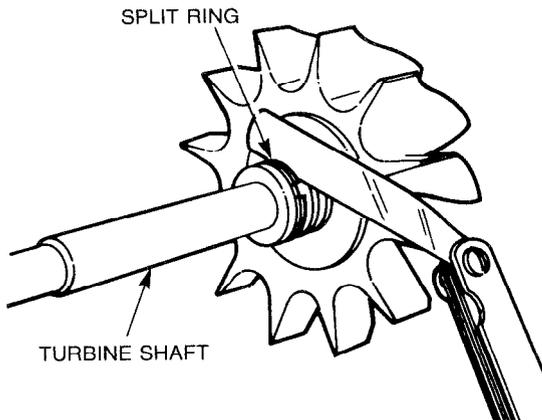


Figure 144 — Measuring Split Ring Seal Clearance

- f. Inspect the bearings for visible signs of wear and discard the bearings if bronze material is visible.

CAUTION
Do not attempt to straighten bent or damaged compressor impeller blades.

- g. Inspect the compressor impeller for cracked, bent or damaged blades and discard the impeller if damage is evident.

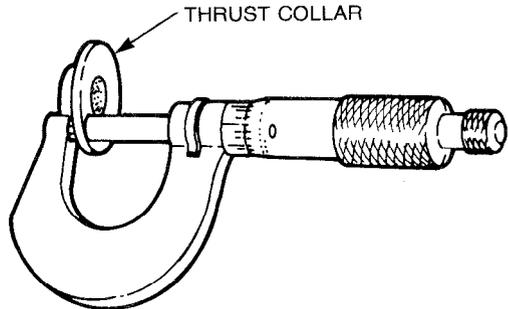


Figure 145 — Measuring Thrust Collar Thickness

- h. Using an outside micrometer, measure the thickness of the thrust collar (see Fig. 145). The standard thickness of the collar is 2.510-2.591 mm (0.0988-0.1020), replace the collar if the thickness is less than 2.489 mm (0.0980 in.).
- i. Measure the thickness of the thrust bearing using an outside micrometer with the micrometer positioned over one of the oil grooves (see Fig. 146). The standard thickness of the thrust bearing is 5.33-5.38 mm (0.210-0.212 in.), replace the bearing if the thickness is less than 5.31 mm (0.209 in.).

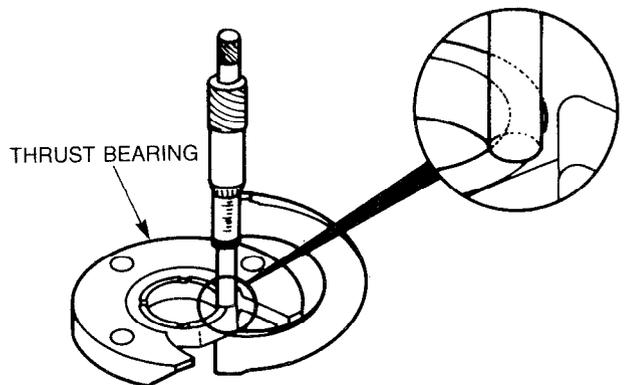


Figure 146 — Measuring Thrust Bearing Thickness

- j. Using an internal micrometer, measure the inside diameter of the bearing hous-

ing bores (see Fig. 147). The standard diameter is 22.255-22.268 mm (0.8726-0.8767 in.), replace the bearing housing if the diameter exceed these limits.

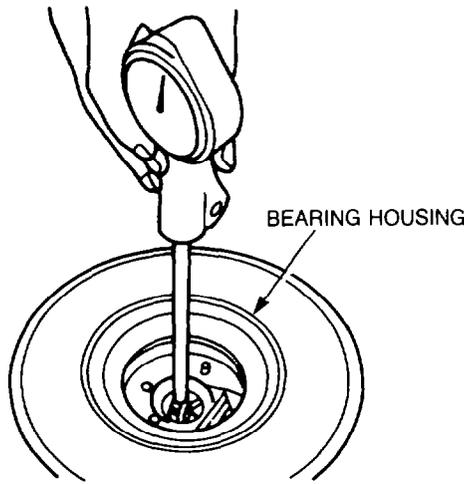


Figure 147 — Measuring Bearing Housing Bore

- k. Install a new split ring seal in the groove in the oil slinger and using a set of feeler gauges measure the side clearance between the split ring seal and the oil slinger groove. The standard side clearance is 0.038-0.08 mm (0.0015-0.003 in.), replace the oil slinger if the clearance exceeds 0.13mm (0.005 in.).
- l. Inspect the insert oil slinger bore for signs of scratching or scoring (see Fig. 148) and replace as necessary.

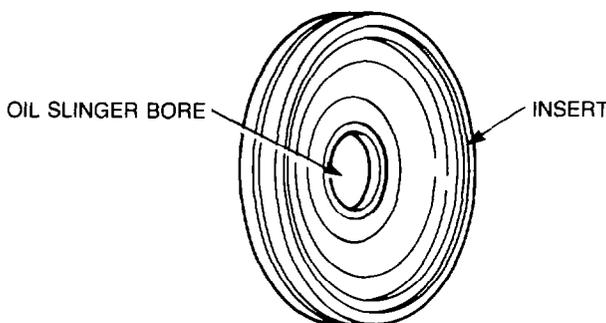


Figure 148 — Insert

- m. Inspect the compressor housing for evidence of impeller contact with the housing and replace as necessary.
- n. Inspect the turbine housing for evidence of turbine wheel and shaft contact and replace the turbine housing if contact has occurred.

- o. Inspect the turbine housing for cracks in the housing or the mounting flange and replace the housing if cracks are evident.
- p. Inspect the mounting flange for cracks (see Fig. 149), and if any cracks found are longer than 15 mm (0.6 in.) replace the turbine housing.

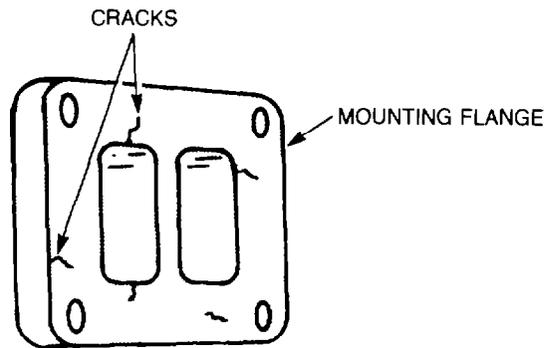


Figure 149 — Mounting Flange — Inspection

- q. Replace the turbine housing if any cracks reach the mounting flange or if any two cracks are closer than 6 mm (0.25 in.).
- r. Cracks in the dividing wall of the mounting flange (see Fig. 150), are acceptable, but must be separated by at least 12.7 mm (0.5 in.) of solid material.

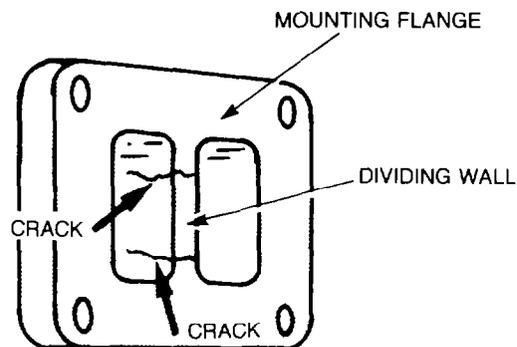


Figure 150 — Mounting Flange Dividing Wall

41. Reassembly

CAUTION

The retaining rings (items 6 and 9) must be installed with the bevelled edge facing the bearing. Excessive end wear can result if the retaining rings are installed incorrectly

- a. Using a suitable pair of circlip pliers, install the retaining ring (see Fig. 139, item 9) into the bearing housing (item 14), then lubricate the bearing (item 8) with clean engine oil and install the bearing in the bearing housing.

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- b. Lubricate the oil control sleeve (item 7) with clean engine oil and install in the bearing housing (item 14), then secure the oil control sleeve and the bearing (items 7 and 8) into the bearing housing with the retaining ring (item 6).

CAUTION

The retaining ring (item 4) must be installed with the bevelled edge facing away from the heat shield (item 5).

- c. Position the heat shield (item 5) on the bearing housing (item 14) and secure in position using the retaining ring (item 4).

CAUTION

The retaining rings (items 15 and 17) must be installed with the bevelled edge facing the bearing. Excessive end wear can result if the retaining rings are installed incorrectly.

- d. Using a suitable pair of circlip pliers, install the retaining ring (item 15) into the bearing housing (item 14), then lubricate the bearing (item 16) with clean engine oil and install the bearing in the bearing housing. Secure the bearing into the bearing housing with the retaining ring (item 17).
- e. Lubricate the thrust collar (item 18) with clean engine oil and install the thrust collar in the bearing housing (item 14) with the large diameter surface toward the retaining ring (item 17).
- f. Install the thrust bearing and the oil baffle (items 19 and 20) into the bearing housing (item 14), then install a new split ring seal (item 23) onto the oil slinger (item 22).
- g. Lubricate the split ring seal (item 23) with clean engine oil, then install the oil slinger (item 22) into the insert (item 24).
- h. Install a new O-ring (item 21) onto the insert (item 24), then install the insert into the bearing housing (item 14).

CAUTION

The retaining ring (item 25) must be installed with the bevelled edge facing away from the insert.

- i. Secure the insert (item 24) into the bearing housing (item 14) with the retaining ring (item 25).
- j. Install the two new split ring seals (item 3) onto the turbine shaft and wheel (item 2) as shown in Fig. 151.
- k. Lubricate the split ring seals (see Fig. 139, item 3) and the bearing bores in the bearings (items 8 and 16) with clean engine oil, then carefully install the shaft and wheel (item 2) into bearing housing (item 14).

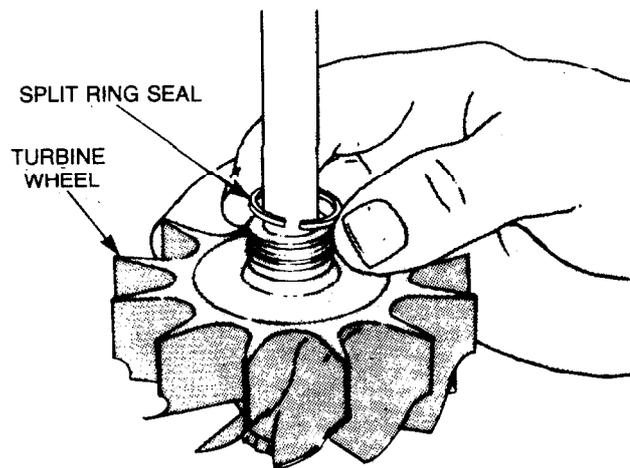


Figure 151 — Split Ring Seal — Installation

CAUTION

The compressor impeller nut (item 27) must be installed with the flat side towards the impeller (item 26).

- l. Install the compressor impeller (item 26) on the turbine shaft (item 2) and secure in position with the compressor impeller nut (item 27).
- m. Secure the turbine wheel and shaft (item 2) with a socket (see Fig. 152), then torque the compressor impeller nut (item 27) to 41 Nm (30 lb.ft).

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CAUTION
Care must be taken when installing the turbine housing to prevent damaging the turbine blades

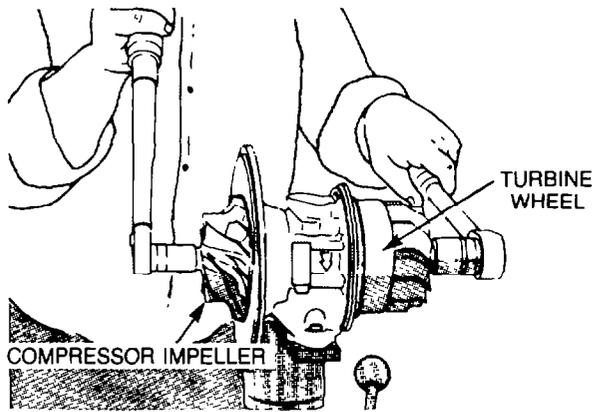


Figure 152 — Compressor Impeller — Installation

- n. Position the V-band clamp (see Fig. 139, item 10) on the bearing housing (item 14) as shown in Fig. 153, then coat the bearing housing and the turbine housing (items 1 and 14) mating surfaces with a suitable anti-seize compound. Install the turbine housing (item 1) onto the bearing housing (item 14) and position the V-band clamp (item 10) over the flange.

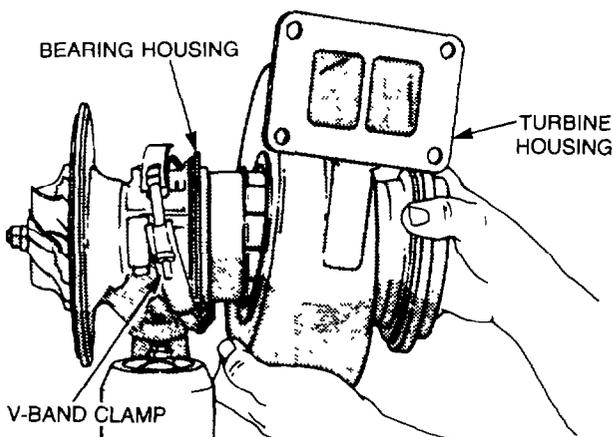


Figure 153 — Turbine Housing — Installation

- o. Align the matchmarks on the bearing housing, the V-band clamp and the turbine housing (see Fig. 139 items 14, 10 and 1), then coat the V-band clamp threads with a suitable anti-seize com-

pound and torque the clamp to 13.6 Nm (10 lb.ft).

CAUTION
Care must be taken when installing the compressor housing to prevent damaging the compressor impeller blades

- p. Install the compressor housing (item 28) onto the bearing housing (item 14) and align the matchmarks, then position and align the clamp plates (item 13) and secure in position with the ten bolts and washers (items 11 and 12). Torque the bolts to 6.8 Nm (5 lb.ft).

CAUTION
Insufficient turbine or compressor radial clearance can cause serious engine damage

- q. Push the turbine wheel (item 2) toward the turbine housing (item 1), then using a set of feeler gauges measure the clearance between the turbine wheel and the turbine housing (see Fig. 154). The standard clearance is 0.25-0.51 mm (0.010-0.021 in.). The minimum allowable clearance is 0.20 mm (0.008 in.).

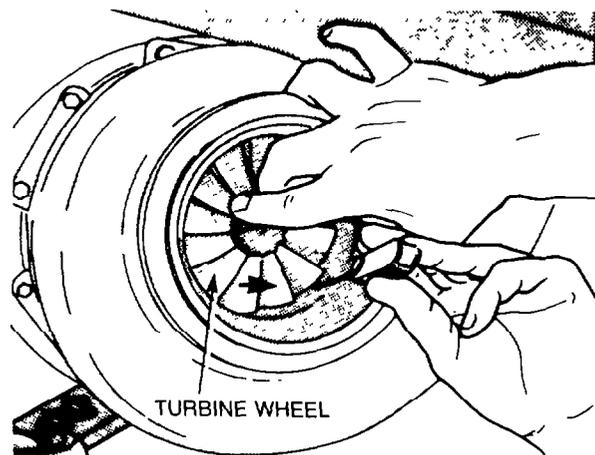


Figure 154 — Measuring Turbine Wheel to Turbine Housing Clearance

- r. Push the compressor wheel (see Fig. 139, item 26) toward the compressor housing (item 28), then using a set of feeler gauges measure the clearance between the compressor wheel and the housing. The standard clearance is 0.18-0.46 mm (0.007-0.018 in.). The minimum

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allowable clearance is 0.15 mm (0.006 in.).

CAUTION
*Incorrect axial clearance can cause
serious engine damage*

- s. Using a suitable dial indicator push the impeller shaft away from the dial indicator, set the indicator to zero, then push the impeller shaft from the compressor housing end toward the dial indicator. The reading Must be between 0.0254-0.1 mm (0.001-0.004 in.).

— SPECIFICATIONS —

Governor Drive Gear and Weight Shaft Gear	
Backlash	0.13-0.23 mm (0.005-0.009 in.)
Governor Driver to Thrust Bearing	
Clearance	0.05-0.13 mm (0.002-0.005 in.)
Gear Pump Shaft	
Diameter	12.695-12.703 mm (0.4998-0.5001 in.)
Gear Pump Drive and Idler Gears	
Diameter	19.006-19.014 mm (0.7483-0.7486 in.)
Gear Pump Gear Recess	
Depth.....	18.994-19.002 mm (0.7478-0.7481 in.)
Gear Pump Cover and Body	
Shaft Bore Diameter	12.733-12.740 mm (0.5013-0.5016 in.)
Shut-off Valve Seat	
Width	More than 0.38 mm (0.015 in.)
Shut-off Valve Coil	
Resistance.....	7.5 ± 0.5 Ohms
Plunger Barrel to Pump Housing	
Interference Fit.....	0.05 mm (0.002 in.)
Drive Shaft Bush	
Inside Diameter	Less than 19.11 mm (0.7525 in.)
Throttle Shaft Set Screws	
Tightening Torque.....	8-10 Nm (70.90 lb.in.)
Pressure Valve	
Installed Depth	0.38 mm (0.015 in.)
Pump Gears	
Installed Distance (from Body End).....	17.27-17.53 mm (0.5013-0.5016 in.)
Pump Cover Retaining Bolts	
Tightening Torque.....	15-18 Nm (11-13 lb.ft)
Drive Shaft	
End Play.....	0.038 mm (0.0015 in.)
Protrusion	60.2-61.3 mm (2.370-2.412 mm)
Cover Plate Retaining Bolts	
Tightening Torque.....	15-18 Nm (11-13 lb.ft)
Shut-off Valve Manual Opening Shaft	
Installed Depth	2.997 mm (0.118 in.)
Coil Housing Retaining Screws	
Tightening Torque.....	2.8-3.4 Nm (25-30 lb.in.)
Shut-off Valve Retaining Bolts	
Tightening Torque.....	7-11 Nm (5-8 lb.ft)
Piston Lock Nut	
Tightening Torque.....	3.4-4.5 Nm (30-40 lb.in.)
Check Valve	
Tightening Torque.....	7 Nm (5 lb.ft)
Tachometer Housing Retaining Bolts	
Tightening Torque.....	47-61 Nm (35-45 lb.ft)
Governor Plunger	
Protrusion	20.3 mm (0.8 in.)
Front Cover Retaining Bolts	
Tightening Torque.....	15-18 Nm (11-13 lb.ft)
Governor Spring Pack Cover Retaining Bolts	
Tightening Torque.....	12-15 Nm (9-11 lb.ft)

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Governor Cut Off	
Engine Speed	2130-2150 R.P.M.
Throttle Leakage	
Rate	110 cm ³ per hour
AFC No Air Fuel Rail	
Pressure	454 kPa (66 psi) at 306 lb. per hour
Check Ball	
Depth	1.40 mm (0.55 in.)
Test Pressure	414 kPa (60 psi)
Leakage	8.5 units maximum
Injector Cup	
Spray Angle	18° ± 2°
No. of Holes	Nine
Injector Springs	
Squareness Testing	Rotate through approximately 270°
Limit	0.41 mm (0.016 in.)
Injector Spring Tolerances	
Part No. 3034167	
Free Length	37.846 mm (1.490 in.)
Min. Load	38.8 kg (85.70 lb.)
Max. Load	43.4 Kg (95.70 lb.)
Length	26.80 mm (1.055 in.)
Part No. 3023478	
Free Length	38.2524 mm (1.506 in.)
Min. Load	49.8 kg (110.0 lb.)
Max. Load	57.1 kg (126.0 lb.)
Length	23.62 mm (0.930 in.)
Cup to Plunger Alignment	
Air Pressure	483 kPa (70 psi)
Tension	77 Nm (57 lb.ft)
Injector Plunger Checking Tool	
Torque Wrench Plunger Height	25.4mm (1.0 in.)
Test Pressure	207 ± 14 kPa (30 ± 2 psi)
Setting	0.266 Nm (2 lb.in.)
Injector Cup Leakage Test	
Test Pressure	414 kPa (60 psi)
Load Cell Test Pressure	1379 kPa (200 psi)
Barrel to Plunger	
Test Pressure	414 kPa (60 psi)
Load Cell Test Pressure	1379 kPa (200 psi)
Dial Indicator Setting	1.22 mm (0.048 in.)
Flowmeter Reading	4.5 units
Check Ball Leakage	
Test Pressure	414 kPa (60 psi)
Load Cell Test Pressure	1379 kPa (200 psi)
Flowmeter Reading	8.4 units
Top Stop Plunger Travel	
Test Pressure	550 ± 20 kPa (80 ± 3 psi)
Fixture Stop Nut Torque	13 Nm (115 lb.in.)
Plunger Travel	5.6896 ± 0.013 mm (0.224 ± 0.0005 in.)
Lock Nut Torque	75 Nm (55 lb.ft)

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Flow Test/Calibration	
Flow	191-193 cm ³ /stroke
Orifice Plug Torque	1 Nm (9 lb.in.)
Top Stop Total Travel	
Fixture Stop Nut Torque	13 Nm (115 lb.in.)
Plunger Travel	7.4676 ± 0.013 mm (0.2940 ± 0.005 in.)
Lock Nut Torque	75 Nm (55 lb.ft)
STC Plunger Lock Nuts	4 Nm (35 lb.in.)
STC Valve Body Housing Retaining Nuts	
Tightening Torque	6.8 Nm (60 lb.in.)
Air Pressure Regulator Bleeding	
Gauge Reading	0.418 kPa (0.60 psi)
Turbine Shaft Bearing Journals	
Standard Diameter	14.254-14.262 mm (0.5612-0.5615 in.)
Worn Limit	14.252 mm (0.5611 in.)
Split Ring Seal Side Clearance	
Standard Clearance	0.038-0.08 mm (0.0015-0.003 in.)
Worn Limit	more than 0.13 mm (0.005 in.)
Thrust Collar Thickness	
Standard Thickness	2.510-2.591 mm (0.0988-0.1020 in.)
Worn Limit	Less than 2.489 mm (0.0980 in.)
Trust Bearing Thickness	
Standard Thickness	5.33-5.38 mm (0.210-0.212 in.)
Worn Limit	Less than 5.31 mm (0.209 in.)
Bearing Housing Bores	
Standard Diameter	22.255-22.268 mm (0.8726-0.8767 in.)
Turbine Housing Mounting Flange	replace if-cracks exceed 15 mm (0.6 in.)
-any two cracks are closer than 6 mm (0.25 in.)	
-dividing wall cracks are closer than 12.7 mm (0.5 in.)	
V-Band Clamp	
Tightening Torque	13.6 Nm (10 lb.ft)
Compressor Housing Bolts	
Tightening Torque	6.8 Nm (5 lb.ft)
Turbine Wheel	
Standard Clearance	0.25-0.51 mm (0.010-0.021 in.)
Minimum Clearance	0.20 mm (0.008 in.)
Compressor Wheel	
Standard Clearance	0.18-0.46 mm (0.007-0.018 in.)
Minimum Clearance	0.15 mm (0.006 in.)
Turbine Shaft	
Axial Clearance	0.254-0.1 mm (0.001-0.004 in.)

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CLUTCH — GROUP 5

Clutch

42. Disassembly

- a. Remove the clutch assembly (refer to EMEI VEH G 884 — GROUP 5).

WARNING
To avoid personal injury, before entirely removing the adjusting ring lock bolt, pry the adjusting ring lock out from the adjusting ring to relieve any tension applied to the lock.

- b. Remove the front clutch plate, intermediate plate and the rear clutch plate from the clutch assembly. Invert the clutch housing and remove the bolt securing the adjusting ring lock to the housing, then pry the lock free of the adjusting ring (see Fig. 155).

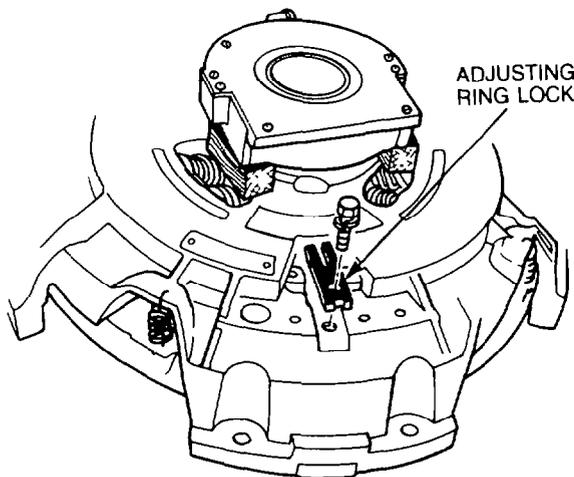


Figure 155 — Adjusting Ring Lock Removal

- c. Using a short piece of tubing with a diameter of 63.5 mm or 69.85 mm (2.5 in. or 2.75 in.), invert the clutch housing and position the release bearing sleeve on the tubing, to ensure that the release bearing sleeve protrudes above the sleeve retainer.
- d. Match mark the pressure plate to the clutch housing, then unhook the pressure plate return springs from the clutch

housing (see Fig. 156) and remove the pressure plate.

- e. Unscrew the adjusting ring in a counter-clockwise direction to release the ring from the clutch housing, then remove the adjusting ring complete with the release levers.
- f. Remove the snap-ring from the release sleeve retainer (see Fig. 157), then position the clutch housing assembly, together with the support tube in an arbor press.

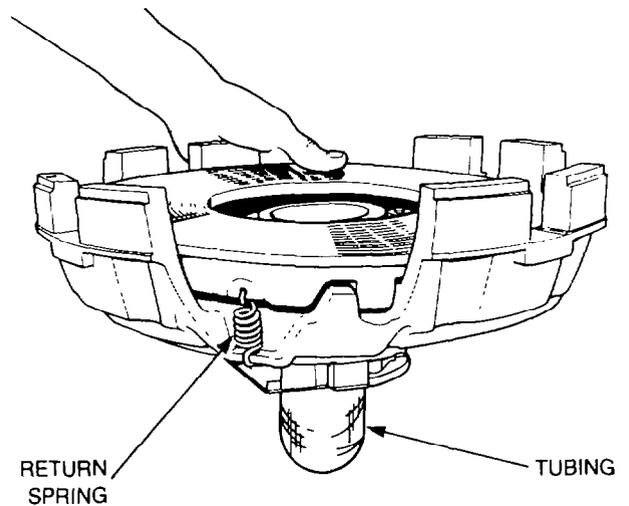


Figure 156 — Pressure Plate Return Springs

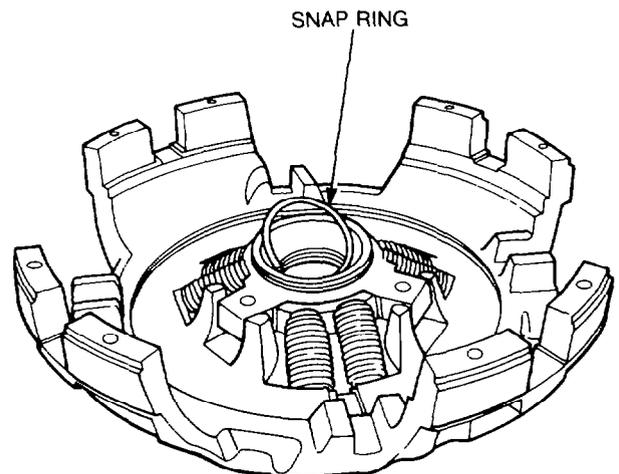


Figure 157 — Removing Snap-ring

NOTE

A specially fabricated tool (see Fig. 1) is required to facilitate the removal of the release bearing sleeve, half-ring locking washers.

- g. Position the fabricated tool over the spring retainer, then compress the springs until the drive lugs bottom on the clutch housing. Remove the wooden blocks from between the release bearing and the clutch housing, then remove the half-ring locking washers (see Fig. 158).

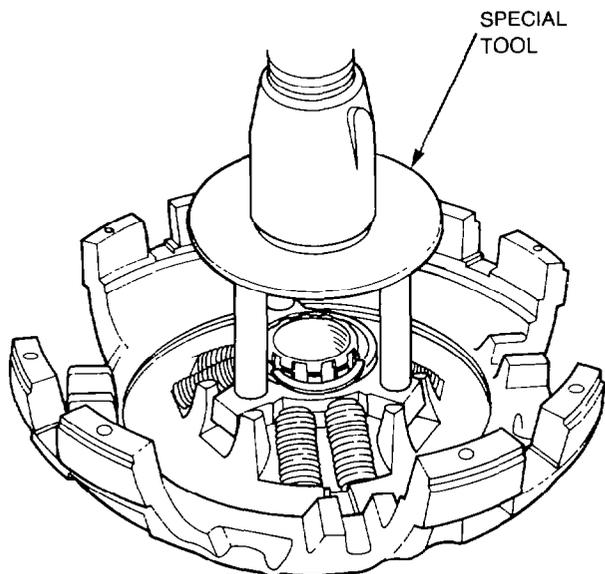


Figure 158 — Removing Half-ring Locking Washers

- h. Gradually release the pressure on the retainer and springs until they are free, then remove the levers, the adjusting ring, the springs and spring pivots and the spring retainer.

43. Cleaning and Inspection

- Clean all of the clutch housing components with a suitable cleaning agent, then blow dry with compressed air.
- Inspect the clutch housing for cracking and for wear in the pressure plate drive slots. Position the pressure plate in the drive slots, with matchmarks aligned, and check for a clearance of 0.076-0.533 mm (0.003-0.021 in.) between the lugs on the pressure plate and the drive slots in the clutch housing. If the clearance exceeds the maximum specified, compare the clutch housing and pressure plate against new components and replace parts as necessary.
- Inspect the pressure plate fulcrum for wear. If the wear exceeds 0.381 mm (0.015 in.), replace the pressure plate.
- Inspect the intermediate plate for wear. If the wear exceeds 0.381 mm (0.015 in.) per side, measure the thickness of the intermediate plate. The standard

thickness is 19.2-19.3 mm (0.757-0.762 in.). If the measured thickness is below this dimension replace the intermediate plate. If the measured thickness is within the dimension, the intermediate plate can be ground to a maximum of 0.381 mm (0.015 in.) per side.

44. Reassembly

- Using a suitable paint brush, coat the threads on the adjusting ring and the internal threads on the clutch housing with DARINA EP-1 (Shell Oil Co.).
- Install the spring pivots into position on both the clutch housing and the release bearing sleeve retainer, then install the release bearing assembly.
- Position the release bearing sleeve retainer on the release bearing sleeve, then install the six angle springs into position between the spring pivots on both the clutch housing and the sleeve retainer.
- Position the clutch housing assembly in an arbor press with the weight of the housing resting on a short piece of tube, with a diameter of 63.5 mm or 69.8 mm (2.5 in. or 2.75 in.) diameter, positioned beneath the release bearing carrier sleeve.

WARNING

Ensure that the clutch angle springs are correctly seated over the spigots before applying pressure to the spring retainer otherwise, when pressure is applied, springs could slip and fly out, causing personal injury.

NOTE

A specially fabricated tool (see Fig. 1) is required to facilitate the installation of the release bearing sleeve, half-ring locking washer.

- Position the fabricated tool over the spring retainer arms and compress the springs until the drive lugs bottom on the clutch housing, then install the half-ring locking washers.
- Remove the housing assembly from the press, then fit the release levers over the pivot lugs on the adjusting ring, then install the adjusting ring and engage the ends of the release levers with the groove in the sleeve retainer.

- g. Place a straight edge across the clutch housing mounting bosses, then measure the distance from the release lever to the straight edge (see Fig. 159). Turn the adjusting ring to obtain a dimension of approximately 63.00 mm (2.48 in.) to pre-set the adjusting ring.
- h. Install the assembly in the press and support the clutch housing to allow movement of the release bearing sleeve. Apply pressure to the sleeve retainer and install two 19 mm (0.784 in.) wooden blocks between the release bearing and clutch housing (see Fig. 160).

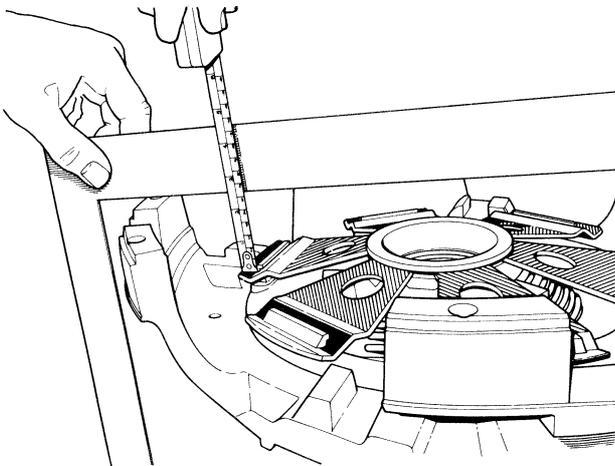


Figure 159 — Setting Adjusting Ring

- i. Remove the clutch housing assembly from the press and install the snap-ring in the release bearing sleeve retainer. Position the adjusting ring lock plate on the clutch housing, ensuring that it is properly engaged with the adjusting ring, then install the retaining bolt and lock washer and tighten the bolt securely.

- j. Position the pressure plate in the clutch housing, aligning the match marks if the original pressure plate is being revised, then attach the return spring to the clutch housing and the pressure plate.

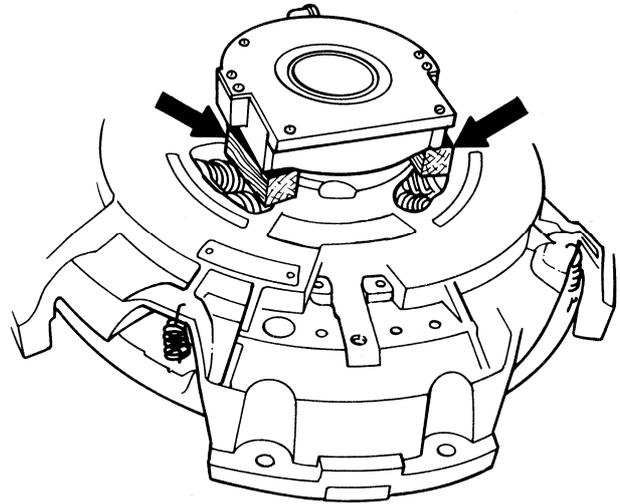


Figure 160 — Installing Wooden Blocks

- k. Assemble the rear clutch plate, the intermediate plate and the front clutch plate on the clutch housing then install the clutch alignment tool.

CAUTION

If the clutch housing assembly is to be stored for any length of time, ensure that it is stored with the pressure plate facing up. Otherwise, damage to the pressure plate return springs will result.

- l. Install the clutch assembly (refer to EMEI VEH G 884 — GROUP 5).

— SPECIFICATIONS —

Pressure Plate

- Drive Lugs to Slot Clearance..... 0.076-0.533 mm (0.003-0.021 in.)
- Fulcrum Wear Less than 0.381 mm (0.015 in.)
- Out-of-flat Concave, 0.000-0.102 mm (0.000-0.004 in.)

Intermediate Plate

- Drive Lugs to Slot Clearance..... 0.381-0.533 mm (0.015-0.021 in.)
- Thickness 19.2-19.3 mm (0.757-0.762 in.)
- Wear Less than 0.381 mm (0.015 in.) per side
- Re-grind Thickness (Maximum) 0.381 mm (0.015 in.) per side
- Out-of-flat Concave, 0.000-0.102 mm (0.000-0.004 in.)

Pilot Diameter

- 435.76-435.69 mm (17.156-17.153 in.)

Disc Assembly

- Maximum Runout 0.381 mm (0.015 in.)
- Maximum Out-of-flat 0.508 mm (0.020 in.)

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— FAULT FINDING —

Clutch

Symptom	Probable Cause	Action
1. Noisy clutch.	a. Clutch release bearings dry or damaged.	a. Lubricate bearing or replace.
	b. Flywheel pilot bearing dry or damaged.	b. Lubricate bearing or replace.
2. Poor release.	c. Clutch release bearing housing striking flywheel ring.	c. Adjust clutch. Also check wear on cross shafts, bell housing bushings, and release yoke fingers. If badly worn replace parts.
	a. Insufficient amount of release travel.	a. Check release travel angle as spring clutches are designed for 12.70 mm (0.50 in.)
	b. Pressure plate not retracting.	b. Check pressure plate drive lugs for proper clearance of 0.152 mm (0.006 in.) minimum. Check pressure plate return springs. Replace if bent or stretched.
	c. Lever nose out of groove in release sleeve retainer.	c. Remove from vehicle. Repair or replace clutch assembly.
	d. Driven disc distorted or warped.	d. Driven disc assembly must be straight within 0.381 mm (0.015 in.) total indicator reading. Replace discs if they can not be straightened.
	e. Damage to driven disc can be caused by poor installation methods. Do not force transmission drive gear into disc hubs. This will distort or bend driven disc causing poor release.	e. Replace clutch assembly.
	f. Splines worn on main drive gear of transmission.	f. Replace drive gear and check driven disc hubs for excessive wear. If worn, replace disc. Check flywheel housing alignment of engine and transmission. Make sure driven discs slide freely on drive gear splines.
	g. Internal clutch adjustment not correct.	g. Readjust clutch for standard release travel. Proper clutch adjustment must be maintained for good clutch release and proper brake squeeze.
	h. Flywheel pilot bearing fitting too tightly in flywheel or on end of drive gear.	h. Replace pilot bearing.
	i. Damaged clutch release bearing.	i. Replace bearing.
j. Clutch release shaft projecting through release yoke.	j. Relocate release shaft so it does not project. Check bell housing bushings and release yoke for wear. Replace if worn.	

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Clutch

Symptom	Probable Cause	Action
3. Clutch slippage.	<ul style="list-style-type: none"> k. Release yoke contacting cover assembly at full release position. l. Release yoke will not align with release bearing properly. m. Broken intermediate plate caused by driver abuse or excessive heat: <ul style="list-style-type: none"> 1. Holding vehicle on hill with clutch. 2. Overload. 3. Starting off in the wrong gear. 4. Wrong cover assembly installed allowing clutch to slip. 5. Intermediate plate hanging allowing clutch to slip. n. Seized pilot bearing. o. Driven disc sticking on input shaft. 	<ul style="list-style-type: none"> k. Replace release yoke with proper yoke. l. Check flywheel. If resurfaced more than the recommended 1.524 mm (0.060 in.), replace flywheel. m. Replace damaged intermediate plate driven disc assembly. n. Replace pilot bearing. o. Clean parts.
	<ul style="list-style-type: none"> a. Weak pressure springs. b. No free pedal travel. c. Worn clutch facings. d. Release mechanism binding. 	<ul style="list-style-type: none"> a. Replace springs. b. Readjust clutch. c. Replace facings or complete driven disc assembly. d. Free up mechanism and linkage. Check clutch adjustment.

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TRANSMISSION — GROUP 6

Transmission

45. Disassembly

- a. Remove the transmission (refer to EMEI VEH G 884 — GROUP 6).
- b. Remove the clutch release shaft and yoke (refer to EMEI VEH G 884 — GROUP 5).
- c. Tag and disconnect the air lines from the air valves on the top of the transmission, then remove the air valves.
- d. Remove the bolts securing the selector housing (top cover) to the transmission and remove the cover complete with the selectors, selector shafts and forks.
- e. Invert the selector housing and place it on a work bench. Ensure that the selectors are in the neutral position, and note the position of the selectors and forks (see Fig. 161). Remove the locating screws securing the selectors and forks to the selector shafts. Remove the selector shafts, taking care not to lose the detent balls and springs and the interlock plungers and pins.

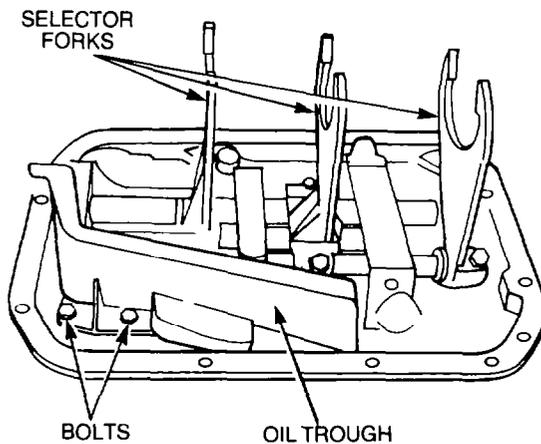


Figure 161 — Selector Housing

- f. Remove the bolts securing the oil trough to the housing, and remove the oil trough.
- g. Position the transmission on a suitable jig or two blocks of wood, with the rear of the transmission uppermost. Using a suitable wedge, block the mainshaft gears to prevent the mainshaft from turning, then remove the output shaft yoke nut, washer and yoke.
- h. Remove the bolts securing the air selector housings to the transmission and

remove the housings, then dismantle the pistons.

- i. Remove the bolts securing the countershaft bearing covers and remove the bearing covers complete with the oil pump and the pressure regulator.
- j. Remove the bolts securing the output shaft bearing cover and remove the bearing cover.
- k. Remove the selector fork stop pin (see Fig. 162) from the rear housing, then remove the bolts securing the rear housing to the front housing.

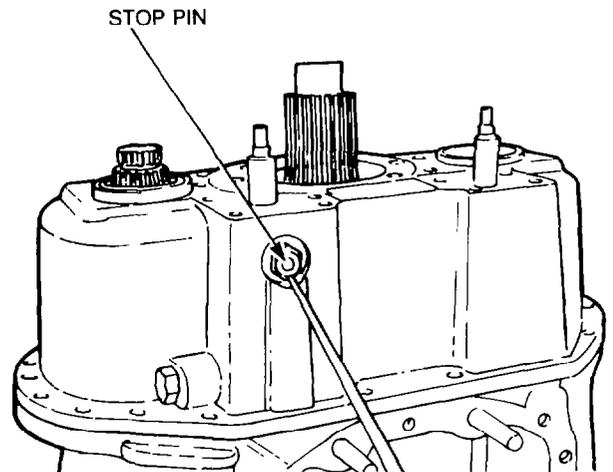


Figure 162 — Selector Fork Stop Pin Location

- l. Attach lifting lugs to the rear housing and, with suitable overhead lifting equipment, remove the rear cover from the transmission assembly (see Fig. 163).

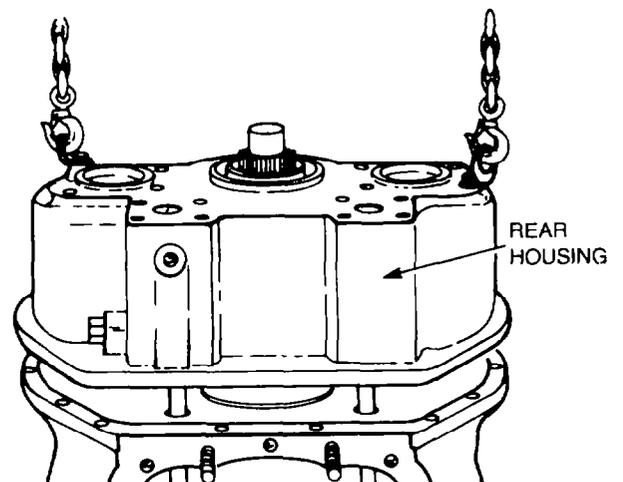


Figure 163 — Rear Housing Removal

NOTE

While removing the rear housing, it will be necessary to tap on the end of the output shaft with a soft-faced hammer to remove the bearing from the output shaft.

- m. Remove the thrust washer and low gear from the output shaft, then remove the output shaft, the selector shaft and fork and the curvic clutch collar (see Fig. 164).

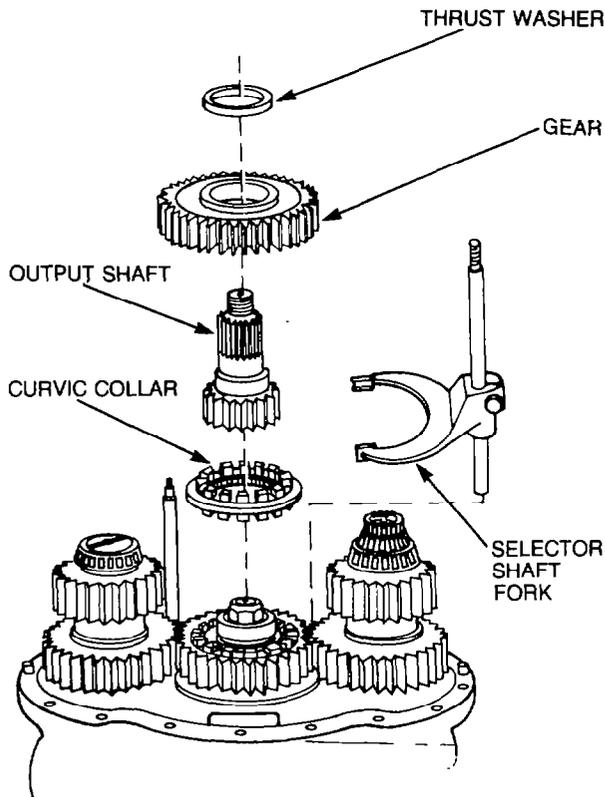


Figure 164 — Low Splitter Gear and Output Shaft — Removal

- n. Note the position of the geared and the slotted countershafts in relation to the transmission, then lift the countershafts from the housing.
- o. Using a suitable wedge, block the mainshaft gears to prevent the mainshaft from turning, then remove the nut securing the output gear to the mainshaft. With the aid of two suitable levers, remove the output gear together with the bearing and thrust washer (see Fig. 165).
- p. With the aid of suitable lifting equipment, position the transmission on a work bench. Remove the bell housing refer to EMEI VEH G 884 — GROUP 5.

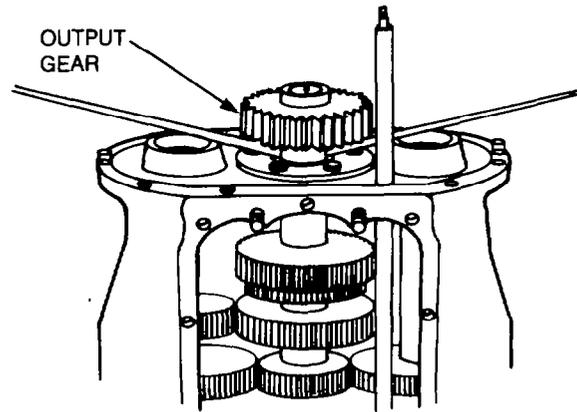


Figure 165 — Removing Output Gear

- q. Remove the locating screw from the splitter gear selector fork, then remove the selector shaft stop-pin from the transmission housing (selector housing mounting surface) and remove the selector fork and shaft.
- r. Insert a 3/8 in. 16 UNC bolt into the end of the reverse idler shaft and remove the shaft by pulling on the bolt. Take care not to lose the lock ball. After removing the idler shaft, roll the upper idler gear toward the side of the housing, then engage the clutch collar with reverse gear.
- s. Remove the mainshaft rear bearing retainer, then remove the rear bearing from the mainshaft using a suitable puller.
- t. Remove the circlip and the internally splined thrust washer from the rear of the mainshaft, then remove the gear bore snap-ring, both the internally and externally splined thrust washers and the remaining gear bore snap-ring (see Fig. 166).

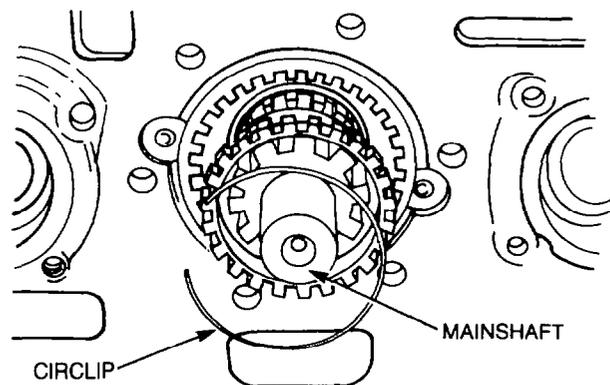


Figure 166 — Removing Snap-rings and Thrust Washers

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- u. Butt reverse gear against first/second gear, and secure the gears together with lockwire to provide enough clearance for the removal of the mainshaft, then attach a suitable sling to the mainshaft between second and third gears.
- v. Remove the input shaft bearing cap and bearing. Remove the input shaft, then using a suitable bearing puller remove the pilot (pocket) bearing from the input shaft (see Fig. 167).

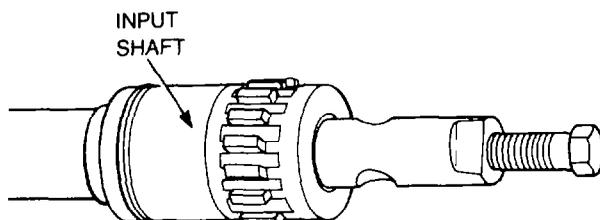


Figure 167 — Pilot (Pocket) Bearing Removal

- w. Using a suitable bronze drift and a hammer, drive the countershafts toward the front of the transmission to enable the bearing puller to be correctly positioned behind the snap-ring on the countershaft front bearings. Remove the snap-ring locating the bearings on the countershafts, then position the feet of the bearing puller behind the snap-ring on the bearing and remove the bearing (see Fig. 168).

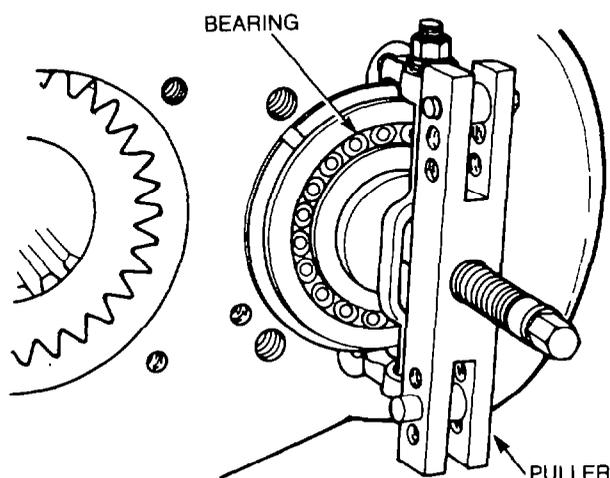


Figure 168 — Countershaft Front Bearing Removal

- x. Remove the drive gear, the clutch ring, the sliding clutch and fifth gear from the front of the transmission housing, then remove the countershaft rear bearing retainers from the transmission housing and remove the bearings with a suitable

puller (see Fig. 169). Remove and retain the spacer ring (if not damaged) for reuse.

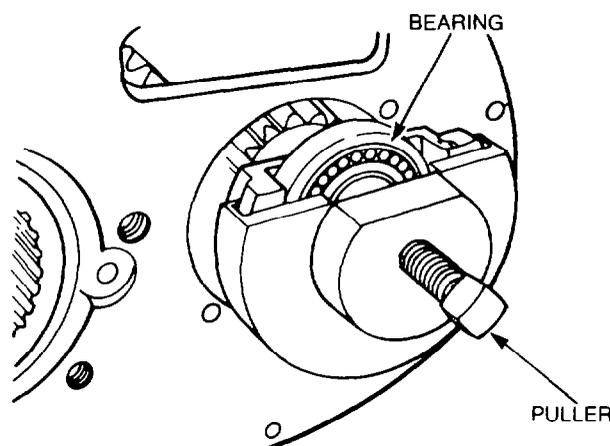


Figure 169 — Countershaft Rear Bearing Removal

- y. Connect the sling, previously attached to the mainshaft, to suitable overhead lifting equipment, then move the countershafts forward and to the side of the transmission housing to provide the necessary clearance for the mainshaft removal. Lift the mainshaft from the housing, then position the mainshaft on a work bench and remove the sling and lifting equipment.
- z. Remove the upper reverse idler gear, then because of the upper idler boss interference, remove the right hand countershaft first, then the left hand countershaft.
 - aa. Insert a bolt into the lower reverse idler shaft and remove the shaft by pulling on the bolt, taking care not to lose the lock ball, then remove the lower reverse idler gear from the transmission.
 - ab. Remove the clutch collar from the front of the mainshaft, then disconnect the lockwire securing reverse gear to first gear and remove reverse gear.
 - ac. Remove the circlip from the front end of the mainshaft, then remove third and fourth gears, complete with the splined thrust washers, from the mainshaft.
 - ad. Remove the circlip locating the second/third gear clutch collar to the mainshaft and remove the sliding clutch.
 - ae. Remove the next circlip and remove the remaining gears from the mainshaft.
 - af. Remove the two remaining circlips locating the first/reverse clutch collar, and

remove the clutch collar. Place the mainshaft components to one side.

ag. Note the positioning of the gears on the countershafts (see Fig. 170), then remove the gears and Woodruff keys from the countershafts.

ah. Using a suitable bearing puller, remove the bearings from the two rear countershafts.

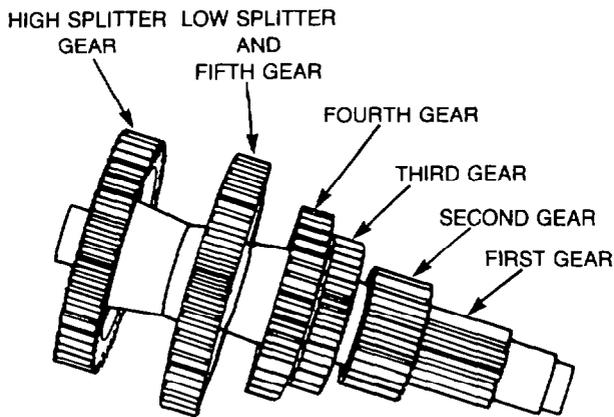


Figure 170 — Countershaft Gear Positions

46. Cleaning and Inspection

a. Clean the transmission housing and covers with a recommended cleaning agent and ensure that all trace of gasket material is removed, then dry the housing and covers with compressed air.

CAUTION
Do Not spin the bearings with compressed air as damage to the bearings may result.

- b. Clean the bearings in a suitable agent, then blow dry with compressed air.
- c. Clean the internal components of the transmission with a suitable cleaning agent, then blow dry with compressed air.
- d. Check the bearings for damage or wear and replace as necessary.
- e. Inspect the gear teeth for wear, damage, scoring, surface fatigue, ridging, corrosion or cracking and replace as necessary. The gears may also be checked by Magnaflux, or similar, to detect cracks which would otherwise not be visible.
- f. Inspect the teeth on the clutch collars and curvic clutch collars for wear on the leading edge of the teeth (see Fig. 171). Replace the clutch collars if excessive wear or damage is evident.
- g. Inspect the mainshaft for shiny areas on the splines, gearlocks either completely worn or with worn corners, bearing surfaces for scoring, pitting or wear. Replace the mainshaft if damage or wear is evident.
- h. Inspect the countershafts for worn key slots, pitted or damaged gear teeth or scored, pitted or worn bearing surfaces. Replace the countershafts as necessary.
- i. Inspect the gear selectors, selector shafts and forks for wear or damage and replace as necessary.
- j. Check the transmission housings for cracks and replace as necessary.
- k. Check all other parts for wear or damage and replace as necessary.

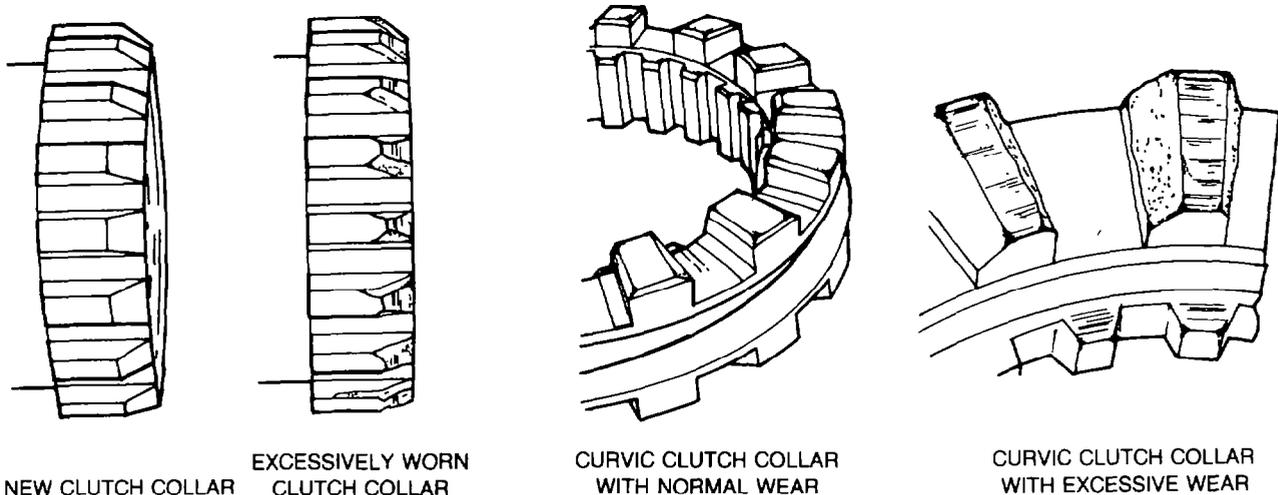


Figure 171 — Clutch Collar Wear

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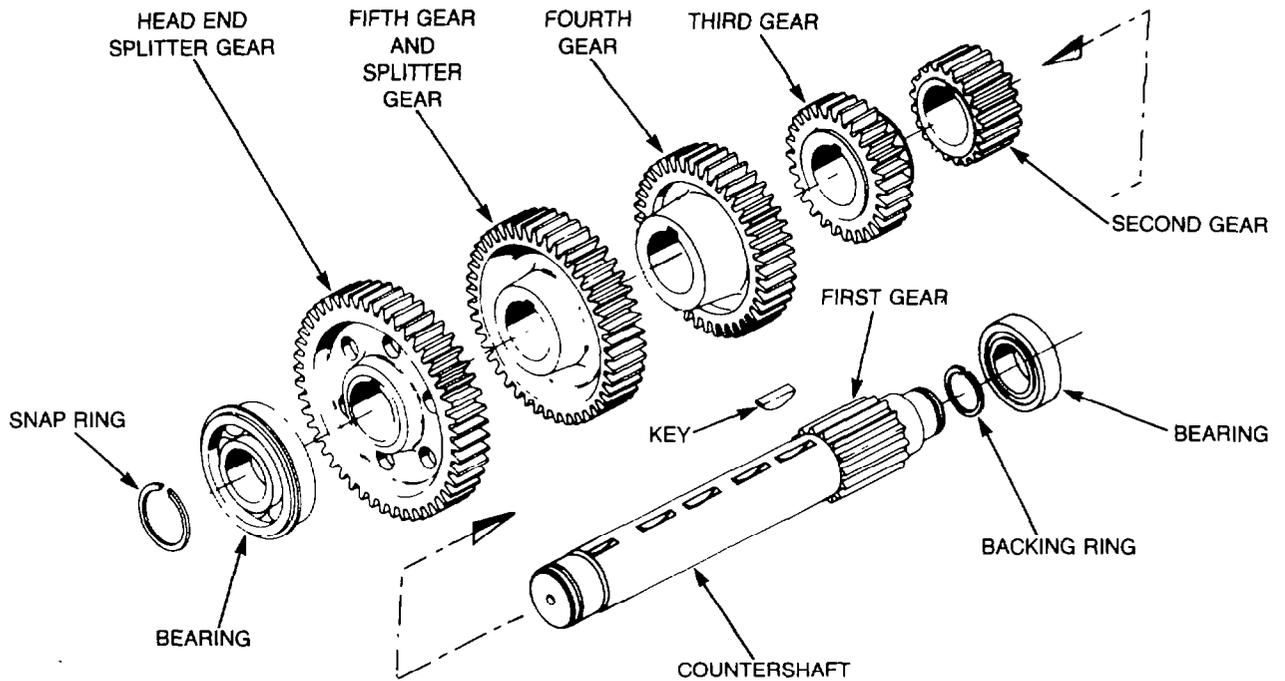


Figure 172 — Countershaft — Exploded View

47. Reassembly

- a. Assemble the countershaft by installing in turn, each Woodruff key and gear onto the countershaft, in the order shown in Fig. 172. Paint the teeth on each gear as the gear aligns with the timing mark on the head end gear (see Fig. 173).

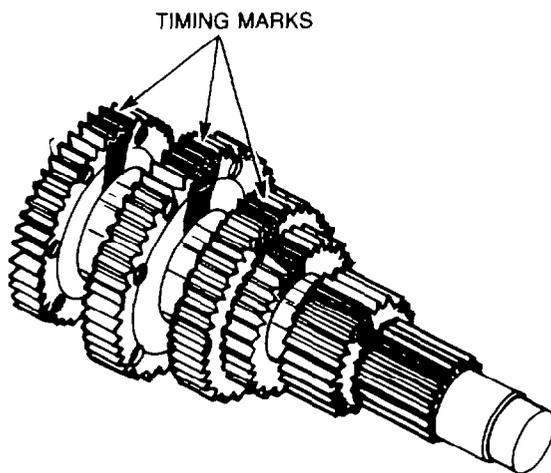


Figure 173 — Timing Mark — Highlighted

NOTE

To ensure that the bearing is correctly located, use the old backing ring or a new one of equivalent thickness.

- b. Install the backing ring on to the rear end of the countershaft.
- c. Liberally coat the gears on the countershafts with transmission oil and ensure that the bearings are well lubricated. Place the countershafts to one side and cover them with a protective cloth.
- d. Lubricate the mainshaft and the first/reverse clutch collar with transmission oil, then install the clutch collar into position on the mainshaft. Install two new circlips into grooves on the mainshaft to hold the clutch collar in position (see Fig. 174).

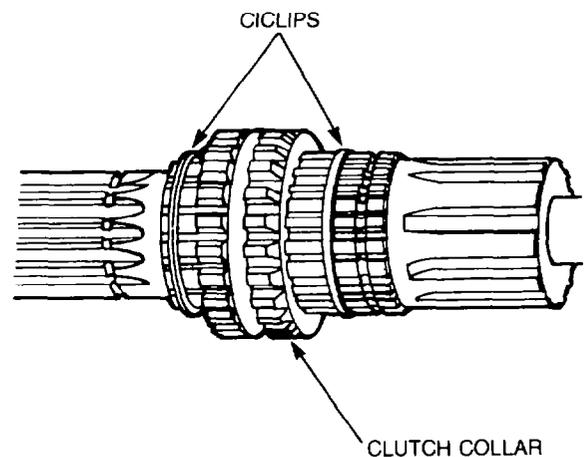


Figure 174 — Installing First/Reverse Clutch Collar

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- e. Lubricate the first gear thrust washers with transmission oil, then assemble the thrust washers into the gear, together with a new snap-ring. Ensure that the externally splined thrust washer is positioned nearest the snap-ring, then install the gear and thrust washer assembly onto the mainshaft, and check that the internally toothed thrust washer butts against the clutch collar locating circlip (see Fig. 175).

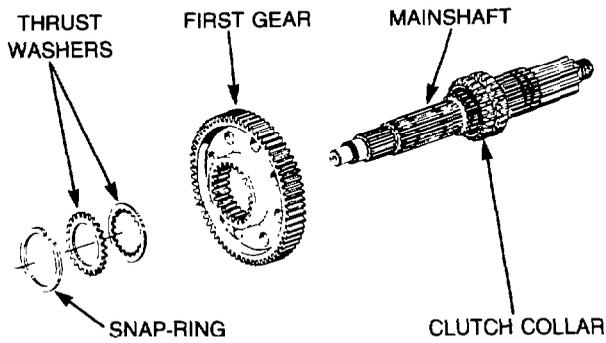


Figure 175 — Installing First Gear

- f. Lubricate the second gear thrust washers with transmission oil, then assemble the thrust washers and snap-ring into the third/fourth gear, ensuring that the externally splined thrust washer is nearest the snap-ring. Position the gear and thrust washer assembly on the mainshaft with the snap-ring or ground hub side of the gear toward the first gear (see Fig. 176).

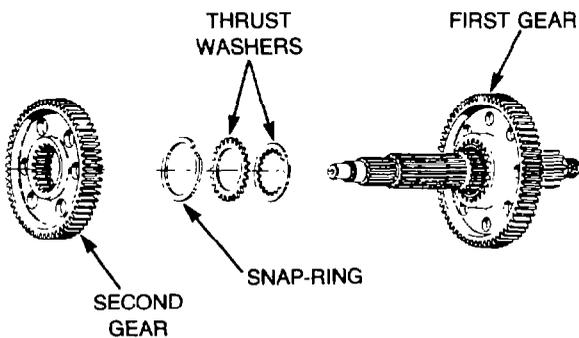


Figure 176 — Installing Second Gear

- g. Lubricate the second/third gear clutch collar, then install the clutch collar, together with new circlips, onto the mainshaft (see Fig. 177).
- h. Lubricate the third gear thrust washers with transmission oil, then assemble the thrust washers and snap-ring into the third gear, ensuring that the externally splined thrust washer is nearest the

snap-ring. Install the gear and thrust washer assembly onto the mainshaft (see Fig. 178).

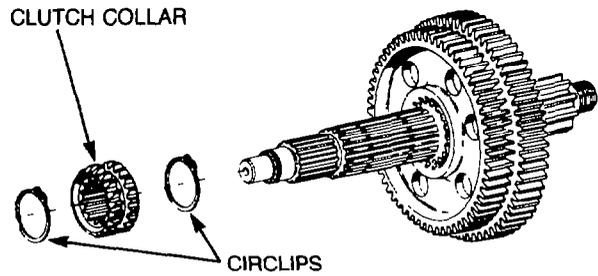


Figure 177 — Installing Second/Third Gear Clutch Collar

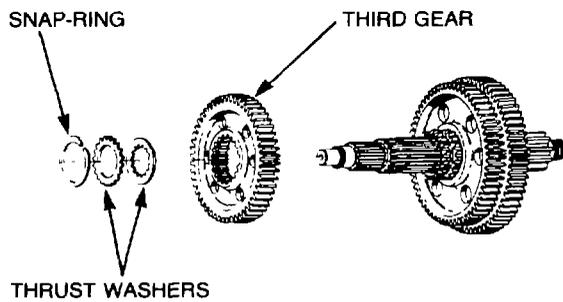


Figure 178 — Installing Third Gear

- i. Lubricate the fourth gear thrust washers with transmission oil, then assemble the thrust washers and snap-ring into the fourth gear, ensuring that the externally splined thrust washer is nearest the snap-ring. Install the fourth gear onto the mainshaft and secure in position with the clutch collar locating circlip (see Fig. 179).

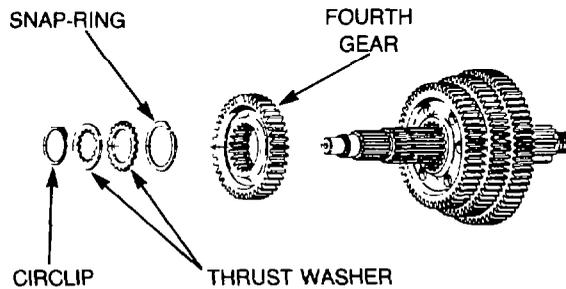


Figure 179 — Installing Fourth Gear

- j. Install the fourth/fifth gear clutch collar onto the front of the mainshaft, then position the reverse gear on the rear of the mainshaft and lock wire reverse gear to first gear to hold in position.
- k. Install new needle roller bearings, together with a new spacer (see Fig. 180), in the lower reverse idler gear, then lubricate the gear and bearings with trans-

mission oil. Position the idler gear in the transmission housing and install the idler gear shaft, ensuring that the lock ball is correctly seated in the shaft and aligned with the detent in the housing.

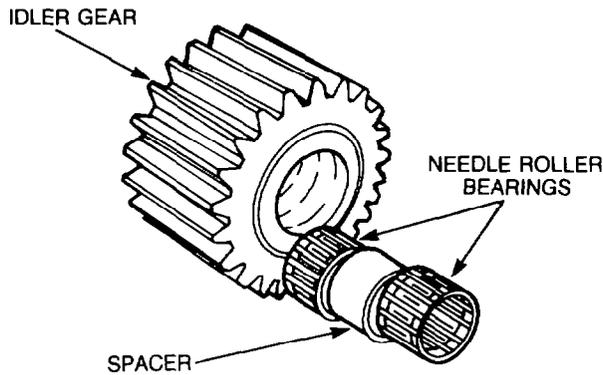


Figure 180 — Idler Gear, Bearings and Spacer

- l. Install the countershafts (left hand countershaft first) into the transmission housing, then install new needle roller bearings, together with a new spacer, in the upper reverse idler gear. Lubricate the idler gear and bearings with transmission oil, then position the idler gear in the transmission, but do not install the idler gear shaft at this stage.
- m. Attach a suitable sling to the mainshaft between second and third gears, then connect the sling to suitable overhead lifting equipment. Move the countershafts forward and to the sides of the transmission housing, then install the mainshaft into the transmission housing. While supporting the mainshaft with the lifting equipment, cut the lock wire securing reverse gear, then slide the gear rearward. Install the gear bore snap-ring, then lubricate and install both the internally splined and the externally splined thrust washers. Secure the thrust washers with a snap-ring, then lubricate and install the second internally splined thrust washer and secure in place with a mainshaft circlip.
- n. Lubricate the mainshaft rear bearing with transmission oil, then position the bearing on the mainshaft. Position the bearing retainer over the rear bearing, then install the six retaining bolts and tighten securely.
- o. Position the splitter ring on fifth gear and secure with a new snap-ring. Highlight the timing marks on the gear with paint, then lubricate the splitter ring and

gear with transmission oil, and install the gear assembly onto the clutch collar at the input end of the mainshaft (see Fig. 181). Position the gears timing marks in the horizontal plane.

NOTE

The pilot bearing must be installed with the markings on the bearing facing toward the rear of the transmission.

- p. Lubricate a new pilot (pocket) bearing with transmission oil, then using an hydraulic press, install the bearing into the recess in the input shaft.
- q. Assemble the clutch ring onto the drive (input) gear and secure the clutch ring with a new snap-ring. Highlight the timing marks on the gear with paint, then lubricate the drive gear assembly with transmission oil and position the assembly on the input shaft.
- r. Install a new snap-ring into the clutch splitter gear, then position the curvic clutch collar onto the splitter gear. Lubricate the assembly with transmission oil and position the assembly in the transmission, ensuring that the splitter gear internal snap-ring is facing the rear of the transmission. Support the splitter gear and install the input shaft into the transmission. Rotate the drive gear to bring the timing marks onto the horizontal plane, then lubricate and install the input shaft bearing together with the bearing cap and new seal. Install the bearing cap retaining bolts and torque the bolts to 46-56 Nm (34-41 lb.ft).

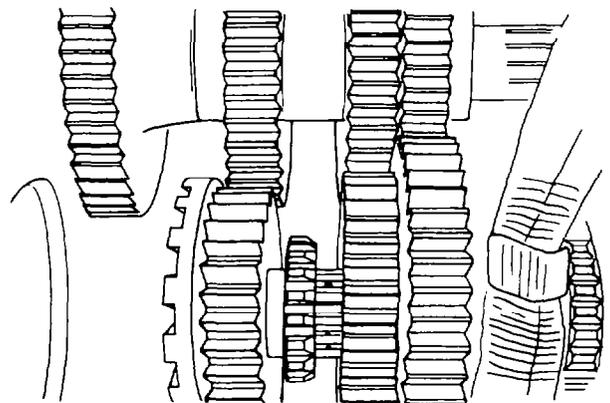


Figure 181 — Installing Ninth/Tenth Gear Assembly

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NOTE

Specially fabricated tools will be necessary to facilitate the timing of the countershaft gears.

- s. Install the fabricated countershaft support tools (4 off) at each end of both countershafts. Rotate the countershafts until the timing mark on each countershaft is facing toward the timing mark on the opposite countershaft, and on the same plain.
- t. Remove the lifting equipment from the mainshaft, then using special tool J-23667, align the timing marks on one countershaft with the timing marks on the mainshaft drive and ninth/tenth gears (see Fig. 182). As the countershaft is timed, remove the fabricated tools from the ends of the countershaft, then install both the front and rear bearings (including retainers) onto the countershaft and lubricate the bearings with transmission oil.

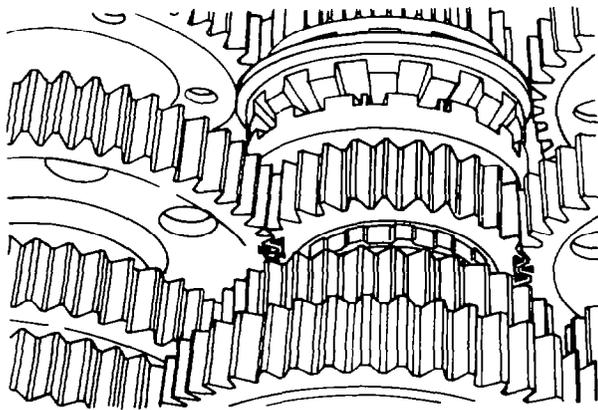


Figure 182 — Timing Countershaft Gears

- u. When the countershaft bearings have been installed check that the countershaft has been timed correctly by rotating the input shaft. If the shaft rotates freely, the gears have been correctly timed. If the shaft locks up, recheck the countershaft gears for correct timing and adjust as necessary.
- v. Repeat the timing procedure in paras. t. and u. for the remaining countershaft. After the countershafts have been correctly timed, install the reverse idler shaft in the upper reverse idler gear, ensuring that the lock ball is correctly

seated in the shaft and aligned with the detent in the housing.

- w. Install the bolts in the countershaft rear bearing retainers and torque the bolts to 46-56 Nm (34-41 lb.ft).
- x. Position the selector fork on the front splitter gear sliding clutch then install the selector shaft (long). Secure the fork to the shaft with the locating screw and secure the locating screw with lock wire, then install the selector shaft stop pin into the housing (see Fig. 183).
- y. Install the bell housing refer to EMEI VEH G 884 — GROUP 5.
- z. Stand the transmission (with the rear uppermost) on a suitable jig or two blocks of wood and install the output gear onto the mainshaft. Lubricate the rear pilot bearing with transmission oil, then install the washer, the pilot bearing and the lock nut. Using a suitable wedge, block the mainshaft gears to prevent the mainshaft from turning, then torque the lock nut to 746-814 Nm (550-600 lb.ft) and remove the wedge.

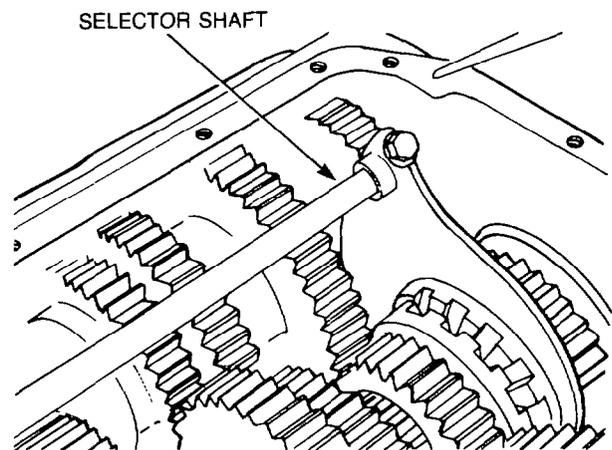


Figure 183 — Installing Selector Shaft, Fork and Stop Pin

- aa. Assemble the Woodruff keys and gears onto the two rear countershafts, then install the tapered roller bearings onto each end of the two countershafts. Highlight the timing marks on the countershaft gears, then lubricate the gears and bearings with transmission oil.
- ab. Ensure that the timing marks on the mainshaft output gear are pointing towards the countershaft bearing caps, then install the two rear countershafts

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in their correct positions with the timing marks on the countershafts aligned with the timing marks on the output shaft.

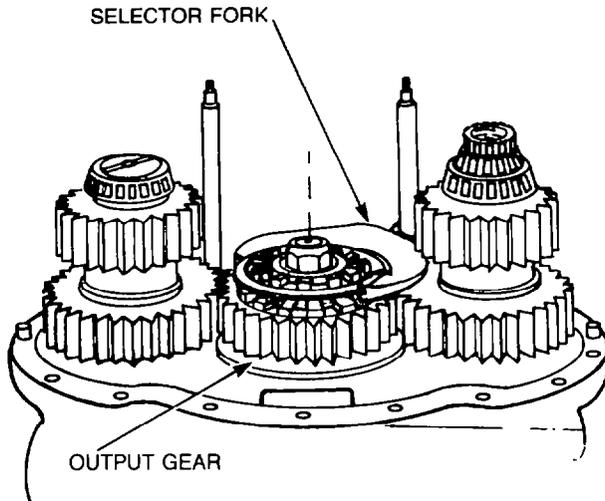


Figure 184 — Installing Selector Fork, Shaft and Clutch Collar

- ac. Assemble the rear selector fork and shaft, together with the clutch collar into position on the output gear (see Fig. 184).
- ad. Position the output shaft over the mainshaft pilot bearing, rotating the clutch collar to align the splines, then install the low gear and thrust washer on the output shaft.
- ae. Position a new gasket on the rear housing-to-front housing mounting surface, then with suitable overhead lifting equipment position the rear housing on the front housing and install the selector shaft stop pin (see Fig. 185). Install the housing retaining bolts and torque the bolts to 46-56 Nm (34-41 lb.ft).

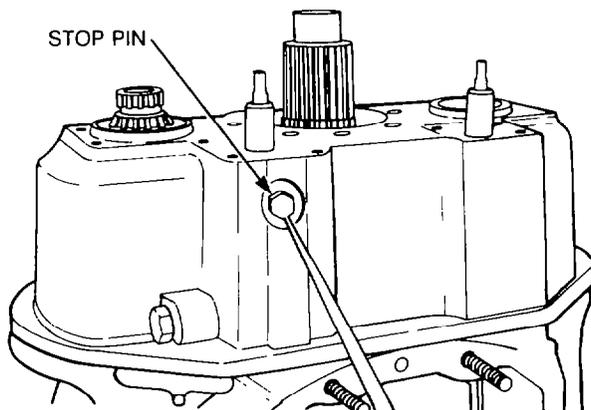


Figure 185 — Installing Selector Shaft Stop Pin

- af. Install a new seal in the output shaft bearing cap, then position the output shaft bearing cap and a new gasket, and

the countershaft bearing caps and new gaskets, together with the air pressure regulator on the rear housing. Install and torque the retaining bolts to 46-56 Nm (34-41 lb.ft).

- ag. Install new O-rings over both selector shafts and into the recesses in the transmission housing, then install the Belleville washers over both selector shafts, with the convex side of the washer toward the transmission housing. Install new quad-seals on both the locating rings and install the locating rings into their respective piston housing.
- ah. Install new O-rings on the inside and outside diameters of the pistons, then install the pistons (with the small O-rings toward the transmission) on the selector shaft and secure with lock nuts.
- ai. Position the piston housings over the pistons and ensure that the locating rings are correctly seated against the Belleville washers. Install the retaining bolts and torque the bolts to 46-56 Nm (34-41 lb.ft).
- aj. Lubricate the seal running surface of the output shaft yoke with transmission oil, then install the yoke onto the output shaft. Block the mainshaft gears with a suitable wedge, then install the flat washer and a new lock nut on the output shaft and torque the lock nut to 746-814 Nm (550-600 lb.ft).
- ak. Assemble the oil trough, the selectors, selector shafts and forks onto the selector housing. Ensure that the detent balls, springs, interlock plungers and pins are lubricated with transmission oil and installed correctly (refer to Fig. 186).
- al. Place the transmission in the horizontal position and move each sliding clutch into neutral. Position a new selector housing gasket on the transmission, check that the selector forks are in neutral, then position the selector housing on the transmission. Install and torque the retaining bolts to 46-56 Nm (34-41 lb.ft).
- am. Install the air valves on the top of the transmission, then connect the air hoses to the air valves to the positions as tagged.
- an. Install the clutch release shaft and yoke (refer to EMEI VEH G 884 — GROUP 5).

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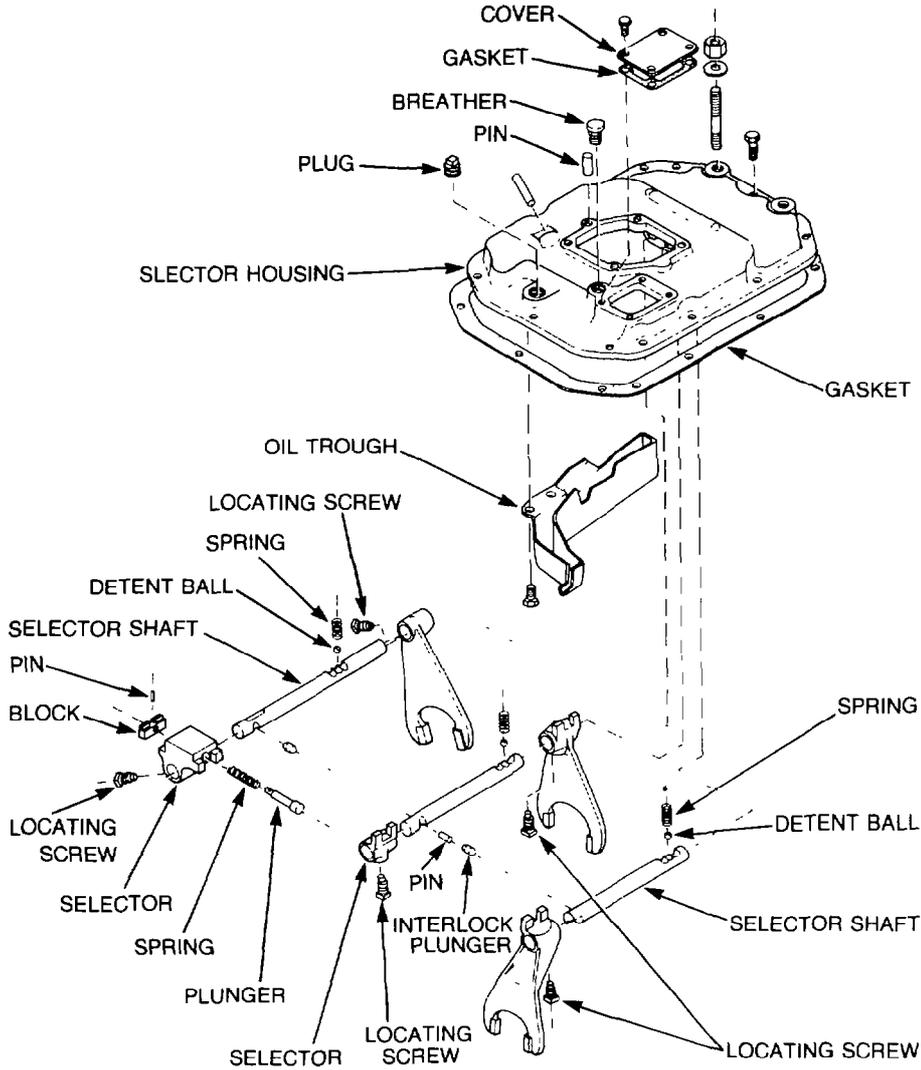


Figure 186 — Selector Housing — Exploded View

ao. Install the transmission (refer to EMEI VEH G 884 — GROUP 6).

c. Remove the four socket-head bolts securing the selector housing to the PTO and remove the selector housing (see Fig. 187).

Power Take-Off (PTO)

48. Disassembly

- a. Clean the PTO and surrounding transmission area using a suitable cleaning agent and blow dry with compressed air.

WARNING
Before removing the PTO, ensure the lubricant temperature is below 50°C, to avoid personal injury occurring.

- b. Disconnect and remove the PTO from the transmission (refer to EMEI VEH G 883 — GROUP 6).

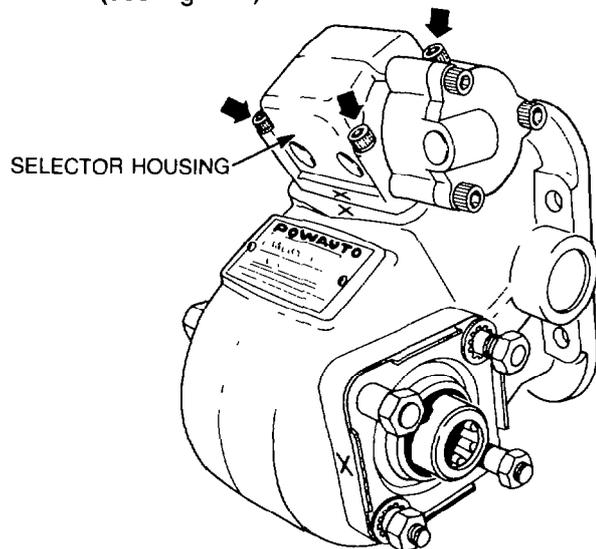


Figure 187 — Selector Housing — Removal

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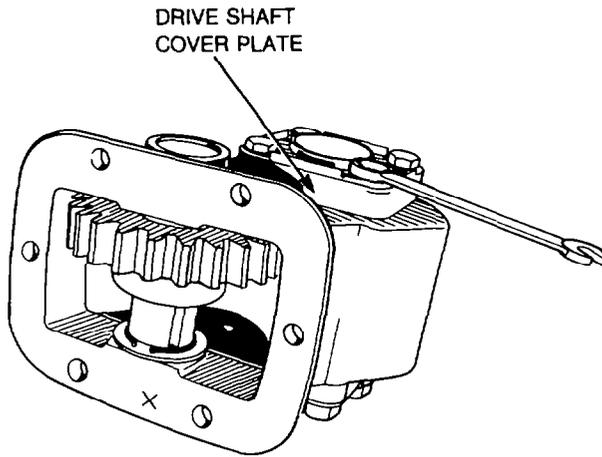


Figure 188 — Welsh Plug — Location

- d. Remove a welsh plug from one end of the idler shaft (see Fig. 188).
- e. Remove the circlip (furthest from the end of the idler shaft from which the welsh plug was removed) and slide it along the shaft. Install the PTO housing in a press and remove the idler shaft using the press and a suitable adapter (see Fig. 189).

NOTE

As the shaft is pressed out of the housing, it will cause the gear, thrust washer and circlip to slide along the shaft and will also remove the other welsh plug and a roller bearing.

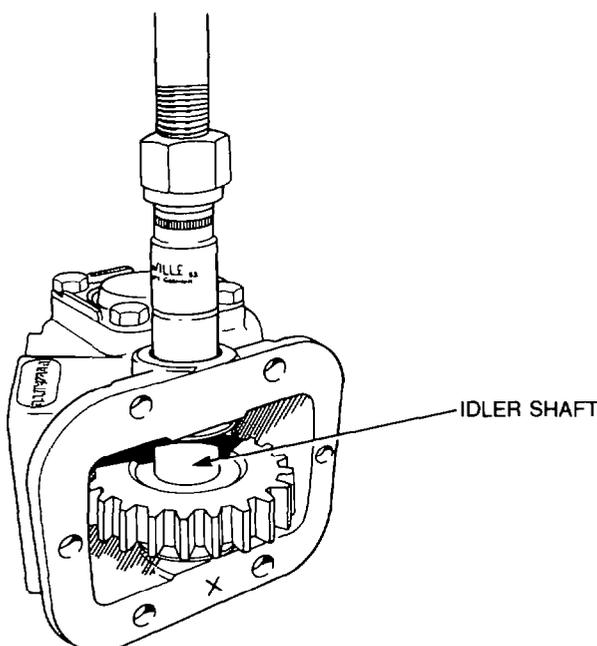


Figure 189 — Removing Idler Shaft

- f. Lift the second circlip from the groove and continue to press the shaft out until the circlips, the thrust washers and the gear can be removed.

NOTE

When the gear is removed from the shaft a steel ball will drop out of an indent within the gear bore. This ball acts as a key, locking the gear and shaft together but still allowing the gear to move lengthways along the shaft.

- g. To remove the remaining needle roller bearing from the housing, press the shaft back in the opposite direction.
- h. Remove the four bolts securing the drive shaft bearing cover plate to the housing and remove the cover plate and gasket (see Fig. 190).

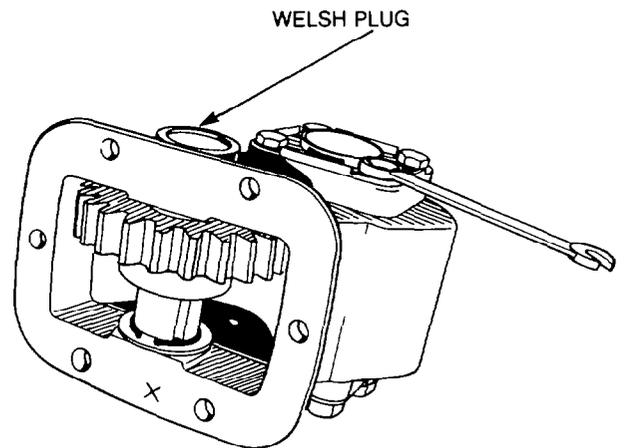


Figure 190 — Removing Bearing Cover Plate

- i. Remove the circlip from the groove in the drive shaft and slide it along the shaft, then remove the bearing cups by hand.
- j. Remove the bearing cone from the shaft at the end opposite the output using a suitable puller. Ensure that the puller is pulling against the inner race and not the cage.
- k. Slide the gear and circlip off the shaft while withdrawing the shaft, complete with the other bearing, from the housing.
- l. Position the drive shaft in a press then press the remaining bearing off the shaft.

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49. Cleaning and Inspection

- a. Clean all parts thoroughly with a suitable cleaning agent then blow dry with compressed air. Ensure that all gasket residue is removed.
- b. Inspect the housing for damage or cracking. Replace if necessary.
- c. Check the gears for cracked, chipped or worn teeth. Check the splines in the drive gear bore for wear. Replace gears as necessary.
- d. Check the idler shaft bearing surfaces for pitting or wear. Also check the channel in the idler shaft for wear. Replace the idler shaft as necessary.
- e. Check the internal and external splines on the drive shaft for wear. Replace the drive shaft as necessary.
- f. Check the condition of the bearings. Replace as necessary.

50. Reassembly

- a. Place the drive shaft in a press, position the bearing on the output end of the shaft with the taper facing away from the splines, then press the bearing onto the shaft until it butts firmly against the shoulder. Remove the shaft from the press.
- b. Install a circlip onto the drive shaft then position the shaft partially in the housing, ensuring that the output end of the shaft is on the correct side of the housing. Install the drive gear in the housing and align with the drive shaft. Feed the drive shaft into the housing and through the drive gear (see Fig. 191).

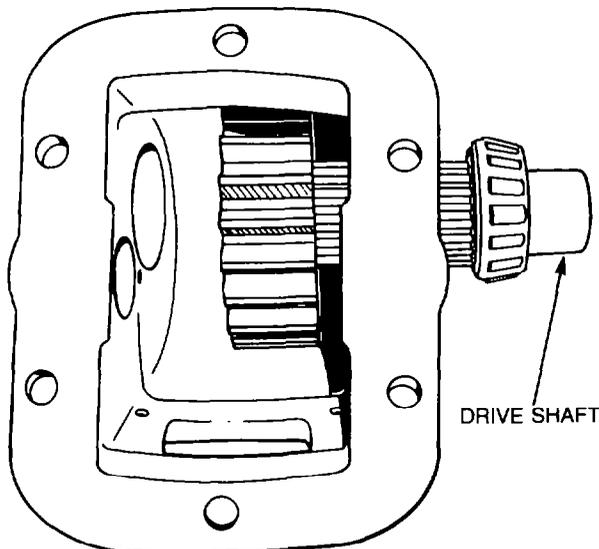


Figure 191 — Installing Drive Shaft and Gear

- c. Place the housing and shaft in a press. Position a bearing, with the taper facing away from the splines, on the drive shaft at the end opposite the output, then press the bearing onto the shaft as shown in Fig. 192, until it butts firmly against the shoulder. Remove the housing from the press.

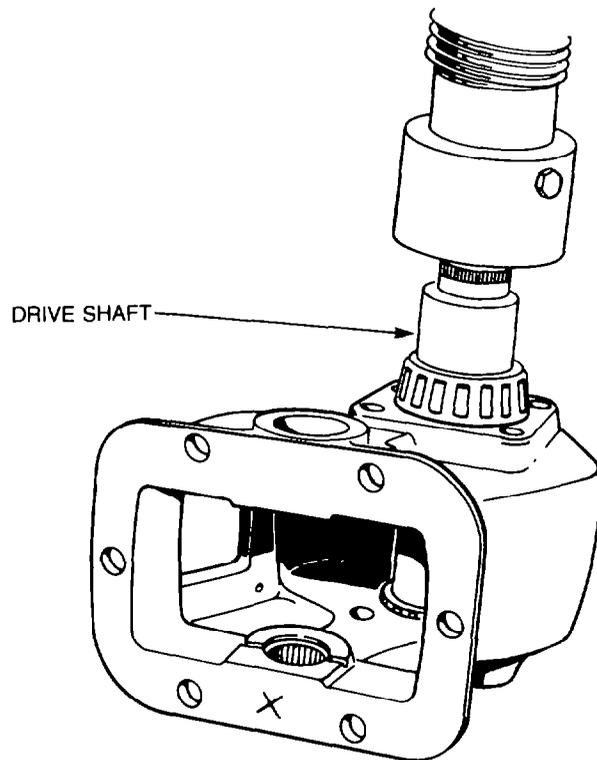


Figure 192 — Installing Drive Shaft Bearing

- d. Lubricate the bearings with clean hydraulic fluid then install the bearing cups into the housing.
- e. Install the bearing cover and gaskets. Install the cover retaining bolts and torque them to 34-38 Nm (25-28 lb.ft).
- f. Position the idler shaft partially into the housing. Install a thrust washer and a circlip onto the shaft. Insert the steel ball into the detent in the idler gear then position the idler gear in the housing. Align the channel in the idler shaft with the steel ball in the idler gear shown in Fig. 193, then push the idler shaft further into the housing and into the idler gear (see Fig. 194). Install the second circlip into the groove on the idler shaft then position the thrust washer on the shaft. Push the idler shaft into the housing, butting the thrust washer against the housing. Position the first thrust washer against the housing and insert

the first circlip into the groove in the idler shaft.

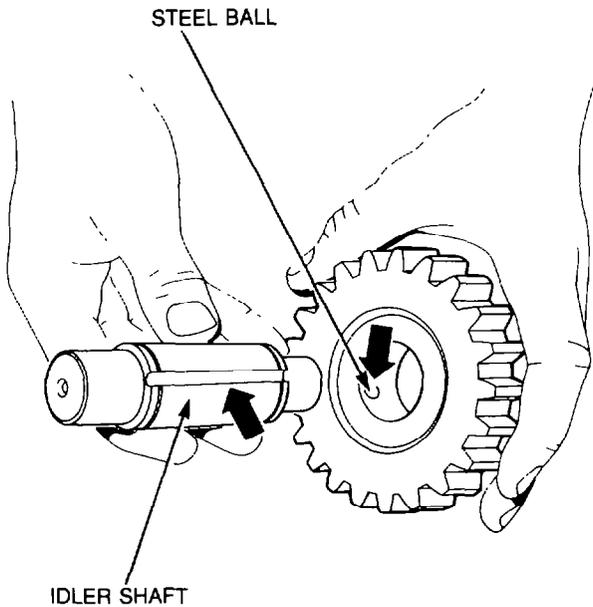


Figure 193 — Channel and Steel Ball

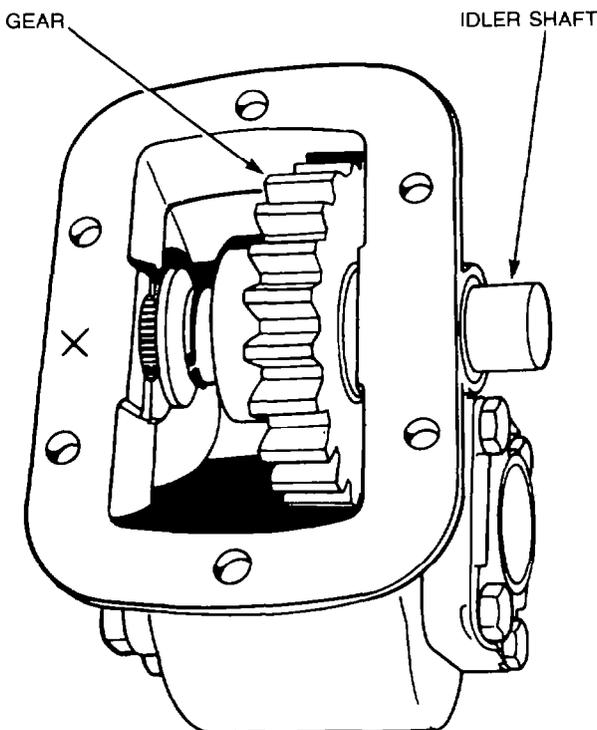


Figure 194 — Installing Idler Shaft and Gear

- g. Lubricate, then press the needle roller bearings into the housing on both ends of the idler shaft, then install the welsh plugs.
- h. Lubricate the gears and bearings of the PTO liberally with clean hydraulic fluid, then place a protective cover over the PTO and set it aside.

PTO Selector — Pneumatic

51. Disassembly

WARNING

Before removing the selector housing air inlet cover, ensure that the circlip used to retain the selector fork to the piston is in place. The selector fork, if properly retained, will prevent the piston flying out of the cylinder under spring pressure, causing possible injury, when the air inlet cover is removed.

- a. Remove the three socket-head bolts from the air inlet cover, shown in Fig. 195, and remove the cover. Discard the O-ring.

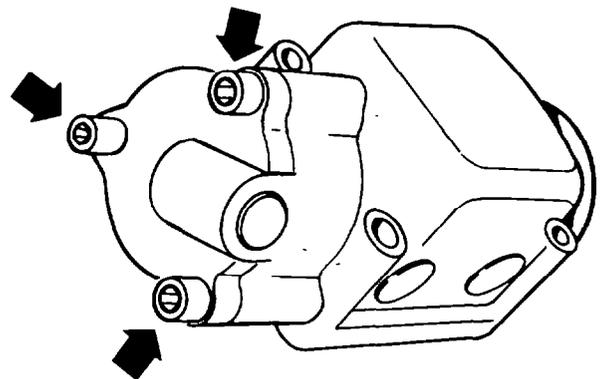


Figure 195 — Air Inlet Cover Retaining Bolts

NOTE

Spring pressure will cause the piston to protrude from the housing when the cover is removed.

- b. Push the piston into the cylinder bore by hand and remove the circlip retaining the selector fork to the piston from its groove (see Fig. 196).
- c. Gradually release the pressure on the piston allowing the piston to move up the bore. Feed the circlip and selector fork off as the piston and return spring are removed.
- d. Remove the selector fork and circlip from the housing taking note as to which way the step in the fork is facing. Discard the circlip.

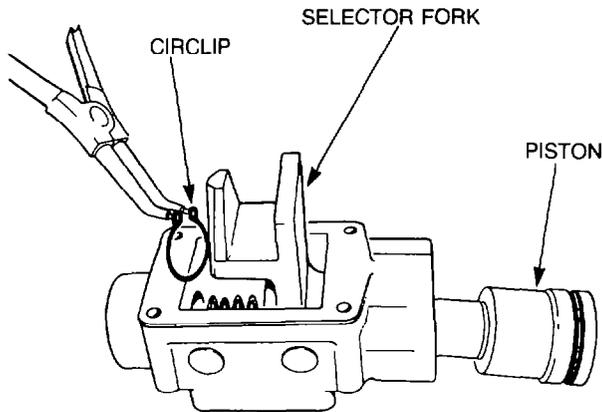


Figure 196 — Removing Circlip

- e. Remove and discard the piston O-ring (see Fig. 197).

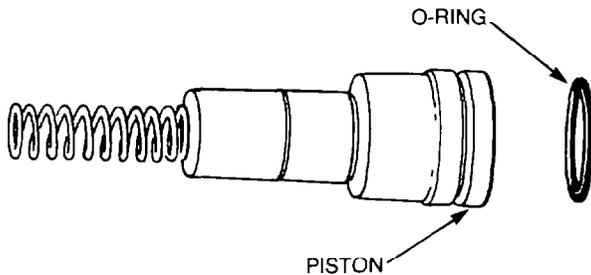


Figure 197 — Piston and O-ring

52. Cleaning and Inspection

- a. Clean all parts with a suitable cleaning agent and blow dry with compressed air.
- b. Inspect the housing cylinder bore and piston for excessive wear or scoring. Replace parts as necessary.
- c. Inspect the selector fork for damage or wear and replace if necessary.
- d. Check the return spring for breaks, cracking or wear. Replace the spring as necessary.

53. Reassembly

- a. Install a new O-ring onto the piston. Lubricate the O-ring with a suitable rubber grease, then install the return spring into the bore of the piston.
- b. Insert the piston partially into the cylinder bore, then position the selector fork and circlip onto the piston (see Fig. 198). Ensure that the step in the fork is facing the correct way.
- c. Push the piston into the bore while feeding the selector fork and circlip onto the piston. Ensure that the circlip is correctly seated in the groove.

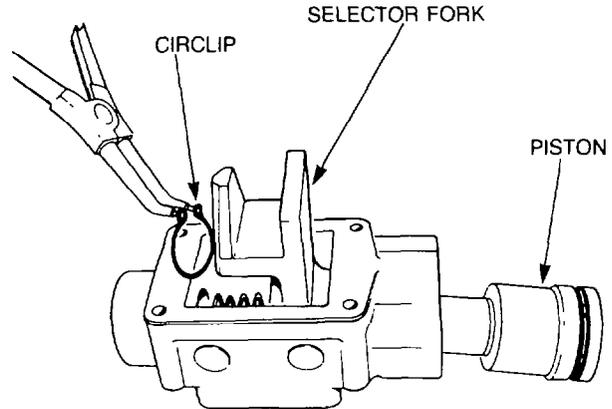


Figure 198 — Installing Circlip

- d. Insert a new O-ring in the groove on the air inlet cover then install the cover onto the housing. Fit the retaining bolts and torque to 9-13 Nm (7-10 lb.ft).
- e. Assemble the selector housing and a new gasket onto the PTO housing, aligning the match marks and ensuring that the selector fork is correctly located over the idler gear.
- f. Install the four socket-head bolts and torque to 34-38 Nm (25-28 lb.ft).

Hydraulic Pump

54. Disassembly

- a. Clean the hydraulic pump, PTO and surrounding transmission area using a suitable cleaning agent, then blow dry with compressed air.

WARNING

Before removing the hydraulic pump, ensure the hydraulic fluid temperature is below 50°C to avoid personal injury occurring.

- b. Drain the fluid from the hydraulic reservoir and remove the hydraulic pump (refer to EMEI VEH G 883 — GROUP 6).
- c. Match mark the front and rear covers to the seal plate, then remove the eight nuts and washers securing the front cover.
- d. Separate the front cover, seal plate and rear cover.
- e. Remove and discard the gaskets and the seals from the seal plate.

- f. Note the position of the front thrust plate window, then remove and discard the thrust plate.
- g. Withdraw the drive and idler gear from the rear cover, then note the location of the rear thrust plate window. Remove and discard the thrust plate.
- h. Remove and discard the two bushes from the front and rear cover, using a suitable bush puller tool.
- i. Remove the two seals and the circlip from the front cover, using a suitable pair of circlip pliers.

55. Cleaning and Inspection

- a. Clean all the components in a suitable cleaning agent, then blow dry using compressed air. Ensure no traces of gasket material remain on the front or rear cover and the seal plate.
- b. Inspect the gear teeth, shafts and splines for damage or excessive wear. Replace the gears as necessary.
- c. Inspect the front cover and seal plate for cracks, damage wear or corrosion. Replace the front cover or the seal plate as necessary.

- d. Inspect the rear cover for damage, cracks, wear to the gear area or erosion. Check for bent, damaged or loose studs and unions, replace the rear cover, studs or unions as necessary.
- e. Check the front cover for nicks or burrs to the sealing surfaces, remove any burrs using an oil stone or replace the cover as required.

56. Reassembly

- a. Apply a liberal coat of clean hydraulic fluid to the outside surface of the bushes, then press two bushes into each cover, using a suitable mandrel and press.

NOTE

The front and rear thrust plates are identical parts. When installing the thrust plates, ensure the bronze side of the plate faces toward the gears.

- b. Position a new thrust plate in the rear cover, with the window toward the inlet side of the cover (as noted).
- c. Install a new balance and back-up seal into the seal plate grooves (see Fig. 199).

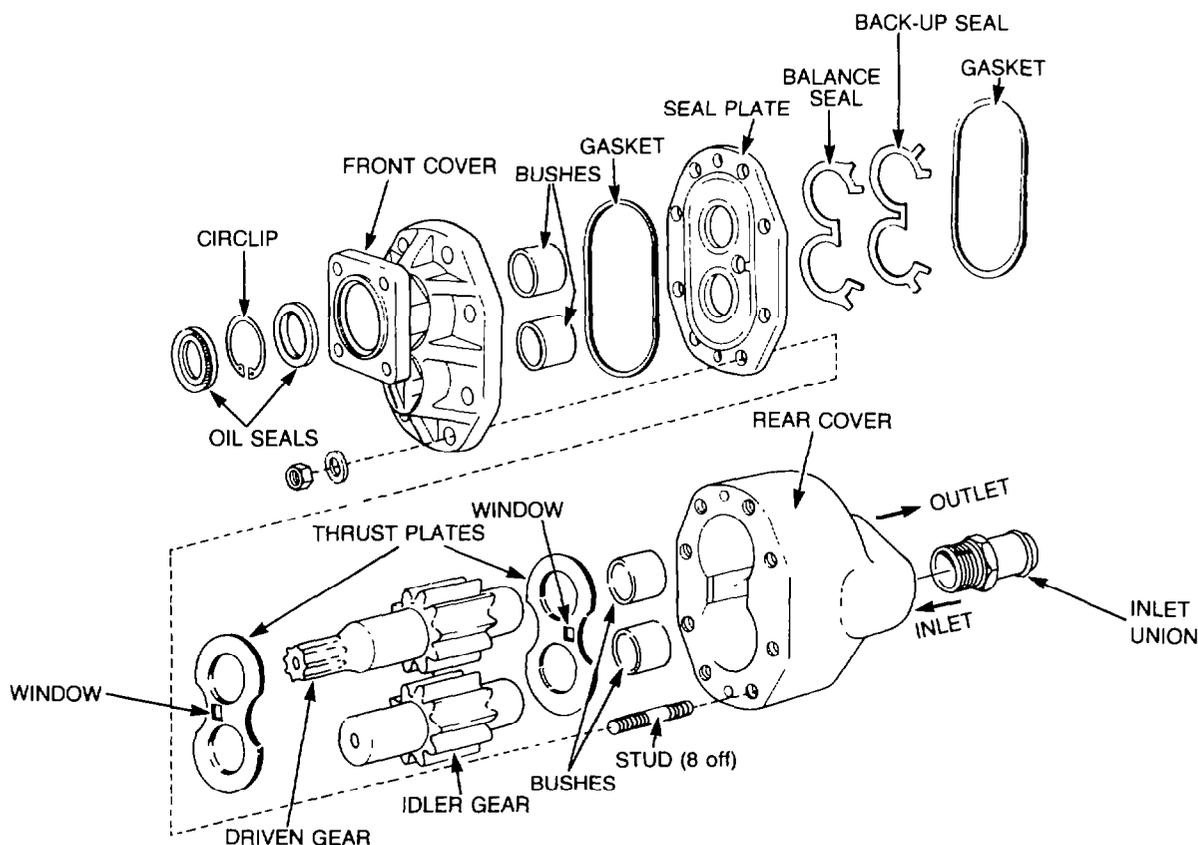


Figure 199 — Hydraulic Pump — Exploded View

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- d. Install a new gasket into the groove on the gear side of the seal plate.
- e. Align the match marks on the rear cover and seal plate, however, do not assemble the pump at this point. Install a new thrust plate onto the seal plate, with the bronze side toward the gears, and the window toward the outlet side of the pump (as noted).
- f. Apply a liberal coat of clean hydraulic fluid to the drive gear, idler gear and the thrust plate face. Align the thrust plate holes with the bearing apertures and install the drive and idler gears into the seal plate.

CAUTION

Ensure the rear gasket and seals remain seated in the seal plate, when assembling the hydraulic pump to prevent fluid leakage under operating conditions

- h. Position the rear cover over the seal plate and gear assembly, aligning the gears in the rear cover bushes and the

match marks on the seal plate and rear cover.

- i. Apply a liberal coat of clean hydraulic fluid to new oil seals, then install one oil seal, with the lip facing inward into the front cover, pushing the seal beyond the retaining ring groove. Secure the circlip in the groove using a suitable pair of circlip pliers, then install the remaining oil seal, with the lip facing outward into the front cover.
- j. Position a new gasket into the front cover side, of the seal plate, locating the gasket correctly in the groove.
- k. Install the front cover over the pump assembly, then position the eight spring washers and nuts finger tight on the studs. Torque the nuts in an alternating sequence to 85-95 Nm (60-70 lb.ft).
- l. Check to ensure the shaft rotates without snagging, and rectify any faults found.
- m. Install the hydraulic pump onto the PTO drive unit (refer to EMEI VEH G 883 — GROUP 6).

— SPECIFICATIONS —

Input Shaft Bearing Cap	
Tightening Torque	46-56 Nm (34-41 lb.ft)
Countershaft Rear Bearing Retainer	
Tightening Torque	46-56 Nm (34-41 lb.ft)
Mainshaft Output Gear Nut	
Tightening Torque	746-814 Nm (550-600 lb.ft)
Rear Housing Retaining Bolts	
Tightening Torque	46-56 Nm (34-41 lb.ft)
Output Shaft Bearing Cap	
Tightening Torque	46-56 Nm (34-41 lb.ft)
Splitter Gear Selector Shaft Piston Housing	
Tightening Torque	46-56 Nm (34-41 lb.ft)
Output Shaft Flange Nut	
Tightening Torque	746-814 Nm (550-600 lb.ft)
Gear Selector Housing Retaining Bolts	
Tightening Torque	46-56 Nm (34-41 lb.ft)
PTO Bearing Cover Retaining Bolts	
Tightening Torque	34-38 Nm (25-28 lb.ft)
PTO Air Inlet Cover Retaining Bolts	
Tightening Torque	9-13 Nm (7-10 lb.ft)
PTO Selector Housing Retaining Bolts	
Tightening Torque	34-38 Nm (25-28 lb.ft)
Hydraulic Pump Front Cover Retaining Nuts	
Tightening Torque	85-95 Nm (60-70 lb.ft)

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— FAULT FINDING —

Transmission

Symptom	Probable Cause	Action
1. Noisy.	a. Chipped or damaged gears.	a. Replace gears, and any damaged or worn components.
	b. Excessive mainshaft gear end play.	b. Correct end-play. Replace parts as required.
	c. Bearing failure.	c. Replace bearings.
2. Difficult gear selection.	a. Worn selector shaft bores.	a. Install new bushes.
	b. Worn mainshaft spigot bearing.	b. Replace spigot bearing.
	c. Worn transmission input shaft splines.	c. Replace input shaft and clutch assembly.
3. Gear disengagement.	a. Bent or worn selector forks.	a. Replace damaged forks.
	b. Bent selector shafts or worn detents.	b. Replace damaged selector shaft and detent balls.
	c. Worn mainshaft spigot bearing.	c. Replace spigot bearing.
	d. Engine flywheel housing misaligned.	d. Rectify.

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REAR AXLES — GROUP 9

Intermediate Differential

57. Disassembly

- a. Remove the intermediate differential assembly (refer to EMEI VEH G 884 — GROUP 9).
- b. Position the differential carrier assembly on a suitable overhaul stand, then slacken the lock nut and remove the thrust screw from the carrier housing (see Fig. 200).

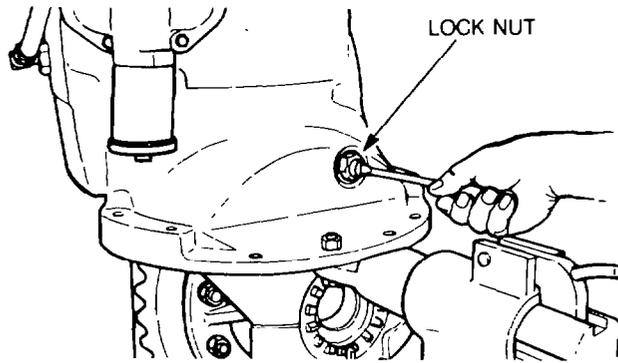


Figure 200 — Removing Thrust Screw — Intermediate Differential

- c. Remove the bolts and lock washers securing the air shift housing to the carrier housing, and remove the air shift housing complete with the selector fork and gasket. Discard the gasket.
- d. Remove the split pin, castellated nut and half-round washer from the selector fork pivot bolt, and remove the selector fork, spring seat, spring and bolt from the air shift housing (see Fig. 201).

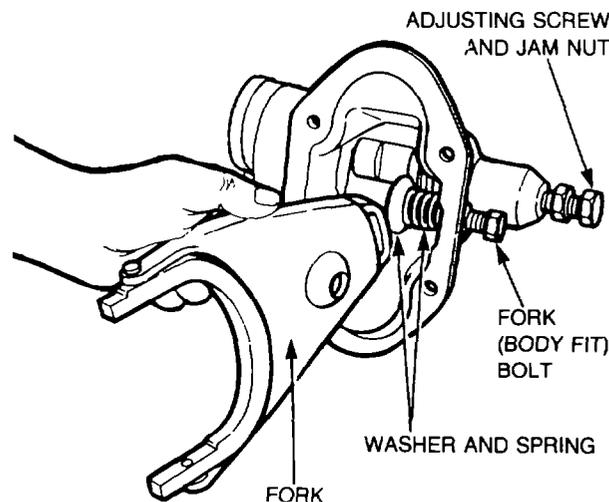


Figure 201 — Selector Fork Removal

- e. Remove the nuts and washers securing the piston housing to the air shift housing, then remove the snap-ring locating the return spring on the piston shaft. Remove the piston housing, spring and spring seat from the air shift housing (see Fig. 202).

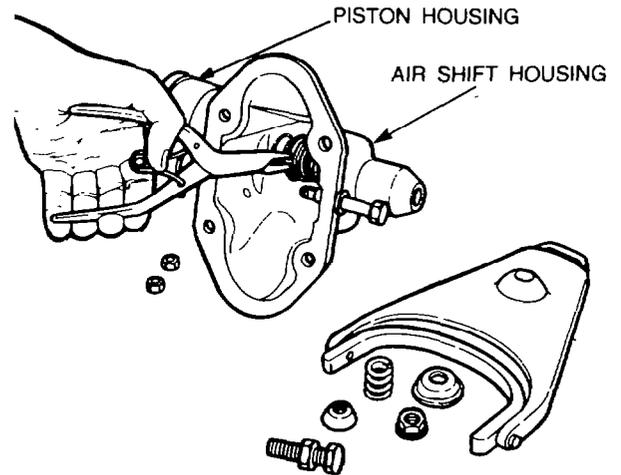


Figure 202 — Piston Housing Removal

- f. Remove bolts and washers securing the pinion bearing cover to the carrier housing, then remove the bearing cover and gasket. Discard the gasket.
- g. Position a yoke holding tool over the input shaft yoke, then slacken the pinion shaft lock nut while preventing the input shaft rotating (see Fig. 203). Do not remove the pinion shaft nut at this time.

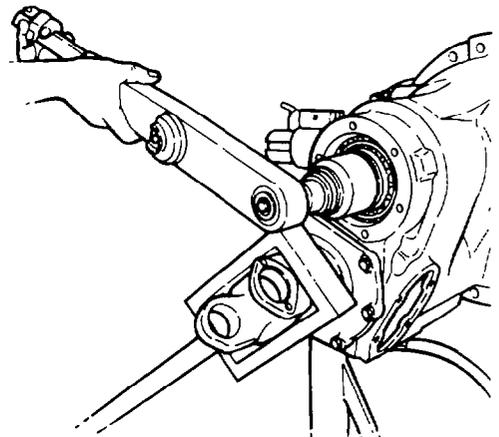


Figure 203 — Slackening Pinion Shaft Nut

- h. With the yoke holding tool on the input shaft yoke, slacken the yoke retaining nut with a socket and lever, but do not remove the nut at this time.

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- i. Remove the bolts and washers securing the input shaft bearing housing to the carrier housing, then turn the carrier housing to a vertical position with the input shaft yoke uppermost. Connect suitable overhead lifting equipment to the input shaft yoke and remove the input shaft and inter-axle differential assembly from the differential housing (see Fig. 204).

NOTE

Tap the housing lightly with a rawhide (leather) hammer to free the assembly from the housing. It may also be necessary to rotate the input shaft to align one flat at the rear of the inter-axle differential case with the transfer gear.

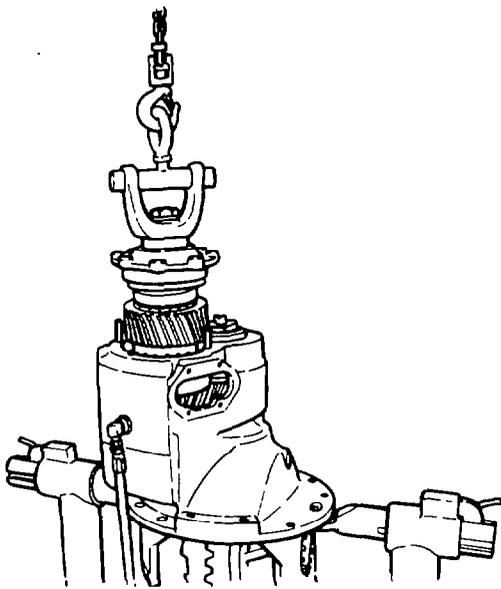


Figure 204 — Input Shaft and Inter-axle Differential Assembly — Removal

NOTE

Prior to removing the crownwheel and differential assembly, measure the crownwheel backlash with a dial indicator and record the dimension.

- j. Invert the carrier assembly to bring the crownwheel and differential assembly uppermost. Match mark one carrier side bearing cap to the bearing pedestal, for correct location at reassembly, then remove the bolts securing the caps to the pedestals and remove the adjusting ring cotter keys.

- k. Remove the bearing caps and adjusting rings, then with the aid of suitable lifting equipment, remove the crownwheel and differential assembly.
- l. Match mark both halves of the differential case, then remove the 12 bolts (four short and eight long) from the differential case. Place the assembly on the side carrier bearing, then separate the two halves of the differential case and remove the cross-shaft, the bevel pinions and thrust washers together with the side gears and thrust washers from the differential case.
- m. Remove the bolts, nuts and washers securing the crownwheel to the differential case and remove the crownwheel. Remove the side carrier bearing cones from both halves of the differential case with the aid of a suitable puller.
- n. Remove the differential carrier from the overhaul stand and position the carrier in a suitable hydraulic press. Remove the pinion shaft nut (loosened previously) and washer, then press the pinion shaft from the front bearing and remove the bearing cone, the two spacers, the transfer gear and the pinion shaft, complete with the rear bearing cone, from the carrier housing.
- o. Using suitable pullers, remove the front and rear bearing cups from the housing. Remove and retain the rear bearing shim pack.
- p. Position the pinion shaft in the hydraulic press with a suitable collar positioned under the inner race of the bearing cone, then press the pinion shaft from the bearing cone.
- q. Remove the inter-axle differential rear side gear and bearing cone from the carrier housing, then with the aid of suitable pullers, remove the bearing cup from the carrier housing and the bearing cone from the side gear.
- r. Remove the snap-ring securing the differential assembly to the input shaft, then slide the differential assembly from the input shaft. Match mark the two halves of the differential case and remove the eight bolts and washers securing the two halves together. Separate the two halves and remove the cross-shaft, pinions and thrust washers.
- s. Slide the helical drive gear, thrust washer and clutch collar from the rear of the

- t. Remove the bearing cup, the oil seal and the O-ring from the bearing housing cage. Discard both the oil seal and O-ring.
- u. Place the input shaft in the hydraulic press with a suitable collar positioned under the inner race of the bearing cone, then press the input shaft from the bearing cone.
- v. If the through shaft is to be removed disconnect the rear propeller shaft from the through shaft yoke, then position the yoke holding tool over the through shaft yoke, then slacken and remove the yoke retaining nut.
- w. Remove the yoke from the through shaft using special tool M14580, then remove the bolts and washers securing the bearing cage to the axle housing.
- x. Tap the bearing cage with a soft face hammer while pulling the through shaft and bearing cage from the axle housing.
- y. Pry the oil seal from the bearing cage, taking care not to damage the bearing cage, then remove the internal snap-ring and spacer from the bearing cage using suitable pliers (see Fig. 205).

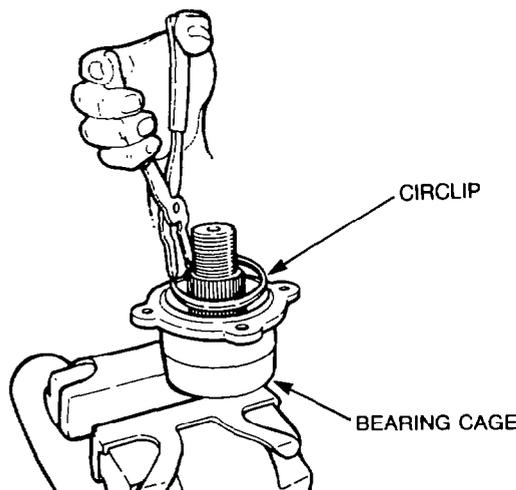


Figure 205 — Removing Snap-ring

- z. Position the through shaft and cage assembly in the hydraulic press and press the through shaft and bearings from the bearing cage, the inner bearing cup will remain in the cage. Remove the

inner bearing cup using a suitable drift and hammer.

- aa. Place a spare bearing cup over the inner bearing cone on the through shaft, then position the assembly in the press and press the through shaft from the bearings (see Fig. 206).

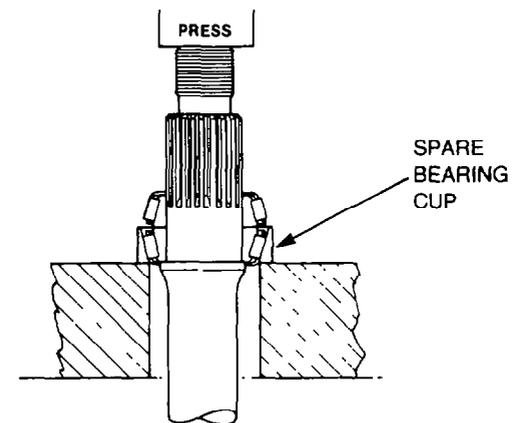


Figure 206 — Removing Bearings

58. Cleaning and Inspection

- a. Clean all parts with a suitable cleaning agent, then thoroughly dry with soft, clean, lintless and absorbent paper towels or wiping cloth.
- b. Inspect the carrier housing for cracks or damage and replace as necessary.
- c. Inspect the gears for wear, damage, scoring, surface fatigue, ridging or cracking. The gears may also be checked by Magnaflux or similar method for cracks which would not otherwise be visible. Ensure that all parts are demagnetised after inspection.
- d. Check the bearings for cracks, etching, pitting, spalling, or flaking and replace as necessary.
- e. Inspect the clutch collar for wear or damage and replace as necessary.
- f. Inspect the input shaft, pinion shaft and through shaft for damage or wear and replace as necessary.

59. Reassembly

NOTE

If a new crownwheel and pinion set is to be installed verify that the crownwheel and pinion is a matched set. Refer to Fig. 207 for the location of:

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1. The part number on the crownwheel always ends with an even number eg. 36786 and the matched pinion ends with an odd number eg. 36787.
2. The tooth combination number, eg. 5-37 indicates the number of teeth on the pinion (5) and the number of teeth on the crownwheel (37).
3. The gear set matching number, eg. M29 or any combination of letter and number stamped on both the crownwheel and the pinion.
4. The pinion code variation number, eg. P.C.+3 or P.C.-5 indicates slight differences in the mounting distance of individual gear sets in thousandths of an inch.

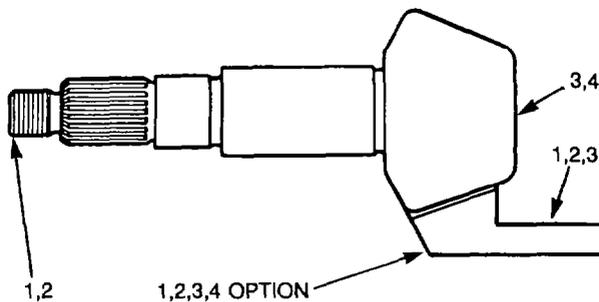


Figure 207 — Location of Identification Numbers Intermediate Differential

- a. Lubricate the main differential case side bearing cones with differential oil, then position each half of the differential case, in turn, in the hydraulic press and press the bearing cones onto both halves of the differential case until the cones butt firmly against the shoulders.
- b. Heat the crownwheel in water to approximately 71°-82° C (160°-180° F) for ten minutes, this will allow easier fitting of the crownwheel on the differential case. Remove the crownwheel from the water, wipe the water from the mounting surface and position the crownwheel over the differential case pilot. Install and torque the retaining bolts, nuts and washers to 244-312 Nm (180-230 lb.ft).
- c. Stand the crownwheel assembly on the differential case (with the crownwheel uppermost), then lubricate a differential side gear and thrust washers with differential oil and install the side gear and thrust washer in the differential case.

- d. Lubricate the differential spider, bevel pinions and thrust washers with differential oil, then assemble the bevel pinions and thrust washers on the spider, and place the spider assembly into position in the differential case.
- e. Lubricate the remaining side gear and thrust washer with differential oil and position the side gear and thrust washer on the spider assembly, then place the remaining half of the differential case into position over the differential gear assembly. Ensure that the match marks are aligned, then apply Loctite 277 to the threaded holes (see NOTE) and install the 12 retaining bolts (four short and eight long) with washers and torque the bolts to 244-312 mm (180-230 lb.ft).

NOTE

If new Dri-Loc bolts are being installed Do Not use any form of liquid adhesive.

- f. Check that the differential gears revolve smoothly without binding when a torque of less than 68 Nm (50 lb.ft) is applied to one side gear, using a fabricated checking tool and a torque wrench.

NOTE

The checking tool can be fabricated by cutting the splined-end of an axle shaft to the appropriate length and welding a suitable nut to the cut end.

- g. Position the pinion shaft in the hydraulic press, then lubricate the pinion shaft rear bearing cone with differential oil and start the bearing onto the shaft. With the aid of a suitable sleeve (or tubing), which bears against the inner race of the bearing cone, press the bearing onto the shaft until it butts firmly against the gear (see Fig. 208).

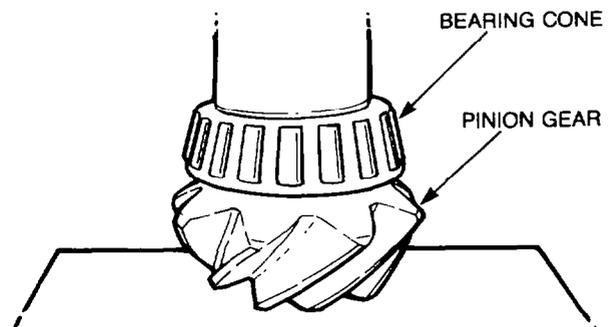


Figure 208 — Installing Pinion Shaft Bearing

- h. Place the carrier housing in the hydraulic press and press the rear pinion bearing (complete with the original shim pack or new shims of equivalent thickness) into position, using a suitable sleeve (or tubing).
- i. Invert the carrier housing and install the front pinion bearing cup, ensuring that the cup butts firmly against the shoulder, then lubricate and install the input shaft rear bearing cup, ensuring that the cup butts firmly against the shoulder.

NOTE

Prior to installing the pinion shaft, measure the depth of the pinion head and record the dimension, and also record the pinion code variation number e.g. P.C. + 3 or P.C. - 5.

- j. Lubricate the pinion shaft bearing cups with differential oil, then start the pinion shaft up through the rear bearing cup. Position the transfer gear over the pinion shaft, align the gear splines with the splines on the pinion shaft and push the shaft through the gear. Position the two spacers and the front bearing cone on the pinion shaft. Place a suitable support under the pinion shaft head, then with the aid of a suitable sleeve, press the front bearing cone onto the pinion shaft. Apply a pressure of two tonne to ensure that the bearings are correctly seated.
- k. Wedge a suitable block of hardwood between the pinion teeth and the carrier housing wall, then install and torque the pinion shaft nut and washer to 136 Nm (100 lb.ft). Remove the block of wood, then secure the carrier housing in the overhaul stand.

NOTE

If the original crownwheel and pinion set together with the original shim pack (or a new shim pack of equivalent thickness) are being installed, it is not necessary to use the pinion setting gauge.

- l. Assemble the pinion setting gauge J4550 or equivalent and the step plate into the differential side carrier bearing pedestals, using the correct adapter discs (see Fig. 209).

- m. Ensure that the micrometer is directly over and at 90° to the step plate. Measure the distance to the step plate and record the dimension.
- n. Using the nominal pinion mounting distance of 222.25 mm (8.750 in.), calculate whether or not shims need to be added or removed. Subtract the pinion head depth from the nominal pinion mounting dimension to establish the pinion nominal gauge dimension, then from that subtract the pinion code variation number and the thickness of the step plate to obtain the corrected micrometer distance. Compare the corrected micrometer distance with the pinion nominal gauge dimension, and if necessary, either add or remove shims to make the corrected micrometer distance equal to the pinion nominal gauge dimension.

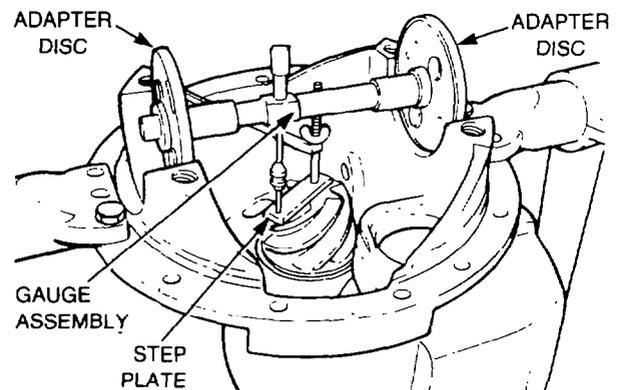


Figure 209 — Pinion Setting Tool

- o. Lubricate the side carrier bearing cups with differential oil and position the cups on the bearing cones. Attach suitable lifting equipment to the crownwheel and differential assembly and lift the assembly into position in the carrier housing (see Fig. 210).

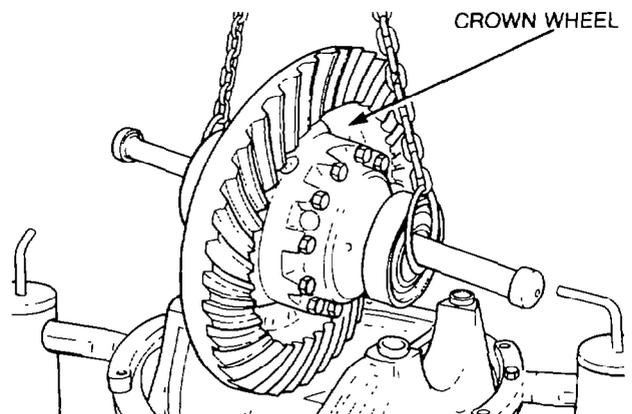


Figure 210 — Installing Crownwheel and Differential Assembly

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- p. Remove the lifting equipment and install the side bearing adjusting rings. Turn the adjusting rings in by hand until the rings butt against the bearing cups, then install the bearing caps into their positions as marked at disassembly.

CAUTION
Do not force the bearing caps into position, otherwise damage to the carrier housing and/or bearing caps may result.

- q. Tap the bearing caps lightly into position, ensuring that the caps are correctly seated over the adjusting rings. If not, remove and reinstall the adjusting ring.
- r. Install the bearing cap retaining bolts and torque the bolts to 638-746 Nm (470-550 lb.ft).
- s. Position a dial indicator on the carrier housing with the indicator plunger resting against the back of the crownwheel, then adjust the side carrier bearing adjusting rings to obtain zero side play.

NOTE

Before proceeding further check the crownwheel runout. If the runout exceeds 0.2 mm (0.008 in.), remove the crownwheel and check for the cause.

- t. Adjust the side carrier bearing adjusting rings to obtain a differential bearing rolling resistance of 1.7-4.0 Nm (15-35 lb.in.).

NOTE

If the original crownwheel and pinion set has been installed, use the crownwheel backlash recorded previously.

- u. Relocate the dial indicator so that the plunger rests against one of the crownwheel teeth (see Fig. 211). Block the pinion shaft to prevent the shaft from turning, then check the backlash by turning the crownwheel in one direction, to zero the dial indicator, and turning the crownwheel in the opposite direction to take a reading. A new crownwheel and pinion set should be adjusted to obtain an initial backlash of 0.254 mm (0.010 in.). If adjustment is necessary, back-off

one adjusting ring and advance the opposite ring an equal amount.

- v. Once the initial backlash has been obtained remove the dial indicator and the pinion shaft blocking device, then apply a light coating of oiled red lead (or similar) to the crownwheel teeth. Rotate the pinion shaft and check the contact patterns on the crownwheel teeth.

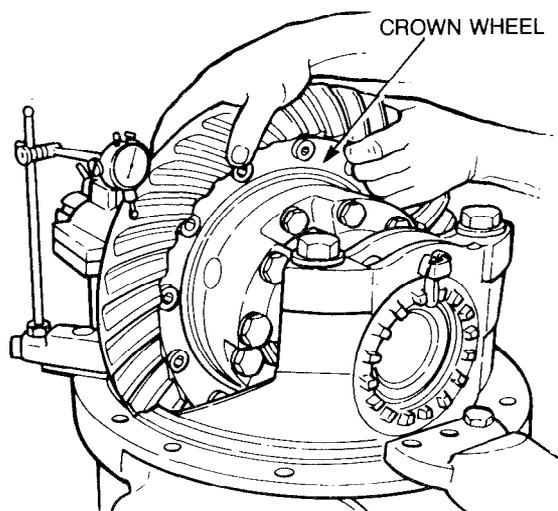


Figure 211 — Positioning Dial Indicator

NOTE

Sharper impressions may be obtained by applying a small amount of resistance to the crownwheel with a flat steel bar and using a wrench to rotate the pinion shaft.

- w. Fig. 212 illustrates the correct contact pattern obtained when both the pinion shaft and the crownwheel are set to the correct specifications.

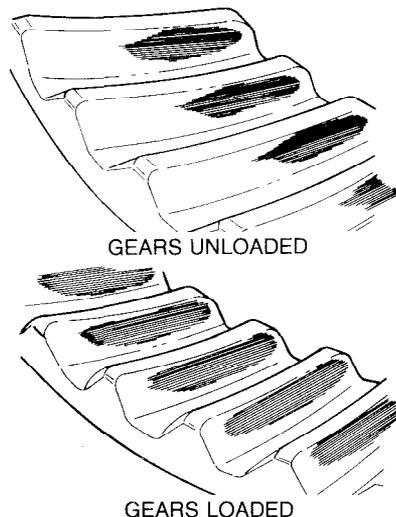


Figure 212 — Correct Contact Patterns

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- x. Fig. 213 illustrates a high contact area, which indicates that the pinion shaft is set too far out. Increase the thickness of the shims between the pinion inner bearing cup and the carrier to obtain the correct pattern. Slight outward movement of the crownwheel may be necessary to obtain the correct pattern.

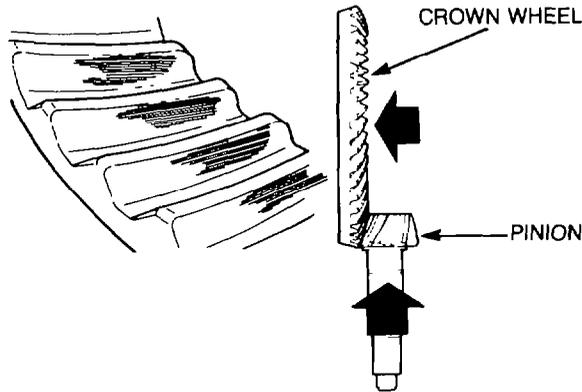


Figure 213 — High Contact Area

- y. Fig. 214 illustrates a low contact area, which indicates that the pinion shaft is set too deep. Decrease the thickness of the shim pack between the pinion shaft bearing cup and the carrier to obtain the correct pinion height. Slight inward movement of the crownwheel may be necessary to obtain the correct pattern.

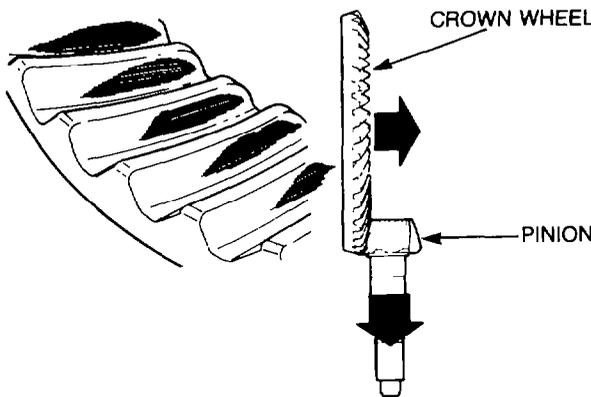


Figure 214 — Low Contact Area

- z. After obtaining the correct gear tooth contacts and establishing the shim thickness for the pinion inner bearing cup, make note of the backlash setting, then remove the crownwheel and differential assembly from the carrier housing.
- aa. Wedge the block of hardwood between the pinion teeth and the carrier housing wall, then remove the nut and washer from the pinion shaft.
- ab. Position the carrier housing in the hydraulic press and press the pinion

shaft from the outer bearing cone and remove the bearing cone and the two spacers from the carrier housing. Invert the carrier housing and reinstall the pinion shaft, ensuring that the long hub of the drive gear is facing toward the pinion teeth and that the gear splines align with the shaft splines (see Fig. 215). Press the pinion shaft in until the bearing cone contacts the bearing cup, then release the pressure.

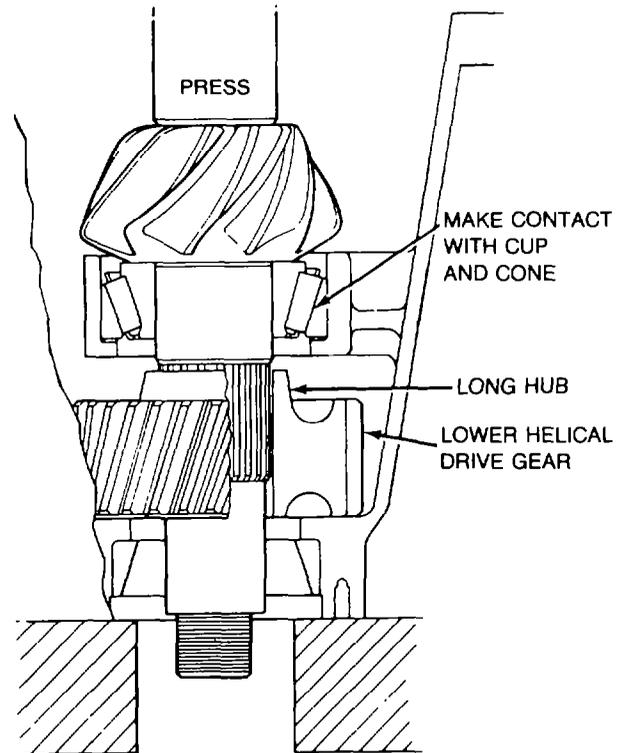


Figure 215 — Installing Pinion Shaft

- ac. Turn the carrier housing over and support the housing on its mounting flange with the shank of the pinion shaft uppermost. Position a suitable block of wood beneath the head of the pinion shaft to ensure that the inner bearing cone and cup are in contact, then with the aid of a suitable sleeve, press the drive gear down until it butts firmly against the inner race of the inner bearing cone.
- ad. Remove the sleeve, then cut two lengths of bar lead or solder approximately 14.0 mm (9/16 in.) long and 16.0 mm (5/8 in.) thick. Position the bearing cone spacer over the pinion shaft and against the drive gear, then position both pieces of lead (solder) on top of the bearing cone spacer, 180° apart. Position the outer bearing cone over the pinion shaft, then press the bearing

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onto the shaft and against the lead pieces. Apply a load of two tonne (two ton) to compress the lead pieces to a specific thickness (see Fig. 216).

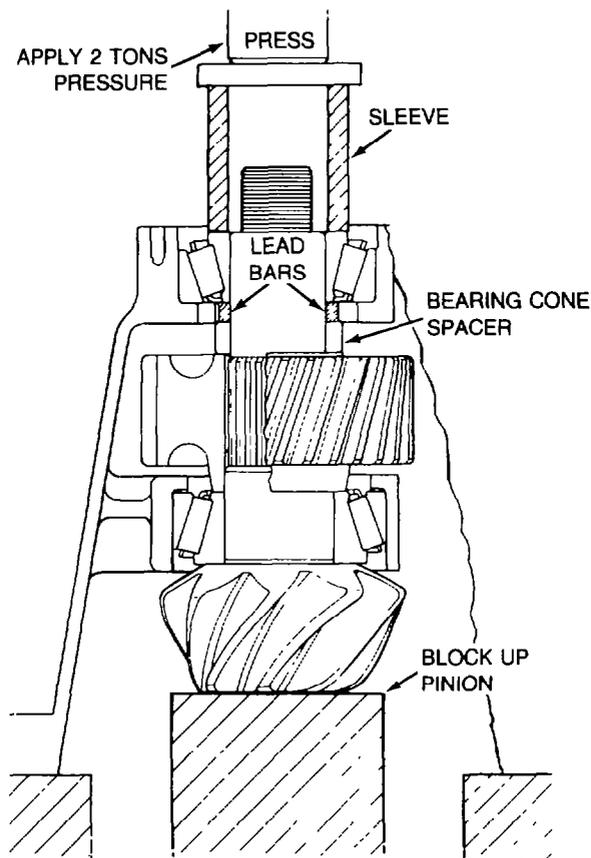


Figure 216 — Establishing Variable Gear Spacer Thickness

- ae. Release the pressure applied to the bearing and remove the block of wood from beneath the head of the pinion shaft, then press the pinion shaft down through the outer bearing cone only. Remove the outer bearing cone and the two pieces of lead. Using a micrometer, measure the compressed pieces of lead and calculate the average thickness. Add 0.10 mm (0.004 in.) to the dimension calculated to determine the thickness of the variable gear spacer required to obtain the proper pinion bearing preload.
- af. Invert the carrier housing and press the pinion shaft in until the inner bearing cone contacts the inner bearing cup. Turn the carrier housing over and position the block of wood under the head of the pinion shaft to ensure that the inner pinion bearing cone and cup are in contact, then with the aid of a suitable

sleeve, press the drive gear down until it butts firmly against the inner race of the inner bearing cone.

- ag. Remove the sleeve and position variable gear spacer and the bearing cone spacer on the pinion shaft. Position the outer bearing cone on the pinion shaft and press the bearing onto the shaft. Apply a pressure of two tonne (two ton) on the inner race of the outer bearing cone and rotate the carrier in both directions to properly seat the bearings, while the pressure is being applied. Release the pressure and remove the carrier housing from the press. Install the carrier housing in the overhaul stand, then install the washer and nut onto the pinion shaft. Wedge a suitable block of hardwood between the pinion teeth and the carrier housing wall and torque the pinion nut to 1220-1630 Nm (900-1200 lb.ft). Remove the block of wood from between the pinion and the carrier wall, then place a torque wrench (lb.in.) over the pinion shaft nut and check the rotating torque of the pinion shaft. The correct bearing pre-load is 0.56-2.8 Nm (5-25 lb.in.) for new bearings or 0.56-1.7 Nm (5-15 lb.in.) for re-used bearings.
 - ah. If the bearing pre-load is not within specification, install a thicker or thinner gear spacer to decrease or increase the bearing pre-load respectively.
 - ai. Once the correct pinion bearing pre-load has been obtained, install the crownwheel and differential assembly, adjust the carrier side bearing pre-load, recheck the gear tooth contact pattern and the crownwheel backlash. If necessary, readjust the backlash to between the limits of 0.127-0.381 mm (0.005-0.015 in.).
- NOTE**
- If the pinion shaft depth has to be adjusted to obtain the correct tooth contact pattern, the variable gear spacer on the pinion shaft must also be altered a like amount, to maintain the correct pre-load.
- aj. After adjusting the crownwheel and pinion, install the adjusting ring cotter keys and the crownwheel thrust screw. Turn the thrust screw in until it seats firmly against the back of the crownwheel, then back the screw out one quarter of a turn. Install and torque the thrust

- screw lock nut to 197-258 Nm (145-190 lb.ft).
- ak. Install the pinion bearing cover, together with a new gasket on the carrier housing, then install and torque the retaining bolts and washers to 47-68 Nm (35-50 lb.ft).
 - al. Lubricate the input shaft bearing cone with differential oil, then start the bearing cone (taper towards the threaded end of the shaft) onto the input shaft. Position the input shaft in a hydraulic press and press the bearing into position on the shaft, with the aid of a suitable sleeve (or tubing) that bears against the inner race of the bearing cone.
 - am. Position the input shaft bearing cage in the press, then lubricate the input shaft bearing cup with differential oil and position the bearing cup in the bearing cage. Using a suitable sleeve (or tubing), press the bearing cup into position in the bearing cage.
 - an. Invert the bearing cage and press a new oil seal into cage, ensuring that the open side of the oil seal is towards the bearing cup. Remove the bearing cage from the press and smear the sealing lip on the seal with differential oil. Smear a new O-ring with differential oil, then install the O-ring in the groove on the outer circumference of the bearing cage.
 - ao. Position the bearing cage on the input shaft, then install the drive yoke, using special tool M14587. Screw the installation shaft of the special tool on the threaded end of the input shaft, lubricate the sealing surface of the drive yoke with differential oil and position the drive yoke over the installation shaft. Assemble the collar and nut, of the special tool, on the installation shaft and tighten the nut with a suitable spanner, while preventing the yoke from turning with the yoke holding tool. When the yoke seats against the bearing, remove the installation tool and install the yoke retaining nut and washer, but do not torque the nut at this stage.
 - ap. Lubricate with differential oil and assemble the clutch collar, thrust washer and the helical drive gear onto the input shaft (see Fig. 217).
 - aq. Lubricate the inter-axle differential spider, pinion gears and thrust washers

with differential oil, then assemble the pinion gears and thrust washers onto the spider. Place the spider assembly in one half of the differential case, then position the second half of the differential case over the spider assembly, ensuring that the match marks on both halves of the case are correctly aligned. Install and torque the eight retaining bolts, nuts and washers to 68-88 Nm (50-65 lb.ft).

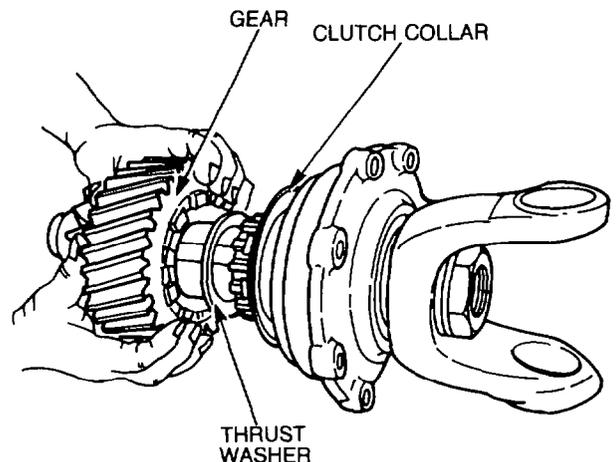


Figure 217 — Installing Clutch Collar, Thrust Washer and Drive Gear

- ar. Position the differential assembly on the input shaft and install the snap-ring to secure the differential to the shaft.
- as. Place the inter-axle differential rear side gear in the hydraulic press. Lubricate the rear bearing cone with differential oil, then press the bearing cone onto the rear side gear until the bearing butts firmly against the shoulder. Remove the side gear from the press.
- at. Position the rear side gear assembly in the differential carrier housing, then attach suitable lifting equipment to the input shaft and install the input shaft into the housing, ensuring that the rear side gear is properly meshed with the pinion gears on the inter-axle differential.

NOTE

The helical transfer gears on both the input shaft and the pinion shaft are stamped with match marks. Ensure that these marks are aligned for correct gear contact.

- au. Install the bearing cage retaining bolts finger tight, while rotating the input shaft to seat the bearings.

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- av. Using a feeler gauge measure the gap between the bearing cage and the mounting surface of the differential carrier. Record the gap measurement, then add 0.001 in. and select a shim pack corresponding to the value.

NOTE

Use a minimum of three shims in the shim pack with the thinnest shims positioned at both sides of the pack to compress for sealing.

e.g. Gap measurement 0.013 in.
 + 0.001 in.
 = 0.014 in.

Shim thickness

Shim selection:

$$0.003 + 0.003 + 0.005 + 0.003 = 0.014 \text{ in.}$$

- aw. Remove the bolts securing the bearing cage to the carrier housing, then lift the input shaft slightly with the lifting equipment, then slide shim pack into position.
- ax. Lower the input shaft into position and install two retaining bolts in diagonally opposite holes. Torque the two bolts to 54-75 Nm (40-55 lb.ft).
- ay. Position a dial indicator, with a magnetic base, on the front face of the carrier housing and seat the plunger against the end of the input shaft. Turn the input shaft in both directions while pushing the input shaft inward to zero the dial indicator. Pull the input shaft outward and observe the dial indicator. The end-play must be within 0.001-0.007 in., if necessary add or remove shims to obtain the correct dimension.

NOTE

Adding shims will increase the end-play and removal of shims decreases the end-play.

- az. When the correct end-play has been obtained, install the remaining bearing cage bolts and torque the bolts to 54-75 Nm (40-55 lb.ft).
- ba. Install the piston housing together with a new gasket on the air shift housing and position the snap-ring, spring seat and spring on the piston shaft while installing the piston housing. Install the piston housing retaining bolts, nuts and washers and tighten the bolts and nuts securely.

- bb. Install the selector fork pivot bolt, spring and spring seat in the air shift housing, then install the selector fork, ensuring that the selector fork is properly engaged with the slot in the diaphragm shaft. Install the half-round washer and the castellated nut. Tighten the nut securely and install a new split-pin.
- bc. Position the air shift housing, together with a new gasket, on the carrier housing, ensuring that the selector fork is correctly engaged with the clutch collar. Install the four retaining bolts and washers and torque the bolts to 47-68 Nm (35-50 lb.ft).
- bd. Slacken the piston adjusting screw lock-nut and slacken the adjusting screw. Apply an air pressure of 414 kPa (60 psi) to the piston housing to move the selector fork and fully engage the clutch collar with the gear. Hold the selector fork in this position, with the air pressure, and screw the adjusting screw in until it is finger tight against the piston shaft, then turn the adjusting screw in an additional half turn to centre the fork in the piston shaft slot. Tighten the adjusting screw lock nut to 54-75 Nm (40-55 lb.ft).
- be. Lubricate the through shaft bearings cones with differential oil, then start the bearing cones onto the through shaft, ensuring that the wide end of the bearings butt together. Position the assembly in the hydraulic press, and with a suitable sleeve, press the bearings into position on the shaft (see Fig.218).

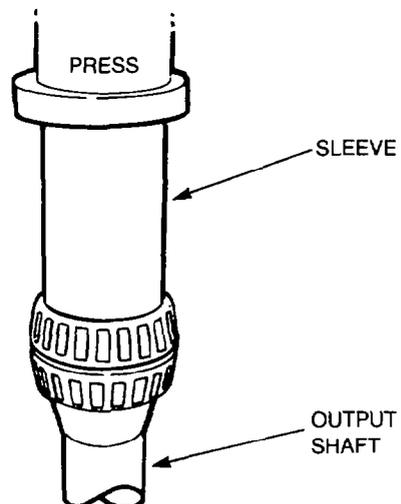


Figure 218 — Installing Through Shaft Bearings

- bf. Using a suitable sleeve, press the inner bearing cup into the bearing cage, with the wide end of the bearing pressed firmly against the shoulder.
- bg. Position the bearing cage over the through shaft bearings, then support the bearing cage in the press and install the outer bearing cup, with the taper towards the bearing, against the outer bearing cone.
- bh. Install the bearing retainer snap-ring into the groove in the bearing cage, then place the through shaft and bearing cage assembly in a soft-jaw vice (securing the assembly by the through shaft) and install the yoke using special tool M14587. Torque the yoke retaining nut to 610-814 Nm (450-600 lb.ft).
- bi. Secure the bearing cage in the soft-jaw vice, then attach a dial indicator to the bearing cage and position the plunger on the end of the through shaft. Turn the yoke from side to side to seat the bearings, then set the dial indicator to zero. Position two pry bars between the yoke and the bearing cage and pry the yoke outward while observing the dial indicator. The end-play must not exceed 0.076 mm (0.003 in.). If no end-play is evident, check the bearing pre-load. If a reading of less than 1.1 Nm (10 lb.in.) is obtained no adjustment is required. If the end-play exceeded 0.076 mm (0.003 in.), install a thicker snap-ring, then check that the end-play is less than 0.076 mm (0.003 in.) and the bearing pre-load is less than 1.1 Nm (10 lb.in.). If necessary, replace the snap-ring until both readings are within specification.
- bj. After correct adjustment has been established, remove the yoke from the output shaft using special tool M14580, and install a new seal into the bearing cage. Lubricate the sealing lip on the oil seal and the sealing surface on the yoke with differential oil and install the yoke using special tool M14587. Torque the yoke retaining nut to 610-814 Nm (450-600 lb.ft).
- bk. Ensure that the differential carrier mounting surface and the axle housing mounting surface are clean and dry. Apply a bead approximately 5 mm (3/16 in.) wide of silicone RTV around the mounting surface of the axle housing and around the edge of the bolt holes to ensure complete sealing. Then install the

carrier assembly (refer to EMEI VEH G 884 — GROUP 9), but do not fill with oil at this stage. Install the through shaft and bearing cage assembly, together with a new gasket, into the axle housing. Ensure that the through shaft is properly engaged with the rear side gear on the inter-axle differential, then install and torque the retaining bolts and washers to 34-47 Nm (25-35 lb.ft). Reconnect the rear propeller shaft to the output shaft yoke.

- bl. Fill the differential carrier to the correct level with differential oil, then install and securely tighten the fill plug.

Rear Differential

60. Disassembly

- a. Remove the rear differential assembly (refer to EMEI VEH G 884 — GROUP 9).
- b. Position the differential carrier assembly on a suitable overhaul stand, then slacken the lock nut and remove the crown wheel thrust screw from the carrier housing (see Fig. 219).

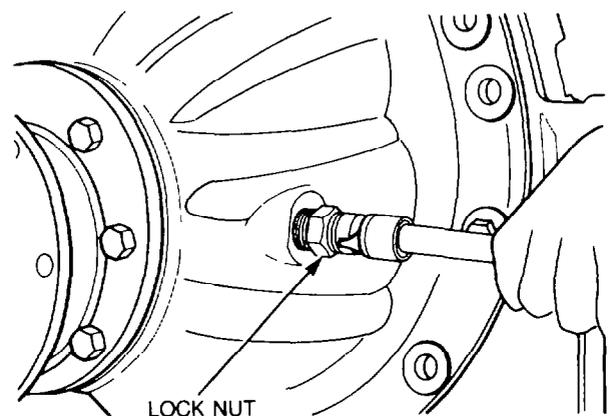


Figure 219 — Removing Thrust Screw — Rear Differential

- c. Invert the assembly and match mark one carrier side bearing cap to the bearing pedestal, for correct location at reassembly, then remove the bolts securing the caps to the pedestals and remove the adjusting ring cotter keys.
- d. Remove the bearing caps and adjusting rings, then with the aid of suitable lifting equipment, remove the crownwheel and differential assembly.

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- e. Match mark both halves of the differential case, then cut the lock wire and remove the 12 bolts (four short and eight long) from the differential case. Place the assembly on the side carrier bearing, then separate the two halves of the differential case and remove the cross-shaft, the bevel pinions and thrust washers together with the side gears and thrust washers from the differential case.
- f. Remove the bolts and nuts securing the crownwheel to the differential case and remove the crownwheel from the differential case. Remove the carrier side bearing cones from both halves of the differential case with the aid of a suitable puller.
- g. Position a yoke holding tool over the pinion shaft yoke and remove the yoke retaining nut and washer with the aid of a socket and lever.
- h. Using special tool M14580, remove the yoke from the pinion shaft, then remove the bolts and washers securing the pinion shaft bearing cage to the carrier housing. Insert suitable size jacking bolts into the threaded holes in the bearing cage and screw the bolts in evenly and alternately until the bearing cage is free of the carrier housing. Remove the bearing cage and pinion shaft assembly from the carrier housing, then remove and retain the shim pack. Measure and note the thickness of the shim pack for use at reassembly.
- i. Press the pinion shaft from the bearing cage and remove the spacer, then position a suitable collar under the inner race of the rear pinion bearing, press the shaft from the bearing. Invert the pinion shaft and remove the pilot bearing from the rear of the shaft.
- j. Position the bearing cage in the press and remove the bearing and oil seal from the cage with the aid of a suitable sleeve.

61. Cleaning and Inspection

- a. Clean all parts with a suitable cleaning agent, then thoroughly dry with soft, clean, lintless and absorbent paper towels or wiping cloth.
- b. Inspect the carrier housing for cracks or damage and replace as necessary.
- c. Inspect the gears for wear, damage, scoring, surface fatigue, ridging or crack-

ing. The gears may also be checked by Magnaflux or similar method for cracks which would not otherwise be visible. Ensure that all parts are demagnetised after inspection.

- d. Check the bearings for cracks, etching, pitting, spalling or flaking and replace as necessary.
- e. Inspect the pinion shaft for damage or wear and replace as necessary.

62. Reassembly

NOTE

If a new crownwheel and pinion set is to be installed verify that the crownwheel and pinion is a matched set. Refer to Fig. 220 for the location of:

1. The part number on the crownwheel always ends with an even number e.g. 36786 and the matched pinion ends with an odd number e.g. 36787.

2. The tooth combination number, e.g. 5-37 indicates the number of teeth on the pinion (5) and the number of teeth on the crownwheel (37).

3. The gear set matching number, e.g. M29 or any combination of letter and number stamped on both the crownwheel and the pinion.

4. The pinion code variation number; e.g. P.C. +3 or P.C. -5 indicates slight differences in the mounting distance of individual gear sets in thousandths of an inch.

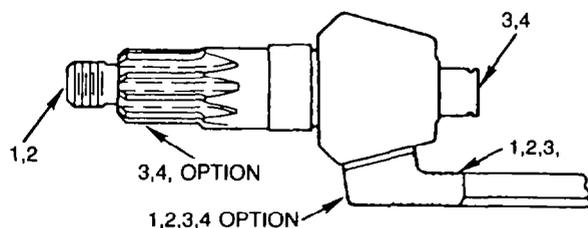


Figure 220 — Location of Identification Numbers
— Rear Differential

- a. Lubricate the rear pinion bearing cone with differential oil and position the bear-

ing cone on the pinion shaft. Place the pinion shaft and bearing assembly in a press and press the bearing onto the shaft with the aid of a suitable sleeve, ensuring that the bearing butts firmly against the shoulder.

- b. Lubricate the pilot bearing with differential oil, then press the bearing onto the rear of the pinion shafts, ensuring that the bearing butts firmly against the shoulder. Install the bearing retainer and the snap-ring and ensure that the snap-ring is properly seated in the groove.
- c. Press the inner and outer bearing cups into the bearing cage, ensuring that the taper on each cup is facing outward.
- d. Position the spacer on the pinion shaft, then lubricate the bearing cups in the bearing cage with differential oil and insert the pinion shaft into the bearing cage.
- e. With the aid of a suitable sleeve press the outer bearing cone onto the pinion shaft until it butts firmly against the spacer. While in the press, rotate the bearing cage several times to seat the bearings, then increase the pressure applied to the bearings to 24.5 tonnes (24.1 tons). Wind several turns of soft wire around the bearing cage and attach a suitable spring scale to one end of the wire. Pull on the scale with a slow steady pull until the cage rotates. The correct load on the scale to keep the cage rotating slowly and evenly is approximately 0.9-2.3 kg. (2-5 lb.). If necessary, install either a thinner spacer or a thicker spacer to increase or decrease the pre-load respectively.
- f. Remove the pinion shaft from the press and install the pinion shaft into the carrier housing. Install the bearing cage retaining bolts and tighten securely, then install the pinion shaft yoke using special tool M14587. Install the yoke retaining nut and washer and torque the nut to 1085-1493 Nm (800-1100 lb.ft), while preventing the yoke from turning with the yoke holding tool.
- g. Recheck the pinion bearing pre-load, if the pre-load is not to specification, replace the bearing spacer to obtain the correct pre-load.
- h. Remove the nut and washer securing the pinion shaft yoke to the pinion shaft, then using special tool M14580 remove the yoke from the pinion shaft. Insert the jacking bolts into the threaded holes in the bearing cage, then screw the bolts in evenly and alternately until the bearing cage is free of the carrier housing.
- i. Lubricate the sealing lip of a new pinion shaft oil seal with differential oil and coat the outside diameter of the seal with a non-hardening sealing compound. Place the bearing cage assembly in the hydraulic press, and press the seal into the bearing cage with the aid of a suitable sleeve.
- j. Install the bearing cage and pinion shaft assembly, together with the shim pack retained at the disassembly (or new shims of equivalent thickness), into the carrier housing. Install the bearing cage retaining bolts and torque the bolts to 115-156 Nm (85-115 lb.ft).
- k. Lubricate the sealing surface of the pinion shaft yoke with differential oil, then install the yoke with the aid of special tool M14587. Install and torque the yoke retaining nut and washer to 1085-1493 Nm (800-1100 lb.ft), while preventing the yoke from turning the yoke holding tool.
- l. Lubricate the main differential case side bearing cones with differential oil, then position each half of the differential case, in turn, in the hydraulic press and press the bearing cones onto both halves of the differential case until the cones butt firmly against the shoulders.
- m. Heat the crownwheel in water to approximately 71°-82°C (160°-180°F) for ten minutes, this will allow easier fitting of the crownwheel on the differential case. Remove the crownwheel from the water, wipe the water from the mounting surface and position the crownwheel over the differential case pilot. Install and torque the retaining bolts and nuts to 244-312 Nm (180-230 lb.ft). Align the castellated nuts with the holes in the bolts and install lockwire.
- n. Stand the crownwheel assembly on the differential case (with the crownwheel uppermost), then lubricate a differential side gear and thrust washer with differential oil and install the side gear and thrust washer in the differential case.

- o. Lubricate the differential spider, bevel pinions and thrust washers with differential oil, then assemble the bevel pinions and thrust washers on the spider, and place the spider assembly into position in the differential case.
- p. Lubricate the remaining side gear and thrust washer with differential oil and position the side gear and thrust washer on the spider assembly, then place the remaining half of the differential case into position over the differential gear assembly. Ensure that the match marks are aligned, then apply Loctite 277 to the threaded holes (see NOTE) and install the 12 retaining bolts (four short and eight long) with washers and torque the bolts to 244-312 mm (180-230 lb.ft)

NOTE

If new Dri-Loc bolts are being installed Do Not use any form of liquid adhesive.

- q. Check that the differential gears revolve smoothly without binding when a torque of less than 68 Nm (50 lb.ft) is applied to one side gear, using a fabricated checking tool and a torque wrench.

NOTE

The checking tool can be fabricated by cutting the splined-end of an axle shaft to the appropriate length and welding a suitable nut to the cut end.

NOTE

If the original crownwheel and pinion set together with the original shim pack (or a new shim pack of equivalent thickness) are being installed, it is not necessary to use the pinion setting gauge.

- r. Before installing the crownwheel and differential assembly, install the pinion setting gauge J4550 or equivalent and side plate into the differential carrier side bearing pedestals, using the correct adapter discs (see Fig. 221).
- s. Ensure that the micrometer is directly over and at 90° to the step plate. Measure the distance to the step plate and record the dimension.

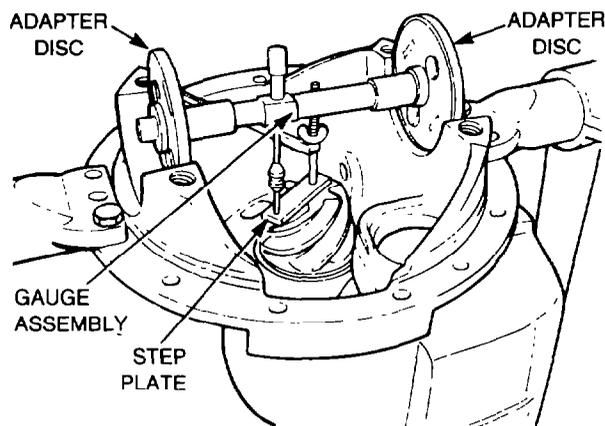


Figure 221 — Pinion Setting Tool

- t. Using the nominal pinion mounting distance of 222.25 mm (8.750 in.), calculate whether or not shims need to be added or removed. Subtract the pinion head depth from the nominal pinion mounting dimension to establish the pinion nominal gauge dimension, then from that subtract the pinion code variation number and the thickness of the step plate to obtain the corrected micrometer distance. Compare the corrected micrometer distance with the pinion nominal gauge dimension, and if necessary, either add or remove shims to make the corrected micrometer distance equal to the pinion nominal gauge dimension.
- u. Lubricate the side carrier bearing cups with differential oil and position the cups on the bearing cones. Attach suitable lifting equipment to the crownwheel and differential assembly and lift the assembly into position in the carrier housing (see Fig. 222).

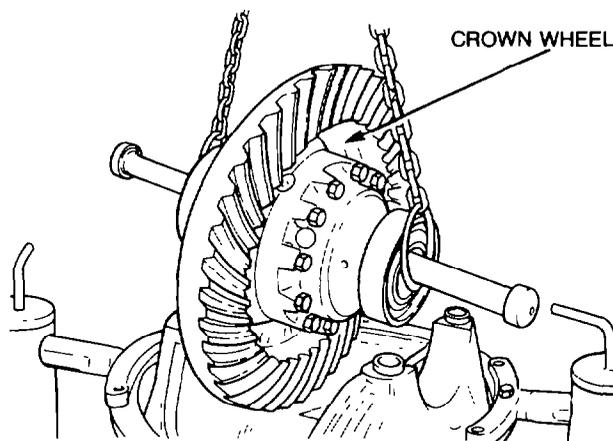


Figure 222 — Installing Crownwheel and Differential Assembly

- v. Remove the lifting equipment and install the side bearing adjusting rings. Turn the adjusting rings in by hand until the rings butt against the bearing cups, then install the bearing cups into their position as marked at disassembly.

CAUTION

Do not force the bearing caps into position otherwise damage to the carrier housing and/or bearing caps may result

- w. Tap the bearing caps lightly into position, ensuring that the caps are correctly seated over the adjusting rings. If not, remove and reinstall the adjusting ring.
- x. Install the bearing cap retaining bolts and torque the bolts to 638-746 Nm (470-550 lb.ft).
- y. Position a dial indicator on the carrier housing with the indicator plunger resting against the back of the crownwheel, then adjust the side carrier bearing adjusting rings to obtain zero side play.

NOTE

Before proceeding further check the crownwheel run-out. If the run-out exceeds 0.2 mm (0.008 in.), remove the crownwheel and check for the cause.

- z. Adjust the side carrier bearing adjusting rings to obtain a differential bearing rolling resistance of 1.7-4.0 Nm (15-35 lb.in.).

NOTE

If the original crownwheel and pinion set has been installed, use the crownwheel backlash recorded previously.

- aa. Relocate the dial indicator so that the plunger rests against one of the crownwheel teeth (see Fig. 223). Block the pinion shaft to prevent the shaft from turning, then check the backlash by turning the crownwheel in one direction, to zero the dial indicator, and turning the crownwheel in the opposite direction to take a reading. A new crownwheel and pinion set should be adjusted to obtain an initial backlash of 0.254 mm (0.010 in.). If adjustment is necessary, back-off

one adjusting ring and advance the opposite ring an equal amount.

- ab. Once the initial backlash has been obtained remove the dial indicator and the pinion shaft blocking device, then apply a light coating of oiled red lead (or similar) to the crownwheel teeth. Rotate the pinion shaft and check the contact patterns on the crownwheel teeth.

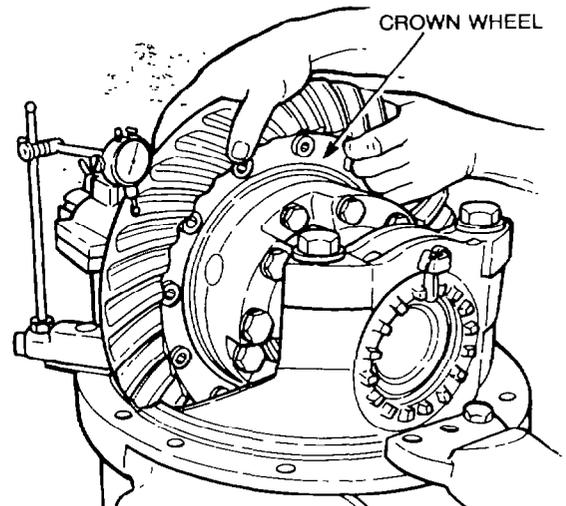


Figure 223 — Positioning Dial Indicator

NOTE

Sharper impressions may be obtained by applying a small amount of resistance to the crownwheel with a flat steel bar and using a wrench to rotate the pinion shaft.

- ac. Fig. 224 illustrates the correct contact pattern obtained when both the pinion shaft and the crownwheel are set to the correct specifications.

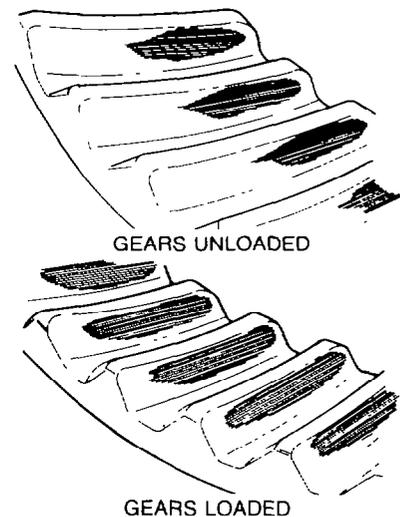


Figure 224 — Correct Contact Patterns

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ad. Fig. 225 illustrates a high contact area which indicates that the pinion shaft is set too far out. Increase the thickness of the shims between the pinion inner bearing cup and the carrier to obtain the correct pattern. Slight outward movement of the crownwheel may be necessary to obtain the correct pattern.

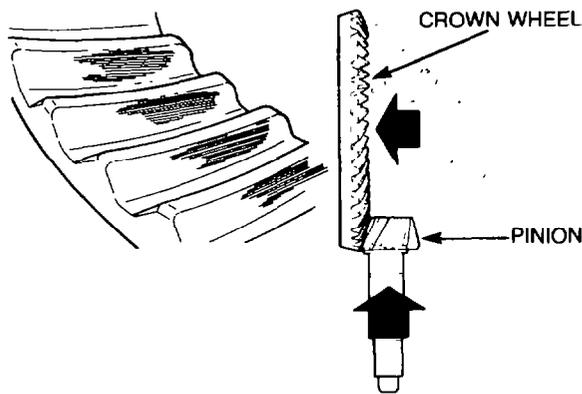


Figure 225 — High Contact Area

ae. Fig. 226 illustrates a low contact area, which indicates that the pinion shaft is set too deep. Decrease the thickness of the shim pack between the pinion shaft bearing cup and the carrier to obtain the correct pinion height. Slight inward movement of the crownwheel may be necessary to obtain the correct pattern.

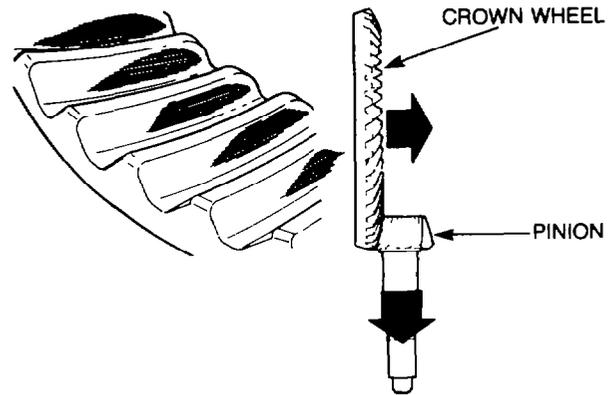


Figure 226 — Low Contact Area

- af. Once the correct tooth contact pattern has been obtained, recheck the crownwheel backlash. If necessary, readjust the backlash to between the limits of 0.127-0.351 mm (0.005-0.015 in.).
- ag. After adjusting the crownwheel and pinion, install the adjusting ring cotter keys and the crownwheel thrust screw. Turn the thrust screw in until the screw seats firmly against the back of the crownwheel, then back the thrust screw out one quarter of a turn. Install and torque the thrust screw lock nut to 197-258 Nm (145-190 lb.ft).
- ah. Install the differential carrier assembly (refer to EMEI VEH G 884 — GROUP 9).

— SPECIFICATIONS —

Crownwheel Heating	
Temperature (Water)	71°-82°C (160°-180°F)
Crownwheel-to-Differential Case Retaining Bolts and Nuts	
Tightening Torque	244-312 Nm (180-230 lb.ft)
Differential Case Retaining Bolts	
Tightening Torque	244-312 Nm (180-230 lb.ft)
Pinion Shaft Nut (Intermediate Differential)	
Tightening Torque (for pinion setting)	136 Nm (100 lb.ft)
Tightening Torque (final)	1220-1630 Nm (900-1200 lb.ft)
Pinion Shaft Nut (Rear Differential)	
Tightening Torque	1085-1493 Nm (800-1100 lb.ft)
Nominal Pinion Mounting Distance	222.25 mm (8.750 in.)
Pinion Bearing Cover Retaining Bolts (Intermediate Differential)	
Tightening Torque	47-68 Nm (35-50 lb.ft)
Differential Carrier Side Bearing Cap Retaining Bolts (Rear Differential)	
Tightening Torque	638-746 Nm (470-550 lb.ft)
Crownwheel Run-out Limit	0.02 mm (0.008 in.)
Crownwheel Backlash	
Initial Setting — New Gears Only	0.254 mm (0.010 in.)
Final Setting — New and Used Gears (after correct tooth contact has been made)	0.127-0.381 mm (0.005-0.015 in.)
Interaxle Differential Retaining Bolts (intermediate Differential)	
Tightening Torque	68-88 Nm (50-65 lb.ft)
Input Shaft Bearing Cage Retaining Bolts (Intermediate Differential)	
Tightening Torque	54-75 Nm (40-55 lb.ft)
Input Shaft End-play (Intermediate Differential)	0.025-0.177 mm (0.001-0.007 in.)
Air Shift Housing Retaining Bolts (Intermediate Differential)	
Tightening Torque	47-68 Nm (35-50 lb.ft)
Piston Shaft Adjusting Screw Lock Nut (Intermediate Differential)	
Tightening Torque	54-75 Nm (40-55 lb.ft)
Input Shaft and Through Shaft Yoke Retaining Nuts (Intermediate Differential)	
Tightening Torque	610-814 Nm (450-600 lb.ft)
Through Shaft Bearing Adjustment (Intermediate Differential)	
Adjustment	From a clearance of 0.076 mm (0.003 in.) to a pre-load of 1.1 Nm (10 lb.in.)
Through Shaft Bearing Cage Retaining Bolts (Intermediate Differential)	
Tightening Torque	34-47 Nm (25-35 lb.ft)
Pinion Shaft (Intermediate Differential)	
Bearing Pre-load (Torque Method) — New Bearings	0.56-2.8 Nm (5-25 lb.in.)
— Re-used Bearings	0.56-1.7 Nm (5-15 lb.in.)
Pinion Shaft (Rear Differential)	
Bearing Pre-load (Spring Scale Method)	0.9-2.3 kg (2-5 lb.)
Differential Bearing Rolling Resistance	1.7-4.0 Nm (15-35 lb.in.)
Crownwheel Thrust Screw Clearance	0.254-0.508 mm (0.010-0.020 in.)
Crownwheel Thrust Screw Lock Nut	
Tightening Torque	197-258 Nm (145-190 lb.ft)

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BRAKE SYSTEM — GROUP 12

Air Compressor

63. Disassembly

- a. Remove the air compressor from the engine (refer to EMEI VEH G 884 — GROUP 12).
- b. Attach the air compressor mounting plate ST-749 to the ball joint vice ST-302, then mount the air compressor on the mounting plate ST-749 as shown in Fig. 227.

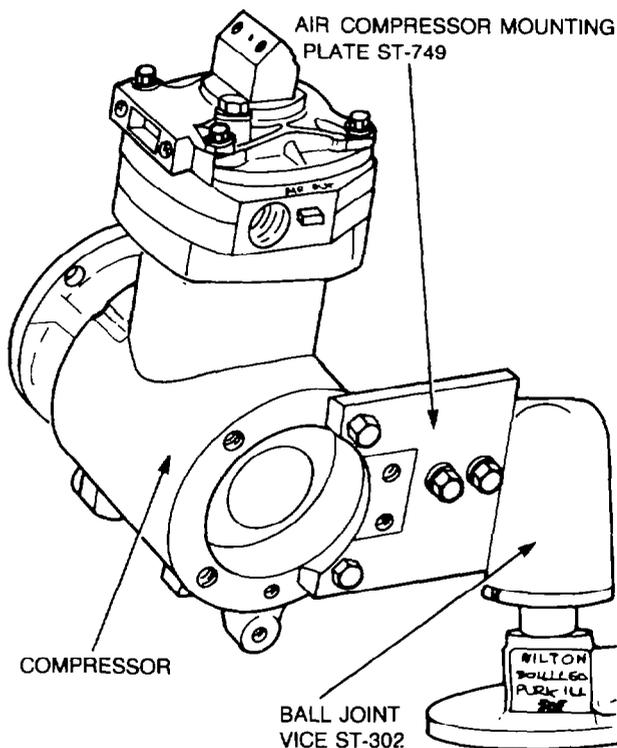


Figure 227 — Compressor on Mounting Plate

- c. Remove the two bolts and washers securing the air inlet connection to the cylinder head cover then remove the connection and discard the gasket.
- d. Remove the two bolts and washers securing the unloader valve assembly to the cylinder head cover, then remove the unloader valve assembly (see Fig. 228).
- e. Remove the unloader cap from the unloader body (see Fig. 229).

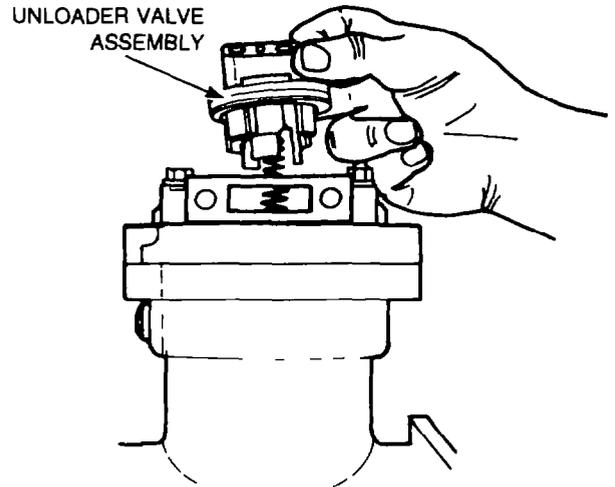


Figure 228 — Unloader Valve Assembly — Removal

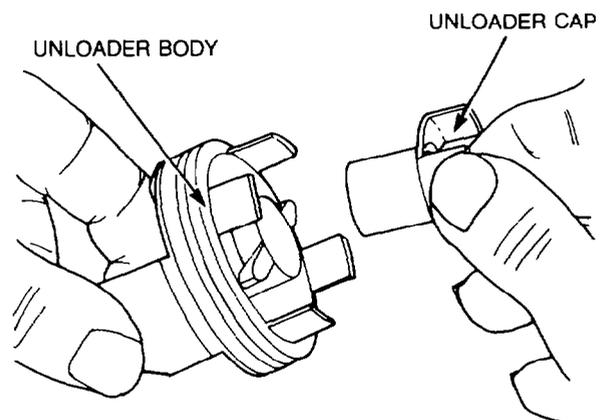


Figure 229 — Unloader Cap — Removal

- f. Remove and discard the O-ring and the seal from the unloader body (see Fig. 230).

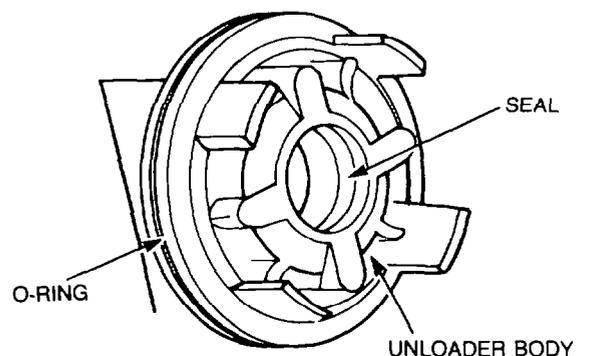


Figure 230 — Unloader Body

- g. Remove the unloader valve spring from the intake valve seat (see Fig. 231).

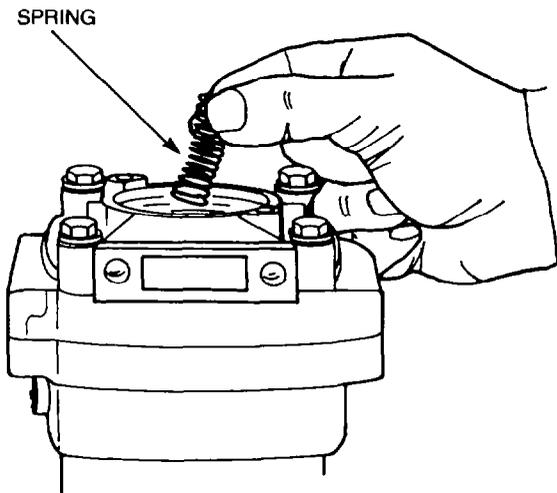


Figure 231 — Unloader Valve Spring — Removal

- h. Remove the intake valve seat, intake valve and the intake valve spring from the cylinder head (see Fig. 232).

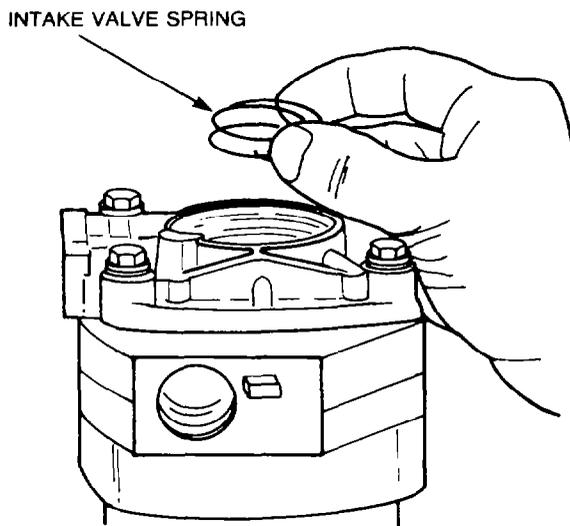


Figure 232 — Intake Seat, Valve and Spring — Removal

- i. Remove the four bolts and washers securing the cylinder head cover and the cylinder head to the crankcase, then remove the cover and the cylinder head (see Fig. 233). Discard the cylinder head cover gasket and the cylinder head gasket.
- j. Press the exhaust valve assembly from the bottom side of the cylinder head, then remove and discard the O-rings. Remove the exhaust valve from the exhaust valve seat. Remove the wear plate and spring from the cylinder head (see Fig. 234).

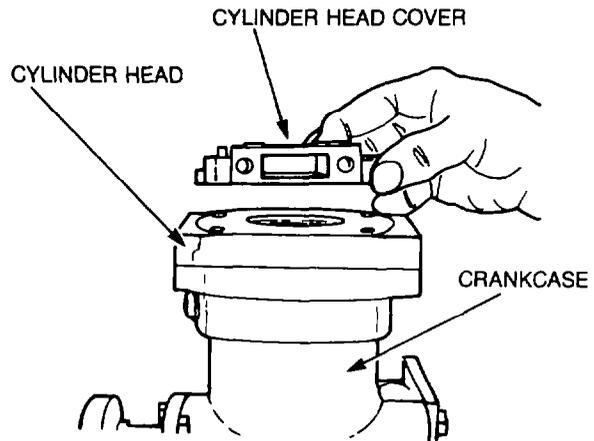


Figure 233 — Cylinder Head Cover and Cylinder Head — Removal

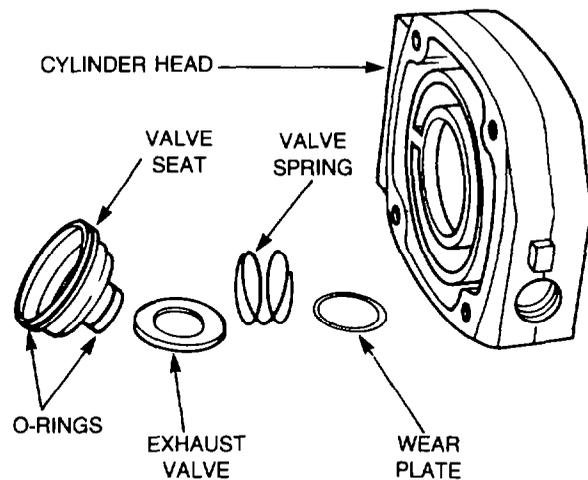


Figure 234 — Exhaust Valve — Exploded View

- k. Using special tool 3376663 remove the spline drive coupling from the crankshaft as shown in Fig. 235, then remove the thrust washer.

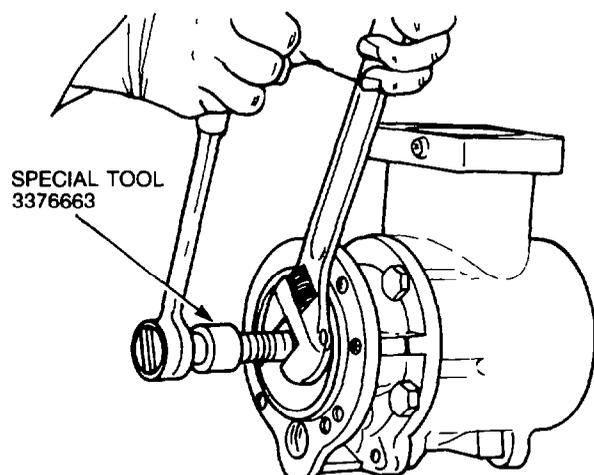


Figure 235 — Spline Drive Coupling — Removal

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- l. Remove the four bolts and washers securing the support to the crankcase then remove the support and discard the gasket.
- m. Rotate the crankshaft until the piston is approximately 90° before or after TDC, then remove the crankshaft from the connecting rod and the crankcase while rotating the crankshaft and guiding the connecting rod over the rear bearing journal (see Fig. 236).

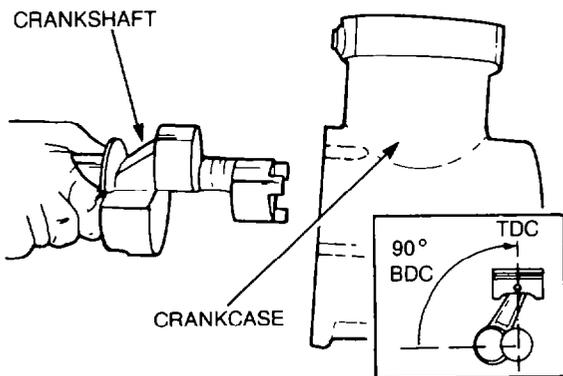


Figure 236 — Crankshaft — Removal

- n. Using a suitable scraper and emery cloth remove the carbon from the top of the cylinder, and the ring ridge from the cylinder bore.
- o. Remove the piston and the connecting rod assembly from the cylinder bore (see Fig. 237).

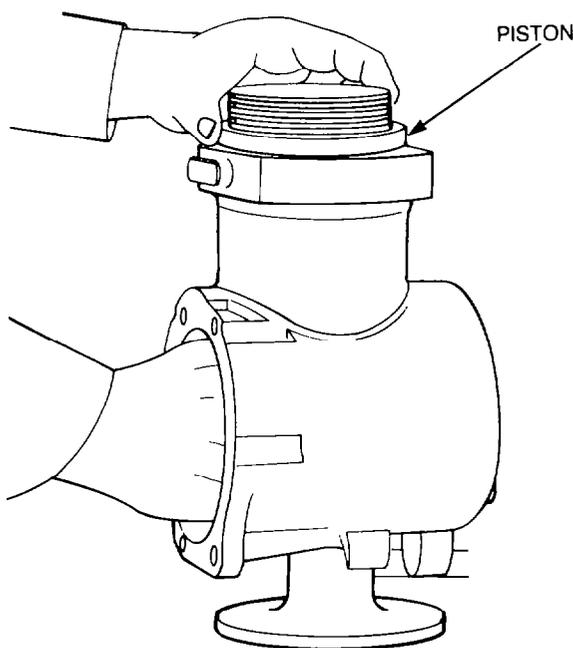


Figure 237 — Piston and Connecting Rod — Removal

- p. Remove the piston and oil control rings from the piston, taking care not to damage the piston, then remove the two cir-clips securing the piston pin into the piston and connecting rod.

CAUTION

If the piston pin cannot be removed by hand pressure, place the piston in a container of boiling water to expand the pin bore. Do not attempt to drive the piston pin from the piston as damage may occur.

- q. Remove the piston pin from the piston and connecting rod, then remove the piston from the connecting rod.
64. Cleaning and Inspection

NOTE

The cleaning agent must have no adverse affect on aluminium.

- a. Immerse the cylinder head and the cover in a suitable cleaning agent to remove all trace of carbon and scale.
- b. Using a stiff non-metallic bristle brush remove all the carbon and rust from the valve and water cavities.
- c. Remove the pipe plug from the end of the crankshaft and thoroughly clean the oil drilling in the crankshaft with a suitable cleaning agent, then blow dry with compressed air. Install the pipe plug in the crankshaft and torque to 4-8 Nm (3-6 lb.ft).
- d. Using a suitable cleaning agent, clean all the remaining parts then blow dry with compressed air.

NOTE

The top of the air compressor head has a contoured surface to provide a good cover to cylinder head seal. The cylinder head is approximately 0.15 mm (0.006 in.) higher in the centre than at the outer edges.

- e. Inspect the cylinder head and cover for cracks, breaks or visible signs of damage. Replace as necessary.
- f. Measure the height of the exhaust valve seat using a micrometer depth gauge as shown in Fig. 238. If the height is less

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than 12.32 mm (0.485 in.) replace the exhaust valve seat.

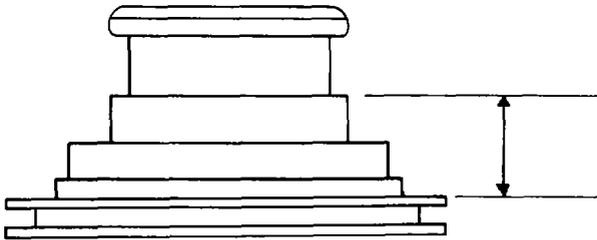


Figure 238 — Exhaust Valve Seat Measurement

- g. Measure the height of the intake valve seat using a micrometer depth gauge as shown in Fig. 239. If the height is less than 6.86 mm (0.270 in.) replace the intake valve seat.

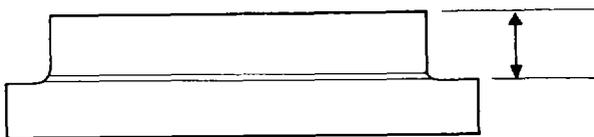


Figure 239 — Intake Valve Seat Measurement

- h. Inspect the unloader valve for scoring, pitting or excessive wear and replace as necessary (see Fig. 240).

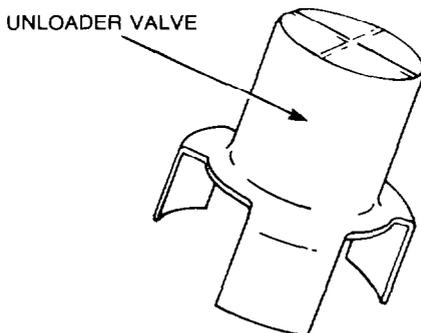


Figure 240 — Unloader Valve

- i. Inspect the unloader cap seating area for distortion, pitting or wear and replace as necessary.
- j. Inspect all the springs for cracks or damage and check the springs on a spring tester for spring length and tension. Replace any spring that is damaged or below the limits listed in Table 13.

Table 13 — Valve Spring Tolerances

Free Length	mm (in.)	
Inlet	12.70 (0.50)	
Exhaust	17.02 (0.670)	
Unloader	41.91 (1.65)	
Tension	min. kg (lb.)	max. kg (lb.)
Inlet	0.30 (0.65)	0.50 (1.10)
Exhaust	3.86 (8.50)	4.72 (10.40)
Unloader	5.90 (13.00)	7.72 (17.00)
Wear Limit	Length mm (in.)	Tension kg (lb.)
Inlet	less than 7.11 (0.280)	0.25 (0.55)
Exhaust	less than 7.11 (0.280)	3.63 (8.00)
Unloader	less than 24.89 (0.98)	5.40 (12.00)

- k. Inspect the crankshaft for scratches, scoring or any visible signs of wear, then measure the crankshaft using a micrometer at the points indicated in Fig. 241. Replace the crankshaft if the measurements are below the wear limits listed in Table 14.

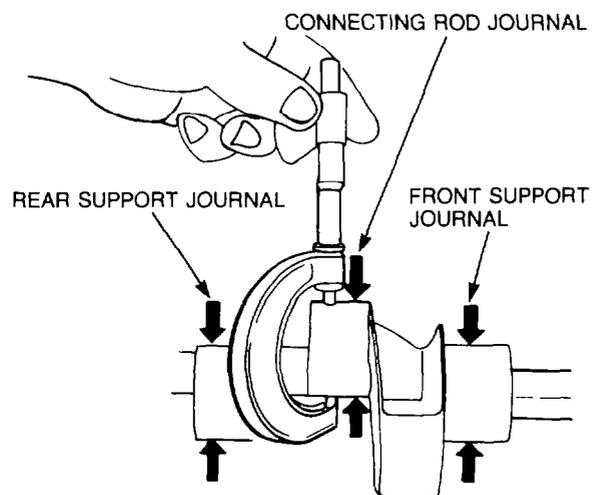


Figure 241 — Measuring Crankshaft Bearing Journals

- l. Inspect the front support for scratches, scoring or wear, then using a suitable depth gauge measure the support thrust flange for wear (see Fig. 242). The standard measurement of the support thrust flange is 33.20-33.27 mm (1.307-1.310 in.) and the wear limit is 32.69 mm (1.287 in.) Replace the support if the measurement is below the wear limit.

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Table 14 — Crankshaft Tolerances

Journal	Minimum mm (in.)	Maximum mm (in.)	Wear Limit mm (in.)
Front support	47.55 (1.872)	47.57 (1.873)	47.52 (1.871)
Connecting rod	49.136 (1.9345)	49.162 (1.9355)	49.098 (1.9330)
Rear support	47.55 (1.872)	47.57 (1.873)	47.52 (1.871)

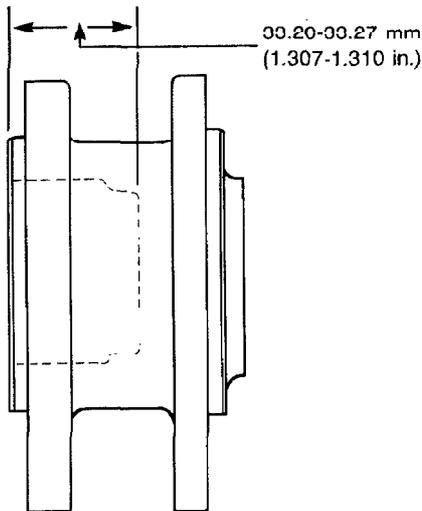


Figure 242 — Front Support Thrust Flange

- m. Using a micrometer measure the thrust bearing thickness the standard thickness is 6.10-6.30 mm (0.240-0.248 in.) Replace the thrust bearing if the measurement is below the lower limit.
- n. Measure the diameter of the support bearing as shown in Fig. 243. The standard diameter is 47.600-47.650 mm (1.8740-1.8760 in.) and the wear limit is 47.688 mm (1.8775 in.). Replace the support if the diameter is below the wear limit.

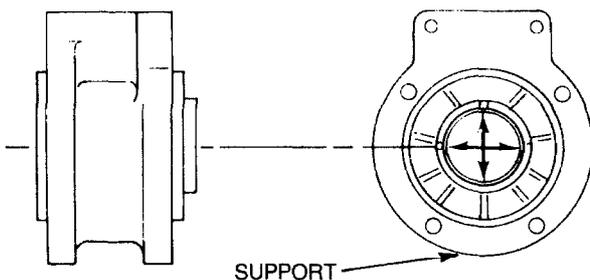


Figure 243 — Measuring Support Bearing

NOTE

The connecting rod small (gudgeon pin) end bushing is made of hardened steel, and is not replaceable.

- o. Inspect the connecting rod for wear or damage and measure the connecting rod small (gudgeon pin) end and the big (connecting rod) end. If the inside diameter of the small end or big end exceeds 17.513 mm (0.6895 in.) or 49.15 mm (1.935 in.) respectively, replace the connecting rod.
- p. Install the connecting rod on an alignment jig and check for bend or twist as shown in Fig. 244. The allowable bend is 0.05mm (0.002 in.) and 0.10 mm (0.004 in.) for twist. Replace the connecting rod as necessary.

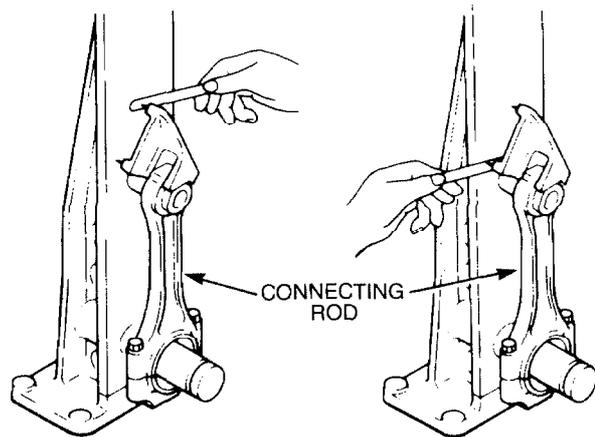


Figure 244 — Checking Connecting Rod Alignment

- q. Inspect the drive coupling for wear or damage and replace the crankshaft as necessary.
- r. Using a micrometer measure the diameter of the gudgeon pin. The standard dimension of the gudgeon pin is 17.462-17.465 mm (0.6875-0.6876 in.). If the diameter of the pin is less than 17.455 mm (0.6872 in.) replace the gudgeon pin.
- s. Using a micrometer measure the piston for wear 6.35 mm (0.250 in.) above the bottom of the piston skirt, at a right angle to the gudgeon pin bore (see Fig. 245). The standard dimension of the piston is 91.92-91.95 mm (3.619-3.620 in.). Replace the piston if the measurement is less than 91.87 mm (3.617 in.).

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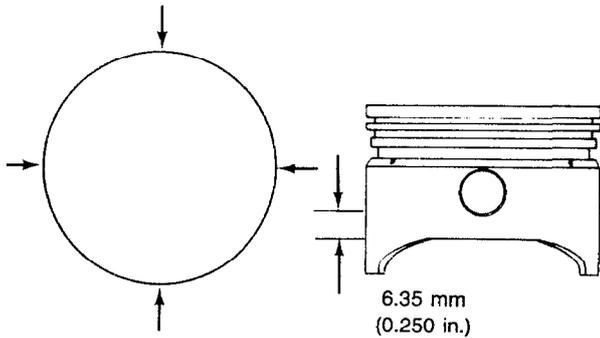


Figure 245 — Measuring Piston Skirt

- t. Measure the gudgeon pin bore as shown in Fig. 246, the standard dimension of the bore is 17.475-17.488 mm (0.6880-0.6885 in.). If the bore is worn larger than 17.501 mm (0.6890 in.) replace the piston.

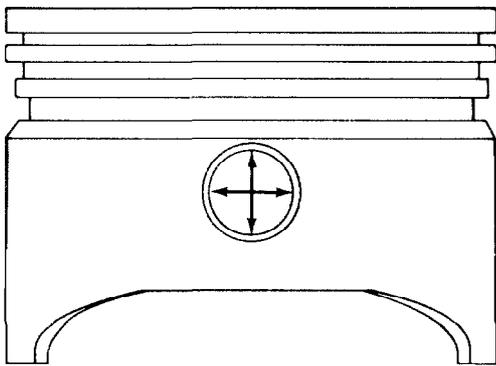


Figure 246 — Measuring Gudgeon Pin Bore

- u. Install a new piston ring in the piston ring groove, then insert a 0.10 mm (0.004 in.) feeler gauge between the ring and the ring groove. Compress the piston ring into the ring groove, with the feeler gauge in place. If the ring compresses below the piston land surface replace the piston.
- v. Install one piston ring at a time squarely into the cylinder bore and measure the piston ring end gap with a set of feeler gauges. A ring end gap of between 0.25-0.51 mm (0.010-0.020 in.) is required for the top and second ring. A ring end gap of 0.38-1.40 mm (0.015-0.055 in.) is required for the oil ring.
- w. 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.

- x. Measure the cylinder bore for out-of-round and wear 25.4 mm (1.00 in.) below the top of the crankcase using an internal micrometer (see Fig. 247). The standard bore diameter is 92.08-92.10 mm (3.625-3.626 in.). If the bore diameter exceeds 92.164 mm (3.6285 in.) the bore will require reboring.

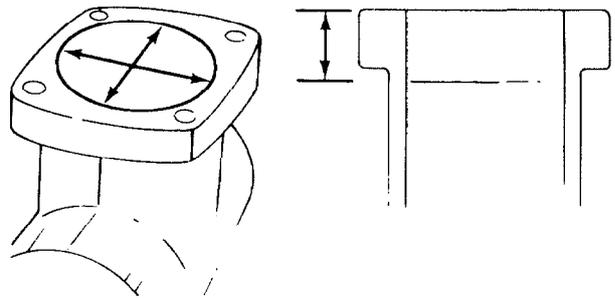


Figure 247 — Measuring Cylinder Bore

- y. If the cylinder bore is not within specifications, bore and hone the cylinder to accommodate a 0.25, 0.51 or 0.76 mm (0.010, 0.020 or 0.030 in.) oversize piston and piston rings.
- z. Measure the crankshaft bush in the crankcase (see Fig. 248) and replace the bush if the measurement exceeds 47.70 mm (1.8780 in.).

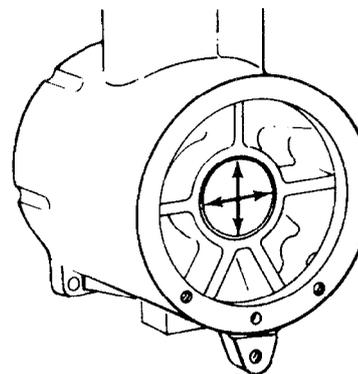


Figure 248 — Measuring Crankshaft Bush

- aa. If the bush requires replacement, support the crankcase and using special tool ST-1105 press out the old bush.
- ab. Lubricate the bush bore in the crankcase and press in the new bush, using special tool ST-1105, until it is flush with the bore surface.

65. Reassembly

NOTE

If the gudgeon pin cannot be installed using hand pressure, place the piston in a container of boiling water to expand the pin bore.

- a. Install one circlip in the gudgeon pin bore of the piston, then position the piston over the small end of the connecting rod. Lubricate the gudgeon pin with clean engine oil, then push the gudgeon pin into position in the piston and connecting rod until it seats against the fitted circlip. Install the remaining circlip to secure the piston onto the connecting rod.
- b. Install the oil ring expander and the oil ring in the lower piston ring groove ensuring that the expander ring gap and the oil ring gaps are staggered 180° apart and that the expander ring ends do not overlap.

NOTE

The compression rings are not interchangeable.

- c. Install the intermediate compression and the top compression ring with the word TOP toward the crown of the piston ensuring that the ring gaps are staggered 180° apart and are not located over the gudgeon pin bore (see Fig. 249).

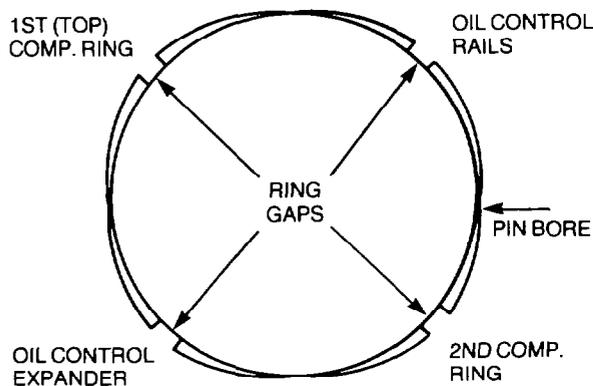


Figure 249 — Piston Ring — Installation

- d. Lubricate the piston rings, piston and the cylinder bore with clean engine oil,

then install a suitable piston ring compressor and compress the piston rings.

- e. Install the piston and connecting rod into the cylinder bore, using a suitable soft-faced tool to push the piston from the ring compressor (see Fig. 250).

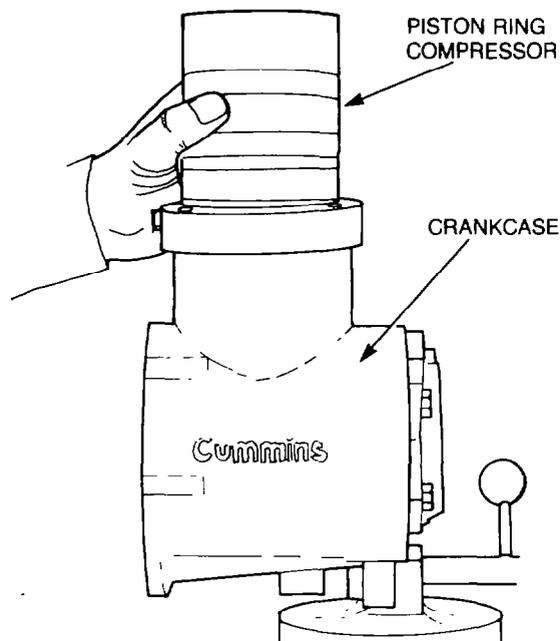


Figure 250 — Piston and Connecting Rod — Installation

- f. Lubricate the crankshaft journal and the crankshaft support with clean engine oil, then install the crankshaft into the support (see Fig. 251).

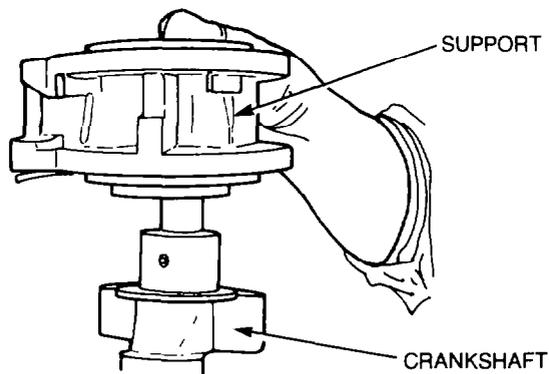


Figure 251 — Crankshaft and Support

- g. Lubricate the thrust bearing with clean engine oil, then install the bearing over the end of the crankshaft and into the support with the slotted side toward the crankshaft (see Fig. 252).

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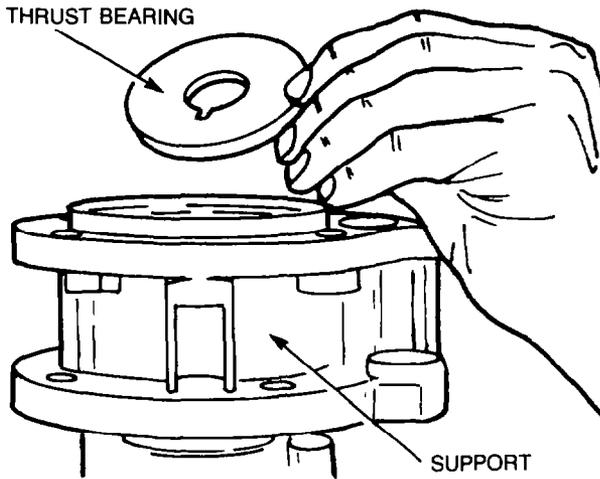


Figure 252 — Thrust Bearing — Installation

h. Using a suitable press, support the crankshaft as shown in Fig. 253 and press the drive coupling onto the crankshaft until it seats firmly against the thrust washer. Measure the clearance between the support and the crankshaft mating surface. The standard clearance is 0.06-0.18 mm (0.002-0.007 in.) and the wear limit is 0.69 mm (0.027 in.).

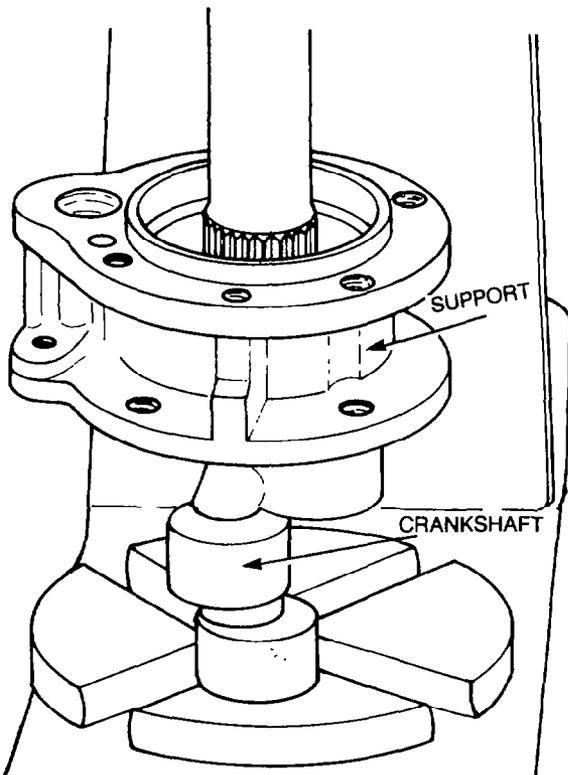


Figure 253 — Drive Coupling — Installation

i. Position the piston approximately 10 mm (0.394 in.) down from the top of the cylinder bore, then lubricate the crankshaft connecting rod journal with clean engine oil. Position a new gasket at the crankcase and install the crankshaft (see Fig. 254) and secure the support with the four washers and bolts. Torque the bolts to 41-47 Nm (30-35 lb.ft).

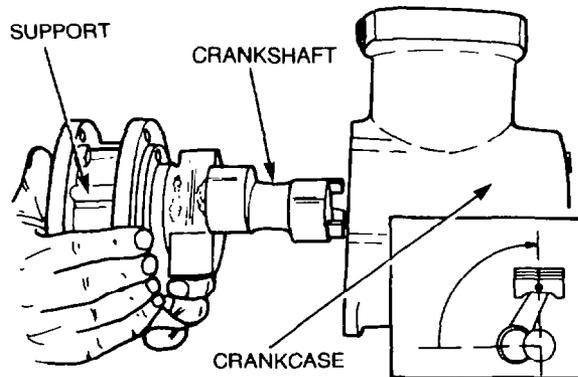


Figure 254 — Crankshaft — Installation

j. Position the exhaust valve on the exhaust valve seat (see Fig. 255).

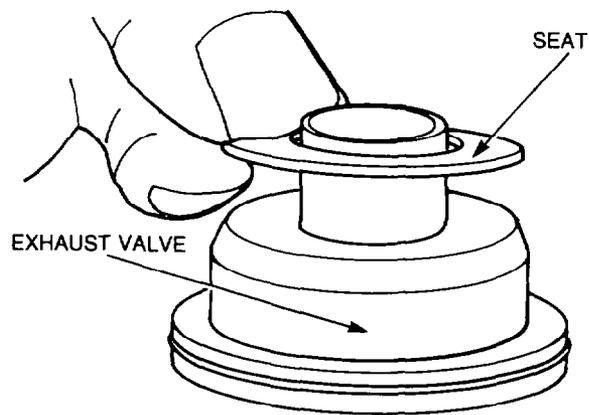


Figure 255 — Exhaust Valve and Seat

k. Install new O-rings on the exhaust valve seat, then lubricate the O-rings with the clean engine oil. Install the exhaust valve seat, wear plate and spring into the cylinder head (see Fig. 256), using thumb pressure to press the exhaust valve into position in the cylinder head.

l. Position the intake valve spring in the exhaust valve seat, then install the

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intake valve and the intake valve seat on the intake valve spring (see Fig. 257).

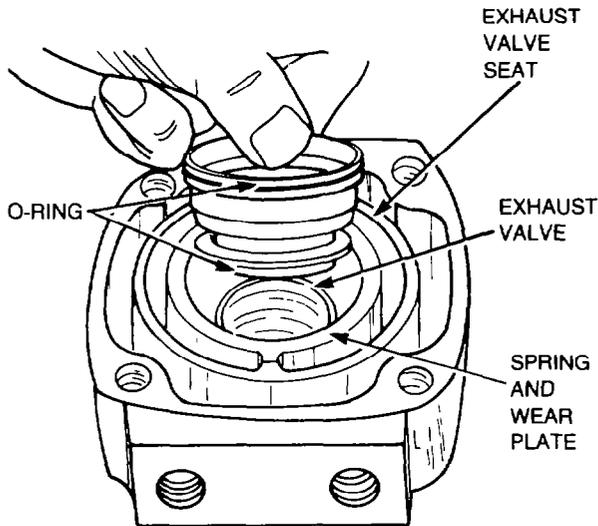


Figure 256 — Exhaust Valve — Installation

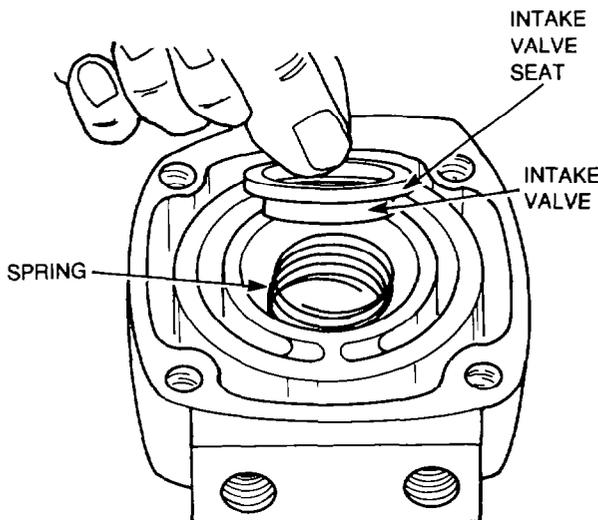


Figure 257 — Intake Valve — Installation

- m. Position the cylinder head, with a new head gasket on the crankcase cylinder bore, then position the cylinder head cover with a new gasket, on the cylinder head and secure both the cylinder head cover and the cylinder head to the crankcase with the four bolts and captive washers. Torque the bolts to 20-26 Nm (15-19 lb.ft).
- n. Install a new O-ring and seal on the unloader body, then lubricate the O-ring with clean engine oil, and the seal with a suitable anti-seize compound. Install the unloader cap into the unloader body (see Fig. 258).

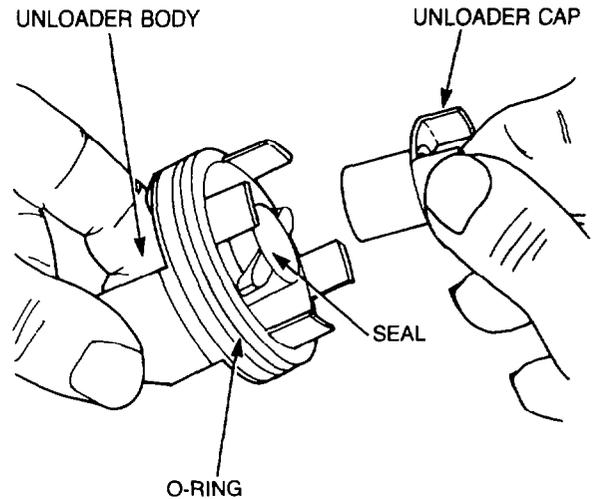


Figure 258 — Unloader Valve — Assembly

- o. Place the unloader spring in the cylinder head, then position the unloader valve assembly over the spring and into the cylinder head cover. Secure the unloader valve assembly to the head cover with the two washers and bolts (see Fig. 259) and torque the bolts to 11-15 Nm (8-11 lb.ft).

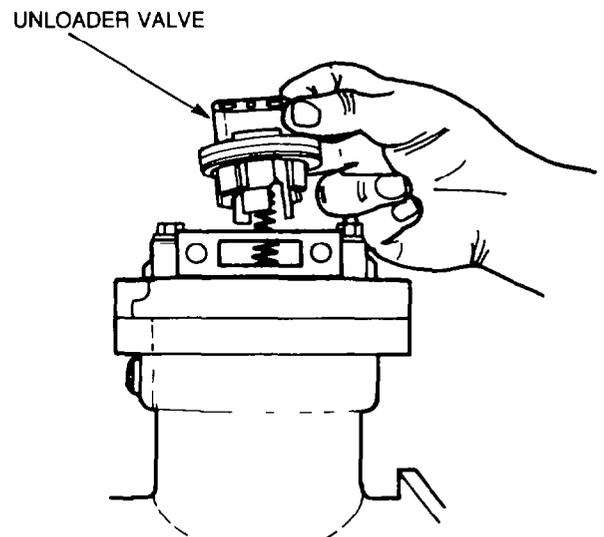


Figure 259 — Unloader Valve Assembly — Installation

- p. Install the air inlet connection onto the cylinder head cover and secure with the two washers and nuts.
- q. Install the air compressor on the engine (refer to EMEI VEH G 884 — GROUP 12).

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Brake Drums

66. Cleaning and Inspection

- a. Clean the brake drums using a steam cleaner or hot water and a suitable non-oil based cleaning agent.
- b. Inspect the brake drum for hard or chill spots, and replace the drum if any hard or chill spots are evident (see Fig. 260).
- c. Inspect the brake drum for heat cracks or damage and replace as necessary.
- d. Check the brake drum for scoring, barrel or bellmouth wear as shown in Fig. 261. Where wear is evident, measure the inside diameter of the drum using a suitable inside micrometer across the braking surface. If the depth of wear exceeds 0.13 mm (0.005 in.) the brake drum must be machined.
- e. Measure the drum braking surface diameter at various points 45° apart, using a

suitable micrometer. Machine the brake drum where the out-of-round exceeds 0.25 mm (0.010 in.). Replace any brake drum that cannot be cleaned up or corrected with out exceeding the maximum diameter of 422.15 mm (16.62 in.).

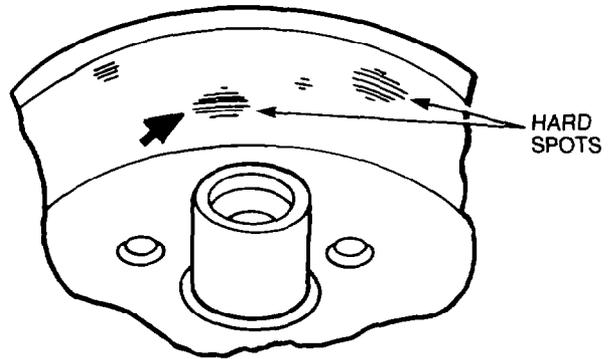


Figure 260 — Brake Drum with Hard Spots

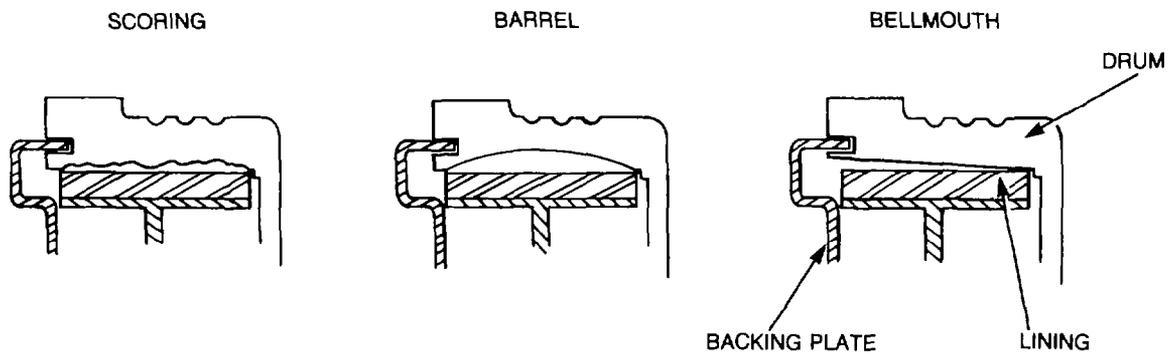


Figure 261 — Barrel and Bellmouth Wear

— SPECIFICATIONS —

Exhaust Valve Seat	
Height.....	12.32 mm (0.485 in.)
Intake Valve Seat	
Height.....	6.86 mm (0.270 in.)
Spring Tolerances	
Free Length	
Intake Valve.....	12.70 mm (0.50 in.)
Exhaust Valve	17.02 mm (0.670 in.)
Unloading Valve.....	41.91 mm (1.65 in.)
Minimum Tension	
Intake Valve.....	0.30 kg (0.65 lb.)
Exhaust Valve	3.86 kg (8.50 lb.)
Unloading Valve.....	5.90 kg (13.00 lb.)
Maximum Tension	
Intake Valve.....	0.50 kg (1.10 lb.)
Exhaust Valve	4.72 kg (10.40 lb.)
Unloading Valve.....	7.72 kg (17.00 lb.)
Worn Limit Length and Tension	
Intake Valve.....	less than 7.11 mm (0.280 in.)0.25 kg (0.55 lb.)
Exhaust Valve	less than 7.11 mm (0.280 in.)3.63 kg (8.00 lb.)
Unloading Valve.....	less than 24.89 mm (0.98 in.)5.40 kg (12.00 lb.)
Crankshaft Tolerances	
Standard Diameter	
Front Support Journal.....	47.55-47.57 mm (1.872-1.873 in.)
Connecting Rod Journal.....	49.136-49.162 mm (1.9345-1.9355 in.)
Rear Support Journal	47.55-47.57 mm (1.872-1.873 in.)
Wear Limit	
Front Support Journal.....	47.52 mm (1.871 in.)
Connecting Rod Journal.....	49.098 mm (1.9330 in.)
Rear Support Journal	47.52 mm (1.871 in.)
Support Thrust Flange	
Standard Depth.....	33.20-33.27 mm (1.307-1.310 in.)
Wear Limit.....	32.69 mm (1.287 in.)
Thrust Bearing	
Thickness	6.10-6.30 mm (0.240-0.248 in.)
Crankshaft Support Bearing	
Standard Diameter.....	47.600-47.650 mm (1.8740-1.8760 in.)
Wear Limit.....	47.688 mm (1.8775 in.)
Connecting Rod	
Small End Diameter.....	17.513 mm (0.6895 in.)
Big End Diameter	49.15 mm (1.935 in.)
Connecting Rod Alignment	
Allowable Bend	0.05 mm (0.002 in.)
Allowable Twist	0.10 mm (0.004 in.)
Gudgeon Pin	
Standard Diameter.....	17.462-17.465 mm (0.6875-0.6876 in.)
Wear Limit.....	17.455 mm (0.6872 in.)

Piston	
Standard Diameter	91.92-91.95 mm (3.619-3.620 in.)
Wear Diameter	91.87 mm (3.617 in.)
Piston Pin Bore	
Standard Diameter	17.475-17.488 mm (0.6880-0.6885 in.)
Worn Limit.....	17.50 mm (0.6890 in.)
Piston Ring	
Clearance	0.10 mm (0.004 in.)
Piston Ring End Gap	
Top and Second Rings	0.25-0.51 mm (0.010-0.020 in.)
Oil ring	0.38-1.40 mm (0.015-0.055 in.)
Cylinder Bore	
Standard Diameter	92.08-92.10 mm (3.625-3.626 in.)
Wear Limit.....	92.164 mm (3.6285 in.)
Crankshaft Bushing	
Wear Limit.....	47.70 mm (1.8780 in.)
Crankshaft Support to Crankshaft End Clearance	
Standard Clearance.....	0.06-0.18 mm (0.002-0.007 in.)
Wear Limit.....	0.69 mm (0.027 in.)
Crankshaft Support to Crankcase	
Tightening Torque	41.47 Nm (30-35 lb.ft)
Cylinder Head	
Tightening Torque	20-26 Nm (15-19 lb.ft)
Unloader Valve	
Tightening Torque	11-15 Nm (8-11 lb.ft)
Brake Drum	
Maximum Diameter	422.12 mm (16.62 in.)

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— FAULT FINDING —

Air Compressor

Symptom	Probable Cause	Action
1. The compressor fails to maintain pressure.	<ul style="list-style-type: none"> a. Air governor faulty or incorrectly set. b. Carbon build-up in cylinder head or discharge line. c. Intake valve stuck open. d. Unloader cap stuck. e. Leaks in vehicle air system. 	<ul style="list-style-type: none"> a. Replace/adjust air governor. b. Remove carbon build-up. c. Replace/free-up valve. d. Free-up unloader cap. e. Repair air leaks.
2. Noisy compressor operation.	<ul style="list-style-type: none"> a. Excessive wear. b. Worn or burned out bearings. c. Excessive crankshaft end play. d. Carbon build-up in cylinder head or discharge line. 	<ul style="list-style-type: none"> a. Overhaul compressor. b. Replace bearings. c. Measure end play and replace thrust bearing. d. Remove carbon build-up.
3. Excessive oil consumption.	<ul style="list-style-type: none"> a. Excessive engine oil pressure. b. Piston rings installed incorrectly or broken. c. Component wear 	<ul style="list-style-type: none"> a. Adjust or regulate the engine pressure regulating valve. b. Replace the rings and install correctly. c. Overhaul compressor.
4. Compressor passes excessive oil to air tanks.	<ul style="list-style-type: none"> a. Worn, scored or out of round cylinder bore. b. Weak or broken valve springs. 	<ul style="list-style-type: none"> a. Overhaul compressor/rebore cylinder. b. Replace valve springs.

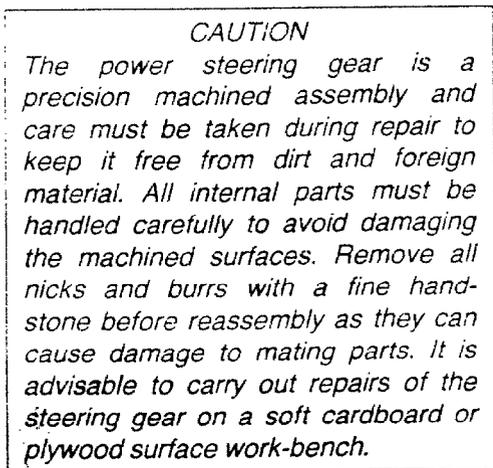
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STEERING — GROUP 14

Steering Box

67. Disassembly

- a. Remove the steering box from the vehicle (refer to EMEI VEH G 884 — GROUP 14).



NOTE

The cylinder head or bearing cap will fit either end of the housing.

- b. Match mark the bearing cap, cylinder head and the housing to assist during reassembly (see Fig. 262).

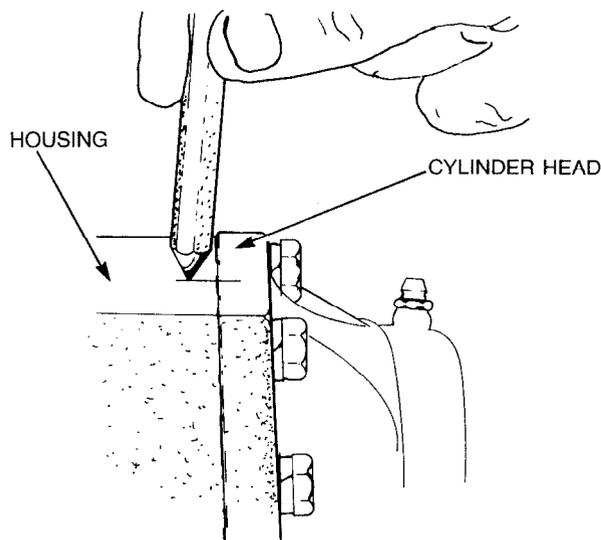


Figure 262 — Marking the Cylinder Head and Housing

- c. Remove the eight bolts and washers securing the pinion gear cover to the housing (see Fig. 263).

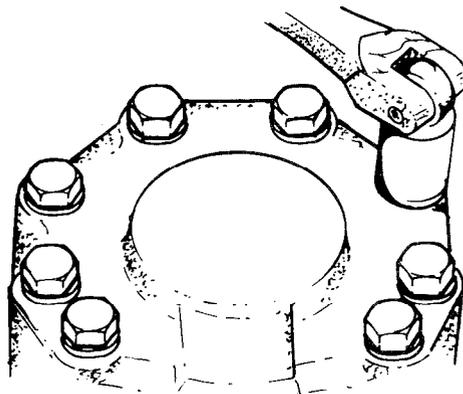


Figure 263 — Pinion Gear Cover — Removal

- d. Clean the exposed portion of the output shaft to prevent damaging the bearing, then using a soft hammer, tap on the end of the shaft to loosen the cover (see Fig. 264).

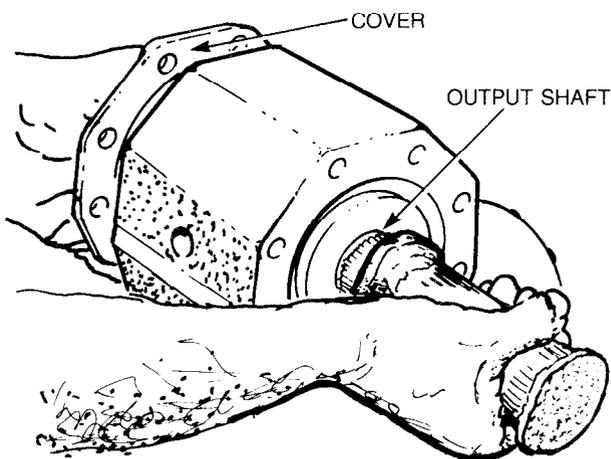


Figure 264 — Tapping Output Shaft

- e. Carefully withdraw the output shaft, pinion gear and cover from the housing (see Fig. 265), then remove the output shaft from the cover. Remove and discard the O-ring from the cover.

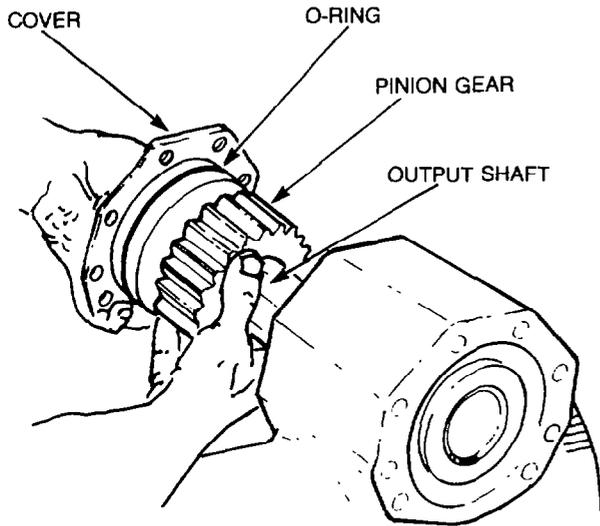


Figure 265 — Output Shaft — Removal

- f. Remove the relief valve plungers from the cylinder head and the bearing cap, then remove and discard the O-rings.
- g. Remove the ten bolts securing the bearing cap to the housing (see Fig. 266), then turn the actuating shaft clockwise to free the bearing cap from the piston and housing.

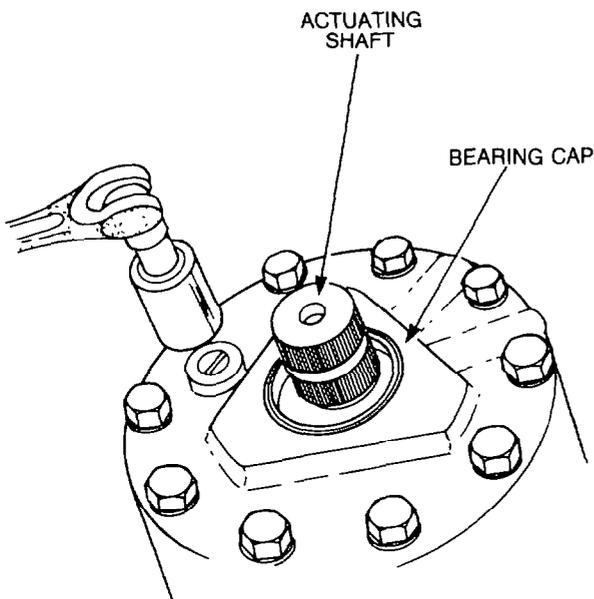


Figure 266 — Bearing Cap Retaining Bolts — Removal

- h. Support the bearing cap and turn the actuating shaft until the shaft is free of the piston (see Fig. 267), then remove and discard the sealing ring.

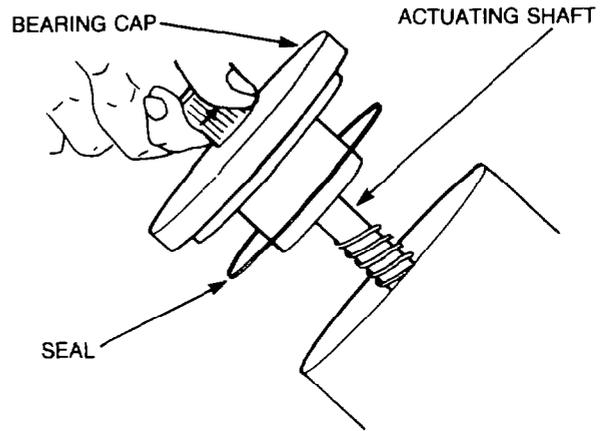


Figure 267 — Bearing Cap and Actuating Shaft — Removal

- i. Remove the ten bolts securing the cylinder head to the housing (see Fig. 268), then remove the cylinder head and discard the sealing ring.

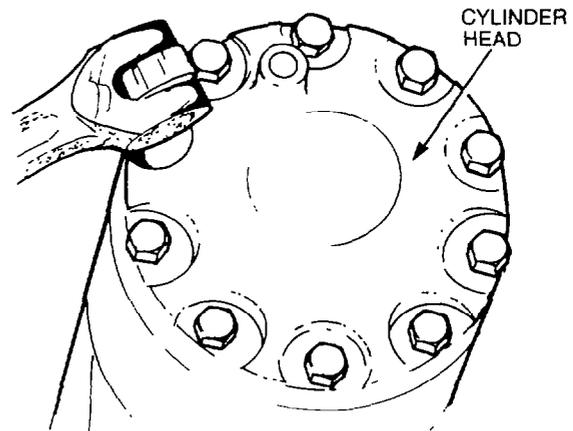


Figure 268 — Cylinder Head — Removal

- j. Carefully withdraw the piston assembly from the housing (see Fig. 269).

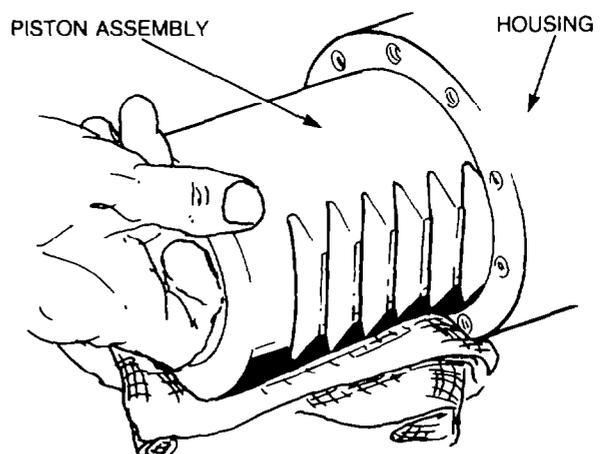


Figure 269 — Piston Assembly — Removal

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NOTE

The input end adjusting nut must not be removed.

- k. Remove the lower piston plug lock pin, using a 2.5 mm (3/32 in.) drill (see (Fig. 270), to drill out the pin.

NOTE

The lock pin may spin during drilling. If this occurs, use a 2.5 mm pin pinch and a hammer to expand and secure the pin in the hole.

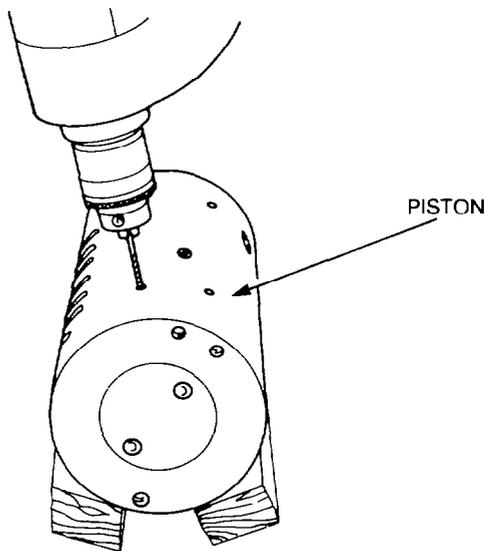


Figure 270 — Lower Piston Plug Lock Pin — Removal

- l. Using special peg spanner A, remove the piston plug from the piston (see Fig. 271), then remove and discard the O-ring and expander.

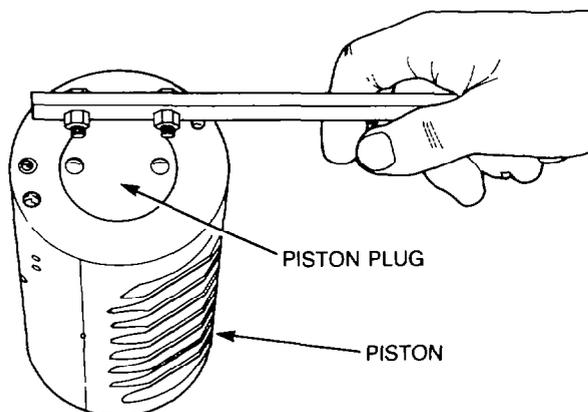


Figure 271 — Piston Plug — Removal

WARNING

Incorrect adjustment of the lower adjusting nut will cause erratic steering.

- m. Match mark the lower adjusting nut and the piston to assist during reassembly (see Fig. 272).

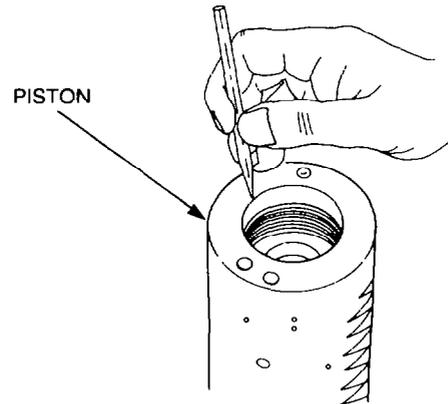


Figure 272 — Marking Adjusting Nut and Piston

NOTE

Two lock pin holes are drilled in the piston assembly. Prior to the disassembly, mark the hole that contains the lock pin.

- n. Using a 2.5 mm (3/32 in.) drill, drill out the lock pin.

NOTE

The lock pin may spin during drilling. If this occurs, use a 2.5 mm pin pinch and a hammer to expand and secure the pin in the hole.

- o. Using a piece of flat stock material, remove the top adjusting nut from the piston (see Fig. 273).

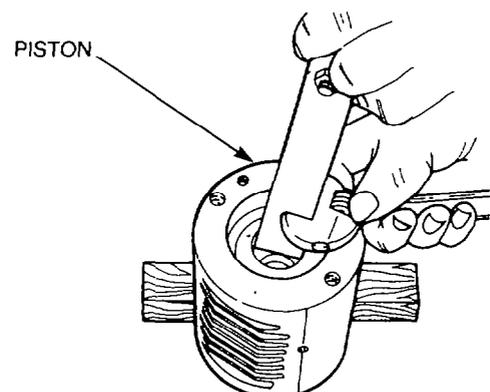


Figure 273 — Lower Adjusting Nut — Removal

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- p. Remove the lower reversing springs from the nose of the actuating valve (see Fig. 274).

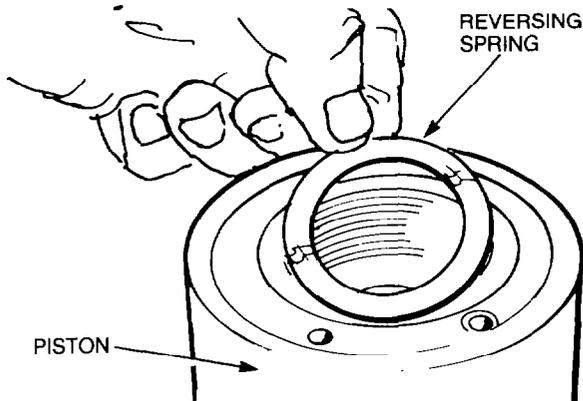


Figure 274 — Reversing Spring — Removal

- q. Pull the actuating valve from the piston (see Fig. 275). Do not force the valve from the piston bore.

NOTE

Because of critical tolerances, the piston and actuating valve are serviced as an assembly only.



Figure 275 — Actuating Valve — Removal

- r. Remove the actuating valve positioning pin from the piston and discard the O-ring, then remove the remaining reversing springs (see Fig. 276).

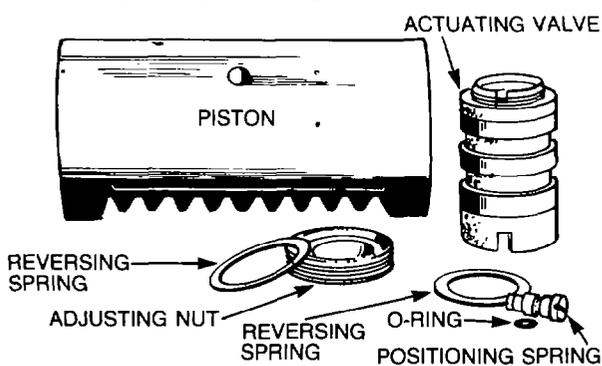


Figure 276 — Positioning Pin and Reversing Spring — Removal

WARNING

The ball valves are under slight spring tension, care must be taken to avoid personal injury.

- s. Using a 3/16 in. Allen key remove the relief valve ball seats, ball valves and spring from the piston (see Fig. 277).

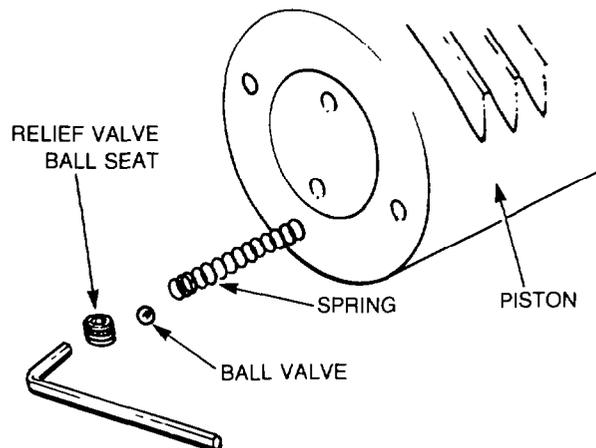


Figure 277 — Relief Valve — Removal

CAUTION

Do not shear the lock pin. If the lock pin is sheared the bearing nut will seize during removal.

- t. Using a 2.5 mm (3/32 in.) drill bit, drill out the lock pin securing the bearing to the actuating shaft.

NOTE

The actuating shaft and bearing are serviced as an assembly only. Do not separate.

- u. Using special peg spanner B, remove the bearing retaining nut from the bearing cap, then tap or press the actuating shaft and bearing from the bearing cap.

NOTE

The high pressure teflon seal incorporates the back-up washer and an external O-ring.

- v. Using a suitable press and a piece of 38 mm (1.490 in.) diameter stock, press the seals out of the bearing cap and discard the seals.

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- w. Using a pin punch and hammer remove the roll pin securing the retaining pin in position (see Fig. 278), then drill out the retaining pin.

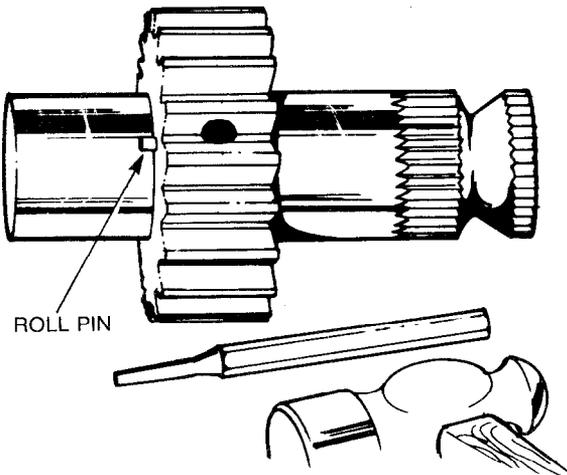


Figure 278 — Roll Pin — Removal

WARNING
To prevent personal injury, care must be taken when shearing off the retaining pin.

NOTE
If the retaining pin cannot be drilled out, it can be sheared off using a suitable press capable of 10 tonnes of pressure. Drive half the pin out of the pinion gear and drill the remaining half out of the shaft.

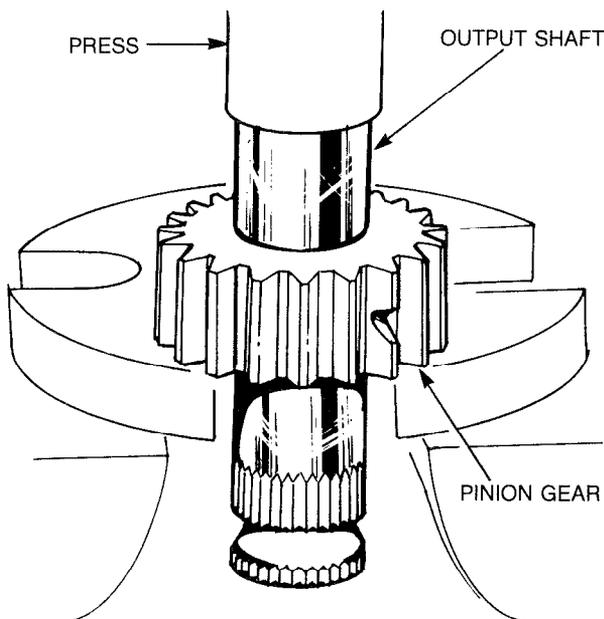


Figure 279 — Pinion Gear — Removal

- x. Press the pinion gear off the output shaft as shown in Fig. 279.
- y. Remove the Quad ring oil seal from the gear housing and discard the oil seal (see Fig. 280).

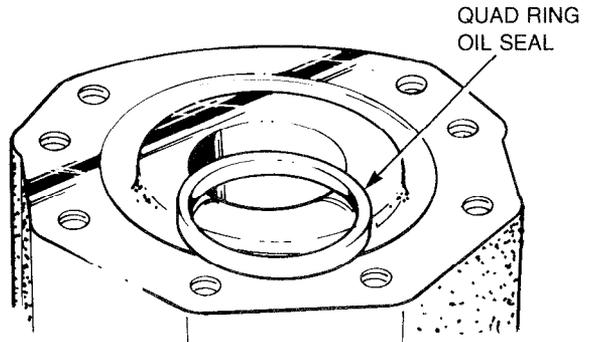


Figure 280 — Quad Ring Oil Seal — Removal

CAUTION
Take care not to damage the bearing bore in the housing.

- z. Using a suitable pin punch and hammer drive the bronze bush out of the housing, by tapping alternate sides of the bush until the bush is removed (see Fig. 281).

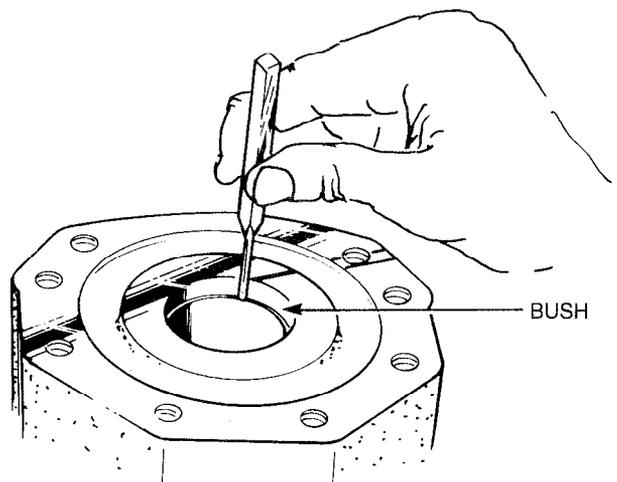


Figure 281 — Bronze Bush — Removal

- aa. Remove the bronze bush from the cover using a suitable bush remover (see Fig. 282).

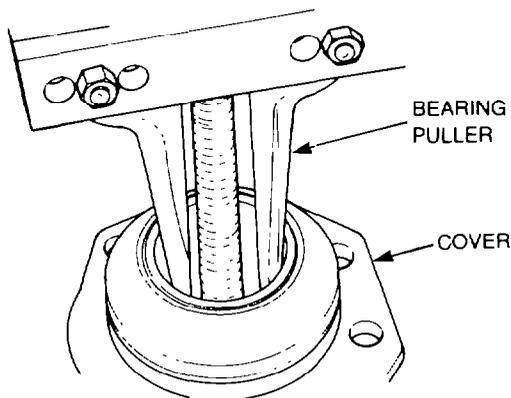


Figure 282 — Cover Bush

68. Cleaning and Inspection

- Thoroughly clean the steering box housing and components with a suitable cleaning agent, then blow dry with compressed air. Remove any nicks or burrs with a fine hand stone or fine emery cloth.
- Inspect the components for discolouration caused by high operating temperatures or binding parts.
- Inspect the bronze bushes for wear caused by the use of incorrect lubricant, overloading or contaminated oil.
- Inspect the actuating shaft and actuating valve thread for wear caused by overloading, insufficient oil flow or continued operation at high temperatures.
- Inspect the housing for cracks caused by accident damage or high operating pressures.
- Inspect the actuating shaft bearing retaining nut for stripped thread caused by accident damage or air in the system.
- Inspect the housing and piston for scoring caused by dirt in the system, overloading, incorrect lubricant used, excessive temperature or air in the system.

NOTE

Minor scoring or scuffing of the piston and housing is acceptable, but should be polished with a fine hand stone or fine emery cloth. Replace damaged parts as necessary.

69. Reassembly

NOTE

The bushes are pre-sized. Boring and honing are not required.

- Using a suitable press, install the bronze bush in the main housing until the bush is flush with the face of the housing (see Fig. 283).
- Using a suitable press, install the bronze bush in the cover until the bush is 13 mm (0.50 in.) below the face of the cover (see Fig. 284).
- Install a new Quad ring, seal in the groove of the gear housing. The Quad ring seal may appear to be too large, but it will fit into the groove (see Fig. 285).

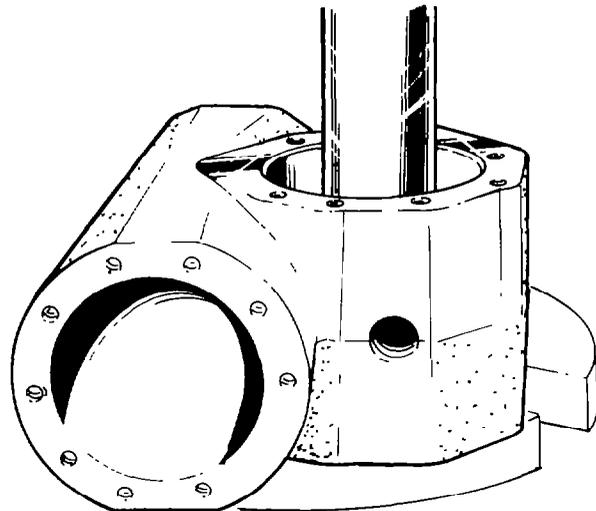


Figure 283 — Gear Housing Bush — Installation

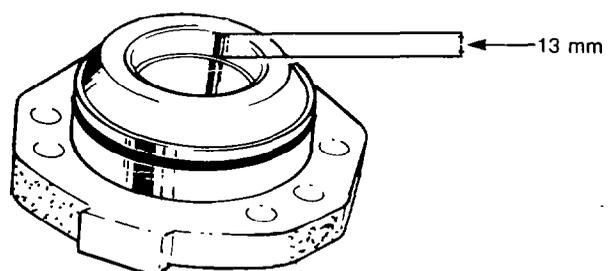


Figure 284 — Gear Cover Bush — Installation

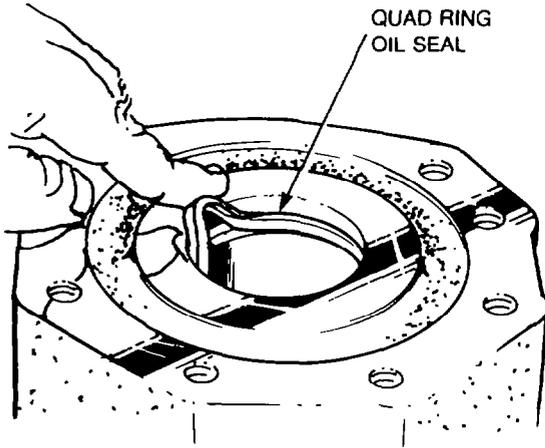


Figure 285 — Quad Ring Seal — Installation

- d. Align the timing marks on the output shaft and the pinion gear, then using a suitable press, install the gear on the shaft until the locating pin holes align. Install the locating pin and secure in position with the roll pin (see Fig. 286).

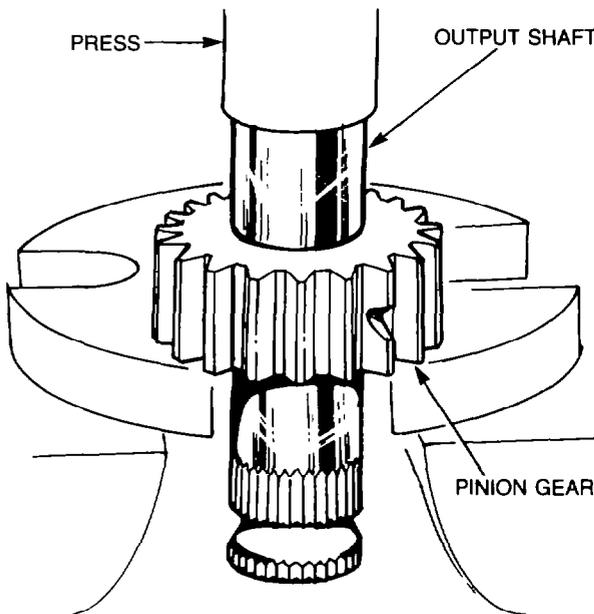


Figure 286 — Pinion Gear — Installation

- e. Insert a suitable mandrel 41.02 mm (1.615 in.) in diameter through the bearing end of the bearing cap until it seats against the internal shoulder in the cap (see Fig. 287). Then position the bearing cap and mandrel on a suitable press and install the dirt seal, with the lip uppermost, into the housing until it seats against the mandrel.

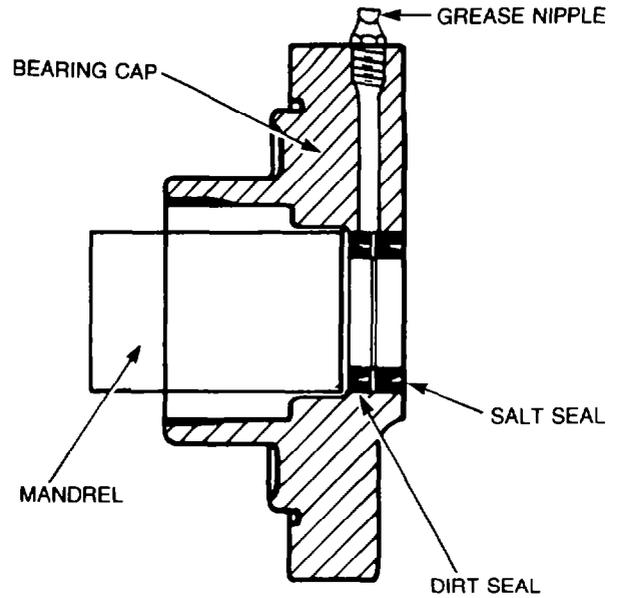


Figure 287 — Seal — Installation

- f. Install the salt seal with the lip uppermost until the seal is flush with the top of the housing.
- g. Apply Loctite 569 to the seal seating surface and outer O-ring, then install the seal in the bearing cap until the seal seats against the shoulder (see Fig. 288).

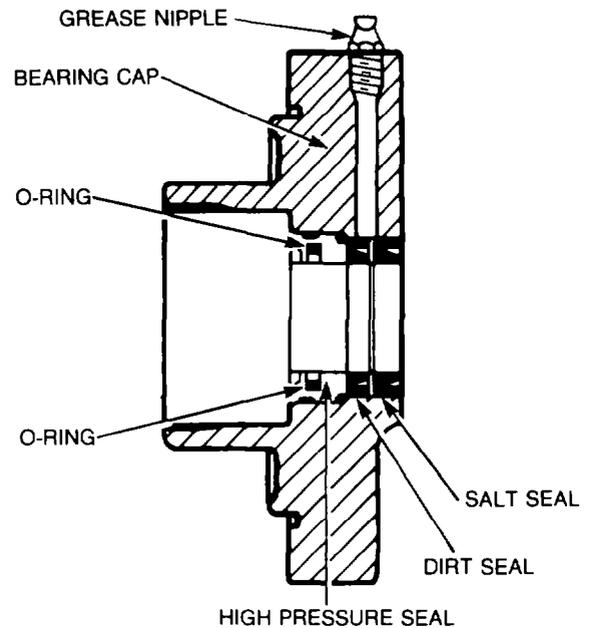


Figure 288 — High Pressure Seal — Installation

- h. Lubricate the seals and fill the cavity between the seals with suitable grease prior to installation of the actuating shaft, then using a suitable press, install

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the actuating shaft and the bearing into the bearing cap.

NOTE

If a new bearing retaining nut is being installed, drill a 2.38 mm (0.9375 in.) hole into the installed nut, through the locking pin hole in the bearing cap, to a depth of 4.8 mm (0.1875 in.).

- i. Install the bearing retaining nut using special peg spanner B, then secure the nut in position with the locking pin.
- j. Lubricate two reversing springs with clean engine oil, then install the two springs on the centre of the adjusting nut in the piston.
- k. Install a new O-ring on the valve positioning pin, then install the pin in the piston until the top of the pin is flush with the surface of the piston.
- l. Place a reference mark on the piston, in line with the screwdriver slot in the positioning valve, to assist in the adjustment of the actuating valve.
- m. Install the actuating valve in the piston (see Fig. 289), ensuring that the long locating slot in the actuating valve is in line with the positioning pin. If necessary, gently rotate the valve positioning pin a few degrees in both directions to help line up the flats on the pin with the slot in the valve. If the valve will not fully engage the pin, remove the valve and unscrew the pin half a turn.

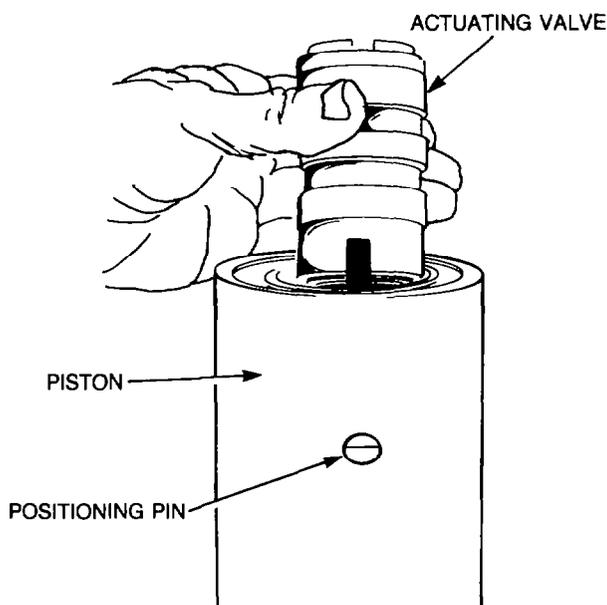


Figure 289 — Actuating Valve Installation

- n. With the actuating valve installed in the piston, check for radial and longitudinal movement of the valve on the positioning pin.
- o. Using the reference mark on the piston as a guide, adjust the valve positioning pin a quarter of a turn, at a time, until drag is felt on the actuating valve. Once drag has been encountered, back off the positioning pin a quarter of a turn, ensuring that the positioning pin is below the surface of the piston.
- p. Lubricate the remaining reversing springs with clean engine oil and install the springs on the nose of the actuating valve (see Fig. 290).
- q. Install the valve adjusting nut by turning it clockwise into the piston until it locates against the reversing springs. Align the reference marks on the nut and the piston, then install the locking pin ensuring that the pin is below the surface of the piston. Under no circumstances drill a new hole for the pin. The pin must engage the hole drilled in the nut during disassembly.
- r. Install the O-ring expander and the O-ring on the lower piston plug, then install the piston plug in the piston. Tighten the plug securely using special peg spanner A, then drill and install the locking pin.

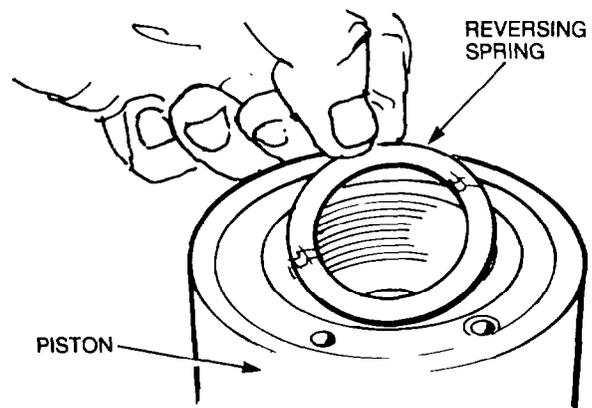


Figure 290 — Reversing Springs — Installation

NOTE

The relief valve ball seats must be flush with or slightly below the end surfaces of the piston.

- s. Install one relief valve ball seat in the end of the piston using a 3/16 in. Allen key, then install a ball valve, the spring, the remaining ball valve and the ball valve seat (see Fig. 291).

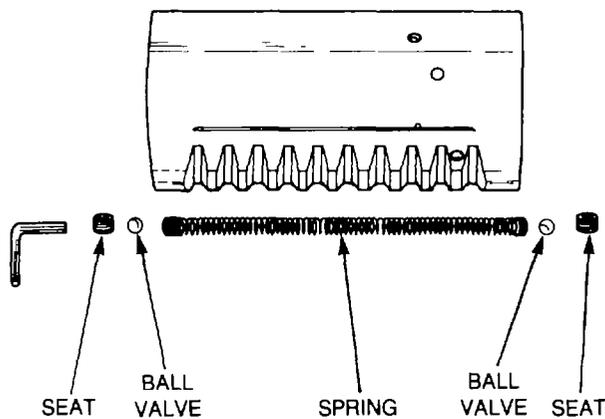


Figure 291 — Relief Valve — Installation

- t. Apply a light coat of clean engine oil to the cylinder bore and the piston, then carefully install the piston in the cylinder bore, ensuring that the opening for the actuating shaft is towards the bearing cap end of the housing (see Fig. 292).

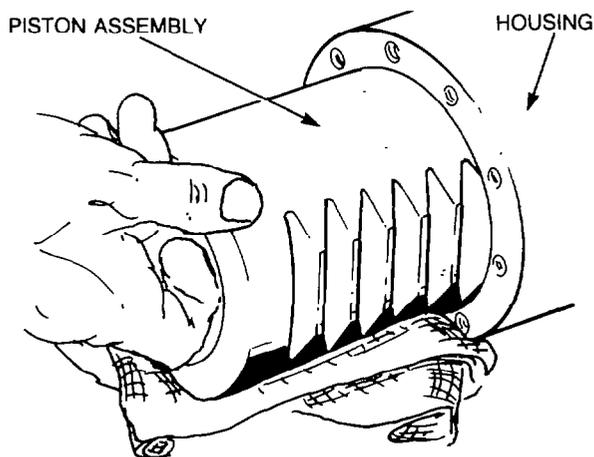


Figure 292 — Piston — Installation

- u. Apply a light coat of chassis grease on the housing bearing and on the Quad ring, and carefully slide the output shaft through the housing. Align the timing marks on the pinion gear with the timing mark on the rack (see Fig. 293).
- v. Install the cylinder head with a new seal. Align the reference marks, then install

and torque the ten bolts to 27 Nm (20 lb.ft).

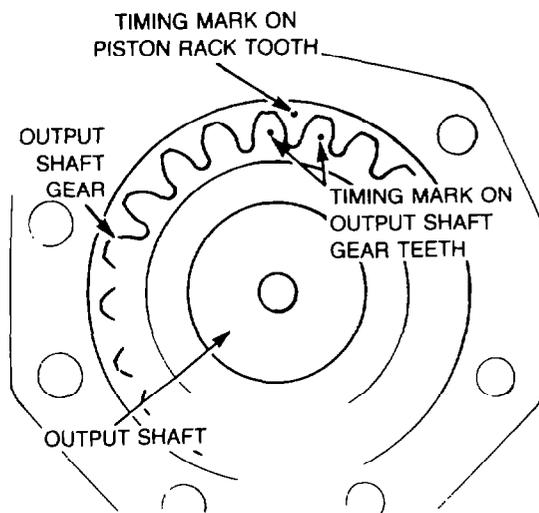


Figure 293 — Aligning Timing Marks

- w. Install a new O-ring on the bearing cap, then thread the actuating shaft into the valve (see Fig. 294). Align the match marks on the bearing cap and the gear housing. Turn the shaft until the cap comes into place on the end of the gear housing. Check the plunger hole alignment with the valve seat in the piston, then install and torque the bolts to 27 Nm (20 lb.ft).

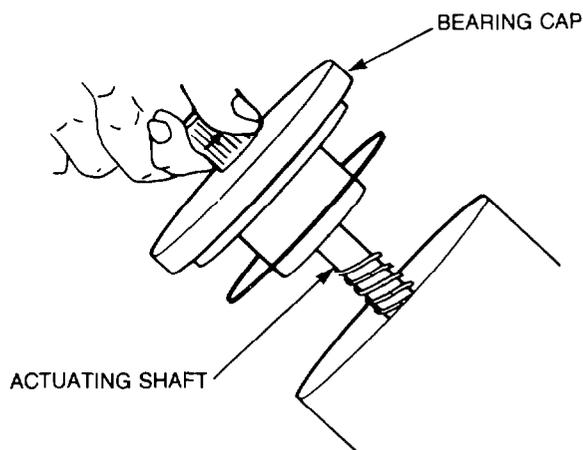


Figure 294 — Actuating Shaft — Installation

- x. Place a new O-ring seal on the pinion housing cover, and install the cover. It may be necessary to tap the cover into place with the aid of a soft hammer. Install the ten bolts and torque to 112 Nm (83 lb.ft).

- y. Install the relief valve plungers, using new O-rings, and screw them in approximately six turns. Final adjustment of the plungers is made after the steering gear is installed on the vehicle.
- z. Install the steering box on the vehicle (refer to EMEI VEH G 883 — GROUP 14).
- aa. Bleed the air from the system (refer to EMEI VEH G 883 — GROUP 14).

70. Relief Valve Plunger Adjustment

NOTE

Operation of the relief valve plungers is indicated by an audible hiss.

- a. Start and run the engine at a fast idle, then with the full weight of the vehicle on all wheels, turn the steering wheel until the bearing cap plunger opens the relief valve. Do not force the steering wheel.
- b. Adjust the bearing cap plunger either in or out until 3.2 mm (0.125 in.) clearance is obtained at the wheel stops. Repeat the same procedure for the cylinder head plunger (see Fig. 295).

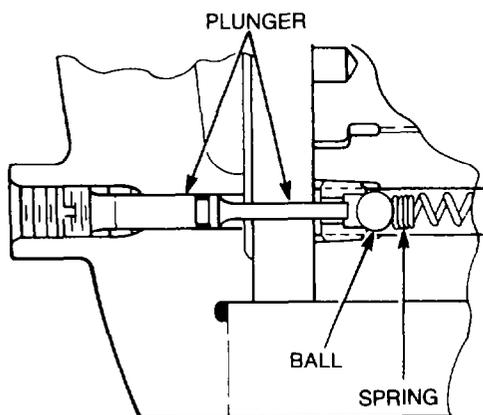


Figure 295 — Relief Valve Plunger — Adjustment

Slave Steering Box

71. Disassembly

- a. Remove the steering box from the vehicle (refer to EMEI VEH G 883 — GROUP 14).

CAUTION
The power steering gear is a precision machined assembly and care must be taken during repair to keep it free from dirt and foreign material. All internal parts must be handled carefully to avoid damaging the machined surfaces. Remove all nicks and burrs with a fine hand-stone before reassembly as they can cause damage to mating parts. It is advisable to carry out repairs of the steering gear on a soft cardboard or plywood surface work-bench.

- b. Remove the eight bolts and washers securing the mounting bracket and the pinion gear cover to the housing (see Fig. 296), then remove the mounting bracket.

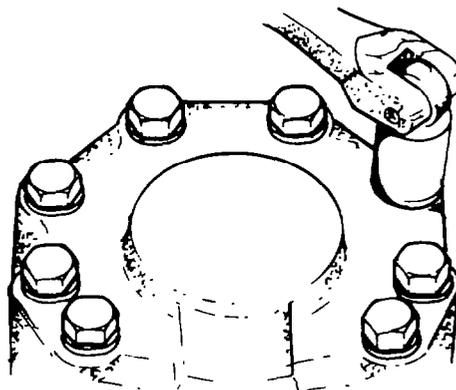


Figure 296 — Pinion Gear Cover — Removal

- c. Clean the exposed portion of the output shaft to prevent damaging the bearing, then using a soft hammer tap on the end of the shaft to loosen the cover (see Fig. 297).

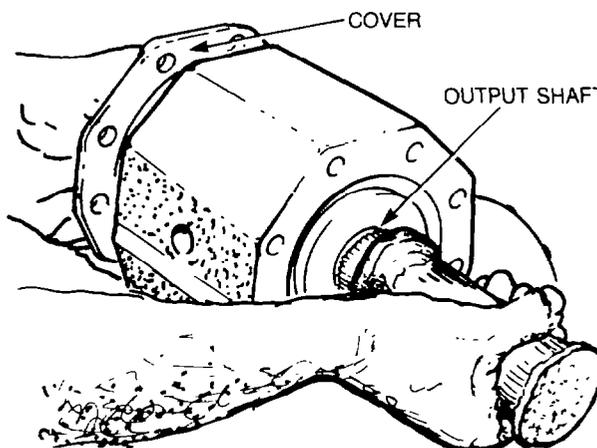


Figure 297 — Tapping Output Shaft

- d. Carefully withdraw the output shaft, and cover from the housing (see Fig. 298), then remove the output shaft from the cover. Remove and discard the O-ring from the cover.

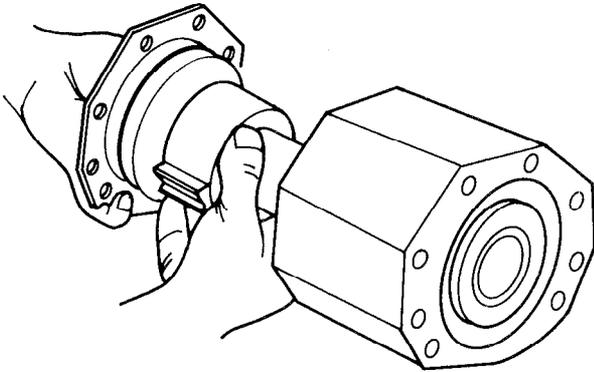


Figure 298 — Output Shaft — Removal

- e. Remove the ten bolts and washers securing each cylinder head to the housing, then remove the cylinder heads and discard the sealing rings (see Fig. 299).

CAUTION
The piston assembly is equipped with teflon piston rings. Care must be taken when removing the piston not to damage the piston rings.

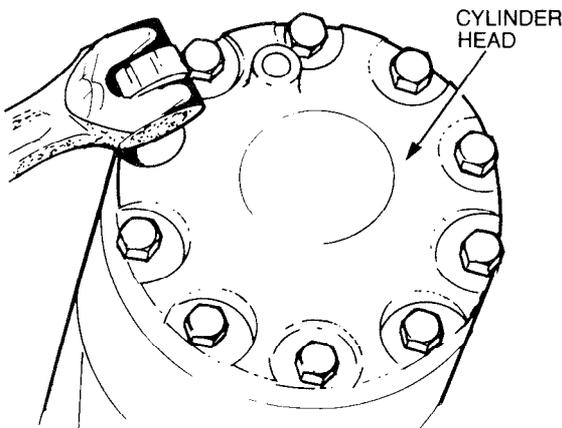


Figure 299 — Cylinder Head — Removal

- f. Carefully, slide the piston from the bore of the housing (see Fig. 300), then remove and discard the piston rings and the O-rings.

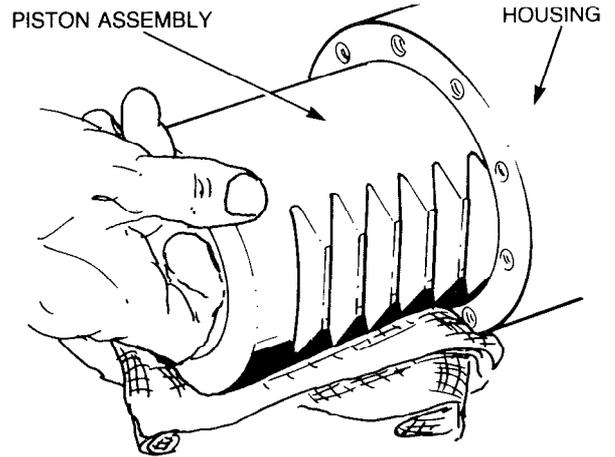


Figure 300 — Piston — Removal

- g. Remove both piston plug lock pins using a 2.5 mm (3/32 in.) drill (see Fig. 301) to drill out the pins.

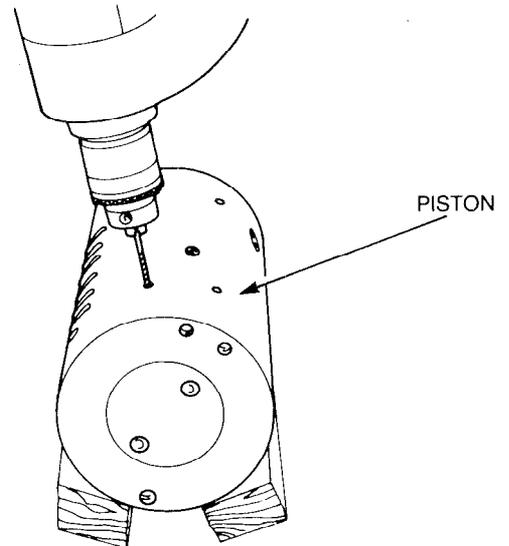


Figure 301 — Piston Plug Lock Pin — Removal

- h. Using special peg spanner A, remove both piston plugs from the piston (see Fig. 302), then remove and discard the O-rings and teflon seal rings.

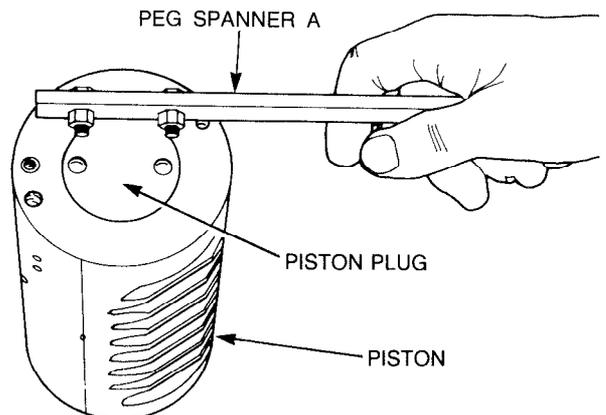


Figure 302 — Piston Plug — Removal

NOTE

The steering gear uses a one piece forged output shaft and pinion gear assembly.

- i. Remove the Quad ring oil seal from the gear housing and discard the seal (see Fig. 303).

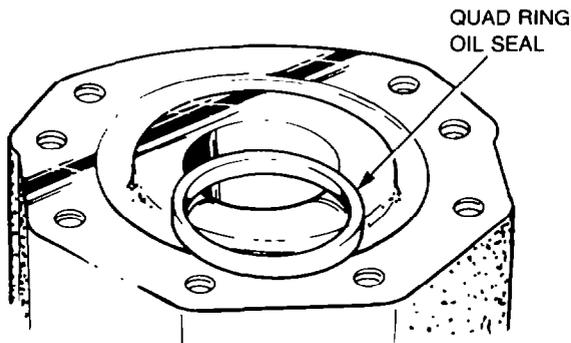


Figure 303 — Quad Ring Oil Seal — Removal

- j. Using a suitable press and mandrel, press the needle roller bearing from the housing (see Fig. 304).

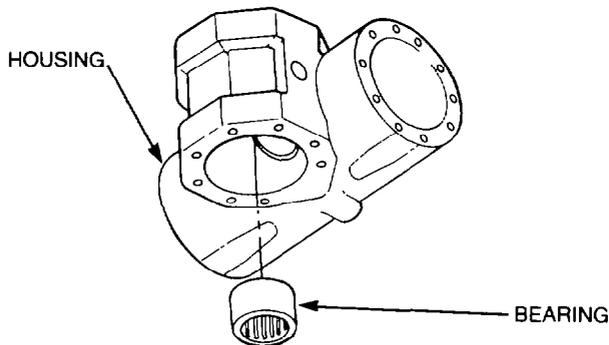


Figure 304 — Housing Bearing — Removal

- k. Using a suitable puller as shown in Fig. 305, remove the needle roller bearing from the cover.

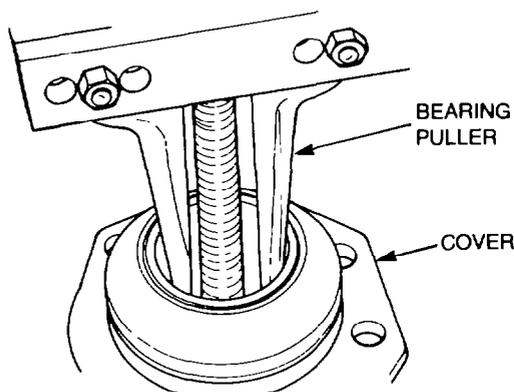


Figure 305 — Cover Bearing — Removal

72. Cleaning and Inspection

- a. Thoroughly clean the steering box housing and components with a suitable cleaning agent, then blow dry with compressed air. Remove any nicks or burrs with a fine handstone or fine emery cloth.
- b. Inspect the components for discoloration caused by high operating temperatures or binding parts.
- c. Inspect the bearings for wear caused by the use of incorrect lubricant, overloading or contaminated oil.
- d. Inspect the housing for cracks caused by accident damage or high operating pressures.
- e. Inspect the housing and piston for scoring caused by dirt in the system, overloading, incorrect lubricant used, excessive temperature or air in the system.

NOTE

Minor scoring or scuffing of the piston and housing is acceptable, but should be polished with a fine handstone or fine emery cloth. Replace damaged parts as necessary.

73. Reassembly

- a. Using a suitable press and mandrel, install the needle roller bearing into the cover until the bearing is flush with the face of the bearing cover bore (see Fig. 306).

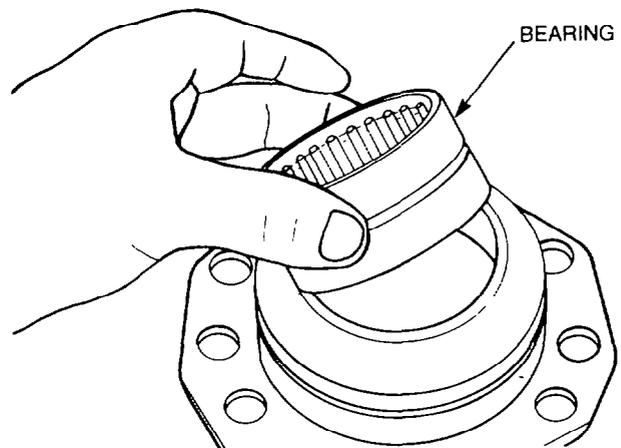


Figure 306 — Cover Bearing — Installation

- b. Using a suitable press and mandrel, install the needle roller bearing into the housing until the bearing is flush with

the inner surface of the housing bore (see Fig. 307).

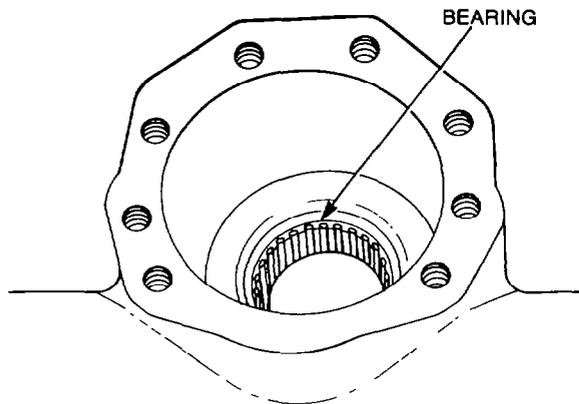


Figure 307 — Housing Bearing — Installation

- c. Install the teflon seal rings and the O-rings on the piston plugs, then install the piston plugs in the piston and tighten securely using special peg spanner A.
- d. Drill and pin the piston plugs into the piston ensuring that the pins are below the surface of the piston.

NOTE

The seal material will stretch as it is fitted to the piston ring grooves. Allow sufficient time for the seal to contract prior to installing the piston into the housing.

- e. Install the O-rings and the piston rings onto the piston and lubricate the housing bore and the piston with clean engine oil. Then using a piston ring compressor, compress the piston rings (see Fig. 308).

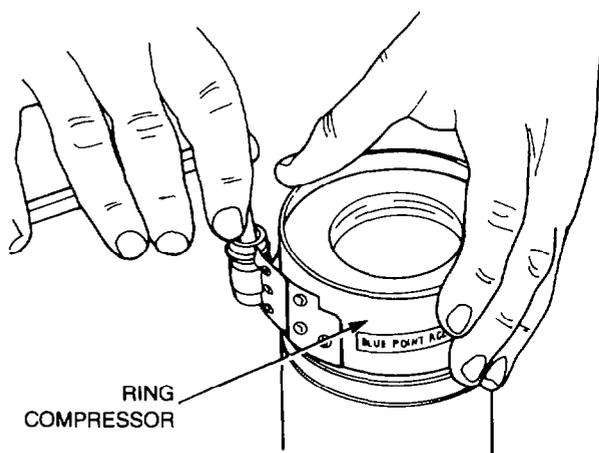


Figure 308 — Compressing Piston Rings

- f. Install the piston in the cylinder bore with the piston gear teeth toward the output shaft opening in the housing. Carefully push the piston down into the cylinder bore until the first piston ring becomes visible in the output shaft opening. using a blunt wooden stick to press the piston ring into the piston ring groove continue pushing the piston until the piston ring has cleared the output shaft opening.
- g. Install a new Quad ring seal in the groove in the housing. The Quad ring seal may appear to be too large, but it will fit into the groove (see Fig.309).
- h. Lubricate the Quad ring seal and the housing bearing with clean engine oil, then carefully slide the output shaft into the housing ensuring that the timing marks on the output shaft and the piston rack align.

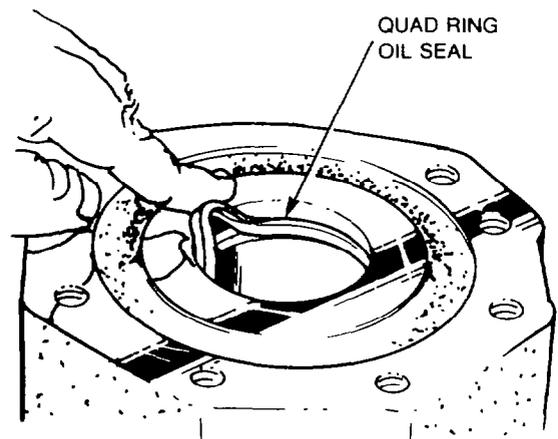


Figure 309 — Quad Ring Seal — Installation

- i. Position new seal rings on the cylinder heads and install the cylinder heads on the housing. Secure each cylinder head to the housing with ten washers and bolts and torque the bolts to 27 Nm (20 lb.ft).
- j. Position a new O-ring on the housing cover, then install and secure the cover and the mounting bracket to the housing with the eight washers and bolts. Torque the bolts to 112 Nm (83 lb.ft).
- k. Install the steering box on the vehicle (refer to EMEI VEH G 883 — GROUP 14).
- l. Bleed the air from the system (refer to EMEI VEH G 883 — GROUP 14).

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— SPECIFICATIONS —

Cover Bush	
Installation Depth	13 mm (0.5 in.) below the face of the cover.
Bearing Retaining Nut	
Locking Pin Depth	4.8 mm (0.1875 in.)
Valve Positioning Pin	
Adjustment.....	tighten the pin a quarter of a turn at a time until drag is felt on the actuating valve, then back of a quarter of a turn.
Cylinder Head Bolts	
Tightening Torque.....	27 Nm (20 lb.ft)
Bearing Cap Bolts	
Tightening Torque.....	27 Nm (20 lb.ft)
Pinion Housing Cover Bolts	
Tightening Torque.....	112 Nm (83 lb.ft)
Relief Valve Plunger	
Adjustment.....	adjust until 3.2 mm (0.125 in.) clearance is obtained at the wheel stops.

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— FAULT FINDING —

Steering

Symptom	Probable Cause	Action
1. Oil leaking at output shaft of steering gear.	<ul style="list-style-type: none"> a. Clogged oil filter in reservoir (high back pressure). b. Pinched or restricted oil return line. c. Damaged Quad ring seal. d. Damaged bronze bushes. 	<ul style="list-style-type: none"> a. Replace filter. b. Locate and correct restriction and check back pressure. c. Replace Quad ring seal. d. Polish output shaft to remove bronze deposits or replace bushes.
2. Oil leaking at actuating shaft of steering gear.	<ul style="list-style-type: none"> a. Worn or damaged oil seal. b. Damaged actuating shaft seal surface. 	<ul style="list-style-type: none"> a. Replace seal. b. Replace damaged parts.
3. Oil leaking at supply pump drive shaft.	<ul style="list-style-type: none"> a. Damaged oil seal. b. Loose or damaged bushing on pump drive shaft. 	<ul style="list-style-type: none"> a. Replace oil seal. b. Repair pump.
4. Lubricant milky or white in appearance.	<ul style="list-style-type: none"> a. Water entry through reservoir venting system. 	<ul style="list-style-type: none"> a. Clean vent system or replace cap assembly. Replace lubricant.
5. Oil forced out of reservoir.	<ul style="list-style-type: none"> a. Clogged oil filter. b. Air in system. c. Faulty supply pump (cavitation). d. Relief plungers of steering gear not adjusted properly. e. Operating temperatures too high. f. Reservoir over-filled. 	<ul style="list-style-type: none"> a. Change oil and filter. b. Bleed air from system and check for air leak on suction side of supply pump. c. Check supply pump for wear or damage or restriction in pump supply. Check for air in system, bleed if necessary. d. Adjust relief plungers. e. Check oil level in reservoir, replenish as necessary. Check for restrictions to oil flow and that the flow rate is correct. f. Adjust to correct level.
6. Lubricating oil discoloured and has a strong odour.	<ul style="list-style-type: none"> a. Operating temperatures too high. b. Incorrect lubricant used. 	<ul style="list-style-type: none"> a. Check oil level in reservoir, replenish as necessary. Check for restrictions to oil flow and that the flow rate is correct. b. Drain, flush and refill the system.
7. High operating temperatures.	<ul style="list-style-type: none"> a. Oil flow restriction. A clogged oil filter, undersized fittings and lines, and pinched lines may cause a high back pressure. b. Oil flow too high. 	<ul style="list-style-type: none"> a. Check back pressure. b. Check maximum oil flow rate and replace orifice as necessary.
8. Oil in reservoir foaming.	<ul style="list-style-type: none"> a. Air leak in suction side of supply pump. 	<ul style="list-style-type: none"> a. Check for air leaks between reservoir and supply pump.

Symptom	Probable Cause	Action
	b. Pump cavitating.	b. Check for restriction in pump supply.
	c. Oil overheating.	c. Check for restrictions to oil flow or high oil flow rate.
	d. Incorrect lubricant used.	d. Drain, flush and refill the system.
9. No power steering on cold start.	a. Hydraulic supply pump vanes not extending.	a. Increase engine speed momentarily to extend the vanes and start pump action. Usually a temporary and infrequent occurrence and not cause for pump repair or replacement.
10. Excessive pump pressure with steering.	a. Pinched oil return line causing high back pressure.	a. Relocate line.
	b. Binding steering column.	b. Repair steering column.
	c. Damaged actuating shaft bearing.	c. Replace damaged parts as required.
11. Wheel cuts restricted.	a. Relief plungers maladjusted.	a. Adjust relief plungers.
12. Erratic steering or no steering at all.	a. Insufficient volume of oil being metered by flow divider to steering gear induced by foreign particles on flow divider valve and causing the valve to hang up in the bore.	a. Polish flow divider valve to remove foreign particles and burrs.
13. Binding, uneven or intermittently hard steering.	a. Flow divider spring takes permanent set because of fatigue, thereby, allowing flow divider valve to move easily and reduce oil volume.	a. Replace flow divider spring.
	b. Broken by-pass spring in flow divider.	b. Replace flow divider valve assembly which includes by-pass spring.
14. Pump or high pressure hose damage.	a. Sticking pressure relief valve.	a. Repair or replace relief valve.
15. Hard Steering.	a. Faulty supply pump.	a. Repair supply pump.
	b. Front axle overloaded.	b. Correct loading practices.
	c. Faulty steering geometry.	c. Align front end.
16. Steering hard in one one or both directions.	a. Bent or damaged kingpins and tie rods.	a. Repair or replace kingpins and tie rods.
	b. Front end load too great for rated axle capacity.	b. Lighten load.
	c. Fatigued by-pass valve spring in pump.	c. Replace flow control valve assembly.
	d. Low oil level in steering system.	d. Replace flow control valve assembly.

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Symptom	Probable Cause	Action
	e. Air in system.	e. Rectify cause of air in system and bleed system.
	f. Caster and camber settings incorrect.	f. Correct to specifications.
	g. Metal or foreign material caught in actuating valve.	g. Remove actuating valve, clean and check parts for damage.
	h. Actuating valve worn or chipped.	h. Replace damaged parts as required.
17. Steering hard in one direction.	a. Broken reversing springs in steering gear. b. Metal or foreign material in relief valve seat in piston of steering gear.	a. Replace reversing springs and damaged parts. b. Remove piston and clean relief valve seats or replace damaged parts.
18. Steering extremely light in one or both directions.	a. Bent or damaged reversing springs.	a. Check for impact or accident damage. Replace all damaged parts.
19. Steering input not smooth (seizing, binding).	a. Worn universal joint. b. Steering shaft universal joints not phased properly. c. Low oil flow.	a. Check and replace as required. b. Phase in universal joints by rotating the intermediate shaft one spline at a time until the steering wheel rotates smoothly. c. Idle speed too slow. Adjust. Check that supply pump is operating to specification. Rectify as necessary.
20. Darting, wandering (oversteering).	a. Oil flow too high. b. Air trapped in steering gear. c. Looseness, worn front end parts. d. Incorrect front end alignment. f. Excessive wear or damage in steering gear. g. Overloading. h. Mechanical bind in steering gear.	a. Check that supply pump is operating to specification. Rectify as necessary. b. Bleed system. c. Check and repair as required. d. Correct to specifications. f. Check and repair as required. g. Reduce load. h. Check steering gear mounting for distortion. Check for damaged or distorted steering gear components.
21. Excessive backlash.	a. Worn universal joint. b. Worn pins and keys, universal joint to actuating shaft and universal joint to steering shaft. c. Low oil volume. d. Pitman arm ball worn egg-shaped.	a. Replace universal joint. b. Replace pins and keys. c. Check flow divider. d. Replace Pitman arm.

Symptom	Probable Cause	Action
	e. Improperly adjusted drag link, Pitman arm to drag link and steering arm to drag link.	e. Adjust drag link, drag link to Pitman arm and drag link to steering arm.
	f. Loose steering gear mounting bolts.	f. Re-torque bolts.
	g. Damaged reversing springs.	g. Check and repair as required.
	h. Rack or piston damaged.	h. Replace parts as required.
	i. Damaged pinion gear on output shaft.	i. Replace pinion gear.
	j. Damaged output shaft splines.	j. Replace output shaft.
	k. Worn output shaft bushing.	k. Replace bushings and polish shaft to remove bronze deposits.
	l. Worn actuating shaft and valve threads.	l. Replace worn parts as required.

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ELECTRICAL — GROUP 15

Wiring Harness

74. General Precautions

- a. Use suitable testing meters or circuit testers 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, then disconnect 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.

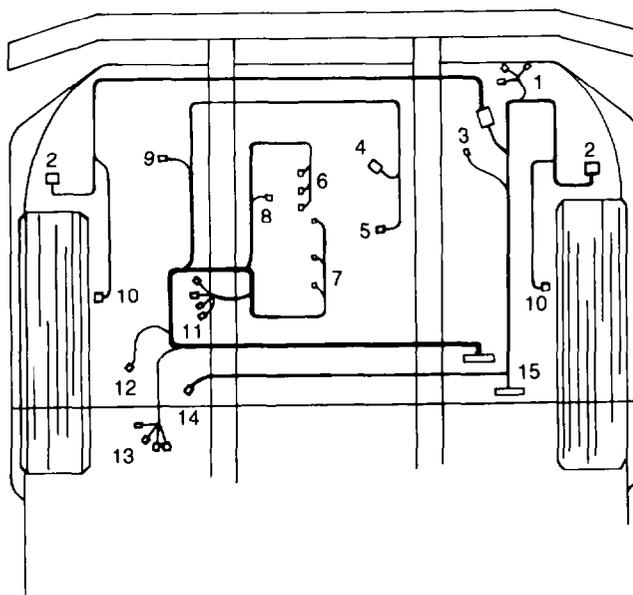
75. Replacement

- a. Disconnect the battery, negative terminal first, then disconnect the positive terminal.

NOTE

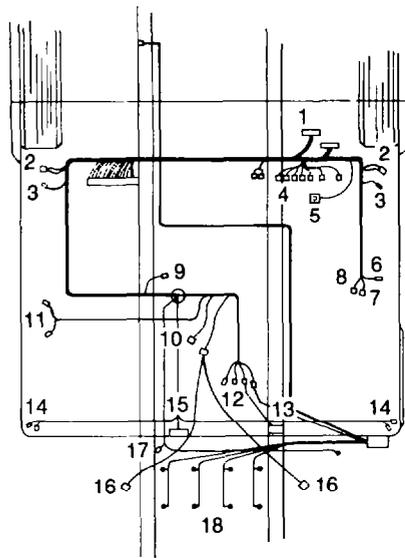
All electrical wiring in the vehicle is colour coded for identification and reference. If necessary, refer to the wiring diagram (EMEI VEH G 883), in conjunction with the relevant illustration, when replacing a wiring harness.

- b. After determining which harness is to be replaced (see Figs. 310, 311 and 312), 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, then remove the harness from the vehicle.
- c. Ensure that the replacement harness is of the correct capacity and 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 connect the negative terminal.
- e. Test the function of the components associated with the wiring harness that has been replaced to ensure correct function.



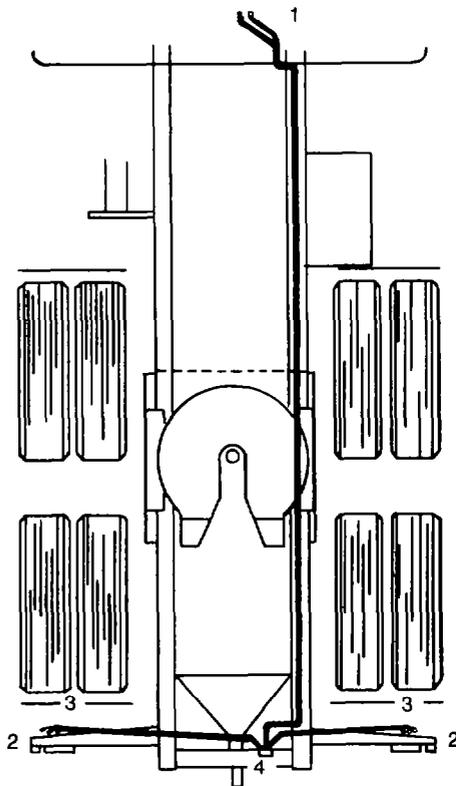
1. Driving and fog lights
2. Headlights
3. Horn
4. Alternator
5. Oil pressure switch
6. Temperature sensors
7. C-brake
8. Fuel Pump solenoid
9. Throttle switch
10. Turn indicator and marker lights
11. Starter motor
12. Cooling system fan solenoid
13. Start (ignition) switch
14. Wiper motor
15. Wiring harness connectors

Figure 310 — Engine Compartment Wiring Harness



1. Wiring harness connectors
2. Mirror light and heater
3. Dome light door switch
4. Warning lights
5. Headlight dimmer switch
6. Work light switch
7. CB radio, map and dome light
8. Sleeper cab light
9. Low air pressure warning switch
10. Overdrive lockout solenoid
11. Fuel level sender unit
12. Tail lights and blackout lights
13. Back-up alarm
14. Wander light
15. NATO socket
16. Work lights
17. Isolation switch
18. Batteries

Figure 311 — Cab Wiring Harness



1. Wiring harness connectors
2. Blackout lights
3. Stop, tail, turn indicator/reversing lights
4. Wander light

Figure 312 — Rear Wiring Harness

FRAME — GROUP 16

Fifth Wheel

76. Disassembly

- a. Remove the fifth wheel assembly from the vehicle (refer to EMEI VEHICLE G 884 — GROUP 16) and clean the assembly with a suitable cleaning agent, then blow dry with compressed air.

CAUTION

This assembly is heavy. Care must be taken to avoid personal injury.

- b. Place the assembly on a flat surface, then using suitable overhead lifting equipment to support the weight of the fifth wheel sub-assembly, remove the two stop bolts and nuts (see Fig. 313). Then using a pin punch and hammer remove the roll pins from the bracket pins and remove the bracket pins.

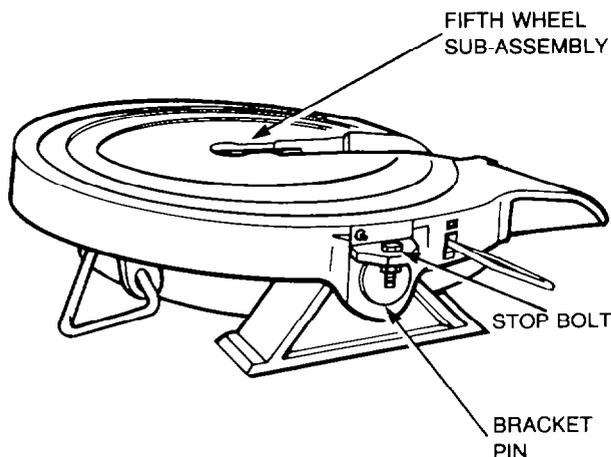


Figure 313 — Fifth Wheel Sub-assembly

- c. Place the fifth wheel sub-assembly on two blocks of wood with the release handles uppermost, then remove the overhead lifting equipment.
- d. Ensure that the locks (see Fig. 314, items 15 and 16) are in the unlocked position, then remove the split pin (item 6) securing the release handle (item 7) into the secondary lock arm (item 11), and remove the release handle.
- e. Remove the split pin (item 8) securing the lock pin (item 9) into the secondary lock arm (item 11) and the fifth wheel sub-assembly (item 3). Remove the lock pin, secondary lock arm and the spring

(items 9, 11 and 10) from the sub-assembly.

- f. Remove the split pin (item 14) and the lock pin (item 13) securing the hinged lock (item 15) to the sub-assembly, then remove the hinged lock and the U-spring (items 15 and 5) from the sub-assembly.
- g. Hold the plunger (item 21) away from the sub-assembly (item 3) by inserting a wedge between the plunger and the sub-assembly casting.
- h. Remove the nut, bolt and washers (items 24, 26 and 25) securing the release arm (item 1) to the sub-assembly, then remove the release arm and release handle (items 1 and 2).
- i. Remove the wedge from between the plunger and sub-assembly (items 21 and 3), then remove the plunger and spring (items 21 and 22) from the sub-assembly.
- j. Remove the nut (item 12) securing the stationary lock (item 16) to the sub-assembly (item 3), then remove the stationary lock.
- k. Remove the Allen head bolt and the lock nut (items 17 and 20) securing the adjusting wedge and spring (items 19 and 18) to the sub-assembly. Remove the adjusting wedge and spring.

77. Inspection

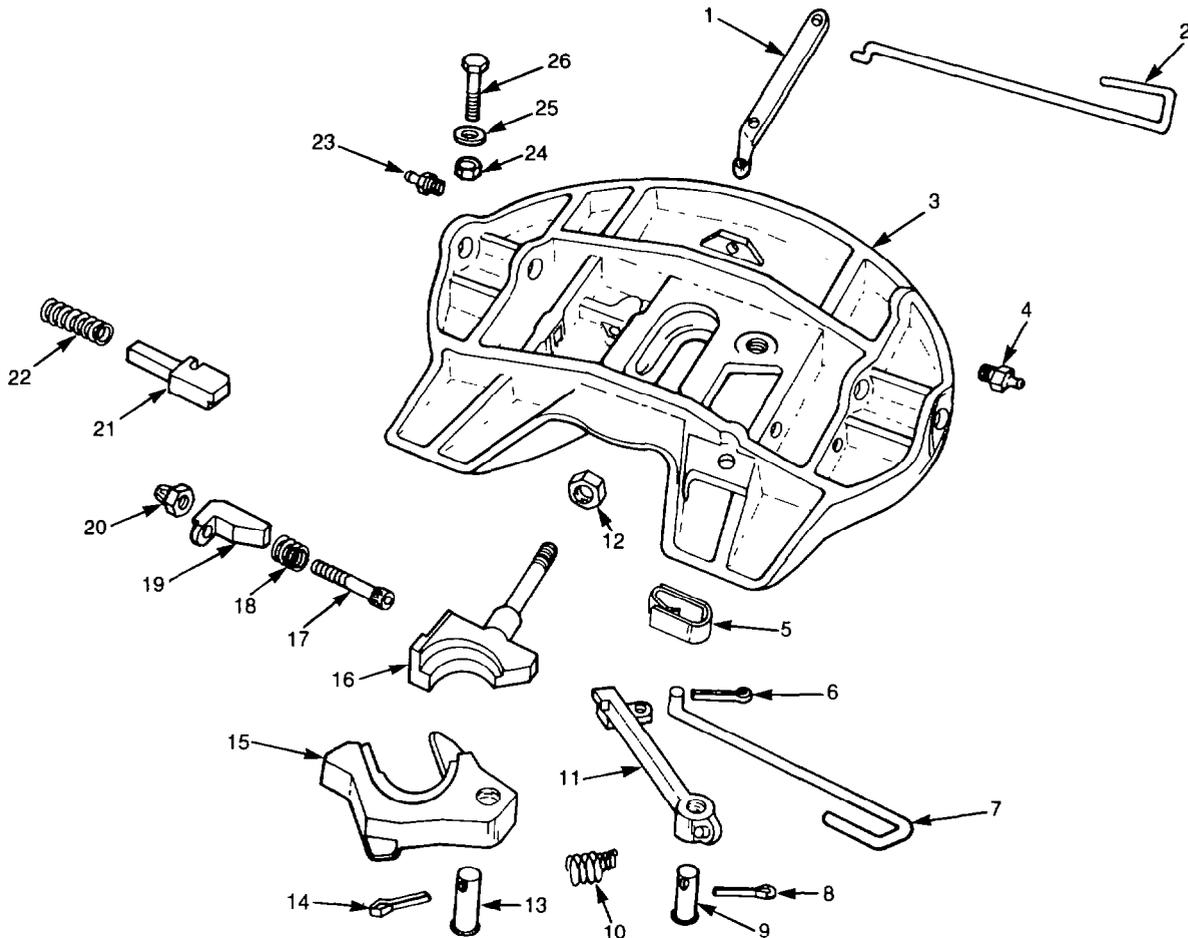
- a. Inspect the fifth wheel sub-assembly for cracks and replace the assembly if any cracks are found.
- b. Inspect the mounting brackets for cracks and wear and replace if cracks are found.
- c. Inspect the rubber mounting bushes and replace as necessary.

78. Reassembly

NOTE

Lubricate all moving parts with clean engine oil prior to reassembly.

- a. Position the adjusting wedge and spring (items 19 and 18) in the fifth wheel sub-assembly (item 3), then install the Allen head bolt and lock nut (items 17 and 20) and tighten the bolt until one thread protrudes through the lock nut.



- | | | |
|-----------------------------|------------------------|---------------------|
| 1. Release arm | 10. Spring | 19. Adjusting wedge |
| 2. Release handle | 11. Secondary lock arm | 20. Locknut |
| 3. Fifth wheel sub-assembly | 12. Locknut | 21. Plunger |
| 4. Grease nipple | 13. Lock pin | 22. Spring |
| 5. U-spring | 14. Split pin | 23. Grease nipple |
| 6. split pin | 15. Hinged lock | 24. Nut |
| 7. Release handle | 16. Stationary lock | 25. Washers |
| 8. Split pin | 17. Allen head bolt | 26. Bolt |
| 9. Lock pin | 18. Spring | |

Figure 314 — Fifth Wheel — Exploded View

NOTE

Do not overtighten the bolt (item 26) as the release arm (item 1) must move freely.

- b. Install the release handle (item 2) through the sub-assembly (item 3) casting and install the release arm (item 1) onto the release handle.
- c. Install one washer (item 25) between the release arm (item 1) and the sub-assembly casting, then install the release arm (item 1) into the slot in the plunger (item 21). Install the remaining washer (item 25) on the bolt (item 26) and insert the bolt through the release arm (item 1) and screw into the casting.
- d. Install the stationary lock (item 16) in the sub-assembly casting (item 3), then install the lock nut (item 12) and tighten securely.
- e. Position the U-spring (item 5) in the sub-assembly (item 3), then install the hinged lock (item 15). Lubricate the lock pin (item 13) with a suitable anti-seize compound then install the pin through the sub-assembly (item 3) and the hinged lock (item 15). Insert the split pin (item 14) through the lock pin (item 13) and splay the split pin.
- f. Install the release handle (item 7) through the sub-assembly (item 3) casting, then lubricate the secondary lock

- arm (item 11) lock pin hole with a suitable anti-seize compound.
- g. Install the secondary lock arm (item 11) onto the release handle (item 7) and secure with the split pin (item 6).
 - h. Install the lock pin (item 9) through the sub-assembly (item 3) casting and the secondary lock arm (item 11) and secure with the split pin (item 8).
 - i. Lock the hinged lock (item 15) and install the spring (item 10) on the secondary lock arm (item 11).
 - j. Using a TLN-1500 lock tester or a new king pin, lock and unlock the fifth wheel several times to ensure correct operation.
- k. Tighten or loosen the bolt (item 17) to ensure there is clearance between the locks (items 15 and 16) and the lock tester or king pin.
 - l. Using suitable overhead lifting equipment position the fifth wheel sub-assembly on the two mounting brackets, then install the bracket pins and secure in position with new roll pins. Install the two bracket stop bolts.
 - m. Remove the overhead lifting equipment.
 - n. Install the fifth wheel assembly on the vehicle (refer to EMEI VEH G 884 — GROUP 16).

WARNING

The plunger (item 21) must move freely behind the hinged lock (item 15) in the locked position. Over adjustment of the plunger can cause a potential partial lock.

BODY — GROUP 17

Cab

79. Removal

WARNING
Care must be taken during this procedure to avoid personal injury.

NOTE

During the removal procedure, remove any cable ties or saddle clamps securing fuel, air lines or electrical wiring harnesses/wiring to the cab as appropriate.

- a. Remove the four eye bolts retaining the bullbar, then lower the bullbar.
- b. Disconnect the earth cables, then the positive cables from the batteries, then tag and disconnect the battery cables from the battery isolation switch.
- c. Remove the nuts, washers and insulators securing the cab to the rear mounting brackets (see Fig. 315).

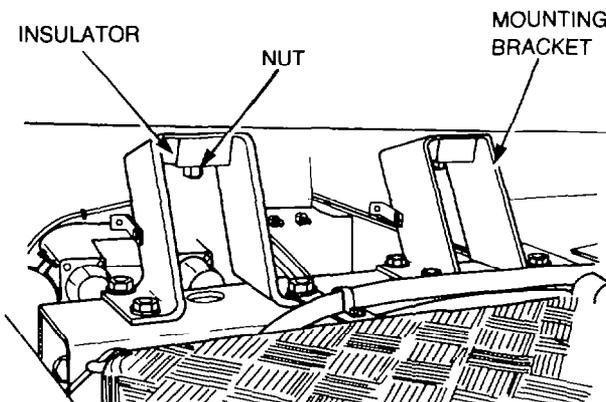


Figure 315 — Rear Cab Mounts

- d. Remove the bonnet (refer to EMEI VEH G 883 — GROUP 17).
- e. Remove the engine skirts and both the front mudflaps.
- f. Remove the nut and insulator from both front cab mounts.
- g. Remove the pinch bolt securing the lower steering shaft universal joint yoke to the intermediate steering shaft (see Fig. 316), then slide the yoke away from the intermediate shaft.

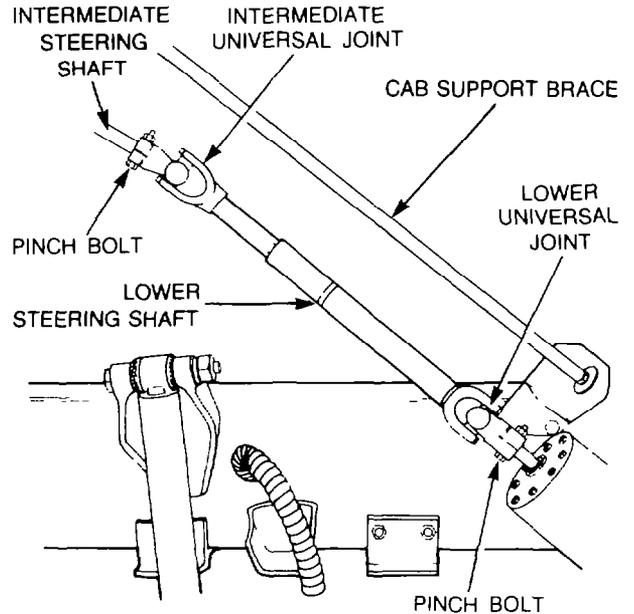


Figure 316 — Steering Shaft — Removal

- h. Remove the cab support braces from the firewall brackets and the chassis mounting brackets, ensuring that the positioning of the insulators and washers are noted to assist during reassembly.
- i. Disconnect the engine and headlight wiring harnesses from the connectors on the engine firewall adjacent to the radiator surge tank, then disconnect the earth leads adjacent to the brake treadle valve air lines.

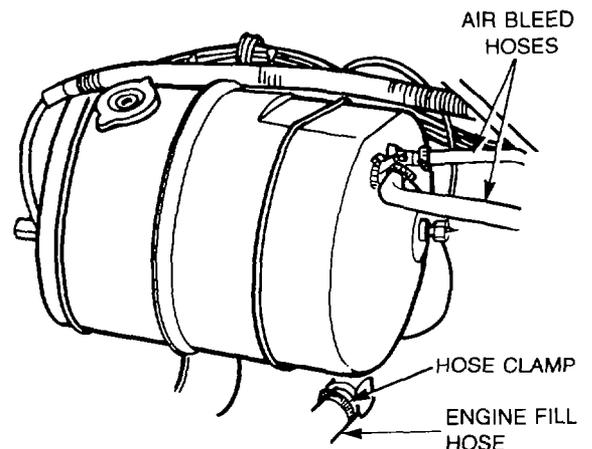


Figure 317 — Engine Fill Hose — Removal

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- j. Loosen the hose clamp securing the engine fill hose to the surge tank (see Fig. 317), then remove the hose from the tank union. Plug the hose to prevent coolant loss.
- k. Loosen the hose clamps and remove the two air bleed hoses from the surge tank.
- l. Remove the split pin and cotter pin securing the clutch actuating shaft yoke to the relay lever (see Fig. 318).

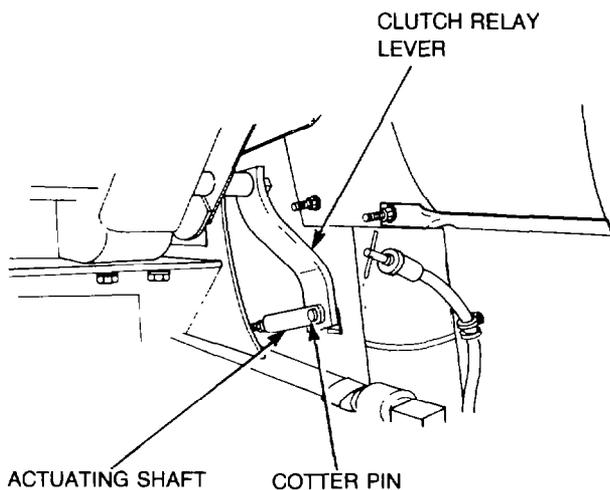


Figure 318 — Clutch Actuating Shaft — Removal

- m. Remove the two radiator support stays from the brackets on the engine firewall, then remove the nuts, washers and insulators securing the stays to the radiator brackets.
- n. Remove the air cleaner assembly (refer to EMEI VEH G 883 — GROUP 4).
- o. Remove the Horton fan clutch air supply line from the filter unit on the engine firewall, then tag and remove the electrical connector.
- p. Disconnect the electrical connector from the windscreen wiper motor, then tag and remove the wiring from the starter solenoid mounted on the engine firewall adjacent to the air cleaner mounting bracket.
- q. Secure the electrical harnesses away from the cab.
- r. Loosen the hose clamps and remove the heater hoses from the cab heater at the engine firewall, then plug the end of the hoses to prevent coolant loss. Remove the bolt, washer and clamp securing the heater hoses to the firewall.

- s. Remove the bolt, washer and clamp securing the fuel hoses to the cab, adjacent to the left hand front cab mount.
- t. Discharge the air conditioner refrigerant (refer to EMEI VEH G 884 — GROUP 18).
- u. Disconnect the refrigerant suction and discharge hoses from the evaporator suction and discharge unions on the engine firewall, then using suitable plugs, seal the unions and hoses.
- v. Remove the windscreen washer supply tubing from the washer reservoir.
- w. Remove the bolt and washer securing the earth strap to the cab.
- x. Tag and disconnect the wiring from the fuel tank sender unit on the left hand fuel tank.
- y. Drain the vehicle air tanks then tag and remove the air lines from the air manifold under the cab floor. Remove the power take-off air line from the union adjacent to the air manifold.
- z. Tag and remove the wiring from the impulse generator at the rear of the transmission.
- aa. Tag and disconnect any electrical leads, harnesses or connectors from beneath the cab floor.
- ab. Remove the engine cover inside the cab, then disconnect the fuel pump accelerator linkage from the accelerator cross-shaft (see Fig. 319).

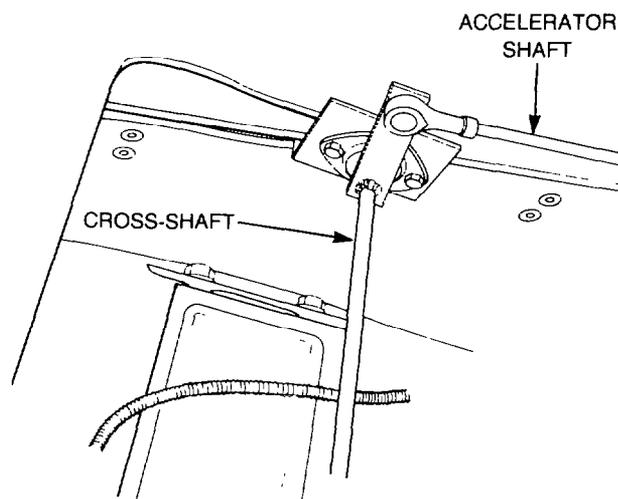


Figure 319 — Accelerator Shaft — Removal

- ac. Ensure that the gear lever is in the neutral position, then remove the six self-

tapping screws securing the gear lever boot to the mounting plate.

- ad. Remove the six bolts securing the boot mounting plate to the floor panel then remove the plate from the boot and gear lever.
- ae. Install a 762 mm (30 in.) length of 101.6 mm (4 in.) diameter aluminium or steel tubing over the gear lever and the gear lever air lines to prevent damage during the cab removal.
- af. Using a spreader beam and suitable overhead lifting equipment attached to the door openings, take the weight and raise the cab approximately 152 mm (6 in.). Ensure that all clamps, supports and wiring harnesses have been disconnected, then remove the cab from the vehicle.
- ag. Support the cab on a suitable floor stand, then remove the lifting equipment.

80. Installation

WARNING
Care must be taken during the procedure to avoid personal injury.

NOTE

During the installation procedure, replace any cable ties or saddle clamps required to secure fuel, air lines or electrical harnesses/wiring to the cab as appropriate.

- a. Install a 762 mm (30 in.) length of 101.6 mm (4 in.) diameter aluminium or steel tubing over the gear lever and the gear lever air lines to prevent damage during installation.
- b. Using a spreader beam and suitable overhead lifting equipment attached to the door openings, raise the cab from the floor stand and position the cab over the vehicle.
- c. Slowly lower the cab ensuring that all fittings and electrical harnesses are clear, then using the cab mounting bolts as guide pins, position the cab on the cab mounts.

NOTE

No specified tension is required on the cab mounting nuts but they must be tightened securely.

- d. Install an insulator on each front cab mounting bolt and secure with a nut.
- e. Install an insulator on each rear cab mounting bolt and secure with a washer and nut.
- f. Remove the tubing from the gear lever and the gear lever air lines, then position the boot mounting plate on the floor panel and secure with the six bolts.
- g. Position the gear lever boot on the mounting plate and secure with the six self-tapping screws.
- h. Connect the fuel pump accelerator linkage to the accelerator cross-shaft (see Fig. 320), then install the engine cover.

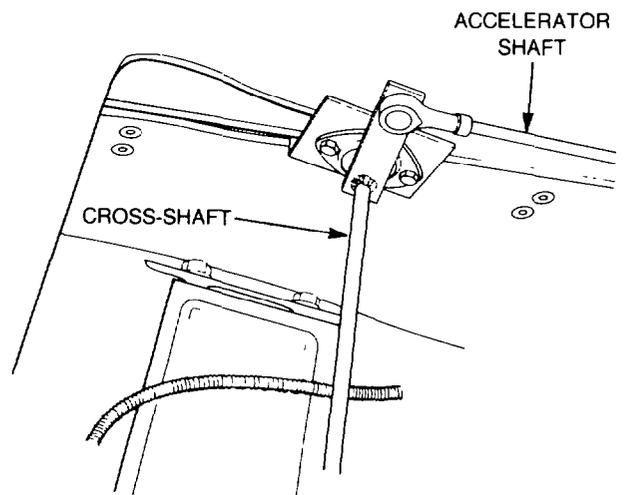


Figure 320 — Accelerator Shaft — Installation

- i. Reconnect any electrical leads, harnesses or connectors beneath the cab floor.
- j. Reconnect the wiring on the impulse generator at the rear of the transmission.
- k. Install the air lines removed from the air manifold under the cab floor, then install the power take-off air line to the union adjacent to the air manifold.
- l. Reconnect the wiring on the fuel sender unit on the left hand fuel tank.
- m. Position the earth lead on the cab and secure with a bolt and washer.

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- n. Remove the sealing plugs and install the windscreen washer supply tubing on the washer reservoir.
- o. Remove the plugs from the refrigerant suction and discharge hoses and evaporator suction and discharge unions and reconnect the hoses to the unions, ensuring the connections are tightened securely.
- p. Secure the fuel hoses to the cab adjacent to the left hand front cab mount with the clamp, washer and bolt.
- q. Remove the plugs and install the cab heater hoses on the cab heater tubes at the engine firewall, then tighten the hose clamps securely. Install the clamp, washer and bolt to secure the hoses to the firewall.
- r. Connect the wiring to the starter motor solenoid mounted on the engine firewall adjacent to the air cleaner mounting bracket, then connect the wiring to the windscreen wiper motor.
- s. Install the Horton fan clutch air supply line on the filter unit mounted on the engine firewall, then reconnect the electrical connector.
- t. Install the air cleaner assembly (refer to EMEI VEH G 883 — GROUP 4).
- u. Install a nut onto the threaded end of both radiator stays followed by a washer, a sleeve, a rubber insulator and a large washer. Insert the ends of the stays through the radiator brackets, then position a rubber insulator, a washer and start the remaining nuts onto the thread of the stays. Align the holes in the stays (at the firewall end) with the holes in the firewall, then install the bolts, nuts and washers and tighten the bolts and nuts securely. At the radiator brackets, adjust both the inner and outer nuts on the stays finger tight so as not to disturb the positioning of the radiator, then tighten both the inner and outer nuts equally until the sleeves are clamped between the inner and outer washers as shown in Fig. 321.
- v. Position the clutch actuating shaft yoke on the relay lever, then install the cotter pin and secure in position with a split pin (see Fig. 322).
- w. Install the two air bleed hoses on the surge tank connections and tighten the hose clamps securely, then install the

engine fill hose and tighten the hose clamp (see Fig. 323).

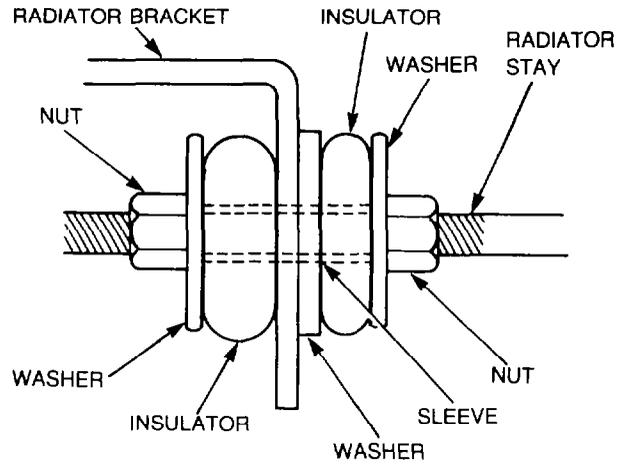


Figure 321 — Radiator Stay and Insulators

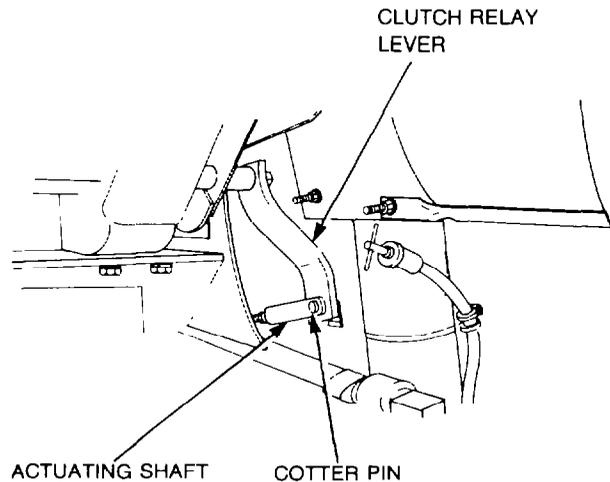


Figure 322 — Clutch Actuating Shaft — Installation

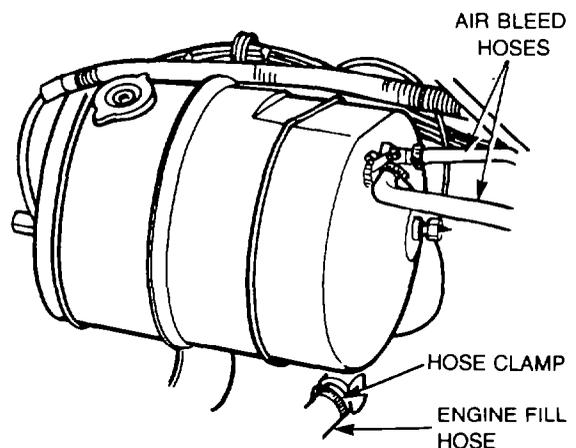


Figure 323 — Engine Fill Hose — Installation

- x. Connect the engine and headlight wiring harnesses to the connectors on the

engine firewall adjacent to the radiator surge tank, then connect the earth leads to the firewall adjacent to the brake treadle valve air lines.

- y. Install the cab support braces to the brackets on the engine firewall and the chassis mounting brackets, ensuring that the insulators and washers are fitted as noted during removal.

NOTE

Ensure that the steering wheel is positioned with the word TOP or the narrow spoke toward the wind-screen.

- z. Slide the lower steering shaft universal joint yoke up onto the intermediate shaft and secure in position with the pinch bolt and nut (see Fig. 324).
- aa. Install the engine skirts and both front mudflaps.
- ab. Charge the air conditioning system with refrigerant (refer to EMEI VEH G 884 — GROUP 18).
- ac. Top up the engine cooling system with coolant.
- ad. Install the bonnet (refer to EMEI VEH G 883 — GROUP 17).

- ae. Reconnect the battery cables to the battery isolation switch, then connect the positive battery cables onto the battery terminals, followed by the earth cables.

- af. Raise the bullbar and secure in position with the four eye bolts.

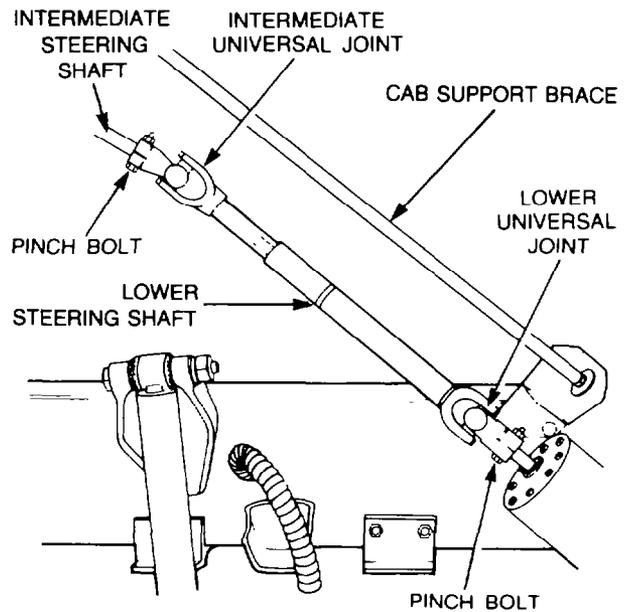


Figure 324 — Steering Shaft — Installation

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CAB HEATING/COOLING — GROUP 18

Air Conditioner Evaporator/Heater Unit

81. Removal

- a. Select the OFF position at the battery isolation switch.
- b. Remove the air cleaner assembly and the mounting bracket (refer to EMEI VEH G 883 — GROUP 4).
- c. Discharge the air conditioner refrigerant (refer to EMEI VEH G 884 — GROUP 18).
- d. Disconnect the air conditioner refrigerant lines from the engine firewall, then plug the lines and the tubes.
- e. Disconnect the heater unit hoses at the engine firewall and plug the hoses to prevent loss of coolant.
- f. Remove the eight screws securing the cover to the air conditioning unit and remove the cover.
- g. Disconnect the hot/cold control inner cable from the peg on the blend door, then remove the screw and clamp securing the outer cable (see Fig. 325) and withdraw the inner and outer cable from the air conditioner unit.

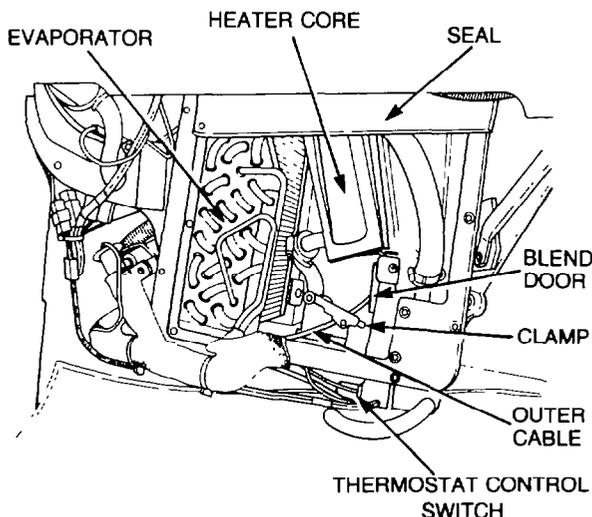


Figure 325 — Hot/Cold Cable — Removal

- h. Tag and disconnect the two wiring connectors from the thermostat control switch, then remove the clip securing the thermostat control inner cable to the switch shaft, and remove the inner cable from the shaft.
- i. Remove the screw and clamp securing the thermostat control outer cable to

the thermostat control switch mounting bracket.

- j. Disconnect the main wiring connector from the terminals beneath the blower fan motor.
- k. Tag and remove the wiring from the blower fan motor.
- l. Remove the two bolts, washers and nuts securing the air conditioner unit mounting bracket to the dash panel brace (see Fig. 326).

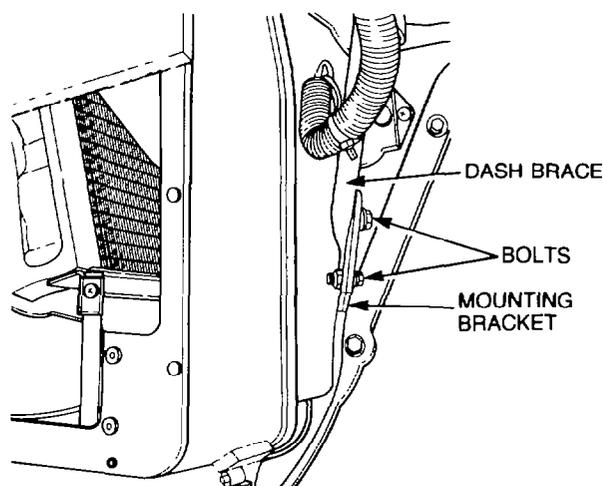


Figure 326 — Air Conditioner Mounting Bracket

- m. Remove the two screws securing the heater inlet and outlet tubes to the firewall in the cab, then remove the four screws securing the refrigerant suction and discharge line sealing plates and grommets to the firewall (see Fig. 327).

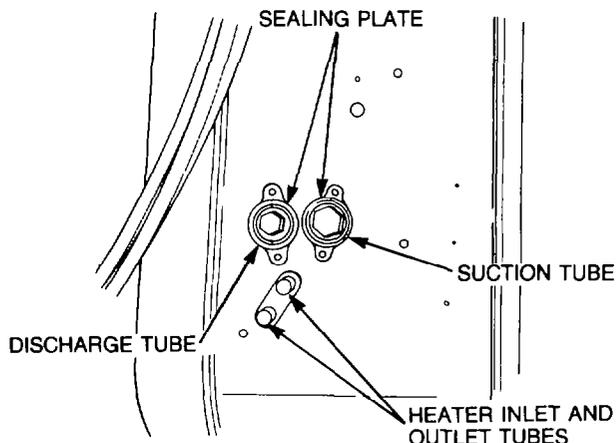


Figure 327 — Sealing Plates

- n. Support the air conditioner unit in the cab, then remove the four nuts securing

the unit on the engine side of the fire-wall.

- o. Carefully manipulate the air conditioning unit from the cab.

82. Installation

- a. Carefully position the air conditioning unit in the cab and secure the unit to the engine side of the firewall with the four nuts. Torque the nuts to 8.1-10.9 Nm (6-8 lb.ft).
- b. Secure the heater inlet and outlet tube to the firewall in the cab with two screws, then secure the refrigerant line sealing plates and grommets to the engine firewall with four screws.
- c. Secure the air conditioning unit mounting bracket to the dash panel brace (see Fig. 328) with the two bolts, washers and nuts.

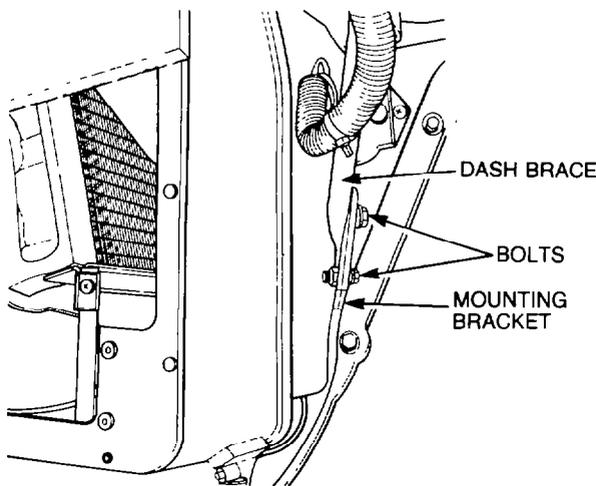


Figure 328 — Air Conditioner Mounting Bracket

- d. Connect the main wiring connector to the terminals beneath the blower fan motor.
- e. Install the thermostat control switch inner cable onto the switch shaft and secure with the clip, then secure the outer cable to the switch mounting bracket with the clamp and screw.
- f. Install the two wiring connectors onto the thermostat control switch.
- g. Install the hot/cold control cable through the air conditioning unit housing and clip the inner cable onto the peg on the blend door, then secure the outer cable with the clamp and screw.
- h. Position the cover on the air conditioning unit and secure with the eight screws.

- i. Remove the plugs from the heater unit hoses and install the hoses on the heater core tubes.
- j. Connect the air conditioner refrigerant lines to the engine firewall.
- k. Recharge the air conditioning system with refrigerant (refer to EMEI VEH G884 — GROUP 4).
- l. Install the air cleaner assembly and mounting bracket (refer to EMEI VEH G 883 — GROUP 4).
- m. Select the ON position at the battery isolation switch.

Blower Motor

83. Replacement

- a. Remove the eight screws securing the cover to the air conditioner unit and remove the cover.
- b. Disconnect the wiring connector from the blower motor, then remove the screws securing the motor to the air conditioner/heater unit housing (see Fig. 329). The motor earth lead is secured to the motor by one of these screws. Remove the vent tube, then withdraw the motor and fan assembly from the housing.
- c. Secure the fan assembly and, using a suitable socket wrench, remove the nut securing the fan to the motor shaft, then remove the fan and the spacer.
- d. Place the spacer on the motor shaft, then install and secure the fan with the nut.

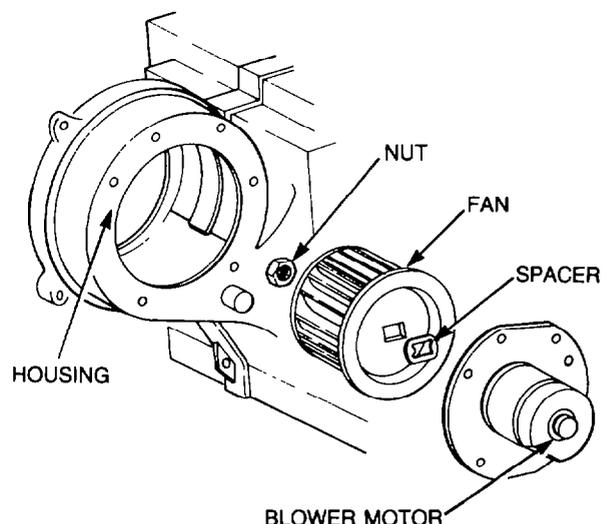


Figure 329 — Blower Motor and Fan — Removal

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- e. Position the fan and motor assembly in the air conditioning/heater unit housing and secure with the screws, ensuring that the earth lead is secured with one of the screws.
- f. Install the vent tube and reconnect the wiring connector onto the motor terminal.
- g. Position the cover on the air conditioning unit and secure with the eight screws.

Evaporator

84. Removal

- a. Remove the air conditioner/heater unit from the vehicle (refer to para. 81).
- b. Remove the three screws securing the cover seal to the housing.
- c. Remove the two screws securing the thermostat control switch to the housing, then remove the screw securing the refrigerant discharge tube to the housing.
- d. Remove the five screws securing the evaporator to the housing, then carefully manipulate the evaporator refrigerant tubes and the thermostat control switch from the housing.

85. Installation

- a. Carefully position the evaporator, refrigerant tubes and the thermostat control switch in the housing and secure the evaporator to the housing with the five screws.
- b. Secure the thermostat control switch to the housing with two screws, then secure the refrigerant suction tube to the housing with one screw.
- c. Install the cover seal and secure to the unit housing with the three screws.
- d. Encase the refrigerant suction and discharge tubes with insulating tape.
- e. Install the air conditioner/heater unit in the vehicle (refer to para. 82).

Heater Core

86. Removal

- a. Remove the air conditioner/heater unit from the vehicle (refer to para. 81).
- b. Remove the three screws securing the cover seal to the housing.

- c. Loosen the hose clamps securing the inlet and outlet hoses to the heater core and remove the hoses from the core.
- d. Remove the screw securing the heater core to the lower mounting bracket at the front of the air conditioner housing (see Fig. 330), then using a suitable chisel and hammer, remove the rivet securing the heater core to the rear of the mounting bracket and remove the front seal.

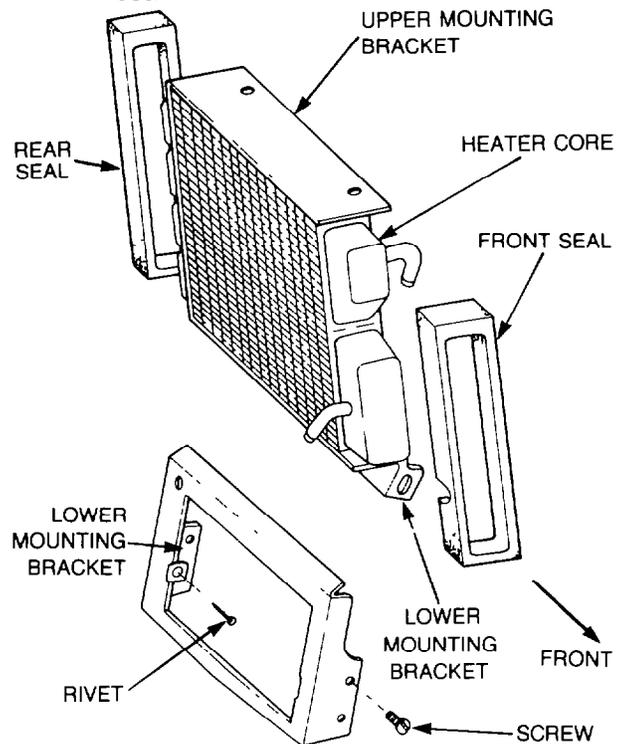


Figure 330 — Heater Core and Mounting

- e. Remove the two screws securing the upper mounting bracket to the top of the air conditioner housing then withdraw the heater core and the rear seal from the housing.

87. Installation

- a. Position the rear seal on the heater core, then install the core in the air conditioner housing and secure the upper mounting bracket to the top of the housing with the two screws.
- b. Position the front seal on the heater core, then secure the front of the core to the lower mounting bracket with the screw.
- c. Secure the rear of the heater core to the lower mounting bracket with a suitable bolt, washer and nut in place of the rivet removed during removal of the heater core.

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- d. Install the heater inlet and outlet hoses on the heater core inlet and outlet tubes, then secure in position with the hose clamps.
- e. Install the air conditioner/heater unit in the vehicle (refer to para. 82).

Air Conditioning Compressor

88. Removal

- a. Discharge the air conditioning refrigerant (refer to EMEI VEH G 884 — GROUP 18).
- b. Remove the refrigerant suction and discharge lines from the top of the compressor.
- c. Remove the seven bolts securing the compressor to the mounting bracket, lower the pump and remove the drive belt, then remove the compressor.

CAUTION
Do not invert the compressor during removal as refrigerant oil may be transferred from the crankcase to the suction cavity.

89. Disassembly

- a. Using special tool SE-2392-4 to secure the clutch pulley, (see Fig. 331), remove the pulley retainer bolt, then install the remover bolt SE-2392-5 into the clutch drive hub and remove the clutch pulley assembly from the crankshaft.

- b. Remove the Woodruff key from the crankshaft, then remove the four bolts securing the field coil to the crankcase (see Fig. 332).

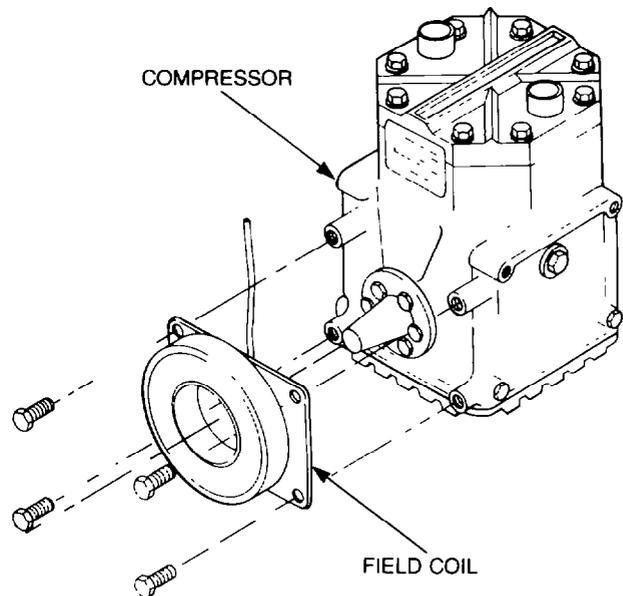


Figure 332 — Field Coil — Removal

- c. Using two screwdrivers, pry the dust cap off the crankshaft (see Fig. 333), then remove the five bolts securing the crankshaft seal plate to the crankcase and remove the seal plate. Discard the O-ring from the seal plate.

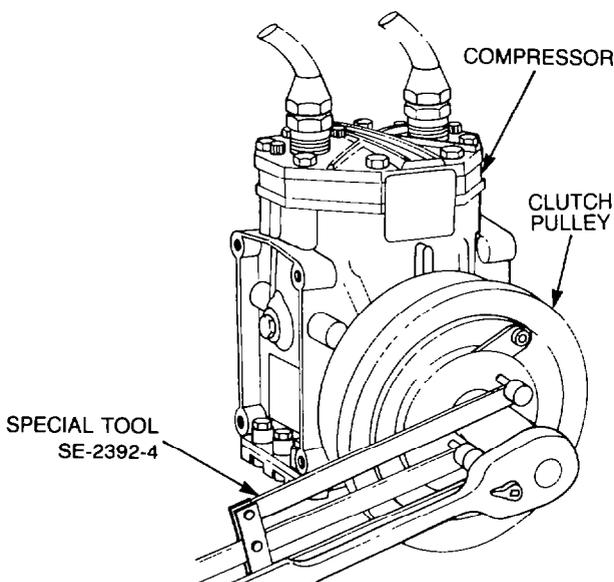


Figure 331 — Clutch Pulley — Removal

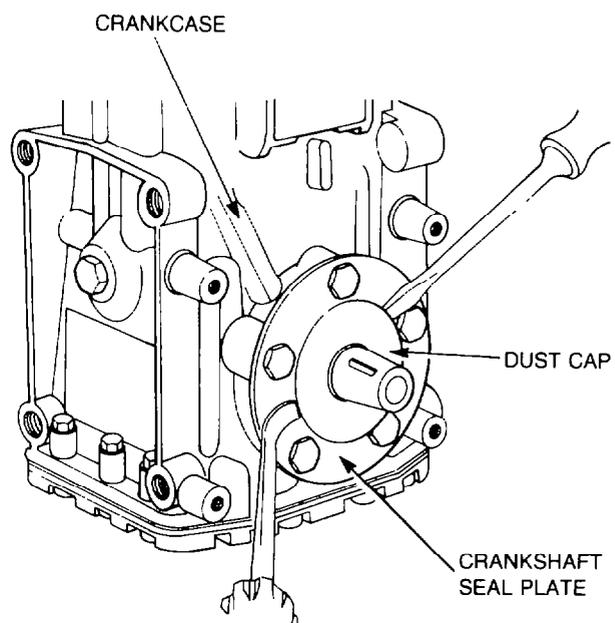


Figure 333 — Dust Cap — Removal

- d. Using special tool SE-2392-1 remove the crankshaft seal from the crankcase (see Fig. 334).

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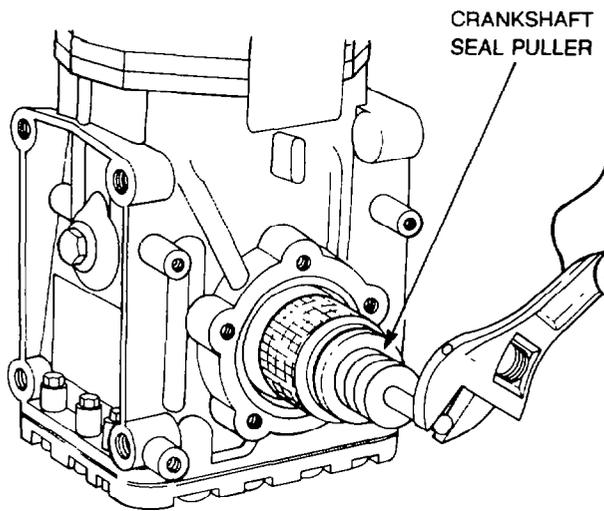


Figure 334 — Crankshaft Seal — Removal

- e. Remove the eight bolts and the four 12-point bolts securing the cylinder head and valve plate to the crankcase, then remove the head and valve plate by gently tapping with a soft-faced hammer (see Fig. 335). Remove and discard the cylinder head and valve plate gaskets.

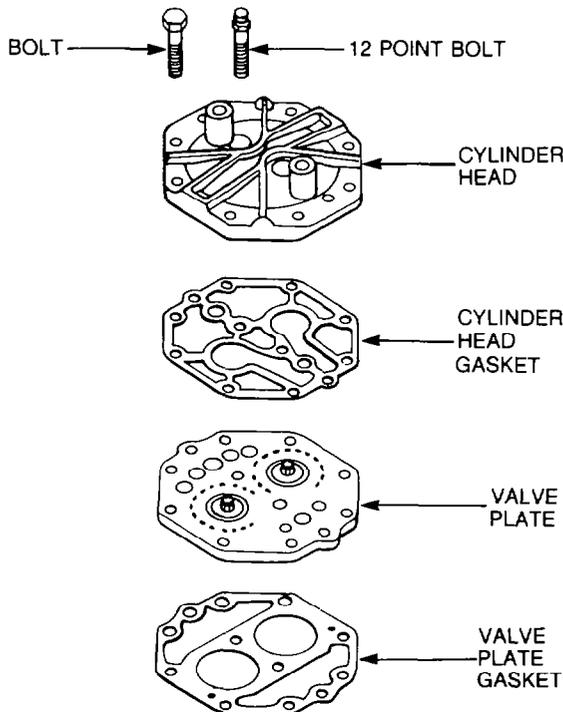


Figure 335 — Cylinder Head and Valve Plate — Removal

- f. Remove the four screws securing the crankshaft rear bearing housing to the crankcase, then using two screwdrivers

pry the housing out of the crankcase bore. Remove and discard the O-ring from the rear bearing housing (see Fig. 336).

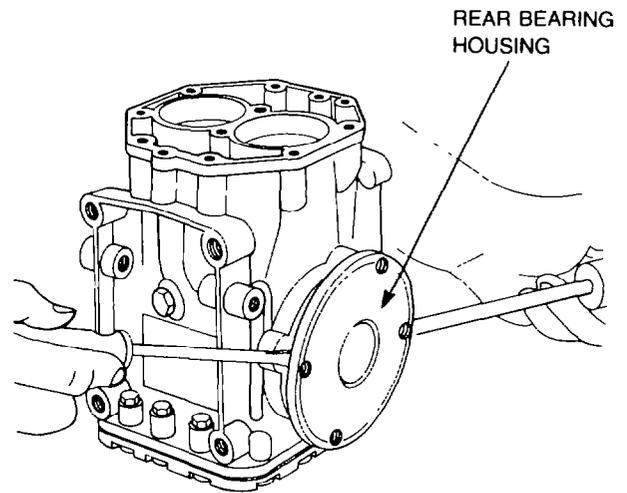


Figure 336 — Crankshaft Rear Bearing Housing — Removal

- g. Remove the fourteen bolts securing the base plate to the crankcase, then gently pry or tap the base plate to loosen the gasket. Remove the base plate and discard the gasket (see Fig. 337).

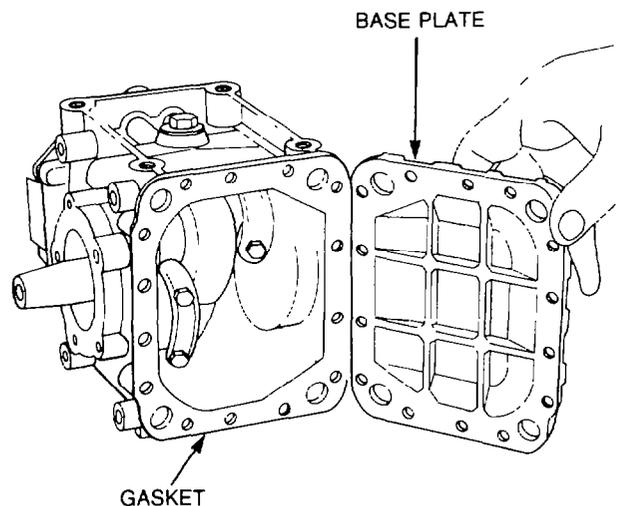


Figure 337 — Base Plate — Removal

- h. Match mark the pistons, connecting rods, bearing caps and the crankshaft journals to ensure they are installed in their original positions during reassembly.
- i. Using a suitable socket wrench remove the bolts securing the bearing caps to

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the connecting rods, then remove the bearing caps.

- j. Carefully remove the pistons and connecting rods from the crankcase (see Fig. 338) and note the position of the piston pin roll pins positioned towards the centre of the compressor.

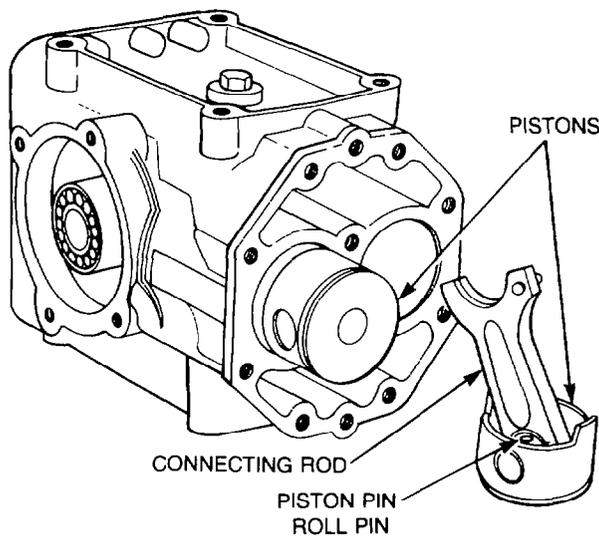


Figure 338 — Piston and Connecting Rod — Removal

WARNING
Care must be taken during this procedure to avoid personal injury.

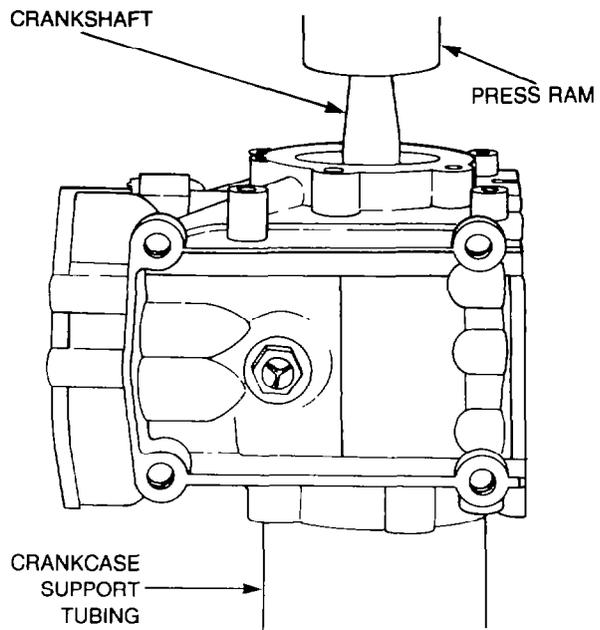


Figure 339 — Crankshaft and Bearing — Removal

90. Reassembly

- a. Using a suitable press, install the rear bearing on the crankshaft by pressing on the inner race of the bearing until the bearing seats firmly.

WARNING
Care must be taken during this procedure to avoid personal injury.

- k. Place the crankcase and crankshaft in a suitable oven and heat the crankcase to a temperature of 149°C (300°F). Remove the crankcase from the oven using a pair of tongs or insulated gloves, then using a soft-faced hammer tap the crankshaft to remove the crankshaft and bearings from the crankcase.
- l. Support the crankshaft in a vice, with the keyway section uppermost, by gripping the unmachined area between the connecting rod journals. Using two large screwdrivers or pry bars, remove the crankshaft bearings and rear bearings from the crankshaft.
- m. If a suitable oven is not available support the crankcase on a suitable press (see Fig. 339) and remove the crankshaft and bearings, then pry the bearings off the crankshaft.

- b. Place the crankcase in a suitable oven and heat the crankcase to a temperature of 149°C (300°F), then using a pair of tongs or insulated gloves remove the crankcase from the oven and install the front bearing into the crankcase recess. If necessary tap the outer race of the bearing with a soft-faced hammer until the bearing is firmly seated in the crankcase.
- c. Allow the crankcase to cool, then position the crankcase on a suitable press ensuring that the front bearing inner race is supported on a length of tubing (see Fig. 340). Install the crankshaft through the rear of the crankcase, then using a piece of tubing on the end of the crankshaft, press the shaft into the front bearing.

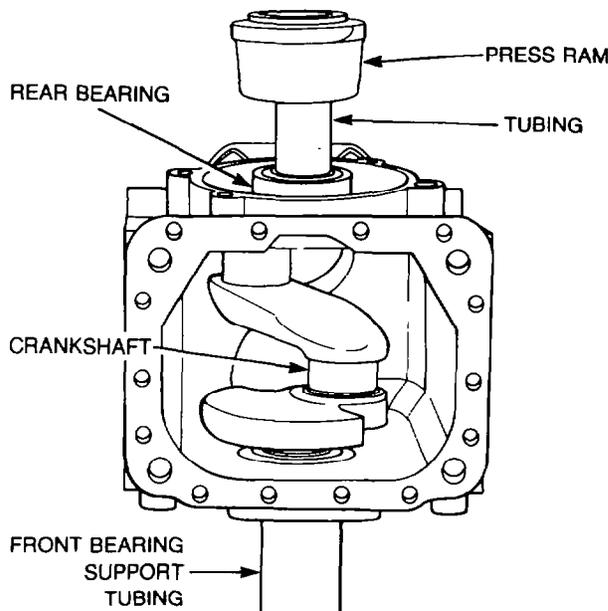


Figure 340 — Crankshaft — Installation

- d. Install a new O-ring on the crankshaft rear bearing housing, then align the screw mounting holes and using a soft-faced hammer, tap the housing onto the bearing. Install and torque the mounting screws to 12-23 Nm (9-17 lb.ft) in the sequence shown in Fig. 341.

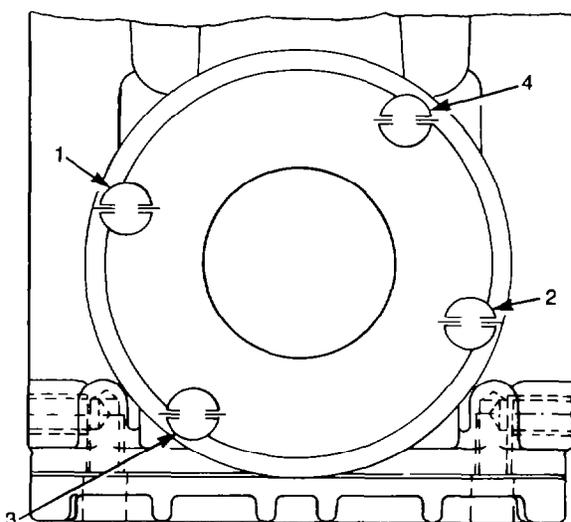


Figure 341 — Rear Bearing Housing — Tightening Sequence

NOTE

Ensure the pistons and connecting rods are installed in the cylinders they were removed from and that the piston pin roll pins are positioned towards the centre of the compressor.

- e. Coat the connecting rod bearing surfaces with clean compressor oil and install the piston and connecting rods in the cylinder bore. Install the bearing caps and tighten the bolts to a torque of 16-22 Nm (12-16 lb.ft).

NOTE

The compressor gaskets are made of a fibre-neoprene material and should be dipped in clean compressor oil prior to assembly.

- f. Using a new gasket install and secure the base plate with the fourteen bolts torqued to 16-24 Nm (12-18 lb.ft) in the sequence shown in Fig. 342.

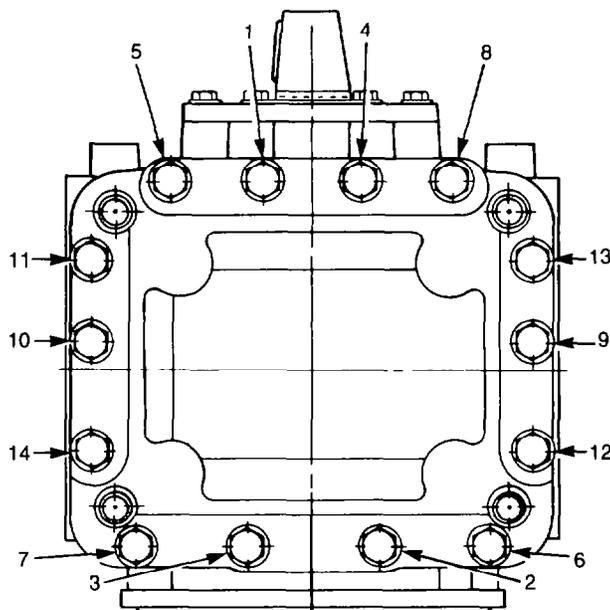


Figure 342 — Base Plate — Tightening Sequence

- g. Apply a thin film of clean compressor oil on the crankcase valve plate mating surface, then position a new gasket on the crankcase.
- h. Apply a thin film of clean compressor oil on the bottom of the valve plate mating surface, then position the plate on the crankcase with the discharge valve assemblies uppermost.
- i. Place a new head gasket and the cylinder head on the valve plate, then install the eight bolts and the four 12-point bolts. Torque the bolts to 20-31 Nm (15-23 lb.ft) in the sequence shown in Fig. 343.

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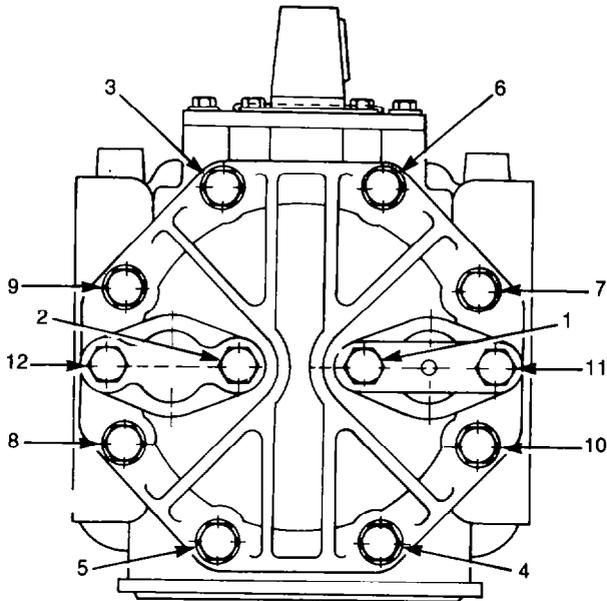


Figure 343 — Cylinder Head — Tightening Sequence

- j. Coat the crankshaft seal with clean compressor oil, then install the seal, less the carbon ring, over the end of the crankshaft with the carbon ring retainer facing out. Using special tool SE-2392-2 push the seal onto the crankshaft until the seal is firmly seated (see Fig. 344).

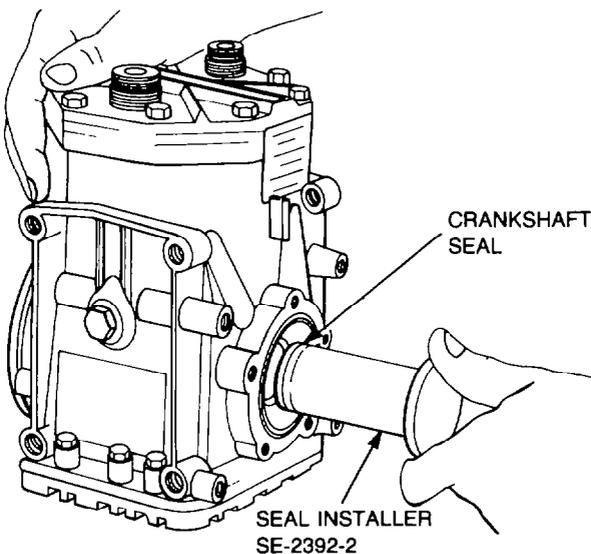


Figure 344 — Crankshaft Seal — Installation

- k. Install the carbon ring in the ring retainer with the lapped surface facing outwards. Ensure that the indentations in the outer edge of the carbon ring engage in the driving lugs.
- l. Lubricate a new O-ring and install the O-ring in the groove in the seal plate, then position the seal plate on the crankcase.

Install the five bolts finger tight, then install special tool SE-2392-2 over the end of the crankshaft with the thin flange of the tool between the crankshaft and the seal plate. Apply downward pressure and torque the bolts to 7-9 Nm (5-7 lb.ft) in the sequence shown in Fig. 345.

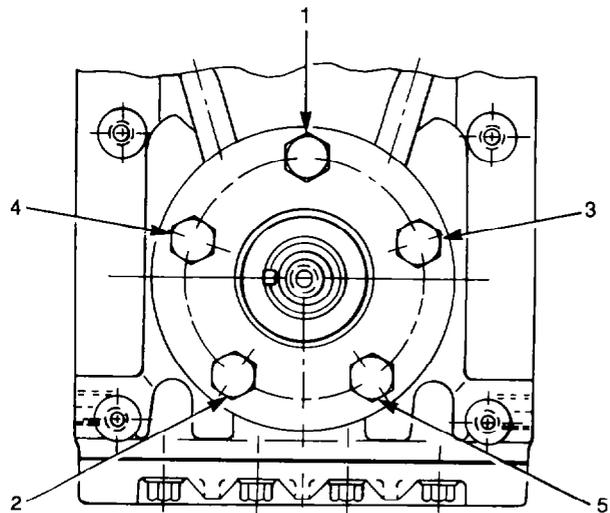


Figure 345 — Seal Plate — Tightening Sequence

- m. Install the dust cap on the crankshaft, then install the Woodruff key in the crankshaft.
- n. Position the field coil on the crankcase and secure with the four bolts torqued to 9-14 Nm (7-10 lb.ft).

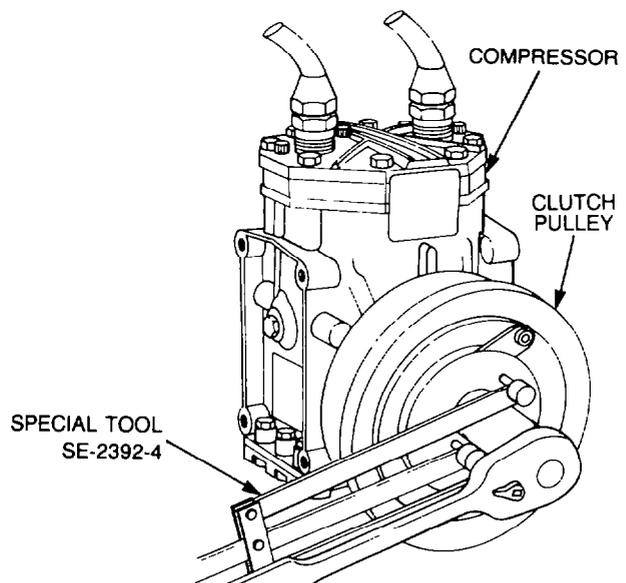


Figure 346 — Clutch Pulley — Installation

- o. Position the clutch pulley on the crankshaft and secure with a new Nyloc

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bolt to the crankshaft. Using special tool SE-2392-4 to secure the clutch pulley as shown in Fig. 346, torque the bolt to 20-27 Nm (15-20 lb.ft). Rotate the pulley by hand to ensure there is no interference between the pulley and the field coil.

- p. Remove the oil fill plug and fill the compressor with clean compressor oil until the dipstick reading is 25.4-34.9 mm (1.00-1.375 in.)

CAUTION
Do not invert the compressor during installation as compressor oil may be transferred from the crankcase to the suction cavity.

91. Installation

- a. Position the compressor in the mounting bracket on the vehicle and install the seven securing bolts finger tight. Install the drive belt on the pulley, then using a suitable lever between the compressor base and the mounting bracket, raise the compressor to adjust the belt and tighten the seven bolts.
- b. Install the refrigerant suction and discharge lines on the top of the compressor, then charge the air conditioning system with refrigerant (refer to EMEI VEH G 884 — GROUP 18).

— SPECIFICATIONS —

Air Conditioning Unit Securing Nuts	
Tightening Torque.....	8.1-10.9 Nm (6-8 lb.ft)
Rear Bearing Housing Bolts	
Tightening Torque.....	12-23 Nm (9-17 lb.ft)
Connecting Rod Bolts	
Tightening Torque.....	16-22 Nm (12-16 lb.ft)
Base Plate Bolts	
Tightening Torque.....	16-24 Nm (12-18 lb.ft)
Cylinder Head Bolts	
Tightening Torque.....	20-31 Nm (15-23 lb.ft)
Seal Plate Bolts	
Tightening Torque.....	7-9 Nm (5-7 lb.ft)
Clutch Pulley Bolt	
Tightening Torque.....	20-27 Nm (15-20 lb.ft)
Oil Level	25.4-34.9 mm (1.00-1.375 in.)

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— FAULT FINDING —

Air Conditioning Compressor

Symptom	Probable Cause	Action
1. Noisy compressor or vibration.	<ul style="list-style-type: none"> a. Low refrigerant. b. Low oil level. c. Worn or damaged crankshaft bearings. d. Worn or damaged drive clutch bearing. e. Compressor drive belt loose. f. Compressor drive clutch pulley misaligned. g. Loose or broken compressor mounting bracket. h. Damaged internal components. i. Excessive refrigerant charge. 	<ul style="list-style-type: none"> a. Add refrigerant. b. Add compressor oil. c. Replace bearings. d. Replace bearing. e. Adjust drive belt. f. Align drive clutch pulley. g. Tighten or replace mounting bracket. h. Replace components. i. Discharge and recharge system with specified amount.
2. Compressor clutch inoperative.	<ul style="list-style-type: none"> a. Incorrect drive belt tension. b. Loose connection or broken wire. c. Faulty field coil. d. Faulty thermostatic control switch. e. Broken drive belt. 	<ul style="list-style-type: none"> a. Adjust drive belt. b. Tighten connection or replace wire. c. Replace field coil. d. Replace switch. e. Replace drive belt.
3. Slipping drive clutch.	<ul style="list-style-type: none"> a. Loose drive pulley. b. Worn drive belt. 	<ul style="list-style-type: none"> a. Tighten pulley. b. Replace drive belt.
4. Compressor runs but does not pump.	<ul style="list-style-type: none"> a. Leaking head gasket. b. Damaged or worn piston or piston rings. c. Damaged or stuck reed valve. d. Leaking valve plate gasket. 	<ul style="list-style-type: none"> a. Replace head gasket. b. Replace compressor. c. Replace reed valve plate assembly. d. Replace gasket.
5. Compressor leaks refrigerant and/or oil.	<ul style="list-style-type: none"> a. Worn or damaged crankshaft seal. b. Leaking head gasket. c. Leaking valve plate gasket. d. Crankshaft damaged. e. Crankshaft seal plate O-ring leaking. f. Crankshaft rear bearing housing O-ring leaking. g. Crankcase base plate leaking. 	<ul style="list-style-type: none"> a. Replace crankshaft seal. b. Replace head gasket. c. Replace gasket. d. Replace compressor. e. Replace O-ring. f. Replace O-ring. g. Replace gasket.

END

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