TECHNICAL MANUAL

DIRECT SUPPORT

AND GENERAL SUPPORT

MAINTENANCE MANUAL

CARRIER, CARGO, TRACKED, 1 1/2 TON, M973
SMALL UNIT SUPPORT VEHICLE (SUSV)
(NSN 2350-01-132-9099)

HEADQUARTERS, DEPARTMENT OF THE ARMY
APRIL 1984

WARNING

CARBON MONOXIDE POISONING CAN BE DEADLY

Carbon monoxide is a colorless, odorless, deadly poisonous gas, which, when breathed, deprives the body of oxygen and causes suffocation. Exposure to air containing carbon monoxide produces symptoms of headache, dizziness, loss of muscular control, apparent drowsiness, and coma. Permanent brain damage or death can result from severe exposure.

Carbon monoxide occurs in the exhaust fumes of fuel-burning heaters and internal-combustion engines and becomes dangerously concentrated under conditions of inadequate ventilation. The following precautions must be observed to ensure the safety of personnel whenever the personnel heater or main engine of the vehicle is operated for either maintenance purposes or tactical use.

(1) Do not operate heater or engine of vehicle in an enclosed area unless it is adequately ventilated.
(2) Do not idle engine for long periods, without maintaining adequate ventilation in the personnel compartment.
(3) Do not drive the vehicle with inspection plates, cover plates, or access doors removed unless required for maintenance purposes.
(4) Be alert at all times during vehicle operation for exhaust odors and exposure symptoms. If either is present, immediately ventilate personnel compartment. If symptoms persist, remove affected personnel from vehicle and treat as follows: Exposure to fresh air; keep warm; do not permit physical exercise; if necessary administer artificial respiration (FM 21-11).

CLEANING SOLVENT

Cleaning solvent, federal specification P-D-680, Type II is flammable and gives off harmful vapors. Use solvent only in a well-ventilated area. Avoid prolonged breathing of solvent vapors. Keep solvent away from flame. Do not use solvent in excessive amounts.

NBC CONTAMINATED FILTERS MUST BE HANDLED USING ADEQUATE PRECAUTIONS (FM 21-40) AND MUST BE DISPOSED OF BY TRAINED PERSONNEL.

After Nuclear, Biological or Chemical (NBC) exposure of this vehicle, all air filters shall be handled with extreme caution. Unprotected personnel may experience injury or death of residual toxic agents or radioactive material are present. If vehicle is exposed to chemical or biological agents, servicing personnel shall wear protective mask, hood, protective overgarments, and chemical protective gloves and boots. All contaminated air filters shall be placed into double lined plastic bags and moved to a segregation area away from the work site swiftly. The same procedure applies for radioactive dust contamination; however, the Company NBC team should measure the radiation prior to filter removal to determine the extent of safety procedures required per the NBC Annex to the unit Standard Operations Procedures (SOP). The segregation area in which the contaminated air filters are temporarily stored shall be marked with appropriate NBC placards. Final disposal of contaminated air filters shall be in accordance with local SOP.

HEATING METAL

To avoid burns after heating metal components to very high temperatures, wear insulated gloves or handle components with pliers.

COMPRESSED AIR

Compressed air used for cleaning purposes will not exceed 30 psi. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

TECHNICAL MANUAL
NO. 9-2350-272-34

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., 2 April 1984

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL
CARRIER, CARGO, TRACKED, 1 1/2 TON, M973
SMALL UNIT SUPPORT VEHICLE (SUSV)
(NSN 2350-01-132-9099)

REPORTING OF ERRORS

You can help improve this publication. If you find any mistakes, or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publication and Blank Forms), or DA Form 2028-2 located in the back of this publication direct to: US Army Tank-Automotive Command, ATTN: DRSTA-MBP, Warren, MI 48090. A reply will be furnished to you.

TABLE OF CONTENTS

HOW TO USE THE MANUAL

This manual is designed to help you maintain the M973 Cargo Carrier and accessory equipment. Listed below are special features which will help you locate the information you need:

Front cover table of contents for quick reference to important information.

An index to the manual contents is located in the final pages of this manual. Use the index to locate specific items of information.

All measurements in this manual are given in both English and Metric units.

A Metric to English conversion chart is also provided on the inside back cover of this manual.

Warning pages are located in the front of this manual. You should learn the warnings before operating or doing maintenance on the vehicle. Important warnings and cautions are also located on other pages in the manual. They appear before a step that may result in personnel injury or damage to equipment. If the instructions are not followed, or care is not taken, you may injure yourself.

Notes are located before a step to make the step or steps following the note easier to understand. Always read all cautions, warnings, and notes before performing the next step.

CHAPTER 1

INTRODUCTION

Section I. GENERAL INFORMATION

1-1. SCOPE.

This manual is for your use in maintaining the M973 Cargo Carrier. It provides information on the maintenance of the equipment which is beyond the scope of the tools, equipment, personnel or supplies normally available to organizational levels of maintenance.

1-2. MAINTENANCE FORMS AND RECORDS.

Maintenance forms and records that you are required to use are explained in DA PAM 738-750.

1-3. METRIC SYSTEM.

The vehicle and its system is metric. Metric tools are required for equipment maintenance. Metric to English conversion tables are on inside back cover.

1-4. EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIRs).

If your equipment needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design. Put it on an SF 368 (Quality Deficiency Report). Mail it to us at US ARMY TANK-AUTOMOTIVE COMMAND, ATTN: DRSTA-MP, Warren MI, 48090. We will send you a reply.

1-5. NOMENCLATURE CROSS REFERENCE.

All nomenclatures are standard US Army.

1-6. ADMINISTRATIVE STORAGE.

TM 740-90-1 has information on administrative storage of vehicles.

1-7. DESTRUCTION TO PREVENT ENEMY USE.

Refer to TM 750-244-6.

SECTION II. EQUIPMENT DESCRIPTION AND DATA

1-8. DESCRIPTION

A general description of the M973 Cargo Carrier and information pertaining to the identification plates are contained in TM 9-2350-272-1 0. A more detailed description of specific components and assemblies is contained in TM 9-2350-272-20 and the applicable sections of this manual.

1-9. DATA

Refer to TM 9-2350-272-10 and TM 9-2350-272-20 for general data information. More detailed data lists are contained in the applicable sections of this manual.

CHAPTER 2

DIRECT SUPPORT AND GENERAL SUPPORT

MAINTENANCE INSTRUCTIONS

Section I. REPAIR PARTS, SPECIAL TOOLS, AND EQUIPMENT

2-1. TOOLS AND EQUIPMENT.

Standard and commonly used tools and equipment having general application to the M973 Cargo Carrier are authorized for issue by the Table of Allowances (TA) and the Tables of Organization and Equipment (TOE).

2-2. SPECIAL TOOLS AND TEST EQUIPMENT.

Table 2-1 in this manual lists special tools and equipment you need for the M973 Cargo Carrier maintenance. Use TM 9-2350-272-24P to request special tools and equipment.

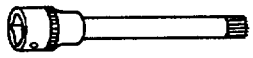
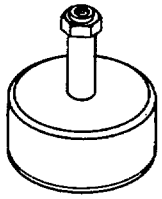
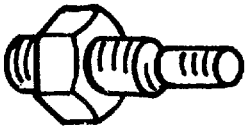
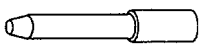
3-2. DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE REPAIR PARTS.

Repair parts are listed in TM 9-2350-272-24P Repair Parts and Special Tools List.

2-4. FABRICATED TOOLS AND EQUIPMENT.

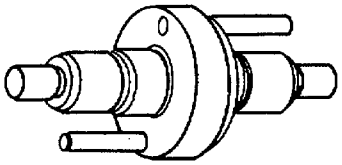
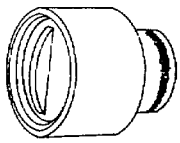
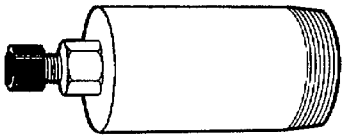
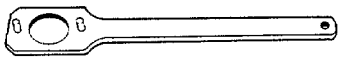
The specially designed tools and equipment are listed in Table 2-2 are for direct and general support maintenance on the M973. The tools and equipment listed in Table 2-2 are not available for issue, but must be fabricated by qualified direct and general support maintenance personnel.

TABLE 2-1. SPECIAL TOOLS AND TEST EQUIPMENT

ITEM	NOMENCLATURE	PART NUMBER [NSN]	USE TO:	ILLUSTRATION
1	Socket, Hex	617589001000 (4537785-023)	Replace Cylinder Head Bolts	
2	Puller	116589203300 (4537785-006) [5120-01-170-6686]	Remove Timing Chain Guide Rail	
3	Bolt, Puller	116589013400 (4537785-007) [5120-01-170-6687]	Remove Timing Chain Guide Rail	
4	Wrench	615589000100 (4537785-002) [5120-01-170-6760]	Adjust Valves	
5	Pipe, Overflow	636589022300 (4537785-024)	Timing Injector Pump	
6	Drift Pin	615589011500 (4537785-030)	Remove Valve Stem Guide	
7	Drift Pin	617589001500 (4537785-031)	Replace Valve Stem Guide	

TA259347

TABLE 2-1. SPECIAL TOOLS AND TEST EQUIPMENT

ITEM	NOMENCLATURE	PART NUMBER [NSN]	USE TO:	ILLUSTRATION
8	Balancing Tool	617589026300 (4537785-040)	Balance Counter-weights for Vibration Damper	
9	Holding Wrench	615589000300 (4537785-001)	Valve Spring Retainer — Holds from Turning	
10	Installation Tool	617589004300 (4537408-099) [5120-01-170-6681]	Install Valve Stem Seals	
11	Plug Wrench	4537408-019 (F1054-036410) [5120-01-166-1992]	Remove Plug Secondary Pump	
12	Extractor Tool	4537408-020 (F1054-036480)	Extract Seals and O-Rings from Transmission and Transfer	
13	Fixture	4537408-021 (F1053-021670) [4910-01-167-1735]	Hold Transmission Shaft from Turning	

TA259350

TABLE 2-1. SPECIAL TOOLS AND TEST EQUIPMENT

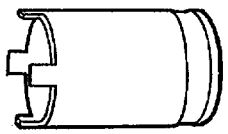
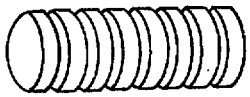
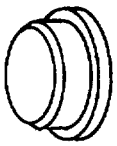
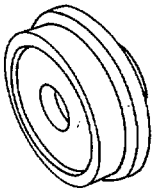
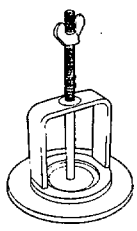
ITEM	NOMENCLATURE	PART NUMBER [NSN]	USE TO:	ILLUSTRATION
14	Tap Wrench	115589010700 (4537408-023) [5120-01-170-6727]	Remove Output Shaft Nut	
15	Testing Device	115589112100 (4537408-024) [5120-01-170-6677]	Check Pin Length for Modulation Vacuum Valve	
16	Compression Tool	4537408-031 (F1054-036470) [5120-01-166-1990]	Remove Secondary Pump	
17	Support Plate	4537409-006 (F1054-036430) [4910-01-167-1740]	Remove Bearing from Front Housing	
18	Adapter Assembly	4537409-008 (F1054-036460) [5120-01-165-0463]	Install Output Bearing	
19	Wrench	4537409-011 (F1052-014360) [5120-01-166-5282]	Replace Clutch Disc Assembly	 TA259778

TABLE 2-1. SPECIAL TOOLS AND TEST EQUIPMENT

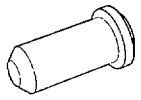
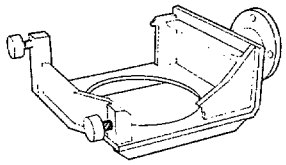
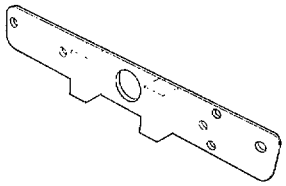
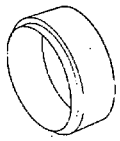
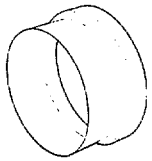
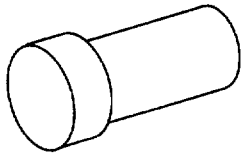
ITEM	NOMENCLATURE	PART NUMBER [NSN]	USE TO:	ILLUSTRATION
20	Drift Pin	4537409-012 (F1054-036440) [5120-01-166-2088]	Install Transmission Bearing	
21	Fixture	4537409-013 (F1051-109480) [4910-01-167-1783]	Hold Transmission During Maintenance	
22	Lock Plate	4537409-014 (F1053-021660) [4910-01-167-1784]	Hold Torque Converter in Place	
23	Installation Tool	116589051400 (4537409-015) [5120-01-170-6682]	Install Position Brake Band B-2	
24	Installation Tool	112589016100 (4537409-016) [5120-01-170-6683]	Install Piston Clutch K-1	
25	Drift Pin	4537409-017 (F1054-037640)	Install Bearing in Transmission Front Housing	 TA259351

TABLE 2-1. SPECIAL TOOLS AND TEST EQUIPMENT

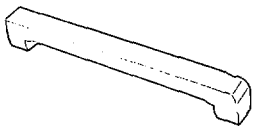
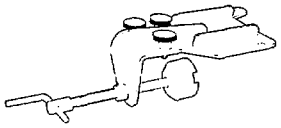
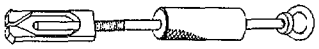
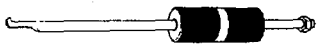
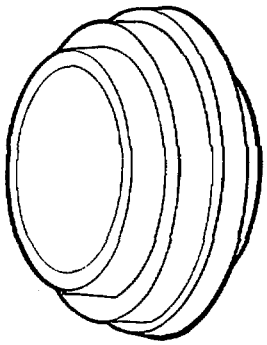
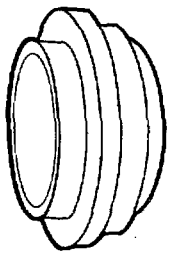
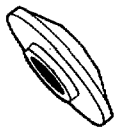
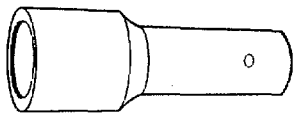
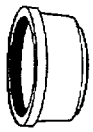
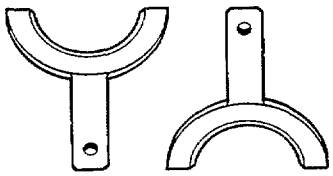
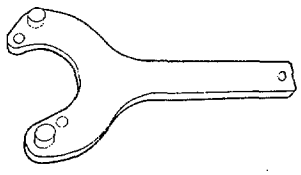
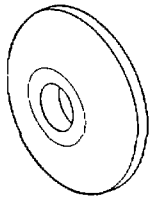
ITEM	NOMENCLATURE	PART NUMBER [NSN]	USE TO:	ILLUSTRATION
26	Measuring Bridge	116589002100 (4537409-018) [5210-01-170-6684]	Measure Play in Gear Assembly	
27	Assembling Tool	116589095900 (4537409-020) [5120-01-170-6693]	Remove/Install Brake Piston Cap	
28	Puller	6899991-821 [5120-01-167-1775]	Remove Brake Band Piston Seal	
29	Extractor	6899994-030 [5120-01-167-1778]	Remove Seal in Secondary Pump	
30	Adapter Puller	4537408-016 (F1054-036830) [5120-01-166-2004]	Install Seals	
31	Adapter Puller	4537408-017 (F1054-036840) [5120-01-166-1988]	Install Seals	 TA259352

TABLE 2-1. SPECIAL TOOLS AND TEST EQUIPMENT

ITEM	NOMENCLATURE	PART NUMBER [NSN]	USE TO:	ILLUSTRATION
32	Mandrel	4537408-018 (F1054-037100) [3460-01-166-2107]	Install Bearing in Flange	
33	Drift Pin	4537408-025 (F1053-021960) [5120-01-166-2077]	Install Dust Guard	
34	Drift Pin	4537408-026 (F1054-037520) [5120-01-169-6350]	Install Dust Guard	
35	Yoke	4537408-027 (F1054-037530) [5120-01-167-1787]	Install Dust Guard	
36	Yoke	4537408-029 (F1053-021930) [5120-01-167-1741]	Hold Differential Input Flange from Turning	
37	Adapter	4537409-036 (F1054-036810) [5120-01-166-1980]	Install Bearing	

TA259353

TABLE 2-1. SPECIAL TOOLS AND TEST EQUIPMENT

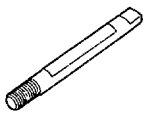
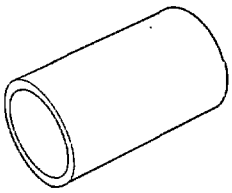
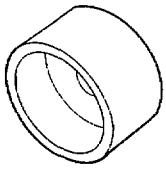
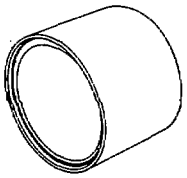
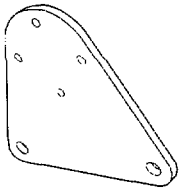
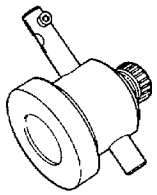
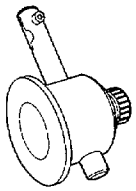
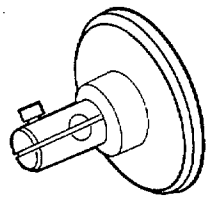
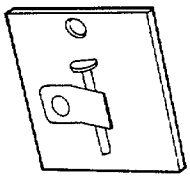
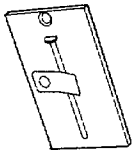
ITEM	NOMENCLATURE	PART NUMBER [NSN]	USE TO:	ILLUSTRATION
38	Alignment Tool	4537409-037 (F1054-037060) [5120-01-166-1983]	Align Input Shaft	
39	Alignment Tool	4537409-038 (F1054-037020) [5120-01-166-1984]	Remove Bearing on Shaft	
40	Drift Pin	4537409-039 (F1054-037030) [5120-01-166-2079]	Install Bearing	
41	Drift Pin	4537409-040 (F1054-036820) [5120-01-166-2080]	Install Bearing on Gear	
42	Drift Pin	4537409-041 (F1054-037040) [5120-01-166-2081]	Remove Gear	
43	Fixture	4537409-042 (F1054-014510) [4910-01-167-1737]	Mount Differential on Stand	 TA259354

TABLE 2-1. SPECIAL TOOLS AND TEST EQUIPMENT

ITEM	NOMENCLATURE	PART NUMBER [NSN]	USE TO:	ILLUSTRATION
44	Holder	4534709-043 (F1053-022070) [5120-01-167-1733]	Holder for Dial Indicator	
45	Holder	4534709-044 (F1053-022080) [5120-01-167-1736]	Holder for Dial Indicator	
46	Holder	4537409-045 (F1053-022060) [5220-01-166-6011]	Holder for Dial Indicator	
47	Gage, Distance Check	4537409-046 (F1054-037580)	Measure Pinion Preload	
48	Gage, Distance Check	4537409-047 (F1054-037570) [5220-01-166-1981]	Measure Pinion Preload	

TA259355

TABLE 2-1. SPECIAL TOOLS AND TEST EQUIPMENT (CONTINUED)

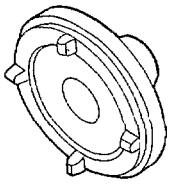
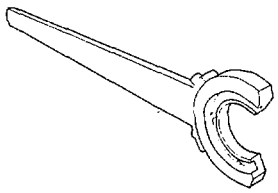
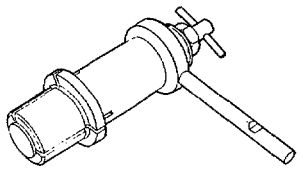
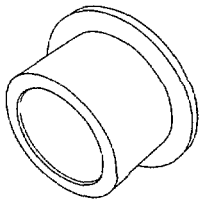
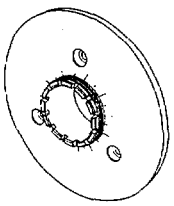
ITEM	NOMENCLATURE	PART NUMBER [NSN]	USE TO:	ILLUSTRATION
49	Wrench Spanner	4537409-048 (F1054-037600) [5120-01-166-2073]	Adjust Bearing Preload	
50	Adjustment Tool	4537409-049 (F1053-022090) [5120-01-166-1985]	Adjust Bearing Preload	
51	Driver	4537409-050 (F1051-109790) [5120-01-166-1982]	Measure Gear Play	
52	Gage, Distance Check	4537409-051 (F1054-037590) [5220-01-166-2005]	Measure Gear Clearance	
53	Adjustment Tool	4537409-052 (F1052-014720) [5120-01-166-2007]	Adjust Bearing Preload	 TA259356

TABLE 2-1. SPECIAL TOOLS AND TEST EQUIPMENT (CONTINUED)

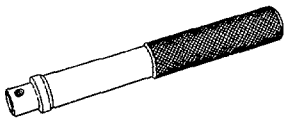
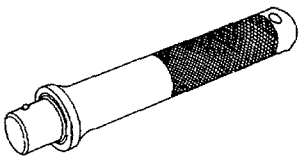
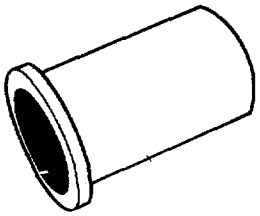
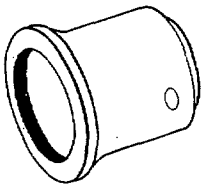
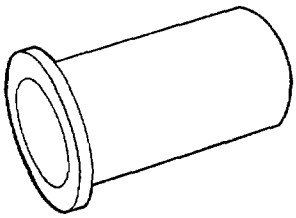
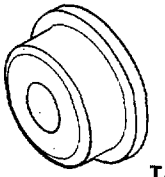
ITEM	NOMENCLATURE	PART NUMBER [NSN]	USE TO:	ILLUSTRATION
54	Handle	6899991-801 [5120-01-167-1774]	Hold Drifts (Mandrels)	
55	Handle	6899992-000 [5120-01-167-1779]	Hold Drifts (Mandrels)	
56	Drift Pin	4537408-022 (F1054-036690) [5120-01-166-2076]	Replace Seal in Transfer	
57	Drift	4537408-028 (F1054-037510)	Install Output Shaft Dust Guard	
58	Drift Pin	4537408-062 (F1054-036700) [5120-01-166-2089]	Install Bearing	
59	Drift Pin	4537409-024 (F1054-036670) [5120-01-166-2082]	Install Bearing	 TA259357

TABLE 2-1. SPECIAL TOOLS AND TEST EQUIPMENT (CONTINUED)

ITEM	NOMENCLATURE	PART NUMBER [NSN]	USE TO:	ILLUSTRATION
60	Drift Pin	4537409-026 (F1054-036680) [5120-01-166-2091]	Replace Bearing on High Speed Gear	
61	Adapter, Arbor	4537409-027 (F1054-036710)	Remove Bearing	
62	Adapter Puller	4537409-030 (F1054-036450) [5120-01-166-1987]	Replace Bearing	
63	Puller	4537409-032 (F1054-036720) [5120-01-166-1978]	Remove Input Shaft	
64	Fixture	4537409-033 (F1052-014530) [5120-01-170-4896]	Mount Transfer to Stand	TA259358

TABLE 2-1. SPECIAL TOOLS AND TEST EQUIPMENT (CNOTINUED)

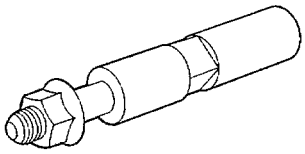
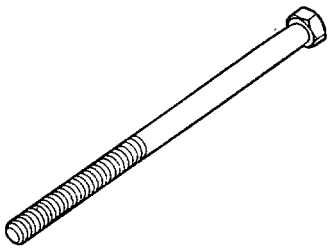
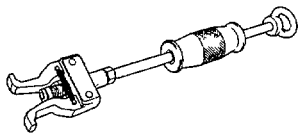
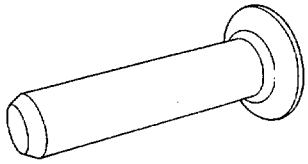
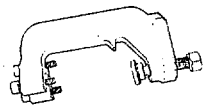
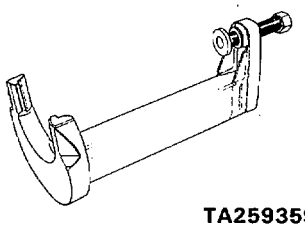
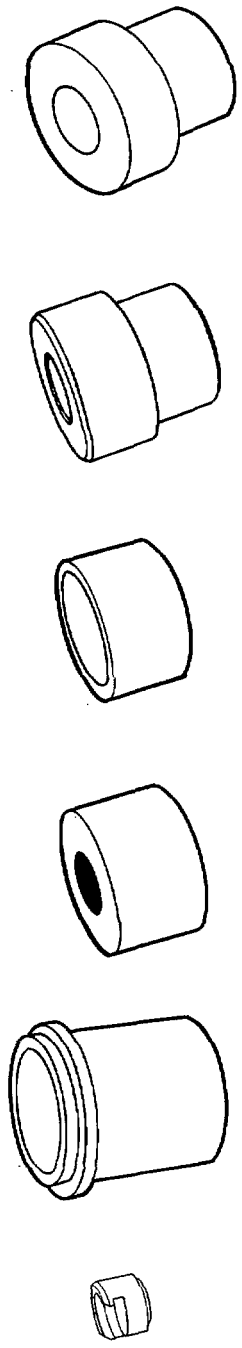
ITEM	NOMENCLATURE	PART NUMBER [NSN]	USE TO:	ILLUSTRATION
65	Screw	4537409-035 (F1054-037320) [5120-01-167-1738]	Used with Transfer Case Holder	
66	Screw	453-7409-034 (F1054-037120)	Used with Fixture Item 64	
67	Screw, Puller	4537409-025 (F1054-037000)	Used with Fixture Item 64	
68	Puller	6899992-097 [5120-01-167-2000]	Remove Bearing	
69	Puller	6899992-291 [5120-01-167-1777]	Instal Input Bearing	
70	Puller	4537408-046 (F1053-021830) [5120-01-166-2155]	Repair Steering System	
71	Clamp	4537408-049 (F1052-014680)	Repair Steering	 TA259359

TABLE 2-1. SPECIAL TOOLS AND TEST EQUIPMENT (CONTINUED)

ITEM	NOMENCLATURE	PART NUMBER [NSN]	USE TO:	ILLUSTRATION
72	Drift Pin	4537408-052 (F1052-036790) [5120-01-166-2083]	Repair Steering Unit	
73	Drift Pin	4537408-053 (F1054-036760) [5120-01-166-2084]	Repair Steering Unit	
74	Drift Pin	4537408-054 (F1054-036780) [5120-01-166-2085]	Repair Steering Unit	
75	Drift Pin	4537408-055 (F1054-036770) [5120-01-166-2086]	Repair Steering Unit	
76	Drift Pin	4537408-056 (F1054-036390) [5120-01-166-2087]	Remove Bearing from Steering Cylinder	
77	Adapter	4537408-058 (F1054-037500) [5120-01-166-1998]	Repair Steering Unit	



TA259360

TABLE 2-1. SPECIAL TOOLS AND TEST EQUIPMENT (CONTINUED)

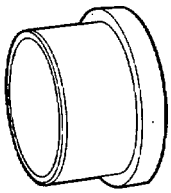
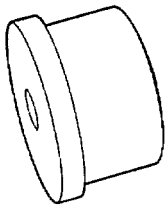
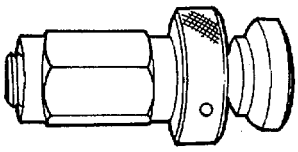
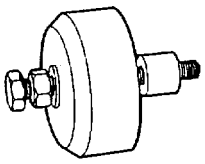
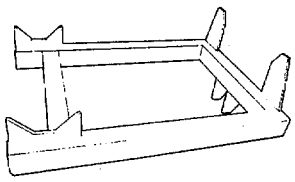
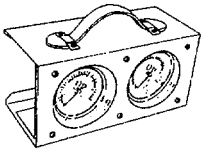
ITEM	NOMENCLATURE	PART NUMBER [NSN]	USE TO:	ILLUSTRATION
78	Adapter Puller	4537408-060 (F1054-036920) [5120-01-166-5283]	Repair Steering Unit	
79	Drift Pin	4537408-061 (F1054-036800) [5120-01-166-5298]	Repair Steering Unit	
80	Fixture	4537408-063 (F1053-022030) [3465-01-167-1782]	Repair Steering Unit	
81	Puller	4537408-064 (F1053-022000) [5120-01-166-1993]	Repair Steering Unit	
82	Frame	4537408-091 (F1051-109630) [2920-01-167-1781]	Remove Steering Unit	
83	Tester	4537408-111 (F1052-014750)	Test Steering Pressure	 TA259361

TABLE 2-1. SPECIAL TOOLS AND TEST EQUIPMENT ((CONITNUED)

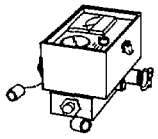
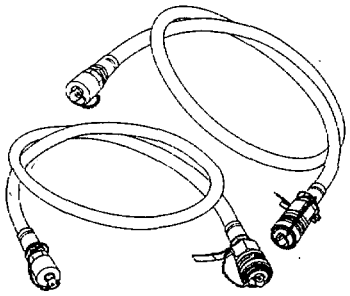
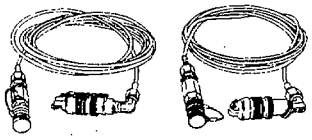
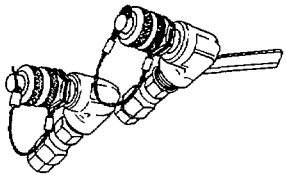
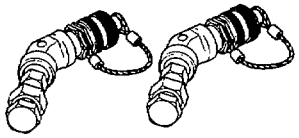
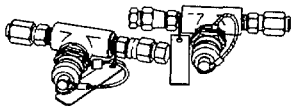
ITEM	NOMENCLATURE	PART NUMBER [NSN]	USE TO:	ILLUSTRATION
84	Tester	4537408-110 (HT 250 R) [5220-01-170-4894]	Test Steering Pressure	
85	Hose	4537408-120 (F1053-022040) [4720-01-170-5016]	Test Steering Pressure	
86	Hose	4537408-130 (F1054-022050) [4720-01-170-5015]	Test Steering Pressure	
87	Connector	4537408-140 (F1054-037540) [5120-01-170-4893]	Test Steering Pressure	
88	Connector	4537408-150 (F1054-037550)	Test Steering Pressure	
89	Connector	4537408-160 (F1054-037560) [4730-01-170-6730]	Test Steering Pressure	 TA259362

TABLE 2-1. SPECIAL TOOLS AND TEST EQUIPMENT (CONTINUED)

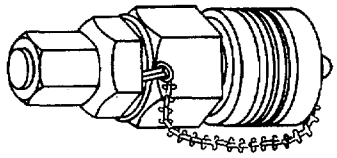
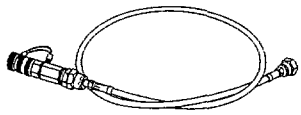
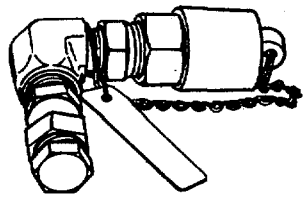
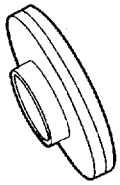
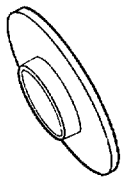
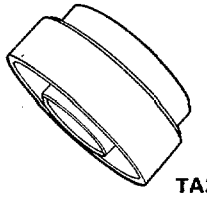
ITEM	NOMENCLATURE	PART NUMBER [NSN]	USE TO:	ILLUSTRATION
90	Connector	4537408-170 (F1054-037470) [5120-01-170-4892]	Test Steering Pressure	
91	Hose	4537408-180 (F1054-037480) [4720-01-170-5014]	Test Steering Pressure	
92	Connector	4537408-190 (F1054-037490) [5120-01-170-6678]	Test Steering Pressure	
93	Alignment Tool	4537408-079 (F1054-037230) [5120-01-166-2003]	Replace Torsion Springs	
94	Alignment Tool	4537408-080 (F1054-037280) [5120-01-166-1991]	Replace Torsion Springs	
95	Adapter	4537408-081 (F1054-037220) [5120-01-166-1996]	Replace Torsion Springs	 TA259363

TABLE 2-1. SPECIAL TOOLS AND TEST EQUIPMENT (CONTINUED)

ITEM	NOMENCLATURE	PART NUMBER [NSN]	USE TO:	ILLUSTRATION
96	Spacer	4537408-082 (F1054-037240) [5220-01-167-1739]	Replace Torsion Springs	
97	Adapter	4537408-083 (F1054-037270) [5120-01-166-1999]	Replace Torsion Springs	
98	Nut	4537408-084 (F1054-037210) [5310-01-166-1994]	Replace Torsion Springs	
99	Spacer, Sleeve	4537408-085 (F1053-022020) [5365-01-167-1948]	Replace Torsion Springs	
100	Spacer, Split Ring	4537408-086 (F1054-037250) [5220-01-167-1786]	Replace Torsion Springs	
101	Spacer, Split Ring	4537408-087 (F1054-037260) [5220-01-167-1785]	Replace Torsion Springs	TA259364

TABLE 2-1. SPECIAL TOOLS AND TEST EQUIPMENT (CONTINUED)

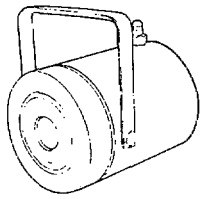
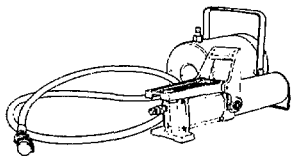
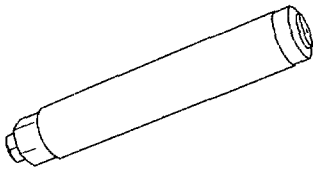
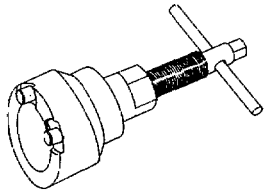
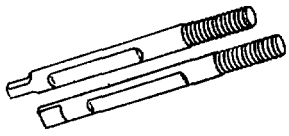
ITEM	NOMENCLATURE	PART NUMBER [NSN]	USE TO:	ILLUSTRATION
102	Drawbar	4537408-088 (F1053-022010) [2450-01-167-1911]	Replace Torsion Springs	
103	Hole Cylinder	4537408-089 (1-CHF660A)	Replace Torsion Springs	
104	Pump	4537408-090 (1PP61123) [4320-01-169-5160]	Replace Torsion Springs	
105	Wrench, Tap	615589000700 (4537408-069) [5120-01-170-6685]	Install *Precombustion* Chamber	
106	Extractor	615589003300 (4537408-071) [5120-01-169-5135]	Remove Precombustion Chamber	
107	Guide Pins	4537409-005 (F1054-036420)	Align Primary Pump	 TA259365

TABLE 2-2. FABRICATED TOOLS AND TEST EQUIPMENT

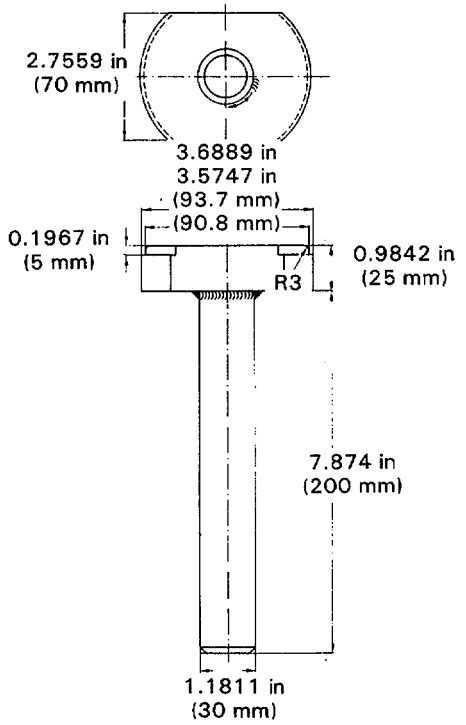
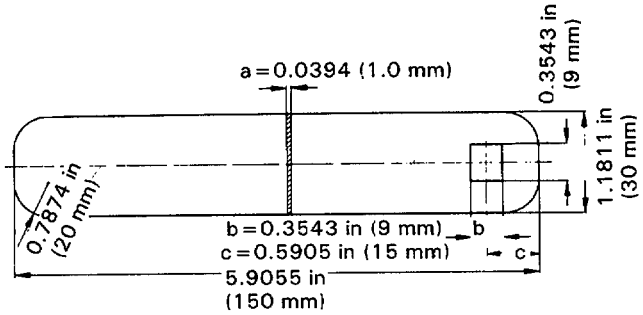
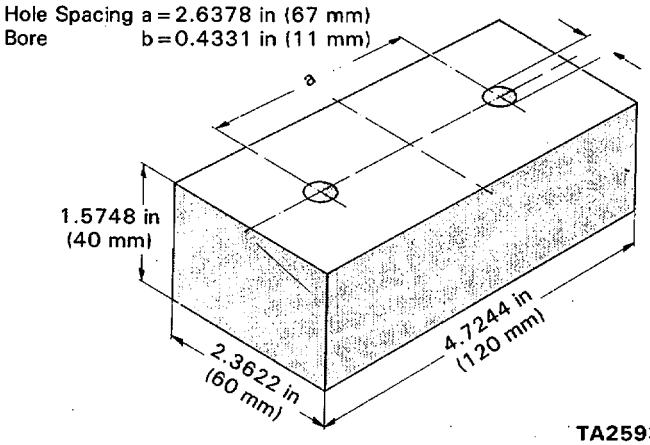
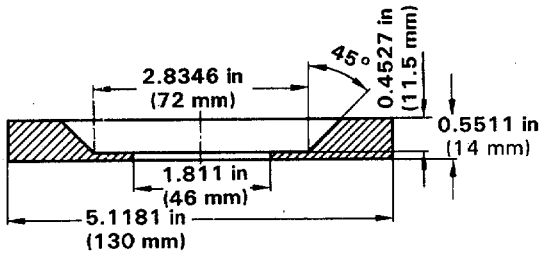
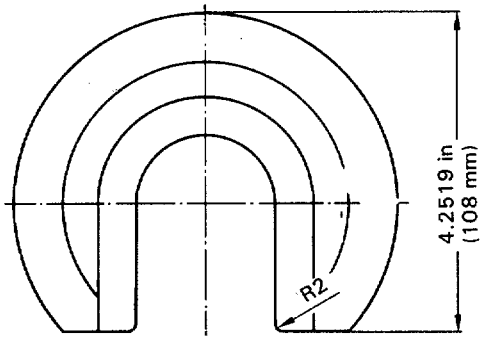
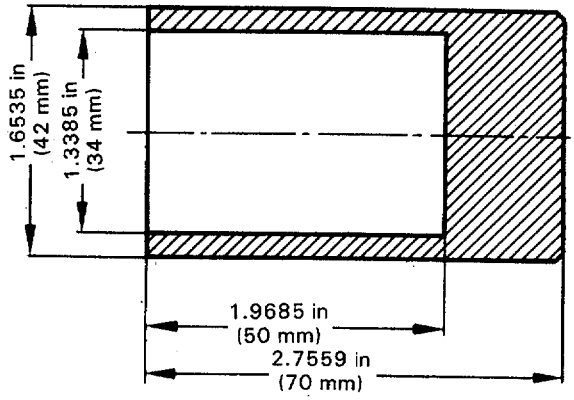
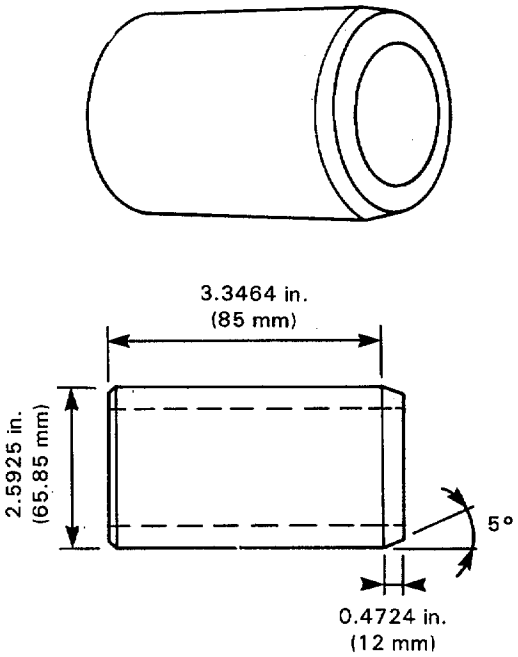
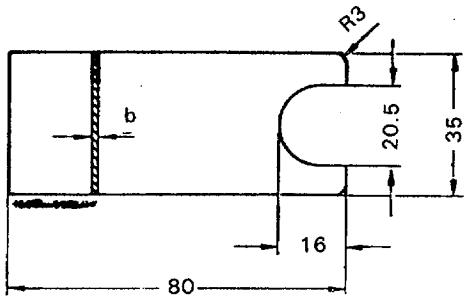
ITEM	NOMENCLATURE	USE TO:	ILLUSTRATION
1	Mandrel (Brass)	Removing or Replacing Cylinder Liners	
2	Gage (Steel)	For Cutting off Rear Radial Sealing Ring	
3	Block (Steel)	Removing or Replacing Connecting Rod Bolts	

TABLE 2-2. FABRICATED TOOLS AND TEST EQUIPMENT (CONTINUED)

ITEM	NOMENCLATURE	USE TO:	ILLUSTRATION
4	Remover (Steel)	Remove Water Pump Impeller	 
5	Sleeve (Steel)	Press in Water Pump Seal	

TA259367

TABLE 2-2. FABRICATED TOOLS AND TEST EQUIPMENT (CONTINUED)

ITEM	NOMENCLATURE	USE TO:	ILLUSTRATION
6	Mandrel (Brass)	Remove Starter Pole Pieces	
7	Spacing Plate (Steel)	Replace Water Pump Fan Hub	

TA259368

Section II. TROUBLESHOOTING INSTRUCTIONS

2-5. HOW TO USE TROUBLESHOOTING TABLES FAULT ISOLATION.

a. Troubleshooting is a logical way to find the cause of equipment failures. Many components are dependent on one another. Mechanical components are generally powered by electrical, pneumatic or hydraulic power. The fault may be electrical, pneumatic or hydraulic and appear to be mechanical. Follow the troubleshooting tables exactly.

b. Your manual cannot list all possible faults. Do the following procedures for problems not covered in the tables. Identify the faulty system. Use test, measurement, and diagnostic test equipment to determine the defective component.

c. Section III contains troubleshooting tables needed to fault isolate component failures. A symptom index is located at the beginning. The symptom index helps you locate fault symptoms quickly in each table.

d. The troubleshooting table has three columns of important information. The columns are explained below:

Column 1 - Lists the malfunction. The malfunction and malfunction number is in the symptom in index for quick reference.

Column 2 - Lists the test or inspection.

Column 3 - Lists the corrective action needed.

e. How to troubleshoot.

Follow the steps below to troubleshoot.

NOTE

Perform all vehicle before operation checks before using this table. Refer to TM 9-2350-272-10.

Step 1. Locate the malfunction number in the symptom index.

Step 2. Read down the left column of the troubleshooting table. Find the number located in the index.

Step 3. Perform the tests or inspections listed.

Step 4. Perform the corrective action in the order listed.

Step 5. Notify your supervisor under these conditions.

- Malfunctions not listed.
- Malfunctions not corrected after the-corrective action is completed.

NOTE

Malfunctions may have more than one probable cause. Complete all tests/inspections for each probable cause to find the correct cause.

f. How to use component test procedures.

Component test procedures are shown before the removal and replacement procedures for the component.

(1) Follow all warnings, cautions, and notes during the tests.

(2) Follow the steps shown below for the-test procedures.

Step 1 Locate the test number given in the troubleshooting table.

Step 2. Perform the steps in the test. Record a reading. Go back to the troubleshooting table. The test procedures tell you if the component is good or bad; The tables tell you when to replace components.

Section III. TROUBLESHOOTING SYMPTOM INDEX

ENGINE MALFUNCTIONS

POWER TRAIN MALFUNCTIONS

STEERING SYSTEM MALFUNCTIONS

BRAKE SYSTEM MALFUNCTIONS

TRACK ASSEMBLY MALFUNCTIONS

WINCH MALFUNCTIONS

TROUBLESHOOTING

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

ENGINE MALFUNCTIONS

1. ENGINE FAILS TO CRANK.

Remove starter. Refer to TM 9-2350-272-20. Rotate engine manually.
Inspect fly wheel ringgear for chipped or broken teeth.
Replace damaged flywheel. Refer to paragraph 3-18.

2. ENGINE CRANKS BUT FAILS TO START.

Step 1. Test fuel supply pump. Refer to paragraph 4-9.
Replace defective pump. Refer to TM 9-2350-272-20.
Stop 2. Check injection pump for start of delivery. Refer to paragraph 4-7.
Adjust start of delivery. Refer to paragraph 4-7.
Step 3. Check camshaft timing. Refer to paragraph 3-5.
Adjust camshaft timing. Refer to paragraph 3-5.
Step 4. Check valve adjustment. Refer to paragraph 3-4.
Adjust valves. Refer to paragraph 3-4.

3. ENGINE LACKS POWER OR RUNS ERRATICALLY.

Step 1. Test fuel supply pump. Refer to paragraph 4-9.
Replace defective pump. Refer to TM 9-2350-272-20.
Step 2. Check injection pump start of delivery. Refer to paragraph 4-7.
Adjust start of delivery. Refer to paragraph 4-7.
Replace defective injection pump. Refer to paragraph 4-5.
Stop 3. Test turbocharger boost pressure. Refer to paragraph 4-10.
Replace defective turbocharger. Refer to TM 9-2350-272-20.
Step 4. Test fuel injection nozzles. Refer to paragraph 4-4.
Replace defective injection nozzles. Refer to paragraph 4-2.
Step 5. Check valve adjustment. Refer to paragraph 3-4.
Adjust valves. Refer to paragraph 3-4.
Step 6. Test compression. Refer to paragraph 3-3.
Replace defective head gasket. Refer to paragraph 3-8.
Repair defective pistons. Refer to paragraph 3-17.
Repair defective cylinder head. Refer to paragraph 3-9.
Step 7. Test cylinder head. Refer to paragraph 3-10.
Replace defective cylinder head. Refer to paragraph 3-8.
Step 8. Check camshaft timing. Refer to paragraph 3-5.
Adjust camshaft timing. Refer to paragraph 3-5.
Replace defective timing chain. Refer to paragraph 3-27.

TROUBLESHOOTING (CONTINUED)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

4. ENGINE SMOKES EXCESSIVELY.

Step 1. Test fuel injection nozzles. Refer to paragraph 4-4.
Replace defective fuel injection nozzles. Refer to paragraph 4-2.
Step 2. Check injection pump start of delivery. Refer to paragraph 4-7.
Adjust injection pump start of delivery. Refer to paragraph 4-7.
Replace defective pump. Refer to paragraph 4-5.
Step 3. Check engine valve adjustment. Refer to paragraph 3-4.
Adjust engine valves. Refer to paragraph 3-4.

5. ENGINE OVERHEATS.

Step 1. Check oil filter thermostat. Refer to paragraph 3-29.
Replace defective oil thermostat. Refer to paragraph 3-29.
Step 2. Check oil spray nozzles. Refer to paragraph 3-28.
Replace defective oil spray nozzles. Refer to paragraph 3-28.

6. LOW OIL PRESSURE.

Step 1. Check oil filter housing.
Replace defective oil thermostat. Refer to paragraph 3-29.
Step 2. Check oil pressure relief valve.
Replace defective valve. Refer to paragraph 3-32.
Step 3. Check oil pump.
Replace defective oil pump. Refer to paragraph 3-31.
Step 4. Check engine main oil ducts. Refer to paragraph 3-12.
Repair engine main oil ducts. Refer to paragraph 3-12.

POWER TRAIN MALFUNCTIONS

TRANSMISSION

1. TRANSMISSION DOES NOT AUTOMATICALLY SHIFT.

Step 1. Test modulating pressure. Refer to paragraph 7-25.
Adjust modulating pressure. Refer to paragraph 7-25.
Step 2. Test working pressure. Refer to paragraph 7-25.
Adjust working pressure. Refer to paragraph 7-25.
Repair transmission. Refer to paragraph 7-19.
Step 3. Test governor pressure. Refer to paragraph 7-26.
Repair transmission. Refer to paragraph 7-19.

TROUBLESHOOTING (CONTINUED)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

2. TRANSMISSION SLIPS.

Test working pressure. Refer to paragraph 7-25.
Adjust working pressure. Refer to paragraph 7-25.
Repair defective transmission. Refer to paragraph 7-1 9.

3. TRANSMISSION WILL NOT UPSHIFT TO SECOND GEAR.

Step 1. Check first gear solenoid.
Replace defective solenoid. Refer to paragraph 7-1 9.
Step 2. Inspect centrifugal governor.
Replace defective centrifugal governor. Refer to paragraph 7-1 9.
Refer to transmission troubleshooting chart on page 2-31.

4. TRANSMISSION DOES NOT OPERATE IN "D" POSITION. REVERSE OPERATES PROPERLY.

Check for broken B2 brake band.
Replace defective brake band. Refer to paragraph 7-20.
Replace defective valve unit. Refer to paragraph 7-1 9.
Refer to transmission troubleshooting chart on page 2-31.

5. TRANSMISSION DOES NOT OPERATE IN REVERSE.

Step 1. Check brake band B3.
Replace defective brake band B3. Refer to paragraph 7-20.
Step 2. Check for defective clutch K2.
Repair defective transmission. Refer to paragraph 7-22.
Refer to transmission troubleshooting chart on page 2-31.

6. TRANSMISSION SHIFTS ERRATICALLY.

Check valve unit for leaks.
Replace defective valve unit. Refer to paragraph 7-1 9.
Refer to transmission troubleshooting chart on page 2-31.

TROUBLESHOOTING

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

7. NOISY TRANSMISSION.

Step 1. Check secondary pump.
Replace defective secondary pump. Refer to paragraph 7-24.
Step 2. Check primary pump.
Replace defective primary pump. Refer to paragraph 7-23.

TRANSMISSION TROUBLESHOOTING CHART

Activated components in different gear positions.

		GEAR SHIFT LEVER POSITION					
C		R	1	2	3	4	
O	F	X	X				
M	B1			X			F = ONE WAY ROLLER
P							CLUTCH
O	B2		X	X	X		B = BRAKE BAND
N	B3	X					K = CLUTCH
E	K1				X	X	
N	K2	X	X			X	
T							
S							

TRANSFER

8. TRANSFER NOISY.
Inspect gears and bearings in transfer. Refer to paragraph 8-3.
Repair defective transfer. Refer to paragraph 8-3.

9. TRANSFER WILL NOT SHIFT.

Inspect transfer gears. Refer to paragraph 8-3.
Repair defective transfer. Refer to paragraph 8-3.

10. TRANSFER LOCKED.

Inspect gears and bearings in transfer. Refer to paragraph 8-3.
Repair defective transfer. Refer to paragraph 8-3.

DIFFERENTIAL

11. DIFFERENTIAL NOISY.

Inspect differential gears and bearings. Refer to paragraph 9-7.
Repair defective differential. Refer to paragraph 9-7.

TROUBLESHOOTING

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

12. DIFFERENTIAL LOCKED.

Inspect differential gears and bearings. Refer to paragraph 9-7.
Repair defective differential. Refer to paragraph 9-7.

STEERING SYSTEM MALFUNCTIONS

1. VEHICLE STEERS HARD TO BOTH SIDES.

Step 1. Test power steering hydraulic pump. Refer to paragraph 12-14.
Replace defective pump. Refer to TM 9-2350-272-20.
Step 2. Test power steering hydraulic valve. Refer to paragraph 12-14.
Replace defective valve. Refer to paragraph 12-4.
Step 3. Test servo valve. Refer to paragraph 12-14.
Replace defective servo valve. Refer to paragraph 12-5.
Step 4. Inspect steering unit pivot for damage.
Replace damaged steering unit. Refer to paragraph 12-10.

2. VEHICLE STEERS HARD TO ONE SIDE, BUT EASILY TO OTHER SIDE.

Step 1. Test power steering hydraulic valve. Refer to paragraph 12-14.
Replace defective valve. Refer to paragraph 12-4.
Step 2. Test servo valve-. Refer to paragraph 12-14.
Replace defective servo valve. Refer to paragraph 12-5.
Step 3. Test steering cylinders. Refer to paragraph 12-14.
Replace defective steering cylinder. Refer to paragraph 12-6.

3. STEERING PULLS TO ONE SIDE.

Step 1. Test power steering hydraulic valve. Refer to paragraph 12-14.
Replace defective power steering hydraulic valve. Refer to paragraph 12-14.
Step 2. Test servo valve. Refer to paragraph 12-14.
Replace defective servo valve. Refer to paragraph 12-5.
Step 3. Test steering cylinders. Refer to paragraph 12-14.
Replace defective steering cylinder. Refer to paragraph 12-6.

4. VEHICLE WILL NOT STEER WITH ENGINE OFF; STEERING NORMAL WITH ENGINE RUNNING.

Test power steering hydraulic valve. Refer to paragraph 12-14.
Replace power steering hydraulic valve. Refer to paragraph 12-4.

TROUBLESHOOTING

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

BRAKE SYSTEM MALFUNCTIONS

1. BRAKES DO NOT STOP VEHICLE.

Step 1. Check master cylinder for leaks.
Repair defective master cylinder. Refer to paragraph 10-5.
Step 2. Check brake calipers.
Repair defective brake caliper. Refer to paragraph 10-6.

2. PARKING BRAKE WILL NOT HOLD VEHICLE.

Check right side brake caliper for proper operations.
Repair defective brake caliper. Refer to paragraph 10-6.

TRACK ASSEMBLY MALFUNCTIONS

WHEELS DO NOT SET PROPERLY ON TRACK.

Inspect torsion spring.
Replace defective torsion spring. Refer to paragraph 11-6.

WINCH MALFUNCTIONS

1. WINCH WILL NOT OPERATE. RELAYS CANNOT BE HEARD WHEN REMOTE CONTROL IS OPERATED.

Step 1. Disconnect two wires from motor themo switch. Connect wires together. Operate winch. If winch operates themo switch is defective. If winch does not operate reconnect wires to themo switch.
Replace defective themo switch. Refer to paragraph 14-4.

Step 2. Check relays. Refer to paragraph 14-3.
Replace defective relay. Refer to paragraph 14-3.

2. WINCH WILL NOT OPERATE. RELAYS CAN BE HEARD WHEN REMOTE CONTROL IS OPERATED.

Check relay. Refer to paragraph 14-3.
Replace defective relay. Refer to paragraph 14-3.
If relay is not defective repair winch motor. Refer to paragraph 14-4.

TROUBLESHOOTING

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

3. WINCH WILL NOT WIND IN UNDER LOAD.

Step 1. Check protective relay. Refer to paragraph 14-3.
Replace defective relay. Refer to paragraph 14-3.
Step 2. Check motor themo switch.
Replace defective motor themo switch. Refer to paragraph 14-4.
Step 3. Check load limiting microswitch. Refer to paragraph 14-3.
Replace defective switch. Refer to paragraph 14-3.
Step 4. Check adjustment of load limiting device. Refer to paragraph 14-10.
Adjust load limiting device. Refer to paragraph 14-10.

4. WINCH BRAKE WILL NOT HOLD LOAD.

Check brake free wheel and brake linings. Unlock drum lock. Pull winch cable quickly. Drum should stop turning immediately.
Replace defective free wheel or brake linings. Refer to paragraph 14-7.

CHAPTER 3
REPAIR OF ENGINE

Section I. DESCRIPTION AND DATA

3-1. DESCRIPTION.

The 617.952 engine is a water cooled, five cylinder, four stroke diesel engine. The cylinders are inline. The engine is a OHV with the camshaft over the cylinder head. The lubrication system is forced circulation type with a thermostat controlled oil cooler to cool the oil. The oil also cools the pistons by means of oil spray nozzles in each cylinder.

The 617.952 engine is fitted with an exhaust turbocharger to produce an increase in horsepower.

3-2. TECHNICAL DATA.

Engine make	Mercedes-Benz
Type	OM617.952
Maximum power rating at 4350 RPM	125 BHP (92 KW)
Maximum torque rating at 2400 RPM	184.5 lb. ft. (250 Nm)
Number of cylinders	5
Cylinder bore	3.5787 in. (90.9 mm)
Stroke	3.6378 in. (92.4 mm)
Compression ratio	21.5:1

NOTE

During general support overhaul of the engine, all maintenance tasks listed in Chapter 3 must be performed. Defective components will be replace by new components to restore the engine to operational readiness.

NOTE

The power pack must be removed to perform maintenance tasks 3-5 through 3-28 and 3-30 through 3-33.

Section II. REPAIR ENGINE

3-3. COMPRESSION TEST.

Step 1. Start engine. Operate engine until temperature gage shows operating temperature.
Step 2. Stop engine.
Step 3. Remove injectors.
Step 4. Push and hold manual shut off lever.
Step 5. Turn ignition switch to start. Allow engine to turn over several times. Release ignition switch.
Step 6. Release manual shut off lever.
Step 7. Connect compression tester.
Step 8. Push and hold manual shut off lever.
Step 9. Turn ignition switch to start position. Allow engine to turn over at least eight revolutions. Release ignition switch.
Step 10. Release manual shut off lever.
Step 11. Read compression tester. Normal compression is 348 to 435 PSI (24 to 30 bar).
Step 12. Remove tester.
Step 13. Repeat steps 7 through 13 until all cylinders have been tested. Compression difference between cylinders can not exceed 44 PSI (3 bar).
Step 14. Replace injectors. Torque injectors 52 to 59 lb. ft. (70 to 80 Nm).

3-4. ADJUST ENGINE VALVES.

NOTE

Engine valve adjustments should be adjusted with the engine cold 68°F (20°C), but can be adjusted with the engine warm 140°F± 59°F (60°C± 15°C). See engine valve adjustment guide below:

ENGINE VALVE ADJUSTMENT GUIDE

VALVE CLEARANCE	ENGINE COLD	ENGINE WARM
	68°F(20°C)	140°F ± 59°F(60°C± 15°C)
Intake	0.004* (0.10* mm)	0.006* (0.15* mm)
Exhaust	0.014 (35 mm)	0.016 (0.40 mm)
*Add 0.002 (0.05 mm) if outside temperatures are continually below -4°F(-20°C).		

Step 1. Remove crankcase ventilation hose, linkages and cylinder head cover.

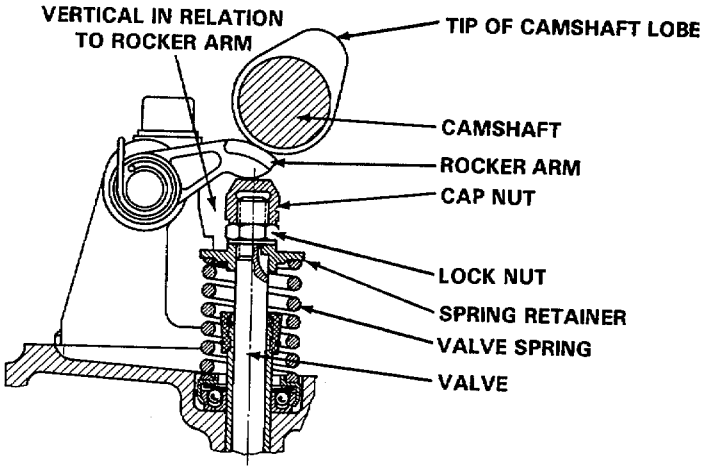
NOTE

When performing engine valve adjustments, adjust valve clearances in cylinder firing order, 1-2-4-5-3, beginning with number 1 cylinder.

CAUTION

Do not rotate engine at mounting bolt of camshaft sprocket. Do not rotate crankshaft backwards. Damage to the engine may result.

Step 2. Use 27 mm socket. Turn engine in direction of rotation and bring number 1 cylinder up on Top Dead Center (TDC) with both intake and exhaust valves closed, rocker arms free and tip of cam lobe vertical in relation to rocker arm.

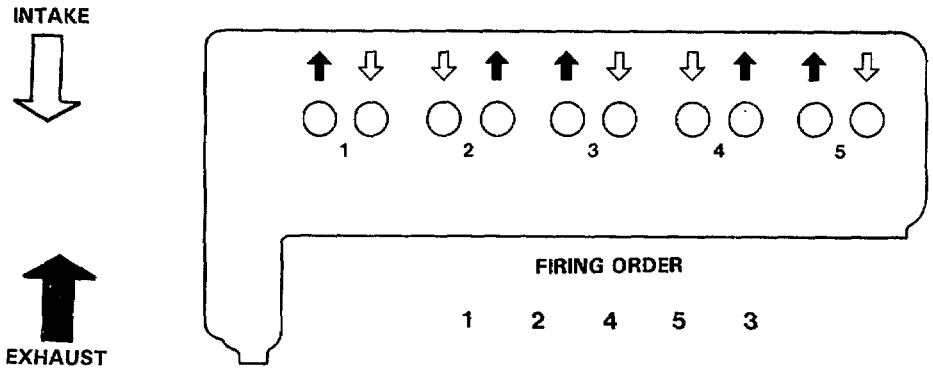


NOTE

Valve clearance is correctly set when a slight drag is felt on gage.

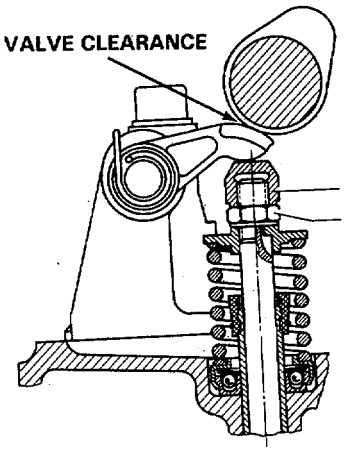
Step 3. Observe location of intake and exhaust valves. See valve location guide below.

VALVE LOCATION GUIDE



TA259369

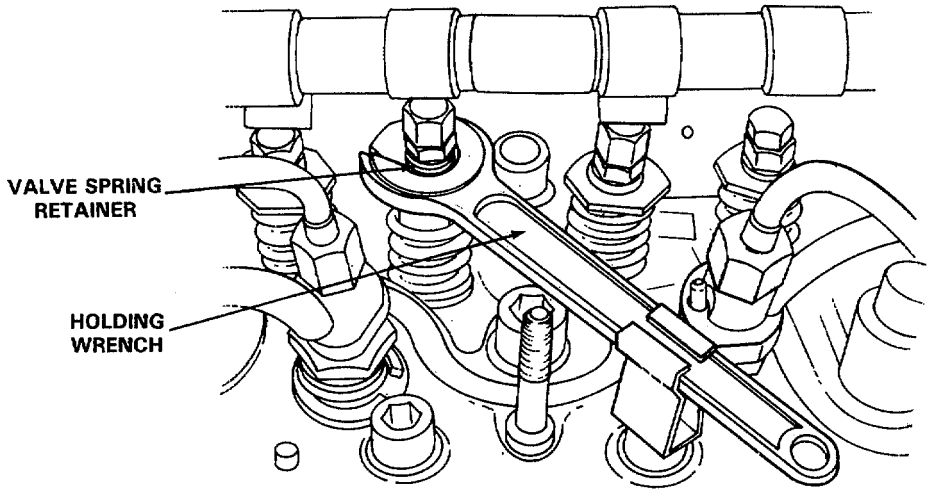
Step 4. Use feeler gage. Check valve clearance between slide surface of rocker arm and cam base circle of camshaft.



NOTE

When making valve adjustments, check cap nut and lock nut for tight seat and wear.

Step 5. To adjust valve clearance, use holding wrench on valve spring retainer. Refer to table 2-1, item 9.

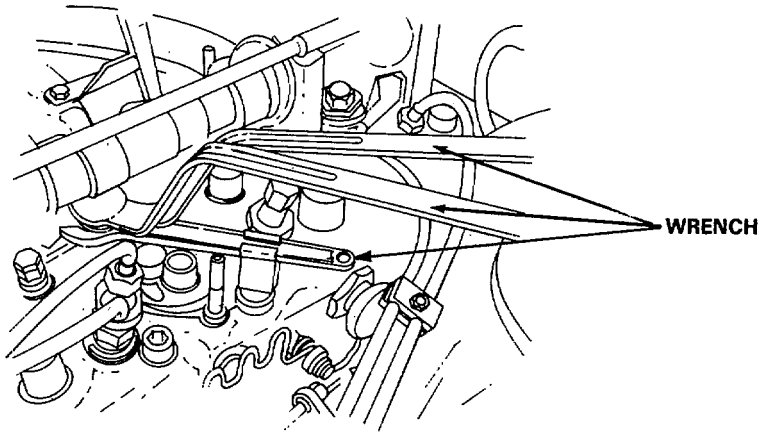


Step 6. Use two wrenches. Loosen cap nut while holding lock nut. Refer to table 2-1, item 4.
Step 7. Use feeler gage. Put in place between slide surface of rocker arm and cam base circle of camshaft.

TA259370

Step 8. Use wrenches. Adjust clearance by turning cap nut. Refer to table 2-1, items 4 and 9.

Step 9. Use wrenches. Tighten and torque lock nut 15 to 22 lb. ft. (20 to 30 Nm) while holding cap nut.



Step 10. Check valve clearance.

Step 11. Repeat steps to check and adjust remaining engine valves.

Step 12. Put cylinder head cover, linkages and crankcase ventilation hose in place. Tighten cylinder head cover nuts to 11 lb. ft. (15 Nm).

TA259371

3-5. CHECK AND ADJUST CAMSHAFT TIMING.

a. General Information.

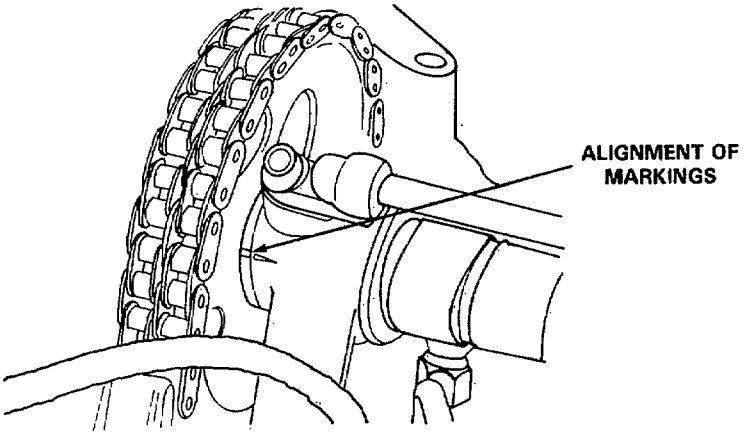
CAMSHAFT TIMING DATA GUIDE

Timing at 0.0787 in (2 mm) valve lift					
Engine	Camshaft code number[1])	Intake valve opens after TDC	closes after BDC	Exhaust valve opens before BDC	closes before TDC
617.952	05[2])	with new timing chain			
		9 °	15 °	27 °	16 °
		with used timing chain (from approx. 12,000 miles (20,000 km)			
		11 °	17 °	25 °	14 °

[1]) Camshaft code number is punched into rear end of camshaft.
[2]) Camshaft made of chilled cast iron.

NOTE

During assembly, alignment of markings in ignition TDC position of the 1st cylinder is made.



NOTE

In special cases, e.g., complaints about performance, check and adjust beginning of opening at intake valve of 1st cylinder. Timing is measured at 0.0787 in. (2mm) valve lift. For this purpose, the valve clearance must be neutralized.

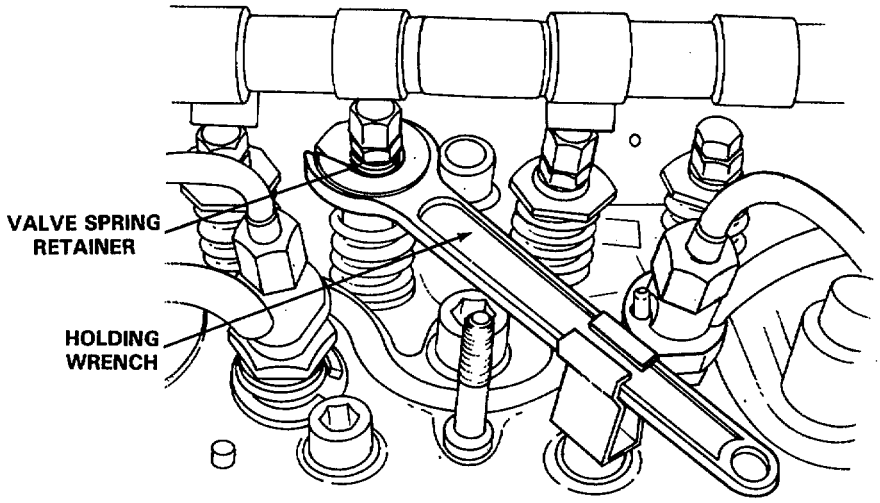
b. Checking Camshaft Timing.

Step 1. Disconnect electrical wire from glow plugs.
Step 2. Loosen and remove glow plugs.
Step 3. Remove crankcase ventilation hose, linkages and cylinder head cover.

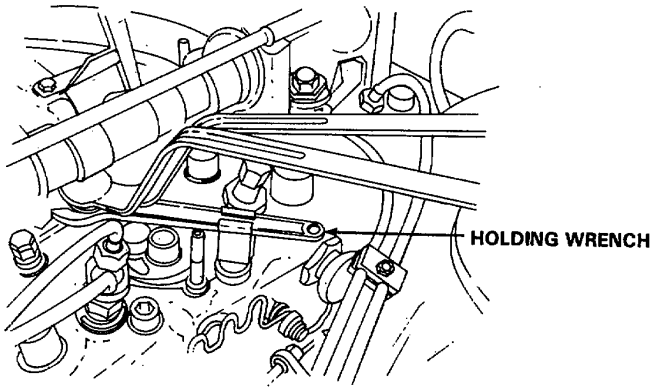
CAUTION

Do not rotate engine at mounting bolt of camshaft sprocket. Do not rotate crankshaft backwards. Damage to the engine may result.

Step 4. Use 27 mm socket. Turn engine crankshaft in direction of rotation until camshaft lobe tip is pointing upwards on intake valve of the number 1 cylinder.
Step 5. Use holding wrench to hold valve spring retainer. Refer to table 2-1, item 9.

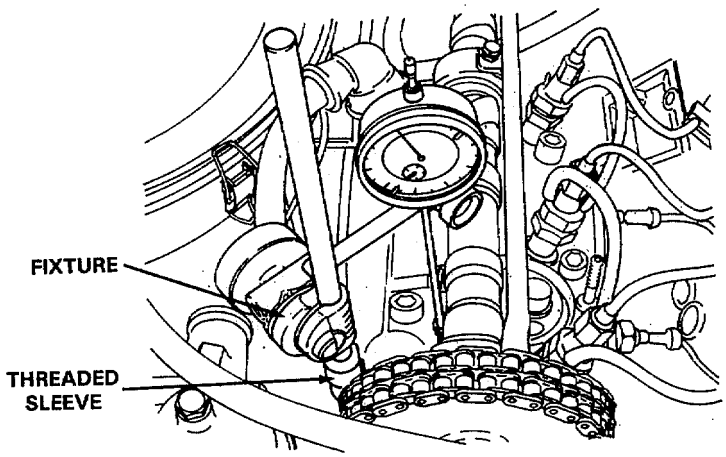


Step 6. Use wrenches. Loosen cap nut, while holding lock nut. Refer **to** table 2-1, item 4.
Step 7. Use wrench, turn cap nut up to cancel valve clearance on intake valve of number 1 cylinder.



TA259373

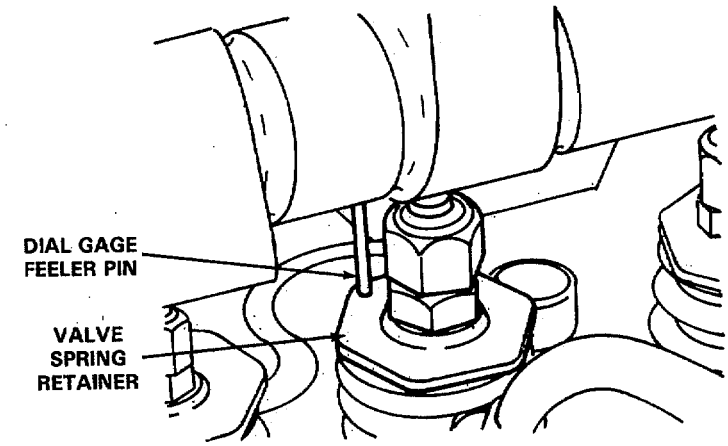
Step 8. Screw dial gage fixture with threaded sleeve onto stud at right front of head.



NOTE

Feeler pin of dial gage must be seated on valve spring retainer in a vertical position.

Step 9. Use dial gage. Put gage in place on fixture, and fasten so that dial gage feeler pin rest on number 1 cylinder intake valve spring retainer.



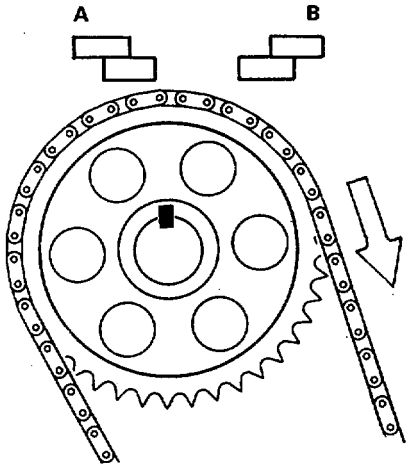
Step 10. Adjust dial gage on fixture to a preload of 0.1181 in. (3 mm).
Step 11. Turn dial of dial gage until large needle aligns with "O" on gage.
Step 12. Use 27 mm socket. Turn engine crankshaft in direction of rotation until small needle of dial gage has gone back 0.0787 in. (2 mm).
Step 13. Check the balancing disk indicator. It must be in agreement with the indicated valve "in take valve opens". Refer to camshaft timing data guide.

TA259374

c. Adjustment of Camshaft Timing.

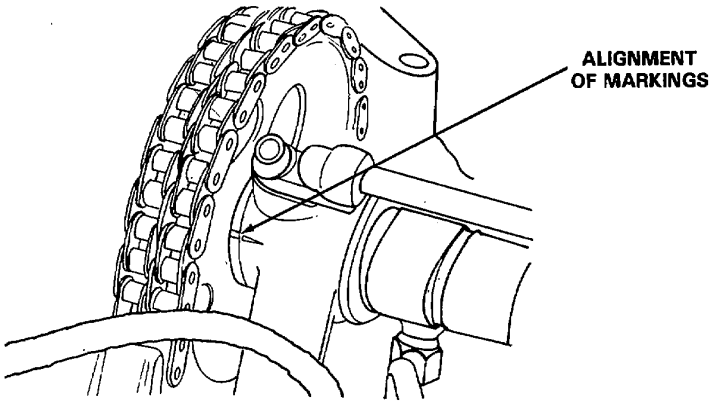
NOTE

If timing is out of adjustment, offset woodruff keys are available in 2°, 3°, 4°, and 5° offset.
If timing chain is excessively elongated, a new timing chain must be installed.
An offset by one tooth on camshaft sprocket results in approximately 18° at crankshaft.
An offset of woodruff keys to the right (Clockwise direction (A)) results in an earlier beginning of the valve opening.
An offset to the left (counter clockwise direction (B)) results in a later beginning of valve opening.



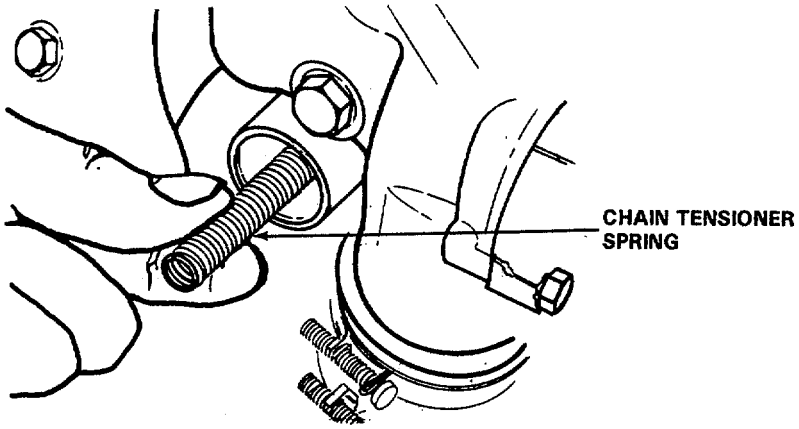
Step 1. Use 27 mm socket. Turn engine crankshaft in direction of rotation and set engine to ignition TDC position of the number 1 cylinder.

Step 2. Check alignment of markings in ignition TDC position of the 1st cylinder, at front camshaft support bracket.

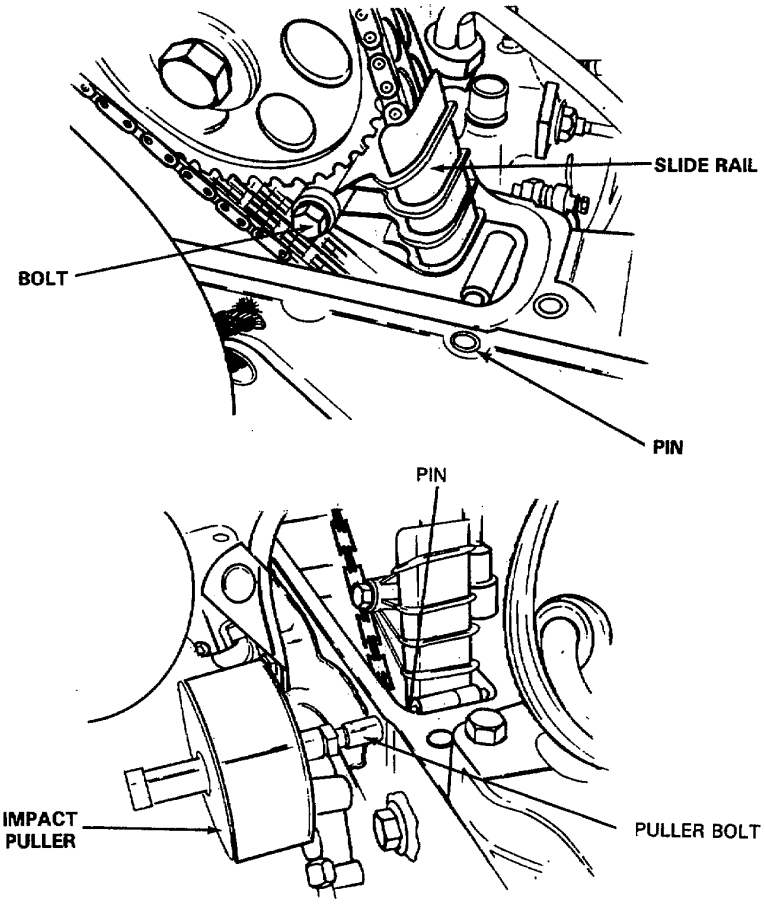


TA259375

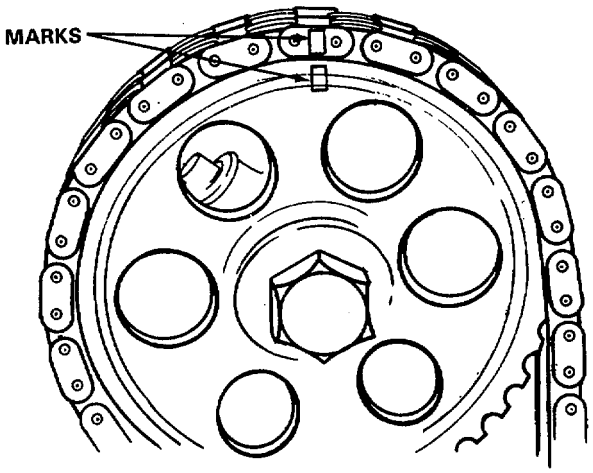
Step 3. Loosen and remove plug from chain tensioner.
Step 4. Remove chain tensioner spring.



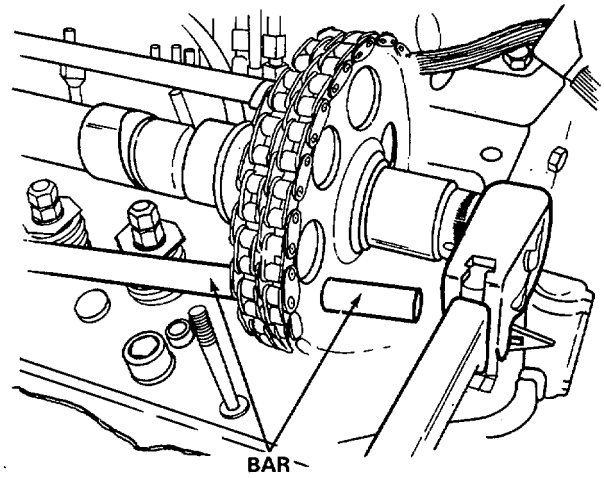
Step 5. Loosen and remove bolt from slide rail.
Step 6. Use impact puller and puller bolt. Remove pin from slide rail. Refer to table 2-1, items 2 and 3.
Step 7. Remove slide rail.



Step 8. Mark camshaft sprocket and timing chain.

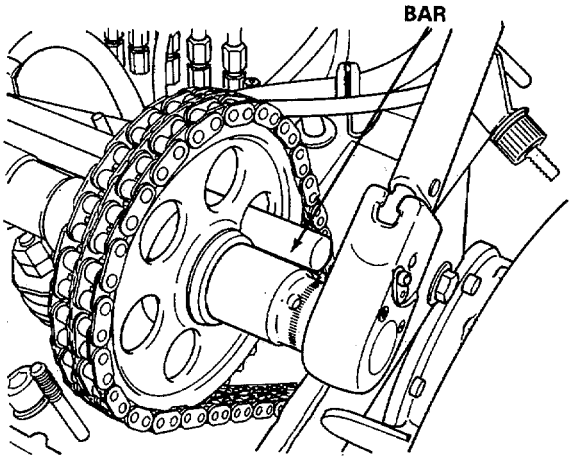


Step 9. Hold camshaft sprocket.
Step 10. Loosen and remove camshaft sprocket screw.
Step 11. Remove camshaft sprocket.

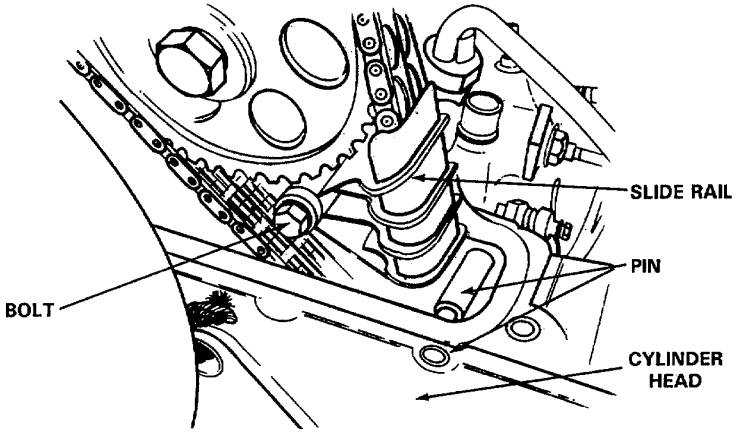


TA259377

Step 12. Place a rag under camshaft.
Step 13. Remove woodruff key.
Step 14. Select proper woodruff key.
Step 15. Put woodruff key in place in camshaft.
Step 16. Align marks while putting camshaft sprocket into timing chain.
Step 17. Put camshaft sprocket with timing chain in place on camshaft.
Step 18. Screw in camshaft sprocket screw to hold camshaft sprocket in place. Do not tighten screw.
Step 19. Check camshaft timing. Refer to paragraph 3-5b.
Step 20. If camshaft timing is incorrect do steps 10 through 19.
If camshaft timing is correct, do steps 21 through 33.
If camshaft timing cannot be corrected with offset woodruff keys, replace timing chain. Refer to paragraph 3-27.
Step 21. Hold camshaft sprocket.
Step 22. Torque camshaft sprocket screw to 59 lb. ft. (80 Nm).

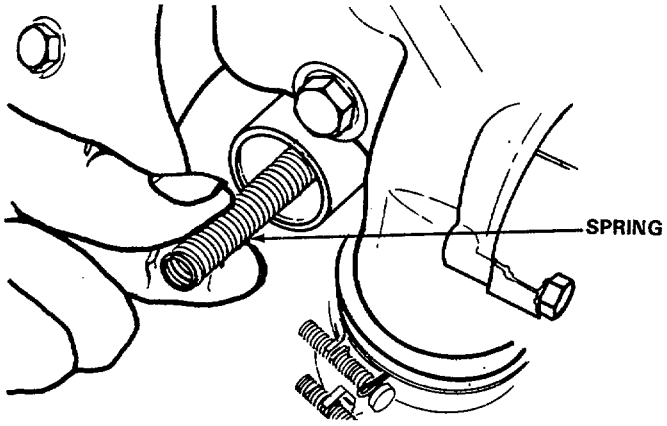


Step 23. Put slide rail in place.
Step 24. Put pin in place in slide rail and cylinder head.
Step 25. Screw in and tighten bolt in slide rail.

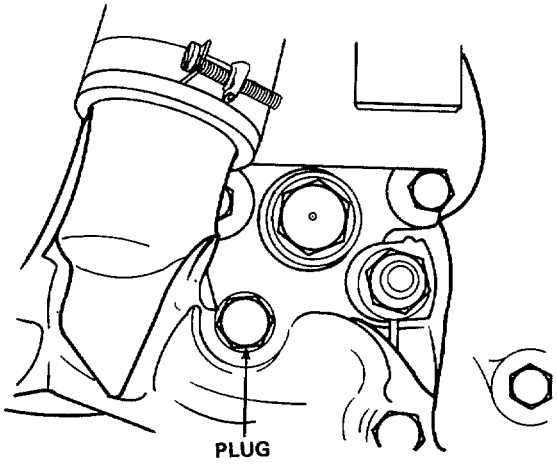


TA259378

Step 26. Put timing chain tensioner spring in place.



Step 27. Put plug and a new seal in place in timing chain tensioner.
Step 28. Torque plug to 66 lb. ft. (90 Nm).



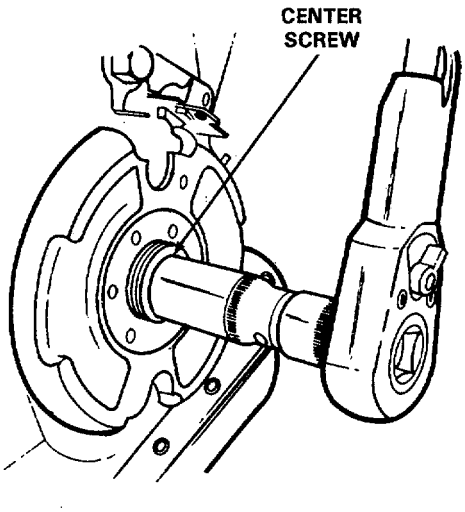
Step 29. Remove dial indicator, fixture, wrenches and holder.
Step 30. Adjust valve clearance at intake valve of number 1 cylinder. Refer to paragraph 3-4.
Step 31. Put cylinder head cover, linkages and crankcase ventilation hose in place. Torque cylinder head cover nuts to 11 lb. ft. (15 Nm).
Step 32. Screw in and tighten glow plugs.
Step 33. Connect electrical wire to glow plugs.

TA259379

3-6. REMOVE AND REPLACE PULLEY, VIBRATION DAMPER AND BALANCING DISC.

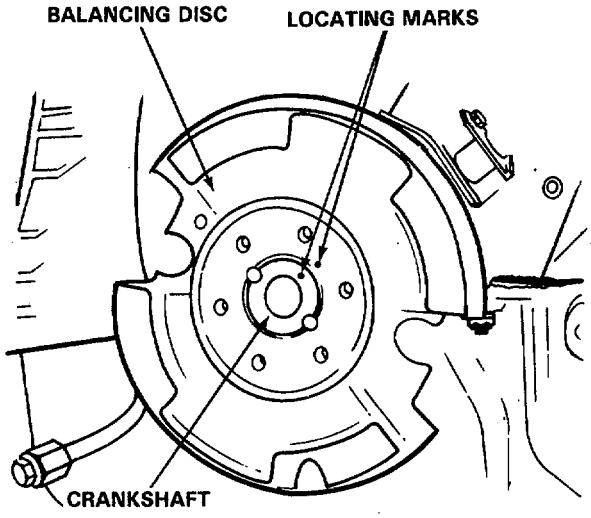
a. Remove.

Step 1. Remove water pump drive belt. Refer to TM 9-2350-272-20.
Step 2. Remove water pump pulley.
Step 3. Remove pulley mounting screws.
Step 4. Remove pulley.
Step 5. Remove vibration damper.
Step 6. Remove center screw and washers from crankshaft.



TA259380

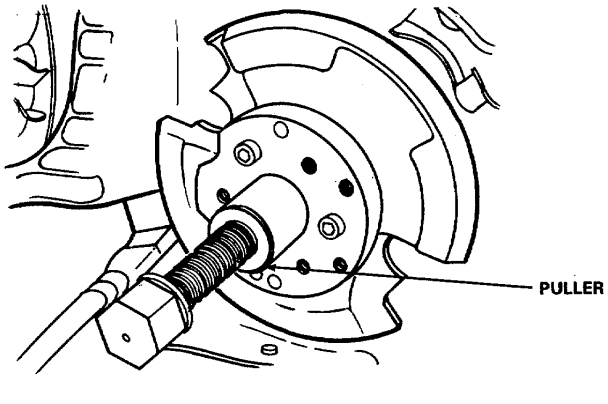
Step 7. **Punch locating marks into crankshaft and balancing disc.**



CAUTION

Do not screw puller screws all the way in. Damage to front seal may result.

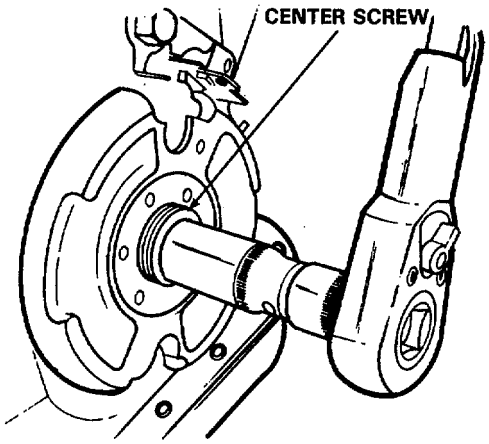
Step 8. Use puller. Remove balancing disc and dowel pins.



TA259381

b. Replace.

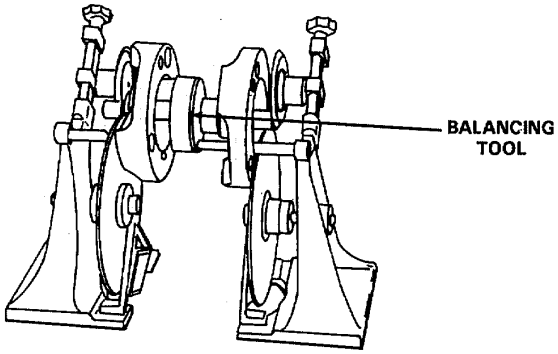
Step 1. Inspect balancing disc, pulley and damper for cracks or damage. Replace damaged part. A new balancing disc must be balanced. Refer to paragraph 3-7.
Step 2. Align locating marks on balancing disc and crankshaft. Put disc on crankshaft.
Step 3. Put in dowel pins.
Step 4. Put new cup washers on mounting screw, crown of washers toward head of screw.
Step 5. Put mounting screw in crankshaft. Torque screw to 199 to 244 lb. ft. (270 to 330 Nm).



Step 6. Put vibration damper on crankshaft
Step 7. Put in pulley and mounting screws. Torque screws to 1 8 lb. ft. (25 Nm).
Step 8. Put on water pump pulley.
Step 9. Install water pump drive belt. Refer to TM 9-2350-272-20.

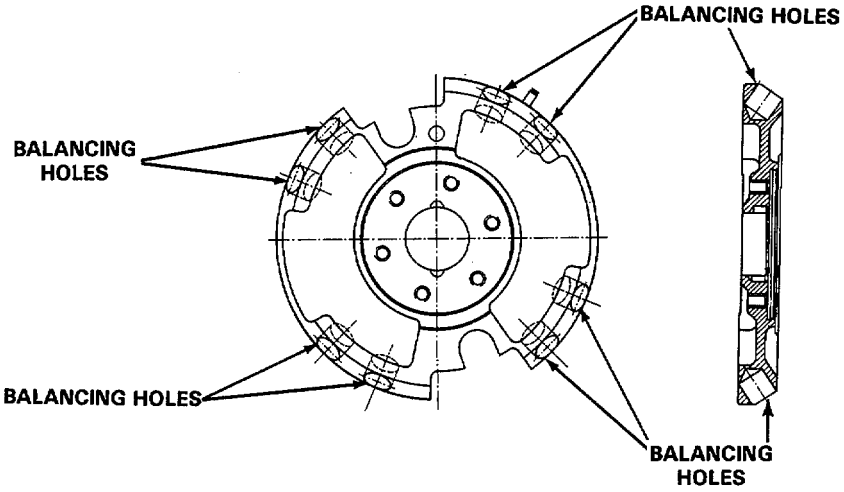
3-7. BALANCING THE BALANCING DISC.

Step 1. Transfer locating mark from old disc to new disc.
Step 2. Mount old and new balancing disc on balancing tooi. Refer to table 2-1, item 8. New disc must be mounted 1800 offset to old disc.
Step 3. Mount balancing discs with balancing tool on rotating fixture.



TA259382

Step 4. Rotate balancing discs and allow them to swing to a stop.

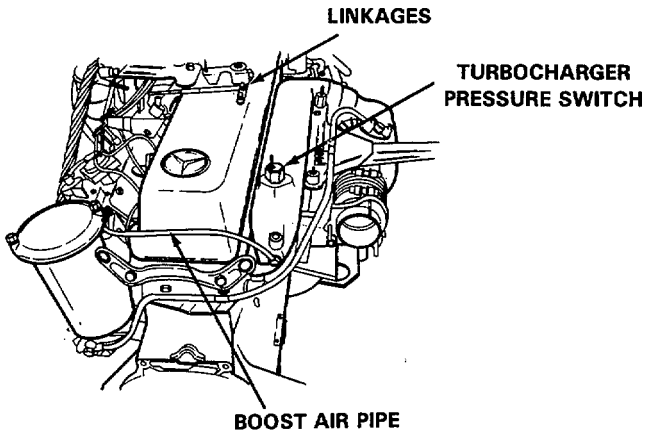


Step 5. Drill a balancing hole in heavy side of new disc. Refer to balancing holes in old disc for proper drilling angle. Maximum drilling depth is 0.59 in. (1 5 mm).

3-8. REMOVE AND REPLACE CYLINDER HEAD.

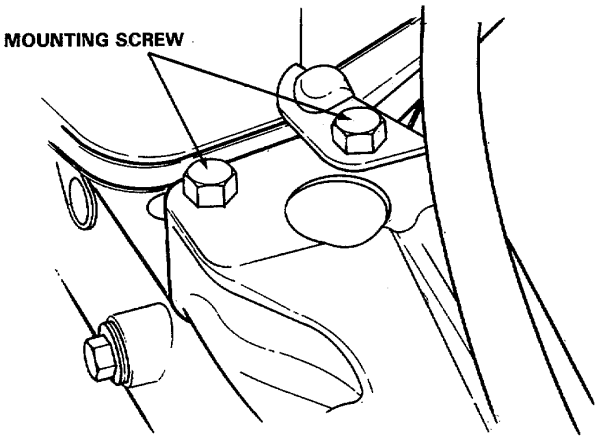
a. Remove.

Step 1. Remove power pack. Refer to TM 9-2350-272-20**.**
Step 2. Disconnect oil supply line from turbocharger**.**
Step 3. Remove fuel injection lines.
Step 4. Disconnect fuel return line from number one fuel injector**.**
Step 5. Remove fuel filter assembly.
Step 6. Remove linkages from cylinder head cover**.**
Step 7. Disconnect wiring harness from glow plugs and temperature switch**.**
Step 8. Disconnect wire from turbocharger pressure switch.

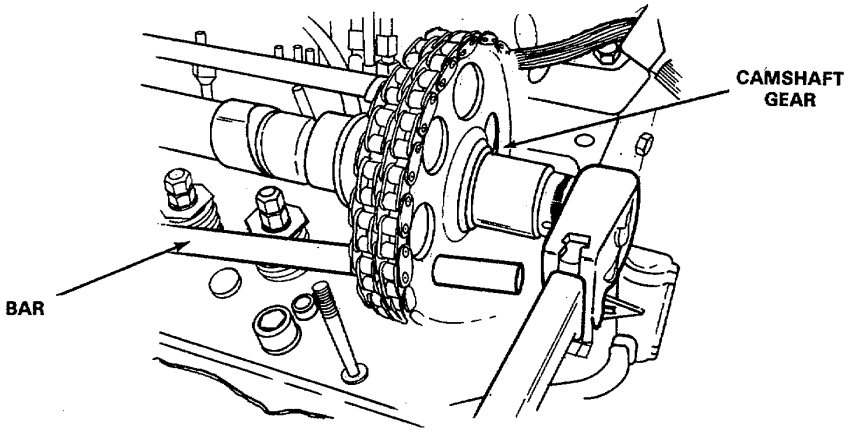


TA259383

Step 9. Remove turbocharger. Refer to TM 9-2350-272-20**.**
Step 10. Disconnect exhaust manifold support from manifold.

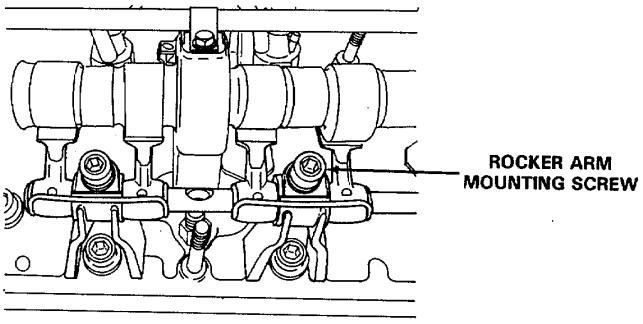


Step 11. Remove cylinder head cover.
Step 12. Hold camshaft gear. Remove camshaft gear mounting screw.

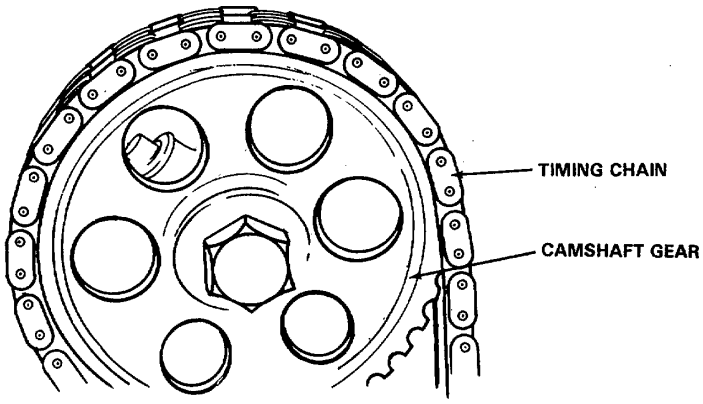


Step 13. Turn crankshaft until camshaft is putting no pressure on rocker arms**.**
Step 14. Remove rocker arm assembly mounting screws**.**
Step 15. Remove rocker arm assemblies and put on location tag.

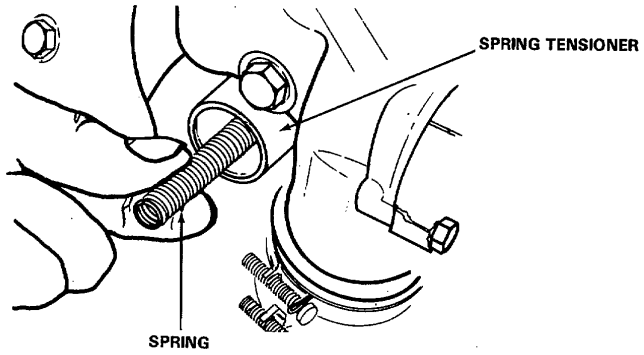
TA259384



Step 16. Turn crankshaft to ignition TDC of number 1 cylinder.
Step 17. Mark camshaft gear and timing chain in relation to each other.

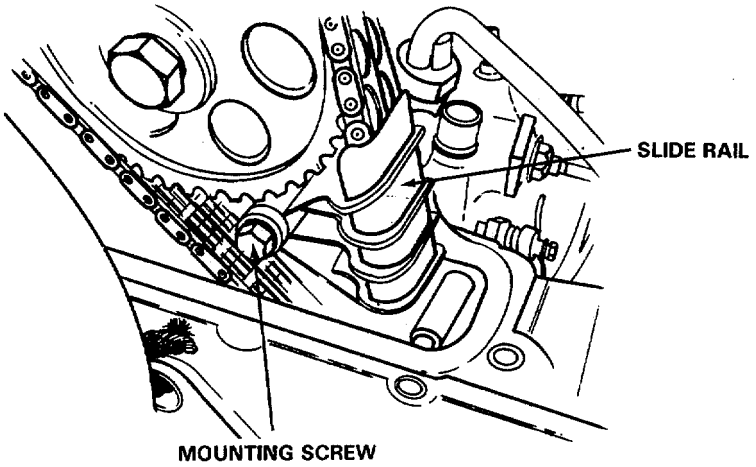


Step 18. Remove plug and spring from spring tensioner.

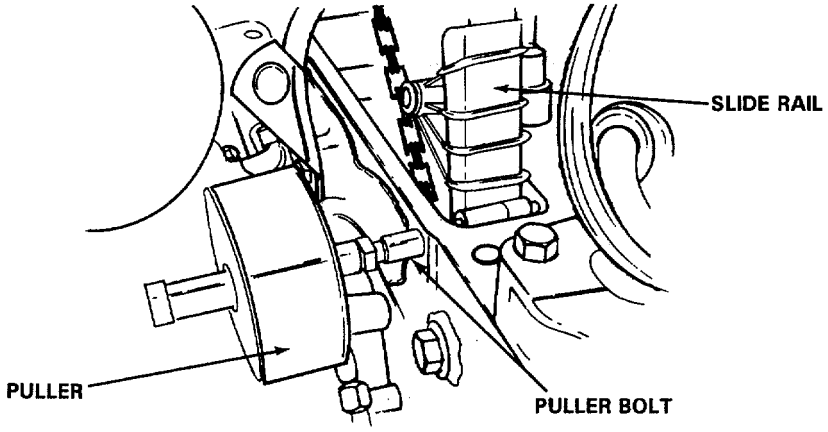


TA259385

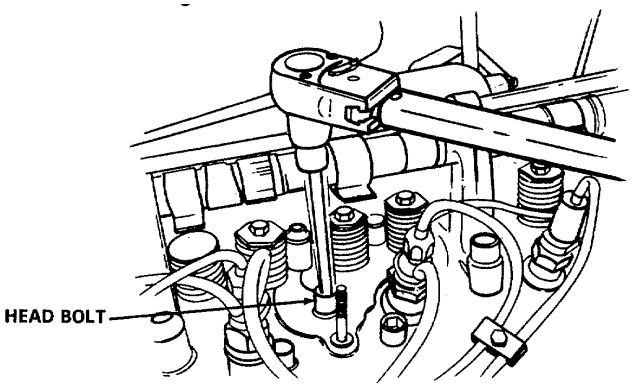
Step 19. Remove slide rail mounting screw and washer.



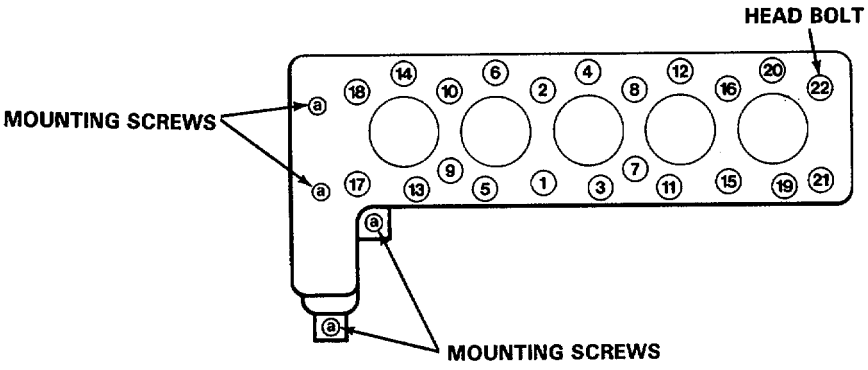
Step 20. Use puller and puller bolt. Remove bearing pin and slide rail. Refer to table 2-1, items 2 and 3.



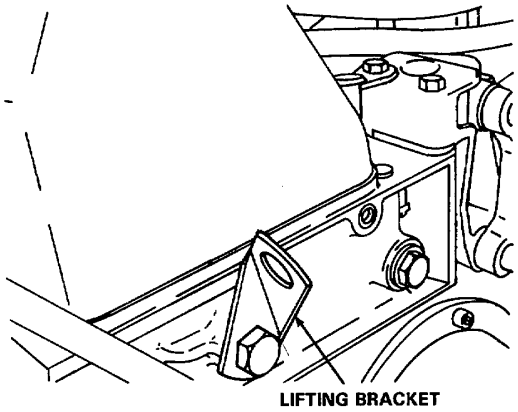
Step 21. Remove camshaft gear.
Step 22. Remove injection nozzles. Refer to paragraph 4-2.
Step 23. Use hex socket. Refer to table 2-1, item 1. Loosen head bolts in reverse order of tightening sequence. Start at end of head and work inward. Remove head bolts and four mounting screws.



TA259386



Step 24. Attach hoist to lifting brackets.
Step 25. Remove cylinder head from crankcase.



TA259387

b. Replace.

NOTE

Serviceable components may be transfered from the unserviceable cylinder head to the serviceable cylinder head.

Step 1. Clean cylinder head and top of crankcase.

CAUTION

Do not remove cylinder head gasket from packing until you are ready to install it on engine. Prolonged exposure to light can damage cylinder head gasket.

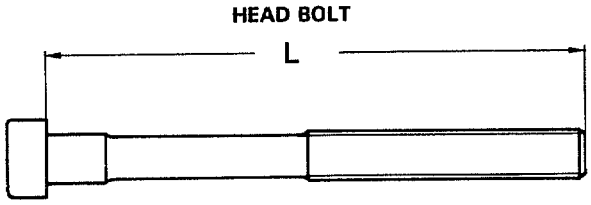
Step 2. Put cylinder head gasket on engine.

NOTE

If head does not seat, turn crankshaft until head seats properly.

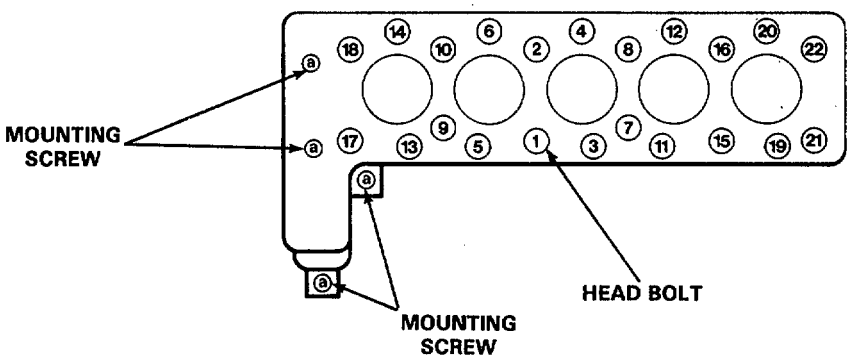
Step 3. Carefully put cylinder head on engine. Remove hoist.
Step 4. Measure cylinder head bolts. If length exceeds the measurements below replace head bolt.

THREAD DIAMETER	NEW LENGTH (.L)	MAXIMUM LENGTH (L)
M12	4.0945 in. (104 mm)	4.154 in. (105.5 mm)
M12	4.685 in. (119 mm)	4.744 in. (120.5 mm)
M12	5.669 in. (144 mm)	5.709 in. (145 mm)

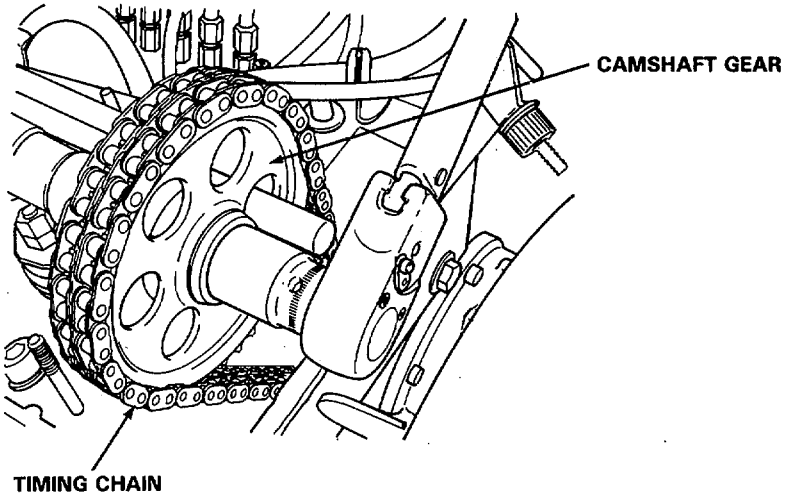


TA259388

Step 5. Lightly lubricate threads of head bolts with oil.
Step 6. Put in head bolts.
Step 7. Refer to torque sequence diagram below for compete torquing of head bolts.
Step 8. Torque head bolts to 30 lb. ft. (40 Nm).
Step 9. Torque head bolts to 52 lb. ft. (70 Nm).
Step 10. Wait ten minutes. Tighten head bolts 900 (% turn).
Step 11. Repeat step 1 0.
Step 12. Put in four mounting screws. Tighten screws.

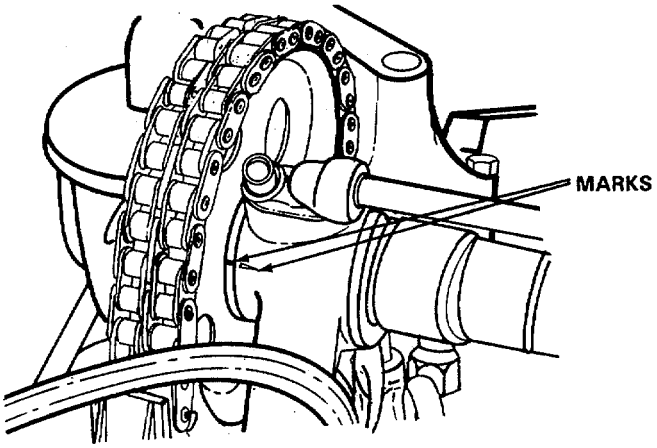


Step 13. Put on camshaft gear and timing chain. Location marks on gear and chain must be aligned.
Step 14. Put in camshaft gear mounting screw.
Step 15. Torque camshaft mounting screw to 59 lb. ft. (80 Nm).

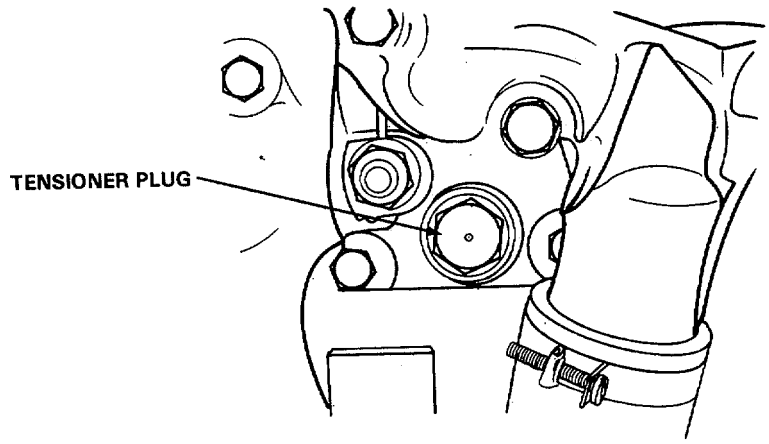


TA259389

Step 16. Install both rocker arm assemblies. Refer to paragraph 3-24.
Step 17. Check that crankshaft is at TDC of ignition of the number 1 cylinder and camshaft marks are aligned.



Step 18. Put on slide rail. Put in slide rail mounting screw and washer.
Step 19. Put in slide rail bearing pin.
Step 20. Install chain tensioner thrust pin from outside to inside**.**
Step 21. Put in chain tensioner spring.
Step 22. Put new seal on chain tensioner plug**.**
Step 23. Put in plug. Torque plug to 66 lb. ft. (90 Nm).



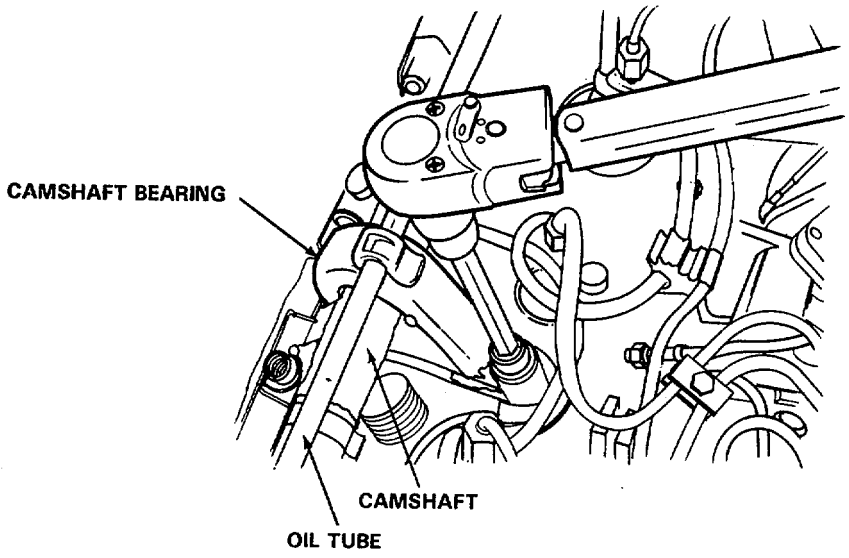
Step 24. Adjust valves. Refer to paragraph 3-4.
Step 25. Install fuel injection nozzles. Refer to paragraph 4-2.
Step 26. Install exhaust and intake manifold assembly. Refer to TM 9-2350-272-20.
Step 27. Install turbocharger. Refer to TM 9-2350-272-20.
Step 28. Install cylinder head cover. Torque nuts to 11lb. ft. (15 Nm}.
Step 29. Connect electrical wire to turbocharger pressure switch**.**
Step 30. Connect wiring harness to glow plugs**.**
Step 31. Connect linkages to cylinder head cover.
Step 32. Install fuel injection lines. Torque lines to 18 lb. ft. (25 Nm).
Step 33. Connect fuel return line to number one injection nozzle**.**
Step 34. Replace power pack. Refer to TM 9-2350-272-20**.**

TA259390

3-9. REPAIR CYLINDER HEAD.

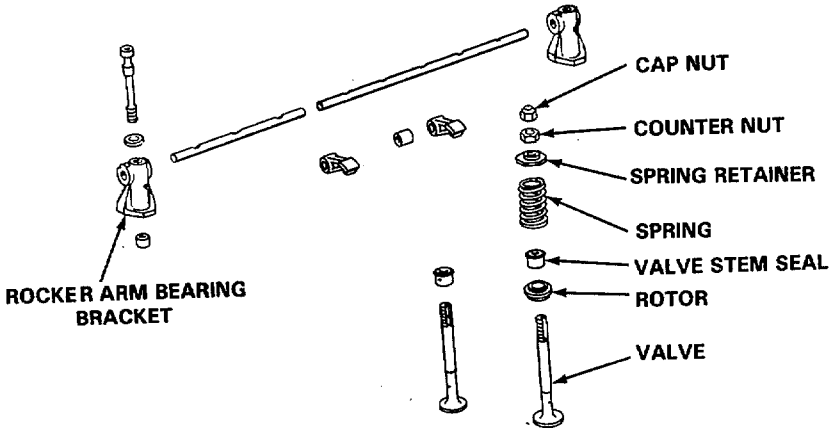
a. Disassemble.

Step 1. Remove cylinder head. Refer to paragraph 3- 8.
Step 2. Remove camshaft bearing screws and nuts.
Step 3. Remove camshaft with bearings and oil tube**.**
Step 4. Remove thermostat housing assembly.

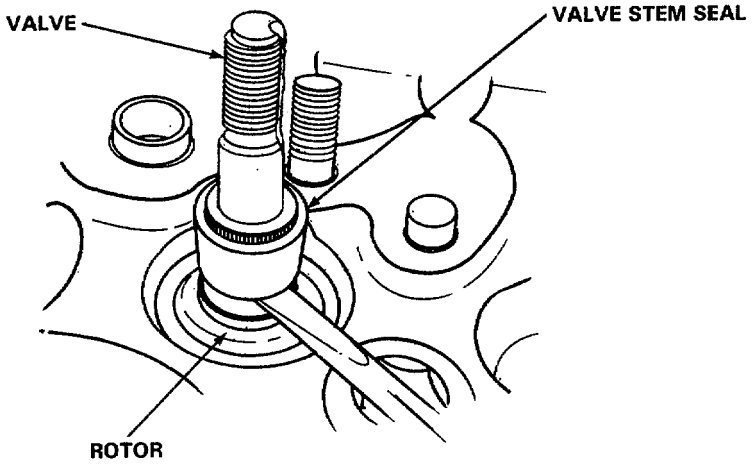


TA259391

Step 5. Use tap wrench and extractor. Remove precombustion chamber. Refer to Table 2-1, item 105 and 106.
Step 6. Remove glow plugs**.**
Step 7. Put holding wrench on valve spring retainer. Refer to table 2-1, item 9.
Step 8. Use valve adjusting wrenches. Hold counter- nut and remove valve cap nut. Refer to table 2-1, item 4.
Step 9. Remove counter nut.
Step 10. Remove valve spring retainer.
Step 11. Remove valve spring.

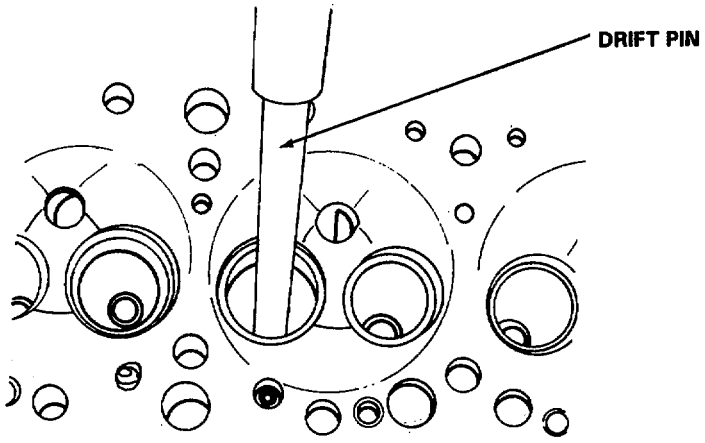


Step 12. Remove valve stem seal and rotor**.**
Step 13. Remove valve and put on location tags.



TA259392

Step 14. Repeat steps 7 through 1 3 until all valves are removed.
Step 15. Measure inside diameter of valve guides at a point 0.187 in. (5 mm) above bottom edge. Correct measurement is 0.523 in. to 0.524 in. (14 mm to 14.02 mm).
Step 16. Use drift pin to remove any worn valve guide. Refer to table 2-1, item 6.



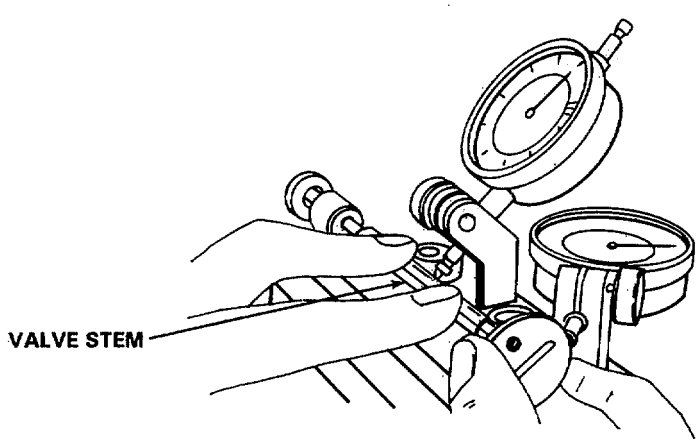
TA259393

b. Inspect.

WARNING

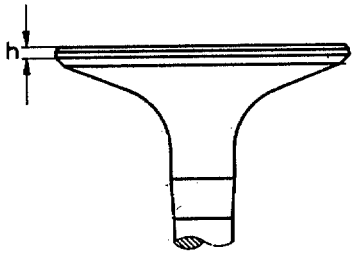
Cleaning solvent, federal specification P-D-680, type 11, is flammable and gives off harmful vapors. Use solvent only in a well ventilated area. Avoid prolonged breathing of solvent vapors. Keep solvent away from flame. Do not use solvent in excessive amounts.

Step 1. Clean all parts with solvent. Dry all parts. Refer to appendix B, item 48.
Step 2. Inspect cylinder head for visible damage. Replace damaged cylinder head.
Step 3. Inspect valves for burnt valve surface and scored stem. Replace burnt or scored valve.
Step 4. Measure runout of valve stem. If runout exceeds 0.001 2 in. (0.03 mm) replace valve.



MEASURING VALVE STEM RUNOUT

Step 5. Measure height "h" of valves. If height "h" is less than 0.0787 in. (2 mm) replace worn valve.

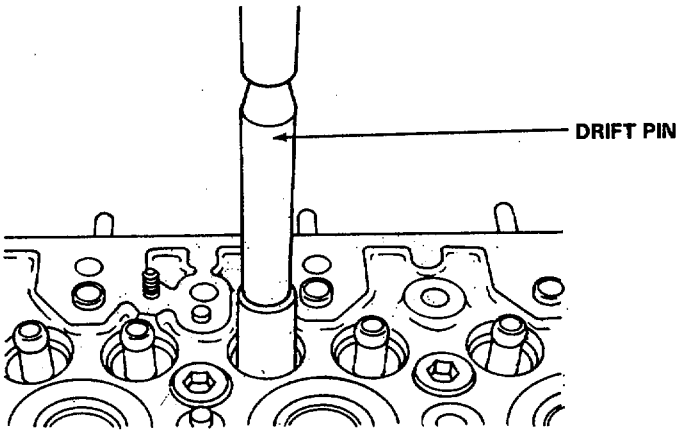


TA259394

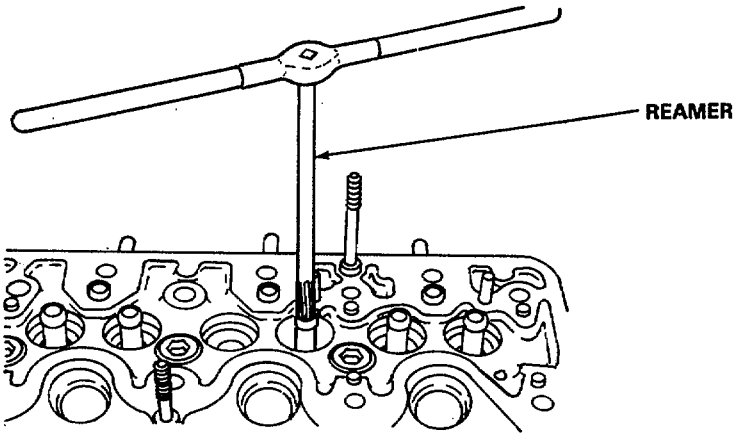
Step 6. Test cylinder head. Refer to paragraph 3- 1 0

c. Assemble.

Step 1. Use drift pin. Refer to table 2-1, item 7. Replace valve guides that were removed.

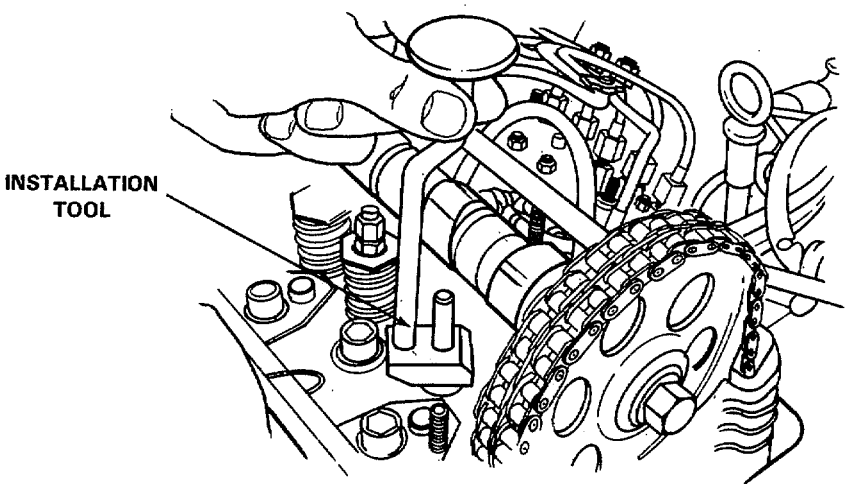


Step 2. Install valves into new valve guides. If valves fit tightly or will not go into guide, use reamer to rearn valve guide.

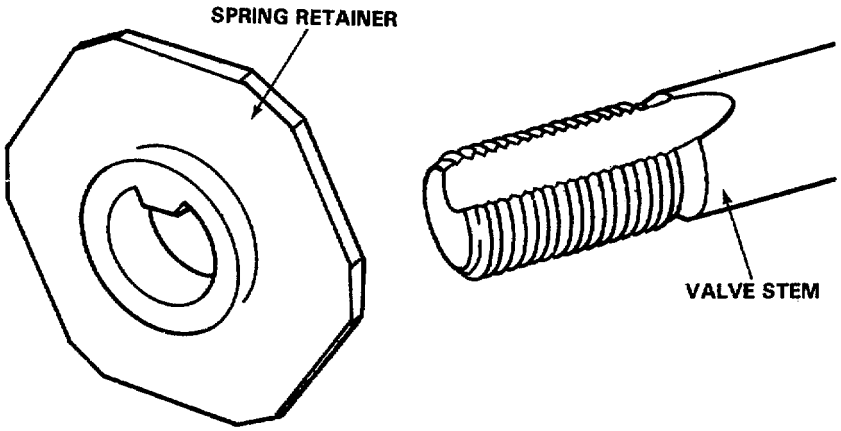


TA259395

Step 3. Put valves into cylinder head.
Step 4. Put new rotors on valve stems.
Step 5. Use installation tool. Put in new valve stem seals. Refer to table 2- 1, item 10.



Step 6. Put valve springs over valve stem. Narrow spring coil and color dots go away from cylinder head.
Step 7. Put on spring retainer. Tab on retainer seats in groove on valve stem.

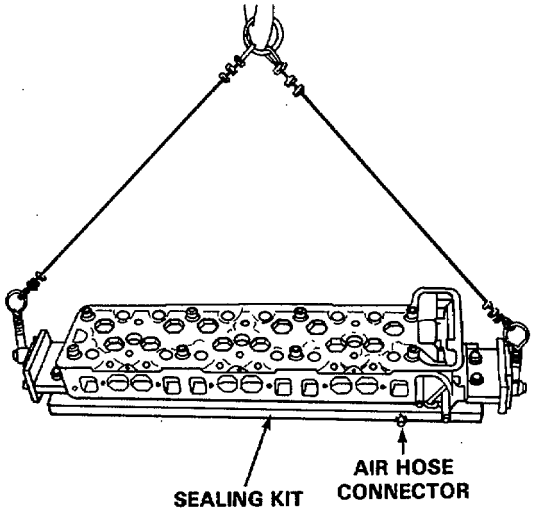


Step 8. Put counternut on valve stem.
Step 9. Put cap nut on valve stem.
Step 10. Put camshaft with bearings and oil tube on cylinder head.
Step 11. Put in camshaft bearing screws. Torque screws to 18 lb. ft. (25 Nm)
Step 12. Use tap wrench. Put in precombustion chambers. Torque to 110 to 132 lb. ft. (150 to 180 mm). Refer to table 2-1, item 105.
Step 13. Put in glow plugs. Tighten plugs.
Step 14. Replace cylinder head. Refer to paragraph 3-8.

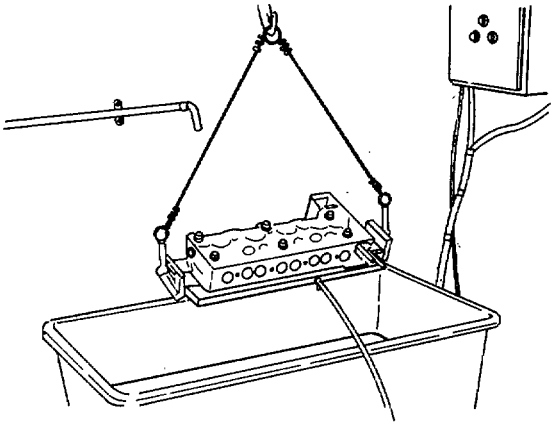
TA259396

3-1O. TEST CYLINDER HEAD.

Step 1. Clean the stripped cylinder head.
Step 2. Attach sealing kit tightly to cylinder head**.**
Step 3. Plug all bores and connections.
Step 4. Connect air hose to seal kit connector**.**
Step 5. Attach sling adapter to cylinder head.



Step 6. Set pressure on air hose to 29 PSI (2 bar**).**
Step 7. Lower head into water tank. Heat water to 176°F (80°C).
Step 8. Rising air bubbles in tank indicate leaking head. Replace leaking head.
Step 9. Remove sling adapter and sealing kit.



TA259397

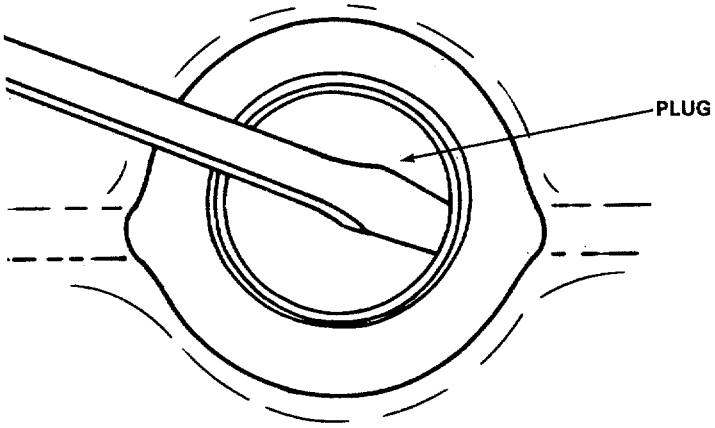
3-1 1. REMOVE AND REPLACE ENGINE BLOCK EXPANSION PLUGS.

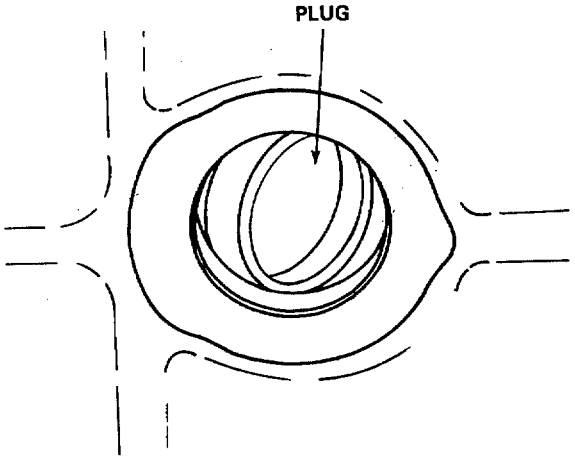
a. Remove.

NOTE

There are six expansion plugs. This procedure applies to all six plugs.

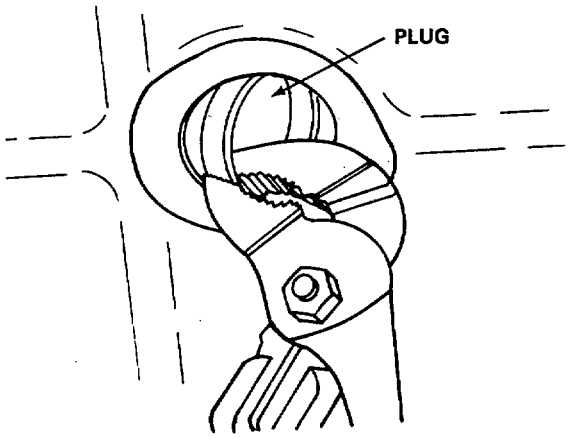
Step 1. Drain cooling system. Refer to TM 9-2350- 272-20.
Step 2. Remove any component which obstructs access to plug.
Step 3. Tap one side of plug until plug turns in the plug opening.





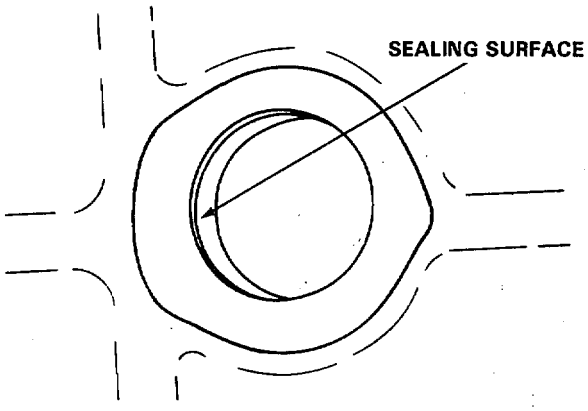
TA259398

Step 4. Pull plug out of engine block.

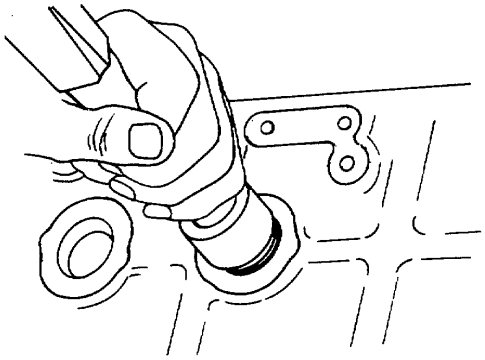


b. Replace.

Step 1. Clean sealing surface of plug opening in engine block.
Step 2. Apply sealant to sealing surface. Refer to appendix B, item 47.



Step 3. Install new expansion plug.



TA259399

Step 4. Replace any component which was removed.
Step 5. Fill and bleed cooling system. Refer to TM 9-2350-272-20.

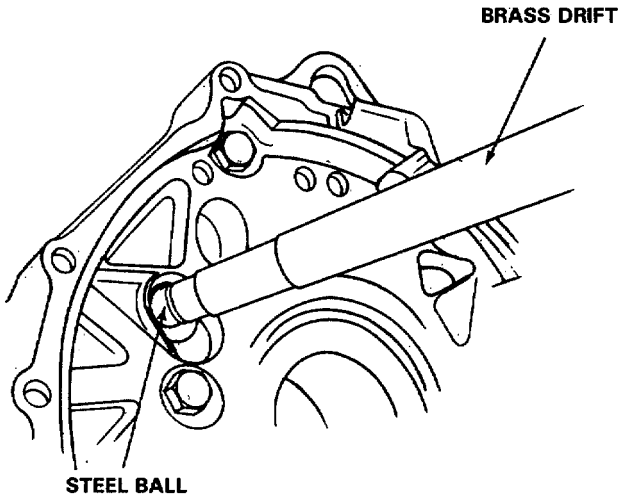
3-12. REMOVE AND REPLACE REAR CRANKSHAFT SEAL AND REPAIR MAIN OIL DUCTS.

a. Remove.

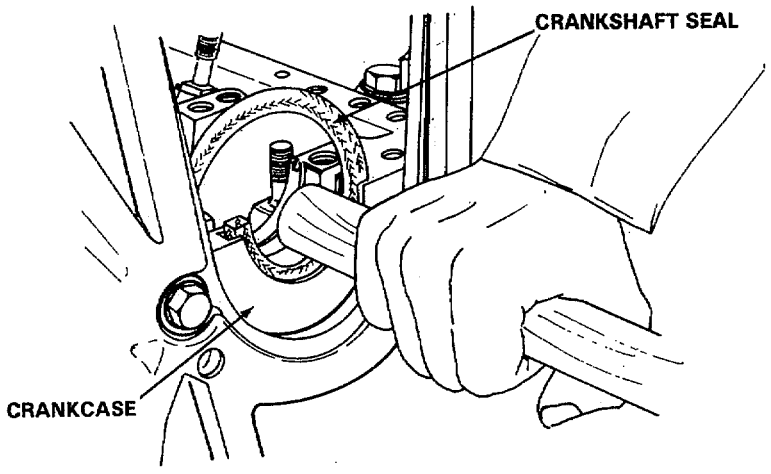
Step 1. Remove crankshaft. Refer to paragraph 3-1 5.
Step 2. Remove rear crankshaft seal from crankcase.
Step 3. Inspect engine main oil ducts. If damaged knock steel ball out of upper and lower oil ducts.

b. Replace.

Step 1. Clean ball end of oil ducts.
Step 2. Put grease on brass drift. Put steel ball ih place.
Step 3. Place steel ball against-oil duct opening.
Step 4. Tap brass drift until steel ball is seated.
Step 5. Repeat steps 8 through 10 for other oil duct.

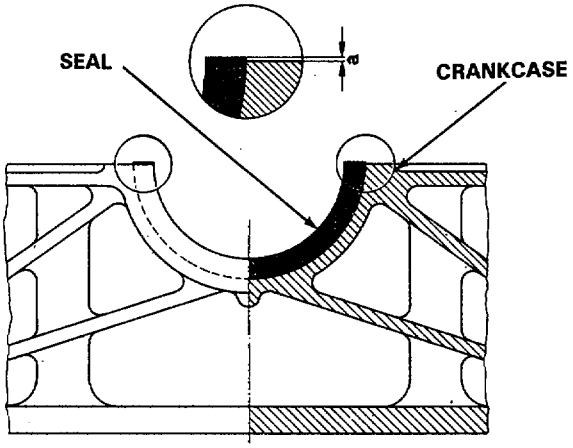


Step 6. Put new rear crankshaft seal into groove in crankcase.



TA259400

Step 7. Use fabricated gage. Cut seal 0.0394 in. (1 mm) above surface of crankcase. Refer to table 2-2, item 2.
Step 8. Lubricate seal with engine oil.
Step 9. Replace crankshaft. Refer to paragraph 3-15.



Dimension a = 1.0 mm

TA259401

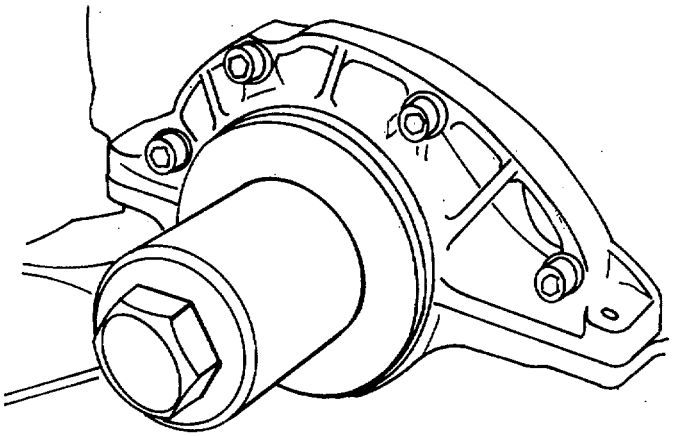
3-13. REMOVE AND REPLACE FRONT CRANKSHAFT SEAL.

a. Remove.

Step 1. Remove pulley, vibration damper and balancing disc. Refer to paragraph 3-6.
Step 2. Remove front crankshaft seat.

b. Replace.

Step 1. Lubricate sealing lip of new crankshaft seal with grease.
Step 2. Install new crankshaft seal.

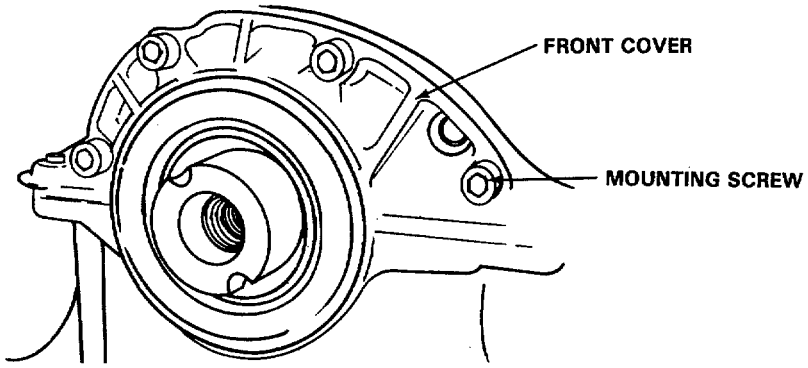


Step 3. Replace pulley, vibration damper and balancing disc. Refer to paragraph 3-6.

3-14. REMOVE AND REPLACE CRANKSHAFT GEAR.

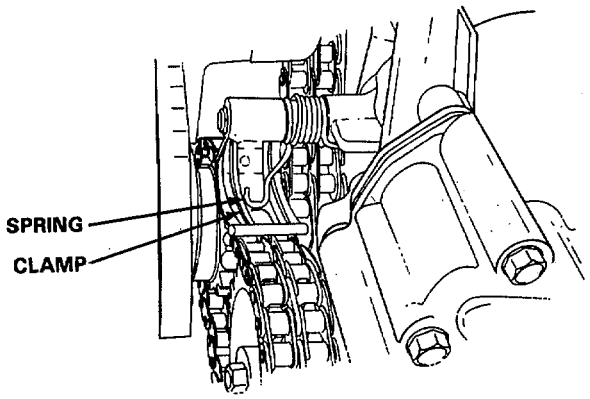
a. Remove.

Step 1. Remove pulley, vibration damper and balancing disc. Refer to paragraph 3-6.
Step 2. Remove front crankshaft seal. Refer to paragraph 3-13.
Step 3. Remove oil pan. Refer to paragraph 3-30.
Step 4. Remove front cover mounting screws.
Step 5. Remove front cover.

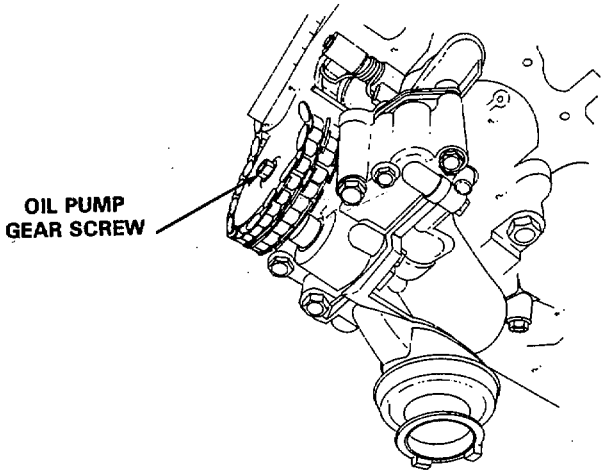


TA259402

Step 6. Disconnect spring from clamp.
Step 7. Turn clamp up.

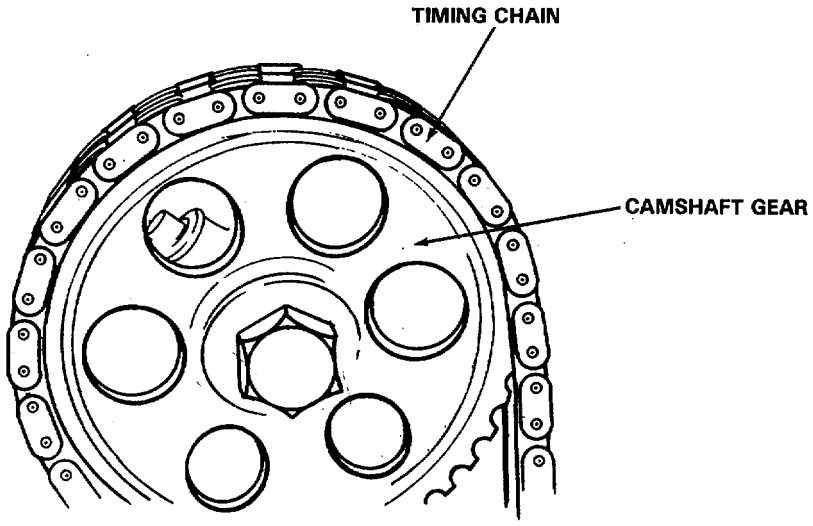


Step 8. Remove screw from oil pump gear.
Step 9. Remove oil pump gear.
Step 10. Remove oil pump drive chain.

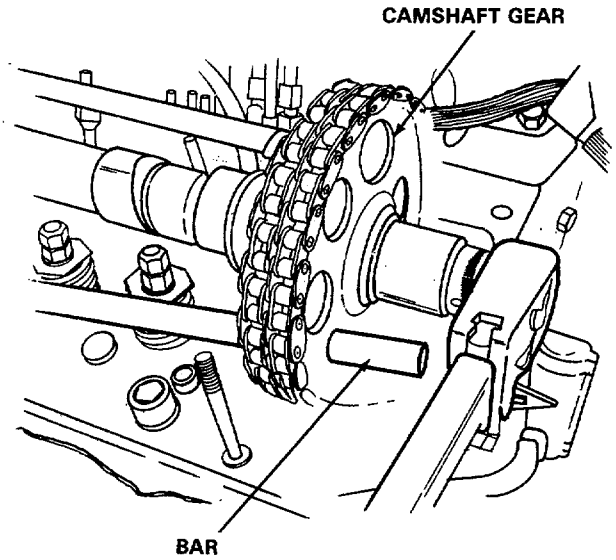


TA259403

Step 11. Remove cylinder head cover.
Step 12. Put screw into front end of crankshaft.
Step 13. Use socket. Rotate crankshaft to TDC of the number one cylinder.
Step 14. Put location mark between timing chain and camshaft gear. Put location mark between timing chain and crankshaft gear.

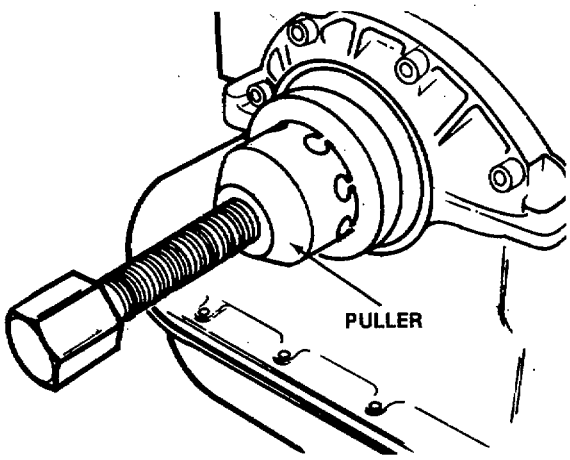


Step 15. Remove chain tensioner. Refer to paragraph 3-23.
Step 16. Hold camshaft. Remove screw from camshaft gear.
Step 17. Remove slide rail. Refer to paragraph 3-21.
Step 18. Remove camshaft gear.

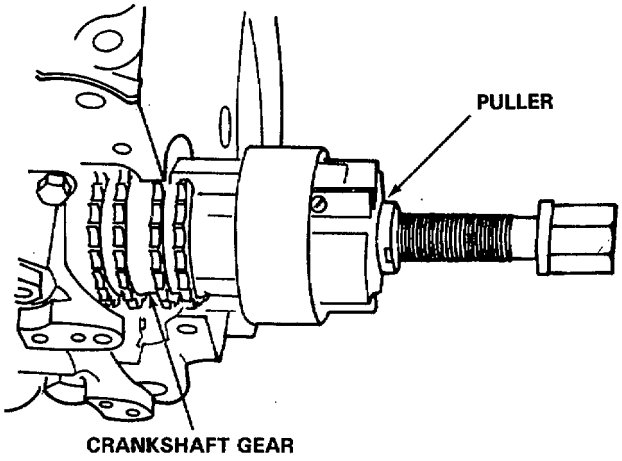


TA259404

Step 19. Remove oil pump.
Step 20. Remove front bearing cap.
Step 21. Remove timing chain from teeth of crankshaft gear.
Step 22. Remove screw from front end of crankshaft.
Step 23. Remove spacer from crankshaft.



Step 24. Remove crankshaft gear.



b. Replace.

Step 1. Transfer location mark from old gear to new gear.

WARNING

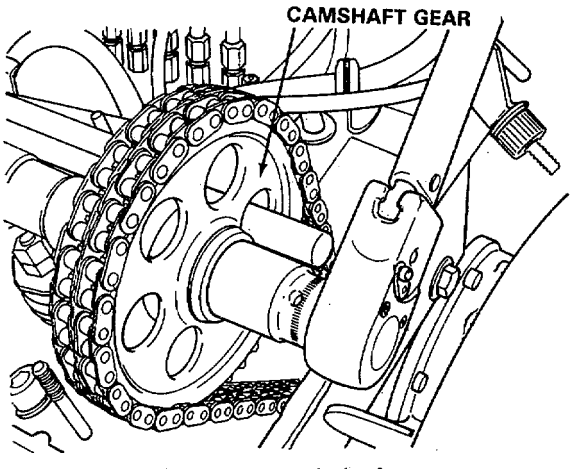
To avoid burns after heating metal components wear insulated gloves or handle components with pliers.

Step 2. Heat crankshaft gear to 176°F (800C). Put gear on crankshaft.
Step 3. Put spacer on crankshaft.

NOTE

Location mark between timing chain and crankshaft gear and between timing chain and camshaft gear must be aligned.

Step 4. Put spacer on camshaft.
Step 5. Put timing chain on crankshaft gear and camshaft gear.
Step 6. Put camshaft gear on camshaft.
Step 7. Hold camshaft gear. Put screw in camshaft gear. Torque to 59 lb. ft. (80 Nm).
Step 8. Replace front bearing cap. Torque cap screws to 66 lb. ft. (90 Nm).
Step 9. Replace oil pump.



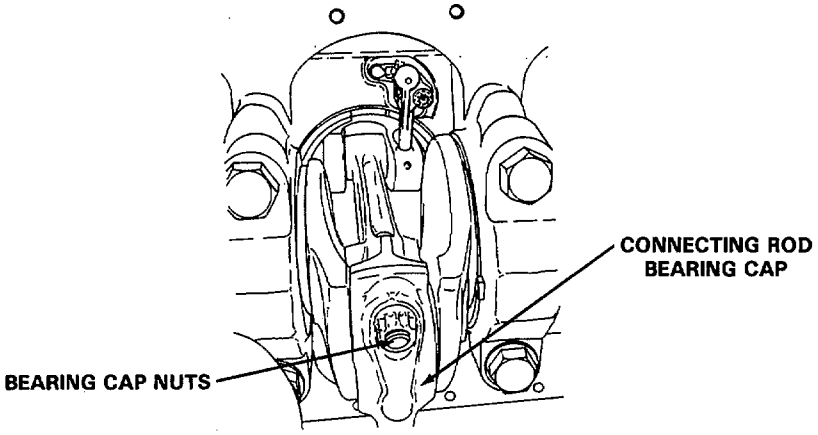
Step 10. Place oil pump drive chain on crankshaft gear.
Step 11. Put chain over oil pump gear.
Step 12. Put gear on oil pump.
Step 13. Put screw into oil pump gear. Torque screw to 22 to 25 lb. ft. (30 to 40 Nm).
Step 14. Move clamp down on top of oil pump drive chain.
Step 15. Connect spring to clamp.
Step 16. Put on front cover.
Step 17. Put screws in front cover. Tighten screws.
Step 18. Replace front crankshaft seal. Refer to paragraph 3-13.
Step 19. Replace balancing disc, vibration damper and pulley. Refer to paragraph 3-6.
Step 20. Put on cylinder head cover. Torque cover nuts to 11 lb. ft. (15 Nm).

3-15. REMOVE AND REPLACE CRANKSHAFT.

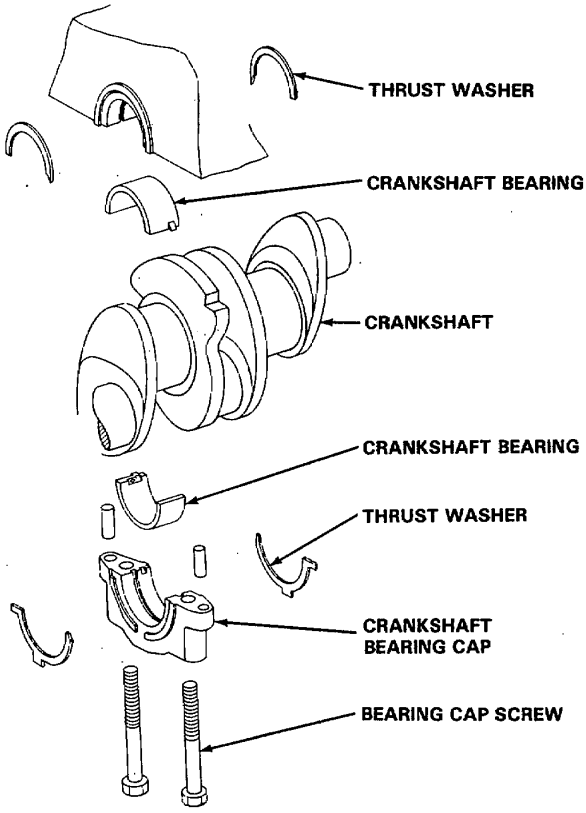
a. Remove.

Step 1. Remove front crankshaft seal. Refer to paragraph 3-13.
Step 2. Remove oil spray nozzles. Refer to paragraph 3-28.
Step 3. Remove flywheel. Refer to paragraph 3-18

Step 4. Remove oil pump. Refer to paragraph 3-31.
Step 5. Remove crankshaft gear. Refer to paragraph 3-14.
Step 6. Remove connecting rod bearing cap nuts.
Step 7. Remove connecting rod bearing caps. Put tags on caps.



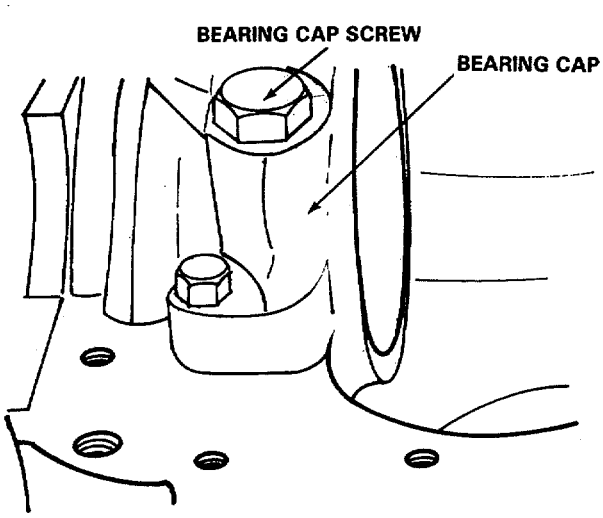
Step 8. Remove screws from crankshaft bearing caps.
Step 9. Remove crankshaft bearing caps.
Step 10. Remove crankshaft.
Step 11. Remove crankshaft bearings from crankcase and bearing caps.
Step 12. Remove thrust washers.



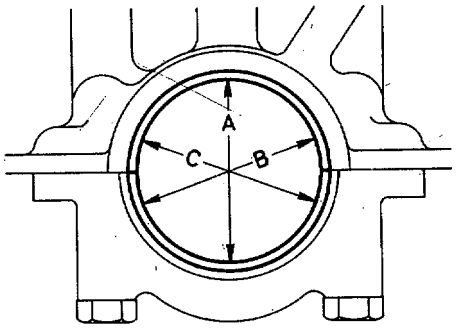
b. Replace.

Step 1. Put on crankshaft bearing caps. Caps must not be interchanged. Check identification mark to insure caps are properly located.

Step 2. Put in bearing cap screws. Torque screws to 66 lb. ft. (90 Nm).



Step 3. Measure bearing bore at points A, B, and C.

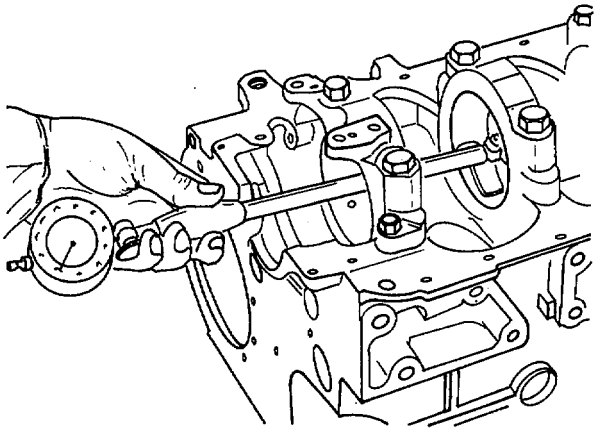


Step 4. Correct bore diameter is 2.9331 to 2.9339 in. (74.50 to 74.52 mm). All three measurements must be within 0.0004 in. (0.01 mm} of each other.

TA259408

Step 5. If measurements are exceeded, touch up contact surface of bearing cap not to exceed 0.0008 in. (0.02 mm).

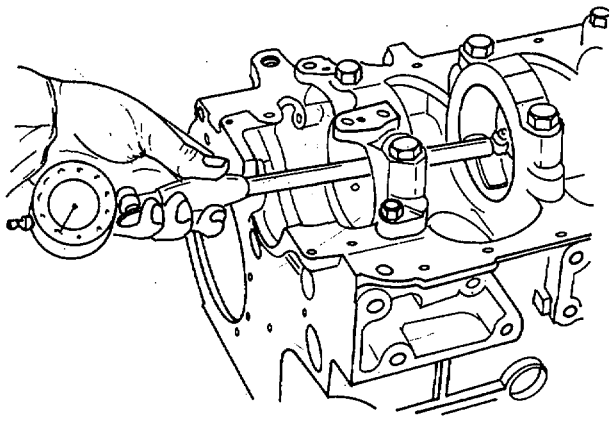
Step 6. Remove crankshaft bearing caps.



Step 7. Put crankshaft bearings in crankcase and bearing caps.

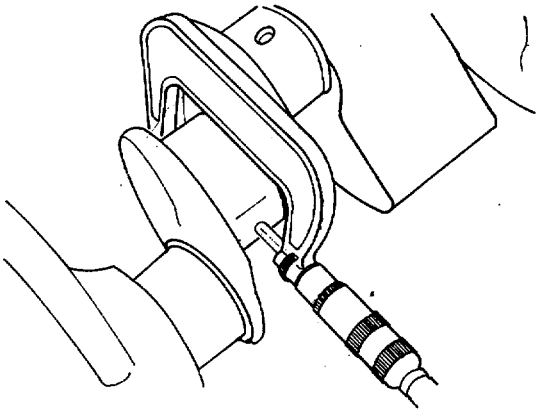
Step 8. Install bearing caps. Torque cap mounting screws to 66 lb. ft. (90 Nm).

Step 9. Measure and record the diameter of each of the six crankshaft bearings.



TA259409

Step 10. Measure and record the diameter of the crankshaft bearing journals. Minimum diameter is 2.715 in. (68.95 mm). If any journal does not meet minimum standard, replace crankshaft.



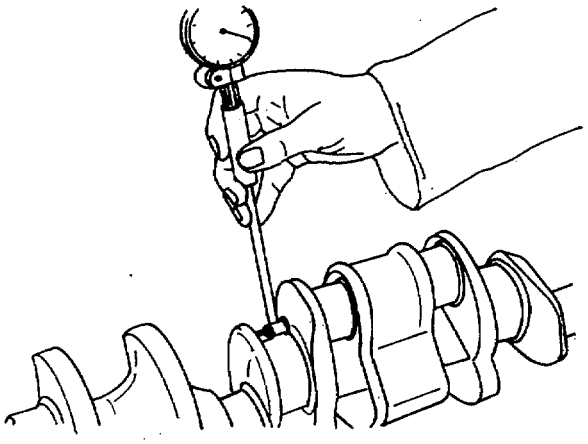
Step 11. Subtract journal measurements from corresponding bearing measurement to get radial bearing play. If radial play of any bearing exceeds 0.0031 in. (0.08 mm), replace bearing with a thicker bearing.

Step 12. Remove crankshaft bearing caps.

Step 13. Remove bearings.

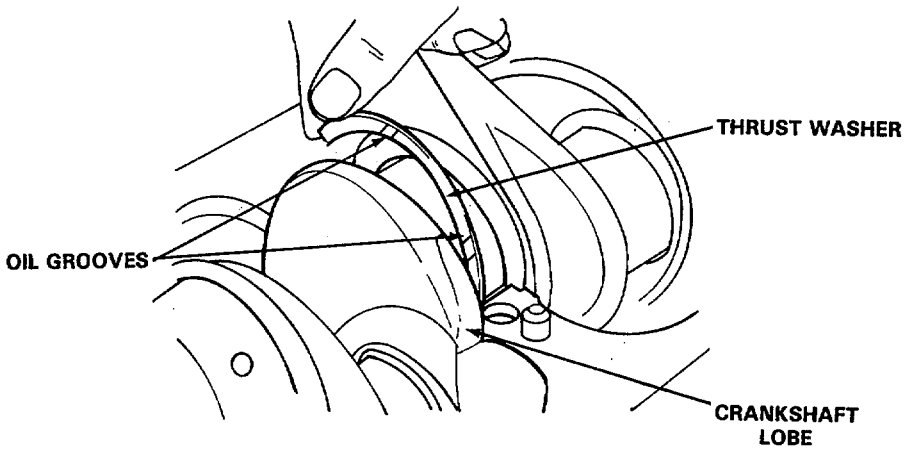
Step 14. Measure width of crankshaft journals. Determine correct thickness of thrust washers for journal. Use following chart.

JOURNAL WIDTH	WASHER THICKNESS
1.3385 to 1.3398 in. (34 to 34.03 mm)	0.0845 in. (2.15 mm)
1.3425 to 1.3437 in. (34.10 to 34.13 mm)	0.0866 in. (2.20 mm)
1.3465 to 1.3476 in. (34.20 to 34.23 mm)	0.0886 in (2.25 mm)
1.3543 to 1.3555 in. (34.40 to 34.43 mm)	0.0925 in. (2.35 mm)
1.3583 to 1.3594 in. (34.50 to 34.53 mm)	0.0945 in. (2.40 mm)

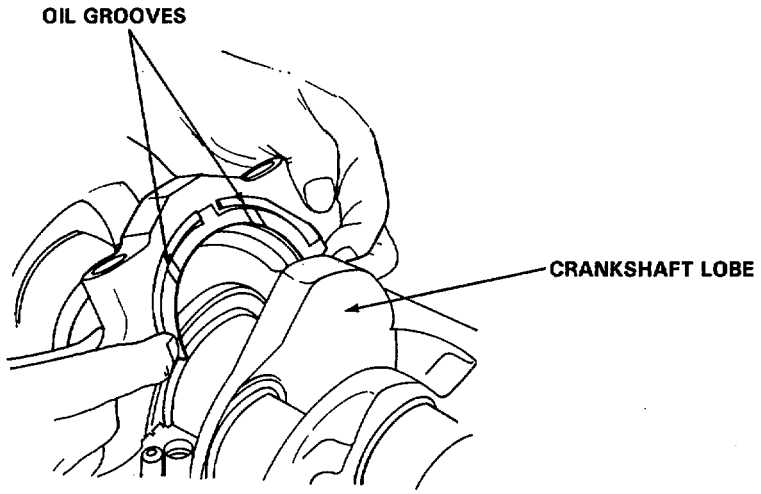


TA259410

Step 15. Replace rear crankshaft seal. Refer to paragraph 3-12.
Step 16. Lubricate crankshaft bearings, rear seal, crankshaft and thrust washers with engine oil.
Step 17. Put bearing halves into crankcase.
Step 18. Put crankshaft into crankcase.
Step 19. Put correct thickness thrust washer into grooves beside crankshaft bearings in crankcase. Oil grooves in thrust washers face toward crankshaft lobes.

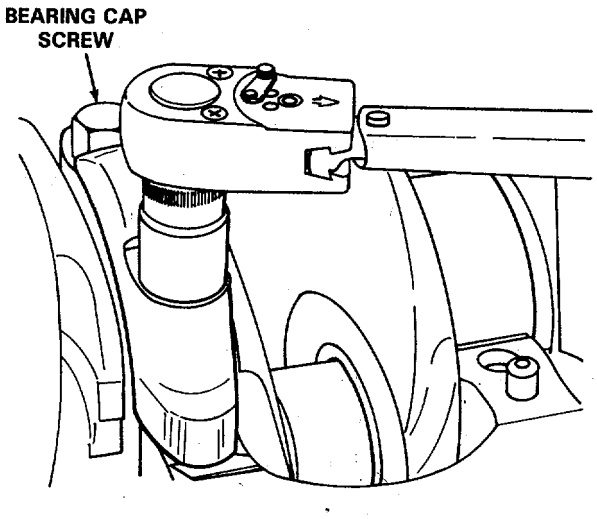


Step 20. Put bearing halves and thrust washers into crankshaft bearing caps. Oil grooves in thrust washers are installed to face toward crankshaft lobes.
Step 21. Hold thrust washers in place and install bearing caps.

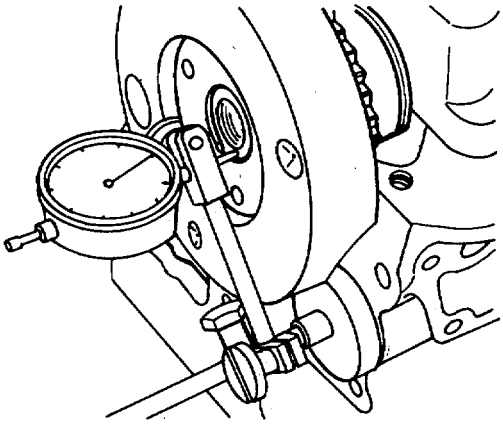


TA259411

Step 22. Put in bearing cap screws. Torque screws to 66 lb. ft. (90 Nm).



Step 23. Mount fixture and dial indicator. Check crankshaft end play. If end play is more than 0.0118 in. (0.30 mm). Replace crankshaft thrust washers.



Step 24. Place connecting rods on crankshaft.
Step 25. Put on connecting rod caps.
Step 26. Put in connecting rod cap screws. Torque screws to 30 to 37 lb. ft. (40 to 50 Nm).
Step 27. Tighten connecting rod cap screws 900 (1/4 turn).
Step 28. Replace crankshaft gear. Refer to paragraph 3-14.
Step 29. Replace oil pump. Refer to paragraph 3-31.
Step 30. Replace oil spray nozzles. Refer to paragraph 3-28.
Step 31. Replace flywheel. Refer to paragraph 3-18.
Step 32. Replace front crankshaft seal. Refer to paragraph 3-13.
Step 33. Replace camshaft gear. Refer to paragraph 3-14.
Step 34. Adjust camshaft timing. Refer to paragraph 3-5.

3-16. REMOVE AND REPLACE CYLINDER LINERS.

a. Remove.

Step 1. Remove cylinder head. Refer to paragraph 3- 8.
Step 2. Remove crankshaft. Refer to paragraph 3-15.
Step 3. Remove connecting rods and pistons. Refer to paragraph 3-17.
Step 4. Use fabricated mandrel. Knock out cylinder liners. Refer to table 2-2, item 1.
Step 5. Measure crankcase cylinder bore. If cylinder bore measures more than 3.7061 in. (94.135 mm), replace crankcase.
Step 6. Check crankcase for damage and cracks at stress points. Replace defective crankcase.

b. Replace.

Step 1. Press new cylinder liners into crankcase. Hold pressure on liners for 10 seconds to insure they are seated.
Step 2. Replace connecting rods and pistons. Refer to paragraph 3-17.
Step 3. Replace crankshaft. Refer to paragraph 3-15.
Step 4. Replace cylinder head. Refer to paragraph 3-8.

3-17. REMOVE, REPAIR AND REPLACE CONNECTING RODS AND PISTONS.

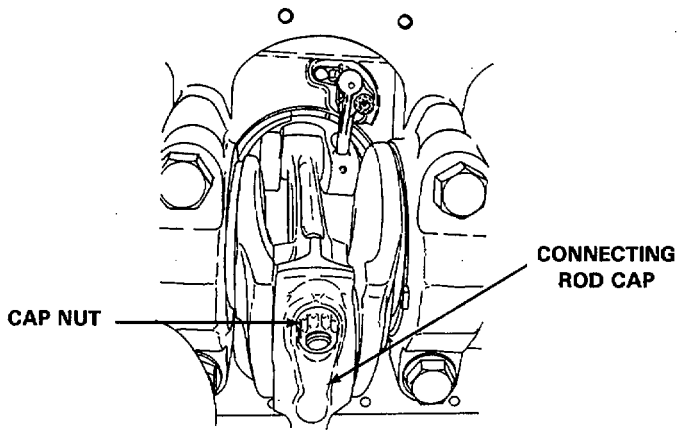
a. Remove.

Step 1. Remove oil pan. Refer to paragraph 3-30.
Step 2. Remove cylinder head. Refer to paragraph 3- 8.
Step 3. Remove oil spray nozzles. Refer to paragraph 3-28.
Step 4. Remove connecting rod cap nuts.

NOTE

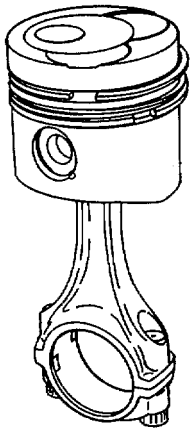
Connecting rods and caps are matched.

Step 5. Remove connecting rod caps. Put on locating tag.

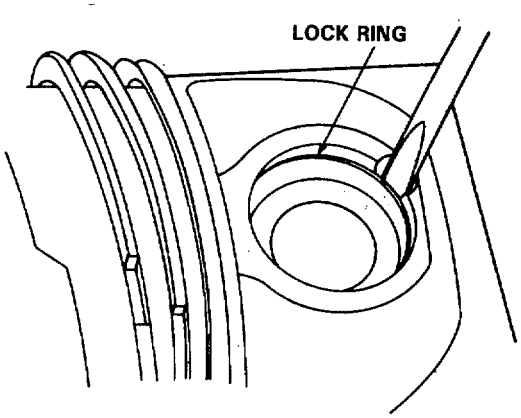


TA259413

Step 6. Push connecting rods upward.
Step 7. Remove pistons with connecting rods from top of cylinder crankcase. Put locating tag on connecting rod.

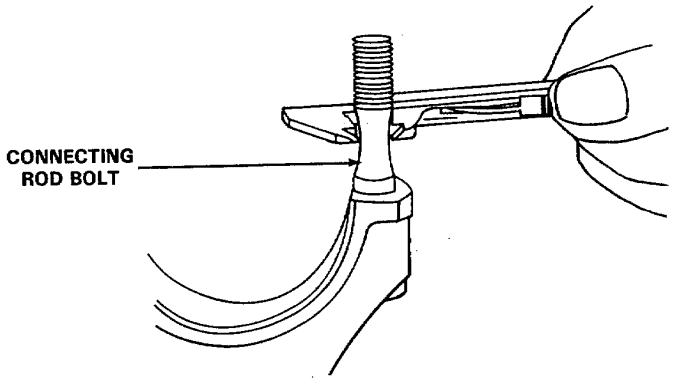


Step 8. Remove piston pin lock rings.
Step 9. Remove piston pins.
Step 10. Remove connecting rods from pistons.



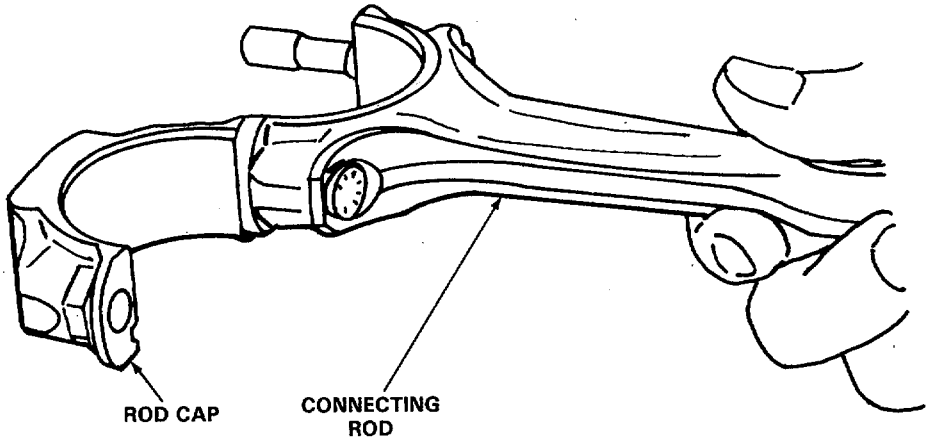
b. Repair.

Step 1. Check connecting rod bolts for thread damage.
Step 2. Measure connecting rod bolt diameter at narrowest point. Diameter must be more than 0.314 in. (8 mm).



TA259414

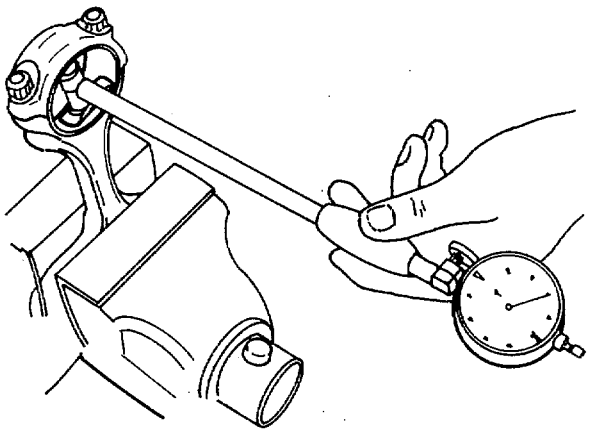
Step 3. Remove damaged or worn connecting rod bolts.
Step 4. Use fabricated block plate. Knock new connecting rod bolts into connecting rod. Refer to table 2-2, item 3.
Step 5. Place one end of connecting rod cap on connecting rod bolt. If cap swings downward under its own weight, bore of cap is worn. Replace connecting rod.
Step 6. Repeat step 5 until both bolt bores in all rod caps have been checked.
Step 7. Remove connecting rod bearing.



NOTE

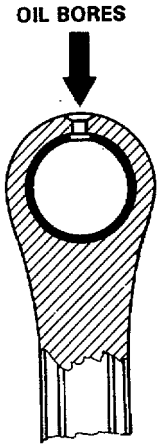
Connecting rods and caps are matched.

Step 8. Put connecting rod caps on matching connecting rods.
Step 9. Put on connecting rod cap nuts. Torque nuts to 30 to 37 lb. ft. (40 to 50 Nm). Tighten nuts 900 (1/4 turn).
Step 10. Measure connecting rod bore. If bore measures more than 2.190 in. (55.62 mm). Replace connecting rod.

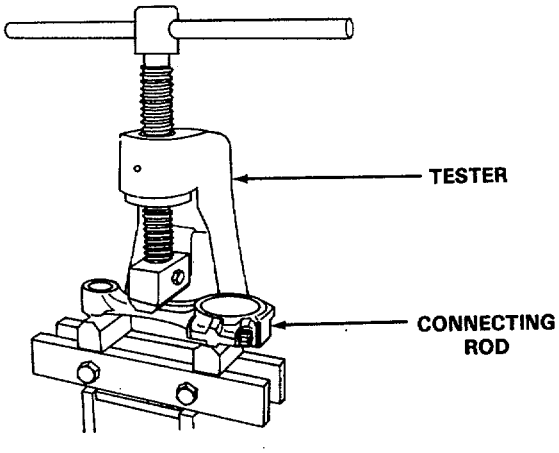


TA259416

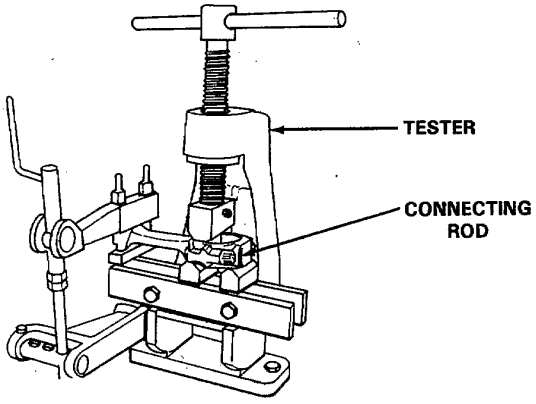
Step 11. Press out connecting rod bushing.
Step 12. Press in new connecting rod bushing. Insure oil bores are aligned.



Step 13. Install connecting rod on a connecting rod tester.



Step 14. Check offset of connecting rod bearing bore in relation to connecting rod bushing bore. If offset is more than 0.0039 in. (O.1 mm), square the connecting rod. Replace connecting rod if offset of less than 0.0039 in. (0.1 mm) can not be obtained.



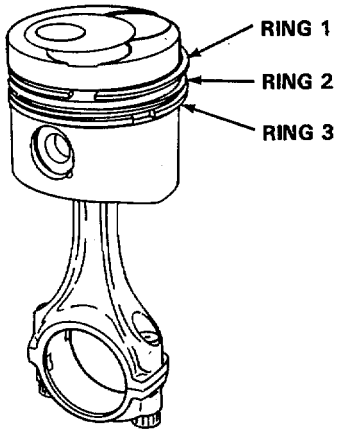
TA259416

Step 15. Measure end gap of piston rings. Replace worn rings. Maximum wear limits are:

Ring 1 =0.059
Ring 2 =0.039
Ring 3 =0.039

Step 16. Measure side clearance of piston rings. Replace worn rings. Maximum wear limits are:

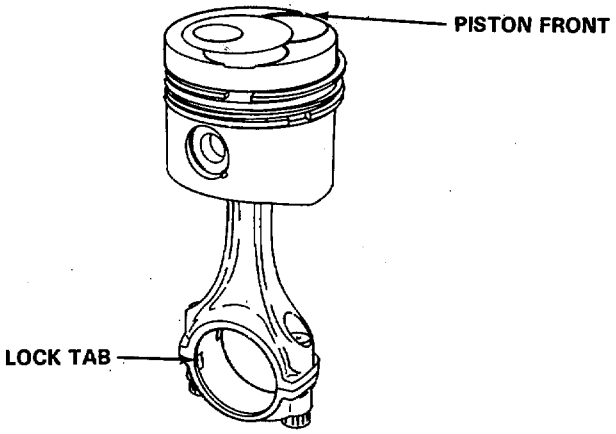
Ring 1 =0.008
Ring 2 =0.006
Ring 3 =0.004



Step 17. Remove connecting rod caps.

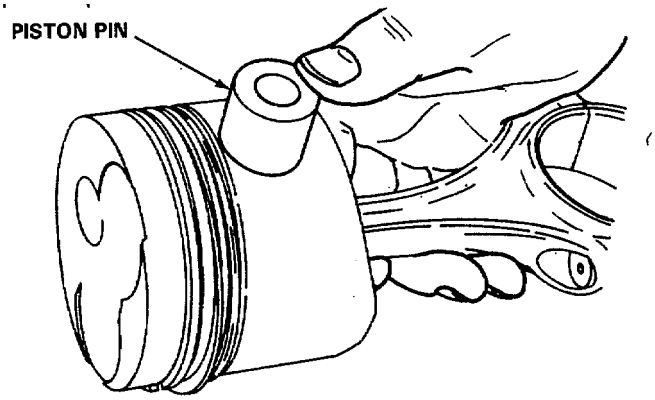
c. Replace.

Step 1. Put new bearings in connecting rod and cap.
Step 2. Put connecting rod in piston so that the front of the piston will be toward front of engine and lock tabs of connecting rod bearing will be toward the left side of engine when facing rear of the engine.

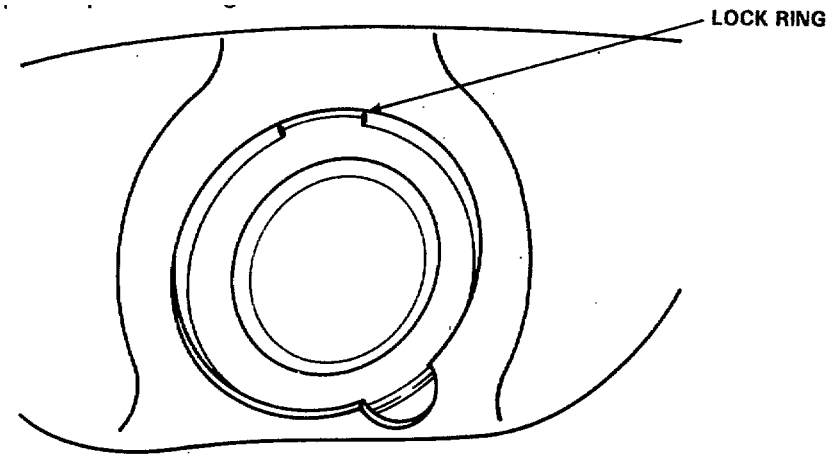


TA259417

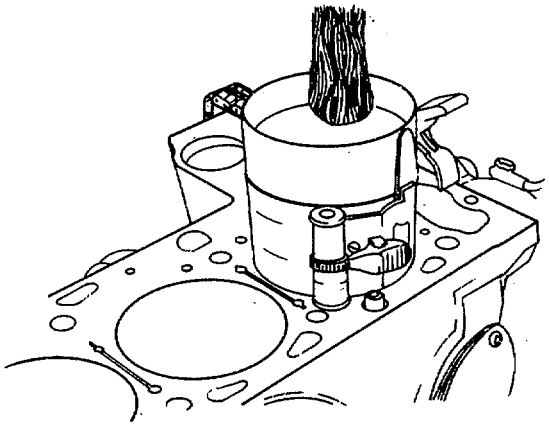
Step 3. Lubricate piston pin with engine oil.
Step 4. Put in piston pin.



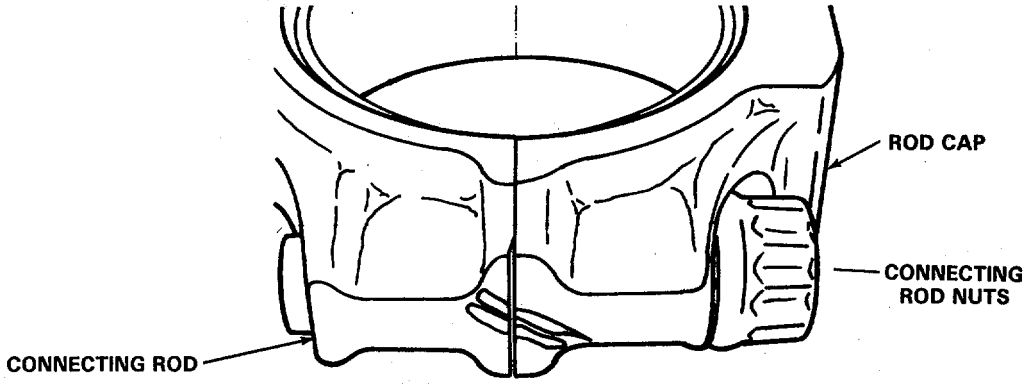
Step 5. Put in piston pin lock rings.



Step 6. Position piston rings so that gaps are not aligned.
Step 7. Put pistons into crankcase, front of piston toward front of engine.



Step 8. Put on connecting rod caps. Code numbers on caps and rods must match and be aligned.
Step 9. Put nuts on connecting rod bolts. Torque nuts 30 to 37 lb. ft. (40 to 50 Nm). Tighten connecting rod nuts 90° (¼4 turn).

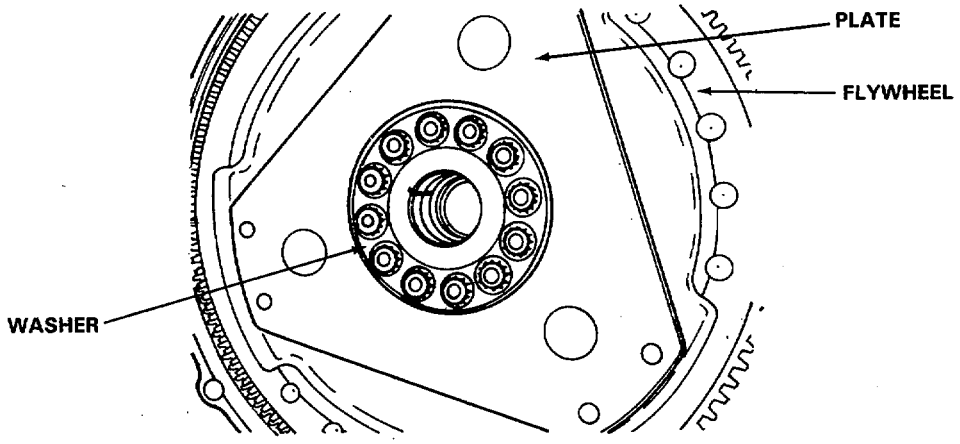


Step 10. Replace oil spray nozzles. Refer to paragraph 3-28.
Step 11. Replace cylinder head. Refer to paragraph 3-8.

3-18. REMOVE AND REPLACE FLYWHEEL.

a. Remove.

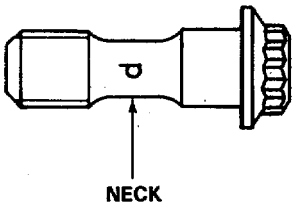
Step 1. Remove transmission. Refer to paragraph 7-18.
Step 2. Prevent engine from turning.
Step 3. Remove flywheel mounting screws.
Step 4. Remove washer, plate and flywheel.



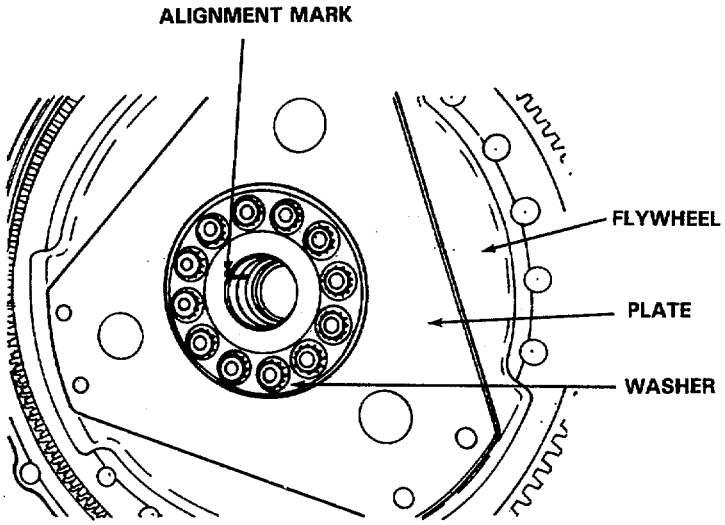
TA259419

c. Replace.

Step 1. Measure neck diameter of flywheel mounting screws. If neck diameter is less than 0.287 in. (7.3 mm) replace with new screw.



Step 2. Put flywheel on crankshaft. Align mark on flywheel with mark on crankshaft.
Step 3. Put on plate and washer.
Step 4. Put in mounting screws.



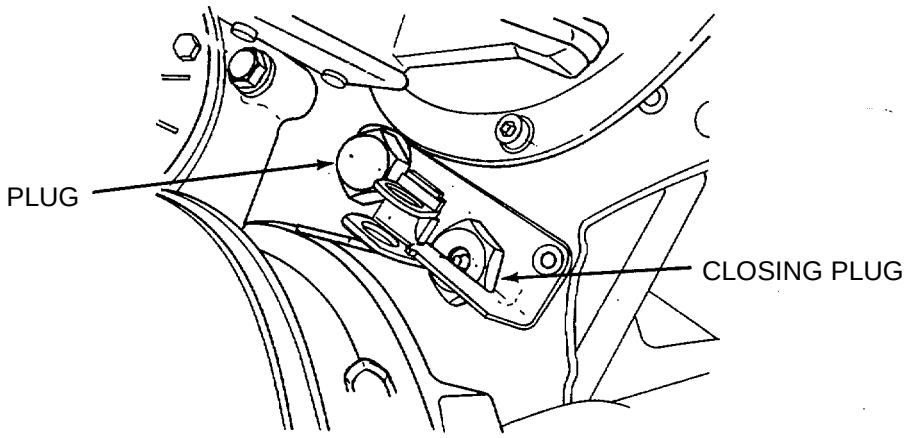
TA259420

Step 5. Torque mounting screws 22 to 29 lb. ft. (30 to 40 Nm).
Step 6. Tighten mounting screws 90° (1/4 turn).
Step 7. Replace transmission. Refer to paragraph 7-18.

3-19. REMOVE AND REPLACE GUIDE RAILS.

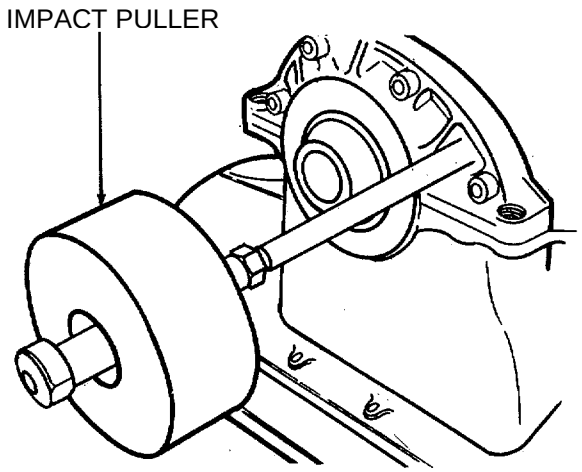
a. Remove.

Step 1. Remove vacuum pump. Refer to paragraph 3-33.
Step 2. Remove balancing disc. Refer to paragraph 3-6.
Step 3. Remove cylinder head cover and linkages. Refer to TM 9-2350-272-20.
Step 4. Remove plug and move TDC transmitter adjusting pointer aside.
Step 5. Remove closing plug and gasket.



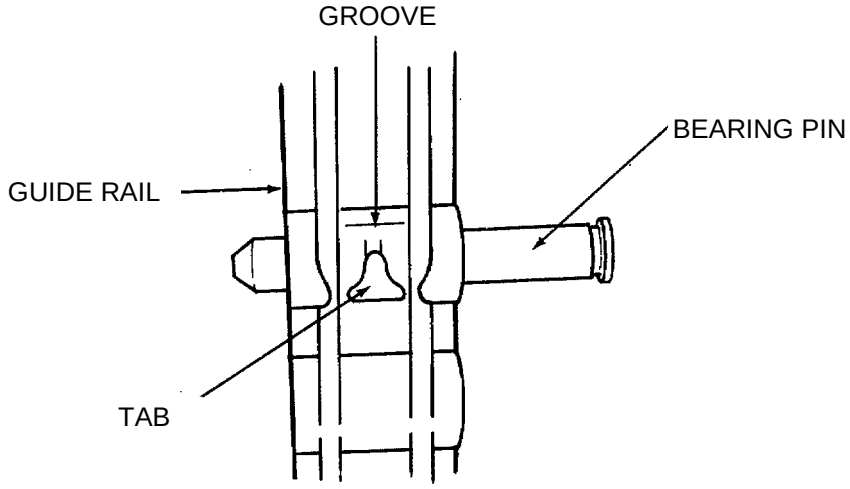
TA259421

Step 6. Remove injection timer. Refer to paragraph 4-8.
Step 7. Use impact puller and puller bolt. Remove lower bearing pin. Refer to table 2-1, items 2 and 3.
Step 8. Remove inner guide rail.
Step 9. Use impact puller and puller bolt. Remove two outer guide bearing pins. Refer to table 2-1, items 2 and 3.
Step 10. Remove outer guide rails.



b. Replace.

Step 1. Hold outer guide rail in place.
Step 2. Use impact puller. Put in bearing pins. Locating groove in lower bearing pin must align with tab on guide rail.
Step 3. Hold inner guide rail in position.
Step 4. Use impact puller. Put in lower bearing pin. Locating groove in bearing pin must align with tab on guide rail.



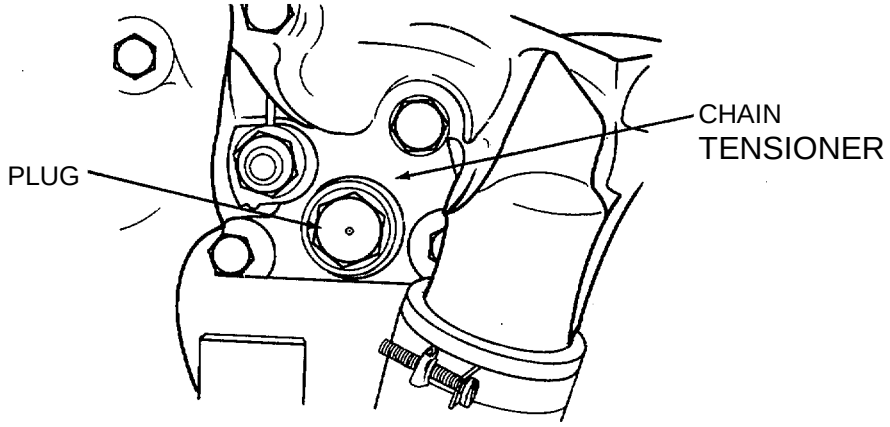
TA259422

Step 5. Put in upper bearing pin and closing plug.
Step 6. Replace injection timer. Refer to paragraph 4-8.
Step 7. Put in plug and position TDC adjusting pointer.
Step 8. Replace vacuum pump. Refer to paragraph 3-33.
Step 9. Replace balancing disc. Refer to paragraph 3-6.
Step 10. Put on cylinder head cover and linkages. Refer to TM 9-2350-272-20.

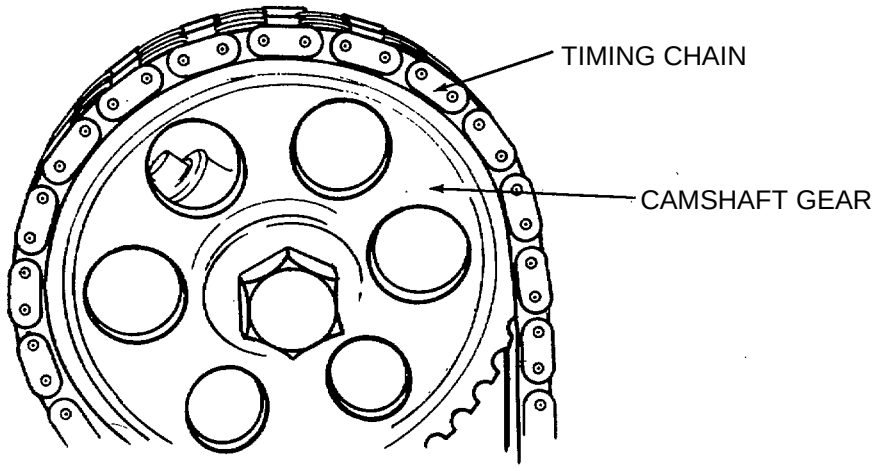
3-20. REMOVE AND REPLACE GUIDE WHEEL.

a. Remove.

Step 1. Remove cylinder head cover and linkages. Refer to TM 9-2350-272-20.
Step 2. Use socket. Rotate crankshaft to ignition TDC of the number 1 cylinder.
Step 3. Remove plug and spring from chain tensioner.

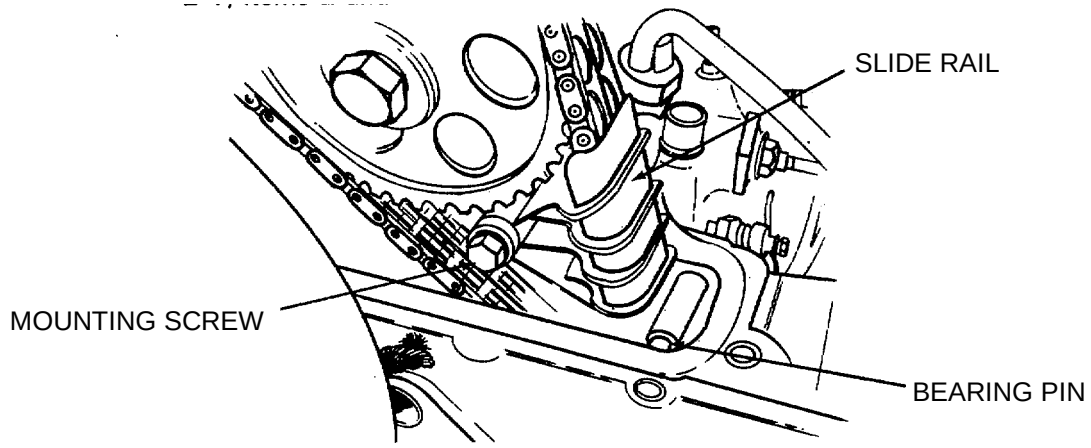


Step 4. Put location mark between camshaft gear and timing chain.

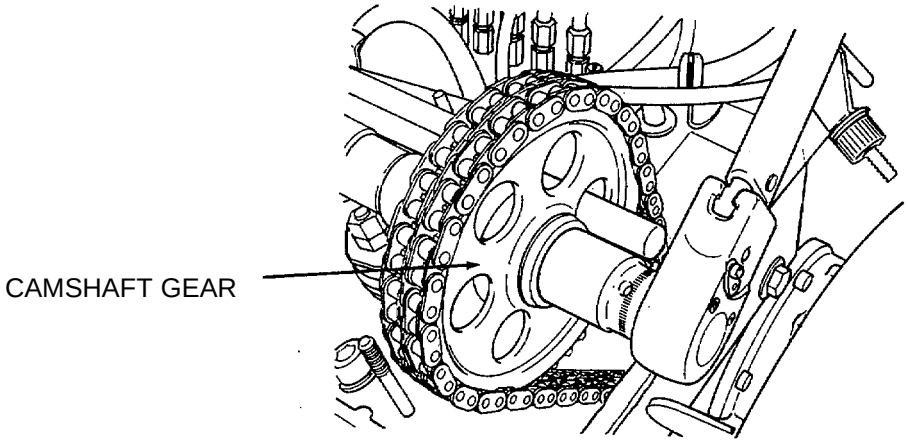


TA259423

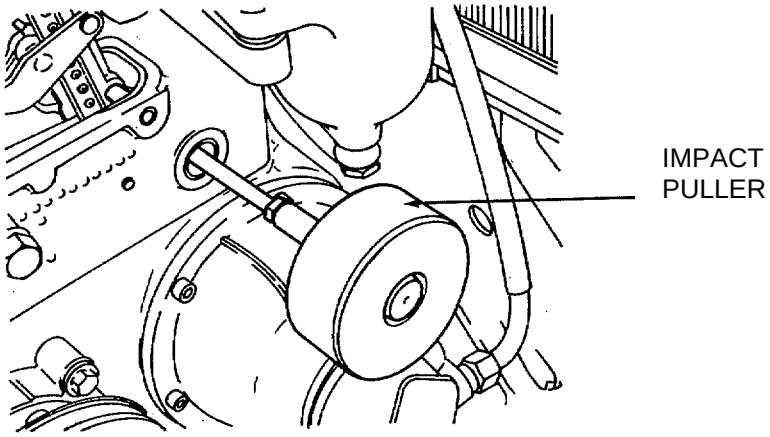
Step 5. Remove mounting screw from slide rail.
Step 6. Use impact puller and puller bolt. Remove bearing pin from slide rail. Refer to table 2-1. items 2 and 3.



Step 7. Hold camshaft. Remove camshaft gear screw.
Step 8. Remove camshaft gear.
Step 9. Remove plug and seal.

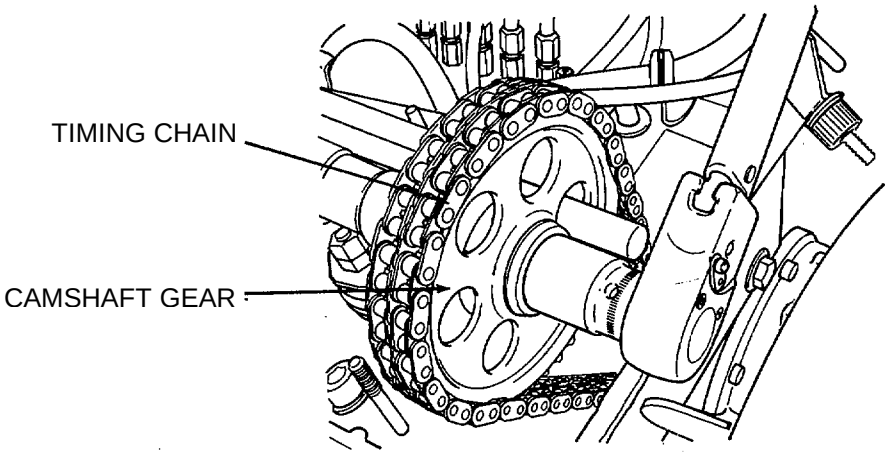


Step 10. Use impact puller. Refer to table 2-1, item 2. Remove guide wheel shaft.
Step 11. Remove guide wheel.

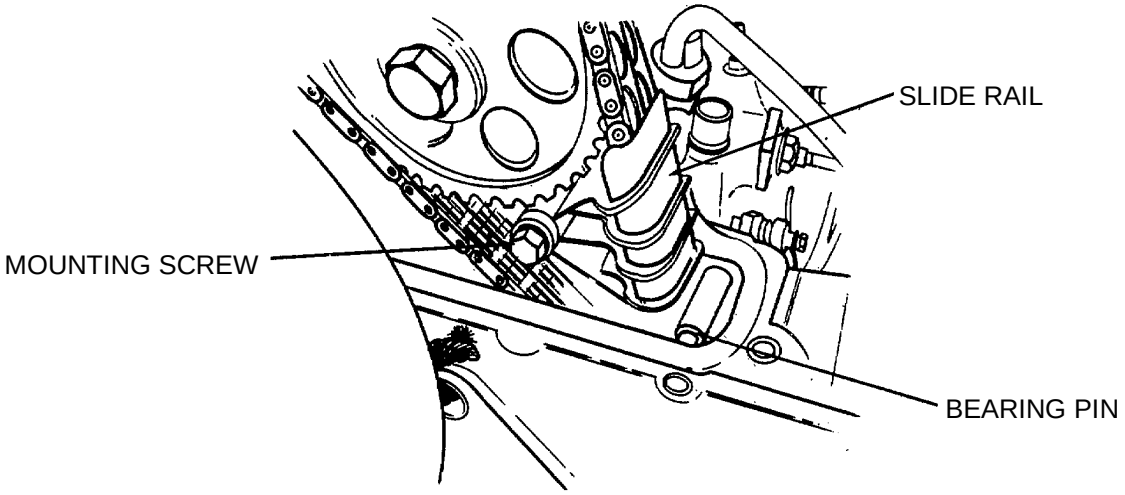


b. Replace.

Step 1. Hold guide wheel in place.
Step 2. Put in guide wheel shaft.
Step 3. Put new seal on plug. Screw plug into guide wheel shaft.
Step 4. Align marks on camshaft gear and timing chain. Put gear on camshaft.
Step 5. Put screw in camshaft gear.
Step 6. Hold camshaft. Torque screw to 59 lb. ft. (80 Nm).

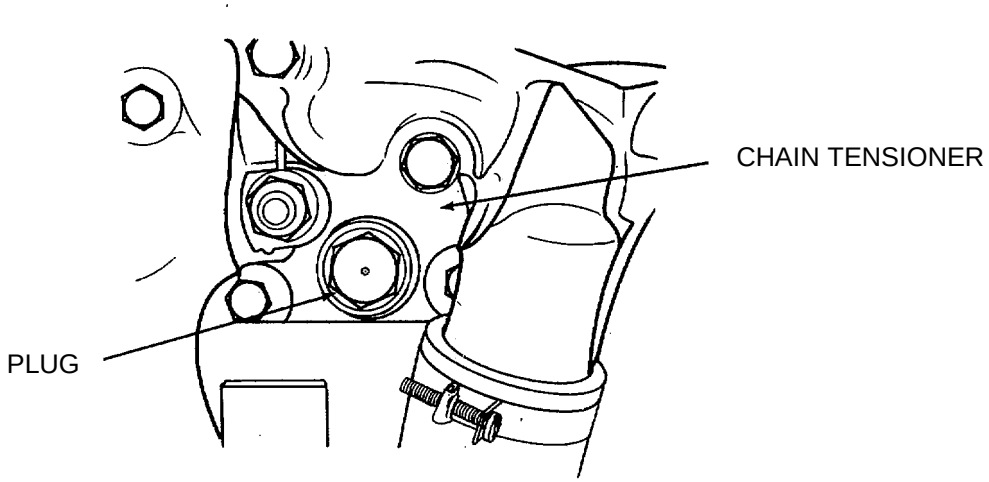


Step 7. Hold slide rail in place. Put in mounting screw. Tighten screw.
Step 8. Put in bearing pin.



TA259425

Step 9. Put spring and plug in chain tensioner. Torque plug to 66 lb. ft. (90 Nm).

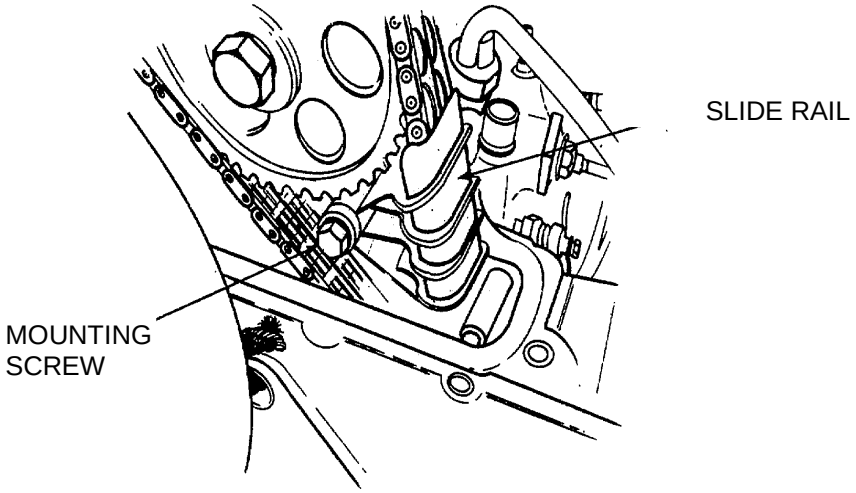


Step 10. Put on cylinder head cover and linkages. Refer to TM 9-2350-272-20.

3-21. REMOVE AND REPLACE SLIDE RAIL.

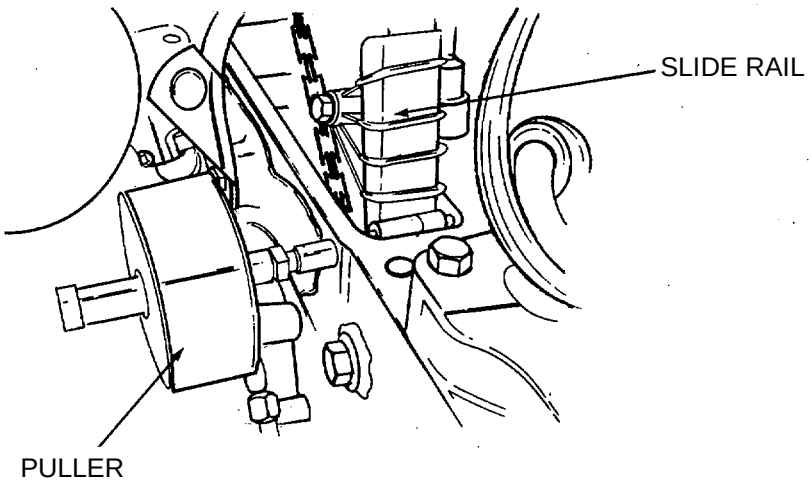
a. Remove.

Step 1. Remove cylinder head cover and linkages. Refer to TM 9-2350-272-20.
Step 2. Remove slide rail mounting screw.



TA259426

Step 3. Use puller and puller bolt. Remove slide rail bearing pin. Refer to table 2-1, items 2 and 3.
Step 4. Remove slide rail.



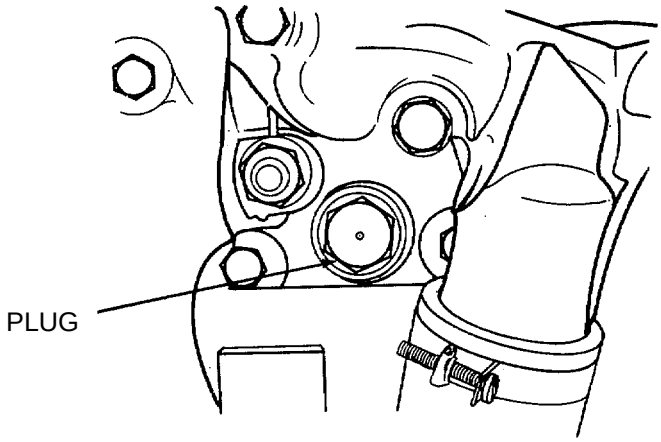
b. Replace.

Step 1. Hold slide rail in place.
Step 2. Use puller and puller bolt. Put in slide rail bearing pin. Refer to table 2-1, items 2 and 3.
Step 3. Put in slide rail mounting screw. Tighten screw.
Step 4. Put on cylinder head cover and linkages. Refer to TM 9-2350-272-20.

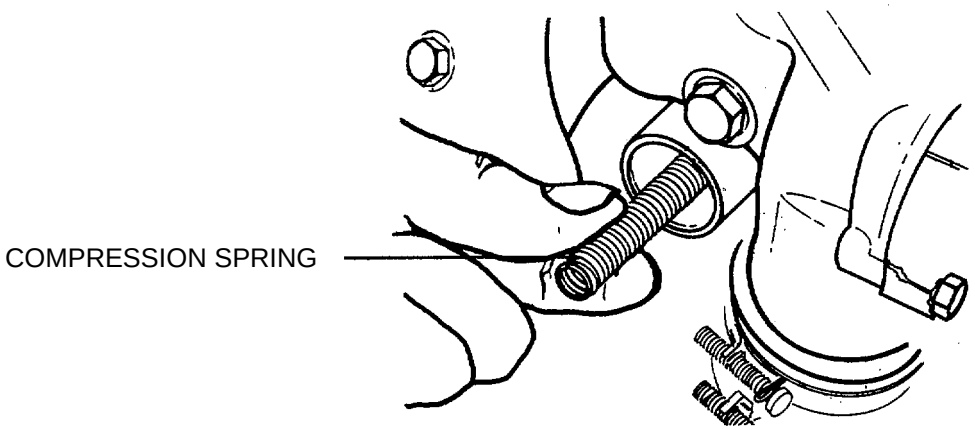
3-22. REMOVE AND REPLACE TENSIONING RAIL.

a. Remove.

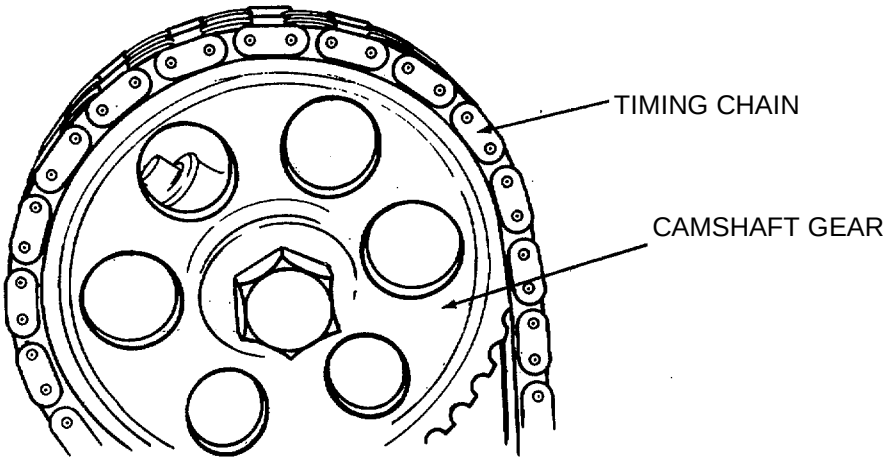
Step 1. Remove vibration damper. Refer to paragraph 3-6.
Step 2. Remove cylinder head cover and linkages. Refer to TM 9-2350-272-20.
Step 3. Use socket. Rotate crankshaft until notch in balancing disc is in front of tensioning rail bearing pin.
Step 4. Remove plug from chain tensioner.



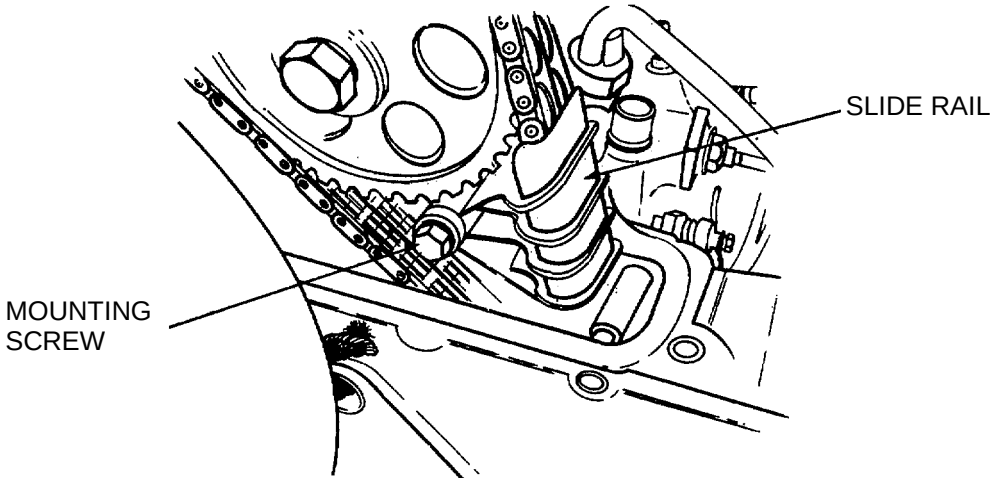
Step 5. Remove compression spring.



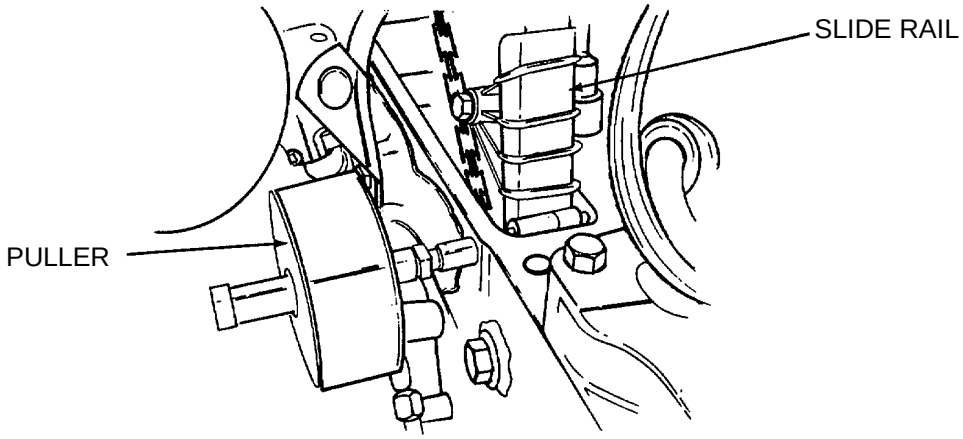
Step 6. Put location mark between camshaft gear and timing chain.



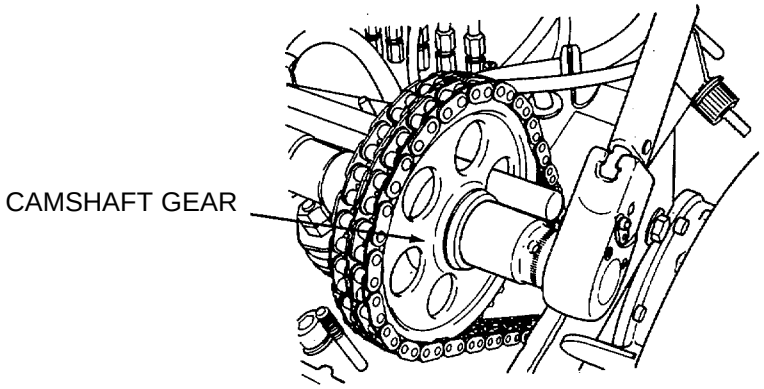
Step 7. Remove slide rail mounting screw.



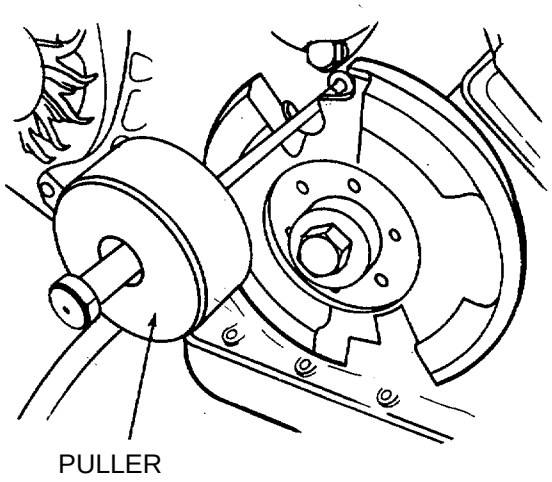
Step 8. Use puller and puller bolt. Remove slide rail bearing pin and slide rail. Refer to table 2-1, items 2 and 3.



Step 9. Remove screw from camshaft gear.
Step 10. Remove camshaft gear.



Step 11. Use puller. Remove tensioning rail bearing bolt. Refer to table 2-1, item 2.
Step 12. Remove tensioning rail.



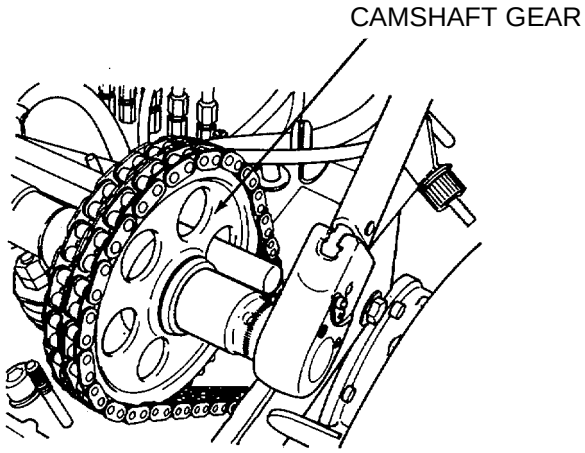
TA259429

b. Replace.

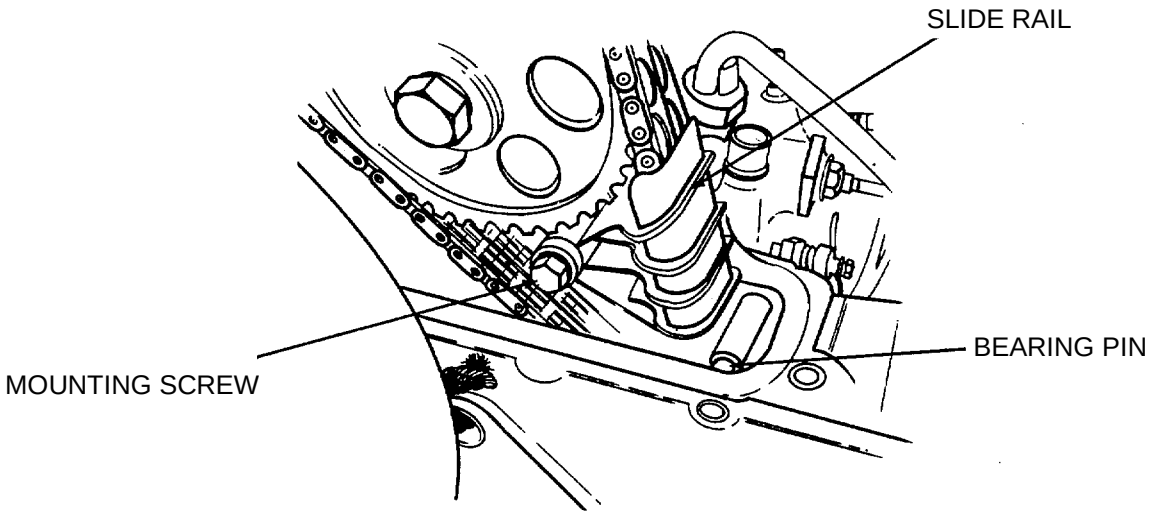
WARNING

Cleaning solvent, federal specification P-D-680, Type II, is flammable and gives off harmful vapors. Use solvent only in a well ventilated area. Avoid prolonged breathing of solvent vapors. Keep solvent away from flame. Do not use solvent in excessive amounts.

Step 1. Clean all parts with solvent. Dry parts. Refer to appendix B, item 48.
Step 2. Replace worn or damaged tensioning rail and bearing pins.
Step 3. Hold tensioning rail in position.
Step 4. Put in tensioning rail bearing pin.
Step 5. Put timing chain on camshaft gear. Align location marks.
Step 6. Put camshaft gear on camshaft.
Step 7. Put in camshaft gear screw.
Step 8. Hold camshaft. Torque camshaft screw to 59 lb. ft. (80 Nm).

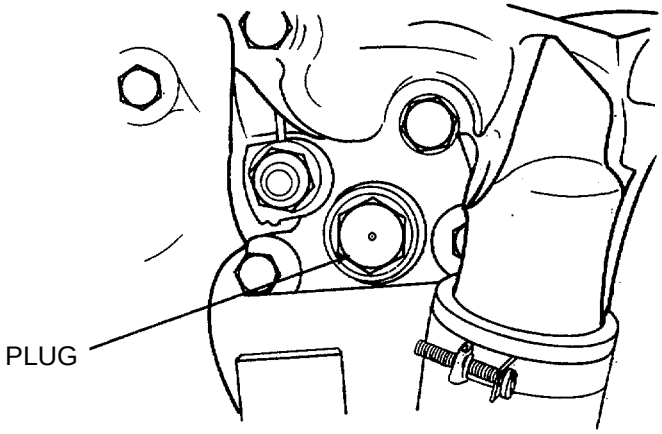


Step 9. Put slide rail in position.
Step 10. Put in slide rail bearing pin.
Step 11. Put in slide rail mounting screw. Tighten screw.



TA259430

Step 12. Put thrust pin into chain tensioner.
Step 13. Put in compression spring.
Step 14. Screw plug into chain tensioner. Torque plug to 66 lb. ft. (90 N*m).*
Step 15. Check that chain tensioner thrust pin is seated on tensioning rail.

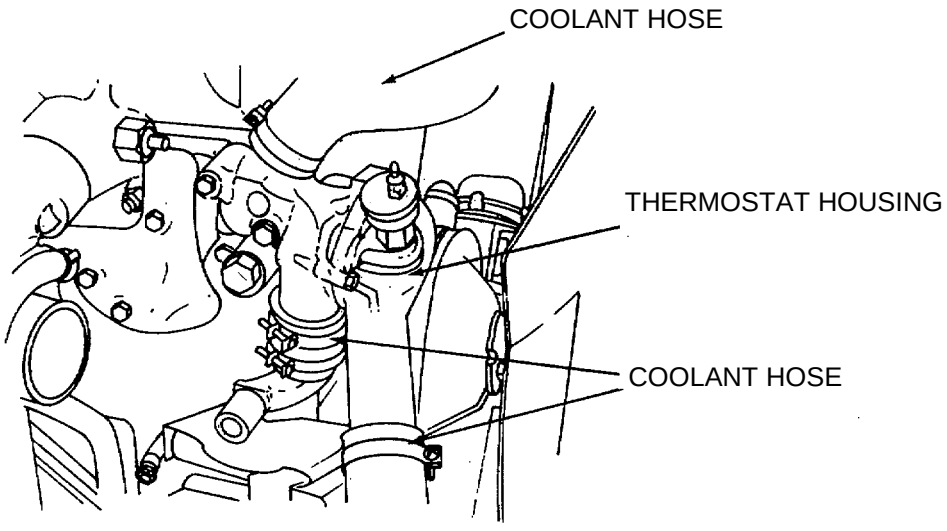


Step 16. Replace vibration damper. Refer to paragraph 3-6.
Step 17. Put on cylinder head cover and linkages. Refer to TM 9-2350-272-20.

3-23. REMOVE AND REPLACE CHAIN TENSIONER.

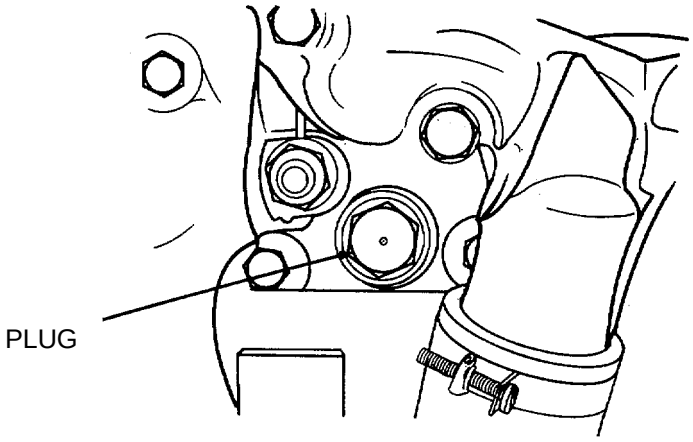
a. Remove.

Step 1. Drain engine coolant. Refer to TM 9-2350- 272-20.
Step 2. Disconnect'/coolant hoses from thermostat housing.
Step 3. Remove thermostat housing.

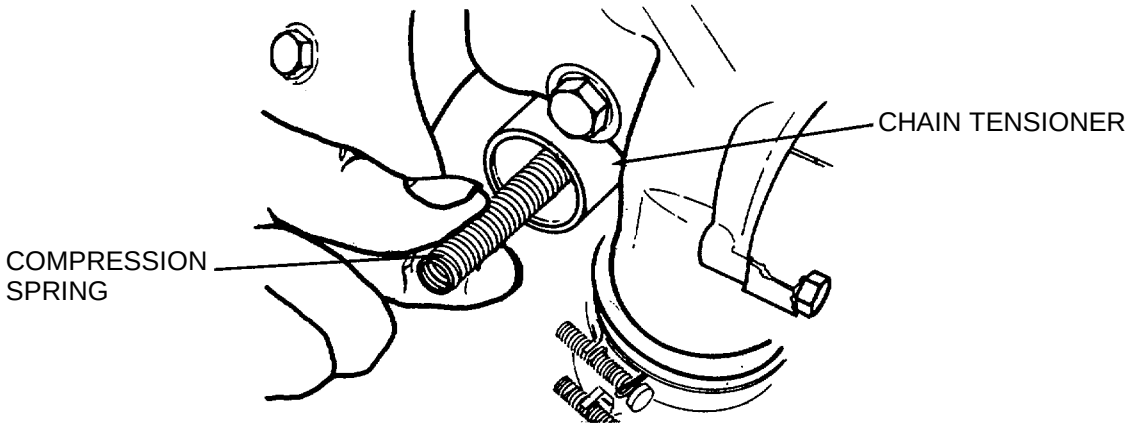


TA259431

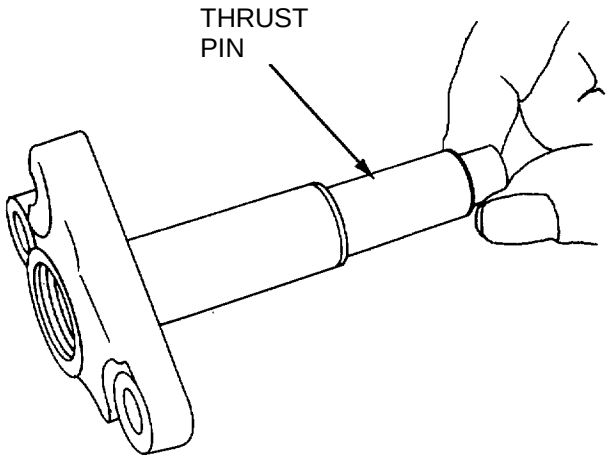
Step 4. Remove plug from chain tensioner.



Step 5. Remove compression spring.
Step 6. Remove chain tensioner mounting screw and exhaust mounting screws.
Step 7. Remove chain tensioner.

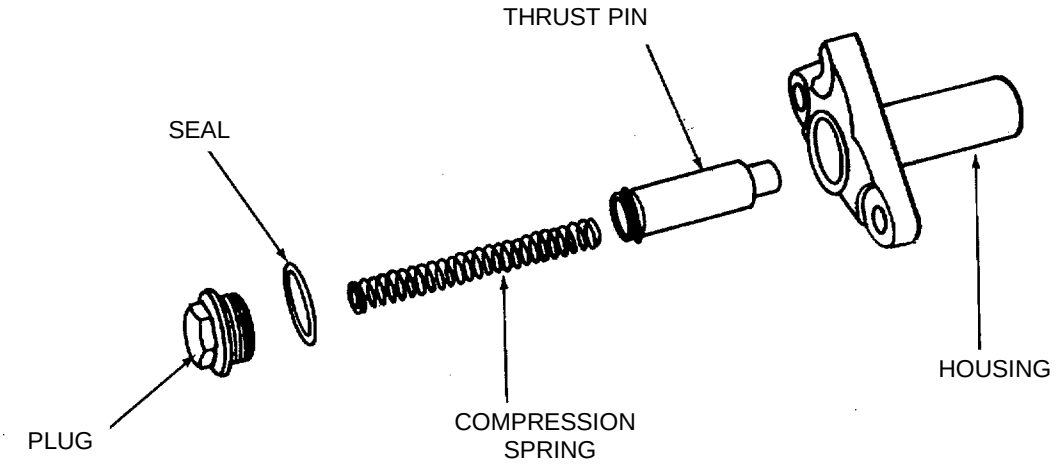


Step 8. Pull thrust pin out of housing in forward direction.



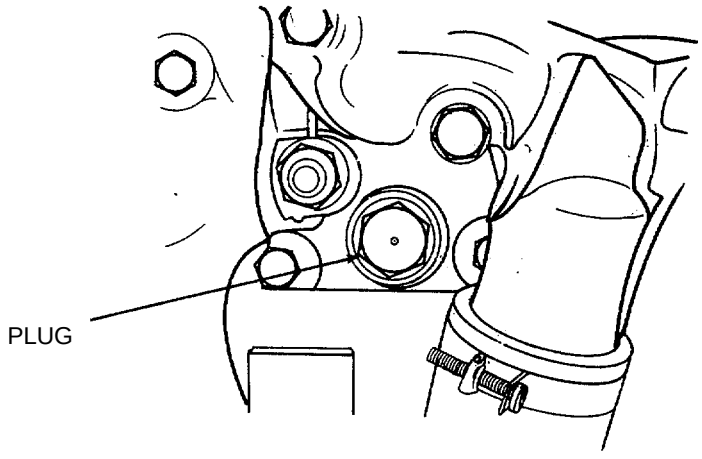
TA259432

Step 9. Clean all parts.



b. Replace.

Step 1. Rotate engine 1/2 turn.
Step 2. Put new gasket on chain tensioner housing.
Step 3. Put housing in place.
Step 4. Put in chain tensioner mounting screws. Tighten screws.
Step 5. Put thrust pin into chain tensioner housing.
Step 6. Put in compression spring.
Step 7. Put new seal on plug.
Step 8. Screw in plug. Torque plug to 66 lb. ft. (90 Nm).



TA259434

Step 9. Install thermostat housing.
Step 10. Connect coolant hoses.
Step 11. Fill and bleed cooling system. Refer to TM 9-2350-272-20.

3-24. REMOVE AND REPLACE ROCKER ARMS.

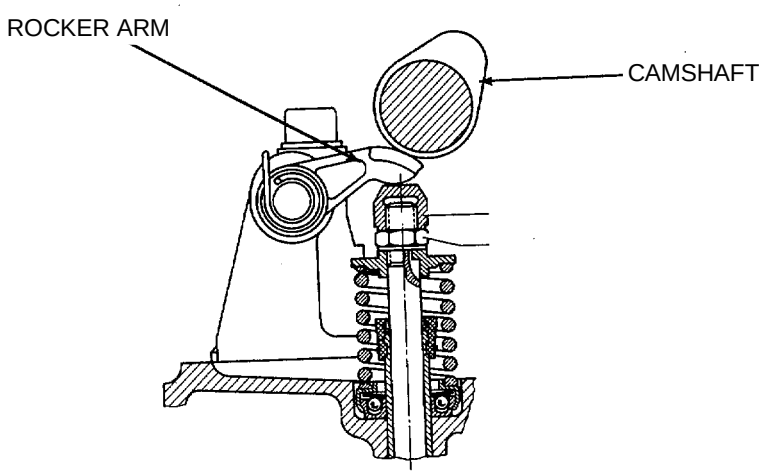
a. Remove.

Step 1. Remove linkages and cylinder head cover. Refer to TM 9-2350-272-20.

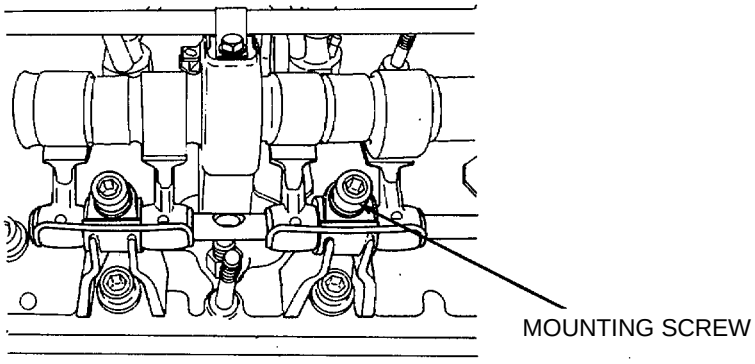
CAUTION

Rocker arms must be replaced in same location from where they were removed. Failure to do so may damage camshaft.

Step 2. Put location tags on rocker arms.
Step 3. Rotate engine until camshaft is not applying pressure on rocker arms.

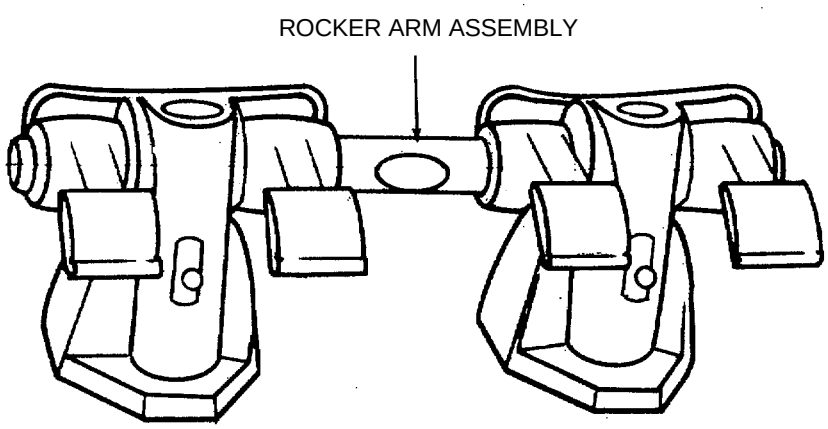


Step 4. Remove mounting screws from rocker arm bearing brackets.



TA259433

Step 5. Remove both rocker arm assemblies.

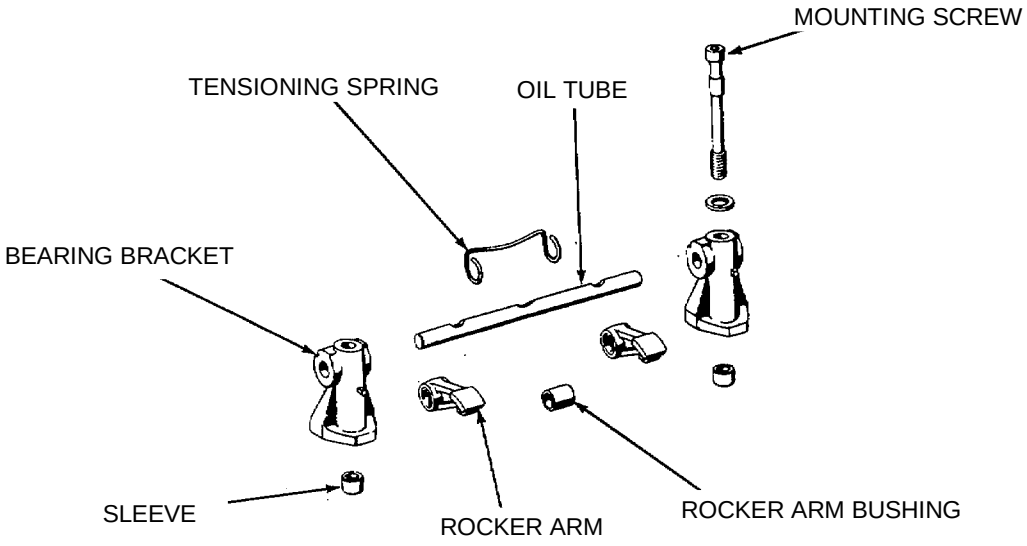


Step 6. Push down tensioning spring.
Step 7. Pu**ll** rocker arms, bearing brackets and tensioning springs off oil tube.
Step 8. Repeat steps 6 and 7 for other rocker arms.
Stop 9. Remove sleeves from bearing brackets.

NOTE

Some rocker arms do not have bushings. Rocker arms without bushings must be replaced if worn. If rocker arms have bushings which are worn, replace the bushings.

Step 10. Remove bushing from rocker arms.



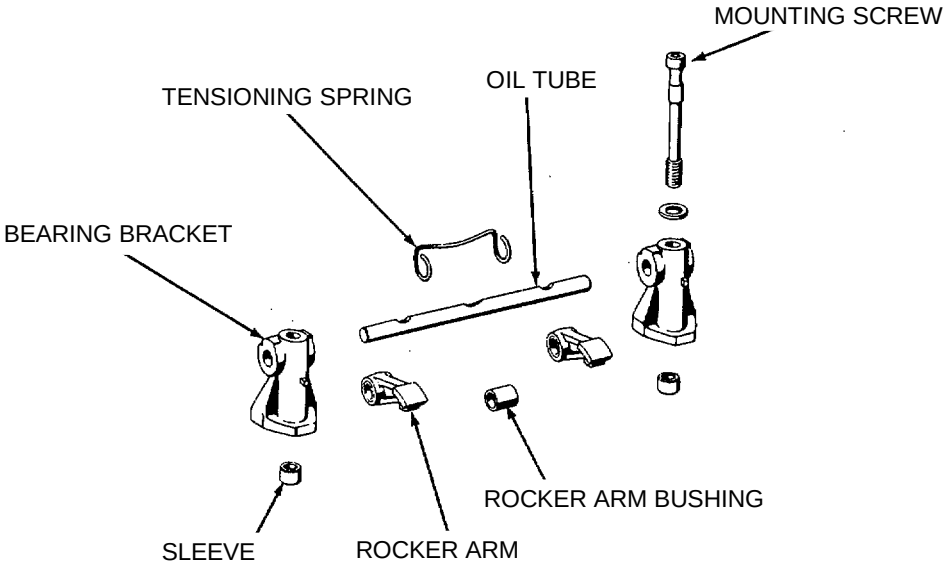
b. Replace.

CAUTION

The camshaft must be replaced if any new rocker arms are installed. New rocker arm can cause damage to old camshaft.

Step 1. Inspect rocker arms for visible wear and damage. Replace worn or damaged rocker arm.

Step 2. Press new bearings in rocker arms.
Step 3. Press new sleeves in bearing brackets.
Step 4. Slide tensioning spring, rocker arms and bearing bracket on oil tube.
Step 5. Lift tensioning spring into groove in bearing bracket.
Step 6. Repeat steps 4 and 5 for other rocker arms.

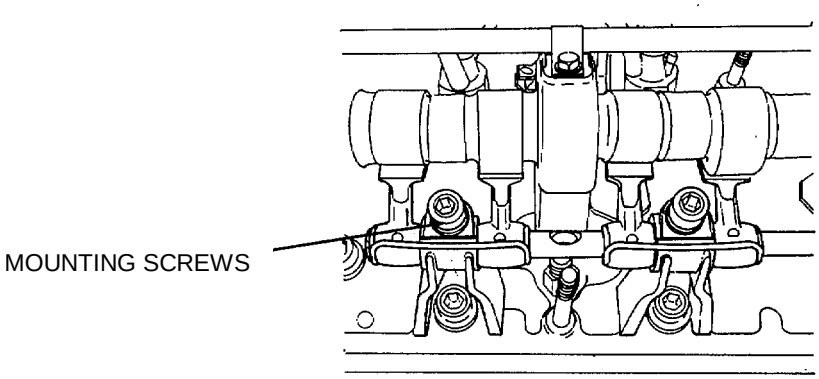


Step 7. Put rocker arm assemblies on cylinder head.
Step 8. Put mounting screws in bearing brackets. Torque screws to 28 lb. ft. (38 Nm).
Step 9. Remove tags from rocker arms.
Step 10. Adjust valves. Refer to paragraph 3-4.
Step 11. Replace cylinder head cover and linkages. Refer to TM 9-2350-272-20.

3-25. REMOVE AND REPLACE CAMSHAFT.

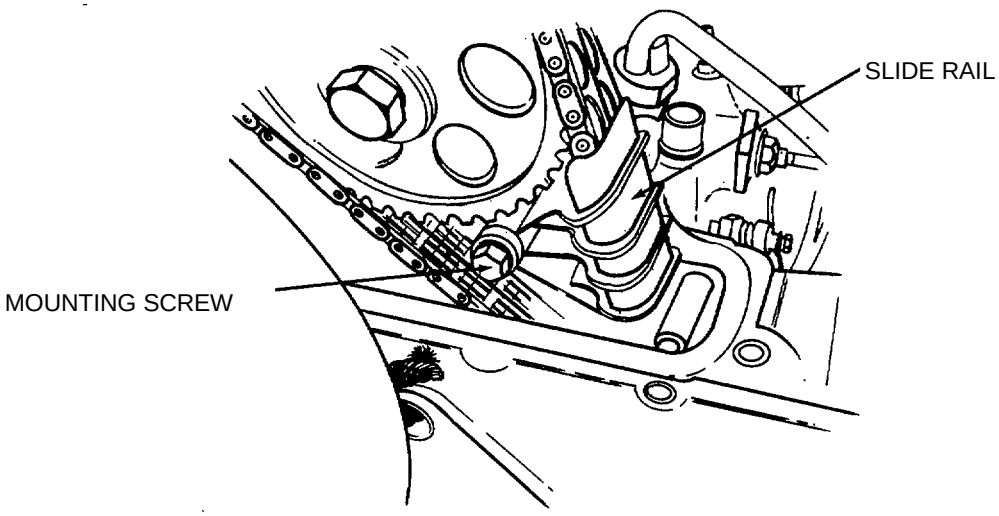
a. Remove.

Step 1. Remove linkages from cylinder head cover. Refer to TM 9-2350-272-20.
Step 2. Remove cylinder head cover. Refer to TM 9-2350-272-20.
Step 3. Remove rocker and bracket mounting screws. Refer to paragraph 3-24.
Step 4. Remove rocker arm assemblies. Put on location tags.

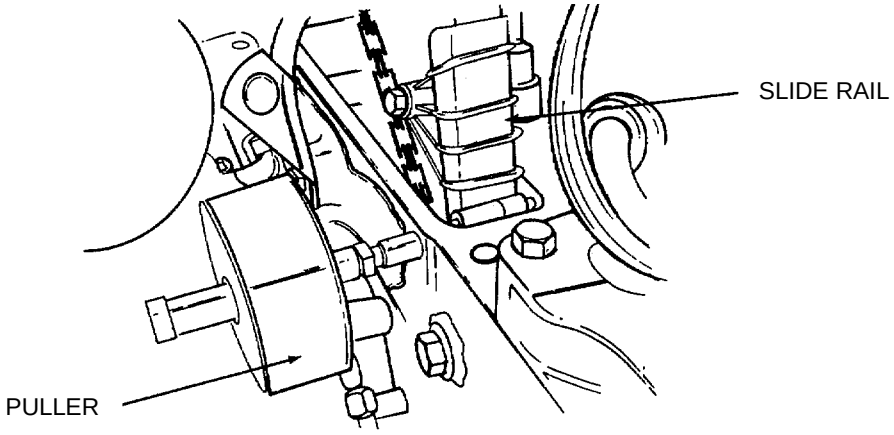


TA259435

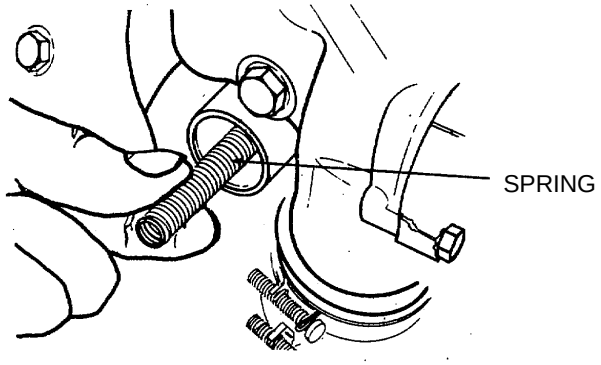
Step 5. Remove mounting screw from slide rail.



Step 6. Use puller and puller bolt. Remove bearing pin from slide rail. Refer to table 2-1, items 2 and 3.

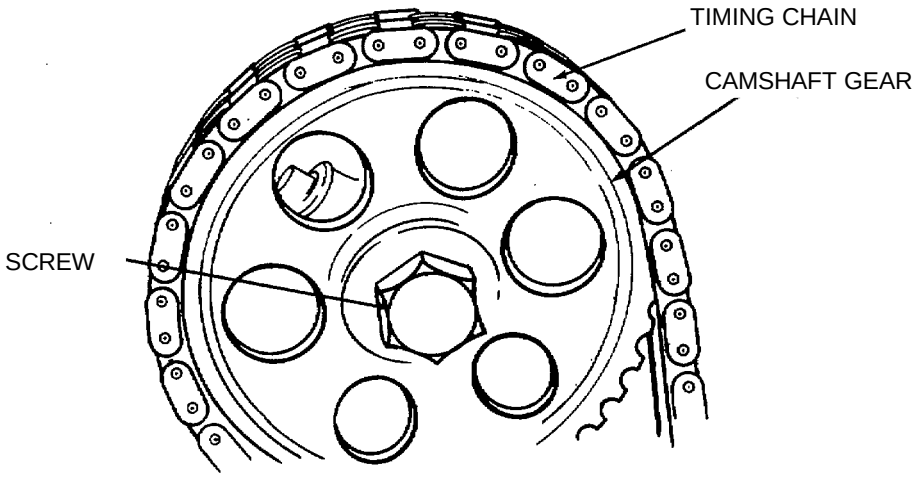


Step 7. Remove plug from chain tensioner.
Step 8. Remove spring.

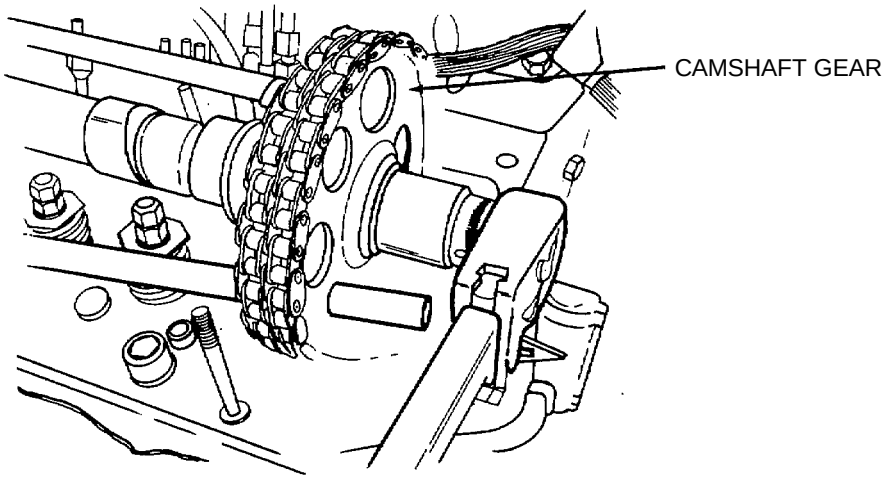


TA259436

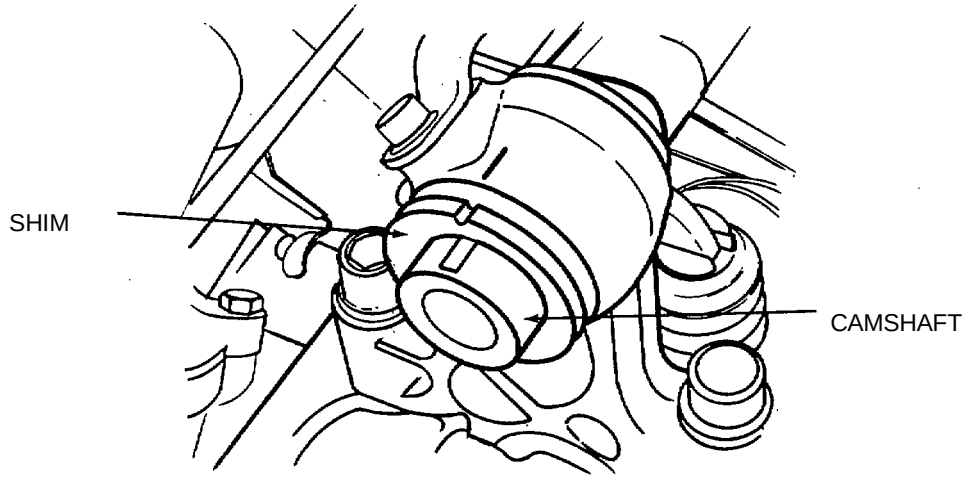
Step 9. Put location mark on camshaft gear and timing chain.
Step 10. Remove screw from carrshaft gear.



Step 11. Remove camshaft

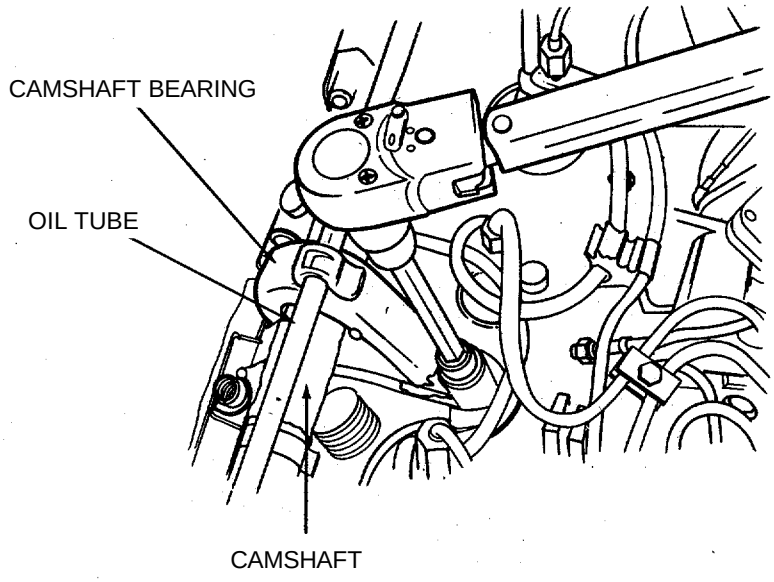


Step 12. Remove shim from camshaft



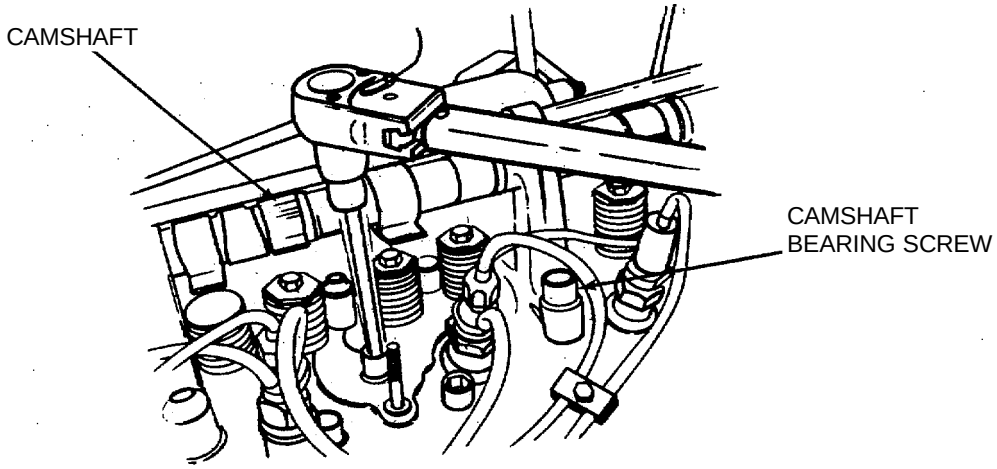
TA259437

Step 13. Remove camshaft bearing screws. Refer to table 2-1, item 1.
Step 14. Remove nuts and washers from camshaft bearing studs.
Step 15. Remove camshaft with bearings and **oil** tube.
Step 16. Pull camshaft out of camshaft bearing in a rearward direction.
Step 17. Remove oil tube.

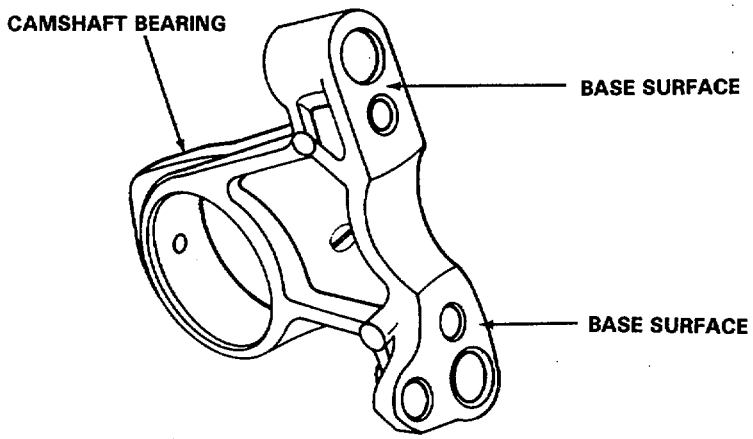


b. Replace.

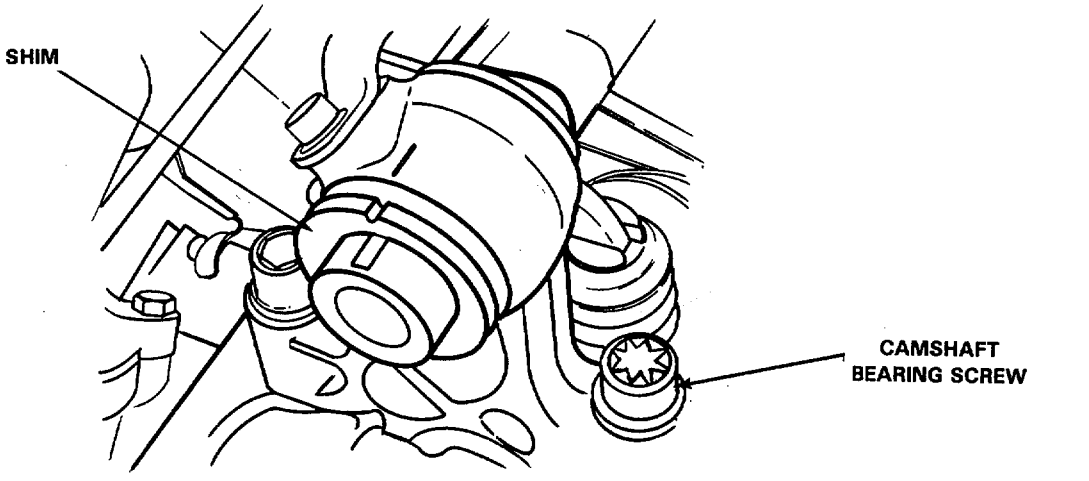
Step 1. Lubricate camshaft bearings, camshaft journals and cams with engine oil.
Step 2. Attach oil tube to camshaft bearings.
Step 3. Put camshaft into camshaft bearing from the rear.
Step 4. Put camshaft with camshaft bearings on cylinder head.
Step 5. Put in camshaft bearing screws. Start at center and work outward torque screws in steps.
Step 6. Torque screws to 30 lb. ft. (40 Nm).
Step 7. Torque screws to 52 lb. ft. (70 Nm).
Step 8. Wait ten minutes. Tighten, screws 900 (1/4 turn).
Step 9. Repeat step 8.



Step 10. Put nuts and washers on camshaft bearing studs. Torque nuts to 18 lb. ft. (25 Nm).
Step 11. Manually rotate camshaft. If camshaft rotates easily go to step 1 6. If camshaft does not rotate easily go to step 12.
Step 12. Loosen front camshaft bearings one at a time. Check ease of camshaft rotation after loosening each bearing individually until binding point is found. Mark last camshaft bearing that was loosened.
Step 13. Remove camshaft.
Step 14. Lap base surface of the binding camshaft bearing.

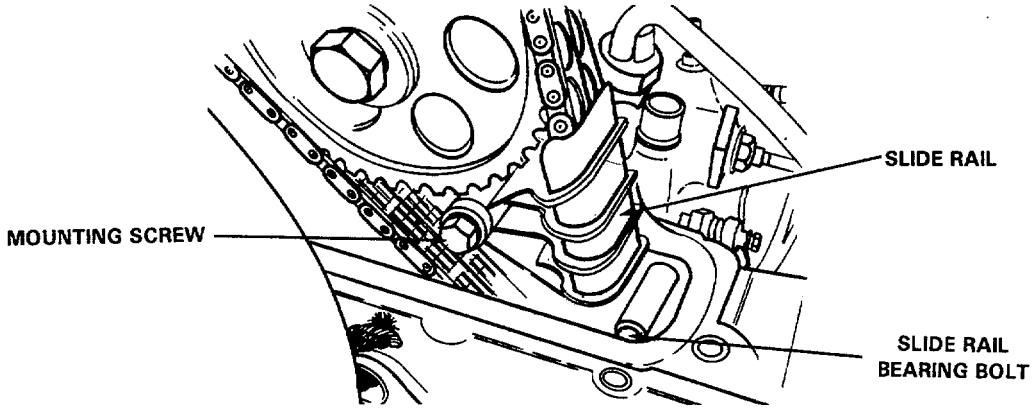


Step 15. Repeat steps 1 through 11.
Step 16. Put shim and key on camshaft.

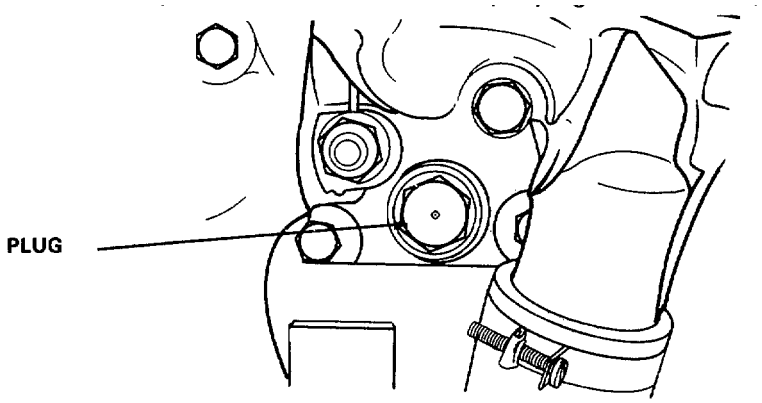


TA259780.

Step 17. Put camshaft gear with timing chain on camshaft while holding camshaft in place. Marks on gear and chain must be aligned.
Step 18. Put screw in camshaft gear. Torque screw to 59 lb. ft. (80 Nm).
Step 19. Mount slide rail.
Step 20. Put in slide rail mounting screw.
Step 21. Put in slide rail bearing pin. Tighten rail mounting screw.



Step 22. Put spring into chain tensioner.
Step 23. Screw plug into chain tensioner. Torque plug to 66 lb. ft. (90 Nm).



CAUTION

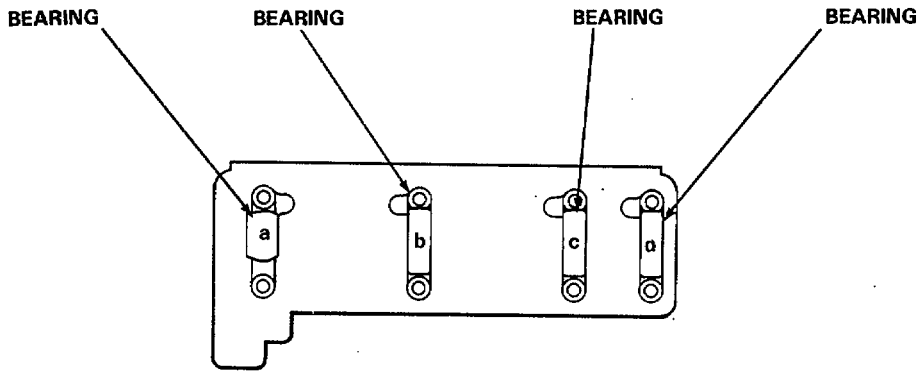
Rocker arms must be replaced in same location from where they were removed. Failure to do so may damage camshaft.

Step 24. Install rocker arm assemblies. Refer to paragraph 3-24.

3-26. REPAIR CAMSHAFT.

Step 1. Remove camshaft. Refer to paragraph 3-25.
Step 2. Inspect camshaft for cracks. Replace cracked camshaft.
Step 3. Inspect camshaft journals for damage. Grind damaged camshaft journals. Journals can only be ground to a size corresponding to the available camshaft bearing.
Step 4. Inspect camshaft bearing for damage. Replace damaged bearing with bearing of the size corresponding to the camshaft journal diameter.
Step 5. Measure camshaft bearings and journals. Check color coding of camshaft bearing. Refer to chart below for correct measurements.

	BEARING DIAMETER	JOURNAL DIAMETER
Standard (No color code)	a=1.3779 to 1.3787 in. (35 to 35.02 mm)	1.3759 to 1.3752 in. (34.95 to 34.93 mm)
	b, c and d=1.9291 to 1.9299 in. (49.00 to 49.02 mm)	1.9272 to 1.9264 in. (48.95 to 49.02 mm)
Color code gray	a=1.3740 to 1.3748 in. (34.90 to 34.92 mm)	1.3720 to 1.3712 in. (34.85 to 34.83 mm)
	b, c and d= 1.9252 to 1.9259 (48.90 to 48.92 mm)	1.9232 to 1.9224 in. (48.85 to 48.83 mm)
Color code red	a=1.3681 to 1.3688 in. (34.75 to 34.77 mm)	1.3661 to 1.3654 in. (34.70 to 34.68 mm)
	b, c and d=1.9192 to 1.9200 in. (48.75 to 48.77 mm)	1.9173 to 1.9165 in. (48.70 to 48.68 mm)

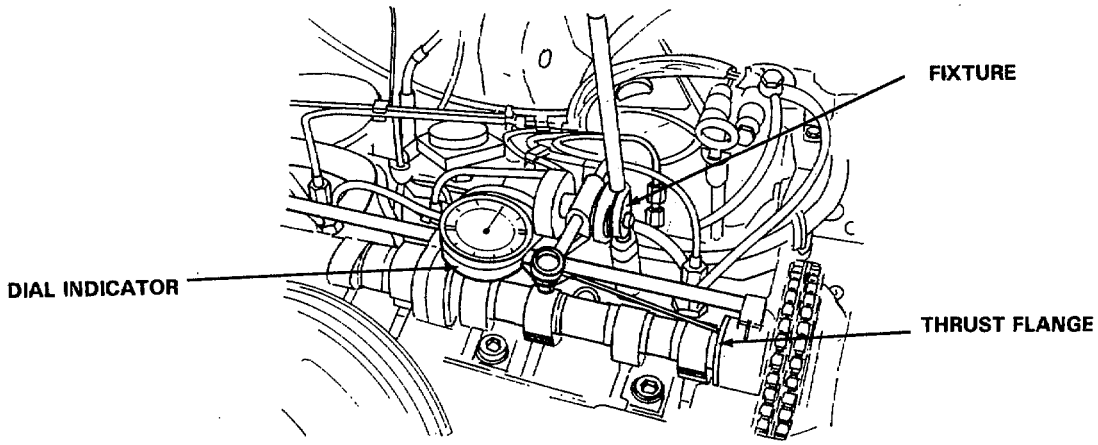


TA259440

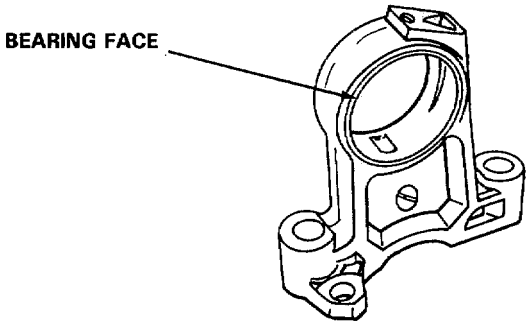
NOTE

New rocker arms must be installed if new camshaft is installed.

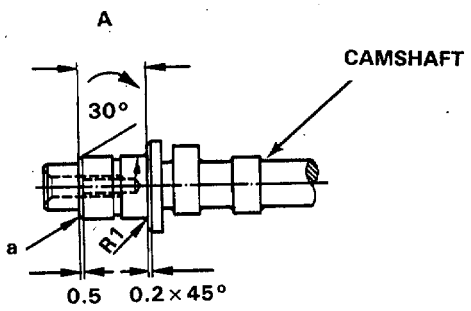
Step 6. Replace camshaft. Refer to paragraph 3-25.
Step 7. Install dial indicator and fixture on left front of head.
Step 8. Position dial indicator against thrust flange of camshaft.
Step 9. Push camshaft toward rear.
Step 10. Set dial indicator at "O".
Step 11. Push camshaft forward.
Step 12. Read dial indicator. Reading indicates camshaft end play. End play must be between 0.0028 and 0.0059 in. (0.07 and 0.15 mm).



Step 13. Remove camshaft if end play is not within tolerance.
Step 14. Grind number one bearing face surfaces if end play is too low. Grind face "a" first bearing journal of camshaft if end play is too high.



TA259441



Step 15. Replace camshaft. Refer to paragraph 3-25.

3-27. REMOVE AND REPLACE TIMING CHAIN.

a. Remove.

Step 1. Remove crankshaft gear. Refer to paragraph 3-14.
Step 2. Remove guide rails. Refer to paragraph 3-1 9.
Step 3. Remove timing chain from crankcase.

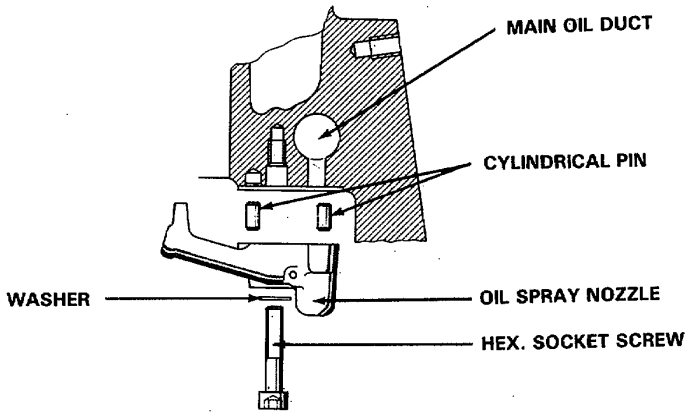
b. Replace.

Step 1. Put timing chain into crankcase.
Step 2. Replace guide rails. Refer to paragraph 3-1 9.
Step 3. Replace crankshaft gear. Refer to paragraph 3-14.
Step 4. Check and adjust camshaft timing. Refer to paragraph 3-5.

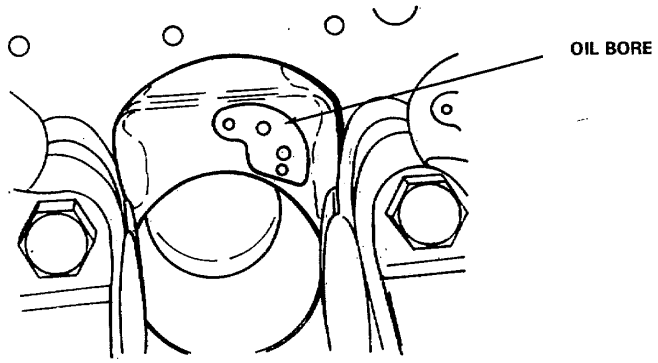
3-28. REMOVE AND REPLACE OIL SPRAY NOZZLES.

a. Remove.

Step 1. Remove oil pan. Refer to paragraph 3-30.
Step 2. Rotate crankshaft until oil spray nozzle to be removed is accessible.
Step 3. Remove mounting screw and washer.
Step 4. Pull oil spray nozzle straight out of crankcase.
Put on location tags.



Step 5. Cover oil bores in crankcase to keep out dirt.



WARNING

Compressed air used for cleaning purposes will not exceed 30 psi. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

TA259443

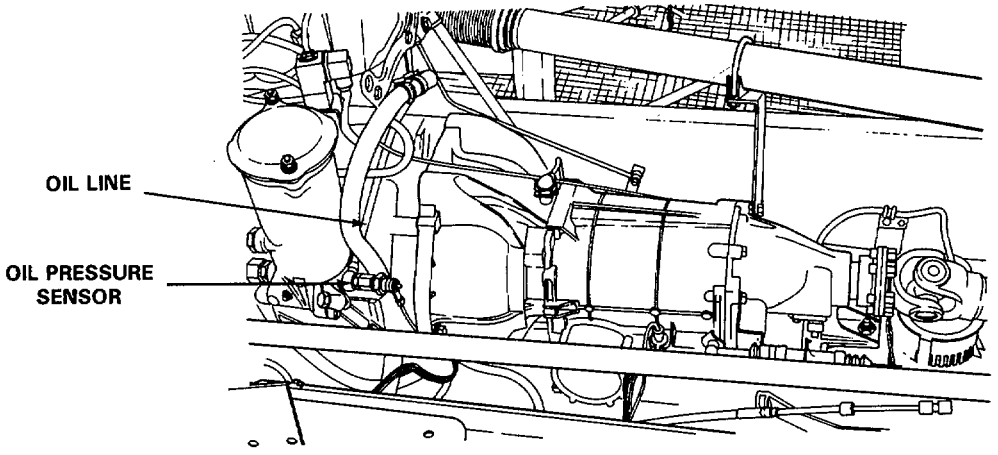
b. Replace.

Step 1. Check bore of oil spray nozzle. Replace nozzle if bore is out of round or burred
Step 2. Clean nozzles with compressed air. Direct the flow of air in same direction as oil flow.
Step 3. Remove cover from oil bores in crankcase.
Step 4. Put oil spray nozzles in crankcase.
Step 5. Put new washer on mounting screw. Put in screw with washer.
Step 6. Torque mounting screw to 7 lb. ft. (10 Nm).
Step 7. Replace oil pan. Refer to paragraph 3-30.

3-29. REMOVE, REPAIR AND REPLACE ENGINE OIL FILTER HOUSING.

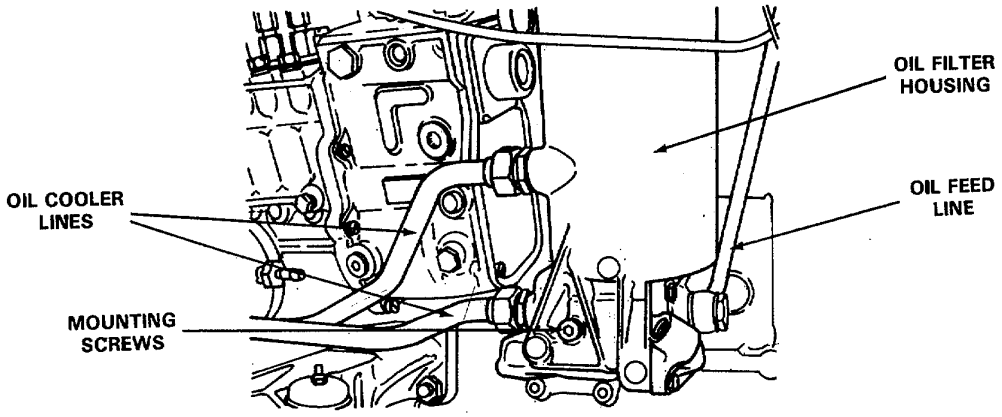
a. Remove.

Step 1. Remove engine oil filter. Refer to TM 9-2350-272-20.
Step 2. Disconnect electrical wire at oil pressure sensor.
Step 3. Disconnect oil line at oil pressure sensor.



TA259446

Step 4. Disconnect oil cooler lines.
Step 5. Disconnect oil feed line to turbocharger.
Step 6. Remove five mounting screws. Remove oil filter housing.



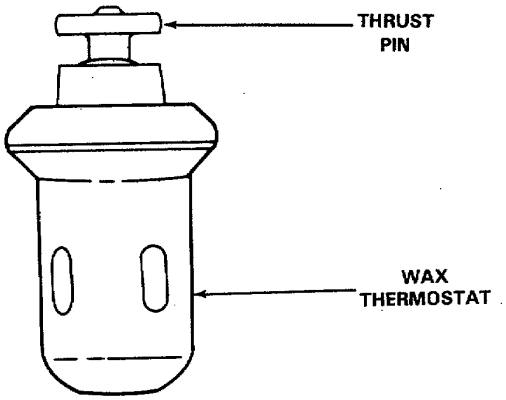
CAUTION

Particles from gasket dropping into clean oil duct may be flushed by the oil to the oil spray nozzles and plug the bore. A plugged oil spray nozzle will result in engine damage.

b. Repair (Remove Thermostat).

CAUTION

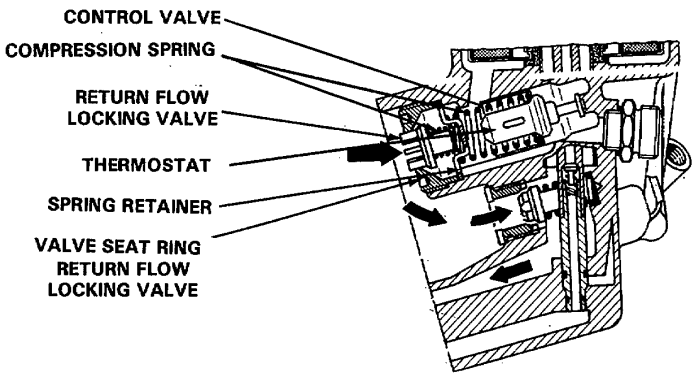
Remove thermostat only at temperatures below 140°F (600C). Temperature above 140°F (60°C) will push thrust pin out of wax thermostat. Never pull thrust pin out of wax thermostat. Damage to thermostat could result.



TA259445

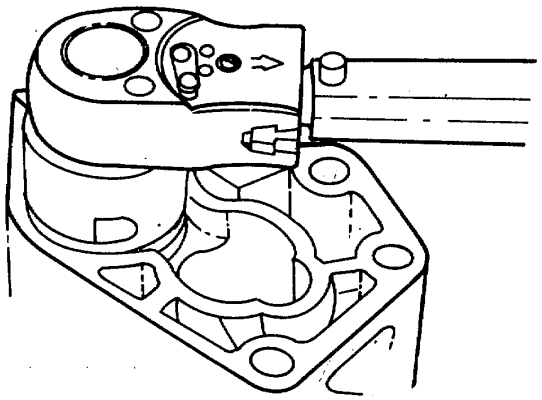
Step 1. Remove the valve seat ring.

Step 2. Remove return flow locking valve with compression spring, spring retainer, compression spring and thermostat with control valve.

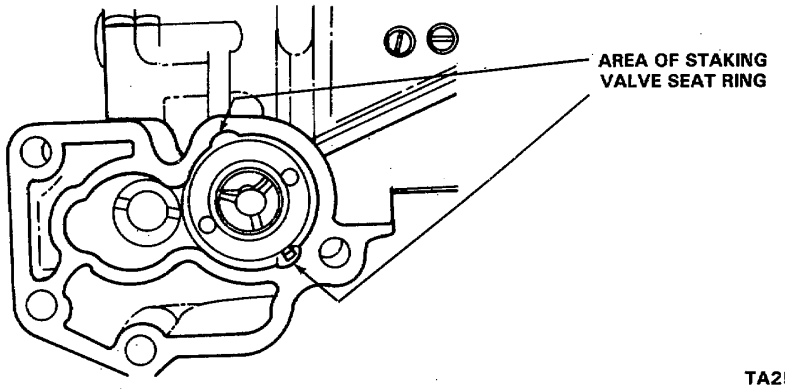


Step 3. Put new thermostat with control valve, compression spring, spring retainer and return flow locking valve with compression spring in oil filter housing.

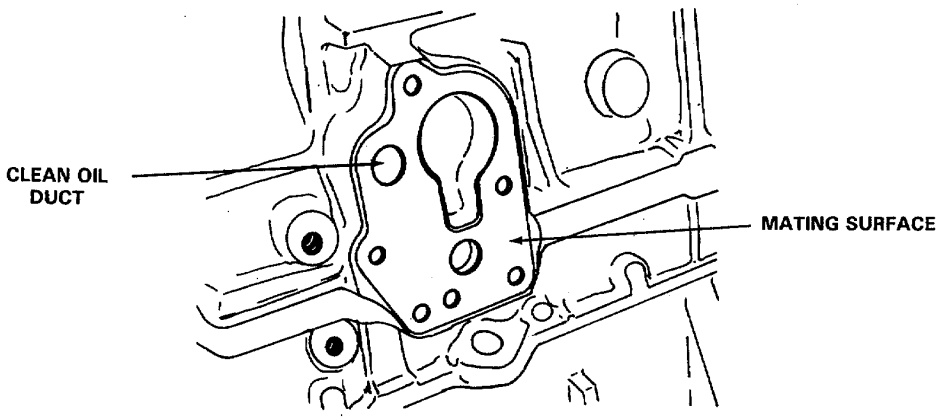
Step 4. Screw in valve seat ring. Torque to 26 to 33 lb. ft. (35 to 45 Nm).



Step 5. Stake valve seat ring in both recesses of oil filter housing.



Step 6. Plug and clean oil duct.
Step 7. Clean mating surfaces of oil filter housing and engine block.



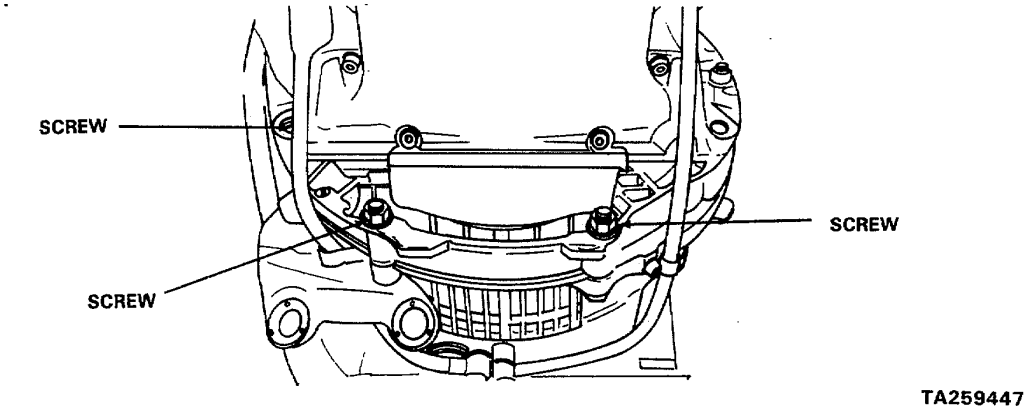
c. Replace.

Step 1. Remove plug from oil duct.
Step 2. Put gasket and oil filter housing in place.
Step 3. Put in mounting screws. Torque screws 5 to 1 8 lb. ft. (1 5 to 25 Nm).
Step 4. Put oil feed line to turbocharger in place.
Step 5. Put hol!ow screw and gaskets in place. Tighten screw.
Step 6. Put oil cooler lines in place. Tighten line nuts.
Step 7. Put oil line in place at oil sensor. Tighten line nut.
Step 8. Connect electrical wire to oil sensor.
Step 9. Replace engine oil filter. Refer to TM 9-2350-272-20.

3-30. REMOVE AND REPLACE OIL PAN.

a. Remove.

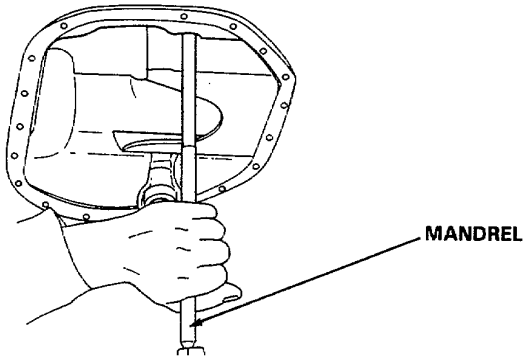
Step 1. Drain engine oil. Refer to TM 9-2350-272- 20.
Step 2. Remove four screws from intermediate flange.
Step 3. Remove cover plate from intermediate flange.
Step 4. Remove screws from lower half of oil pan.
Step 5. Remove lower half of oil pan.



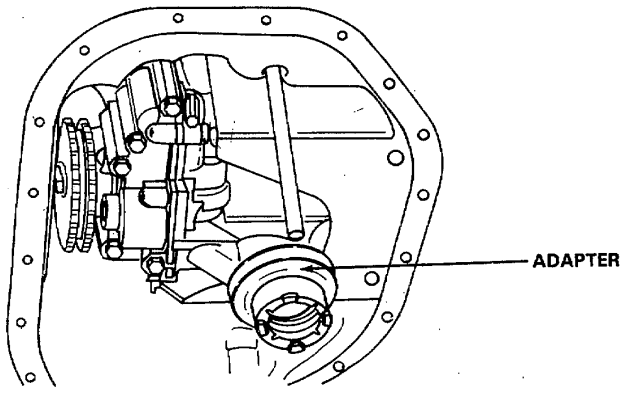
NOTE

Oil dipstick guide tube cannot be completely removed until oil pan mounting screws are removed.

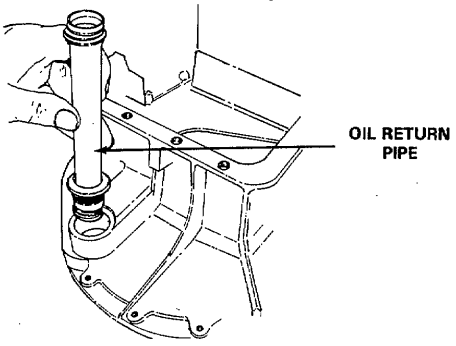
Step 6. Tap out oil dipstick guide tube as far as possible.



Step 7. Remove adapter with strainer from oil pump.



Step 8. Remove mounting screws from upper half of oil pan.
Step 9. Turn crankshaft until oil pan will clear connecting rods.
Step 10. Remove oil pan upper half.
Step 11. Remove oil return pipe and sealing ring from oil pan upper half.
Step 12. Remove oil return pipe preformed packings.

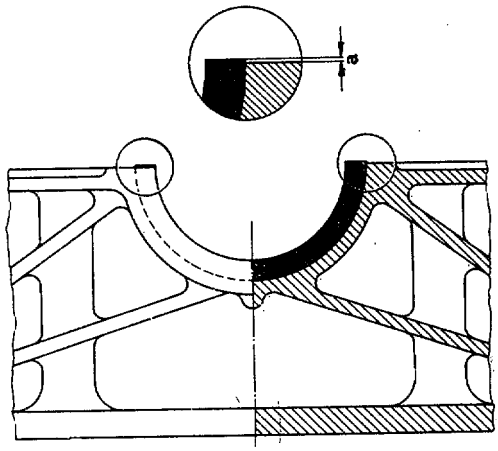


TA259448

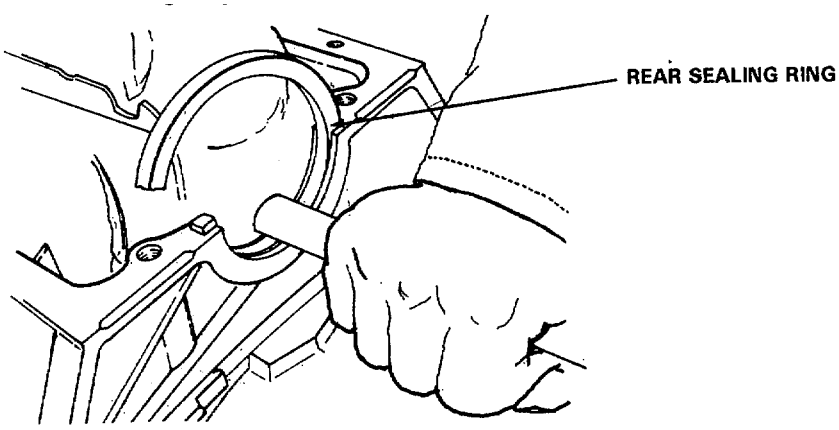
Step 13. Remove rear sealing ring from oil pan.

b. Replace.

Step 1. Clean oil pans.
Step 2. Put new rear sealing ring in oil pan groove. Seat rear sealing ring.
Step 3. Use fabricated gage. Cut off rear sealing 0.394 in. (1 mm) above surface of oil pan. Refer to table 2-2, item 2.

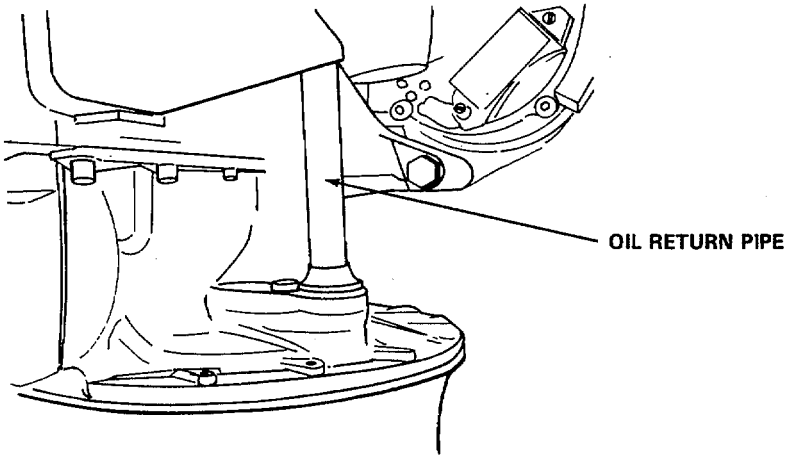


Step 4. Lubricate rear sealing ring with engine oil.

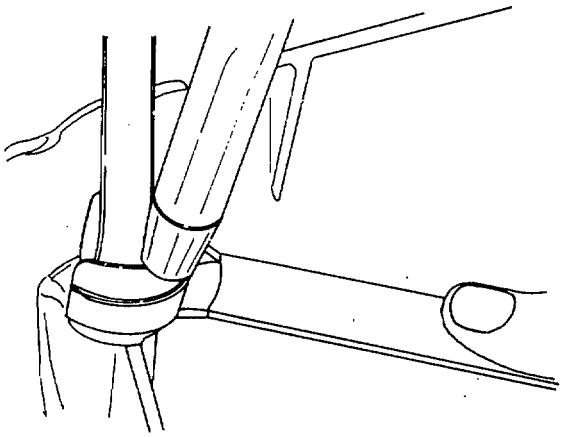


Step 5. Put new preforrned packings on oil pipe.
Step 6. Put in new oil return pipe sealing ring.
Step 7. Install oil return pipe.
Step 8. Coat top flat surface of upper oil pan with sealing compound, appendix B, item 47.

Step 9. Put upper oil pan on engine. Oil return pipes must be in alignment.



Step 10. Put in oil dipstick guide tube.
Step 11. Put in upper oil pan mounting screws and washers. Torque screws to 7 lb. ft. (10 Nm).

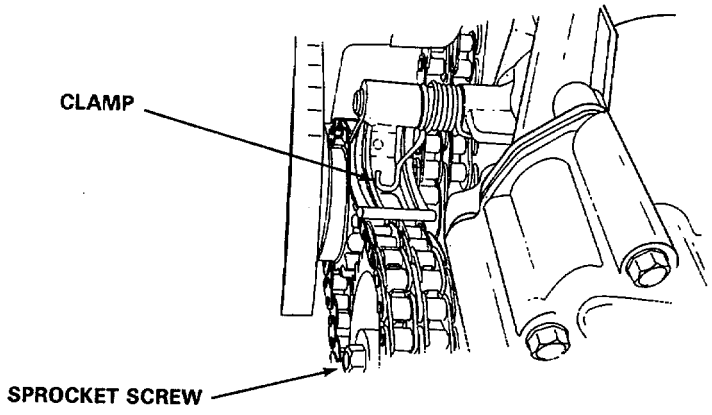


Step 12. Install adapter and strainer on oil pump.
Step 13. Put new gasket on lower oil pan.
Step 14. Put lower oil pan on upper oil pan.
Step 15. Put in lower oil pan screws. Torque screws to 7 lb. ft. (10 Nm).
Step 16. Install cover plate on intermediate flange.
Step 17. Put four screws in intermediate flange. Tighten screws.
Step 18. Put in engine oil. Refer to LO 9-2350-272- 1 2.

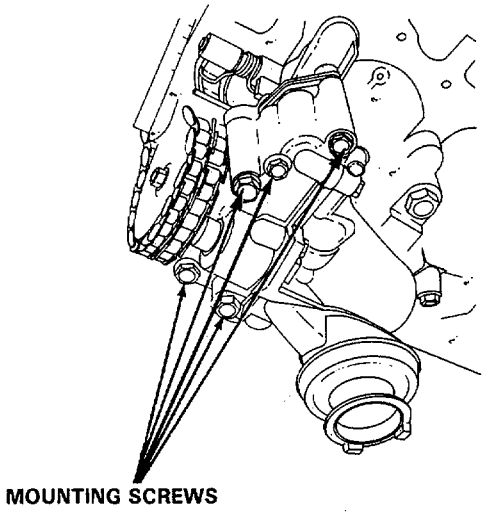
3-31. REMOVE AND REPLACE OIL PUMP.

a. Remove.

Step 1. Remove oil pan. Refer to paragraph 3-30.
Step 2. Remove torsion spring to the rear from the clamp.
Step 3. Turn clamp upward.

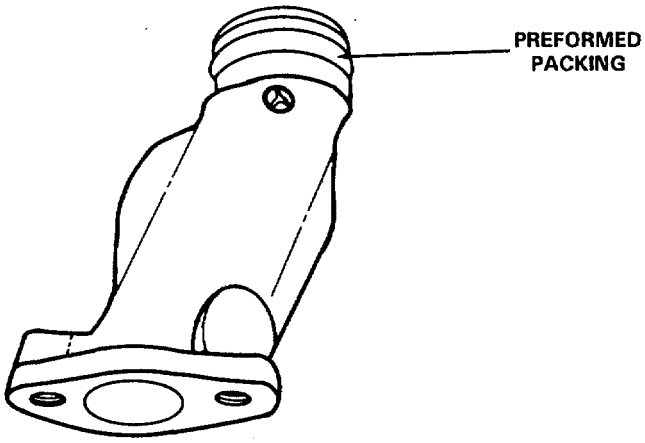


Step 4. Remove fastening screw from sprocket.
Step 5. Pry sprocket off pump shaft.
Step 6. Remove oil pump mounting screws.
Step 7. Remove oil pump.



TA259451

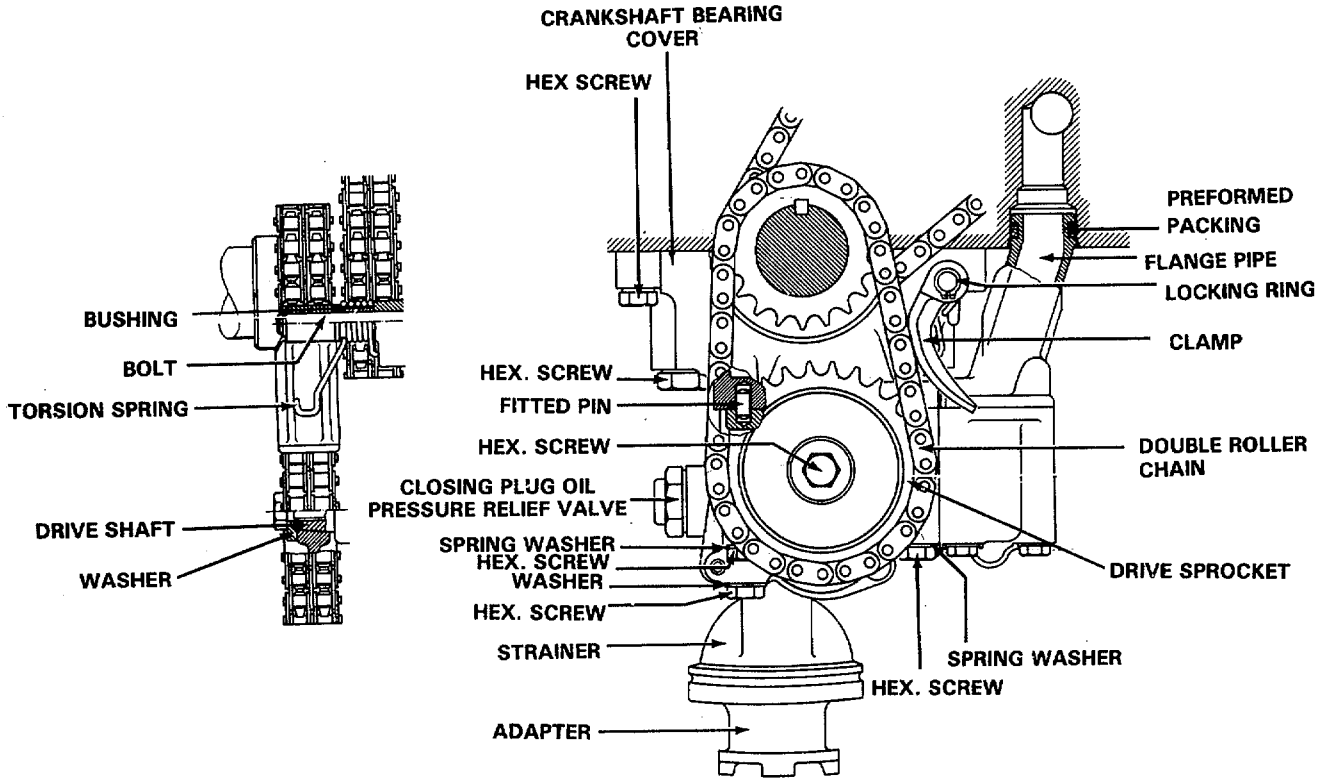
Step 8. Remove sprocket from chain.
Step 9. Pull flange pipe out of crankcase.
Step 10. Remove preformed packing from flange pipe.



TA259452

b. Replace.

Step 1. Put new preformed packing on flange pipe.
Step 2. Put flange pipe into crankcase.
Step 3. Place sprocket on double chain.
Step 4. Put oil pump into place. Put in pump mounting screws.
Step 5. Torque pump mounting screws in crankcase to 1 5 to 1 8 lb. ft. (20 to 25 Nm).
Step 6. Torque pump mounting screws in flange pipe to 7 to 8 lb. ft. (9 to 11 Nm).
Step 7. Put sprocket on pump shaft.
Step 8. Put in fastening screw. Torque screw to 22 to 26 lb. ft. (30 to 35 Nm).
Step 9. Set clamp on chain.
Step 10. Install torsion spring on clamp.
Step 11. Replace oil pan. Refer to paragraph 3-30.



TA259453

3-32. REMOVE AND REPLACE OIL PRESSURE RELIEF VALVE.

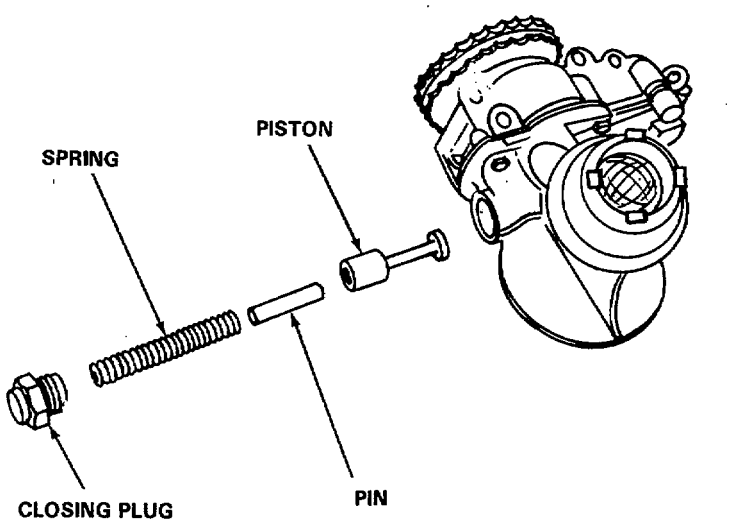
a. Remove.

Step 1. Drain engine oil. Refer to TM 9-2350-272-20.
Step 2. Remove lower oil pan mounting screws.
Step 3. Remove lower oil pan.

NOTE

There is spring pressure on the closing plug.

Step 4. Loosen and remove closing plug.
Step 5. Remove spring and pin.
Step 6. Remove valve piston.



b. Replace.

Step 1. Put in piston, pin and spring.
Step 2. Screw in closing plug. Torque closing plug to 26 to 33 lb. ft. (35 to 45 Nm).
Step 3. Put new gasket on lower oil pan.
Step 4. Put on lower oil pan. Put in oil pan mounting screws.
Step 5. Torque mounting screws to 7 to 8 lb. ft. (9 to 11 Nm).
Step 6. Put oil in engine. Refer to LO 9-2350-272- 12.

3-33. REMOVE AND REPLACE VACUUM PUMP.

a. Remove.

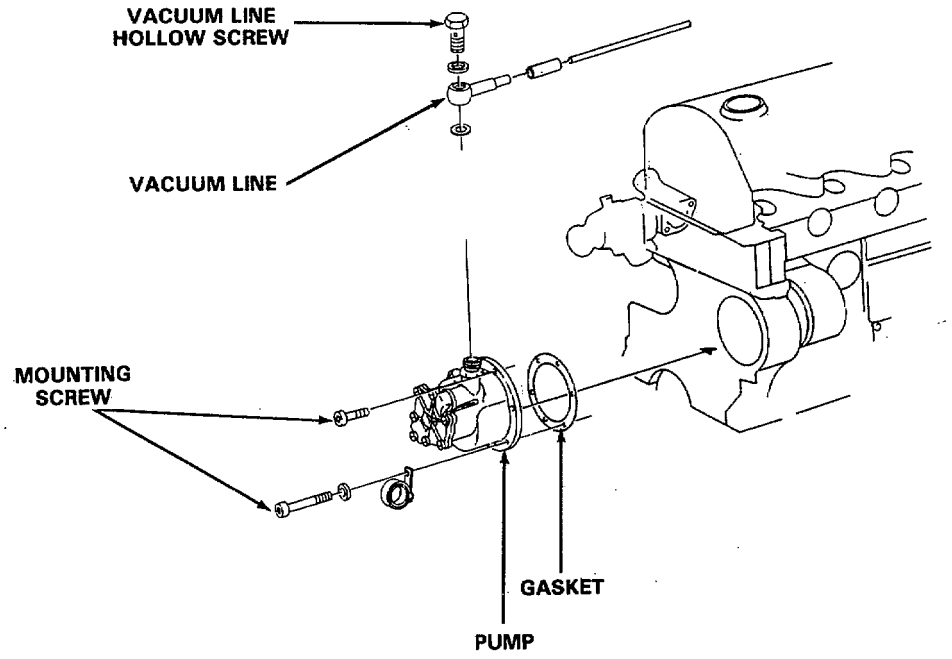
Step 1. Disconnect vacuum lines from pump.
Step 2. Remove vacuum pump mounting screws.
Step 3. Remove vacuum pump and gasket.

b. Replace.

Step 1. Clean mounting surface. Put new gasket on mounting surface.
Step 2. Put on vacuum pump.

NOTE
If pump does not fit flush, crankshaft must be turned slightly.

Step 3. Put in vacuum pump mounting screws. Tighten screws.
Step 4. Connect and tighten vacuum lines.



TA259455

CHAPTER 4
REPAIR OF FUEL SYSTEM

Section I. DESCRIPTION AND DATA

4-1. DESCRIPTION.

The fuel system consists of fuel tanks, a fuel sediment bowl with shut-off valve, a mechanical fuel pump, a fuel filter, a fuel metering pump, fuel injectors and a turbocharger.

a. The two fuel tanks are mounted on the rear panel of the front car, and are connected by a hose and piping. The right fuel tank contains a float type fuel level sensor. Both tanks have fuel return lines.

b. The fuel sediment bowl is mounted above the left fuel tank in the suction line between the fuel tanks and fuel metering pump.

c. The fuel shut-off valve is mounted as part of the sediment bowl and is used to shut off the fuel during service or maintenance.

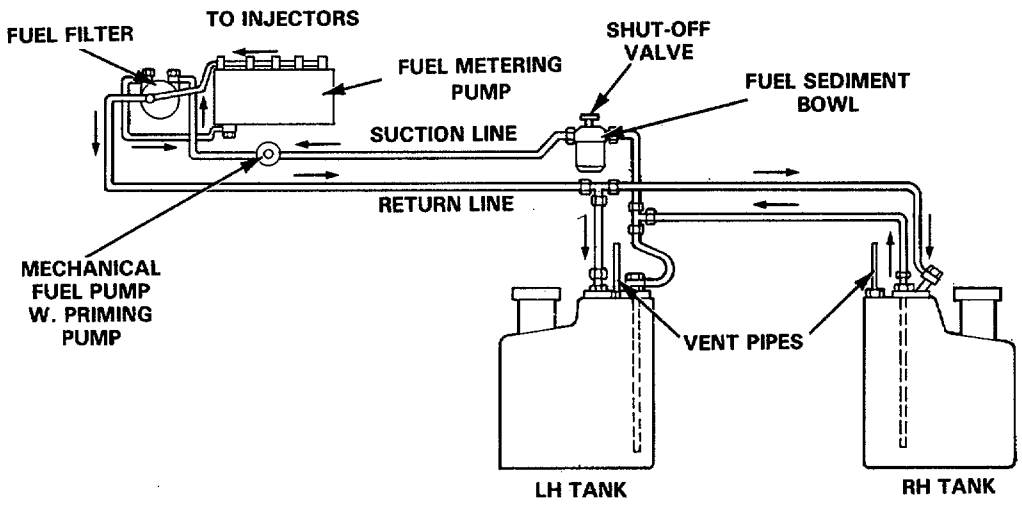
d. The mechanical fuel pump is a piston type, driven by the camshaft of the fuel metering pump. A hand pump for bleeding air from the fuel system is mounted on the mechanical fuel pump.

e. The final fuel filter is mounted at the left front of the engine and is the spin-on/off type.

f. The fuel metering pump is mounted on the left side of the engine. It is driven by the engine camshaft and is lubricated by the engine lubricating system. The amount of fuel supplied to the injectors is determined by a centrifugal governor and a pressure compensator (Alda Cell). The compensator registers the operating pressure of the turbocharger and atmospheric air pressure. A vacuum control valve on the fuel metering pump supplies modulating pressure for the automatic transmission. To adjust the quantity of fuel to a varying engine load, a pressure compensator (Alda Cell) is installed on the fuel metering pump.

The compensator relates the injection amount to the actual charging pressure and the outside atmospheric pressure.

g. The fuel injector delivers fuel to the cylinders in a finely atomized spray. Surplus fuel from injectors and fuel metering pump is returned to fuel tanks.

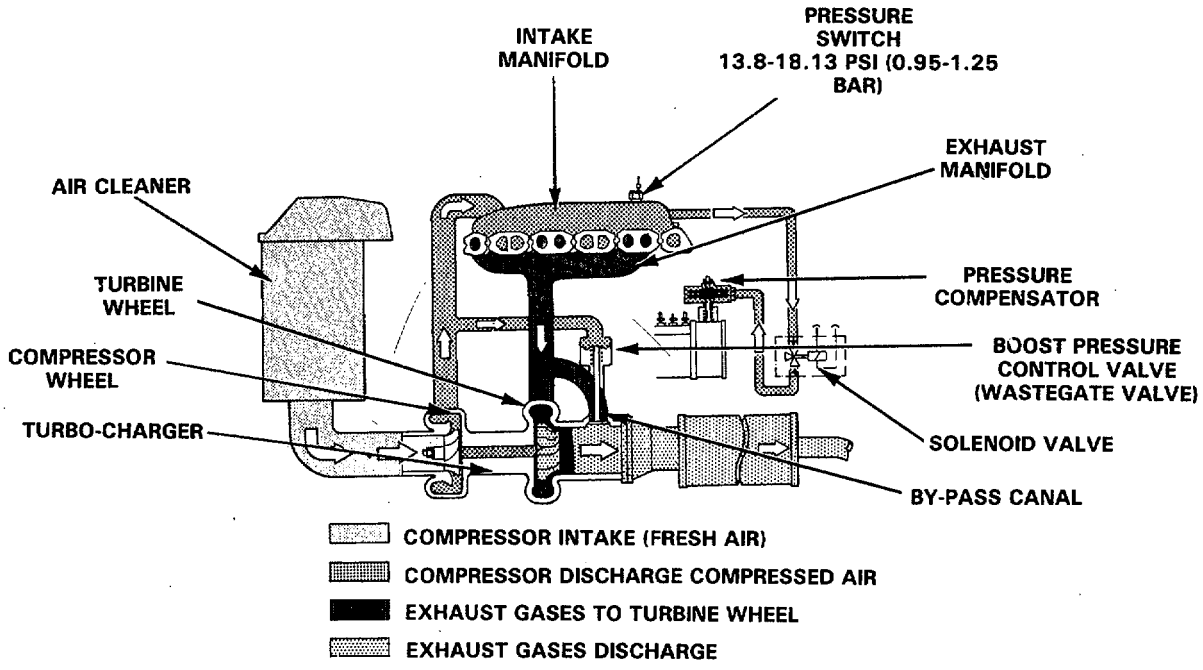


h. The turbocharger is mounted on the right side of the engine. It is an exhaust-gas driven turbo compressor to raise power produced by the engine. The turbo compressor increases the amount of air to the cylinders. It permits the engine to burn more fuel during each power stroke, which increases the power developed.

To limit the charging pressure to the engine at high speeds, the turbocharger is provided with a boost pressure control valve (waste-gate) which opens to permit exhaust gases to by-pass the turbine wheel to the exhaust pipe. The boost pressure control valve (waste gate) is controlled by the charging pressure and the turbine wheel is driven by the engine exhaust gases. The speed of the turbocharger will automatically adapt to load and speed of engine.

Overloading of the engine is prevented by a pressure switch on the intake manifold. The pressure switch controls a solenoid valve in the line between the intake manifold and the pressure compensator.

If the turbocharger pressure is too high, the connection between the pressure compensator and the charging pressure is closed. The compensator registers only the atmospheric pressure. It will then reduce the fuel quantity supplied to the injectors, and the power developed by the engine is reduced.

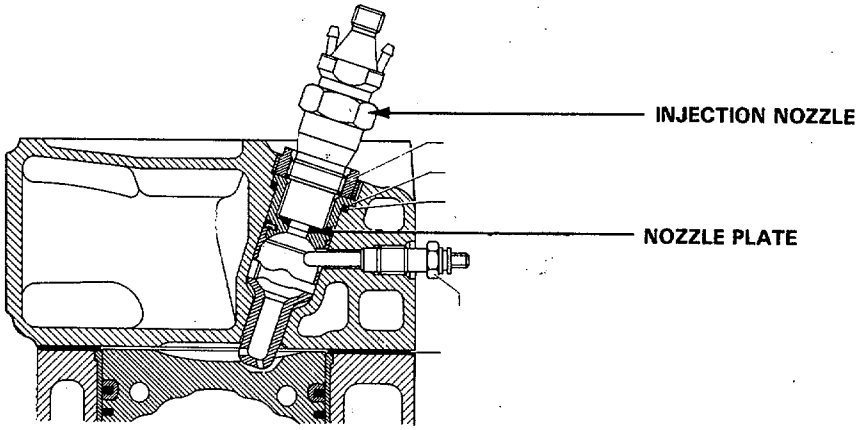


Section II. REPAIR OF FUEL SYSTEM

4-2. REMOVE AND REPLACE FUEL INJECTION NOZZLES.

a. Remove.

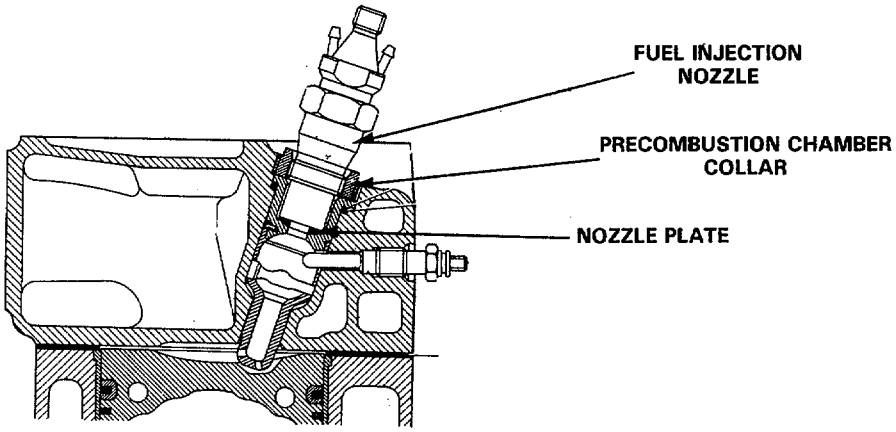
Step 1. Disconnect fuel injection lines from injection nozzles.
Step 2. Disconnect fuel return hoses from injection nozzles.
Step 3. Remove plug from number five injection nozzle.
Step 4. Remove injection nozzles.
Step 5. Remove injection nozzle plates.



TA259460

b. Replace.

Step 1. Tighten all precombustion chamber collars.
Step 2. Put in new nozzle plates.
Step 3. Screw in fuel injection nozzles.
Step 4. Torque fuel injection nozzles to 52 to 59 lb. ft. (70 to 80 Nm).

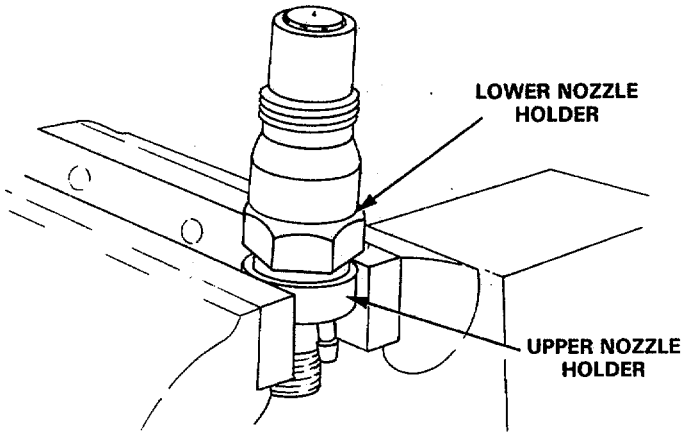


Step 5. Attach fuel return hoses to injection nozzles.
Step 6. Replace plug in number five injection nozzle.
Step 7. Connect injection lines. Torque line nuts to 1 8 lb. ft. (25 Nm).

4-3. REPAIR FUEL INJECTION NOZZLES.

a. Disassembly.

Step 1. Clamp upper nozzle holder in a vise.
Step 2. Loosen lower nozzle holder. Remove from vise. Separate upper and lower nozzle holder.



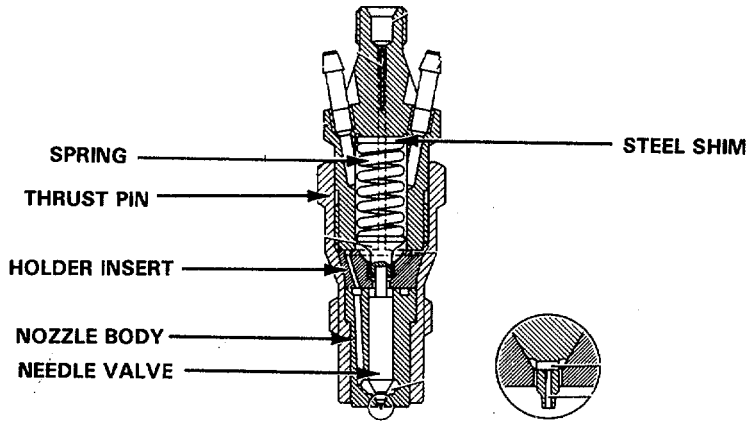
TA259461

Step 3. Remove steel shim.
Step 4. Remove spring and thrust pin.
Step 5. Remove nozzle holder insert, nozzle body and needle valve.

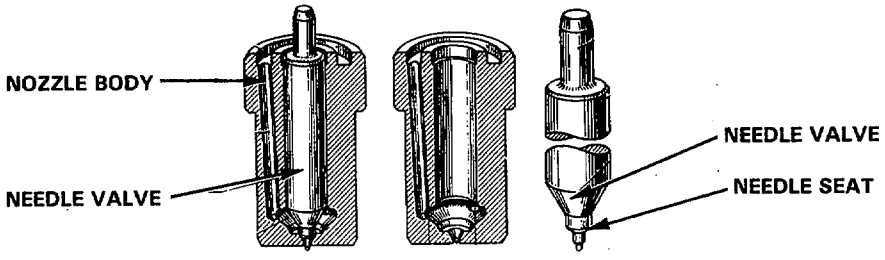
CAUTION

Improper use of cleaning tools could enlarge orfice and effect spray pattern.

Step 6. Remove upper nozzle holder from vise.
Step 7. Use brass brush. Remove carbon deposits from nozzle body and needle valve.
Step 8. Use scraper. Clear nozzle body chamber.

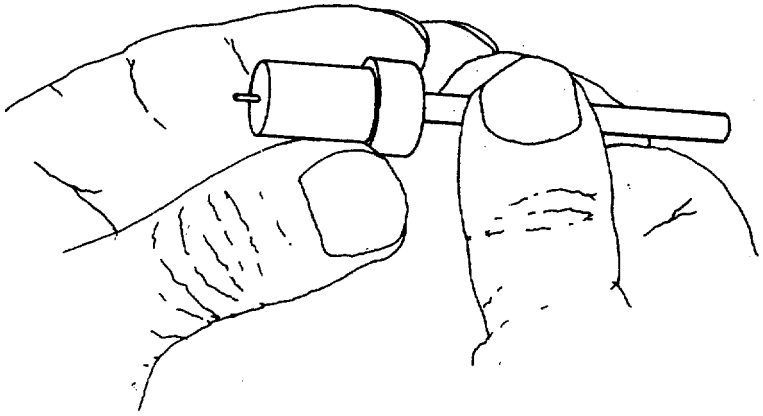


Step 9. Use cleaning cutter. Clean needle seat.
Step 10. Use cleaning needle. Clean center hole of needle valve.



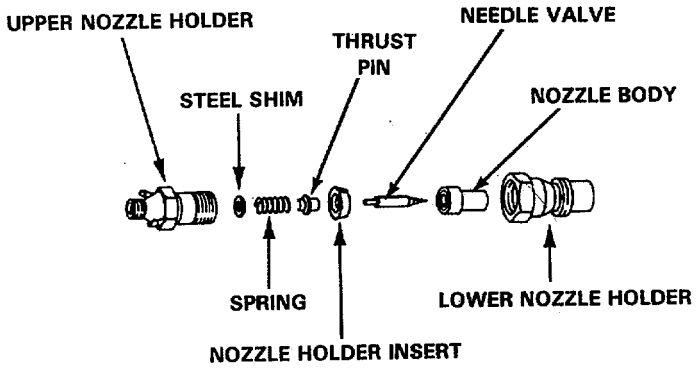
TA259462

Step 11. Use injection hole cleaner. Work from inside to outside. Clean nozzle orifice.
Step 12. Inspect all parts for roughness or damage. Replace rough or damaged parts.



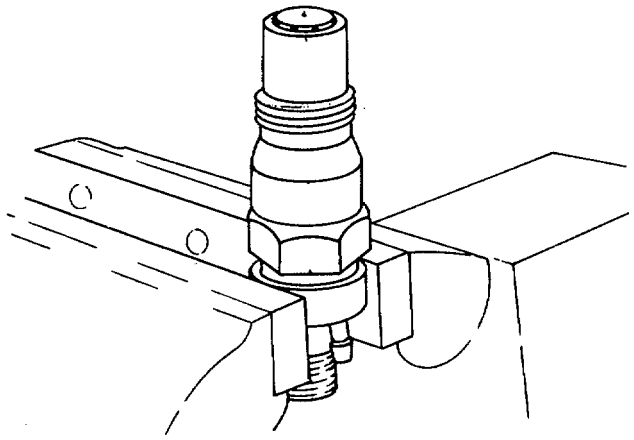
b. Assembly.

Step 1. Put nozzle body into lower nozzle holder.
Step 2. Put needle valve into nozzle body.
Step 3. Put in nozzle holder insert.
Step 4. Place thrust pin on needle valve.
Step 5. Put spring on thrust pin.
Step 6. Install steel shim.
Step 7. Screw upper nozzle holder on lower nozzle holder.



TA259463

Step 8. Clamp upper nozzle holder in vise.
Step 9. Torque lower nozzle holder to 52 to 59 lb. ft. (70 to 80 Nm).

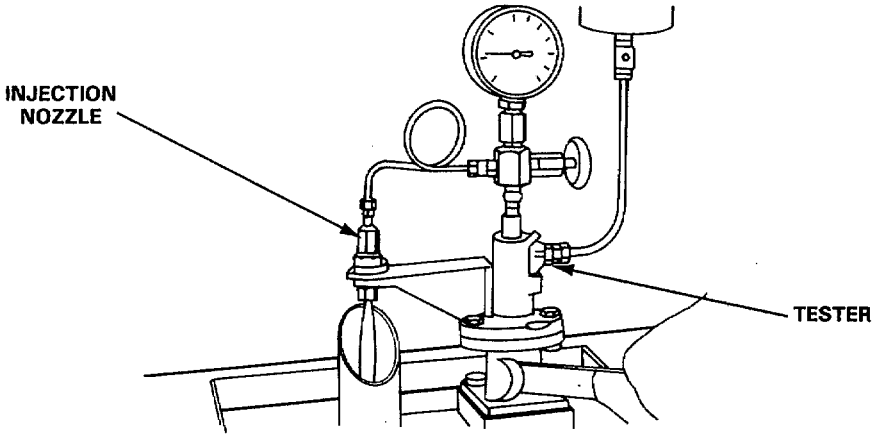


4-4. TEST FUEL INJECTION NOZZLES.

WARNING

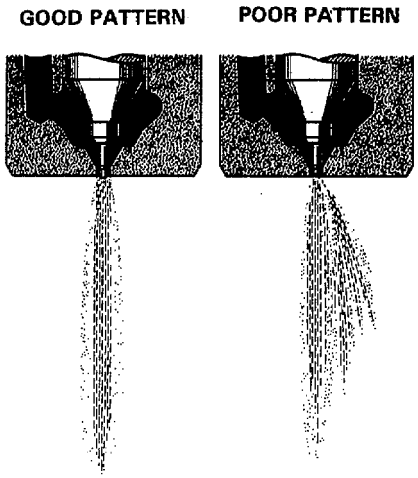
Keep hands away from nozzle tip when testing fuel injector cracking pressure. The finely atomized fuel is ejected with sufficient force to penetrate the skin and cause blood poisoning.

Step 1. Connect fuel injection nozzle to tester. Turn off tester gage.
Step 2. Pump tester with a very rapid motion. Injection nozzle should make a high pitched whistling sound. Failure to produce this sound indicates the needle valve is not moving properly.

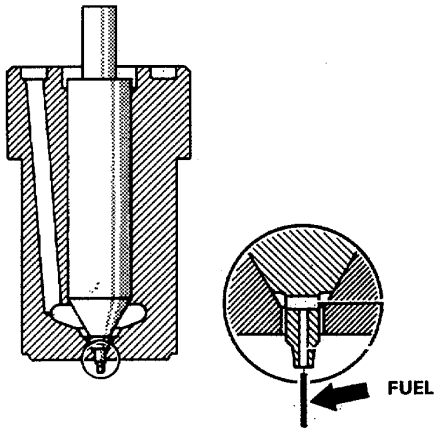


TA259464

Step 3. Pump tester with fast short pumping motion.
Step 4. Observe spray pattern. Pattern should be straight with a narrow, fine mist spray. Broad spray with large drops indicates a faulty injection nozzle.

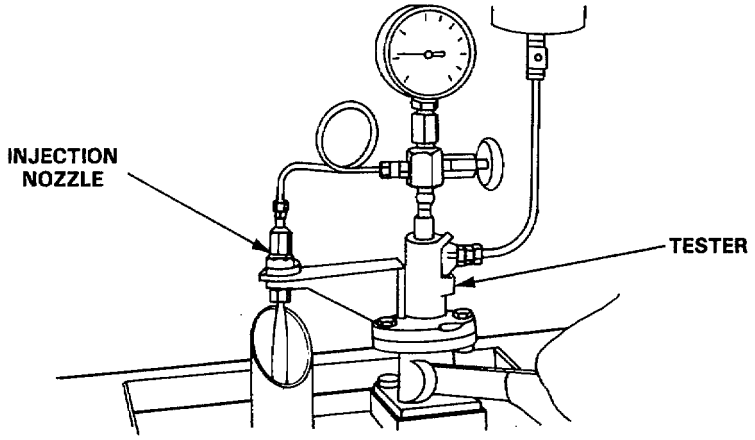


Step 5. Pump tester with slow smooth pumping motion.
Step 6. Observe the start of the fuel delivery from the nozzle tip. Fuel should come out of nozzle in a straight thin stream. A broad stream or drops indicate a faulty injection nozzle.



TA259465

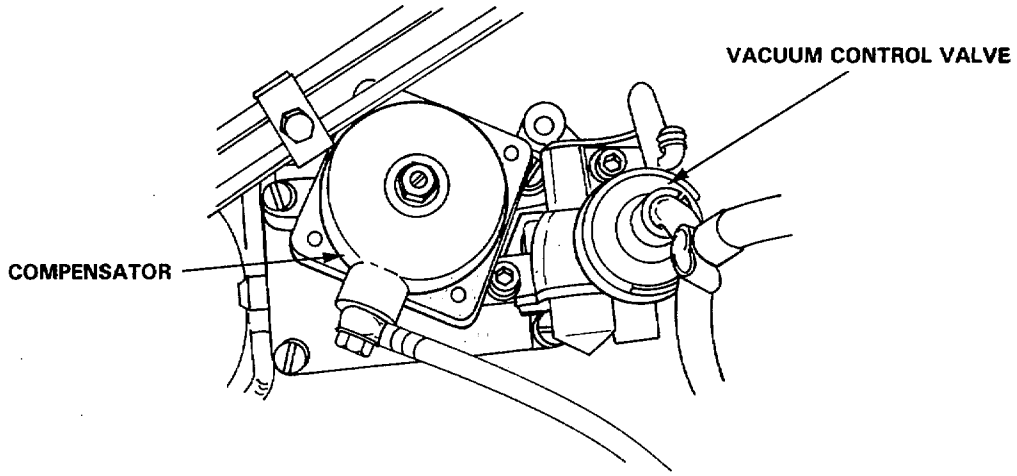
Step 7. Turn on tester gage.
Step 8. Pump tester with slow smooth motion.
Step 9. Watch tester gage. When injector cracks fully open, gage should read 1958 to 2074 PSI (135 to 143 bar). Incorrect cracking pressure indicates a faulty injection nozzle.
Step 10. Slowly pump tester until injection nozzle reaches cracking pressure.
Step 11. Release pump handle. Observe injection nozzle for leakage. Leakage indicates a faulty injection nozzle.



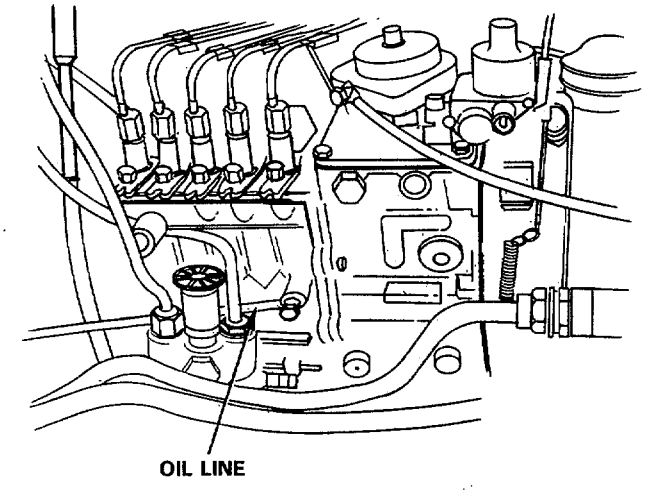
4-5. REMOVE AND REPLACE FUEL METERING PUMP.

a. Remove.

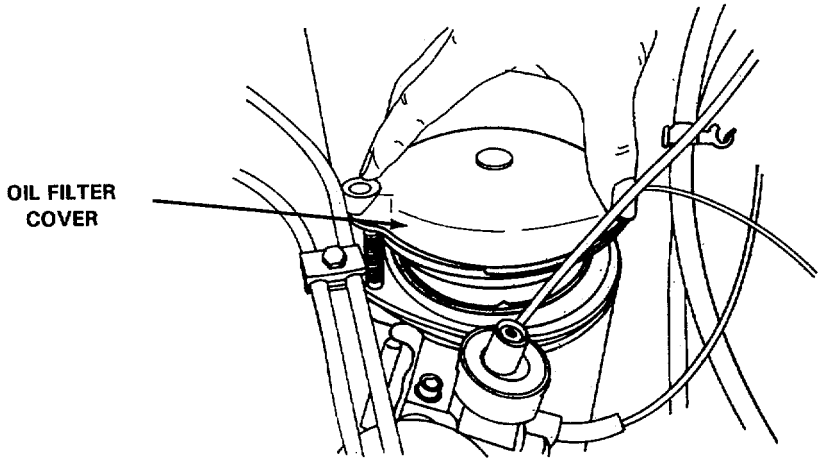
Step 1. Remove engine cover and disconnect vacuum line from vacuum co.. -A
Step 2. Disconnect line from vacuum control valve.
Step 3. Remove delivery line from compensator.
Step 4. Disconnect control rod.



Step 5. Disconnect fuel injection lines.
Step 6. Disconnect fuel supply and return hoses from fuel metering pump.
Step 7. Remove oil line screw from fuel metering pump. Disconnect oil line.

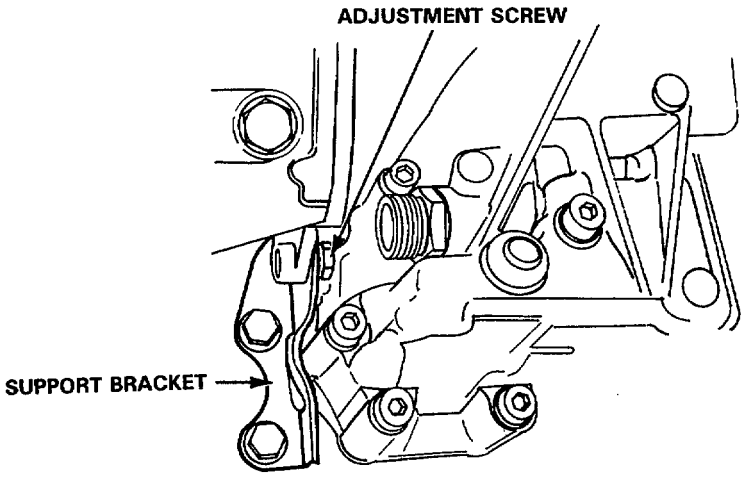


Step 8. Remove upper cover of engine oil filter.



TA259467

Step 9. Remove screws holding support bracket to engine.
Step 10. Remove three fuel metering pump mounting nuts and washers.
Step 11. Remove adjustment screw.

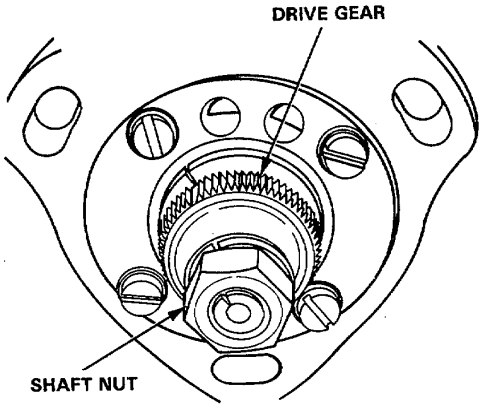


Step 12. Remove engine oil filter housing. Refer to paragraph 3-29.
Step 13. Pull fuel metering pump out of crankcase.
Step 14. Remove coupling sleeve from fuel metering pump drive.
Step 15. Remove support bracket and spring from fuel metering pump.
Step 16. Remove shaft nut and washer.

CAUTION

Pull gear carefully. Gear teeth can be damaged.

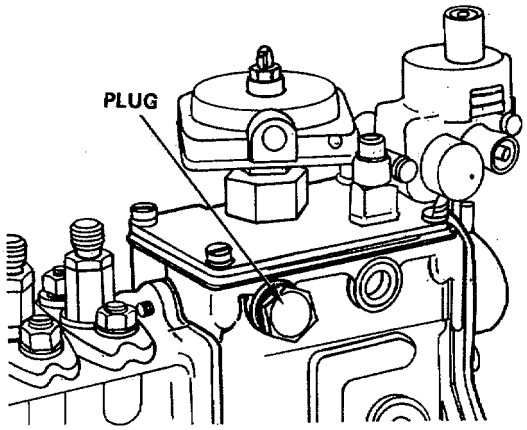
Step 17. Pull drive gear from shaft.
Step 18. Remove shaft key.



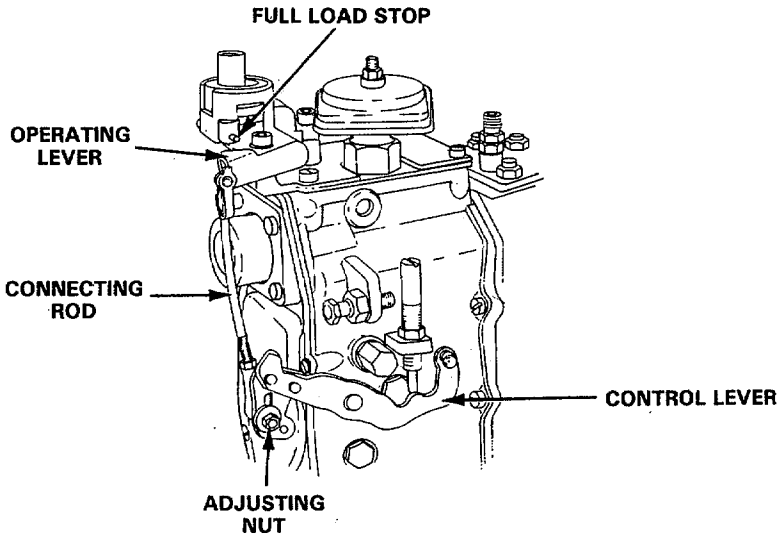
TA259468

b. Replace.

Step 1. Put key in groove of drive shaft.
Step 2. Put on drive gear.
Step 3. Put on washer and shaft nut. Tighten nut.
Step 4. Remove plug from fuel metering pump.
Step 5. Pour 0.1 8 pint (0.4 liter) engine oil into fuel metering pump.
Step 6. Replace plug in fuel metering pump. Tighten plug.

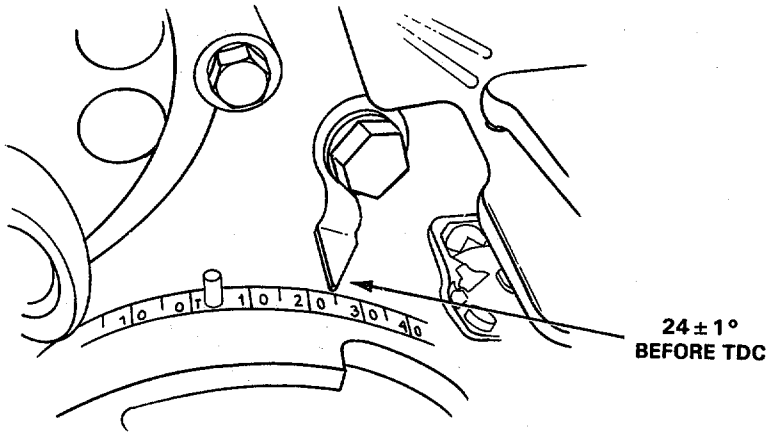


Step 7. Move control lever until it touches stop screw.
Step 8. Measure distance between operating lever and full load stop. Correct distance is 0.020 in. (0.5 mm). If adjustment is needed go to step 9. No adjustment needed, go to step 12.
Step 9. Loosen adjusting nut.
Step 10. Move connecting rod up and down to obtain correct distance.
Step 11. Tighten adjusting nut.

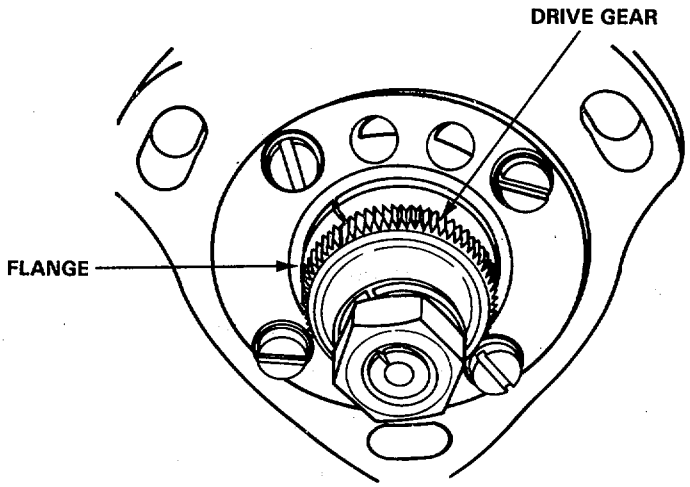


TA259469

Step 12. Turn crankshaft until it is 24 ± 1° before TDC of compression stroke of number one cylinder.

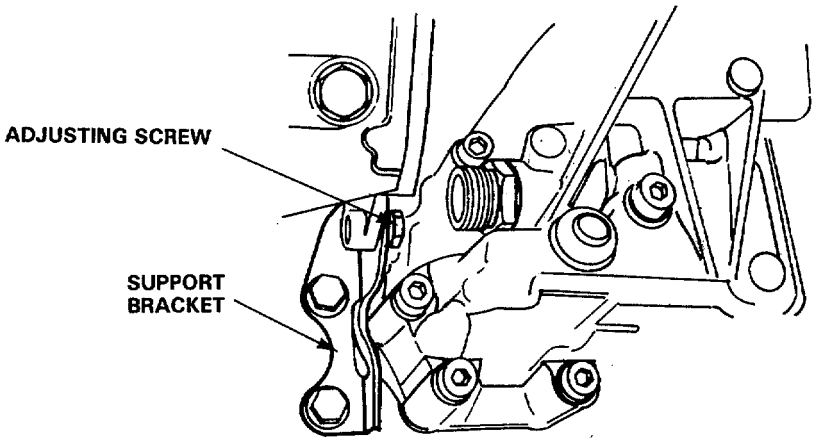


Step 13. Put new gasket on fuel metering pump.
Step 14. Turn pump drive gear until mark on drive gear aligns with mark on pump flange.
Step 15. Put coupling sleeve on drive gear.

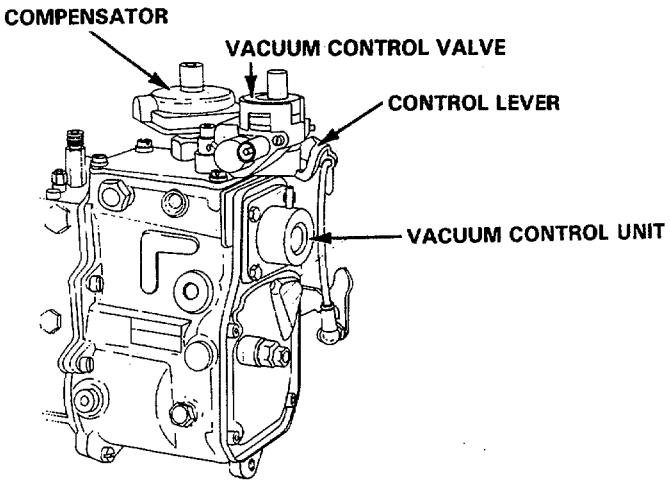


TA259470

Step 16. Put fuel metering pump on crankcase.
Step 17. Put on pump mounting nuts and washers. Tighten nuts hand tight.
Step 18. Connect fuel supply lines and return lines to pump.
Step 19. Check and adjust fuel metering pump start of delivery. Refer to paragraph 4-7.
Step 20. Tighten pump mounting nuts.
Step 21. Put in support bracket mounting screws. Tighten screws.
Step 22. Put in adjusting screw. Tighten screw.



Step 23. Position oil line on fuel metering pump. Put in oil line screw. Tighten screw.
Step 24. Replace oil filter housing and cover. Refer to paragraph 3-29.
Step 25. Connect fuel injection lines to pump. Torque line nuts to 1 8 lb. ft. (25 Nm).
Step 26. Connect delivery line to compensator.
Step 27. Connect vacuum lines to vacuum control unit and vacuum control valve.
Step 28. Connect control rod to control lever.
Step 29. Check and adjust idle speed. Refer to TM 9- 2350-272-20.



TA259471

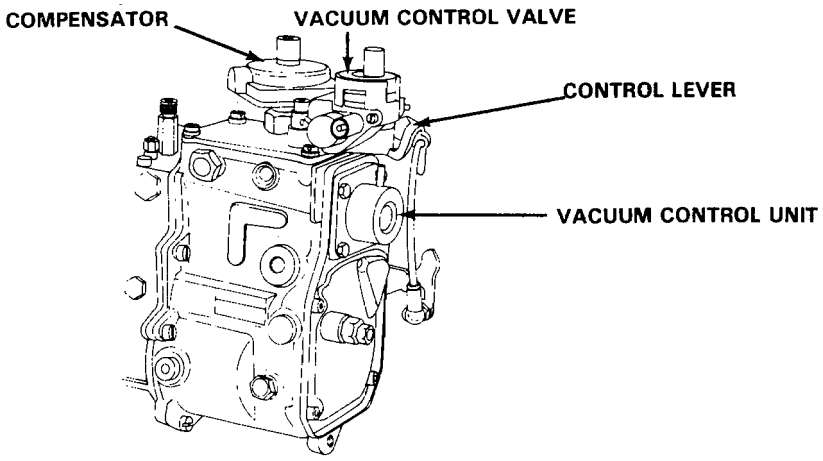
4-6. REMOVE AND REPLACE FUEL METERING PUMP COMPONENTS.

a. Remove.

Step 1. Disconnect vacuum line from compensator.
Step 2. Unscrew and remove compensator.
Step 3. Disconnect vacuum lines from vacuum control valve.
Step 4. Remove vacuum control valve mounting screws. Remove valve.
Step 5. Disconnect vacuum line from vacuum control unit.
Step 6. Remove vacuum control unit mounting screws. Remove control unit.

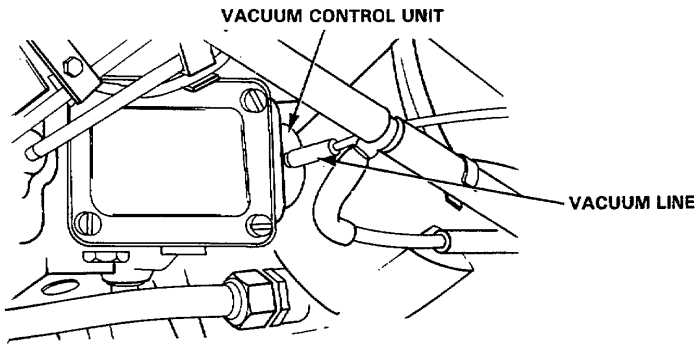
b. Replace.

Step 1. Put vacuum control unit in fuel metering pump.
Step 2. Put in control unit mounting screws. Tighten screws.
Step 3. Put vacuum control valve in place.
Step 4. Put in control valve mounting screws. Tighten screws.
Step 5. Screw compensator into fuel metering pump. Tighten compensator.
Step 6. Connect all vacuum lines.

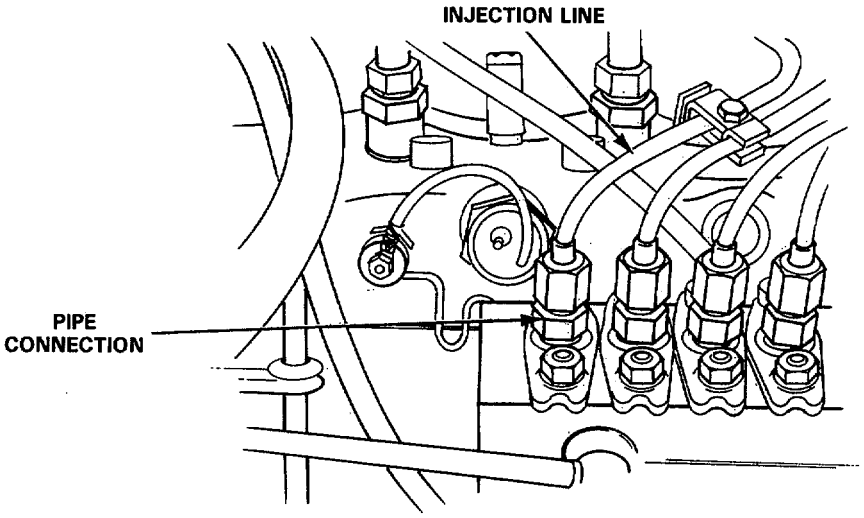


4-7. CHECK AND ADJUST FUEL METERING PUMP START OF DELIVERY.

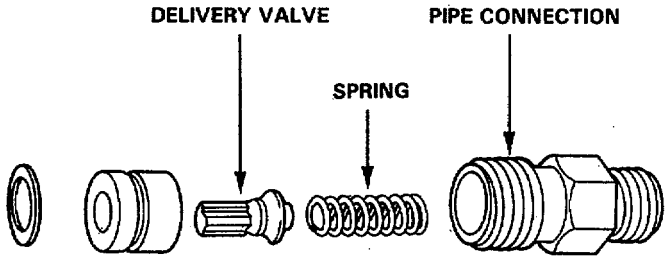
Step 1. Remove engine cover.
Step 2. Clean top of fuel metering pump.
Step 3. Disconnect vacuum line from vacuum control unit.



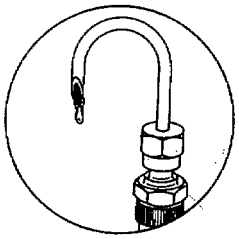
Step 4. Remove injection line to number one cylinder.
Step 5. Remove cylinder number one pipe connection from fuel metering pump.



Step 6. Remove spring and delivery valve for pipe connection.
Step 7. Screw pipe connection into number one cylinder of fuel metering pump. Tighten pipe connection.

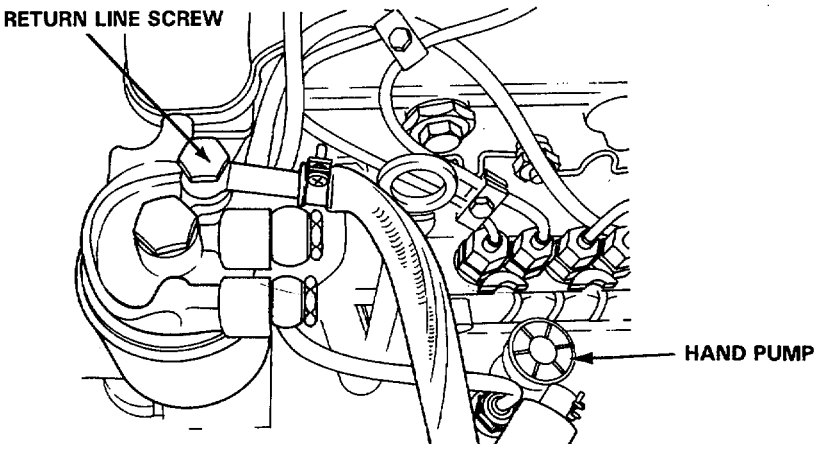


Step 8. Screw overflow pipe into pipe connection. Place empty container under overflow pipe. Refer to table 2-1, item 5.

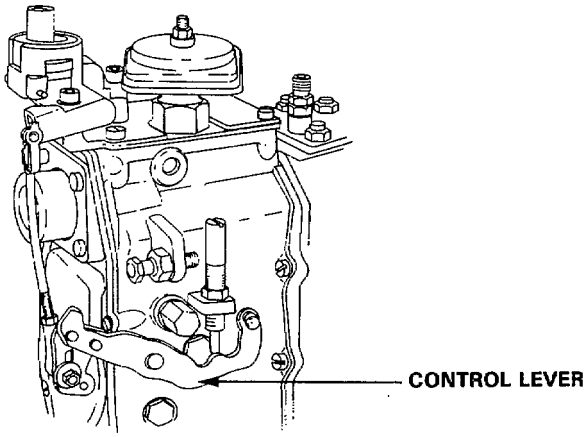


TA259473

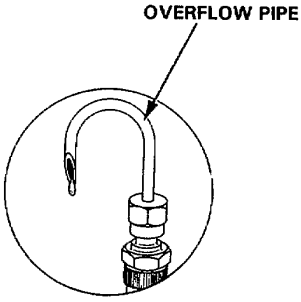
Step 9. Remove propeller shaft between engine and hydraulic pump. Refer to TM 9-2350-272-20.
Step 10. Turn crankshaft until crank angle is just before 250 TDC on compression stroke of number one cylinder.
Step 11. Loosen return line screw on fuel filter.
Step 12. Operate hand pump until fuel flows out of overflow pipe. Operation of the hand pump may be necessary throughout the check to insure enough fuel is reaching the fuel metering pump.



Step 13. Push and hold control lever in the full load position.



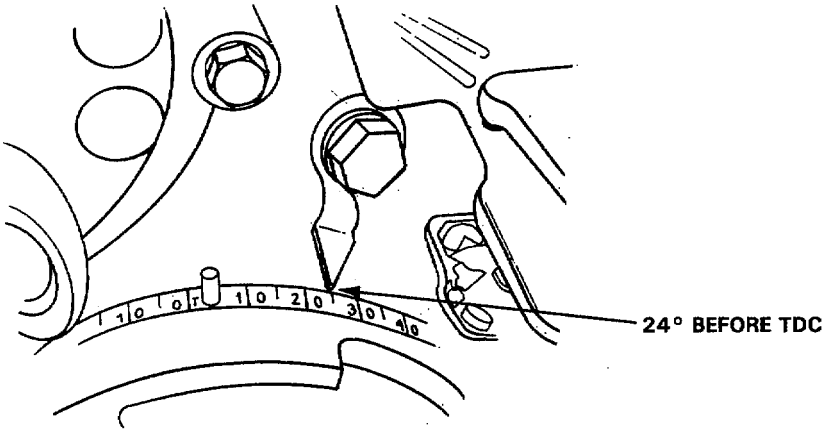
Step 14. Turn crankshaft slowly in direction of engine rotation.
Step 15. Stop turning crankshaft when fuel flow from overflow pipe has decreased to one drop per second.
Step 16. Release control lever.



TA259474

Step 17. Check timing indicator on engine damper. Correct reading for start of delivery of the fuel metering pump is 24 ± 1 ° before TDC on compression stroke of number one cylinder. If reading is correct go to step 26. If reading is incorrect go to step 18.

Step 18. Turn crankshaft in direction of engine rotation until timing indicator is at 240 before TDC or compression stroke of number one cylinder.

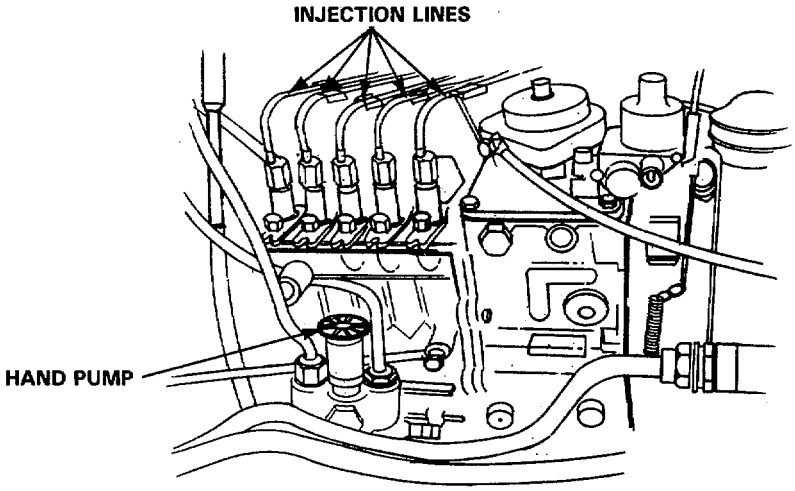


Step 19. Disconnect injector lines from fuel metering pump.

Step 20. Loosen pump mounting nuts.

Step 21. Loosen adjusting nut in support bracket.

Step 22. Pump hand pump until fuel comes from overflow pipe.



Step 23. Move fuel metering pump until fuel comes from overflow pipe at a rate of one drop per second. Push pump toward engine, to advance start of delivery. Pull pump away from engine to retard start of delivery.

Step 24. Tighten pump mounting nuts and adjusting nut.

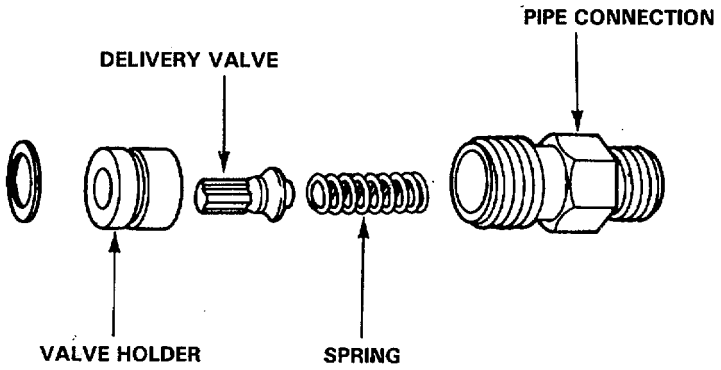
Step 25. Repeat steps 1 2 through 1 7.

Step 26. Remove overflow pipe.

Step 27. Remove pipe connection for number one cylinder on pump.

TA259475

Step 28. Remove valve holder from fuel metering pump.
Step 29. Put delivery valve in valve holder. If delivery valve does not move freely in valve holder, replace both delivery valve and holder.
Step 30. Put valve holder with delivery valve into fuel metering pump. Groove on valve holder goes down.
Step 31. Put spring into pipe connection.
Step 32. Screw pipe connection into fuel metering pump. Torque pipe connection to 30 to 37 lb. ft. (40 to 50 Nm).



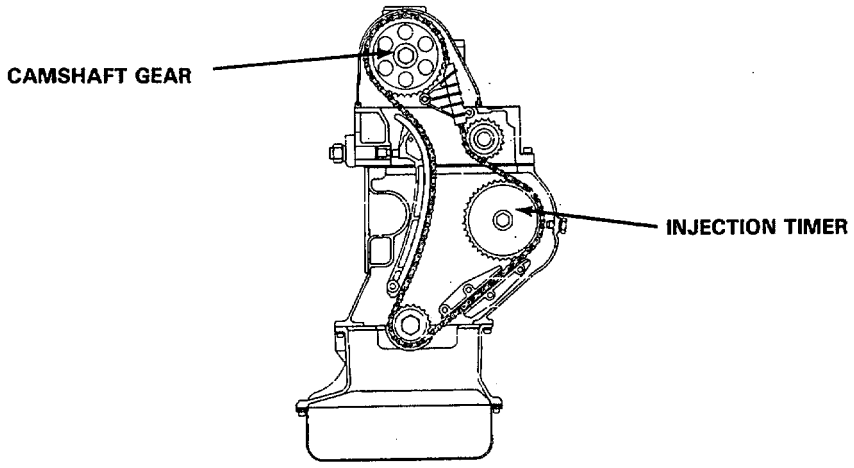
Step 33. Put on injection line to cylinder number one.
Step 34. Connect all injection lines to fuel metering pump. Torque line nuts to 1 8 lb. ft. (25 Nm).
Step 35. Connect vacuum line to vacuum control unit.
Step 36. Replace propeller shaft. Refer to TM 9-2350-272-20.
Step 37. Tighten return line screw on fuel filter.
Step 38. Bleed fuel system. Refer to TM 9-2350-272-20.
Step 39. Replace engine cover.

TA259476

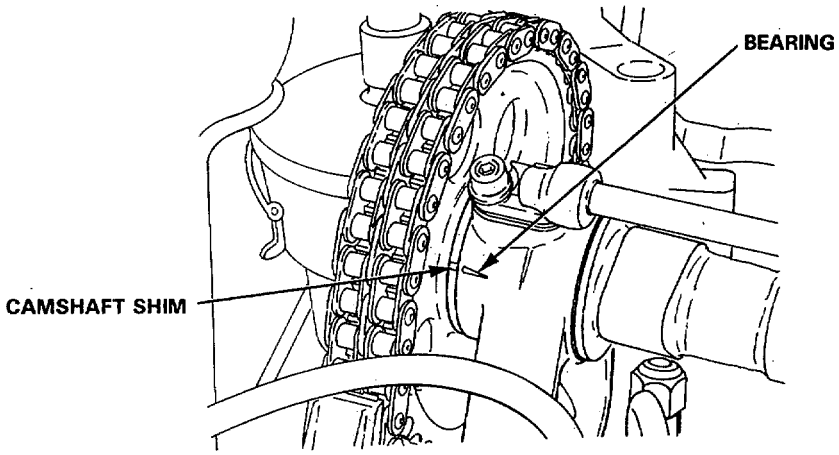
4-8. REMOVE-AND REPLACE INJECTION TIMER.

a. Remove.

Step 1. Disconnect suction line from vacuum pump.
Step 2. Remove vacuum pump from engine.
Step 3. Remove mounting screw and washer from injection timer.
Step 4. Remove linkages and cylinder head cover.
Step 5. Remove screw from camshaft gear.



Step 6. Rotate crankshaft in direction of engine rotation.
Step 7. Stop rotating crankshaft when timing indicator is at TDC and timing mark on camshaft shim is aligned with mark on number one camshaft bearing.



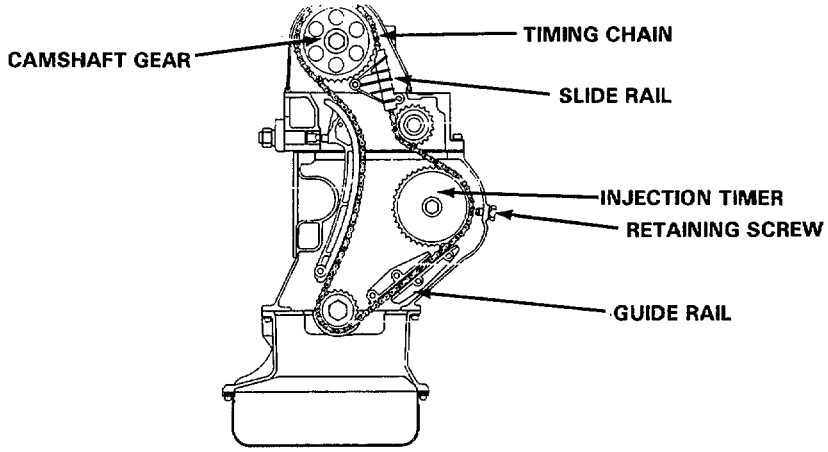
Step 8. Use point. Mark timing chain and injection timer at meshing point of chain.
Step 9. Put location mark on timing device and crankcase.
Step 10. Remove chain tensioner. Refer to paragraph 3-23.
Step 11. Remove screw and washer from slide rail.
Step 12. Remove bearing pin from slide rail.
Step 13. Remove slide rail.

TA259477

NOTE

Do not remove timing chain from camshaft gear.

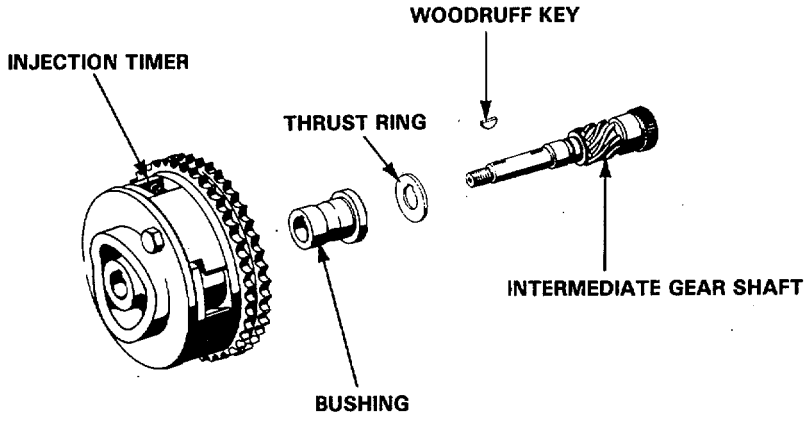
Step 14. Remove camshaft gear. Lay camshaft gear and chain aside.
Step 15. Remove retaining screw.
Step 16. Use Puller and puller bolt. Remove upper pin from guide rail. See table 2-1, items 2 and 3.



NOTE

Do not turn crankshaft or camshaft after removing injection timer.

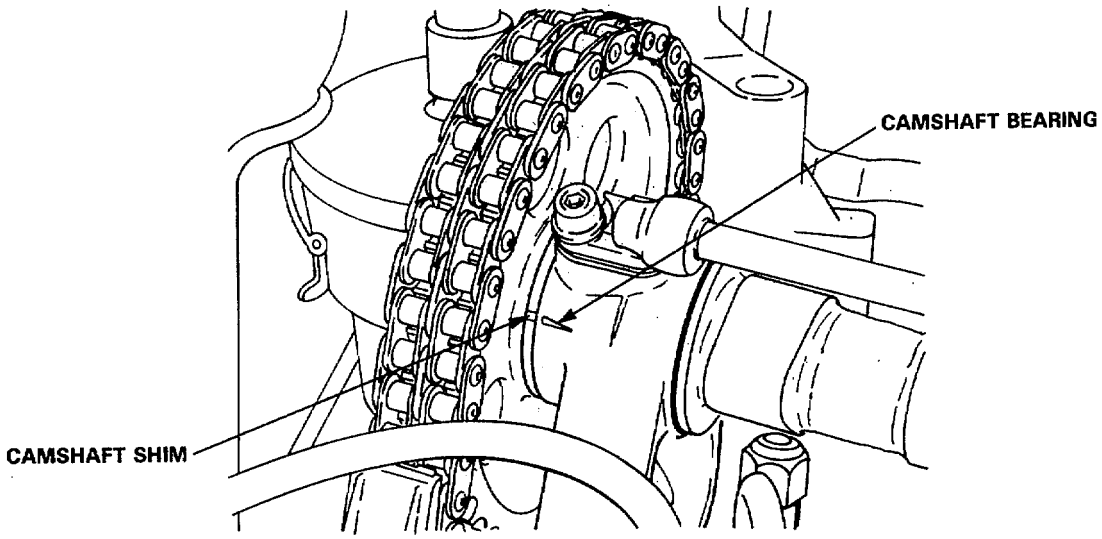
Step 17. Remove injection timer.
Step 18. Remove bushing from intermediate gear shaft.
Step 19. Remove thrust ring.
Step 20. Remove woodruff key from shaft.



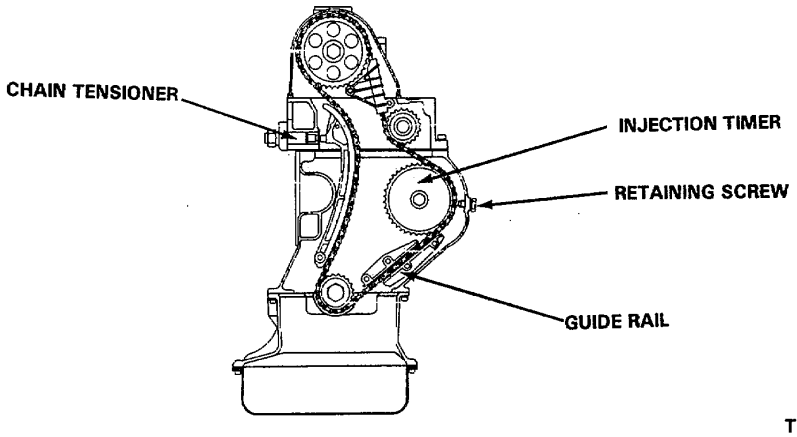
TA259478

b. Replace.

Step 1. Lubricate thrust ring and bushing with engine oil.
Step 2. Install woodruff key on intermediate gear shaft.
Step 3. Put thrust washer on intermediate shaft.
Step 4. Put bushing on intermediate shaft.
Step 5. If new injection timer is being installed transfer location mark from old injection timer to new injection timer.
Step 6. Put injection timer on intermediate gear shaft. Align location marks.
Step 7. Lift camshaft gear with chain.
Step 8. Pull chain up
Step 9. Check location marks on injection timer and crankcase. If not aligned, lift chain and align marks.
Step 10. Align timing mark on camshaft shim with mark in camshaft bearing. Put camshaft gear on camshaft.



Step 11. Install chain tensioner. Refer to paragraph 3-23.
Step 12. Align guide rail. Put in bearing- pin. Wire retainer must go into notch in bearing pin.
Step 13. Put new seal on retaining screw.
Step 14. Put in retaining screw. Tighten screw.

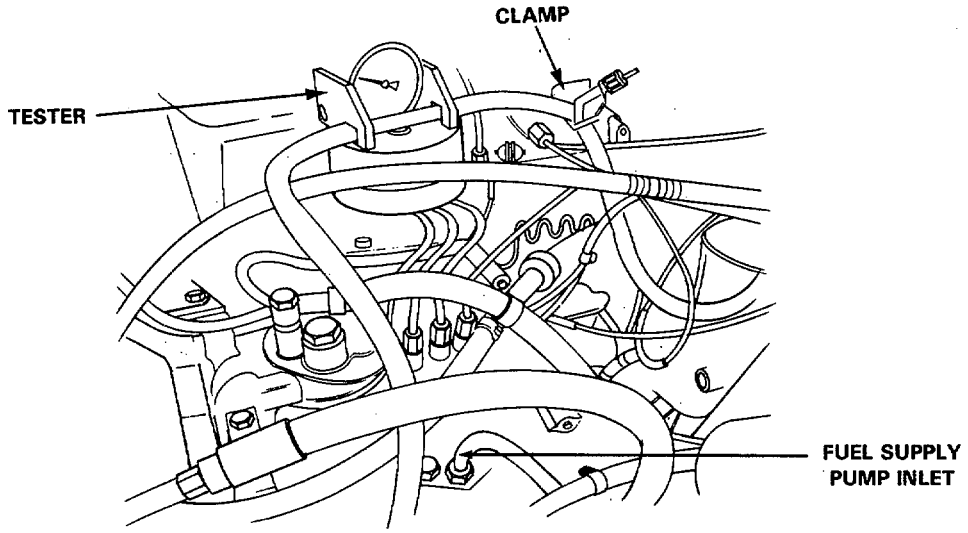


Step 15. Put on injection timer, mounting screw and washer. Torque screw to 30 lb. ft. (40 Nm).
Step 16. Check end play of intermediate shaft. End play must be between 0.002 and 0.005 in. (0.05 to 0.12 mm). If necessary remove thrust ring.
Step 17. Put in camshaft gear mounting screw. Torque screw to 50 lb. ft. (80 Nm).
Step 18. Put on slide rail. Refer to paragraph 3-21.
Step 19. Put in slide rail bearing pin.
Step 20. Install cylinder head cover and linkages.
Step 21. Put new gasket on vacuum pump.
Step 22. Install vacuum pump. Refer to paragraph 3-33.
Step 23. Fill and bleed cooling system. Refer to TM 9-2350-272-20.

4-9. TEST FUEL SUPPLY PUMP AND BY-PASS VALVE.

a. Measure Negative Pressure.

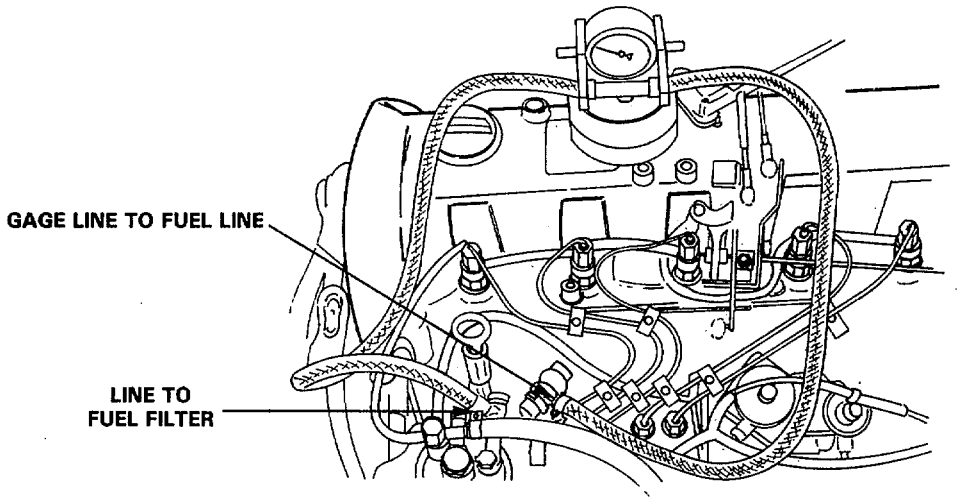
Step 1. Remove engine cover.
Step 2. Connect tester to fuel supply pump inlet.
Step 3. Disconnect fuel supply pump outlet line.
Step 4. Bleed air from injection system. Refer to TM 9-2350-272-20.
Step 5. Clamp outlet line of gage.
Step 6. Start engine. Refer to TM 9-2350-272-1 0.
Step 7. Measure vacuum pressure at idle speed 750 to 850 RPM.
Step 8. Read gage. Reading must be minus 1.45 PSI (0.1 bar}.
Step 9. If gage fails to read minus 1.45 PSI (0.1 bar), replace fuel supply pump. Refer to TM 9-2350-272-20. If gage reading is correct. Reconnect lines to pump.



TA259480

b. Testing Fuel Feed Pressure.

Step 1. Disconnect fuel line from fuel filter.
Step 2. Connect inlet line from gage to fuel filter.
Step 3. Connect outlet line from gage to fuel line.



Step 4. Bleed air from injection system. Refer to TM 9-2350-272-20.
Step 5. Start and warm up engine. Refer to TM 9- 2350-272-1 0.

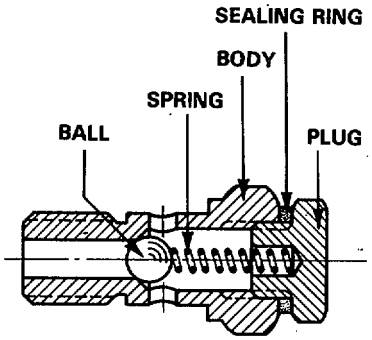
NOTE

Fuel feed pressure is measured at idle 750 to 850 RPM and at 3000 RPM.

Step 6. Measure fuel feed pressure at idle 750 to 850 RPM.
Step 7. Read gage. Reading must be 8.7 to 11.6 PSI (.6 to 0.8 bar).
Step 8. Measure fuel feed pressure at 3000 RPM.
Step 9. Read gage. Reading must be at a minimum of 11.6 PSI (0.8 bar).
Step 10. If gage fails to read 8.7 to 11.6 PSI (.6 to 0.8 bar) at idle 750 to 850 RPM and a minimum pressure of 11.6 PSI (0.8 bar) at 3000 RPM, do steps 11 through 20. If gage reads correctly, go to paragraph 4-9c.

TA259481

Step 11. Shut engine down. Refer to TM 9-2350-272- 10.
Step 12. Remove fuel bypass valve from fuel return line at fuel metering pump.
Step 13. Disassemble-fuel bypass valve.
Step 14. Inspect fuel bypass valve for damage, scored ball and seat, broken spring and dirt.
Step 15. If fuel bypass valve has damage, scored ball and seat or broken spring, replace fuel bypass valve.
Step 16. If fuel bypass valve is dirty, clean valve components.
Step 17. Assemble fuel bypass valve.

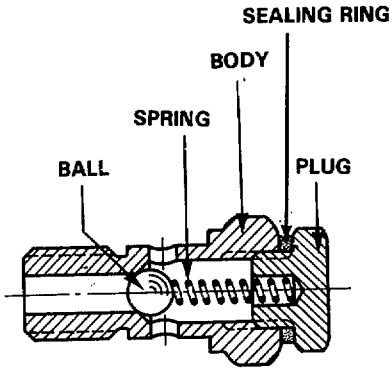


Step 18. Install fuel bypass valve in fuel return line at fuel metering pump.
Step 19. Bleed air from injection system. Refer to TM 9-2350-272-20.
Step 20. Start and warm up engine. Refer to TM 9- 2350-272-1 0.

NOTE

Fuel feed pressure is measured at idle 750 to 850 RPM and at 3000 RPM.

Step 21. Measure fuel feed pressure at idle 750 to 850 RPM.
Step 22. Read gage. Reading must be 8.7 to 11.6 PSI (.6 to 0.8 bar).
Step 23. Measure fuel feed pressure at 3000 RPM.
Step 24. Read gage. Reading must be at a minimum of 11.6 PSI (0.8 bar).
Step 25. If gage fails to read 8.7 to 11.6 PSI (.6 to 0.8 bar) at idle 750 to 850 RPM and a minimum pressure of 11 .6 PSI (0.8 bar) at 3000 RPM, go to step 26. If gage reads correctly, go to paragraph 4-9c.
Step 26. Shut engine down. Refer to TM 9-2350-272- 1 0.
Step 27. Remove fuel bypass valve from fuel return line at fuel metering pump.
Step 28. Disassemble fuel bypass valve.
Step 29. Stretch spring to 1.0236 to 1.0629 in. (26 to 27 mm).
Step 30. Assemble fuel bypass valve.



TA259482

Step 31. Install fuel bypass valve in fuel return line at fuel metering pump.
Step 32. Bleed air from injection system. Refer to TM 9-2350-272-20.
Step 33. Start and warm up engine. Refer to TM 9- 2350-272-10.

NOTE

Fuel feed pressure is measured at idle 750 to 850 RPM and at 3000 RPM.

Step 34. Measure fuel feed pressure at idle 750 to 850 RPM.
Step 35. Read gage. Reading must be 8.7 to 11.6 PSI (.6 to 0.8 bar).
Step 36. Measure fuel feed pressure at 3000 RPM.
Step 37. Read gage. Reading must be at a minimum of 11.6 PSI (0.8 bar).
Step 38. If gage fails to read 8.7 to 11.6 PSI (.6 t9 0.8 bar} at idle 750 to 850 RPM and a minimum pressure of 11.6 PSI (0.8 bar)- at 3000 RPM, go to step 39. If gage reads correctly, go to paragraph 4-9c.
Step 39. Shut down engine.
Step 40. Replace fuel filter.
Step 41. Bleed air from injection system. Refer to TM 9-2350-272-20.
Step 42. Start and warm up engine. Refer to TM 9- 2350-272-10.

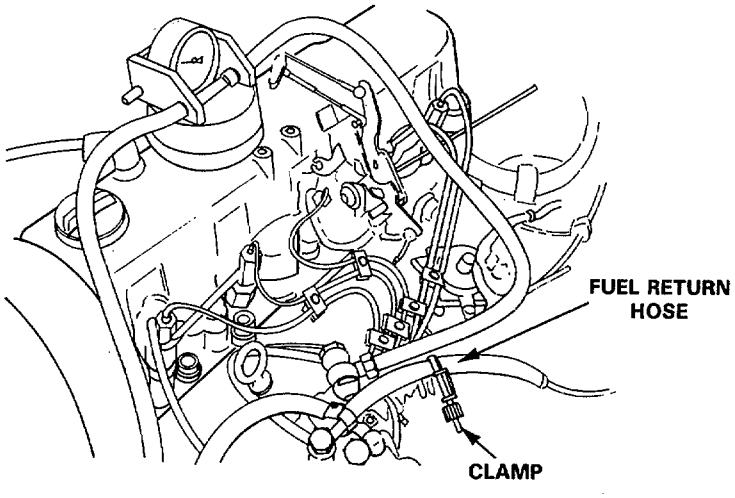
NOTE

Fuel feed pressure is measured at idle 750 to 860 RPM and at 3000 RPM.

Step 43. Measure fuel feed pressure at idle 750 to 850 RPM.
Step 44. Read gage. Reading must be 8.7 to 11.6 PSI (.6 to 0.8 bar).
Step 45. Measure fuel feed pressure at 3000 RPM.
Step 46. Read gage. Reading must be at a minimum of 11.6 PSI (0.8 bar).
Step 47. If gage fails to read 8.7 to 11.6 PSI (.6 to 0.8 bar) at idle 750 to 850 RPM and a minimum pressure of 11.6 PSI (0.8 bar) at 3000 RPM, replace fuel supply pump. Refer to TM 9-2350-272-20.
Step 48. Shut down engine. Refer to TM 9-2350-272- 10.

c. Testing Final Fuel Feed Pressure.

Step 1. Clamp fuel return hose,



Step 2. Start engine. Refer to TM 9-2350-272-10**.**

NOTE

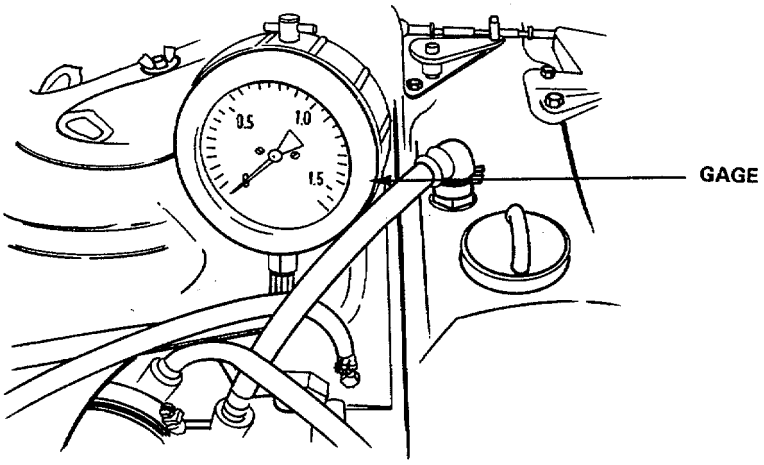
Final fuel feed pressure is measured at idle 750 to 850 RPM, and at 3000 RPM.

Step 3. Measure final fuel feed pressure at idle 750 to 850 RPM.
Step 4. Read gage. Reading must be no lower than the minimum pressure of 15.95 PSI (1.1 bar).
Step 5. Measure final fuel feed pressure at 3000 RPM.
Step 6. Read gage. Reading must be no lower than the minimum pressure of 18.85 PSI (1.3 bar).
Step 7. If gage fails to read the minimum pressures replace the fuel supply pump, refer to TM 9-2350-272-20. If gage reading is correct. Reconnect fuel lines.
Step 8. Replace engine cover.

TA259484

4-10. TEST TURBOCHARGER.

Step 1. Remove engine cover and remove plug from intake manifold.
Step 2. Connect pressure gage to intake manifold.



CAUTION

Full load test must be kept as short as possible because the total driving energy has to be absorbed by the vehicle's own brakes. Failure to do so may cause damage.

Step 3. Place transfer in high range.
Step 4. Place gear selector in position 1 or 2.
Step 5. Drive vehicle at full load with engine speed at 4000 RPM.
Step 6. Accelerate to full throttle, with the aid of service brakes. Hold engine speed at 4000 RPM.
Step 7. Read boost pressure tester. Reading must be 10.15 to 12 PSI (0.7 to 0.8 bar).
Step 8. Decelerate. Bring vehicle to a halt.
Step 9. Disconnect boost pressure tester from intake manifold.
Step 10. Put plug in place in intake manifold. Tighten plug and replace engine cover.

TA259485

CHAPTER 5
REPAIR OF COOLING SYSTEM

Section I. DESCRIPTION AND DATA

5-1. DESCRIPTION.

The cooling system consists of a radiator, expansion vessel, water pump, thermostat housing, thermostat, temperature sensor, regulating valve, heat exchangers, water inlet and outlet housing, hoses, lines, tubing and fittings, fan and fan drive belts, transmission oil cooler and coolant circulation pump.

a. The radiator is vertically mounted forward of the engine. It has a tube type core with a radiator drain cock on the bottom. The radiator has an expansion tube outlet on top.

b. The expansion vessel is mounted in front of the radiator under the front grill. It consists of a plastic type vessel with cap. It has inlet and outlet hoses.

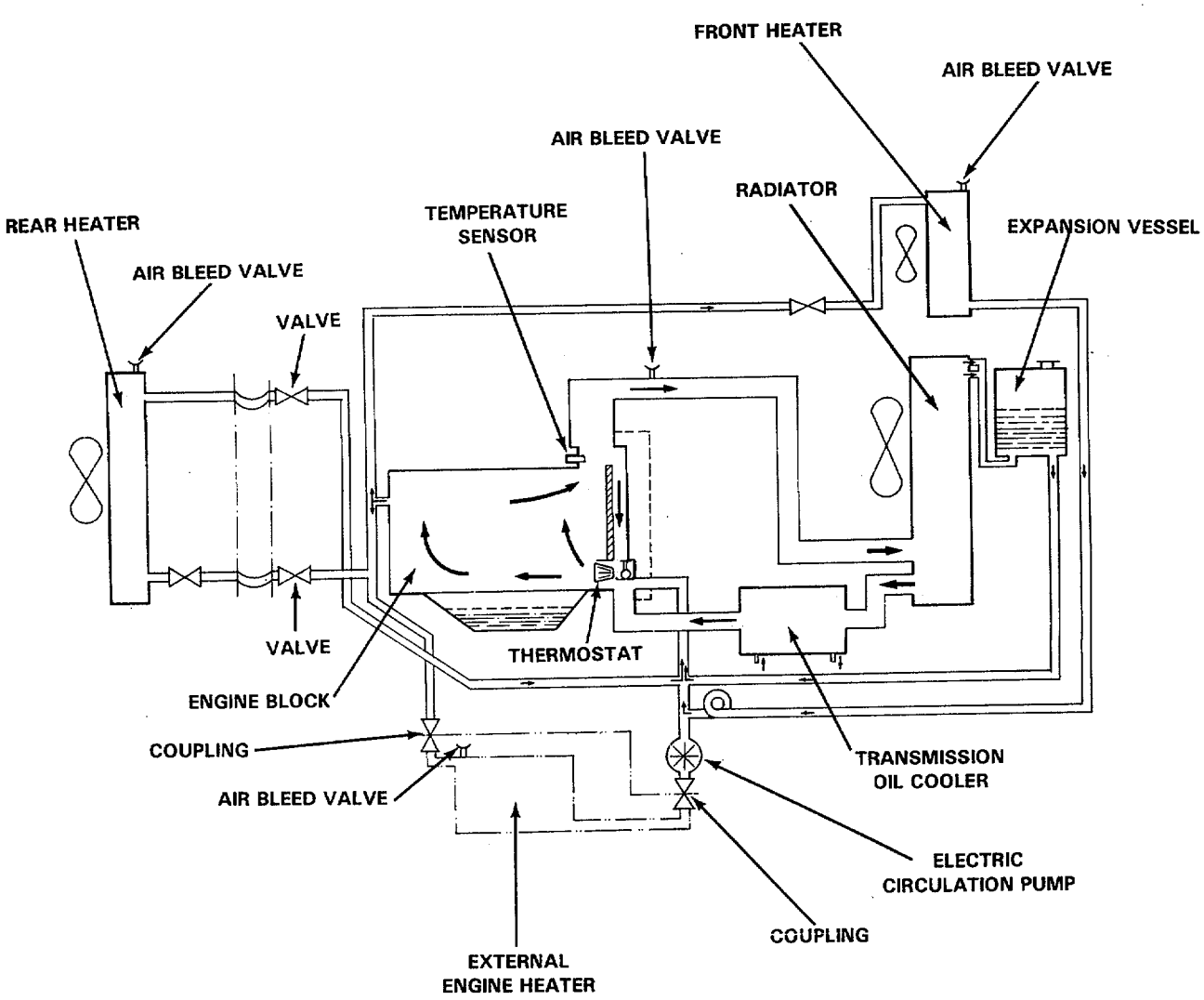
c. The water pump is a centrifugal impeller type. It is located at right front of engine. The water pump has a pulley mounted on front of the pump drive shaft. It is driven by a V-type belt.

d. The thermostat controls coolant temperature in cooling system while engine is running. It is mounted inside thermostat housing. The thermostat housing is located at right front side of engine. The thermostat valve is fully closed whenever coolant temperature is below 175°F (80°C). This prevents flow of coolant from engine to radiator. When coolant temperature rises above 175°F (80°C) the valve opens. A gradual flow of coolant moves from radiator until temperature reaches 202°F (95°C). The thermostat valve is fully opened at 202 °F (95°C) position allowing unrestricted circulation of coolant.

e. The regulating valve allows coolant to flow to heat exchangers heating front and rear cars.

f. The water inlet and outlet housings, hoses, lines, tubing and fittings make up the coolant circuit.

g. The fan is mounted in front of the engine on a pulley. It is driven by a V-belt powered by a pulley mounted on the hydraulic steering pump.



CIRCUIT AT COOLANT TEMPERATURE ABOVE 202°F (95°C)

Section II. REPAIR OF COOLING SYSTEM

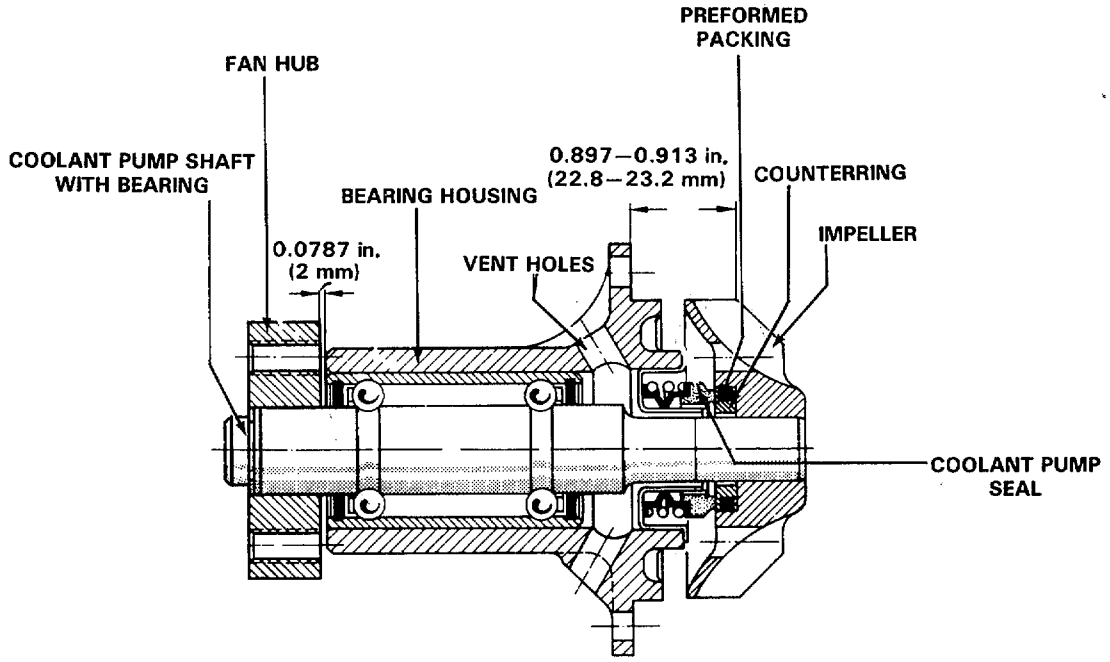
5-2. REPAIR OF RADIATOR.

Test and repair radiator. Refer to FM 43-2.

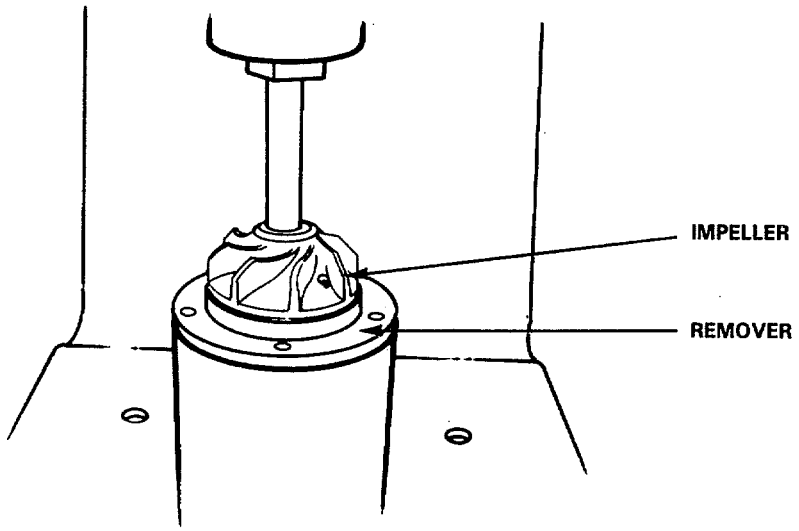
5-3. REPAIR OF COOLANT PUMP.

a. Disassembly.

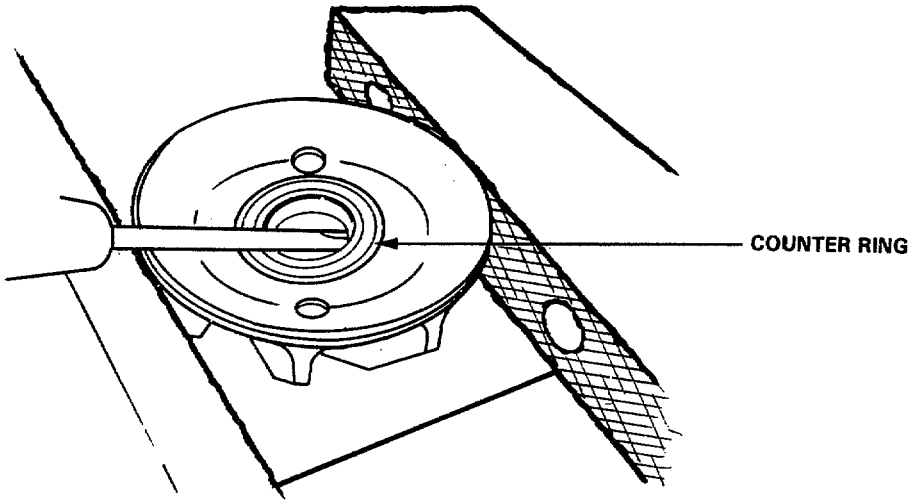
Step 1. Use press. Remove fan hub.
Step 2. Press the coolant pump shaft with bearing, seal and impeller out of coolant pump bearing housing.



Step 3. Using remover, press coolant pump shaft out of impeller. Refer to table 2-2, item 4.



Step 4. Remove coolant pump seal from bearing housing.
Step 5. Remove counterring with packing from impeller.



TA259561

b. Inspection.

NOTE

Do not clean coolant pump shaft with bearing in cleaning solvent.

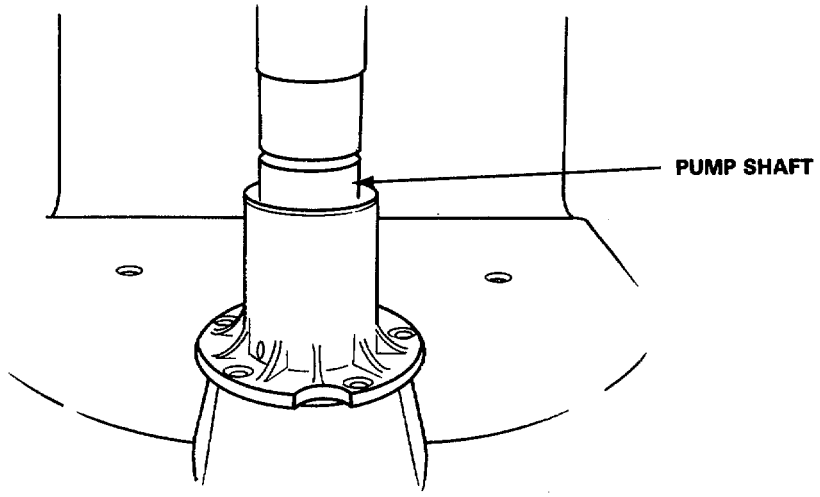
Step 1. Clean all coolant pump parts. Dry with low pressure compressed air.
Step 2. Inspect fan hub, bearing housing and impeller for cracks, breaks, elongation and damage.
Step 3. Inspect coolant pump seal, counterring and packing for cracks, scoring, and damage.
Step 4. Replace defective parts.

c. Assembly.

CAUTION

Do not press against coolant pump shaft or damage to bearing may result. Long end of shaft must face impeller.

Step 1. Press in coolant pump shaft. Bearing must be flush with bearing housing.



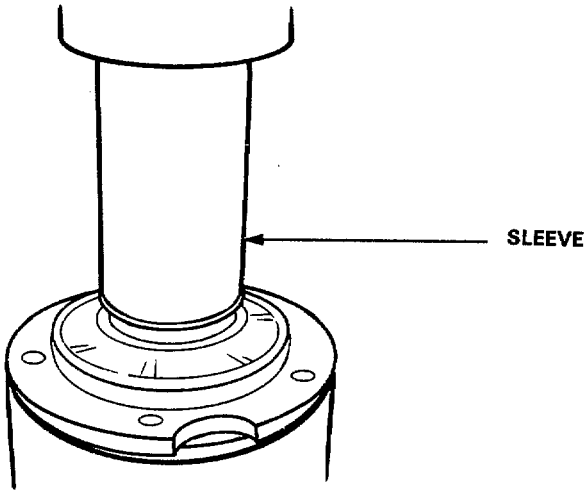
TA259562

Step 2. Apply a light coat of sealant to seal end of bearing housing.

NOTE

Do not allow coolant pump shaft to come in contact with any surface while pressing in seal assembly.

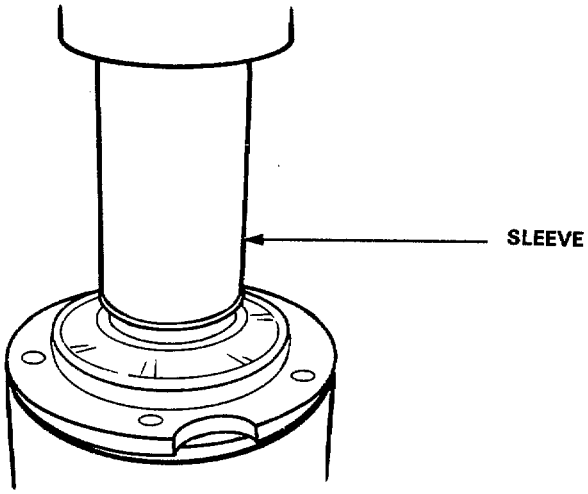
Step 3. Support bearing housing.
Step 4. Use sleeve. Press in coolant pump seal into bearing housing. Refer to table 2-2, item 5.



Step 5. Apply soapy water to coat packing on counterring.

NOTE

Chamfered side of counterring must go towards impeller.

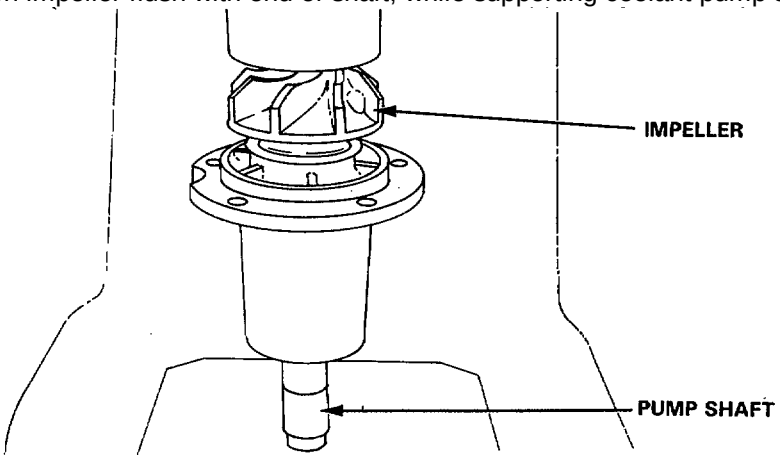


Step 6. Push counterring with packing into impeller.

CAUTION

Sealing surfaces of counterring and coolant pump seal must be free of dust prior to assembly or damage to sealing surfaces may result.

Step 7. Clean end of coolant pump shaft and impeller bore.
Step 8. Press-on impeller flush with end of shaft, while supporting coolant pump shaft.

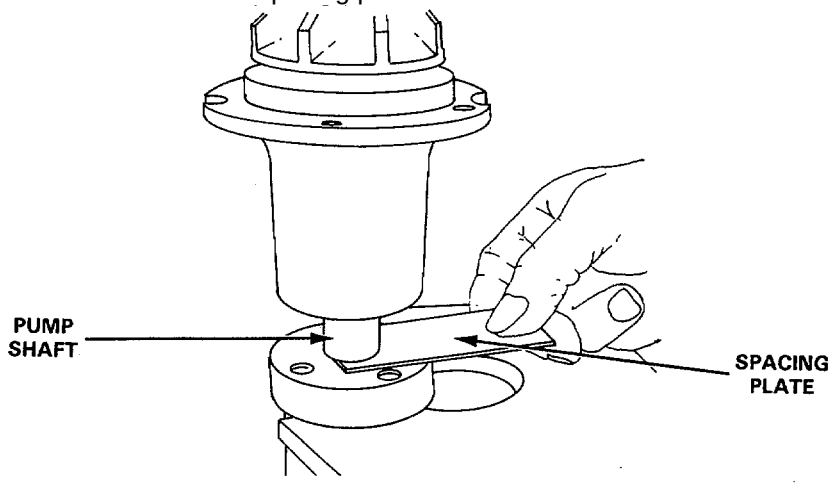


Step 9. Heat fan hub to 572°F (300°C).

WARNING

To avoid burns after heating metal components wear insulated gloves or handle components with pliers.

Step 10. Place heated fan hub on a recessed base.
Step 11. Use fabricated spacing plate. Refer to table 2-2, item 7. Hold spacing plate on coolant pump shaft.
Step 12. Put coolant shaft into fan hub.
Step 13. Apply compressed air against fan hub until firm.
Step 14. Remove fabricated spacing plate.



TA259564

Step 15. Dip in water to cool fan hub.

CHAPTER 6
REPAIR OF ELECTRICAL SYSTEM.

Section I. GENERAL INFORMATION

6-1. DESCRIPTION AND DATA.

a. General.

The electrical system has two heavy duty 12 volt storage batteries connected in series. Batteries are placed on an electric heater plate and are protected by an insulated battery cover. Batteries are charged by an alternator with integral rectifier. A power outlet, located under driver's seat in a electrical connector box, is connected directly to batteries. The power outlet can be used for auxiliary starting and winch operation. This electrical connector box also contains a relay switch for the electrical system. The relay is operated by the ignition switch. A diode in the control circuit of the relay protects the electrical system should batteries be accidentally connected in reverse.

b. Technical Data.

ALTERNATOR.

Make	Bosch N1-28 V 55 A 25
Rated current	55A
Rated voltage	28V
Rated power	1,260W
Maximum speed	12000 RPM
Direction of rotation	Clockwise
Cooling	Air
Speed ratio, engine-alternator	1:2.1
Drive, belts	2
Mass (weight)	11 lbs. (5 kg)

TIGHTENING TORQUES

Upper mounting screw	38 lb. ft. (52 Nm)
Lower mounting screw	19 lb. ft. (26 Nm)
Pulley nut	26-30 lb. ft. (35-40 Nm)

MECHANICAL TEST VALVES

Rotor body radial runout, maximum	0.05 mm
Slip ring radial runout, maximum	0.03 mm
Slip ring minimum diagram	26.8 mm
Brushers, minimum length	5 mm
Brush spring thrust	3-4 N

ELECTRICAL TEST VALUES

Rotor winding resistance, over slip rings	9.0-9.9 ohm
Stator winding resistance, phase-to-phase	0.21-0.23 ohm

POWER DELIVERY TEST (ALTERNATOR WARM 140 ℉ (60 ℃))

ALTERNATOR SPEED		ENGINE SPEED		CURRENT, MIN
r/s	r/min	r/s	r/min	A
24	1,450	Bench test		10
42	2,500	20	1,200	36
100	6,000	48	2,900	55

CHARGING REGULATOR

Type ..... Transistorized
Make, designation..... Bosch 0 192 053 005
Regulated voltage..... 27.6-28.4 V

STARTING MOTOR

Make, designation..... Bosch 0 001363 120
Rated voltage ..... 24 V
Chassis connection ..... Negative
Rated power at 21 V ..... 3.5 KW
Number of teeth, drive pinion..... 10

MECHANICAL TEST VALUES FOR STARTING MOTOR

Rotor axial clearance ..... 1 -0.3 mm
Rotor radial runout, maximum ..... 0.05 mm
Collector radial runout, maximum ..... 0.05 mm
Collector diameter, minimum ..... 39.5 mm
Brush spring thrust ..... 11.5-13.0 N
Friction torque, rotor brake ..... 0.45-0.75 N
Distance, pinion-to-gear ring (rim)..... 2.0-3.0 mm
Pinion freewheeling torque ..... 0.28-0.40 Nm
(i.e. torque required to rotate pinion of assembled motor in normal direction of rotation, when rotor is held stationary)
Gear backlash ..... 0.4-0.7 mm

ELECTRICAL TEST VALUES FOR STARTING MOTOR

Starting motor at no load:
23.5, maximum 35A ..... minimum 7000 RPM
Pinion locked:
15.5 V and 630-750 A ..... 0 RPM
14.5 V and 580-700 A ..... 0 RPM

BILGE PUMPS

Number of 2
Make, designation..... Watski 13447
Rated voltage ..... 24 V
Pumping capacity
at 0 m head, maximum ..... 1.5 dm^3/s
1 m ..... 1.2 dm^3/s
2 m..... 0.75 dm^3/s

COOLANT CIRCULATING PUMP, FOR ENGINE HEATER

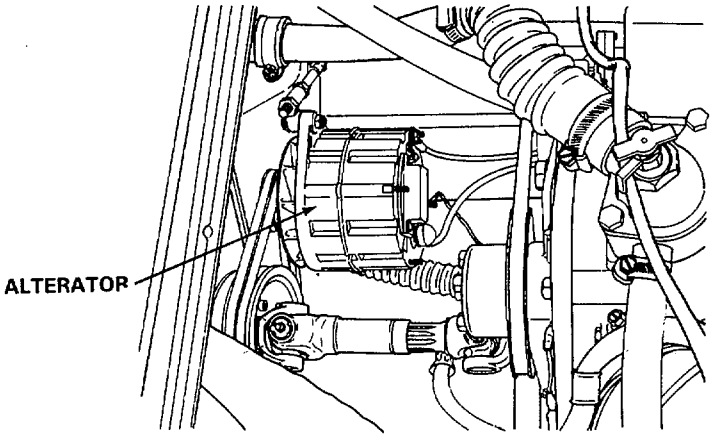
Number of 1
Make, designation ..... Bosch 0 130 002 068
Rated voltage ..... 24 V

Section II. REPAIR OF ELECTRICAL SYSTEM

6-2. REPAIR OF ALTERNATOR.

a. Description (General).

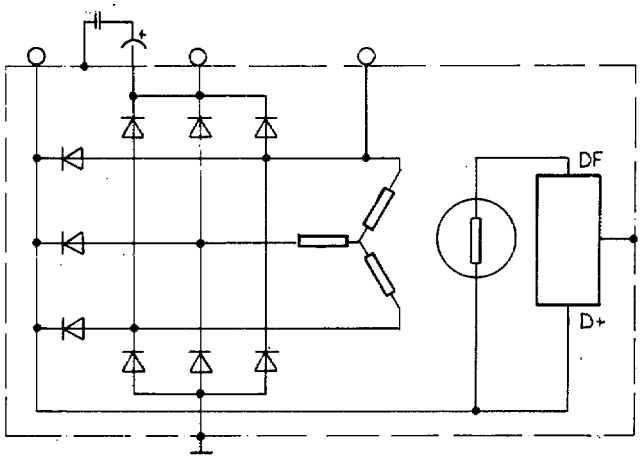
The alternator is located at right front of engine and is driven by two V-belts from a pulley on the hydraulic pump.



The charging regulator is transistorized. As the alternator limits its output current to approximately 55 A, and as the diodes do not pass current in their reverse direction, the regulator is essentially a voltage regulator.

A defective regulator cannot be adjusted or repaired, but must be replaced by a new one.

The alternator slip ring brushes are mounted on the regulator. The charging indicator is mounted on the control panel.



ALTERNATOR CIRCUIT DIAGRAM (REGULATOR)

TA259565

The alternator is a three-phase AC generator, with the rotor carrying the magnetizing, or field, winding and the stator supplying the output voltage.

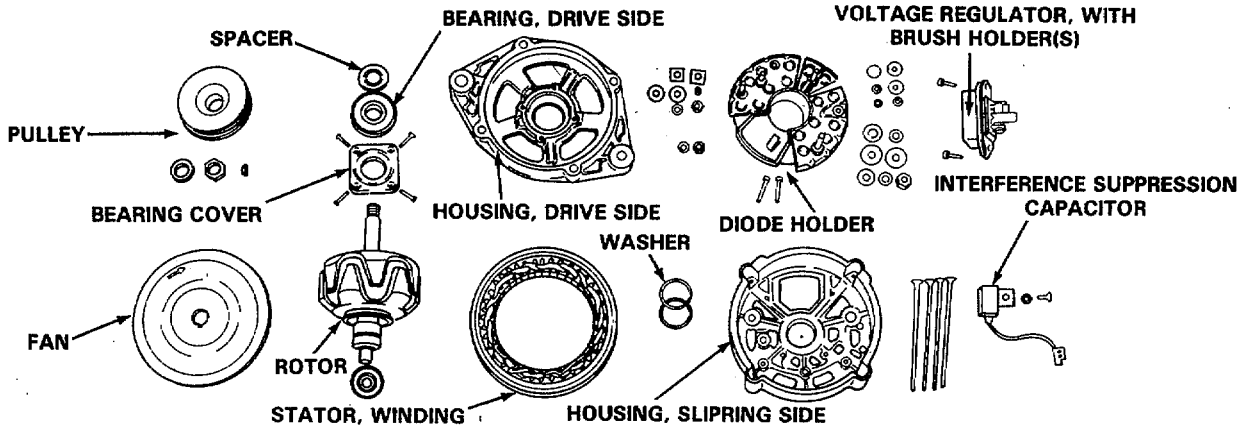
When the rotor rotates, and is supplied with a magnetizing direct current, alternating voltages are induced in the Y- connected stator windings. These voltages are rectified by six silicon diodes to provide direct current for charging the battery and for supplying other power consumers in the carrier.

Three other silicon diodes rectify the stator output voltage to supply magnetizing current for the rotor at normal operating rpm.

When starting and at low speed, the magnetizing current for 'the rotor is supplied by the battery through the charging indicator lamp. The lamp goes out when the alternator is self-energizing through the magnetizing diodes.

The alternator automatically limits the charging current to approximately 55 A.

b. Disassembly and Test.



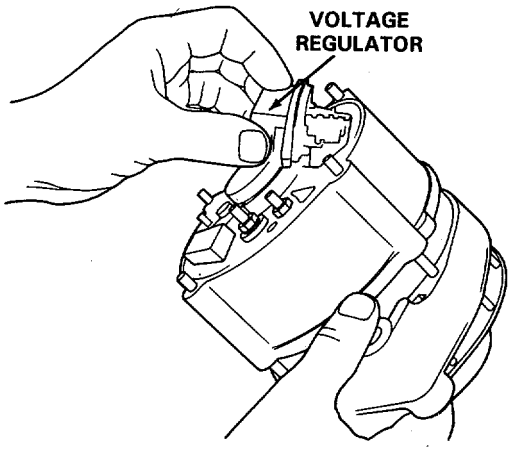
ALTERNATOR DISASSEMBLED

TA259566

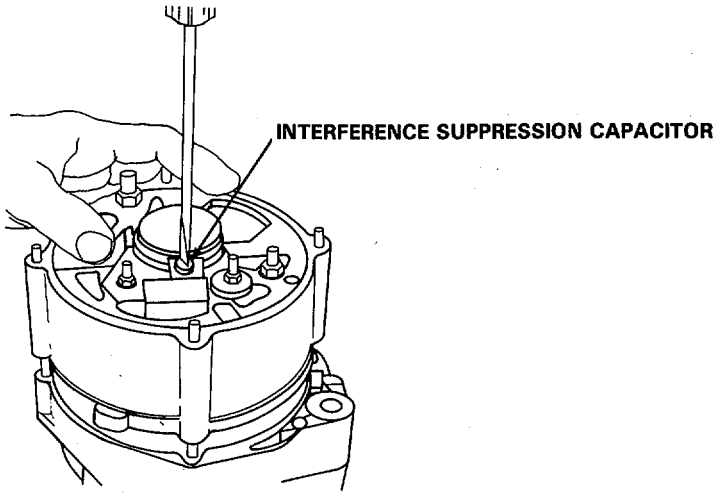
NOTE

Handle voltage regulator carefully. Do not damage brushes.

Step 1. Remove voltage regulator.



Step 2. Remove radio interference suppression capacitor.

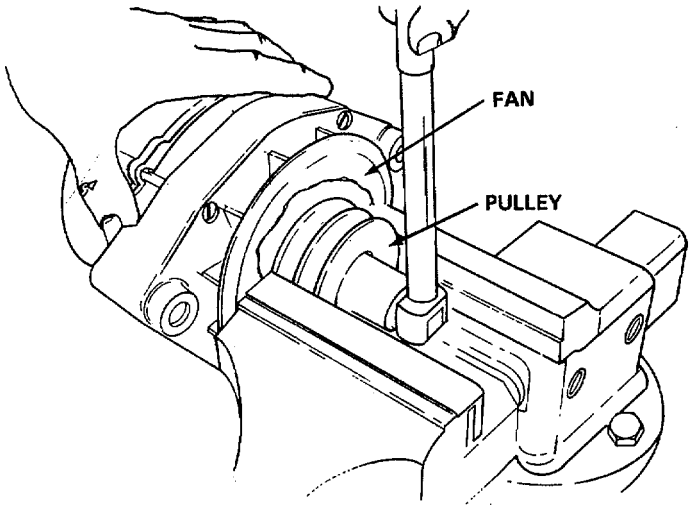


TA259567

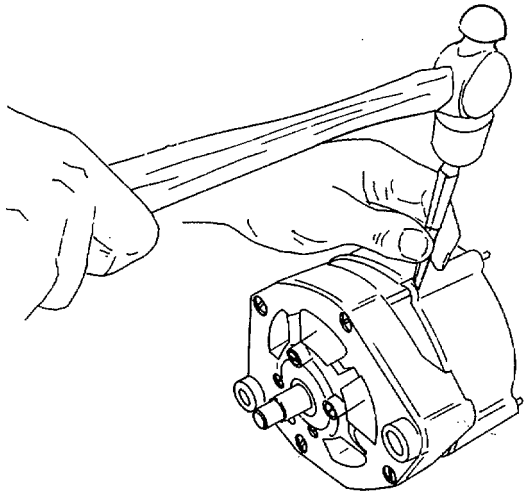
NOTE

Use vise jaw caps in vise.

Step 3. Place V-belt pulley in vise.
Step 4. Remove nut, pulley, key and cooling fan.

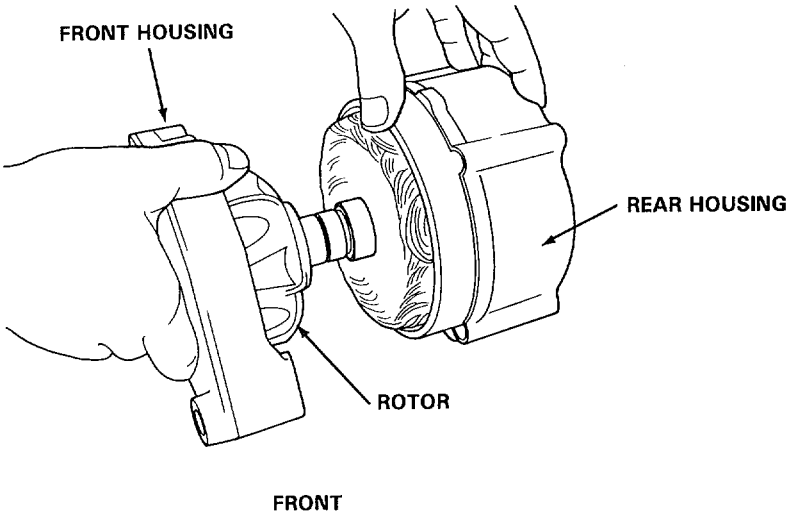


Step 5. Scribe mark housing sections.

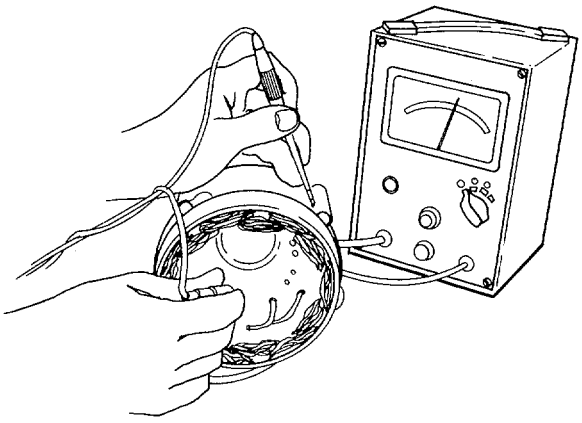


TA259568

Step 6. Remove four housing screws.
Step 7. Remove front housing with rotor.
Step 8. Remove washer from rear housing slipring bearing housing.

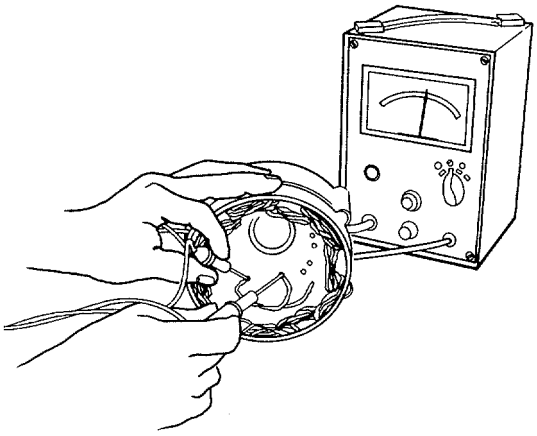


Step 9. Use multimeter. Test diodes.

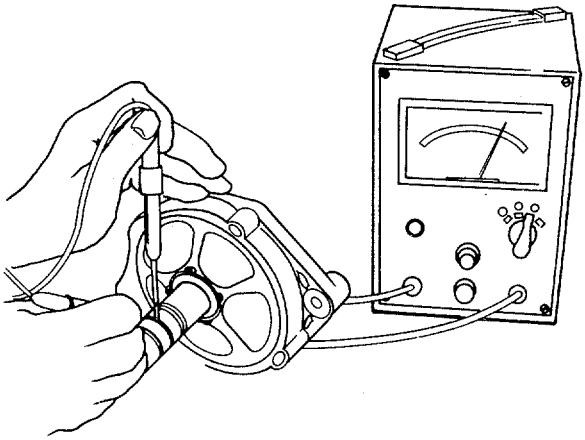


TA259569

Step 10. Using multimeter, measure stator phase winding resistance; current value should be 0.22-0.24 ohms. Three measurements must be made: between phase windings 1 and 2, between phase windings 2 and 3, between phase windings 3 and 1.

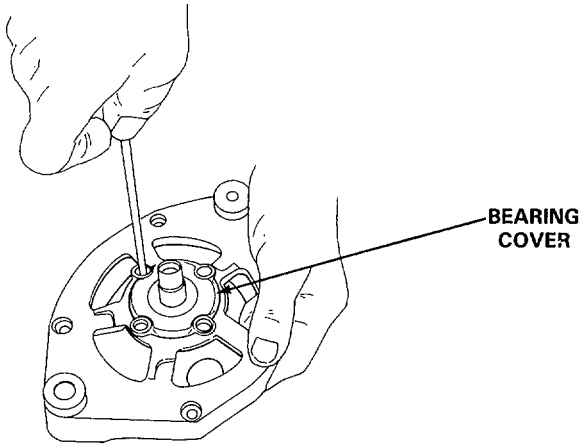


Step 11. Using multimeter, measure rotor winding resistance. Correct value is 9.0-9.9 ohms.
Step 12. Using test lamp, check that insulation between rotor winding and rotor body are intact.

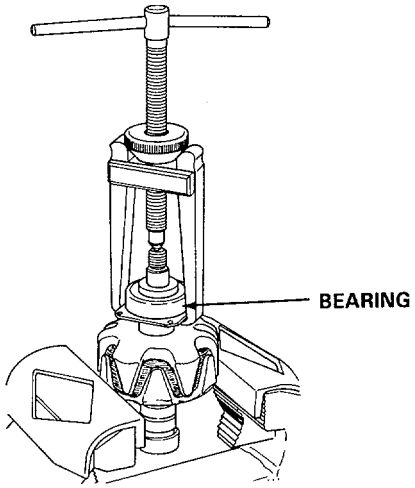


TA259570

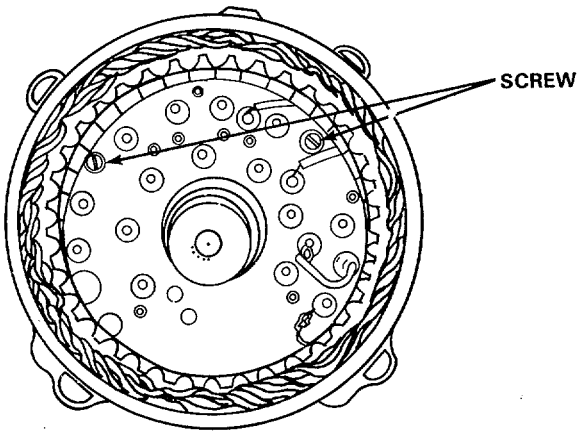
Step 13. Remove four screws from front housing bearing cover.



Step 14. Use a puller. Remove bearing from front of rotor shaft.

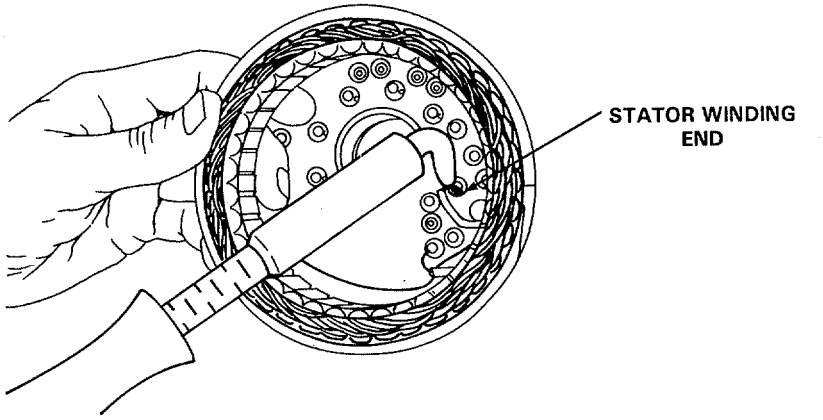


Step 15. Remove two screws holding diode plate in housing.



TA259571

Step 16. Remove nuts and washers from terminals B+, D+, and W. Remove housing.
Step 17. Remove insulating bushings from terminals B +, D +, and W.
Step 18. Using test lamp, check that insulation between stator windings and stator body is intact.
Step 19. Unsolder stator winding ends.



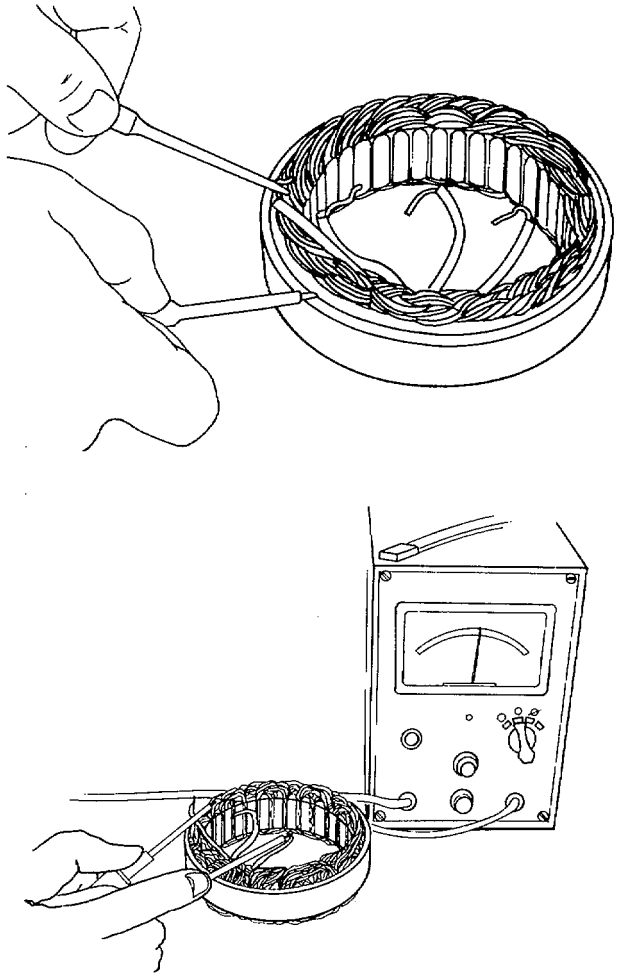
c. Inspection and Repair.

CAUTION

Do not place bearings and carbon brushes in dry cleaning solvents. Damage to parts will result. Wipe clean with a moistened rag only.

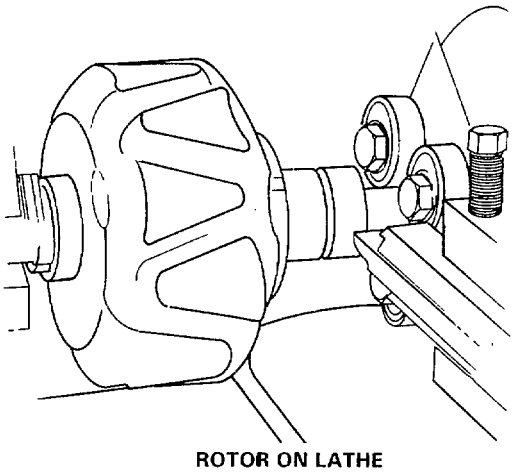
Step 1. Clean components. Dry with low pressure compressed air.
Step 2. Inspect all components for damage. Replace defective or damaged components.
Step 3. Using a test lamp, check that insulation between stator windings, and stator body is intact.
Step 4. Using multimeter, measure stator phase winding resistance; correct valve is 0.22-0.24 ohms. Three measurements must be made: between phase windings 1 and 2, between phase windings, 2 and 3, between phase windings 3 and 1

TA259572



NOTE

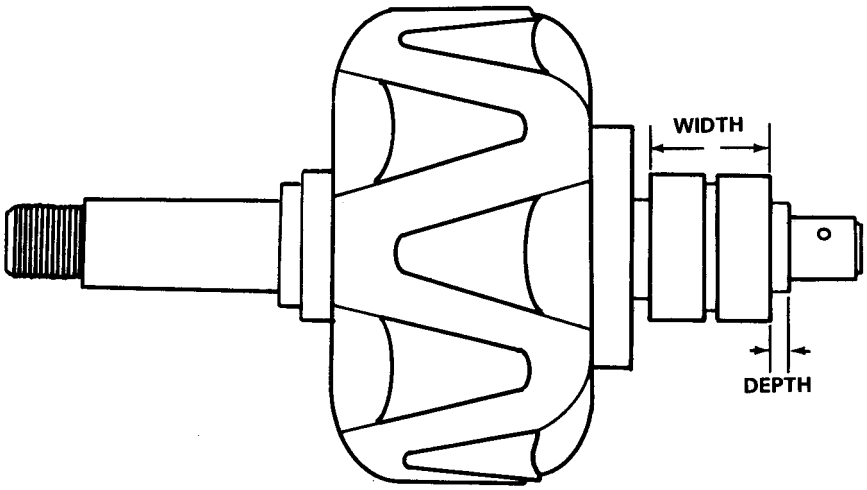
Burnt or unevenly worn sliprings must be turned on a lathe and polished with a fine abrasive paper. Rotor must be centered correctly. A commutator chuck is recommended.



ROTOR ON LATHE

TA259573

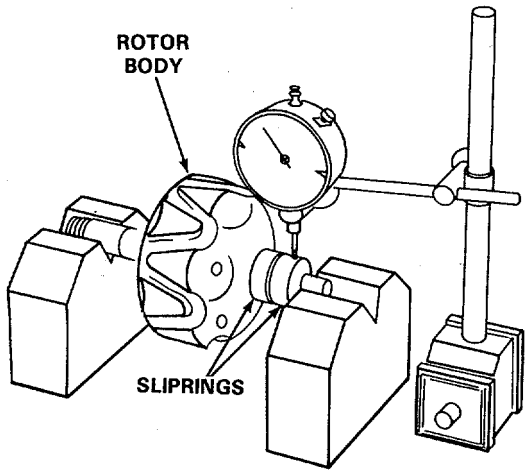
Step 5. Turn slipring surfaces perfectly smooth; do not exceed total slipring width of 0.7874 in. (20 mm).



TURNING WIDTH AND MOUNTING DEPTH FOR SLIPRING

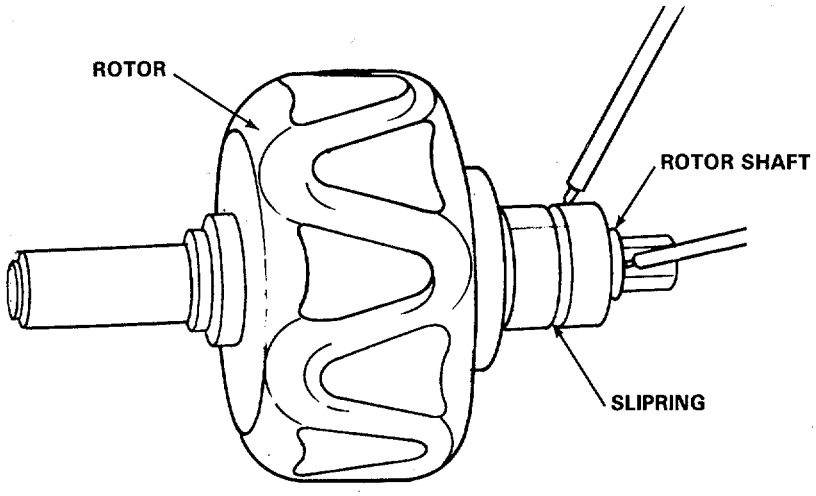
Step 6. Check slipring diameter. Minimum slipring diameter is 1.0551 in. (26.8 mm).
Step 7. Using dial indicator, check out of round of rotor body and sliprings

- Rotor body must not exceed 0.002 in. (0.05 mm)
- Sliprings must not exceed 0.0012 in. (0.03 mm)

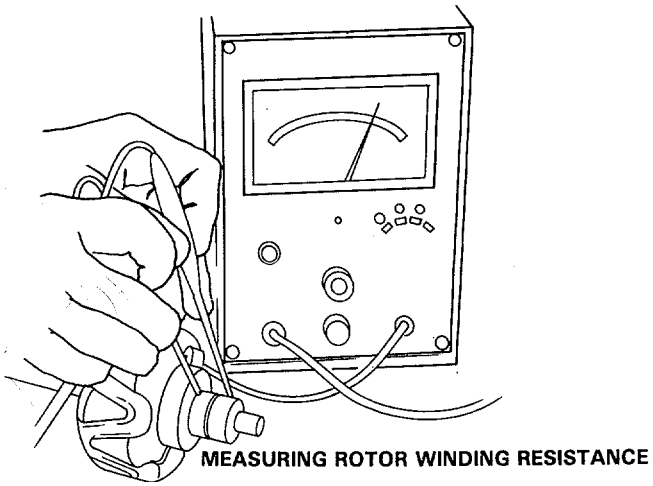


TA259574

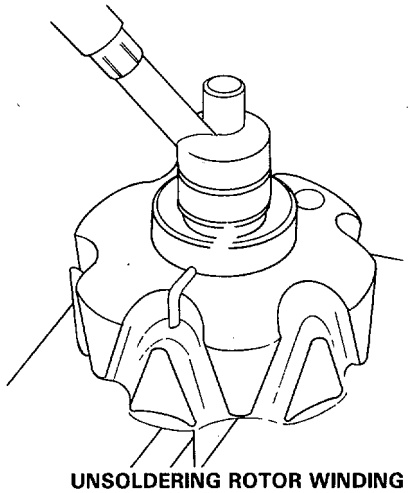
Step 8. Using test lamp, check that insulation between rotor winding and rotor body are intact.



Step 9. Using multimeter, measure rotor winding resistance; correct value should be 9.0-9.9 ohms.


MEASURING ROTOR WINDING RESISTANCE

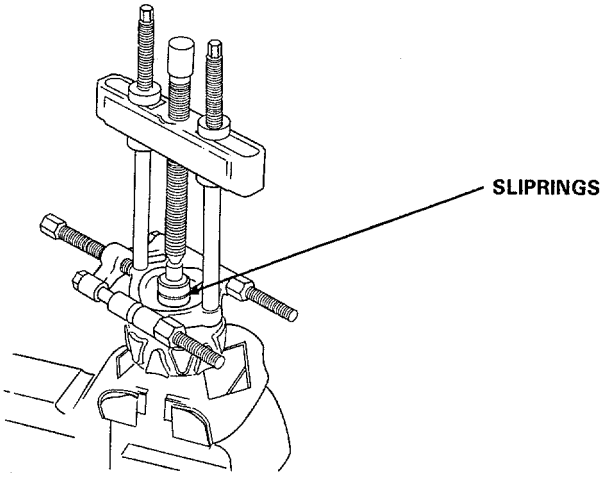
Step 10. Unsolder both ends of winding at sliprings.


UNSOLDERING ROTOR WINDING

NOTE

Care must be taken not to damage varnish coating holding ends of winding to rotor body.

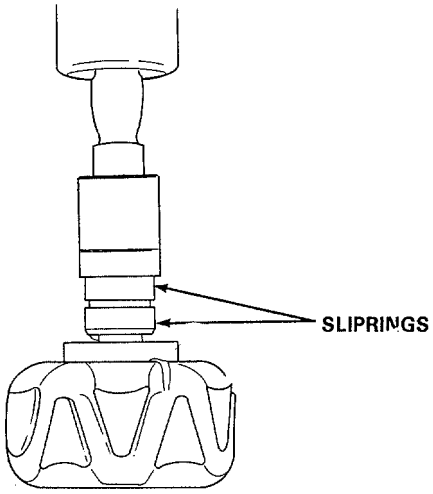
Step 11. Using puller, remove sliprings from rotor shaft.



NOTE

Align slipring grooves directly opposite winding ends, and as slipring is pressed in, check that slipring is correctly positioned 0.1457 ± 0.0039 in. (3.7 ± 0.1 mm) from end of bearing seat.

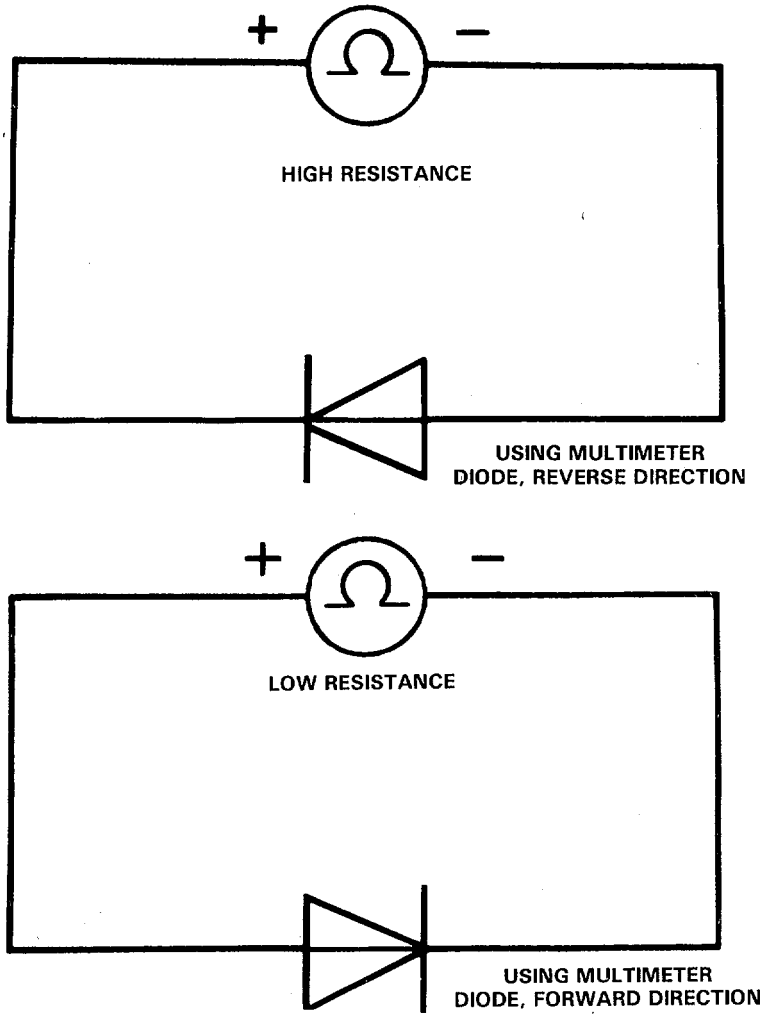
Step 12. Using a press and mandrel, press slipring in place.

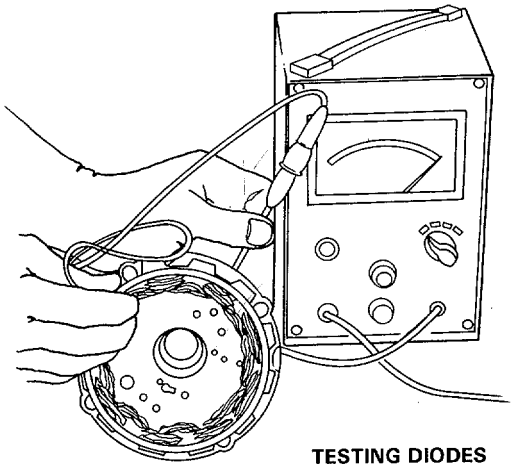


NOTE

Winding ends must be flush with rotor end.

Step 13. Solder winding ends in slipring grooves.
Step 14. Using test lamp, check that insulation between rotor winding and rotor are intact.
Step 15. Unsolder diodes from stator windings.
Step 16. Test all diodes, using a multimeter.





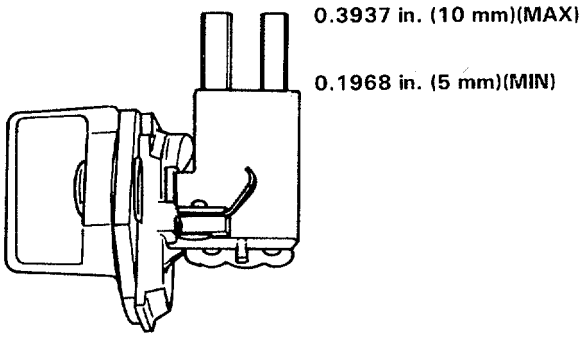
TESTING DIODES

TA259577

NOTE

If any one diode is defective, the entire diode plate must be replaced.

Step 17. Measure between soldered points and B + terminal to check positive side diodes.
Step 18. Measure between soldered points and heat sink of negative diodes to check negative side diodes.
Step 19. Measure between soldered points and D + terminal to check magnetizing current diodes.
Step 20. Check that preformed packing is complete and correctly positioned in front housing bearing seat.
Step 21. Measure brush length. Correct length should be between 0.3937 in. (10 mm) and 0.1968 in. (5 mm).



MEASURING BRUSH LENGTH

NOTE

Do not allow solder to flow into brush leads. New brushes must slide freely in holders.

Step 22. Unsolder connections at brush holder. Put new brushes in place. Solder connections at holder.

d. Assemble.

Step 1. Put new bearing in place on slipring end of shaft.
Step 2. Put new bearing in front housing. Put on cover with screws and tighten screws.
Step 3. Press front housing with spacer onto rotor shaft.
Step 4. Solder stator winding ends.
Step 5. Put washers and insulating bushings on terminals B +, D +, and W.
Step 6. Put diode plate in place in rear housing.

TA259578

Step 7. Put washers and nuts on terminals B +, D +, and W.
Step 8. Put in two screws holding diode plate. Tighten screws.
Step 9. Apply a light coat of grease to bearing seat in rear housing.
Step 10. Put washer in bearing seat in rear housing.

NOTE

During assembly align scribe marks.

Step 11. Put front housing with rotor in place with rear housing.
Step 12. Put in and tighten four screws.
Step 13. Put voltage regulator with brush holder and rubber gasket in place in rear housing.
Step 14. Put in and tighten two screws.
Step 15. Put radio interference capacitor in place.
Step 16. Put in and tighten screw.
Step 17. Put in key, cooling fan and pulley.
Step 18. Screw on nut. Place V-belt pulley in vise with jaw caps.
Step 19. Tighten and torque nut to 26-30 lb. ft. (35- 40 Nm).

e. Testing.

NOTE

Test of alternator or voltage regulator can be done on a test stand or in vehicle.

(1) Alternator.

Step 1. Connect a voltmeter between B + and chassis.
Step 2. Connect a ampmeter between B+ and-battery leads to battery and consumers.
Step 3. Connect a variable load resistor across battery.
Step 4. Measure ampere at the three speeds given in the table below.

NOTE

If correct readings are not obtained, replace voltage regulator and repeat test. If repeated test fails, alternator is defective.

ALTERNATOR RPM	ENGINE RPM	CHARGING RATE
1450	Bench Test	10A
2500	1200	30A
6000	2900	55A

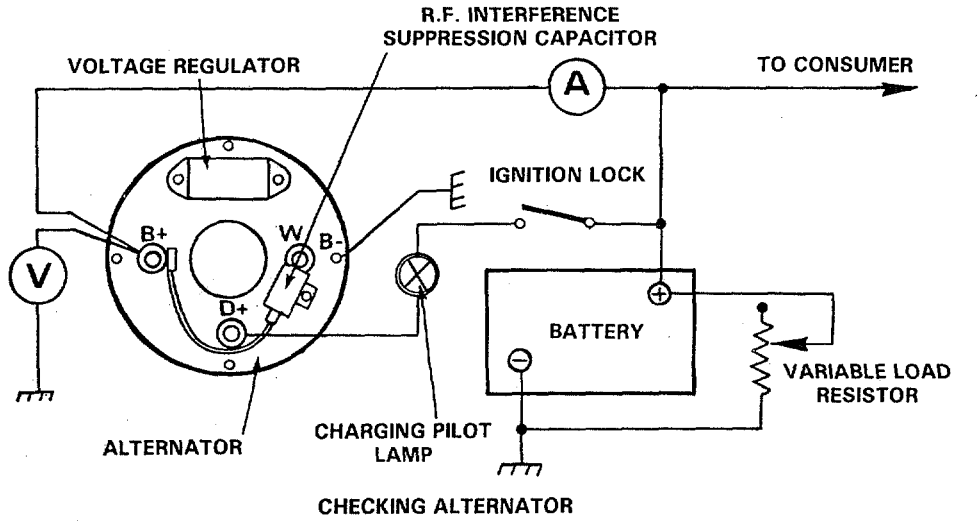
(2) Voltage Regulator.

Step 1. Connect a voltmeter between B + and chassis.
Step 2. Connect an ampmeter between B + and battery leads to battery and consumers.
Step 3. Connect a variable load resistor across battery. Refer to drawing below.
Step 4. Read voltage and ampere.

NOTE

If it is difficult to produce a current load of 5 A, check regulator voltage at a higher current load, but do not exceed 20 A.

ALTERNATOR RPM	ENGINE RPM	LOAD CURRENT	REGULATED VOLTAGE
4000	1900	5A	27.6-28.4V



CHECKING ALTERNATOR

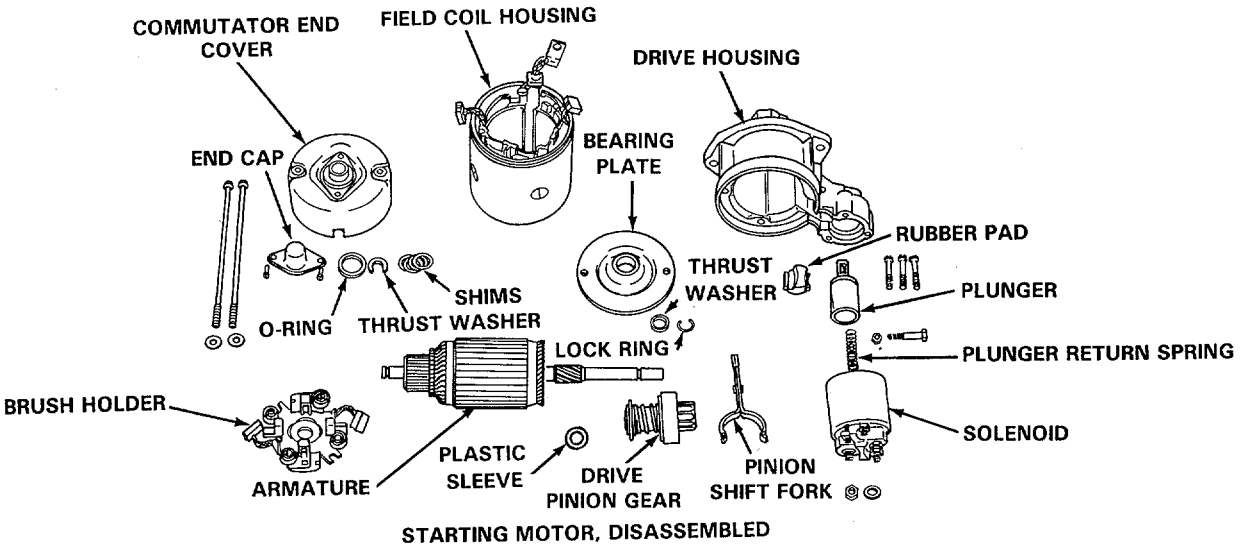
6-3. REPAIR OF STARTER.

a. Description.

Starting system consists of an ignition switch, starter, battery and battery cables. The starter is a 24V, 4 pole, DC motor with a solenoid. The solenoid has a winding and a spring loaded movable plunger connected to one end of a shift lever-fork. The fork end shifts the starter motor pinion gear. The solenoid has two terminal screws: for the battery positive cable; and the starter motor field coil windings and for energizing solenoid coil windings.

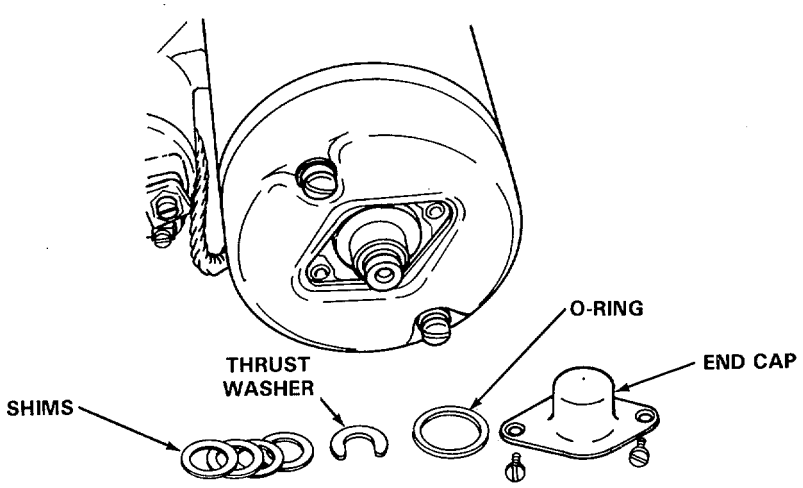
When the ignition key is turned to start position the circuit is closed to supply current to the solenoid coil winding. The plunger is pulled and shifts the pinion gear to engage with the flywheel ring gear. The pinion shift lever-fork moves to the end of plunger movement. The end of plunger presses against the end of a contact button and pushes a contact disk across switch contacts to operate starter motor.

b. Disassembly.



STARTING MOTOR, DISASSEMBLED

Step 1. Remove end cap with preformed packing from commutator end cover.
Step 2. Remove washer and shims.



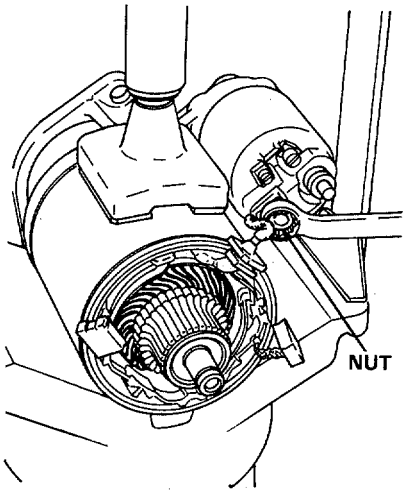
Step 3. Remove two housing screws.
Step 4. Remove commutator end cover.

TA259581

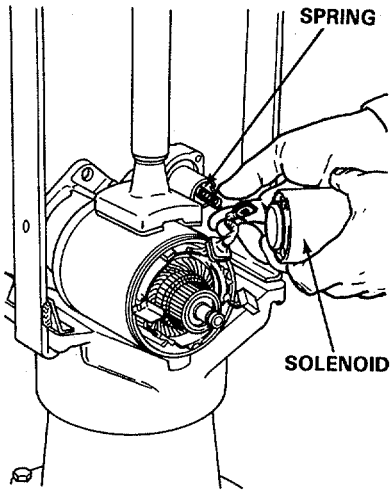
NOTE

Positive brushes are mounted on field coil winding, and negative brushes on brush holder.

Step 5. Bend tabs to release springs. Remove brushes from brush holder.
Step 6. Remove brush holder.
Step 7. Remove nut from solenoid terminal screw.
Step 8. Remove terminal screw.

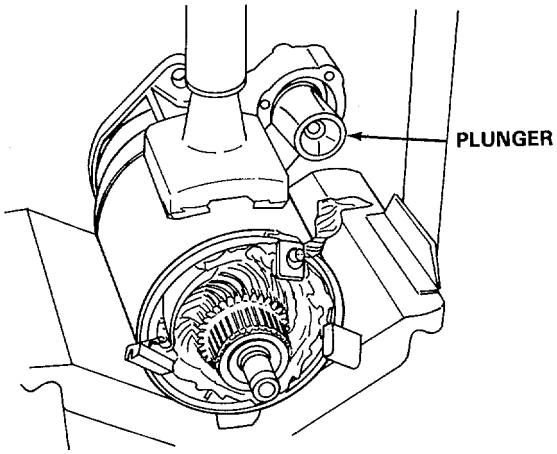


Step 9. Remove solenoid mounting screws, solenoid, and plunger return spring.

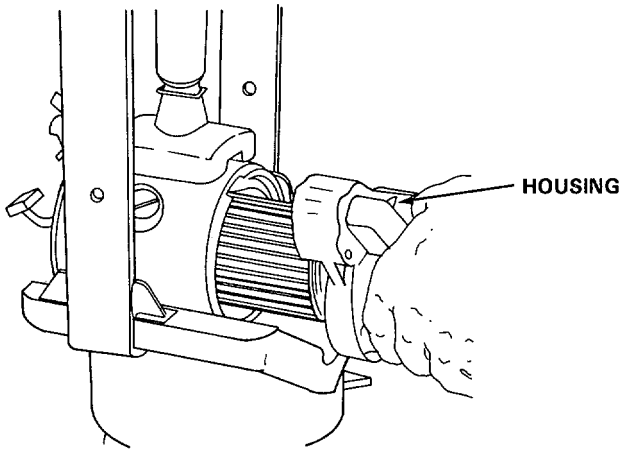


TA259582

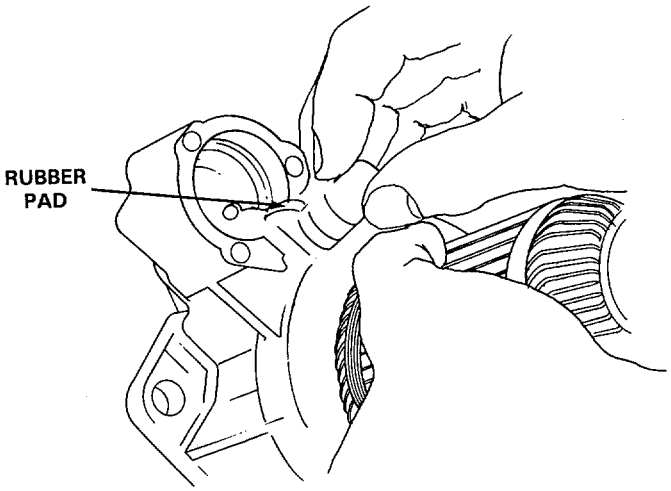
Step 10. Disconnect plunger from pinion shift fork.



Step 11. Remove drive housing from field coil housing.

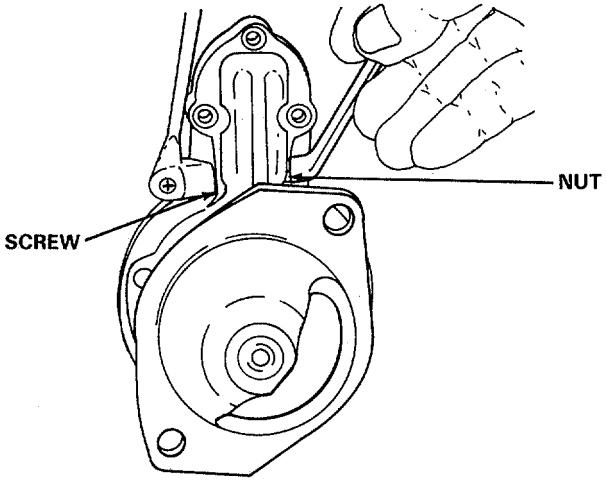


Step 12. Remove rubber pad from drive housing.



TA259583

Step 13. Remove nut and screw from drive housing holding pinion shift fork.

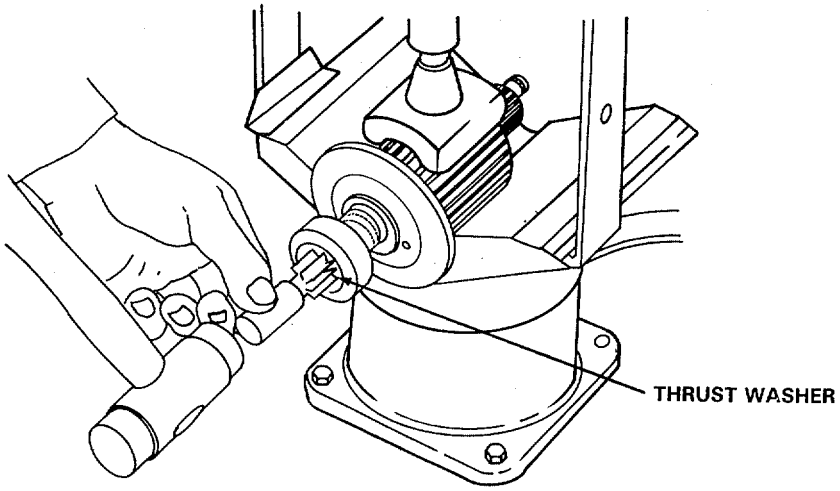


Step 14. Remove armature and shift lever fork from drive housing.
Step 15. Drive back thrust washer.

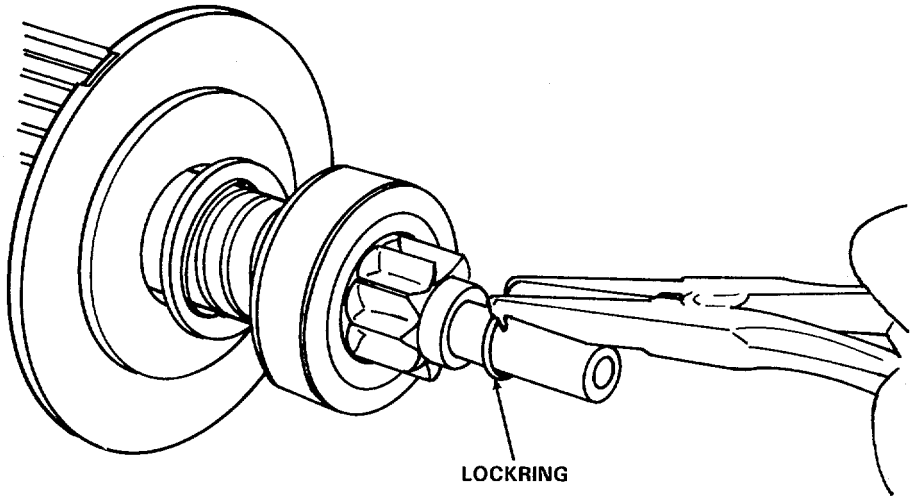
NOTE

Do not damage armature shaft bearing surfaces.

Step 16. Expand and remove lock ring.



TA259584



Step 17. Remove burrs from lock ring groove. Remove drive pinion thrust washer, plastic sleeve and bearing plate.

c. Inspection and Repair.

WARNING

Compressed air used for cleaning purposes will not exceed 30 psi. Use only with effective chip guarding and personal protective equipment {goggles/ shield, gloves, etc.).

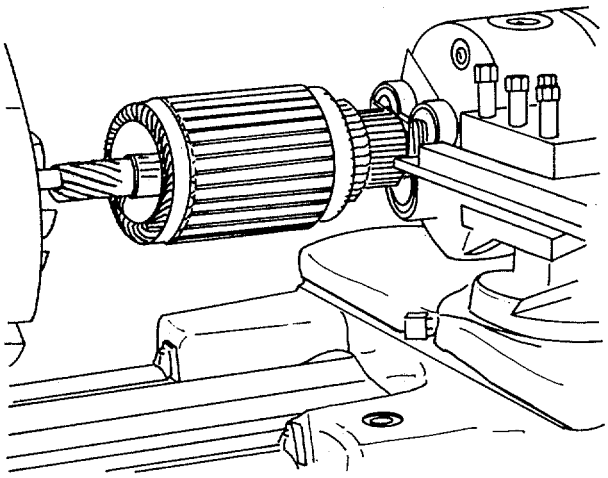
Step 1. Clean components and dry with low pressure compressed air.
Step 2. Inspect all components for damage. Replace defective or damaged components.

NOTE

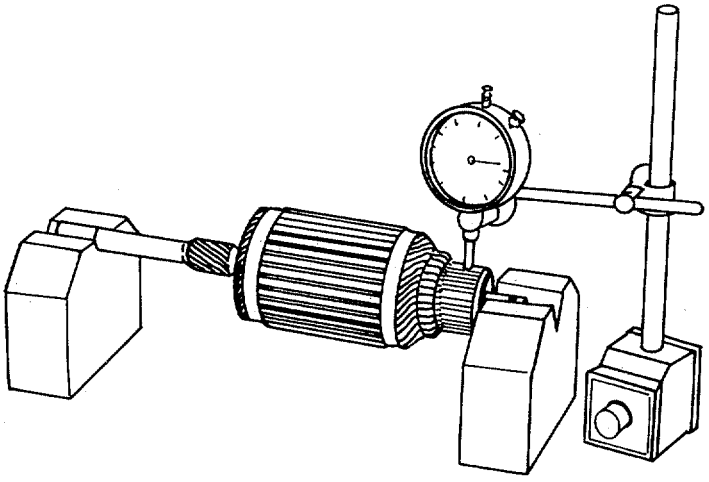
Burnt, scratched or unevenly worn commutators must be turned on a lathe, under cut and polished. Commutator diameter must not be less than 1.3189 in. (35.5 mm). Out of round can not exceed 0.0020 in. (0.05 mm).

TA259585

Step 3. Check diameter and out of round of commutator.



TURNING COMMUTATOR



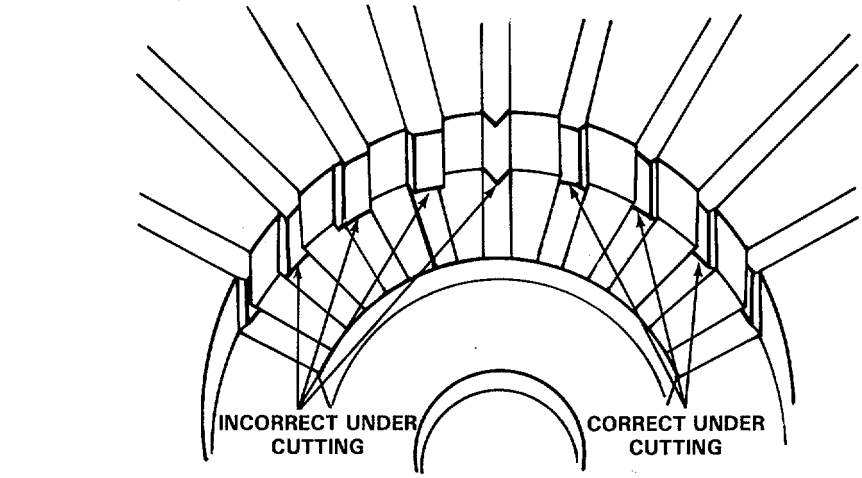
CHECKING OUT-OF-ROUND OF COMMUTATOR

NOTE

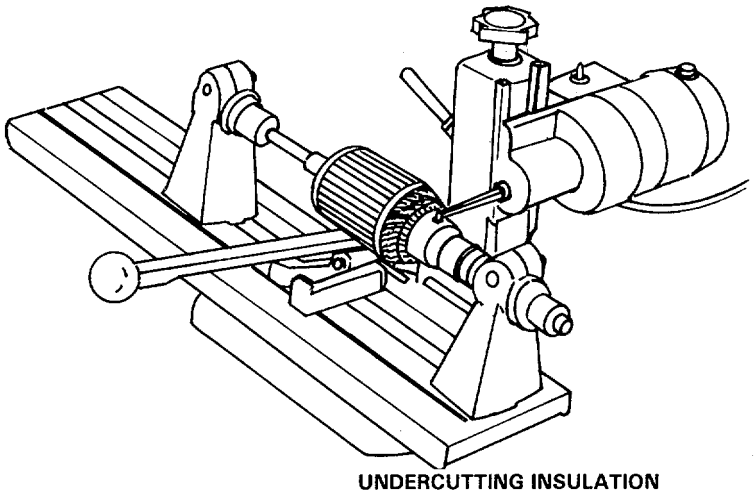
Under cutting commutator must not exceed 0.0197 to 0.0315 in. (0.5 to 0.8 mm).

TA259586

Step 4. Under cut commutator and polish with a fine abrasive paper.

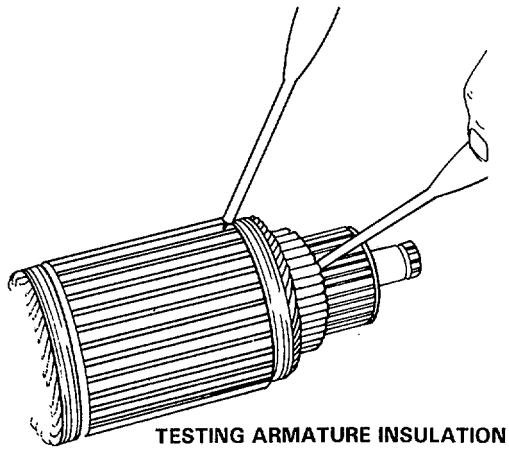


DEPTH OF COMMUTATOR GROOVES



UNDERCUTTING INSULATION

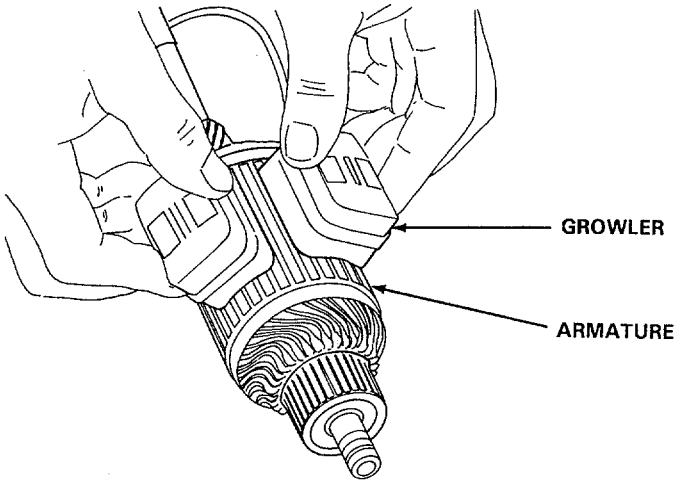
Step 5. Using a test lamp, check that insulation between armature and armature windings are intact.



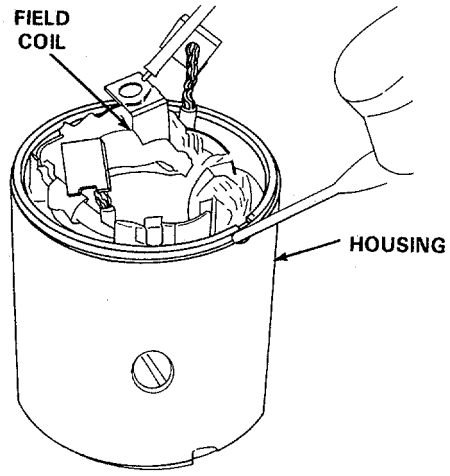
TESTING ARMATURE INSULATION

TA259587

Step 6. Using a growler, check armature.



Step 7. Using a test lamp, check that insulation between field coil and housing are intact.



TESTING FIELD COIL WINDING INSULATION

Step 8. Using a 6V test lamp, check field coil windings,

NOTE

Replace burnt or defective windings.

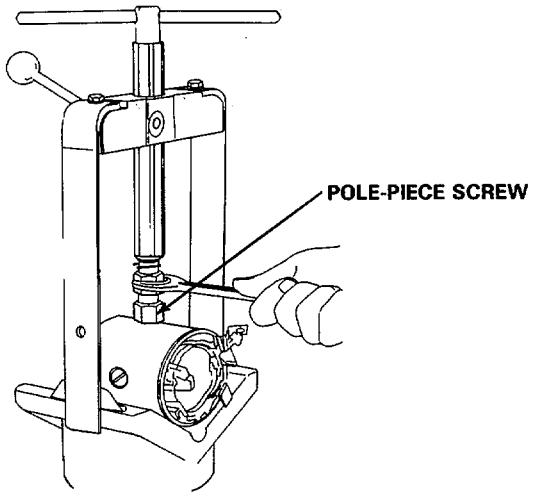
When replacing the field coil windings, all four coils must be replaced at the same time.

Step 9. Mark positions of the pole-pieces in the housing before disassembling.
Step 10. Place fabricated mandrel in field coil housing. Refer to table 2-2, item 6 for fabricated tools.

NOTE

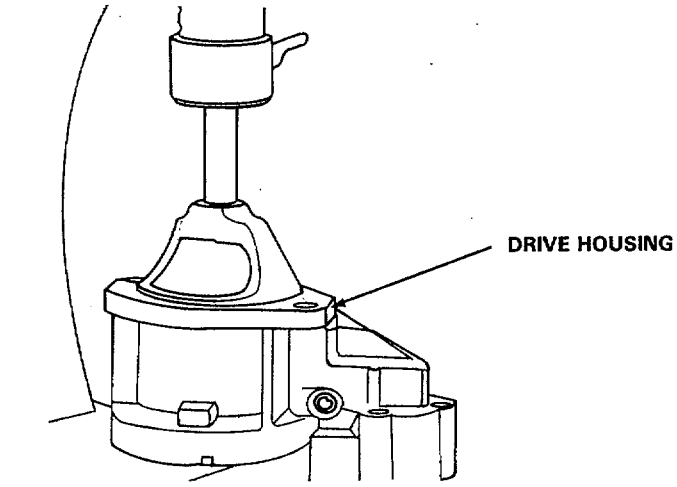
Use vise jaw caps when using a vise.

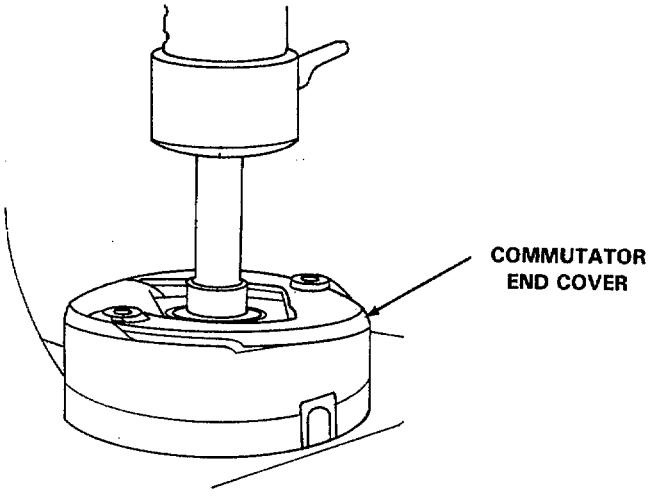
Step 11. Place field coil housing in a fixture or vise.
Step 12. Remove pole piece screws.



TA259589

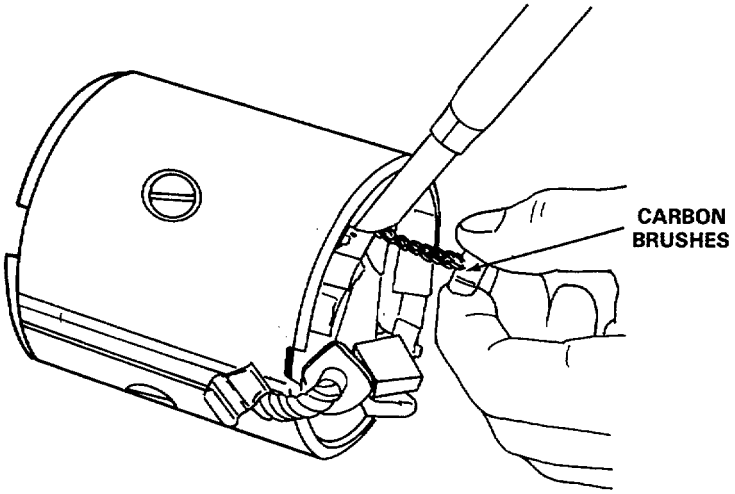
Step 13. Remove mandrel pole-pieces and coils from housing.
Step 14. Put new field coils in place in housing.
Step 15. Put pole piece in place. Put in screws and hand tighten.
Step 16. Put mandrel in place in housing.
Step 17. Tighten screws and remove mandrel.
Step 18. Soak bushings in a light weight oil at least 30 minutes before installing. All bushings must be replaced at the same time.
Step 19. Press out bushing from drive housing, bearing plate and commentator end cover.





TA259590

Step 20. Clean bushing seat.
Step 21. Press new oil-filled bushing in place in drive housing and commentator end cover.
Step 22. Remove two bushings from drive pinion gear.
Step 23. Clean bushing seats.
Step 24. Press new oil-filled bushings in place in drive pinion gear.
Step 25. Check drive pinions gear. The free-wheeling torque should be within 0.0052 to 0.0082 in. (0.14 to 0.22 mm).
Step 26. Unsolder and remove worn brushes.

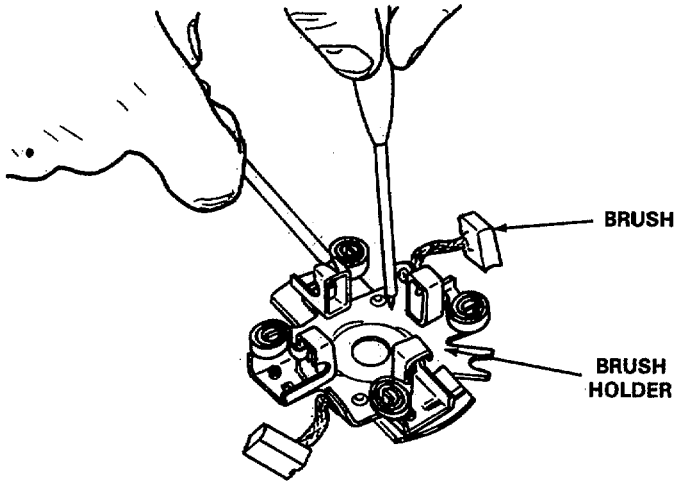


TA259591

NOTE

Do not allow solder to flow into brush leads.

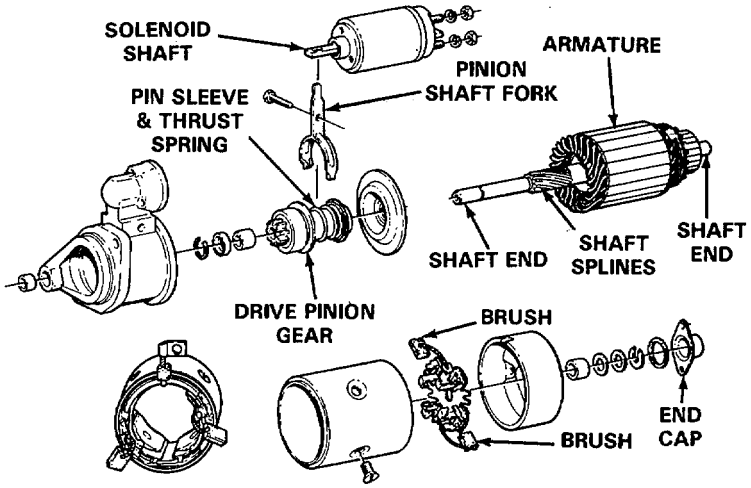
Step 27. Clean off plastic insulation from soldered joint of positive brushes.
Step 28. Solder new brushes in -place.
Step 29. Using test lamp, check that there are no shorts between insulated brush holders and holder plate.



TA259592

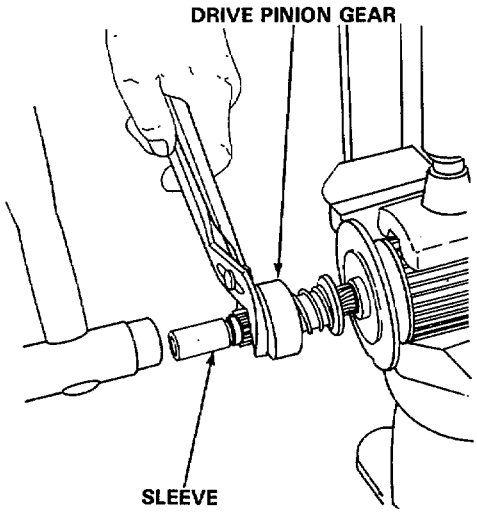
d. Starter Motor Lubrication.

Step 1. Lubricate starter before or during assembly. Care must be taken not to allow lubricants to come in contact with brushes or commentator.
Step 2. Apply a small amount of grease in end cap.
Step 3. Apply a thin coat of grease on washers and shaft end.
Step 4. Apply a thin coat of grease on pinion sleeve and thrust spring.
Step 5. Apply a thin coat of grease on shaft end and splines.
Step 6. Apply a thin coat of grease on fork joints.
Step 7. Apply a thin coat of grease on solenoid and return spring.



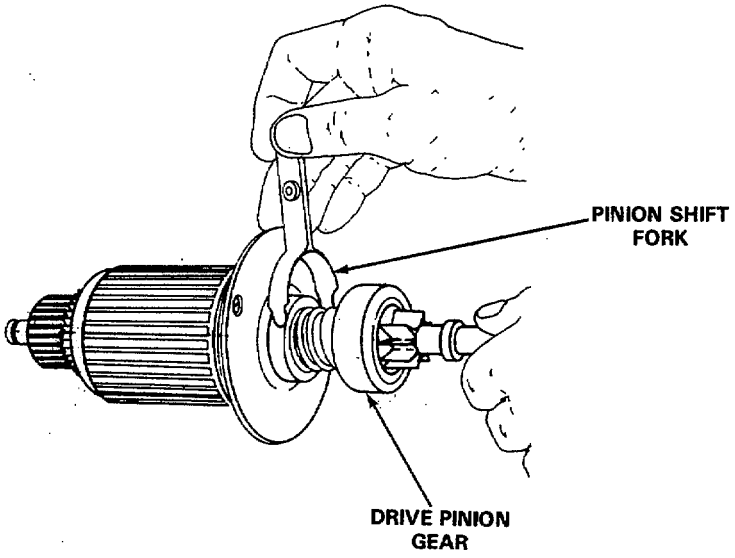
e. Assembly.

Step 1. Put bearing plate, plastic sleeve, drive pinion thrust washer and lock ring in place on armature shaft.
Step 2. Using a pair of pliers, compress lock ring to minimum diameter.
Step 3. Using a sleeve against the lock ring hold pinion firmly against the thrust washer. Turn pinion.
Step 4. Using a plastic hammer tap sleeve firmly. Seat lock ring in thrust washer.



TA259593

Step 5. Put pinion shift fork in place with-drive pinion gear.



Step 6. Put armature and pinion shift fork in drive housing.
Step 7. Put in screw holding pinion shift fork. Screw on nut and tighten nut.
Step 8. Put rubber pad in drive housing.
Step 9. Connect plunger to pinion shift fork.
Step 10. Put plunger return spring and solenoid on drive housing.
Step 11. Put in three screws and tighten screws.
Step 12. Put field coil housing in place.
Step 13. Put terminal screw in place and tighten screw.
Step 14. Put field coil strap and nut on solenoid terminal. Tighten nut.
Step 15. Put brush holder and brushes in place.
Step 16. Put on commentator end cover.
Step 17. Put in housing screws. Tighten nut.
Step 18. Put in place shims and thrust washer.
Step 19. Turn armature and check for binding.
Step 20. Check for play. Adjust clearance with shims. Clearance should be 0.0020 to 0.1 182 in. (0.05 to 0.3 mm).
Step 21. Put on end cap with preformed packing and two screws. Tighten screws.
Step 22. Test starter motor.

TA259594

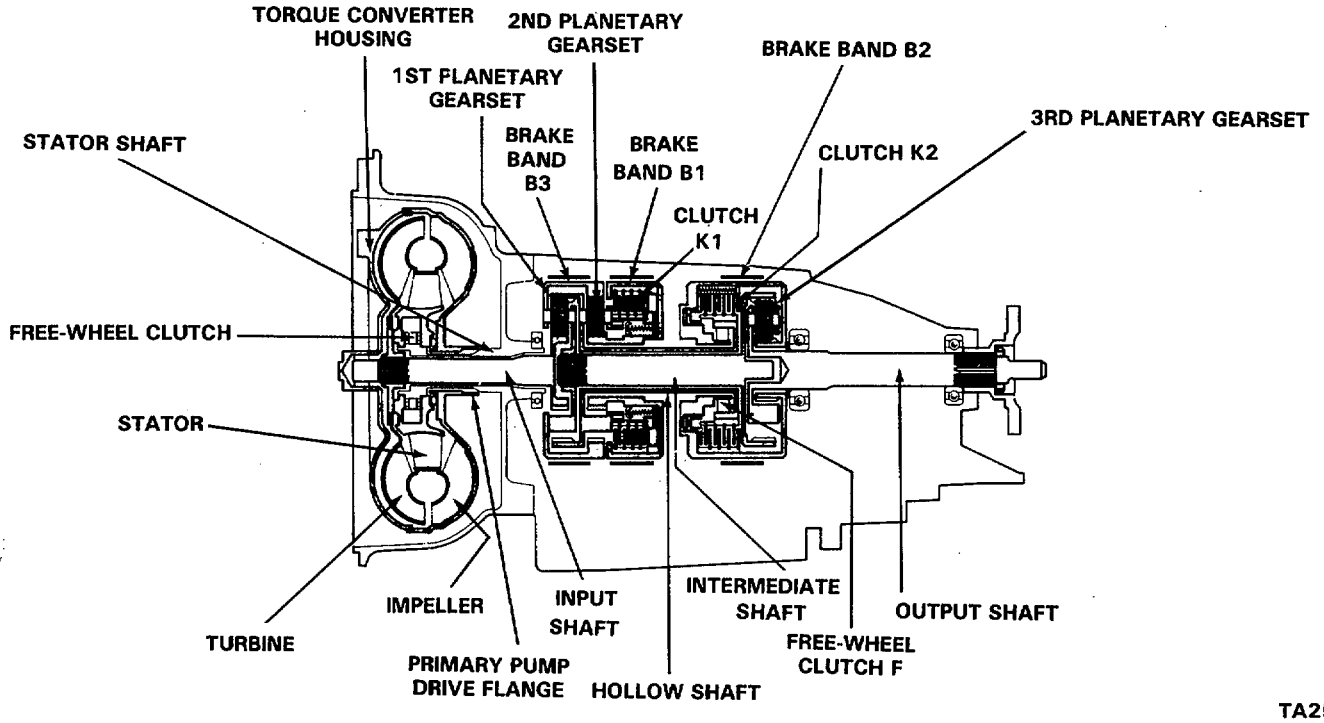
CHAPTER 7
REPAIR OF TORQUE CONVERTER AND TRANSMISSION

Section I DESCRIPTION AND DATA

7-1. DESCRIPTION

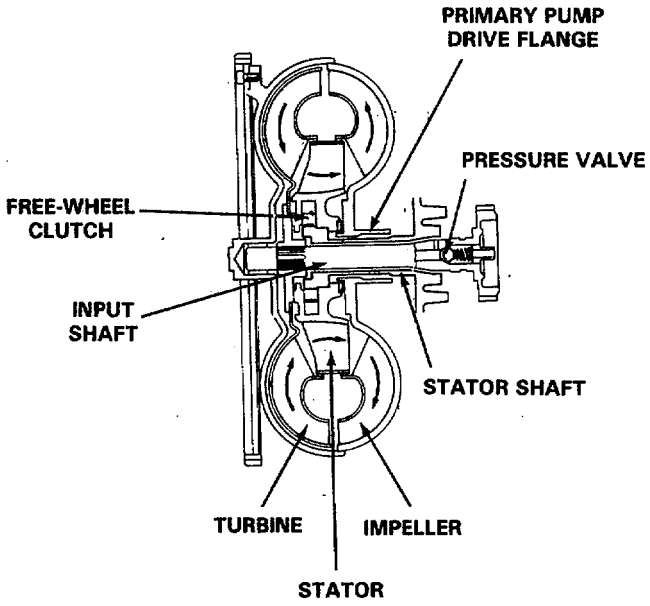
a. Transmission.

The transmission is fully automatic. It has five speeds (4-forward, 1-reverse) with a hydraulic torque converter. The transmission is divided into three housings: front housing, transmission housing and rear housing. The front housing contains the torque converter and the primary oil pump. The transmission housing contains the input shaft, intermediate and hollow intermediate shaft and the output shaft. In the transmission housing there are three sets of planetary gears, two disc clutches and three drums with brake bands. The rear housing contains a centrifugal governor, secondary oil pump and modulating pressure transmitter. A gear shift valve housing is an essential part of the hydraulic control system. The gear shift valve housing is located in the lower part of the transmission housing. Oil for the operation of the torque converter and the transmission is supplied by the primary oil pump. The pump is driven by the torque converter. The transmission oil is cooled by an oil cooler. The cooler is located under the engine. The transmission electric system consists of a start interlock, reverse lamp switch, first gear switch and solenoid valve. The start interlock switch prevents starting the engine when the gear selector is in any position except neutral (N). The reverse lamp switch activates the backup light when the gear selector is placed in reverse (R). A solenoid valve locks the transmission in first gear when the gear selector is placed in the 1 position.



b. Torque Converter.

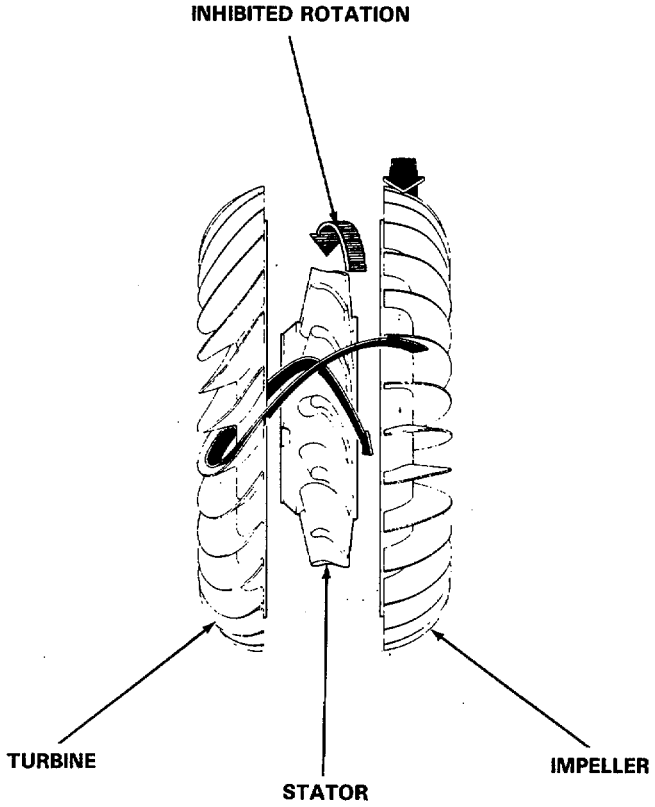
The torque converter consists of an impeller, turbine wheel and stator. The impeller is connected to the engine crankshaft by the torque converter housing. The turbine wheel is connected to the transmission input shaft. The stator connects to the transmission housing through a free wheel clutch and stator shaft. The torque converter is a self contained unit. Oil enters the torque converter between the stator shaft and the primary pump drive flange. The oil exits the converter through a channel in the input shaft and a pressure control valve which maintains pressure within the torque converter. The oil is cooled by the transmission oil cooler. The turbine rotates freely in the housing. The impeller rotates with the housing. The stator on the free wheel clutch prevents oil flow in the opposite direction of engine rotation. The blade of the turbine, impeller and stator are all curved and angled for minimum friction through turbulence.



TA259596

7-2. TORQUE CONVERTER FUNCTION.

The rotation of the impeller causes oil to flow outward between the impeller blade through centrifugal force. The mechanical energy from the engine is transmitted to the turbine by the force of the oil. At low speed, only the impeller rotates. Impelier speed increases as engine speed increases. The force of the oil coming off the impeller forces the turbine to start turning. The oil flow leaves the turbine and enters the stator where direction of flow changes to allow for easier entry back into the impeller. This causes an increase in torque. The output to input torque ratio at starting is 1.7:1. This ratio decreases as the turbine speed increases. The entry angle to the stator will also change as turbine speed increases. Oil flow now strikes the back of the stator blade, causing the stator to rotate in the same direction as the impeller and turbine. The input and output become the same. This occurs when turbine speed reaches 86 to 91 percent of impeller speed. Now the torque converter is functioning as a hydraulic coupling.



TA259597

7-3. TRANSMISSION FUNCTION.

a. Neutral.

The following components in the transmission are rigidly connected with each other:

(1) Torque converter turbine, transmission input shaft and first planetary sun gear.

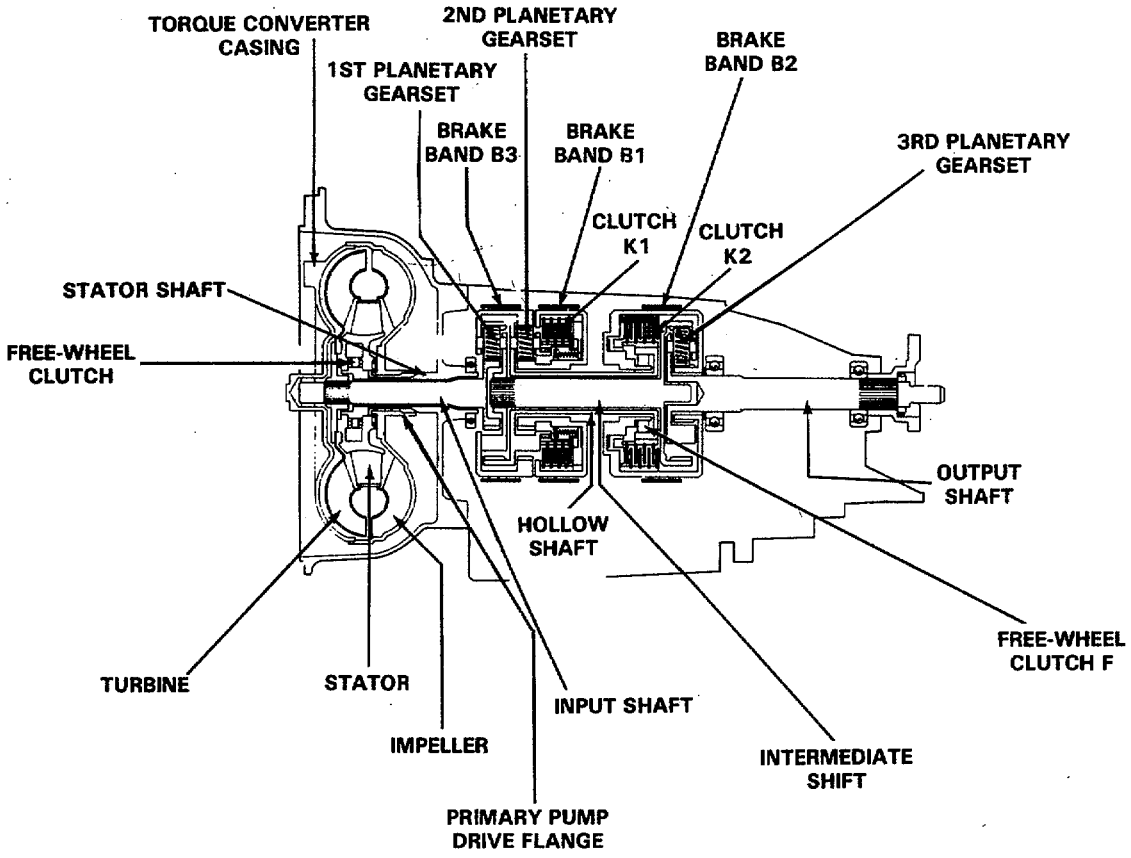
(2) B3 brake drum, second planetary ring gear, first planetary carrier, transmission intermediate shaft and third planetary ring gear.

(3) First planetary ring gear, second planetary carrier, K1 clutch inner disc carrier, hollow intermediate shaft, free wheel clutch outer race and K2 clutch inner disc carrier.

(4) B1 brake drum, K1 clutch outer disc carrier and second planetary sun gear.

(5) B2 brake drum, K2 clutch outer disc carrier, free wheel clutch inner race, and third planetary sun gear.

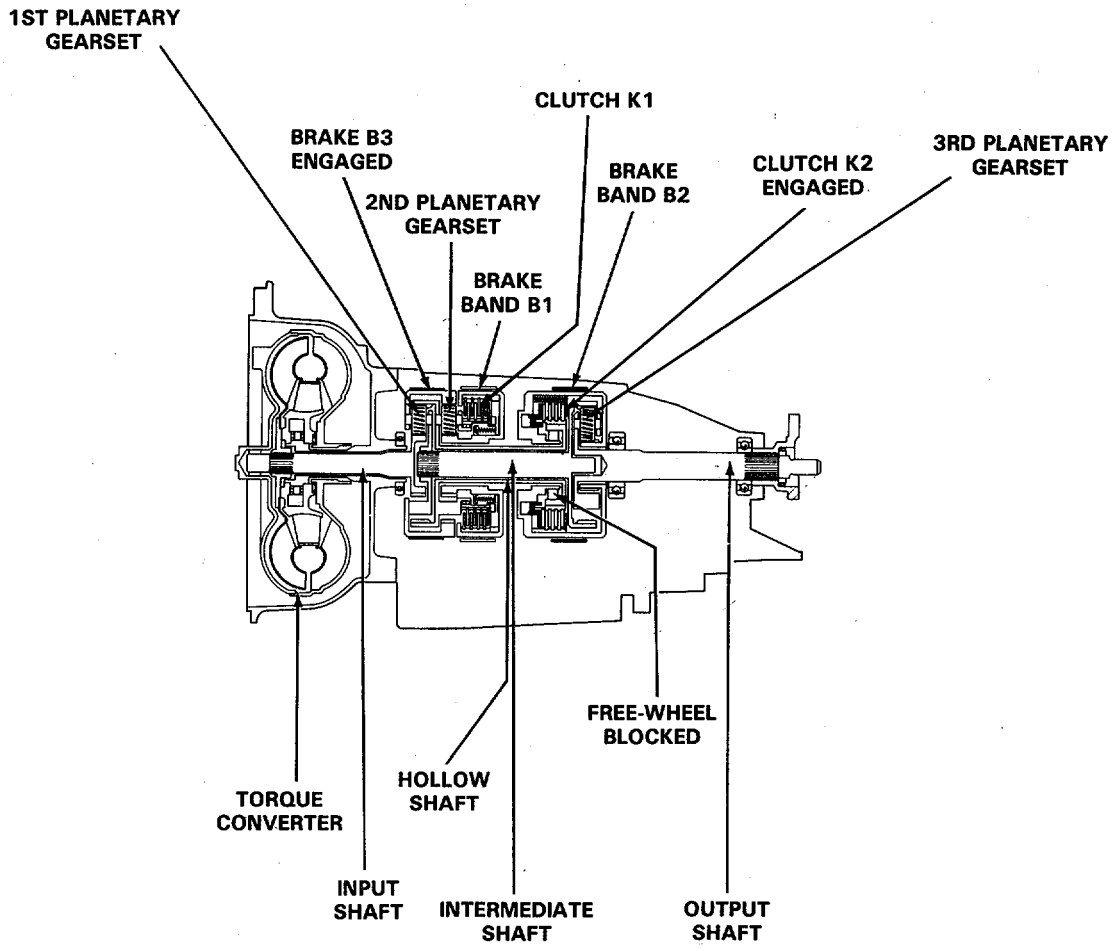
(6) Third planetary carrier and transmission output shaft.



TA259598

b. Reverse.

When the transmission is in reverse, B3 brake and K2 clutch are engaged. B3 brake band locks the first planetary carrier and through the intermediate shaft it also locks the third planetary ring gear. With first planetary carrier locked, the first planetary sun gear, through the planetary gears, drives the first planetary ring gear in reverse direction. The reduction ratio of the first planetary gear set is 1.734:1. The hollow shaft connected to first planetary ring gear is also turning in reverse. This drives the third planetary sun gear through K2 clutch. The third planetary ring gear is locked by B3 brake band. The intermediate shaft and the first planetary gear carrier rotates in reverse direction. The reduction ratio of the third planetary gears is 3.1 7:1. Total reduction ratio in reverse gear is 1.734 x 3.1 7 = 5.495:1.



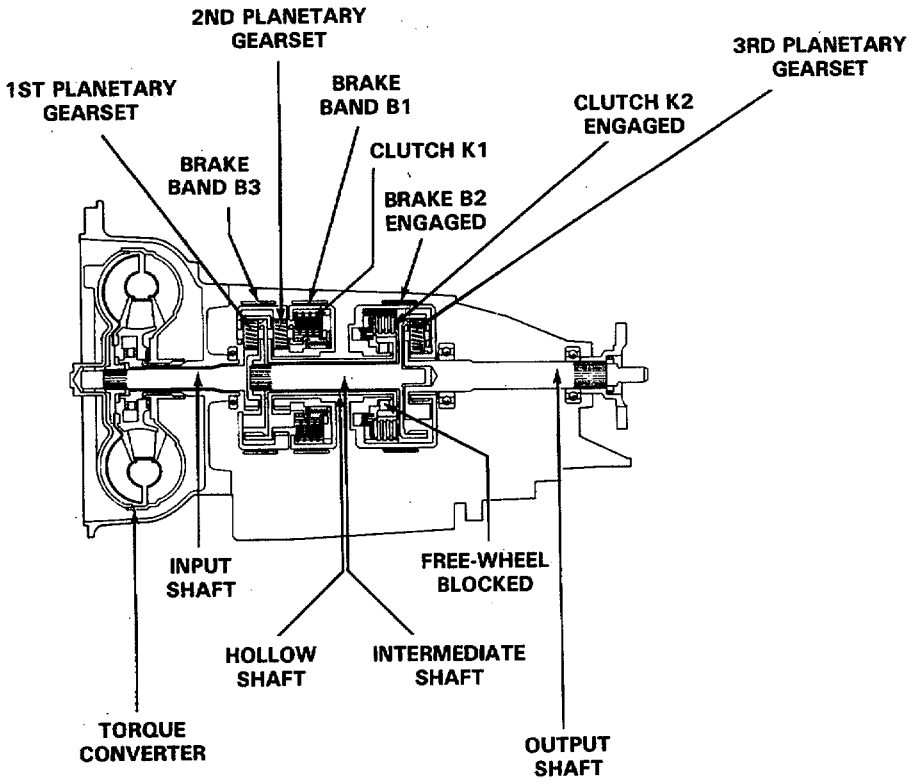
REVERSE SPEED ENGAGED

TA259599

c. First Gear.

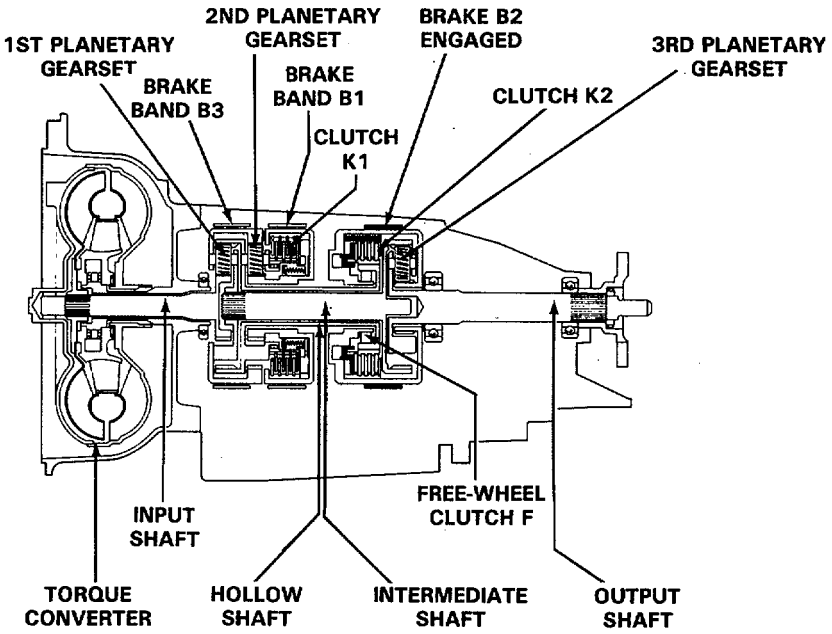
B2 brake band and K2 clutch are engaged. The hollow shaft clutch K2 and the free wheel clutch lock the first planetary ring gear. The free wheel clutch and clutch K2 are locked against the B2 brake drum which is held by B2 brake band. The first planetary gear carrier turns in the ring gear. It turns in the same direction being driven by the planetary gears. The planetary gears are driven by the first planetary sun gear. Ratio in the first planetary gear set is 2.734:1.

The intermediate shaft connects the third planetary ring gear to the first planetary gear carrier. The third planetary ring gear is driven at the same speed as the first planetary gears. The third planetary ring gear drives the third planetary gear carrier. As the carrier rotates, the planetary gear turns on the stationary sun gear and drives the output shaft in the same direction. Reduction ratio of the third planetary gear set is 1.463:1. Total reduction in first gear is 2.734 x 1.463 = 4.007:1.



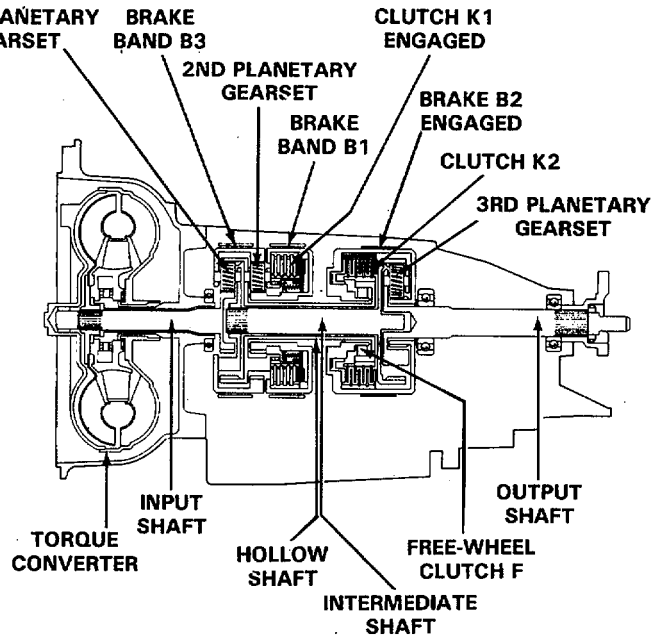
d. Second Gear.

B1 brake band and B2 brake band are engaged. Engagement of B1 brake band reduces the transmission ratio in the first planetary gear set. B1 brake band locks the second planetary sun gear. The second planetary ring gear is driven by the first planetary gear carrier. The second planetary gears react against the locked sun gear. This drives the first planetary ring gear in the direction of rotation by way of the planetary gear carrier. The first planetary gear carrier will accelerate in relation to first gear and will reduce the reduction ratio from 2.734 to 1.635:1. Reduction ratio in first and second planetary gear set is 1.635:1. Reduction ratio in third planetary gear set is 1.463:1. Total reduction ratio in second gear is 1.635 x 1.463 = 2.392:1.



e. Third Gear.

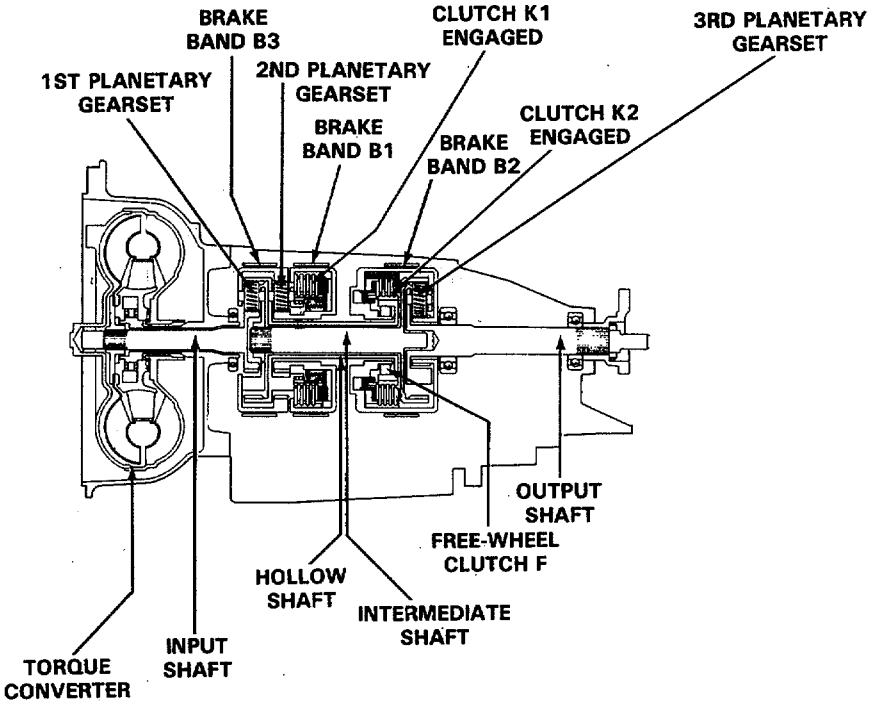
B2 brake band and Kl clutch are engaged. The second planetary sun gear and gear carrier are locked together by the outer and inner disc carriers of the K1 clutch. The second planetary gear set rotates as a unit. The second planetary ring gear connects to first planetary gear carrier. The first planetary ring gear is connected to the second planetary gear carrier. Both first and second planetary gear sets will rotate as a unit. There is no reduction in the first and second planetary gear sets. The input shaft and the intermediate shaft rotate at the same speed. The reduction and the power transmission is controlled by the intermediate shaft and the third planetary ring gear. Total reduction ratio in third gear is 1.463:1.



TA259601

f. Fourth Gear.

K1 clutch and K2 clutch are engaged. The third planetary sun gear is locked to the hollow shaft by the outer and inner disc carriers of K2 clutch. The hollow shaft rotates at input speed in third gear and continues to do so in fourth gear. The hollow shaft drives third planetary sun gear by way of K2 clutch and free wheel clutch. All the planetary gear set from input shaft to output shaft is rotating at engine speed. Total reduction ratio in fourth gear is 1:1.



7-4. TRANSMISSION OIL FILTER.

The pump draws oil through a fine filter located in the oil sump. If the filter becomes clogged, the oil is diverted through a bypass valve and a strainer.

7-5. OIL PUMPS DESCRIPTION AND FUNCTION.

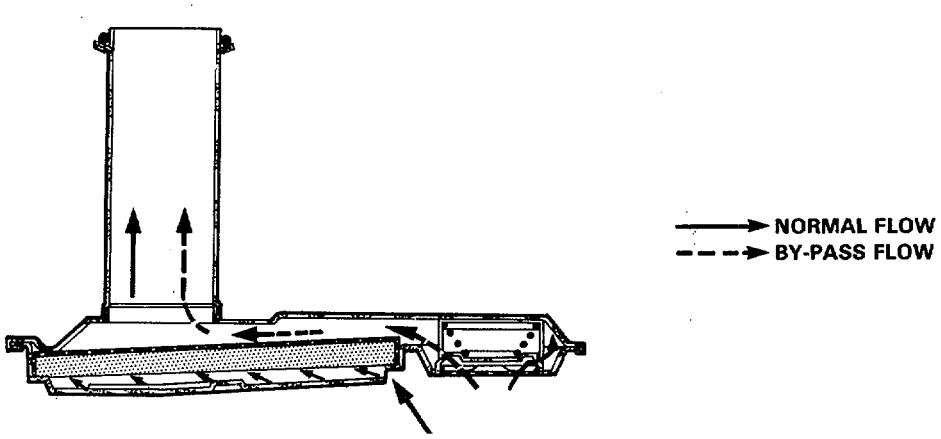
a. Description.

The transmission has two oil pumps, a primary and a secondary pump. The primary pump is a gear type pump with internal teeth. It is located in the transmission front housing. The primary pump is driven by the torque converter and supplies oil whenever the engine is running. The primary pump supplies the oil necessary to lubricate the transmission. It supplies oil pressure for the operation of the gear shifting parts. The secondary pump is a piston type pump located in the rear transmission housing. The secondary pump is driven by the transmission output shaft. The secondary pump will only deliver oil when the primary pump output pressure is too low.

TA259602

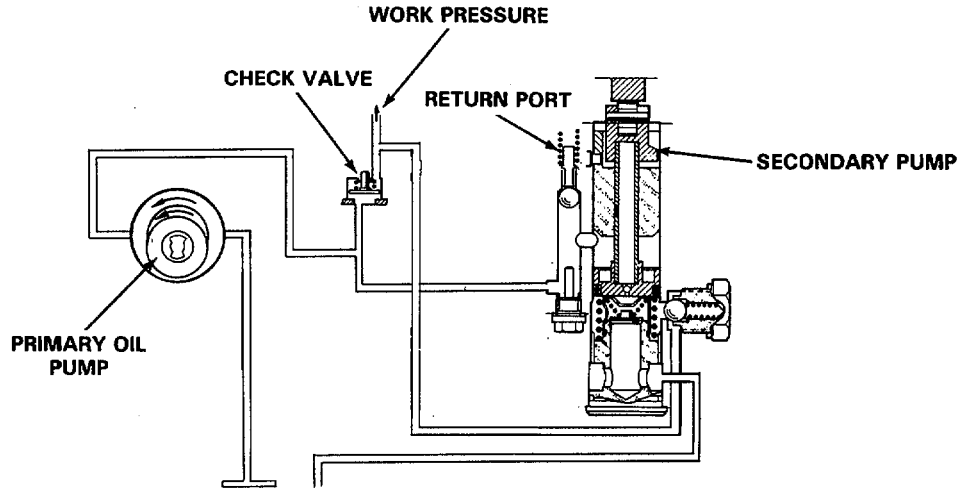
b. Function.

The oil is drawn through the fine filter in the oil sump. From the discharge side of the primary pump, the oil flows through a check valve to working pressure control valve. The oil also flows to the secondary pump piston. The secondary pump piston is forced downward against a thrust spring. The secondary pump piston rod is lifted free of the output shaft cam and the secondary pump can not operate.



FILTER

If the primary pump output pressure becomes too low, the thrust spring will push the secondary pump piston upward. The piston rod will now make contact with output shaft cam. The check valve will close, preventing pressure in the system from escaping through the primary pump. Now, when the vehicle is driven, oil will be supplied by the secondary pump.



TA259603

7-6. SUPPLY AND CONTROL OF TRANSMISSION HYDRAULIC PRESSURES.

Controlling the transmission hydraulic pressure and moving the shifting parts requires the following pressures:

Working pressure
Reduced working pressure
Lubricating pressure
Modulating pressure
Control pressure
Increased governor pressure
Governor pressure

a. Working Pressure.

The working pressure applies the brake bands and clutches.

Control is effected by the control valve working pressure.

Working pressure is set to its lowest value when the control valve piston moves to the left hand stop. The basic pressure control spring will then set the idle speed working pressure.

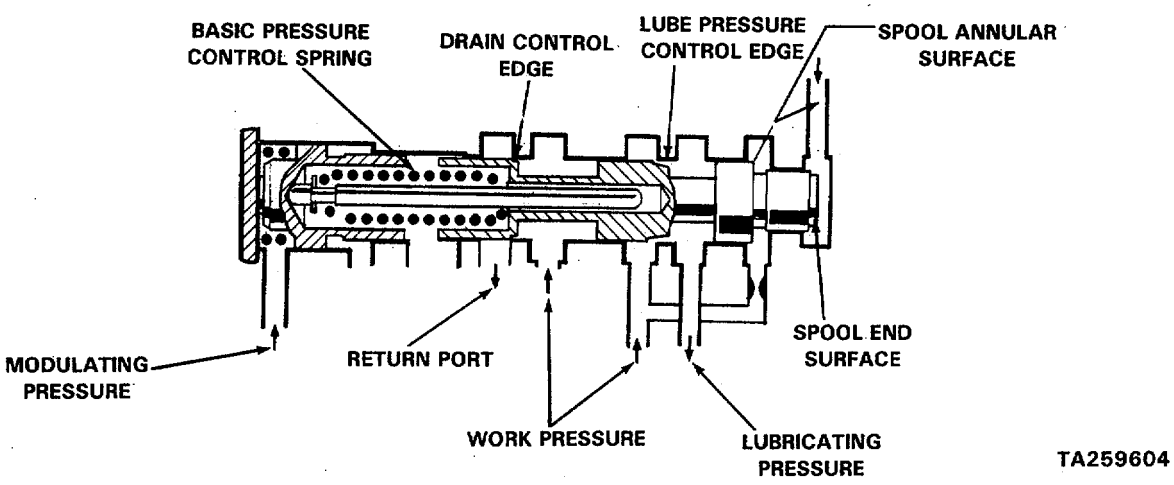
When the engine is at partial to full throttle, working pressure is determined by the applied modulating pressure. The modulated pressure is applied from the left opposite the working pressure. The working pressure acts against the spool and surface and the spool annular surface.

In first and reverse gear, working pressure acts against the annular surface, so that a high pressure is applied.

WORKING PRESSURE CONTROL

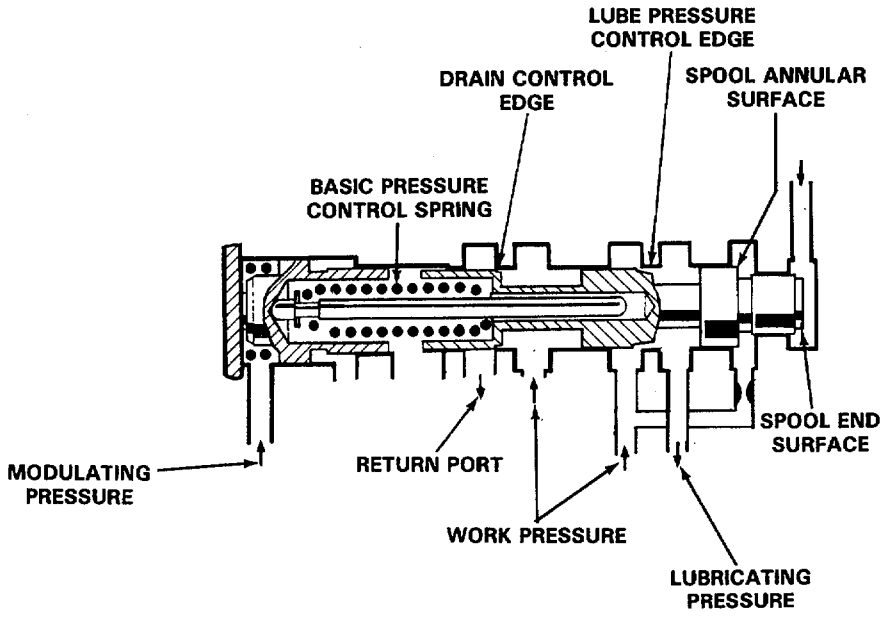
low modulating pressure - low working pressure
high modulating pressure - high working pressure.

Surplus oil will first flow along lube pressure control edge into the lube pressure system.
Surplus oil will then flow along the drain control edge back into the oil pan.



b. Lubricating Pressure.

The oil flows along lube pressure control edge. The oil then moves through the oil cooler and torque converter into the input shaft. Oil from the input shaft lubricates the mechanical section of the transmission.



TA259605

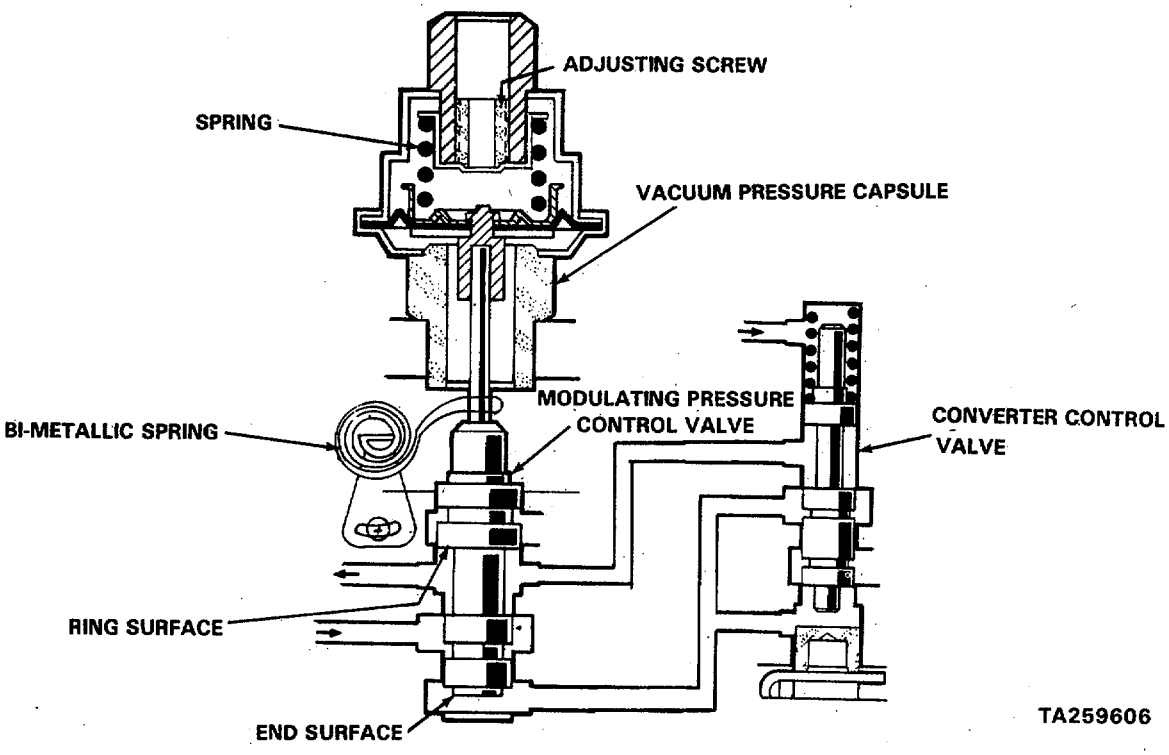
c. Modulating Pressure.

The modulating pressure controls and modifies the work pressure according to the needs of the transmission. This occurs throughout the entire range, from idle to full throttle. The modulating pressure is derived from the work pressure and is controlled by the modulating pressure control valve, converter control valve and vacuum capsule. The resulting pressure is a function of the vacuum control valve and is dependent on engine speed.
The spring in the modulating pressure control valve forces the valve spool downward to the open position. Vacuum is admitted into the spring chamber of the vacuum capsule. The vacuum and modulating pressure act upon the ring surface and the end surface to oppose the thrust of the spring. The increased modulating pressure forces the control valve spool upward. Partially opening the valve spill port. The vacuum in the vacuum capsule opposes the spring thrust and reduces the controlled modulating pressure.

High, vacuum, low engine torque = low modulating pressure.
Low vacuum, high engine torque = high modulating pressure.

The torque increase produced by the torque converter in the engine low speed range calls for an increase of the modulating or work pressure. During starting the converter control valve reduces pressure acting on the end surface. When the pressure on the end surface is low, the modulating pressure on the ring surface is proportionally high. At approximately 12 MPH (20 Km/h) the speed dependent governor pressure is high enough to move the spool in the converter control valve to the bottom position. The pressure on the end surface and ring surface is now the same. The modulating pressure can be adjusted with an adjusting screw in the vacuum pressure capsule.

A bimetal spring causes the modulating pressure control valve to adjust modulating and work pressures to the temperature of the oil. High oil temperature gives an increase-in modulating and work pressures.

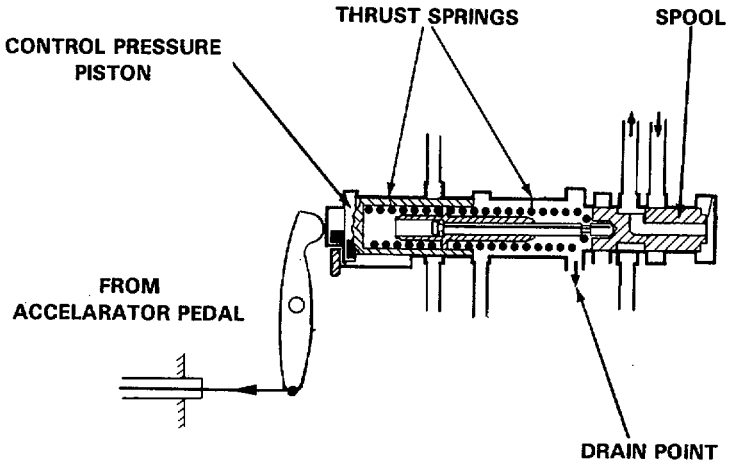


d. Control Pressure.

Control pressure is used for actuating control valves against governor pressure to modify gear- shift points. Control pressure is taken from the modulating pressure and is controlled by a control-pressure control valve. The control-pressure control valve is held in the open position by springs. Modulating pressure passes through the control-pressure control valve. Increasing control pressure forces the spool against the spring into a control position and oil supply is reduced. The thrust of the spring is controlled by the accelerator pedal through the control pressure linkage. Increasing the throttle opening increased oil supply and reducing throttle opens the valve drain port.

Idle speed, low spring thrust = low control pressure
Full speed, high spring thrust = high control pressure

At full speed the control pressure equals modulating pressure.



TA259607

e. Governor Pressure.

The governor pressure is diverted from the working pressure. The governor pressure is con- trolled by, the centrifugal governor, depending on the vehicle speed.

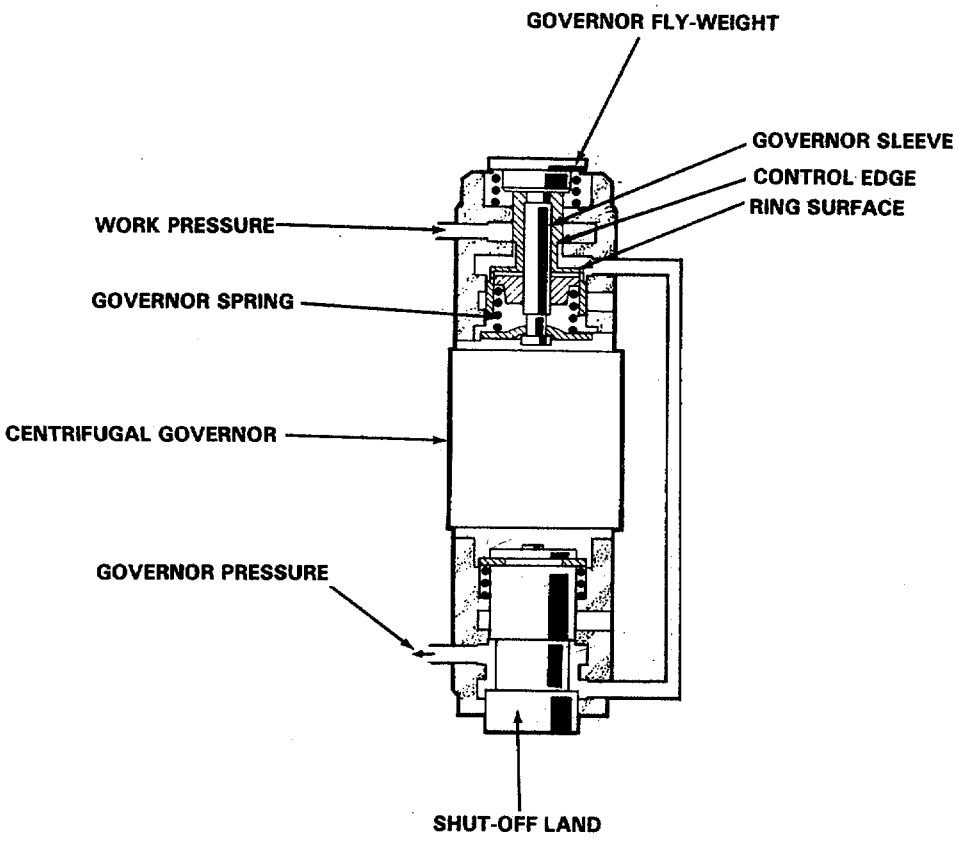
The governor pressure is regulated at the control edge, depending on the centrifugal forces at the governor sleeve, the governor spring and the flyweight.

The governor pressure against the ring surface acts against the centrifugal force. The governor pressure will keep sleeve in regulating position.

This means:
low speed -- low governor pressure
high speed -- high governor pressure

The shut off land opens the connection to the-governor pressure system at approximately 2 mph (3.5 km/h), and closes the connection again below 1 mph (2 km/h).

The opening and closing points depend on the centrifugal forces, and upon closing in addition on the pressure.



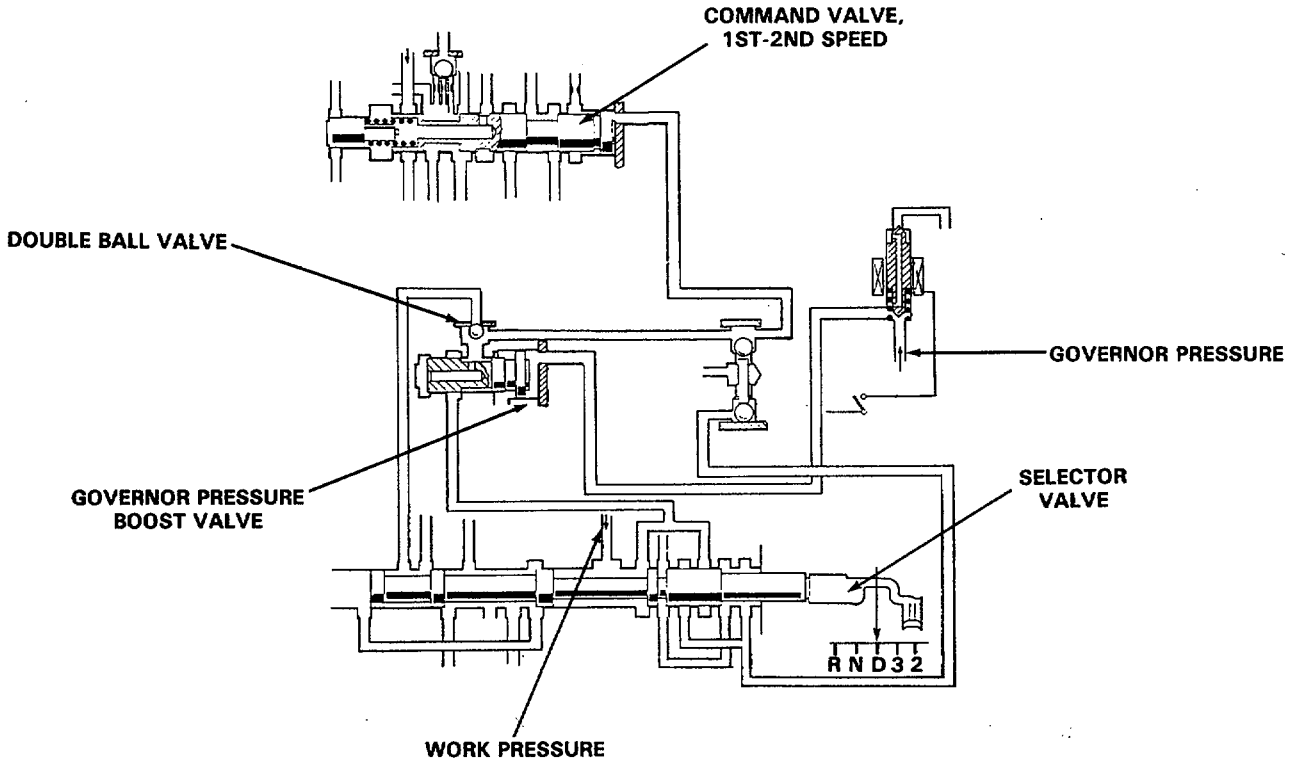
TA259608

f. Increased Governor Pressure.

The increased governor pressure is diverted from the working pressure. Increased governor pressure is regulated at the booster valve governor pressure.

The booster valve governor pressure is forced to the left by the force of spring and governor pressure. As a result, working pressure will flow through the now open connection into the higher governor pressure system and through the radial bore to the lefthand end of the booster valve governor pressure. The increasing high governor pressure forces valve into the regulating position. The oil inflow will be throttled as required, or the zero outflow will be opened in the event of pressure reduction.

The higher governor pressure depends on the governor pressure, and forces the command valve from 1st gear into 2nd gear.



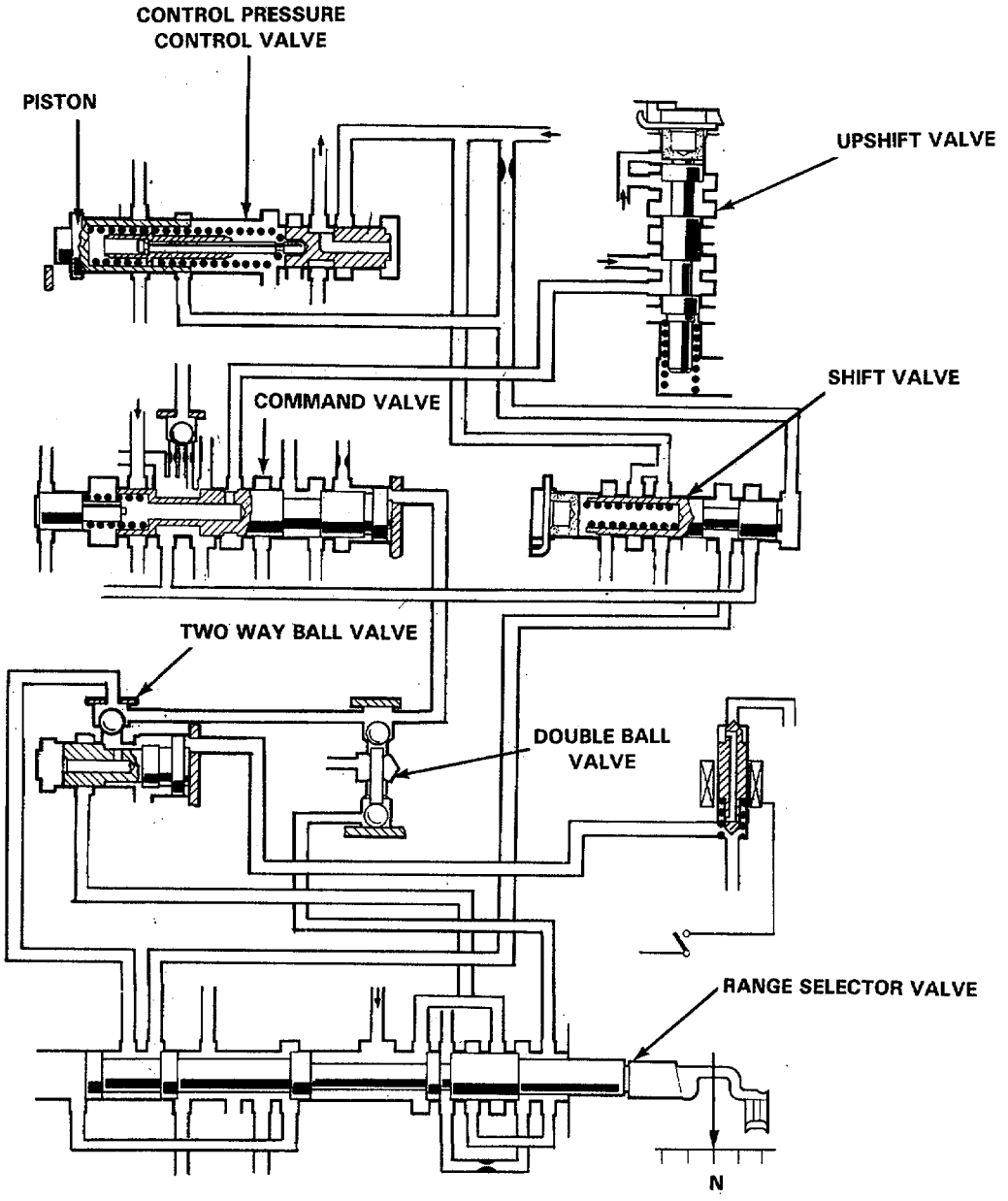
TA259609

(1) Downshift 2nd to 1st.

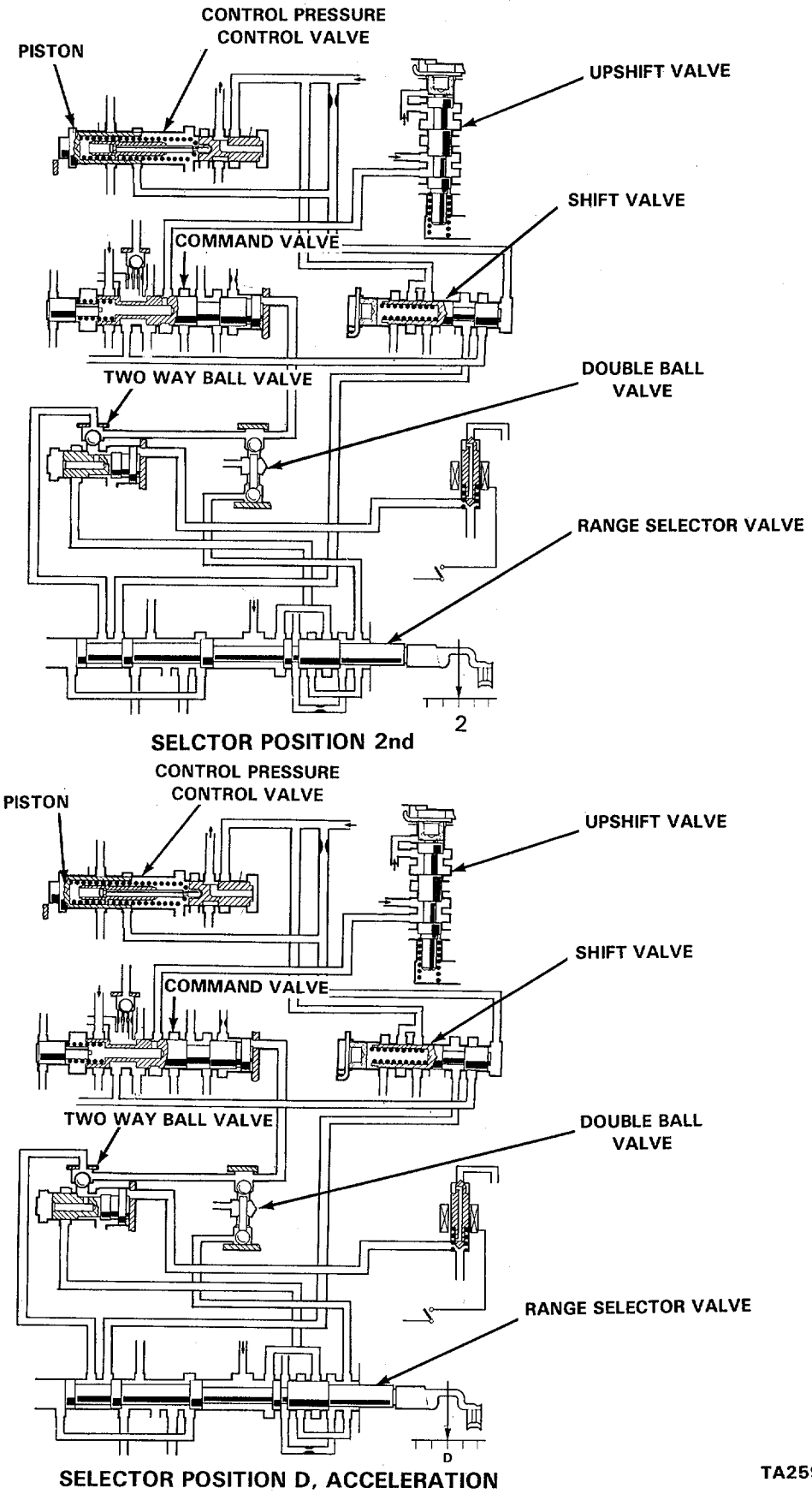
Gear selector lever in D or 3 position the vehicle starts in 2nd and downshifts into 1st when accelerating and loading the engine. The control pressure linkage shifts. The-piston to the right, blocking modulating pressure to the drain port. The build-up of modulating pressure forces the shift valve to the left, closing the work pressure supply line and discharging the end of the command valve. The spring forces the command valve into position for 1st gear.

(2) Starting off in 1st or 2nd

The vehicle starts in 1st. The working pressure acting on the command valve is drained through the range selector valve.



SELECTOR POSITION N, IDLING TA259610



SELECTOR POSITION D. ACCELERATION

7-7. FUNCTION OF COMMAND VALVES.

a. General.

Command valves serve the purpose of initiating the gearshifts. The following command valves apply:

Command valve	
No. 20	1-2-1
No. 7	2-3-2
No. 14	3-4-3

The function of all command valves is the same in principle. The function is explained below with regard to command valve 14.

In the starting position, the command valve is held in the position of the lower gear by force of the righthand spring and righthand control pressure.

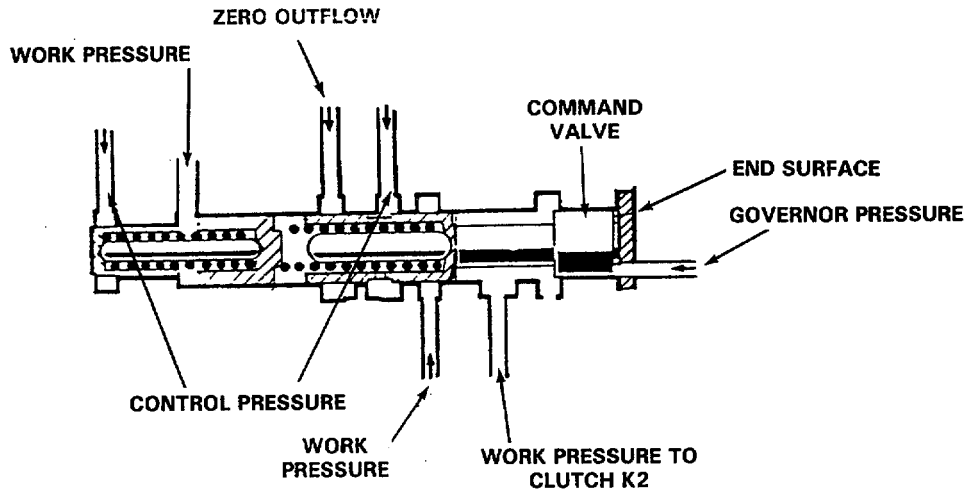
At increasing driving speed, the governor pressure against the end surface increases. The governor pressure pushes the command valve initially and slowly to the left. As soon as the recess on the command valve releases the connection zero outflow, the control pressure in the spring chamber is quickly reduced via the radial bore. A power surplus from direction of governor pressure end will occur. The command valve will snap into the position of the higher speed.

The snap effect during the downshift is obtained by the control pressure entering the righthand spring chamber. The initiating move to the command valve against the governor pressure depends on the driving condition.

- at partial throttle, through the force of the righthand spring.

- during full throttle downshifts, through the force of the control pressure at the lefthand piston.

The command valves operate in 'association with shifting and releasing valves. The valves are controlled by the filling pressure of the clutches and will apply or release the brake bands.

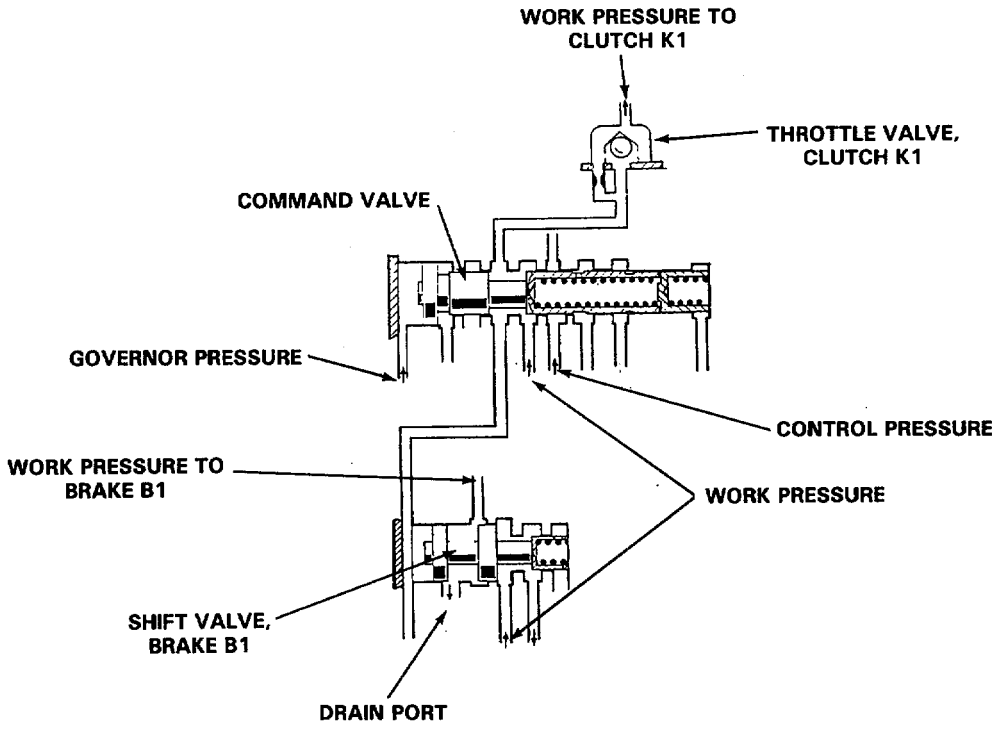


b. Command Valve (Upshifts and Downshifts).

(1) Upshift 2nd to 3rd: Clutch K1 must be applied and brake B1 must be released.

The governor pressure forces the command valve into the position of the higher speed. Working pressure will flow through one- way throttle valve toward K1 and to the left of shift valve.

As soon as clutch K1 is positively connected, the shift valve will change over brake band B1. The shift valve will connect the shifting end of brake band B1 to the zero outflow. The clutch filling pressure has to overcome the spring and the working pressure acting against the differential surface of the shift valve brake band.

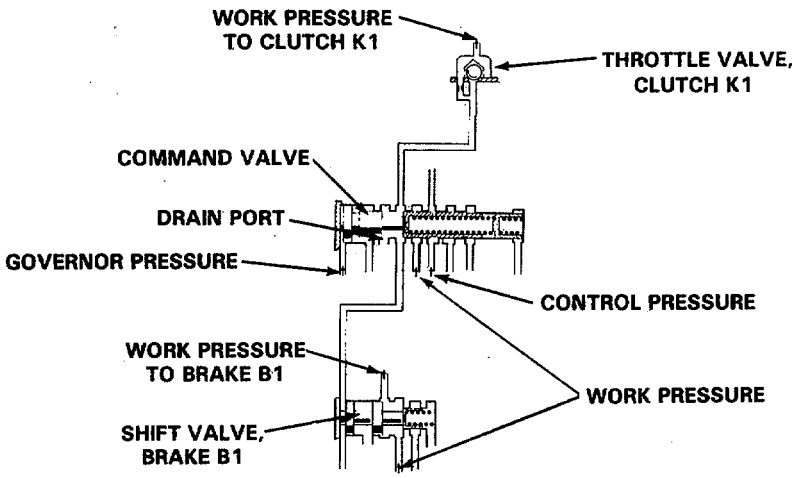


(2) Downshift 3rd to 2nd: Brake band B1 must be applied and clutch K1 must be released.

The command valve moves to the left into the position of the lower speed.

Clutch K1 and the lefthand end of the shift valve brake B1 is connected to drain port. Clutch K1 will slowly discharge through a throttle bore at one-way throttle valve. The shift valve brake B1 is pushed to the left by the spring and the working pressure. The shifting end of brake band B1 is provided with working pressure.

Brake band B1 will be positively connected upon closing of reaction valve or at synchronous speed.



c. Command Valve 14 (Upshifts and Downshifts).

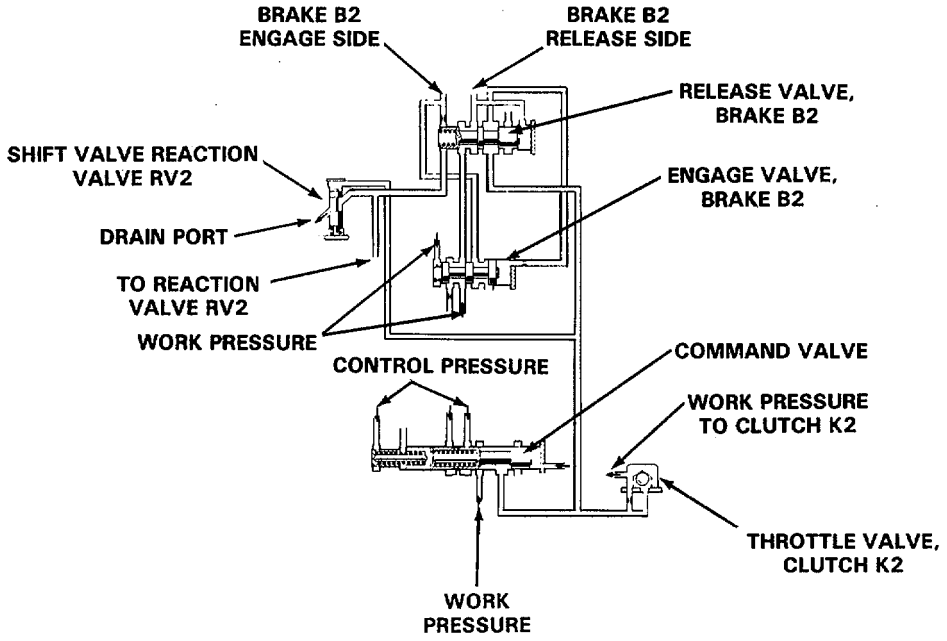
(1) Upshifts 3rd to 4th: For this gearshift, the clutch K2 must be applied and brake band B2 must be released.

The governor pressure forces the command valve into the position of the higher speed.

Working pressure will then flow through one-way throttle valve to clutch K2 and via a branch connection toward releasing end of brake band B2. Working pressure will also flow toward flat surfaces of shift valves, release valve and engage valve.

The clutch filling pressure will first force the shift valve releasing end downwards, discharging reaction valve RV2. The release valve brake band B2 will move to the left. Release valve brake band B2 provide full working pressure against releasing piston end of brake band B2. As soon as clutch K2 is positively connected, the engage valve brake band B2 will change-over and connect the shifting end of brake band B2 to the zero outflow.

The clutch filling pressure has to overcome the spring force at the left and the working pressure at engage valve, brake band B2.

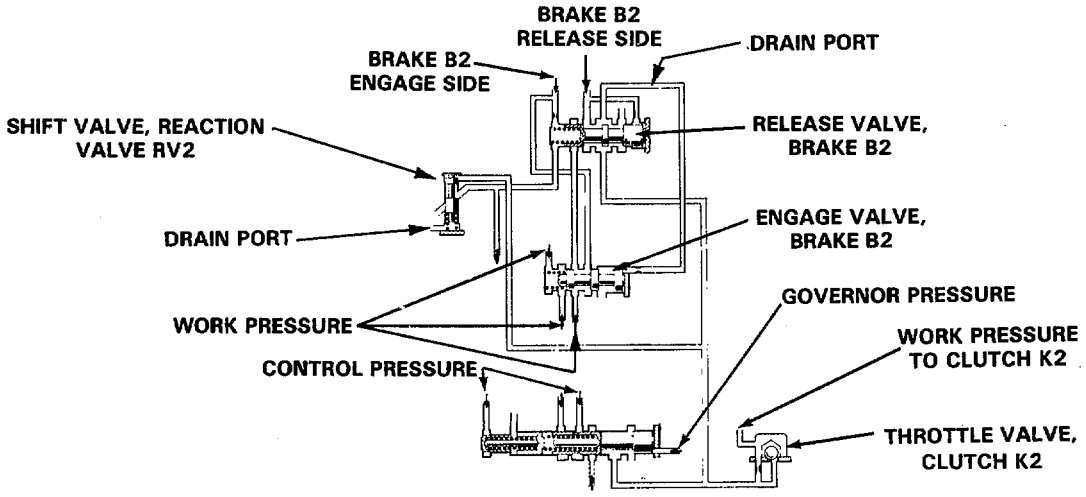


(2) Downshifts 4th to 3rd: For this gearshift, the brake band B2 must be applied and clutch K2 must be released.

Command valve is pushed back into starting position and opens the zero outflow.

The flat surfaces of the shift valve releasing end brake, and the engage valve brake B2 lose pressure. The spring force pushes the shift valve releasing end brake band B2 into the other end position and closes the zero outflow. The engage valve brake B2 moves to the right. Working pressure flows toward shifting end of brake band piston of brake band B2. Clutch K2 slowly discharges at one-way throttle valve of clutch K2.

When the reaction valve closes, the release valve of brake band B2 is pushed to the right. The releasing end of brake band B2 connects to zero outflow. The brake band is fully applied.



TA259615

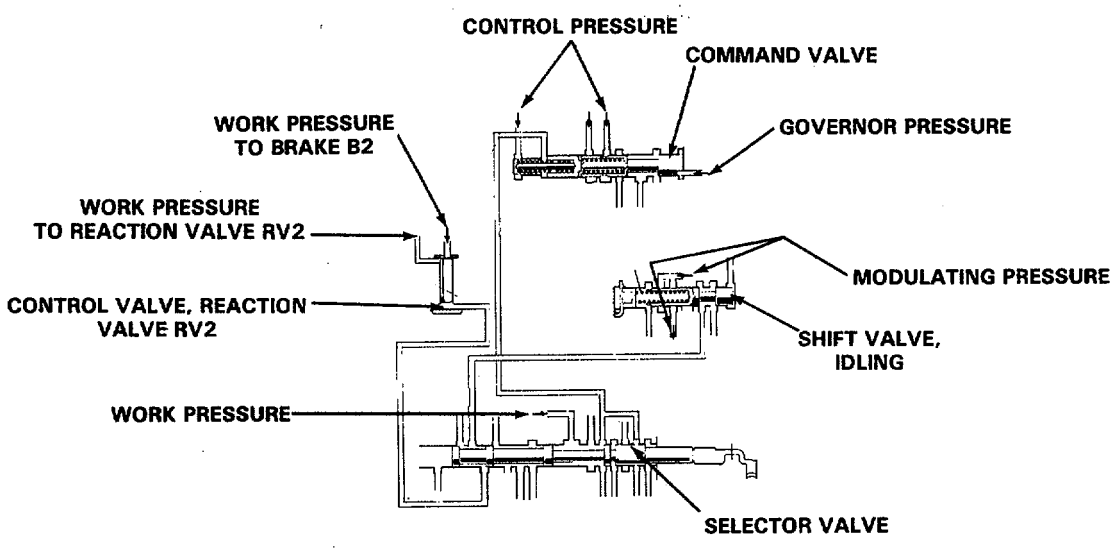
7-8. SELECTOR LEVER DOWNSHIFTING.

a. Downshifting 4th to 3rd Gear.

In selector lever position "3", working pressure moves from selector valve into lefthand spring chamber of command valve. The command valve is pushed into lower speed position, independent of the vehicle and governor pressure.

During a downshift under load, the reaction valve RV 2 closes due to reversal of rotation of the brake band drum. Brake band B2 will be positively connected.

During a downshift under deceleration and idle throttle, the connection of the working pressure is done by the shift valve idle throttle via the selector valve toward control valve. The control valve closes the connection to the reaction valve RV 2 and simulates a closed reaction valve.

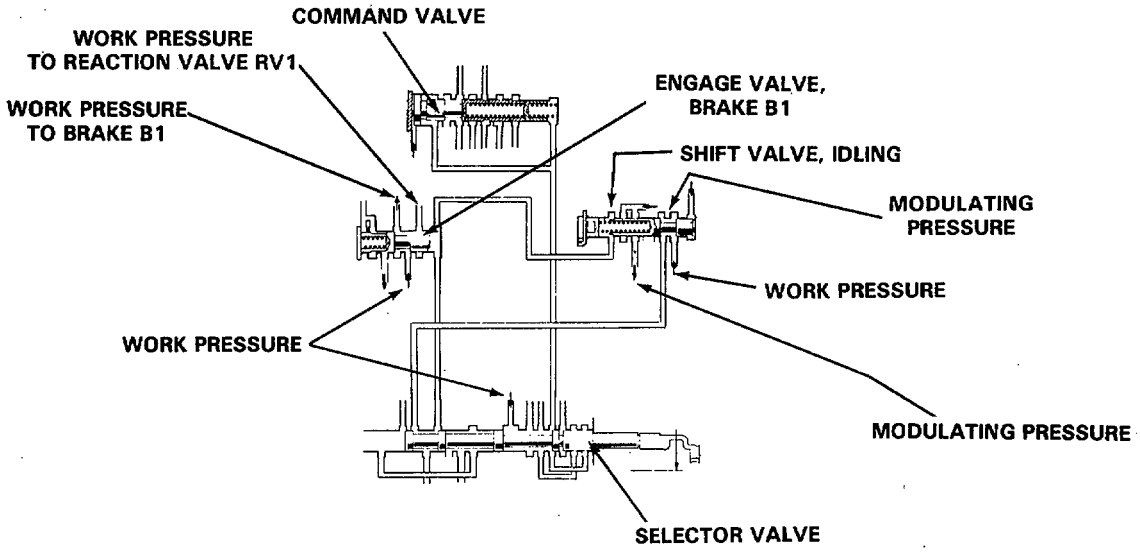


b. Downshifting 3rd to 2nd Gear.

In selector lever position "2", working pressure flows selector valve toward spool ring surface on command valve and to righthand piston. Command valve is held in lower speed position, in- dependent of the driving speed and extent of governor pressure.

During a downshift under load, the reaction valve RV 1 will close due to the reversed rotation of the brake band drum. Brake band B1 will be positively connected.

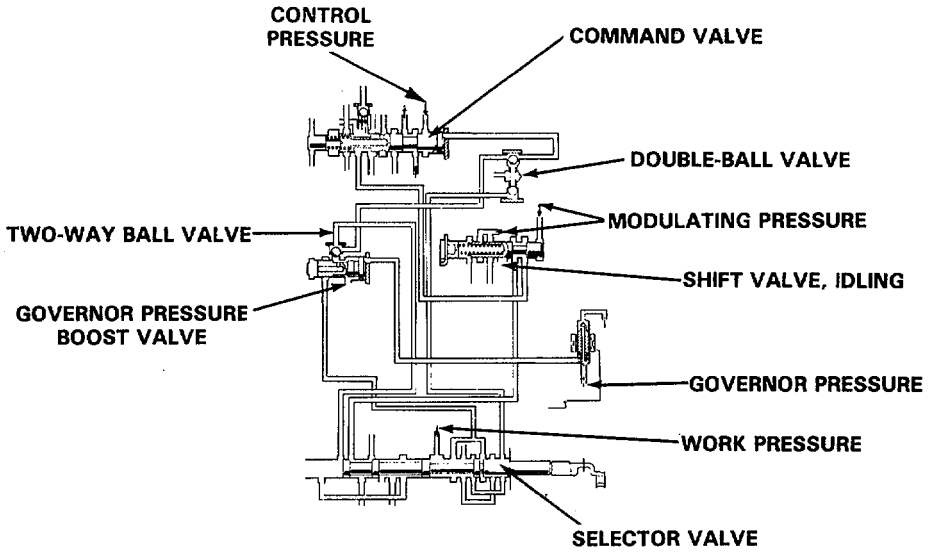
During a downshift under deceleration and idle throttle, the reaction valve RV 1 will not close. The direction of rotation of the brake band drum is not changed. Working pressure from shift valve flows via the selector valve to the engage valve brake B1 through a connection. The engage valve brake B1 moves left and interrupts the connection to the reaction valve. Brake band B1 is positively connected.



c. Downshifting 2nd to 1st Gear.

A stop on the selector lever keeps selector valve in driving position "2" when driving position "1" is engaged. The selector lever dead travel is absorbed by the gearshift linkage dead travel.

Via a switch, voltage is supplied to solenoid valve. The solenoid valve is bolted to the oil distributor plate of the valve body assembly. The valve channels downwards, plugs the governor pressure feed and ventilates the line to the governor pressure boost valve. No intensified governor pressure can be established. Command valve remains in the RH position of the 1st speed.



TA259617

7-9. REACTION VALVES FUNCTION.

a. General.

For downshifts during acceleration, the engine speed must be increased according to reduction of transmission. During the gearshift, the shift component of the higher speed will therefore release slowly. The engine increases speed until the shift component of the lower speed engages when synchronous speed is attained.

The synchronous speed is attained when the speed ratio between the input and the output shaft is in alignment, in accordance with transmission ratio. At that moment, the brake band drum stops for a short moment. The brake band is applied. Smooth gearshifts will result.

The required brake band shifts in two stages, an application position to feel the direction of rotation of the brake band drum and a shift position to apply the brake band firmly.

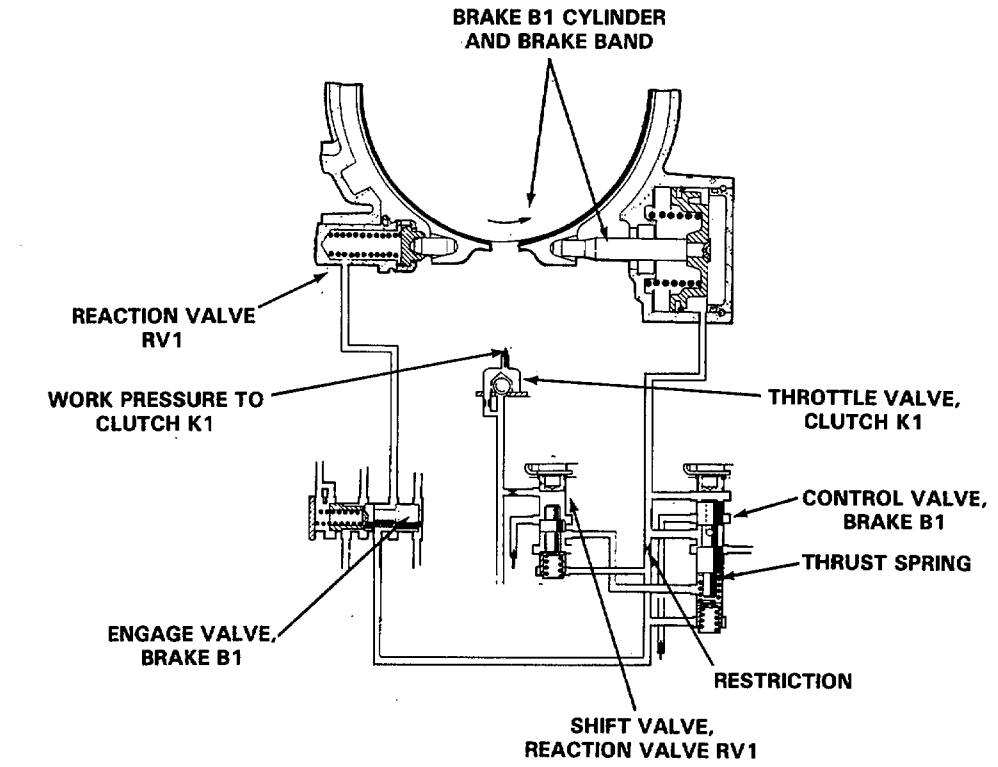
During deceleration and-while the engine is increasing speed, the brake band drum will rotate against brake band piston. The reaction valve remains open. No pressure can build up behind throttle.

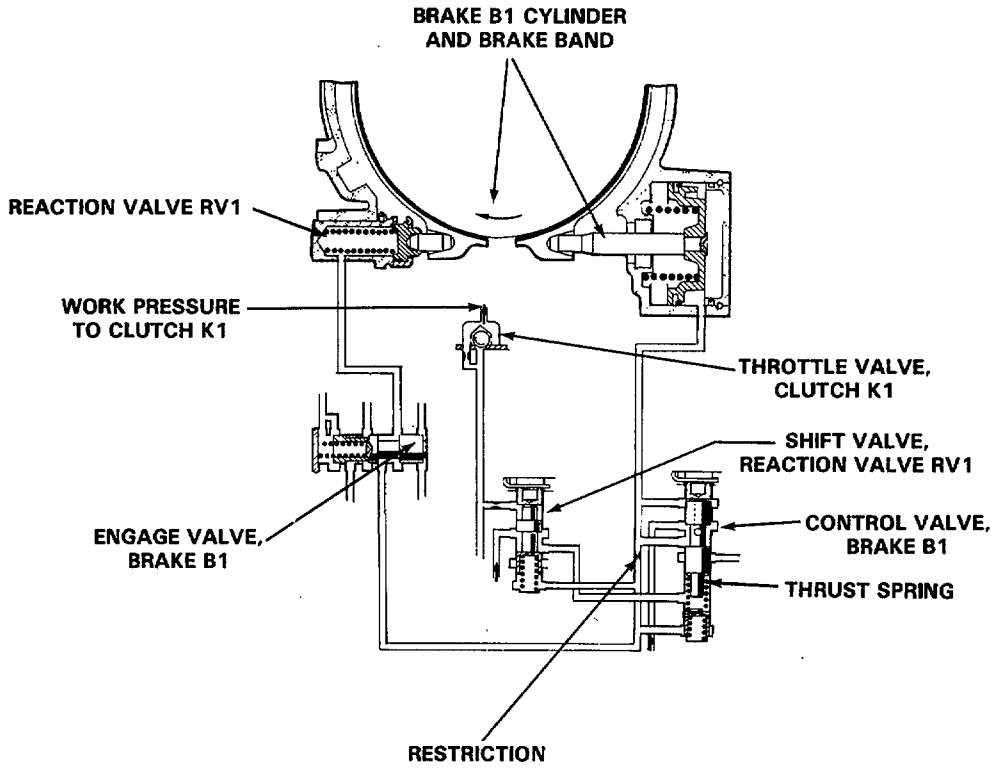
During acceleration or in opposite direction of rotation, the drum rotates against reaction valve. The reaction valve closes. Pressure will be established behind the throttle.

b. Downshift under Acceleration, Initiated by Command Valve.

Upon start of downshift, working pressure will flow via regulating control valve brake B1 to brake band piston B1, toward opened reaction valve. As soon as the application pressure of approximately 29 PSI (2.0 bar) on brake band piston B1 or on flat surface of regulating (control) valve brake B1 (29) has been attained, the regulating (control) valve brake band B1 moves downward against the force of thrust spring. This throttles the infeed and no higher oil pressure will build up at brake band piston B1.

As soon as the reaction valve RV 1 closes, the force of the oil pressure established behind the throttle forces the regulating control valve brake B1 and the shift valve reaction valve RV 1 upwards. The brake band piston receives the full working pressure. The brake band is positively connected. Due to the shift valve, reaction valve RV 1, working pressure will flow under control valve brake B1 -and prevents unwanted regulating position of control valve under excessive deceleration.


BRAKE B1 CYLINDER
AND BRAKE BAND
REACTION VALVE
RV1
WORK PRESSURE TO
CLUTCH K1
THROTTLE VALVE,
CLUTCH K1
CONTROL VALVE,
BRAKE B1
THRUST SPRING
ENGAGE VALVE,
BRAKE B1
RESTRICTION
SHIFT VALVE,
REACTION VALVE RV1


BRAKE B1 CYLINDER
AND BRAKE BAND
REACTION VALVE RV1
WORK PRESSURE
TO CLUTCH K1
THROTTLE VALVE,
CLUTCH K1
SHIFT VALVE,
REACTION VALVE RV1
CONTROL VALVE,
BRAKE B1
ENGAGE VALVE,
BRAKE B1
THRUST SPRING
RESTRICTION

TA259618

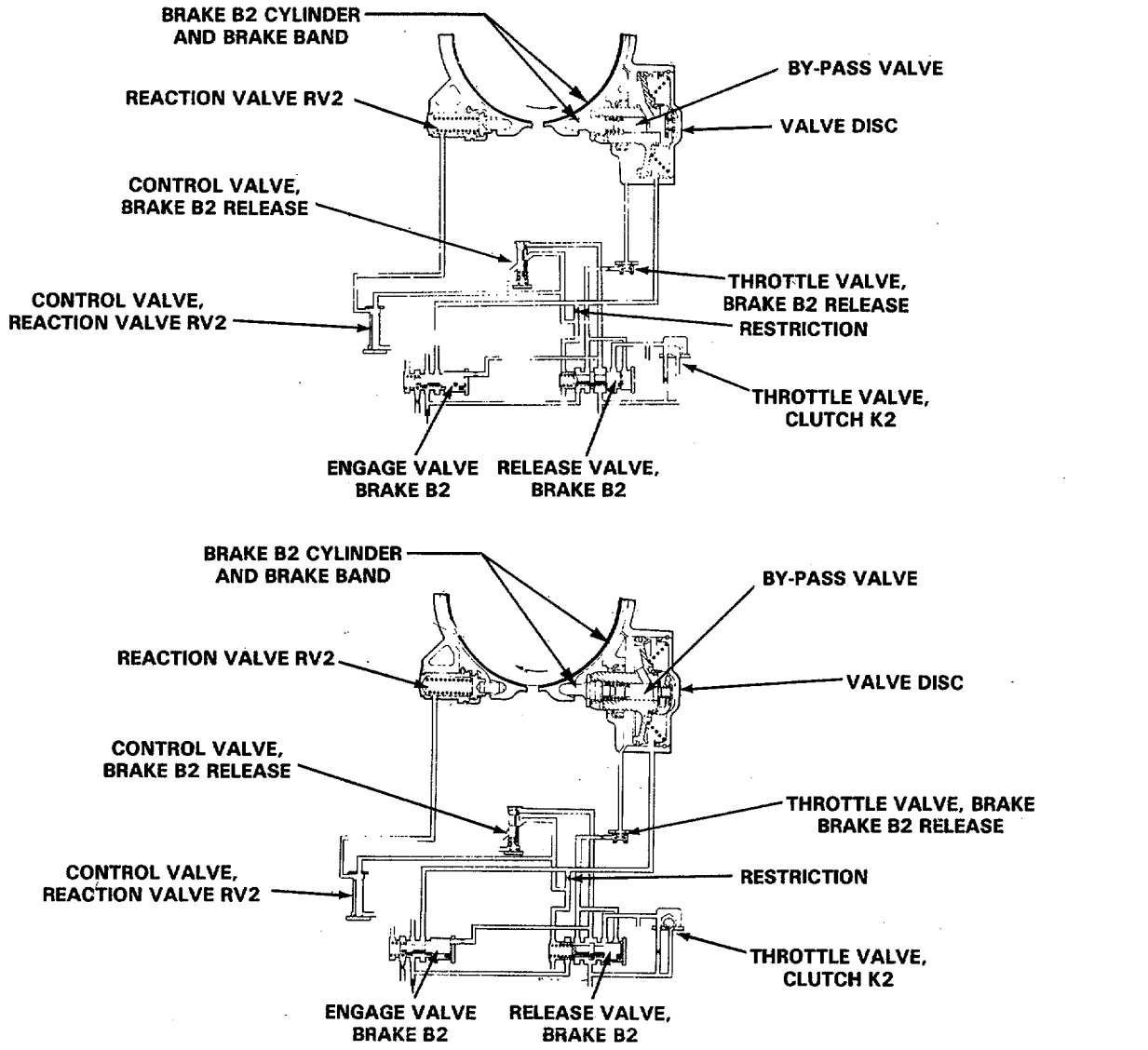
c. Downshifts Under Acceleration, Initiated by Command Valve.

Upon initiation of downshift, working pressure flows toward shift end of brake band piston B2, toward opened reaction valve RV 2. The force of the oil pressure coming from the shift end opens the bypass valve. Oil from releasing end will flow toward shift end. This direct oil exchange permits application of brake band B2 in approximately 5/1 00 seconds.

The application force results from the differential surface of the brake band piston.

If pressure equalizes between the shifting and releasing end, the force of the spring pushes the spring of the valve disc against its seat and interrupts the connection. When the oil pressure reduces at the releasing end, the bypass valve is pushed back into starting position.

When the reaction valve RV 2 closes, the force of the oil pressure behind the throttle pushes the releasing valve brake B2 to the right and connects the releasing end brake band B2, reducing remaining pressure of clutch K2 to zero. Brake band B2 is positively connected.



TA259619

7-10. ENGAGEMENT OF REVERSE GEAR.

In selector lever position "R", working pressure from selector valve arrives at brake band piston B3 via throttle valve brake B3 and fast filling valve and through a branch connection at clutch K2.

This working pressure flows at first in unthrottled condition via the open valve cone. As soon as the brake band rests against the brake band drum, the starting pressure increases at the brake band piston and forces the valve piston against the thrust spring. The valve cone will close the inflow passage.

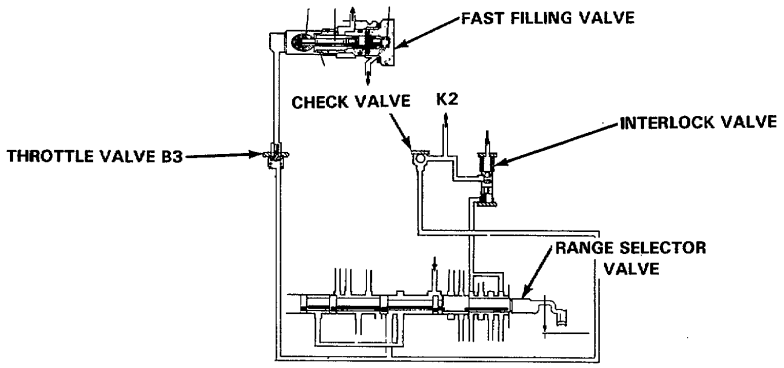
The remaining oil flows through the restriction bore, until the pressure is completely built-up.

When the reverse gear is released, the filling passage on selector valve is evacuated. The returning oil will lift the valve cone from its seat. The pressure at brake band piston 3 is quickly reduced.

7-11. FUNCTION OF INTERLOCK VALVE AND REVERSE GEAR LATCH.

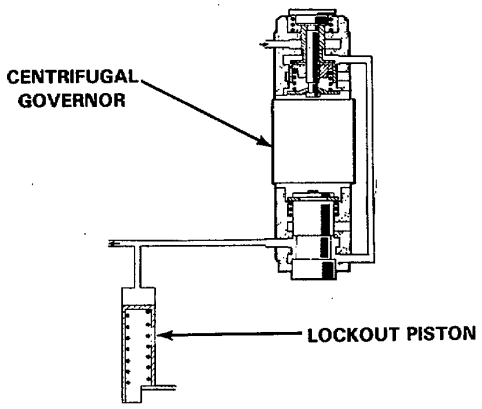
a. Interlock Valve.

Transmission operating in 1st gear. The interlock valve is locked in open position and clutch K2 is engaged.



b. Reverse Gear Latch.

Governor pressure extends the lockout piston and locks the selector mechanism and reverse gear cannot be engaged.



TA259620

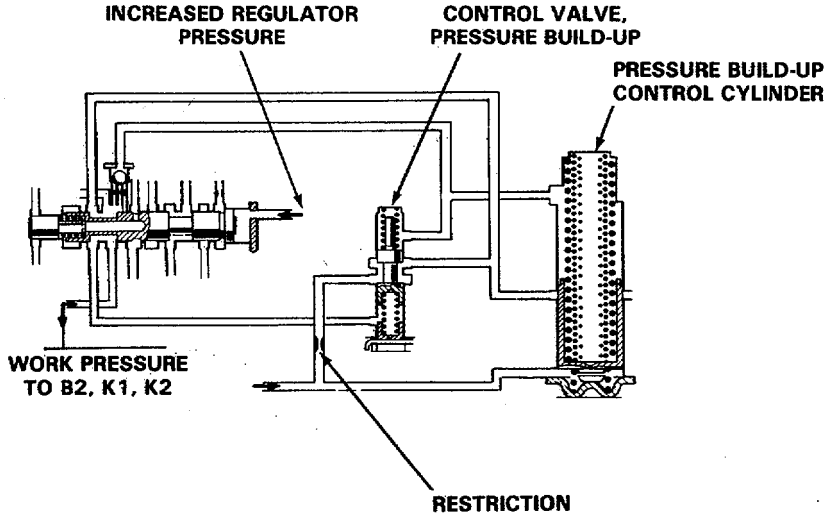
7-12. FUNCTION OF BUILD-UP CONTROL CYLINDER {B1, K1, AND K2).

The build-up control cylinder controls the progressive increase of the working pressure when the gear shift members brake band B1, clutch K1 and K2. This is in order to ensure smooth gear shifting.

The oil quantity for shifting the gear shift members brake band B1, clutch K1 and K2 flows from control valve or pressure build up control cylinder to command valve via an annular passage.

The restriction in oil passage to control valve is to establish a pressure drop following a reduction in cross section, when engaging a gear shift member or when a large oil volume is required. The spring chamber of the pressure build up control cylinder connects to an annular duct on command valve via the three-throttle valve. The spring chamber is also under reduced pressure. The piston is displaced in the direction of the end stop. The resulting open connection permits the required oil to flow in unthrottled. The force of the increasing filling pressure influences the gear shift member so the pressure in the spring chamber of the pressure build up control cylinder increases via the three-throttle valve. The piston is moved into its starting position. The full force of the working pressure against the control element can now be built-up.

While the pressure build up control cylinder operates, the control valve closes the inflow passage by canceling the center position. The control valve rests under pressure control for a moment against the upper or lower stop in opposing movement of the accumulator.



7-13. FUNCTION OF PRESSURE CONTROL CYLINDER.

The pressure control cylinder provides a smooth shift for brake band B2 when a forward driving speed is engaged. The gear set, which is freely wheeling in selector lever position "N", is slowly decelerated to pre- vent sudden jerks.

When the selector lever position "D", "3", "2", "1", is engaged, working pressure will flow from selector valve via a throttled feed passage through engage valve brake B2 to shift side of brake band piston B2 and front surface of pressure control cylinder. With increasing pressure against brake band piston B2 or pressure control cylinder, the piston of the cylinder moves to the right, so the oil volume of the spring chamber is evacuated through the throttle bore of the partition in the housing.

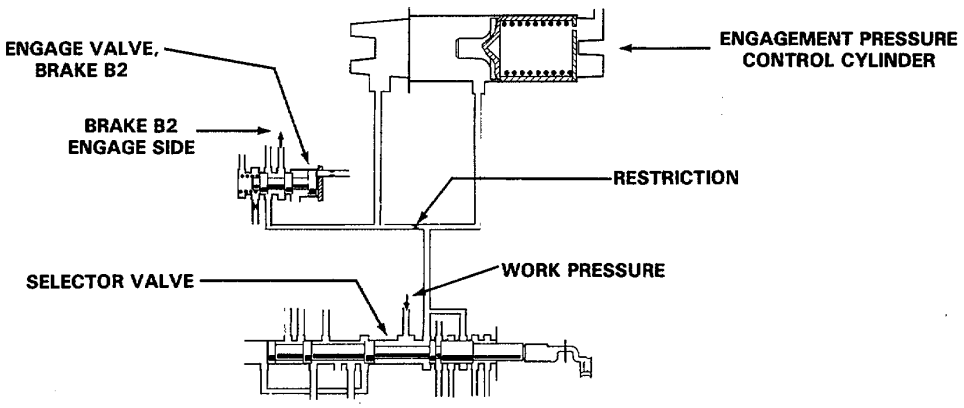
The displacement of the control cylinder piston slows down the pressure build up at shift of brake band B2.

TA259621

NOTE

The cross section of the throttle bore determines the operating time of the pressure cylinder and the pressure build-up at shift end of brake band B2.

Prior to arriving at end stop, the piston releases the working pressure in the center. Pressure compensation results. Brake band B2 is fully applied.

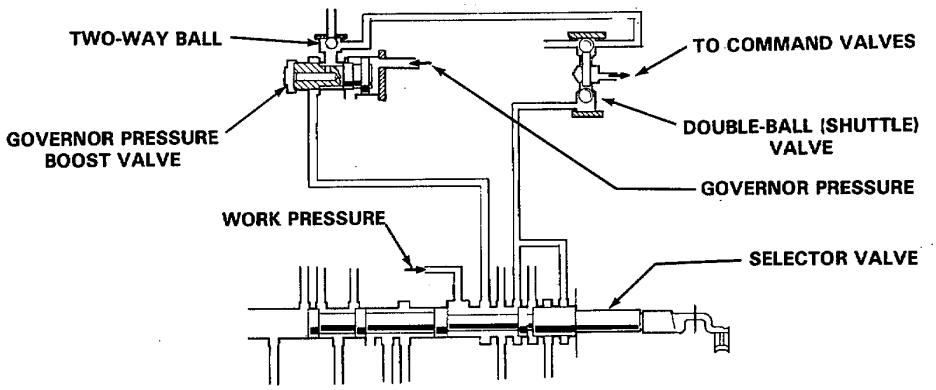


7-14. FUNCTION OF DOUBLE BALL VALVE.

Double ball valve is installed in shift valve housing lower half. The double ball valve reduces the leak losses in shift valve housing in selector lever position.

In selector lever position "2", working pressure flows from selector valve to bottom of double ball valve. The lower ball is forced against its seat and the upper ball is lifted via the plastic pin. Increased governor pressure, lower than the working pressure, now flows through the opened ball valve to command valves and upshift valve.

This reduces internal leak losses by approximately 20 percent.

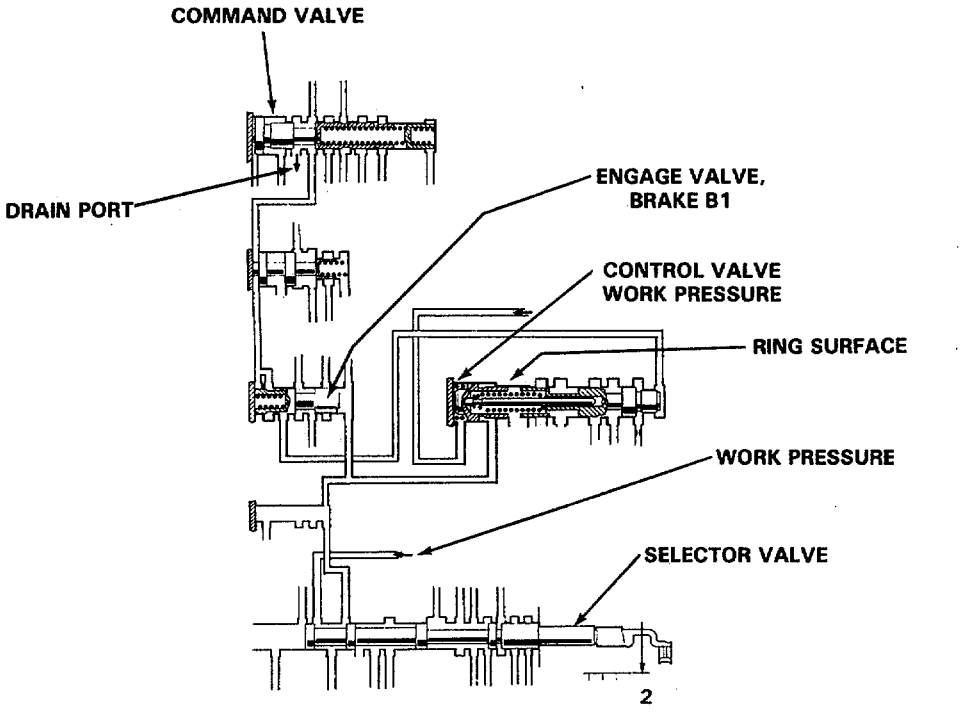


TA259622

7-15. CONTROLLING WORK PRESSURE.

Working pressure flows via selector valve to ring annular surface on control valve working pressure to reduce the working pressure in partial and full load range.

The flat surface (face) of control valve working pressure is connected to zero outflow via the engage valve brake B1 and command valve.



TA259623

7-16. TECHNICAL DATA.

Make	Daimler-Benz
Type	W4A018
Weight, with oil	108 lbs. (approx. 49 kg)
Demultiplication ratios:	
1st gear	4,007:1)
2nd gear	2,392:1)
3rd gear	1,463: 1)x torque converter ratio
4th gear	1:1)
Reverse	5,495:1)
Torque converter	
diameter	0.. 1.6 in. (270 mm)
stalling speed	2000-2200 RPM (33.5-36.5 r/s)
demultipliuation ratio, max	1.7:1

Mechanical adjustment data

Axial clearance, gearbox front housing - gear assembly	0.01 57-0.0 1 96 in. (0.4-0.5 mm)
Clearance, brake pistons B1 and B2	0. 1 18-0.1 57 (3.0-4.0 mm)
Adjusting screw, brake B3	Tightening torque 4 lb. ft. (5 Nm)
	then back off 1 3/4 turns, secure with locknut.

Gear assembly

Axial clearance, 3rd planetary gearset	0.0098-0.01 37 in. (0.25-0.35 mm)
Axial clearance, hollow shaft	0.0079-0.0118 in. (0.2-0.3 mm)
Axial clearance, 2nd planetary gearset	0 .0079-0.0118 in. (0.2-0.3 mm)

Clutch K1

Clearance	0.0314-0.0472 in. (0.8-1.2 mm)
Springs, number off	25-28
Springs, free length	1.22 in. (31 mm)
Springs, wire dia.	0.0394 in. (1.0 mm)

Clutch K2

Clearance	0.0314-0.0472 in. (0.8-1.2 mm)
Springs, number off	14-1 6
Springs, free length	1.30 in. (33 mm)
Springs, wire dia.	0.0314 in. (0.8 mm)

Tightening torques

Location of screws	
Oil pan - gearbox	5 lb, ft. (7 Nm)
Oil filter	3lb.ft. (4 Nm)
Drive flange nut	87lb.f (1f18 Nm)
Gearbox front and rear housings	101 b. ft. (1 3 Nm)
Drive flange nuts	132 lb. ft. (1 80 Nm)
Solenoid valve, kick-down	21 lb. ft. (29 Nm)
Modulating pressure housing	5 lb. ft. (7 Nm)
Start interlock and reverse lamp switch	4 lb. ft. (5 Nm)
Shift valve housing, upper and lower	5 lb. ft. (7 Nm)
Drain plug, torque converter	12 lb. ft. (1 6 Nm)
Shift valve housing-gear box	10 lb. ft. (1 3 Nm)
Torque converter casing, M8	101 b. ft. (1 3 Nm)
Torque converter casing, M 10	18 lb. ft. (25 Nm)
Torque converter drive plate	24 lb. ft. (32 Nm)
Primary pump	15 lb. ft. (20 Nm)

Section II. REPAIR OF TORQUE CONVERTER.

7-17. REMOVE, REPAIR AND REPLACE TORQUE CONVERTER.

a. Remove Torque Converter.

Step 1. Drain transmission oil. Refer to TM 9-2350- 272-20.
Step 2. Remove starter.
Step 3. Remove vacuum hose from transmission.
Step 4. Disconnect oil cooler hoses from transmission. Plug hoses and connectors.
Step 5. Remove linkage between engine and transmission.
Step 6. Remove rubber plug from bottom of engine flywheel housing.
Step 7. Rotate engine crankshaft to gain access to torque converter nuts. Remove six nuts and washers.
Step 8. Attach lifting sling and lift to transmission.
Step 9. Remove transmission mounting screws and washers.
Step 10. Remove transmission with torque converter from engine.
Step 11. Remove plastic plug from transmission front housing.
Step 12. Remove torque converter from transmission front housing.

b. Torque Converter Repair.

Step 1. Remove plug and seal from torque converter.
Step 2. Inspect plug. Replace damaged plug with new plug.
Step 3. Put in plug with new seal. Torque plug to 1 2 lb. ft. (1 6 Nm).
Step 4. Inspect studs. Replace damaged studs.
Step 5. Inspect torque converter for cracks. Replace cracked torque converter.

c. Replace Torque Converter.

Step 1. Install torque converter in transmission front housing. Insure torque converter is fully seated in place. The two long slots on torque converter must slide over primary pump key ways.

Step 2. Put plastic plug in transmission front housing. If plug touches torque converter, the converter is not properly seated.
Step 3. Lift transmission in place on engine.
Step 4. Put in transmission mounting screws and washers. Torque screws to 30 lb. ft. (40 Nm).
Step 5. Put nuts on torque converter studs. Torque nuts to 24 lb. ft. (32 Nm).
Step 6. Put rubber plug in bottom of flywheel housing.
Step 7. Put on linkage rod between engine and transmission.
Step 8. Connect vacuum line.
Step 9. Install starter on engine.
Step 10. Remove plugs from oil cooler hoses. Connect and tighten hoses.
Step 11. Fill transmission with oil. Refer to LO 9- 2350-272-1 2.

Section III. REPAIR OF TRANSMISSION.

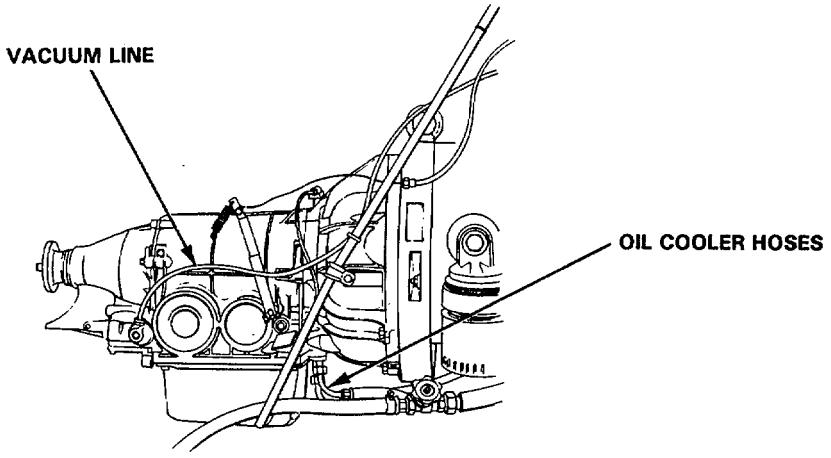
7-18. REMOVE AND REPLACE TRANSMISSION.

a. Remove Transmission.

Step 1. Remove power pack. Refer to TM 9-2350-272- 20.
Step 2. Drain transmission oil;-Refer to TM 9-2350- 272-20.
Step 3. Remove vacuum hoses from transmission.
Step 4. Disconnect oil cooler hoses from transmission. Plug hoses and connectors.
Step 5. Remove linkage between engine and transmission.
Step 6. Remove cover from bottom of engine flywheel housing.
Step 7. Rotate engine crankshaft to gain access to torque converter bolts. Remove six bolts and twelve washers.
Step 8. Attach lifting sling and lift to transmission.
Step 9. Remove transmission tube assembly mounting bracket and tube assembly.
Step 10. Remove transmission mounting screws and washers.
Step 11. Remove transmission with torque converter from engine.

b. Replace Transmission.

Step 1. Flush transmission oil cooler and oil lines with automatic transmission fluid.
Step 2. Align transmission to engine through torque converter and through flywheel holes.
Step 3. Put in transmission mounting screws and washers. Torque screws to 30 lb. ft. 140 Nm).
Step 4. Put bolts with washers in torque converter. Flat washers must go against flywheel. Torque nuts to 24 lb. ft. (32 Nm).
Step 5. Put cover in bottom of engine flywheel housing.
Step 6. Put on linkage rod between engine and transmission.
Step 7. Put transmission tube assembly in place.
Step 8. Remove plugs from oil cooler hoses and connectors.
Step 9. Connect oil cooler hoses. Tighten hoses.
Step 10. Fill transmission with oil. Refer to LO 9- 2350-272-12.
Step 11. Connect vacuum line.

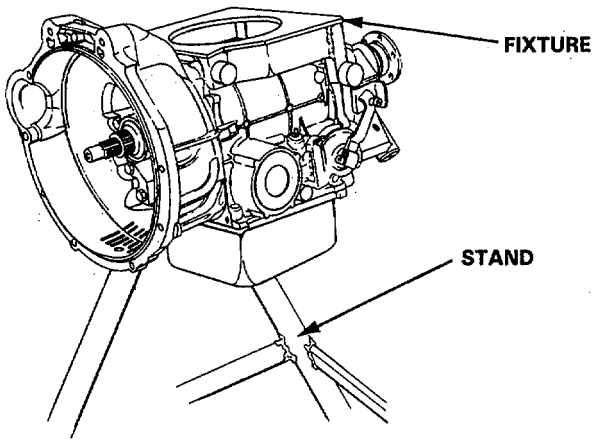


TA259624

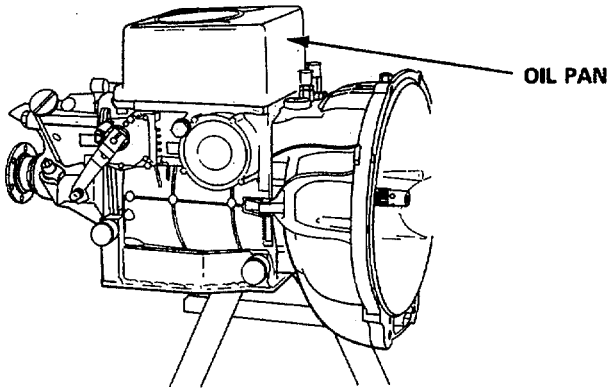
7-19. REPAIR TRANSMISSION.

a. Disassemble Transmission.

Step 1. Remove plastic plug from transmission front housing.
Step 2. Remove torque converter from transmission front housing.
Step 3. Remove control pressure lever.
Step 4. Attach fixture to transmission. Refer to table 2-1, item 21.
Step 5. Mount transmission on stand. Remove lifting sling.

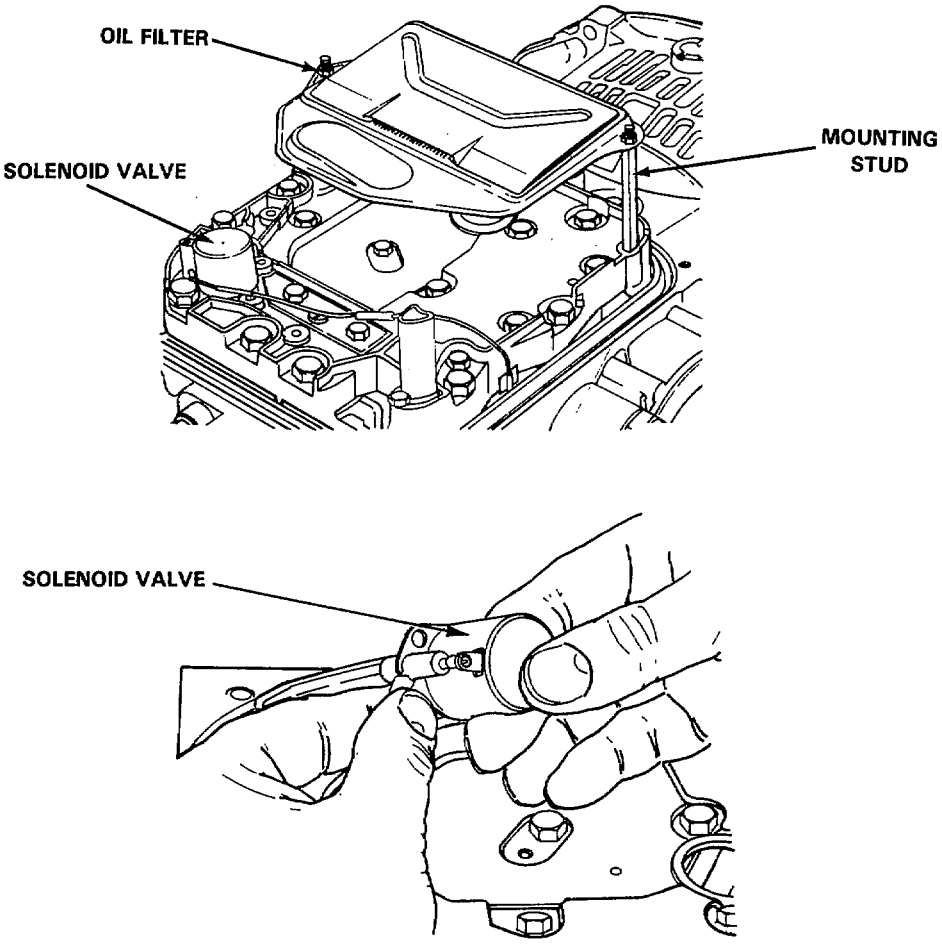


Step 6. Rotate transmission until oil pan is up.
Step 7. Remove oil pan screws.
Step 8. Remove oil pan and gasket.

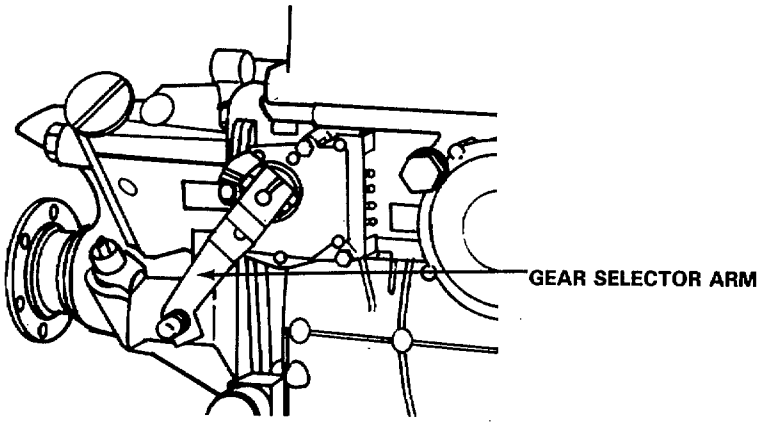


Step 9. Remove oil filter and mounting studs.
Step 10. Remove solenoid valve and gasket.

TA259625

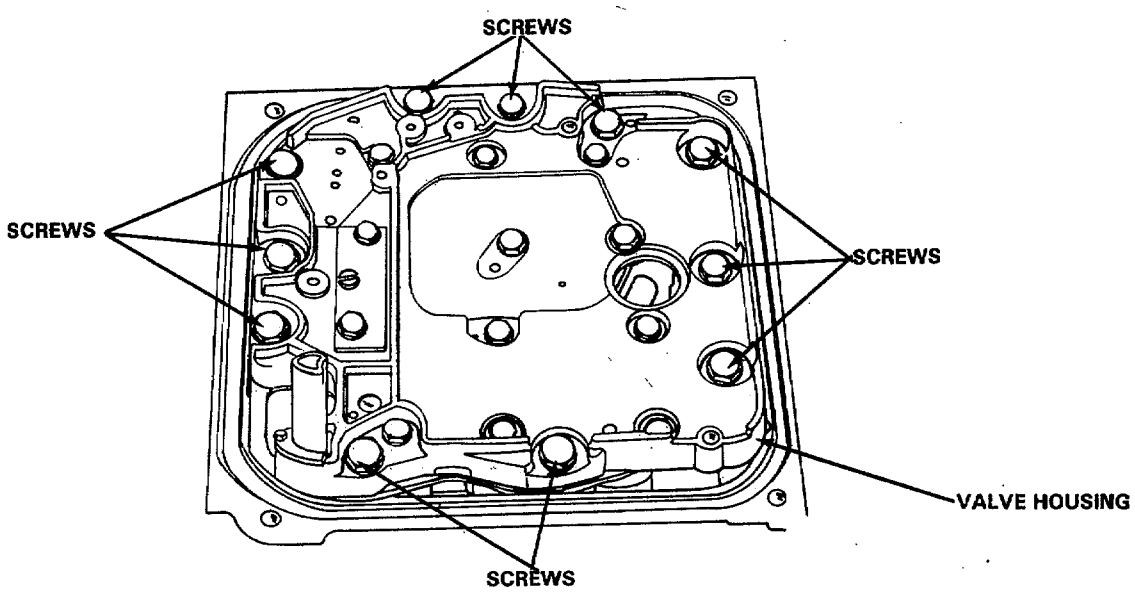


Step 11. Place gear selector between Park (P) and Reverse (R).



TA259626

Step 12. Remove shift valve mounting screws.
Step 13. Remove shift valve housing.

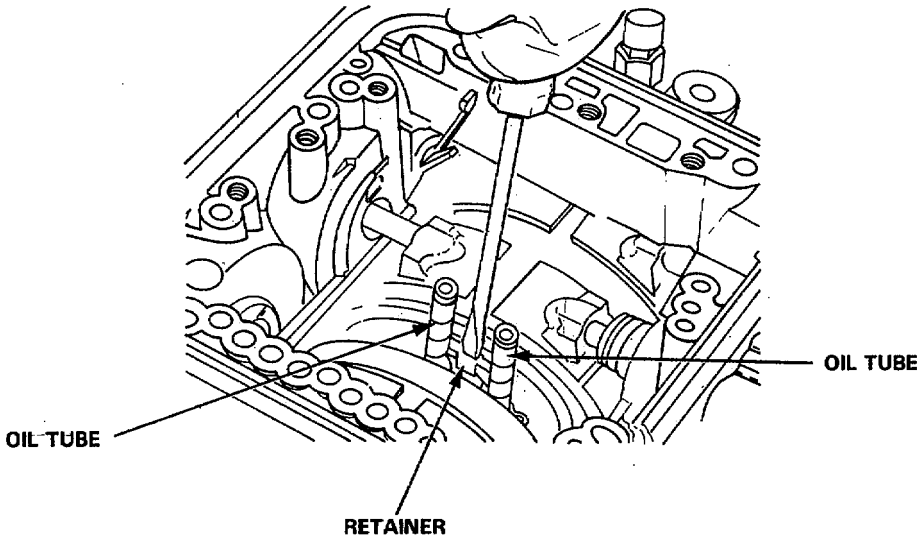


Step 14. Remove brake band guide.

CAUTION

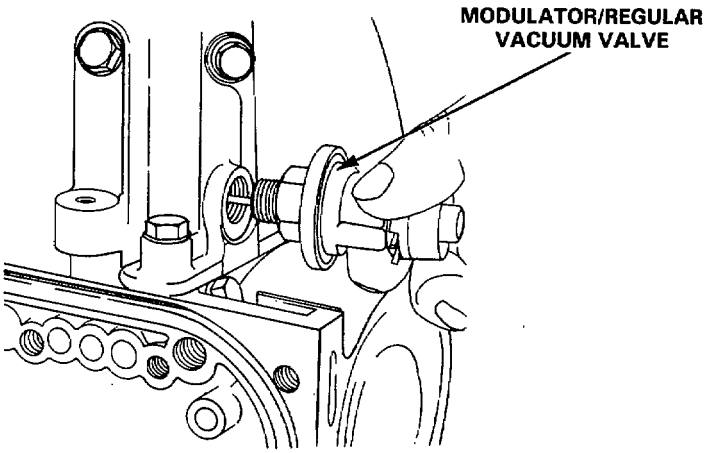
Do not pull on retainer. Retainer can be damaged.

Step 15. Spread open retainer. Remove oil tubes.

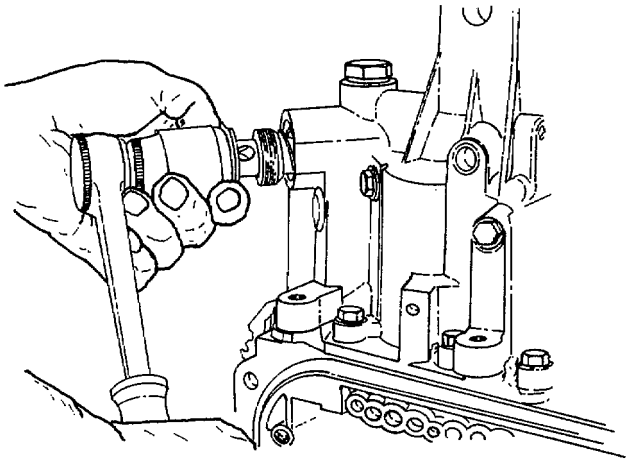


TA259627

Step 16. Rotate transmission until rear housing is up.
Step 17. Remove modulator/regulator vacuum valve.

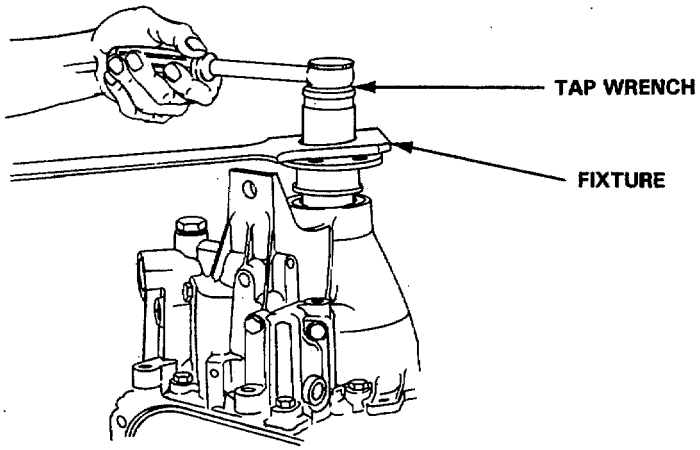


Step 18. Use plug wrench. Remove secondary oil pump plug and thrust spring. Refer to table 2-1, item 11.
Step 19. Remove screw, washer and speedometer adapter.



TA259628

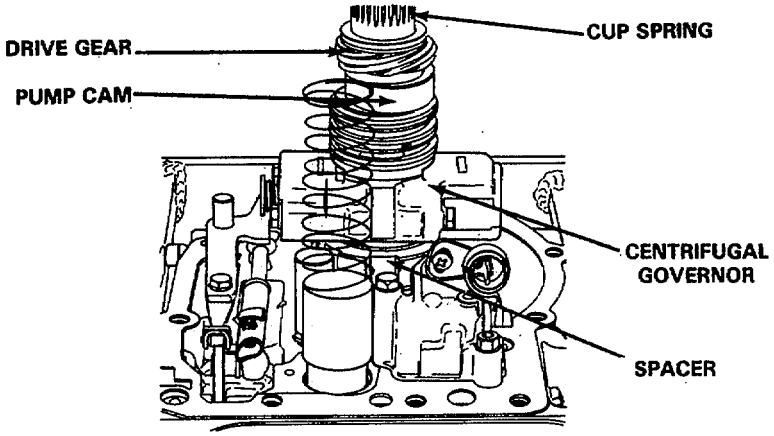
Step 20. Use fixture and tap wrench. Remove drive flange locknut. Refer to table 2-1, items 13 and 14.
Step 21. Remove drive flange.



Step 22. Remove transmission rear housing screws and washers.
Step 23. Remove transmission rear housing.
Step 24. Remove servo accumulator piston and spring.
Step 25. Remove cup spring and drive gear.
Step 26. Remove pump cam.
Step 27. Remove centrifugal governor.
Step 28. Remove spacer.

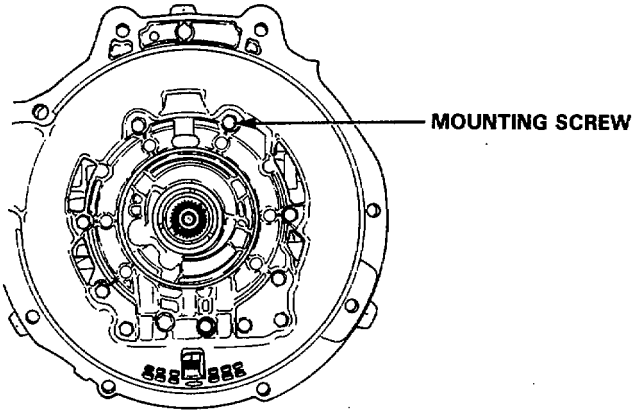
NOTE

Do not loosen screw on plate securing spring on modulation valve unless spring is damaged.

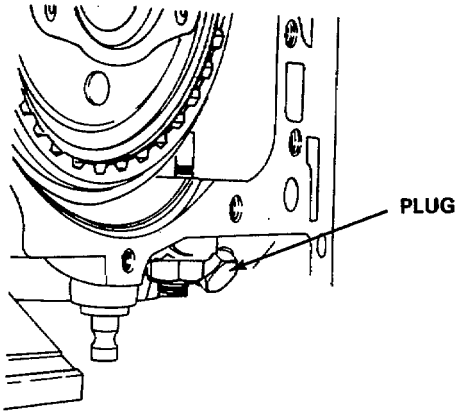


Step 29. Remove modulating valve housing screws.
Step 30. Remove modulating valve housing.
Step 31. Remove rear housing gasket.
Step 32. Rotate transmission until input shaft is up.
Step 33. Remove mounting screws and washers from front housing.
Step 34. Remove front housing and gasket.

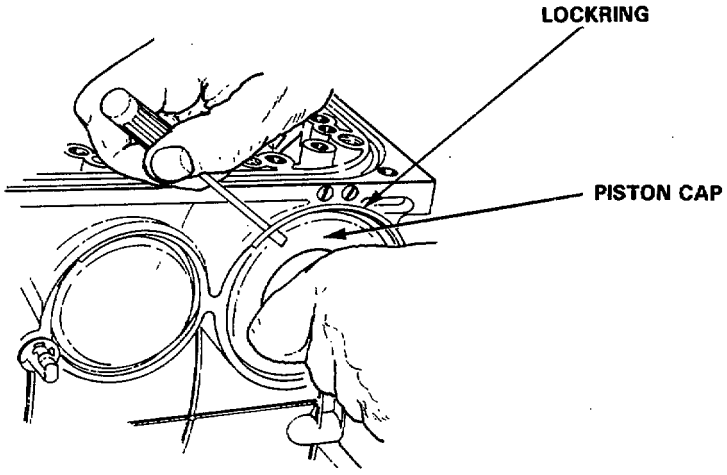
TA259629



Step 35. Turn transmission parallel to floor with top of transmission on the bottom. Remove plug and seal.

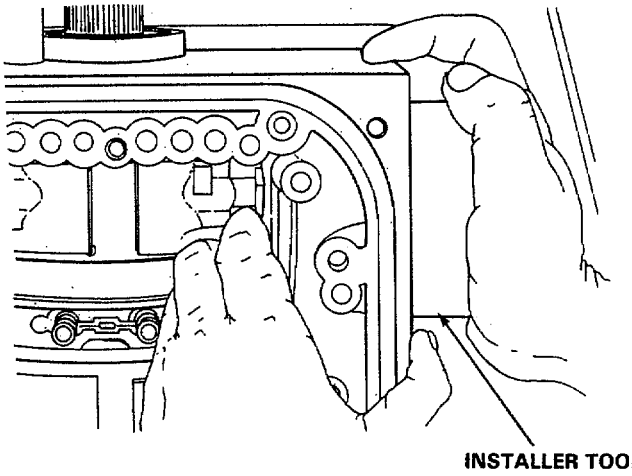


Step 36. Press in brake B2 piston cap. Remove lock ring.

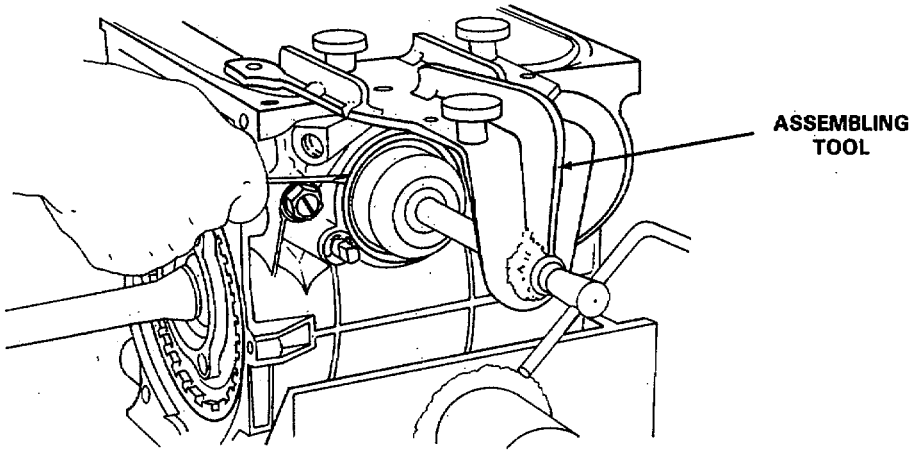


TA259630

Step 37. Put installer tool in opening for brake B2 piston. Refer to table 2-1, item 23.
Step 38. Pull out brake B2 piston.

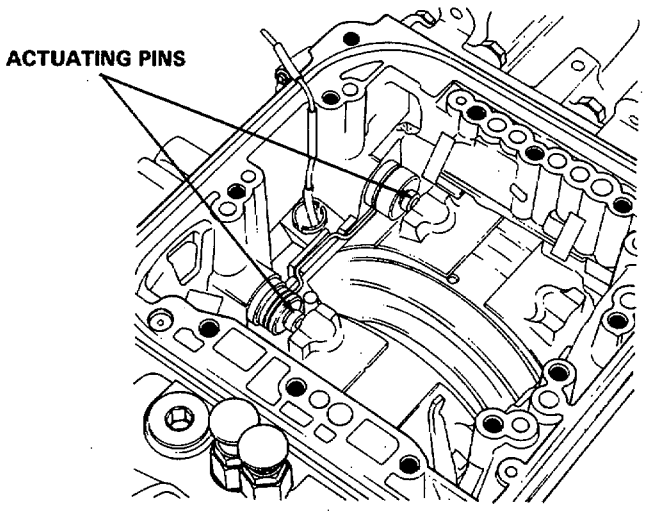


Step 39. Use assembling tool. Remove lock ring from brake B1 piston cap. Refer to table 2-1, item 27.
Step 40. Remove assembling tool.
Step 41. Remove brake B1 piston cap, piston and thrust spring.

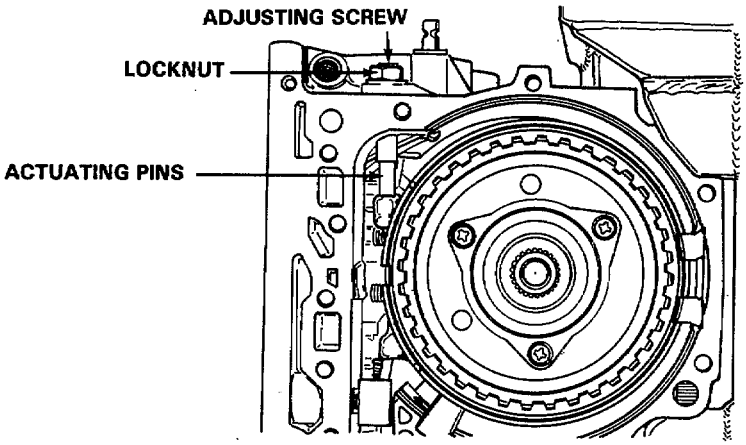


Step 42. Remove actuating pins for brake bands B1 and B2.

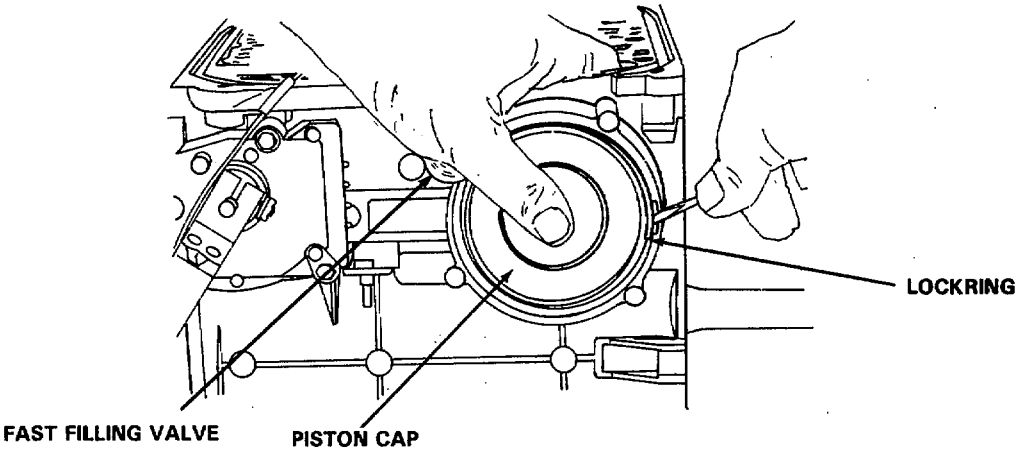
TA259631



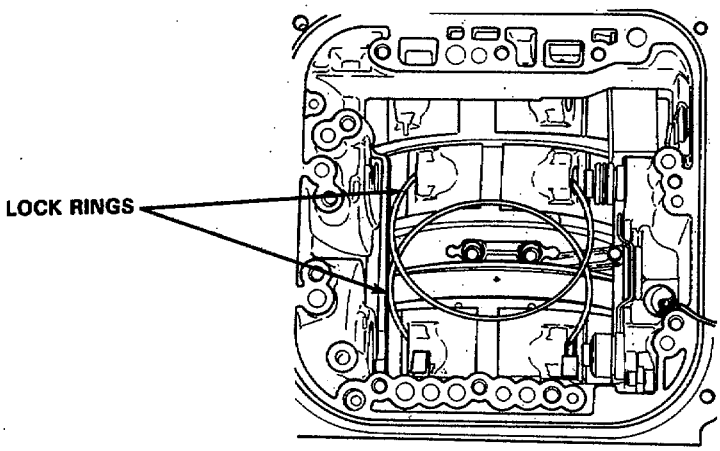
Step 43. Loosen locknut.
Step 44. Remove adjusting screw for brake band B3.
Step 45. Remove two actuating pins.



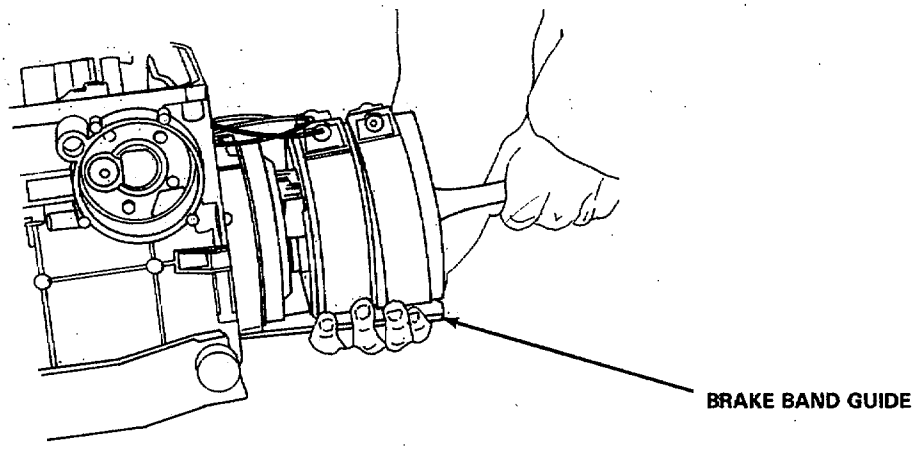
Step 46. Push in brake B3 piston cap. Remove lock ring.
Step 47. Remove piston cap, piston and spring. Remove fast filling valve.



Step 48. Use lock rings from brake piston caps B2 and B3. compress brake bands B1 and B2.

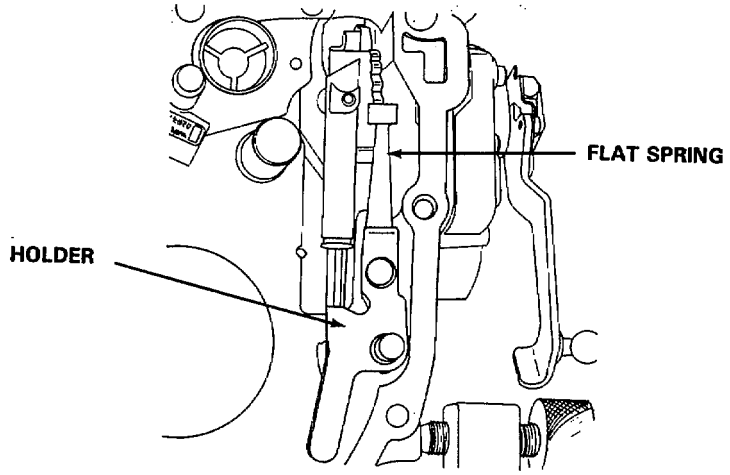


Step 49. Pull out planetary gearing assembly complete with brake bands and brake band guide.
Step 50. Remove brake bands and brake band guide.
Step 51. Remove output shaft and bearings from housing.

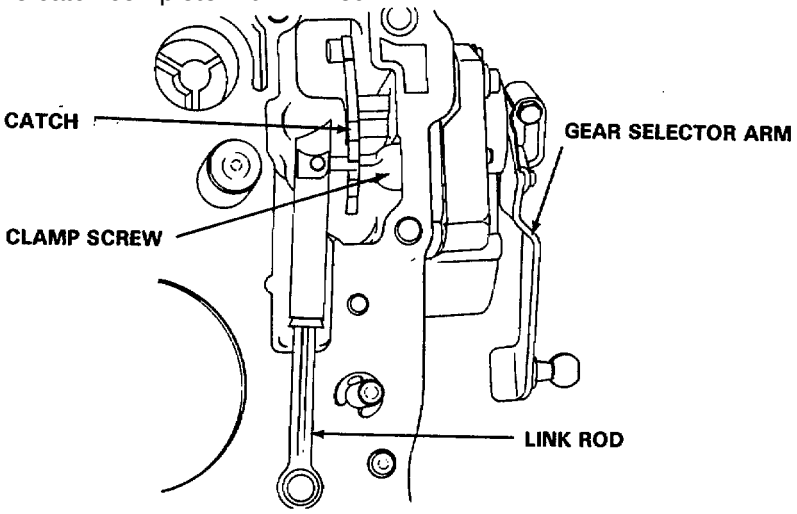


Step 52. Remove holder and flat spring complete with screw and lock ring.

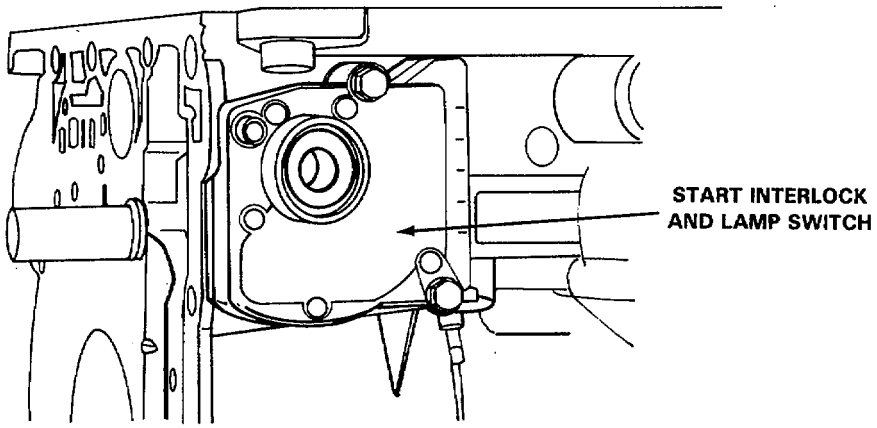
TA259633



Step 53. Remove clamp screw from catch.
Step 54. Pull out gear selector arm.
Step 55. Remove catch complete with link rod.

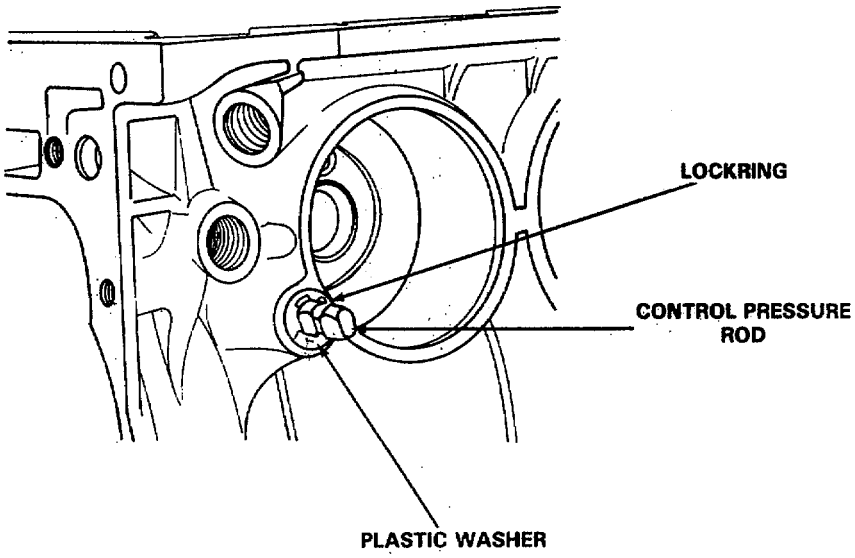


Step 56. Remove start interlock and reverse lamp switch.

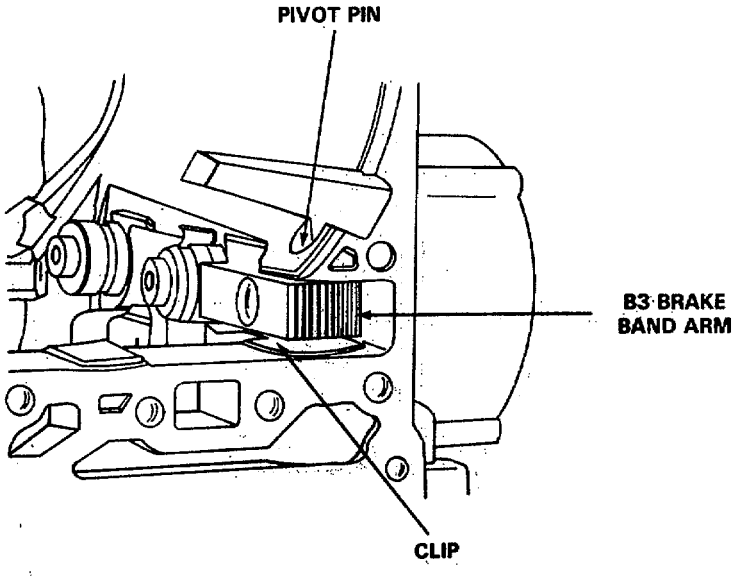


TA259634

Step 57. Remove lock ring from control pressure rod.
Step 58. Remove plastic washer.
Step 59. Pull out control pressure rod.

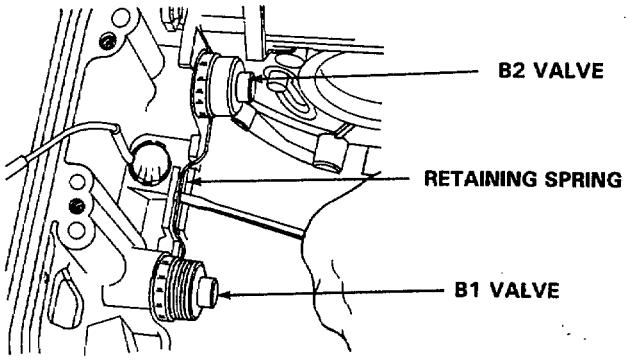


Step 60. Remove retaining clip from brake band B3 pivot pin.
Step 61. Tap out pivot pin.

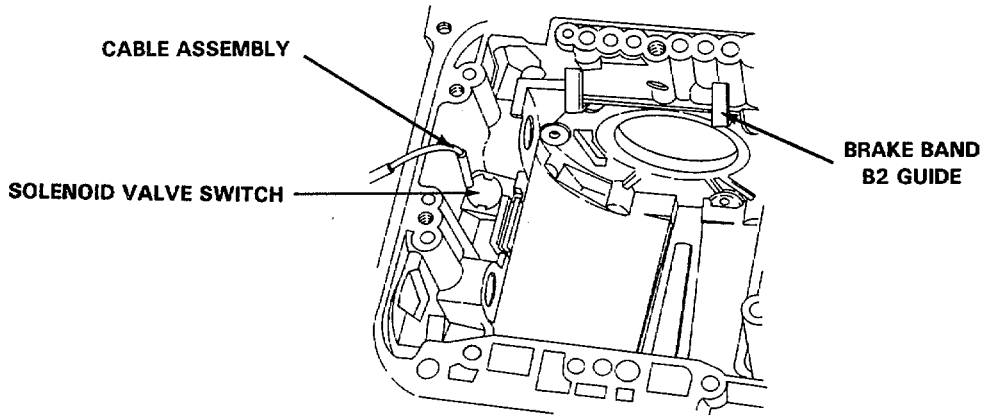


Step 62. Remove retaining spring.
Step 63. Remove B1 and B2 valves.

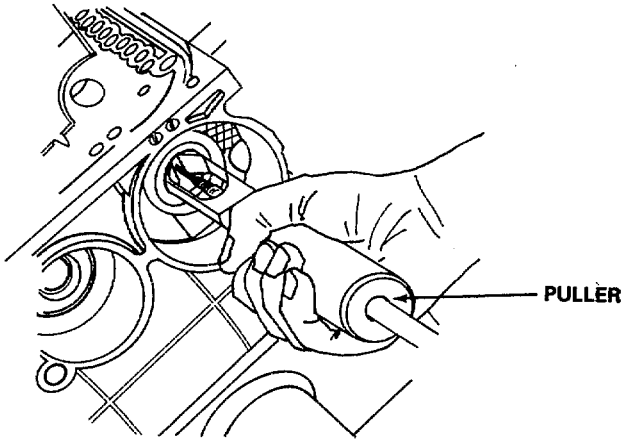
TA259635



Step 64. Remove cable assembly.
Step 65. Remove brake band B2 guide.

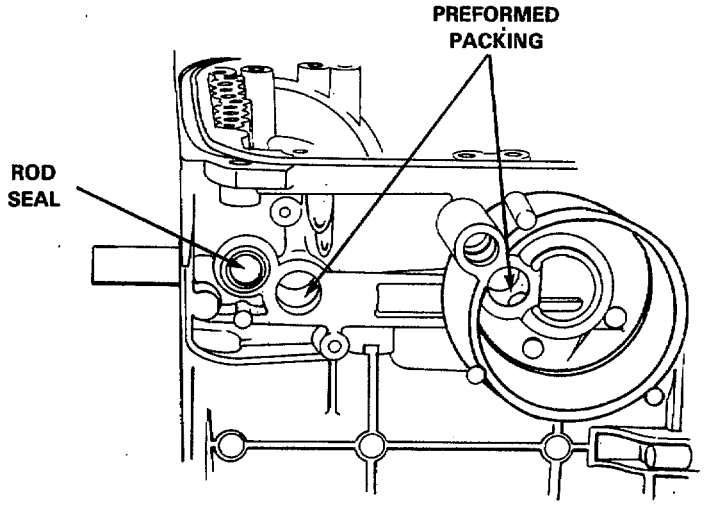


Step 66. Use puller. Remove B2 piston seal from transmission housing. Refer to table 2-1, item 28.



TA259636

Step 67. Remove gear selector rod seal.
Step 68. Remove brake pressure pad preformed packing.



WARNING

Cleaning solvent, federal specification P-D-680, Type II, is flammable and gives off harmful vapors. Use solvent only in a well-ventilated area. Avoid prolonged breathing of solvent vapors. Keep solvent away from flame. Do not use solvent in excessive amounts.

Step 69. Clean and flush transmission housing with cleaning solvent. Refer to appendix B, item 48.

WARNING

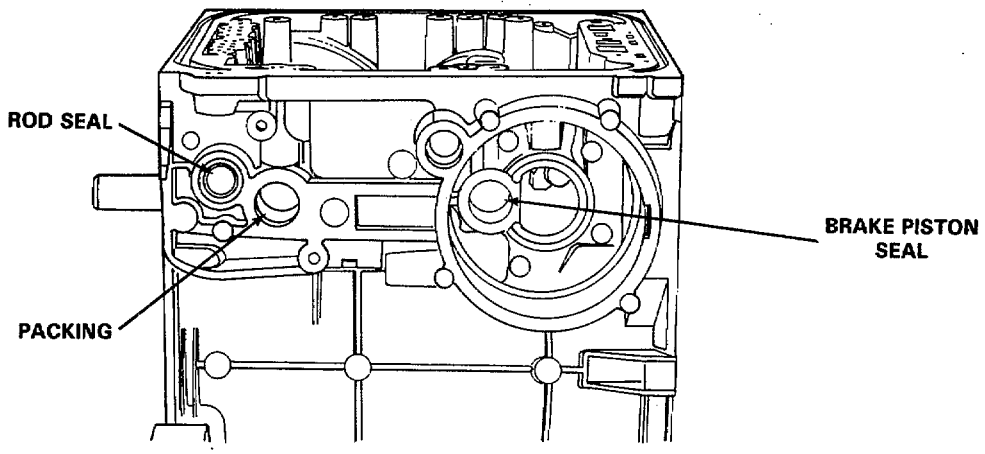
Compressed air used for cleaning purposes will not exceed 30 psi. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

Step 70. Dry housing with compressed air.

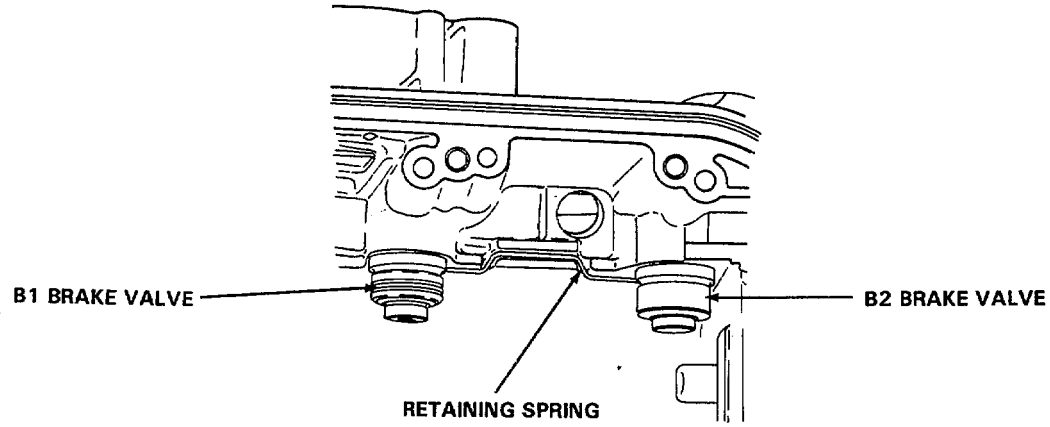
b. Assemble Transmission Housing.

Step 1. Put new B2 brake piston seal in housing.
Step 2. Put in new gear selector rod seal.
Step 3. Put in new brake pressure pad preformed packing.

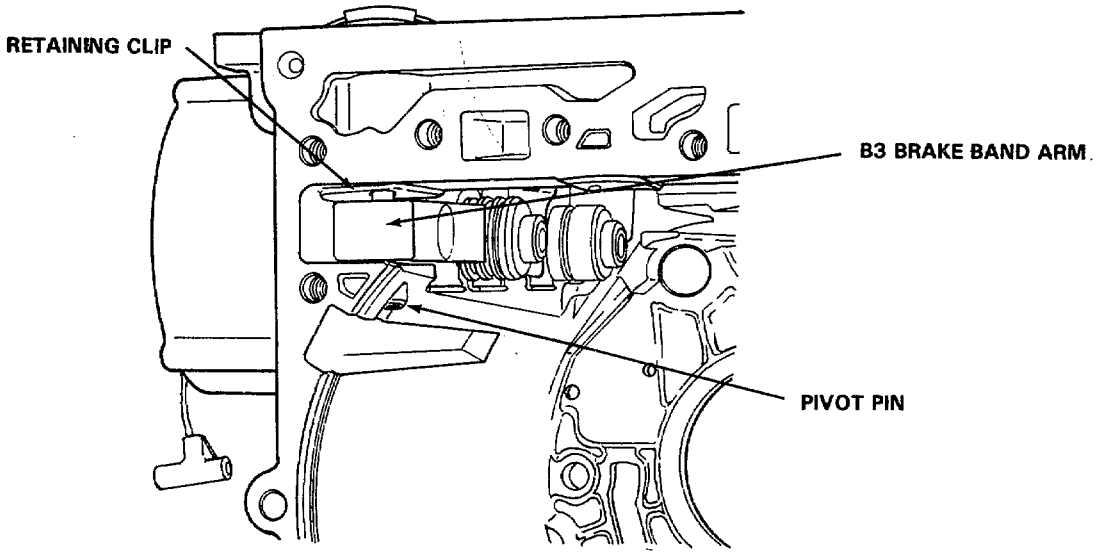
TA259637



Step 4. Put B1 and B2 brake valve into housing.
Step 5. Install brake valve retaining spring.

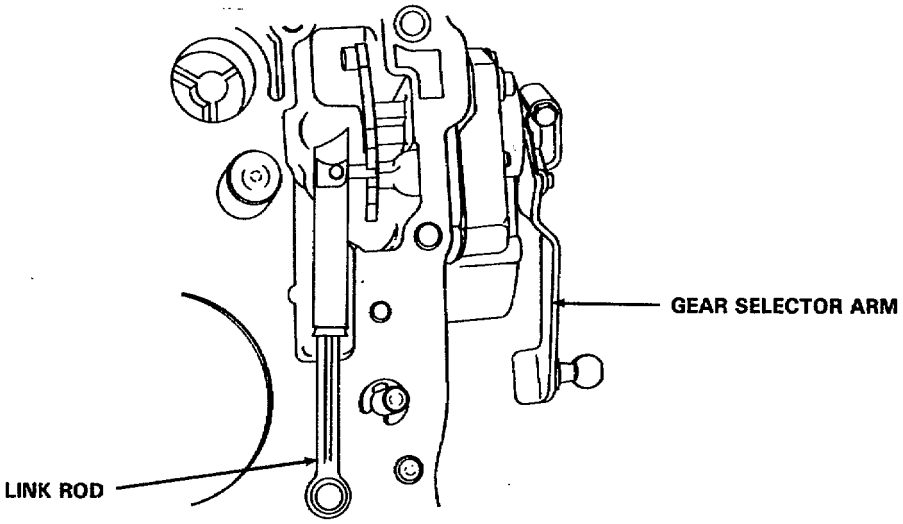


Step 6. Put B3 brake band arm into housing.
Step 7. Put in pivot pin from above.
Step 8. Put on retaining clip.

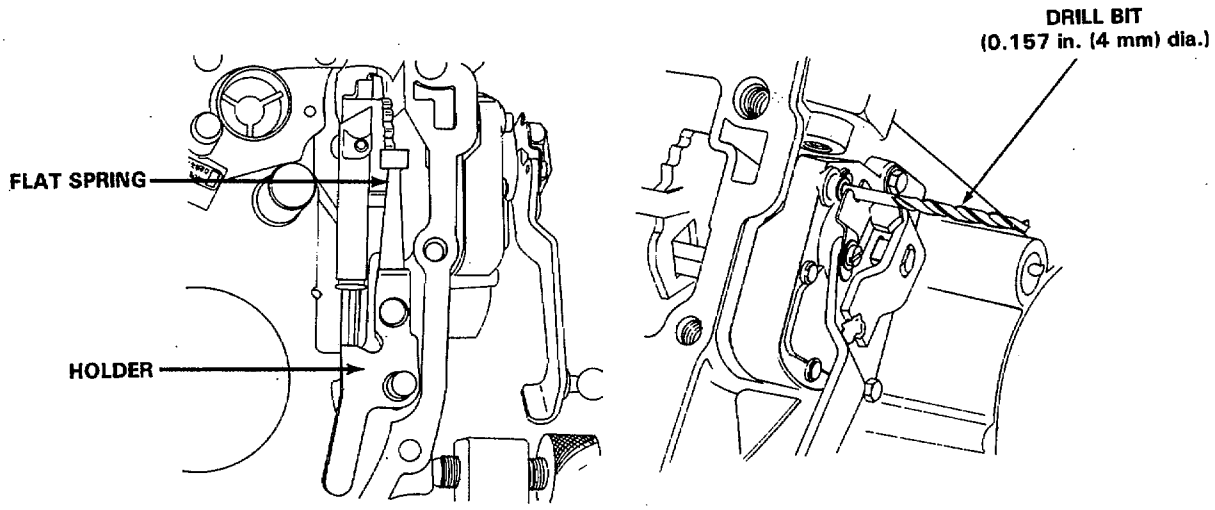


TA259638

Step 9. Install start interlock and reverse switch. Do not tighten mounting screws.
Step 10. Put catch with link rod into housing.
Step 11. Put on gear selector arm. Mesh with catch teeth.
Step 12. Put in clamp screw. Torque clamp screw to 7 lb. ft. (10 Nm).
Step 13. Tighten and torque mounting screws to 4 lb. ft. (5 Nm).

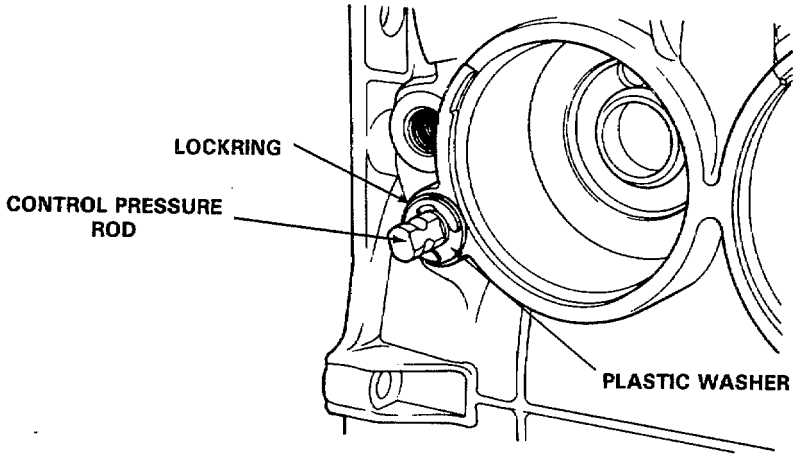


Step 14. Put on flat spring complete with screw and lock ring.
Step 15. Put selector arm in Neutral (N) position.
Step 16. Put on holder and torque screw to 7 lb. ft. (10 N*m).*
Step 17. Use a 0.157 in. (4 mm) diameter drill bit in screw head. Align contact arm and tighten catch screw. Remove drill bit.

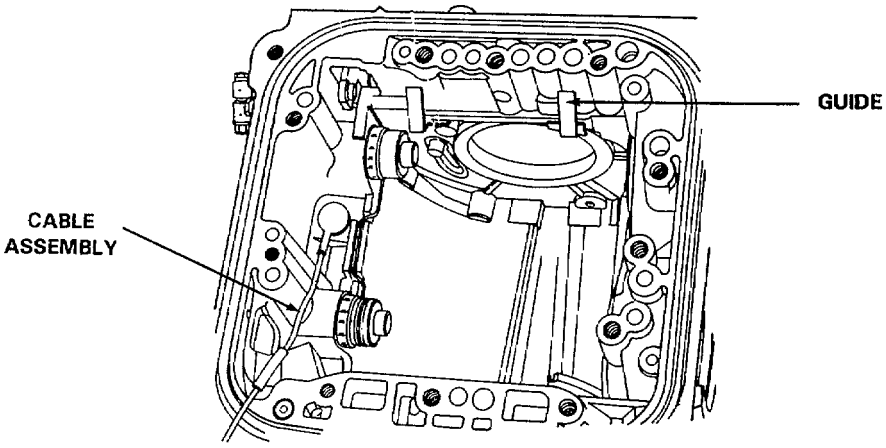


Step 18. Put new seal on control pressure rod.
Step 19. Put in control pressure rod with a new plastic washer.
Step 20. Put on lock ring.

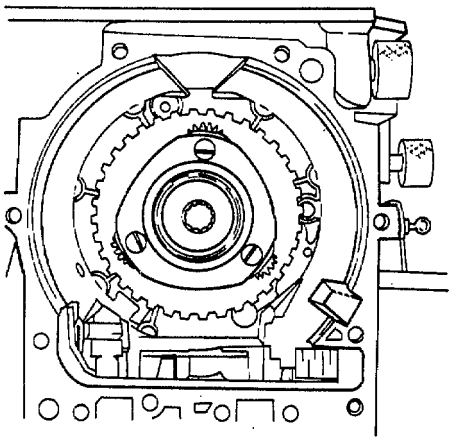
TA259639



Step 21. Put in cable assembly.
Step 22. Put in plastic guide for B2 brake band.



Step 23. Put output shaft in transmission housing.

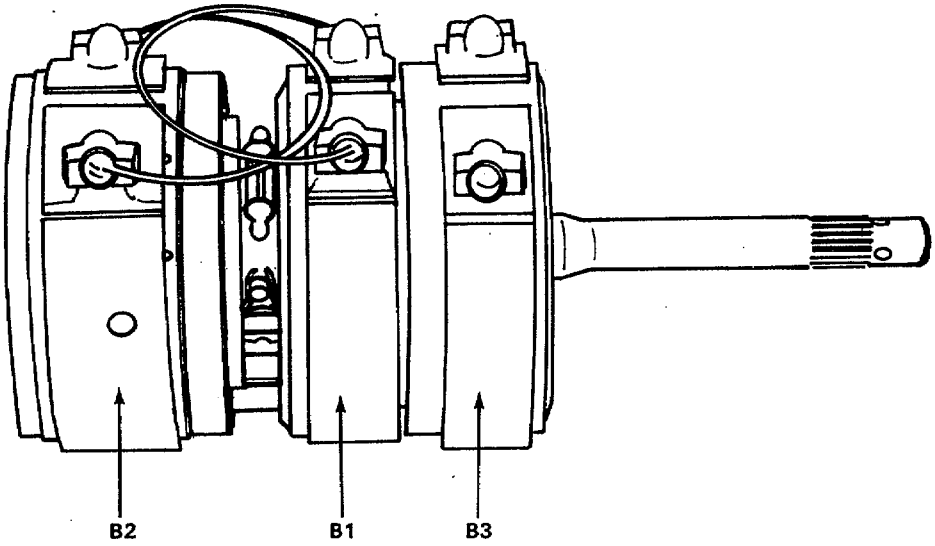


TA259640

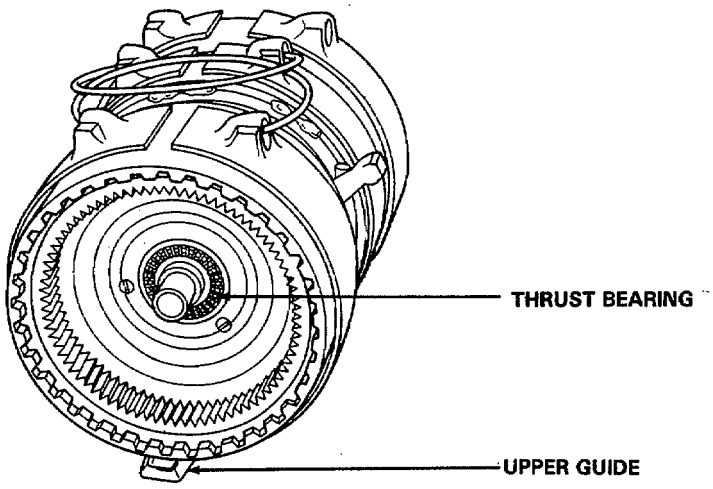
NOTE

B1 and B3 brake bands are same size. B1 brake band has less tension when compressed.

Step 24. Put brake bands on planetary gearing assembly.
Step 25. Lay planetary gearing assembly with brake bands on upper guide.
Step 26. Use B2 and B3 piston cap lock rings. Hook together ends of B1 and B2 brake bands.

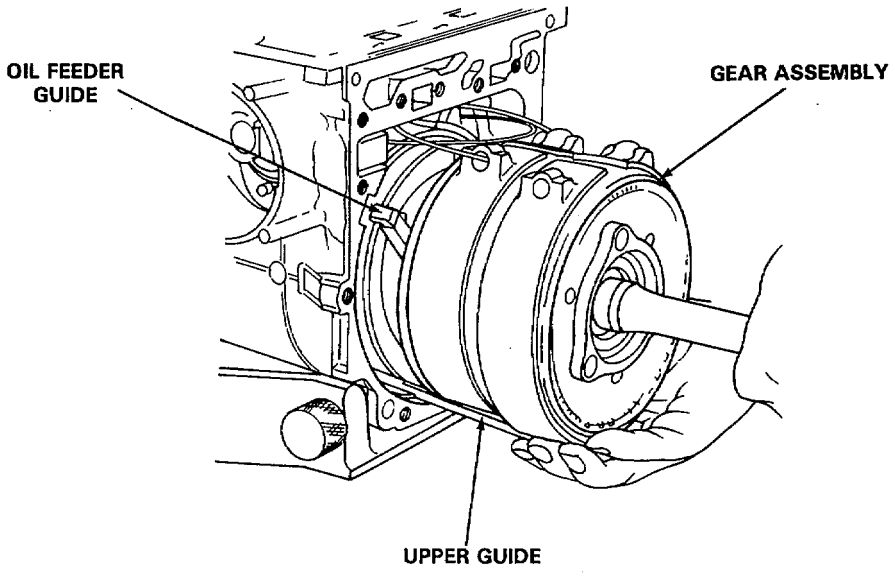


Step 27. Check thrust bearing. Bearing must be in place.

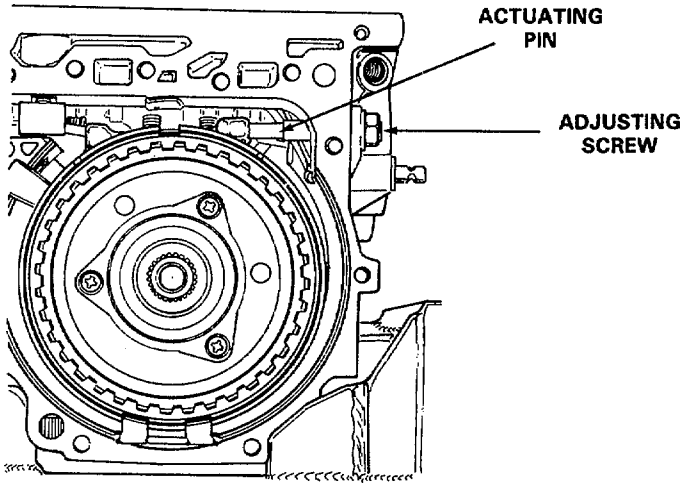


Step 28. Put gear assembly with brake bands and upper guide into transmission housing. Make sure oil feeder guide goes into groove in transmission housing.

TA259641

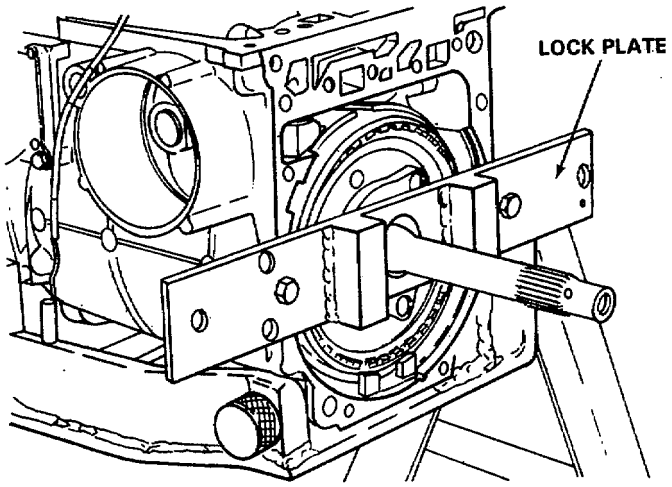


Step 29. Remove lock rings from B1 and B2 brake bands.
Step 30. Put in two B3 brake actuating pins.
Step 31. Put sealing compound on adjusting screw. Put adjusting screw into transmission housing.
Step 32. Tighten adjusting screw until B3 brake band is held in place.

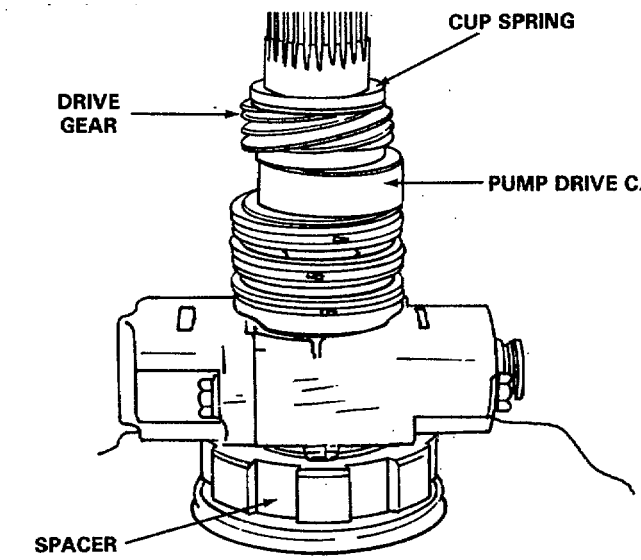


TA259642

Step 33. Put lock plate on transmission housing. Refer to table 2-1, item 22.
Step 34. Turn transmission housing until output shaft is pointing up.

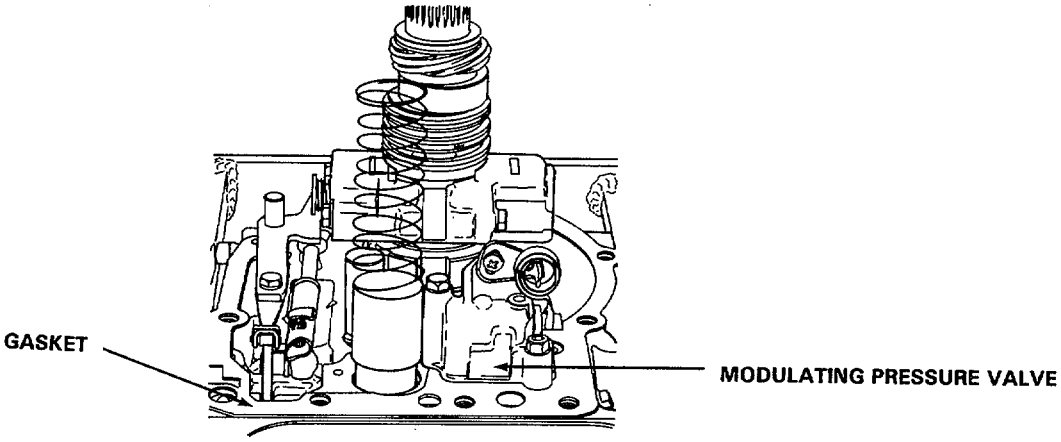


Step 35. Put spacer, centrifugal governor and pump drive cam on output shaft.
Step 36. Put drive gear on output shaft. Wide side of gear toward governor.
Step 37. Put cup spring on output shaft. Put convex side of cup spring toward drive gear.

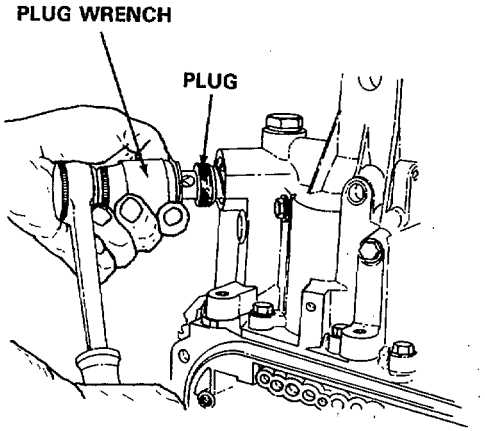


Step 38. Put new gasket on transmission rear housing.
Step 39. Put in modulating pressure valve and mounting screws.
Step 40. Torque mounting screws to 5 lb. ft. (7 Nm).
Step 41. Move secondary pump piston.
Step 42. Put in servo accumulator piston and spring.

TA259643

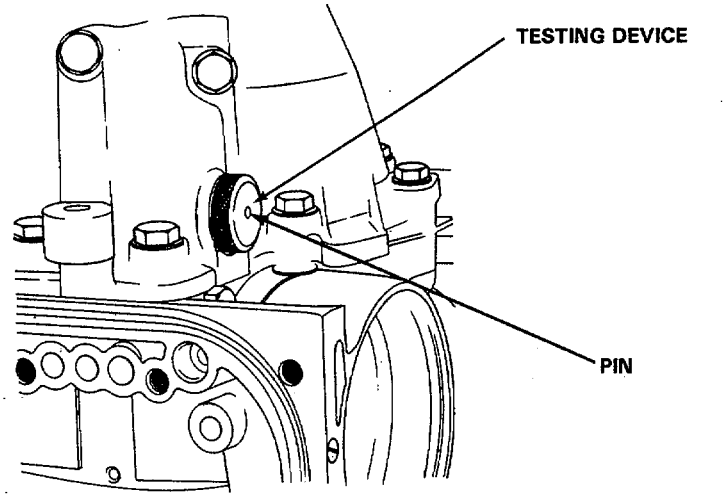


Step 43. Put rear housing on transmission housing.
Step 44. Put bracket in place. Put in rear housing mounting screws. Torque screws to 10 1b. ft. (13 Nm).
Step 45. Put in new secondary pump preformed packing.
Step 46. Put in spring and plug.
Step 47. Use plug wrench. Tighten plug. Refer to table 2-1, item 11.

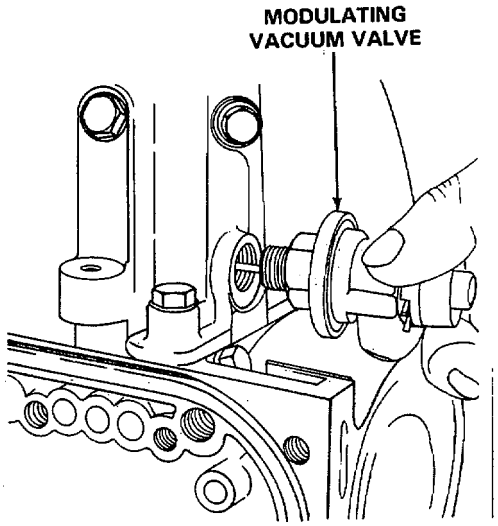


TA259644

Step 48. Put testing device into housing. Tighten finger tight. Refer to table 2-1, item 15.
Step 49. Use different length actuating pins. Insert pin into testing device until tip of pin makes contact inside housing. End of pin must be even with surface of testing device. Keep inserting different pins until correct length pin is found.
Step 50. Remove testing device.

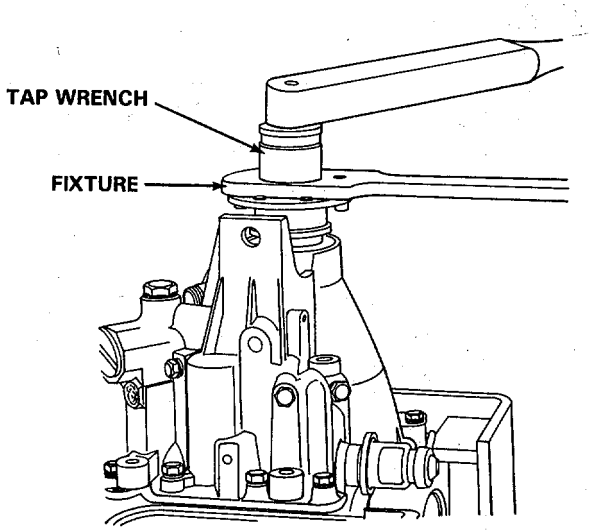


Step 51. Glue actuating pin into modulating vacuum valve. Refer to appendix B, item 46.
Step 52. Screw modulating vacuum valve into rear housing.

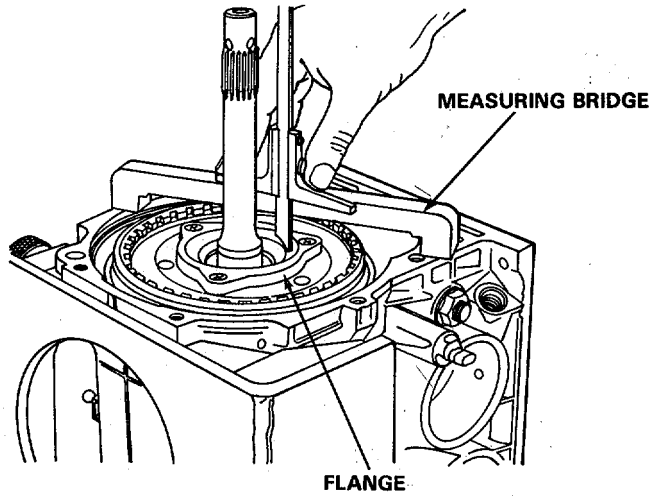


Step 53. Put new preformed packing on speedometer gear housing.
Step 54. Put new seal in speedometer gear housing.
Step 55. Put speedometer gear into housing.
Step 56. Put speedometer gear adapter in rear housing. Put in mounting washer and screw.
Step 57. Torque mounting screw to 6 lb. ft. (8 Nm).
Step 58. Put washer and drive flange on output shaft.
Step 59. Put locknut on output shaft.
Step 60. Use tap wrench and fixture. Tighten locknut. Torque-to 87 lb. ft. (118 Nm). See table 2-1, items 13 and 14.
Step 61. Punch flange of locknut into groove of output shaft.

TA259645

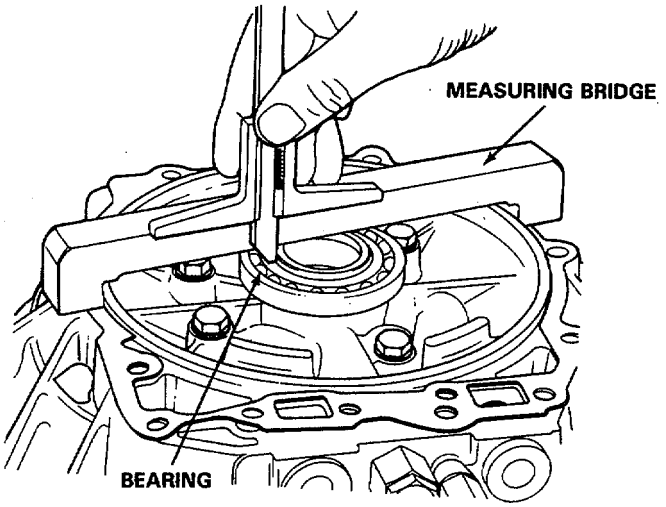


Step 62. Turn transmission until output shaft is down.
Step 63. Remove lock plate.
Step 64. Place measuring bridge on transmission housing flange. Measure distance from top of measuring bridge to inner flat surface of support flange. Refer to table 2-1, item,26.

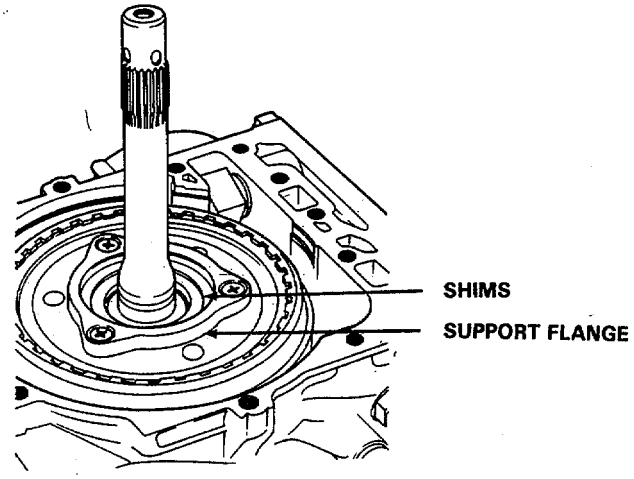


TA259646

Step 65. Subtract height of measuring bridge (measuring bridge = 30 mm). Record measurement A.
Step 66. Put a new gasket on transmission front housing.
Step 67. Place measuring bridge on transmission front housing.
Step 68. Measure distance from top of measuring bridge to bearing.
Step 69. Subtract from height of measuring bridge (measuring bridge = 30 mm). Record measurement B.

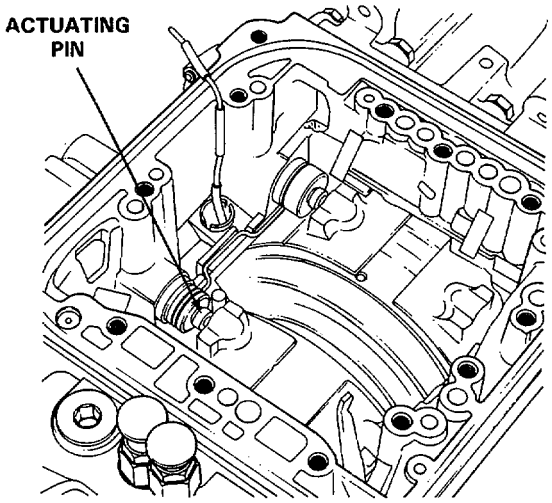


Step 70. Clearance C = A - B. Clearance must be 0.0157 to 0.0196 in. (0.4 to 0.5 mm).
Stop 71. Add shims to support flange to adjust clearance C.
Step 72. Put pressure seal on input shaft.
Step 73. Put front housing on transmission housing.
Step 74. Put in housing screws. Torque screws to 10 1b. ft. (13 Nm).

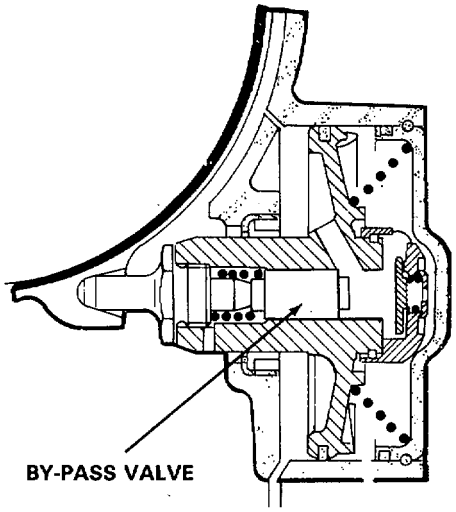


TA259647

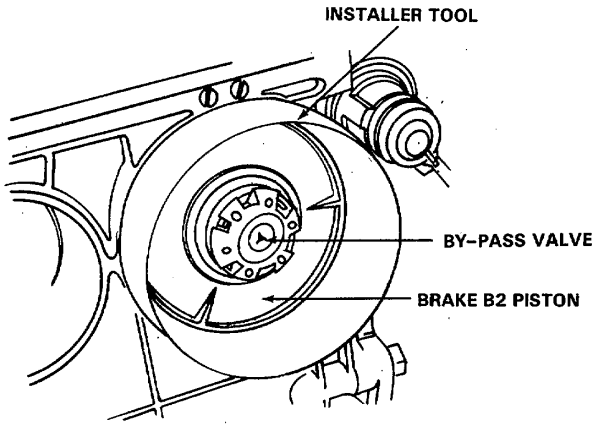
Step 75. Put actuating pins in brake B2 and brake B1. Longer pin is for brake B2.



Step 76. Put in new oil seal for brake B2 by-pass valve.

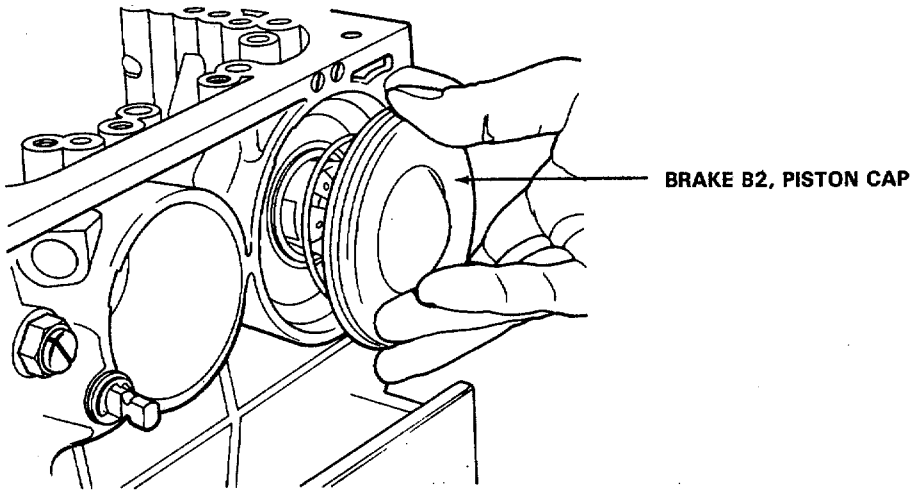


Step 77. Use installer tool. Put in brake B2 piston. Actuating pin must be seated in brake band. Refer to table 2-1, item 23.

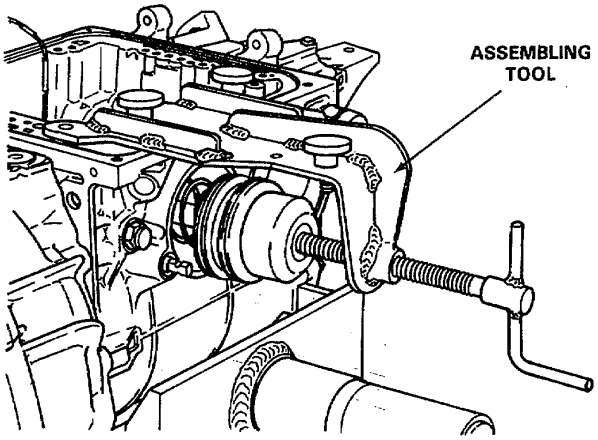


TA259648

Step 78. Put new seal ring in brake B2 piston cap.
Step 79. Put spring and preformed packing into brake B2 piston cap.
Step 80. Put in brake B2 piston cap. Put in lockring.

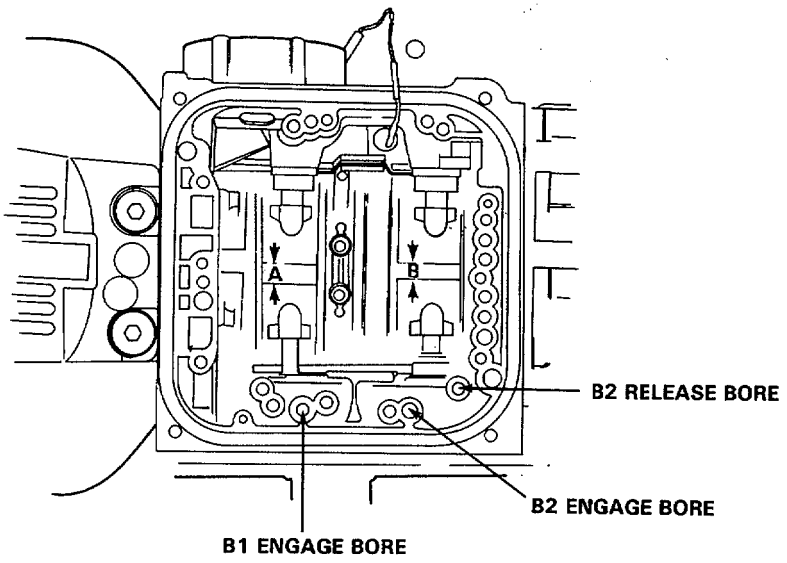


Step 81. Put assembling tool on transmission. Refer to table 2-1, item 27.
Step 82. Put new seal and springs on brake B1 piston.
Step 83. Put new preformed packing on brake B1 piston cap.
Step 84. Press in brake B1 piston and cap. Spring must center on guide.
Step 85. Put on lockring. Remove assembling tool.

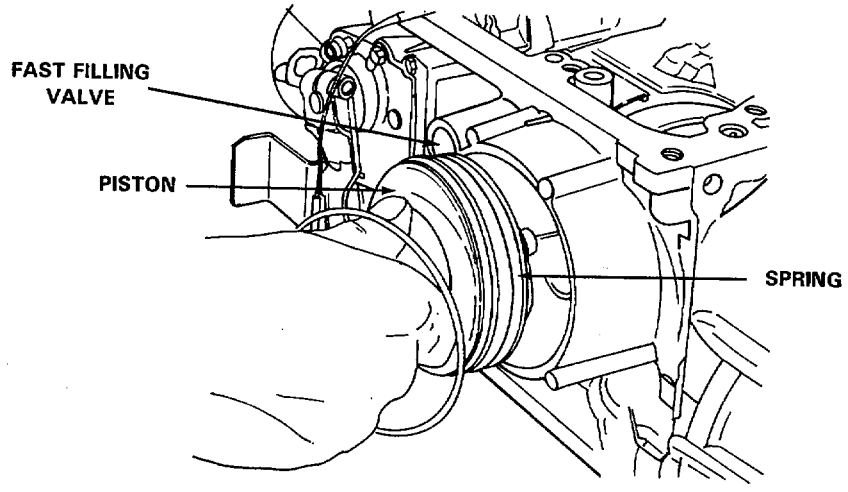


Step 86. Apply air pressure to B2 release bore until piston B2 is lifted.
Step 87. Measure and record distance B.
Step 88. Apply air pressure to B2 engage bore until piston B2 is engaged.
Step 89. Measure and record distance B.
Step 90. Determine the difference between the two distance B measures to get clearance L. Clearance L must be 0.11 8 to 0.157 in. (3 to 4 mm).
Step 91. Adjust clearance L by putting in different length actuating pin.
Step 92. Measure and record distance A for brake B1.
Step 93. Apply air pressure to B1 engage bore until B1 piston is in engage position.
Step 94. Measure and record distance A.
Step 95. Determine the difference between the two distance A measurements to get clearance L. Clearance L must be 0.118 to 0.157 in. (3 to 4 mm).
Step 96. Adjust clearance L by putting in different length actuating pin.

TA259649

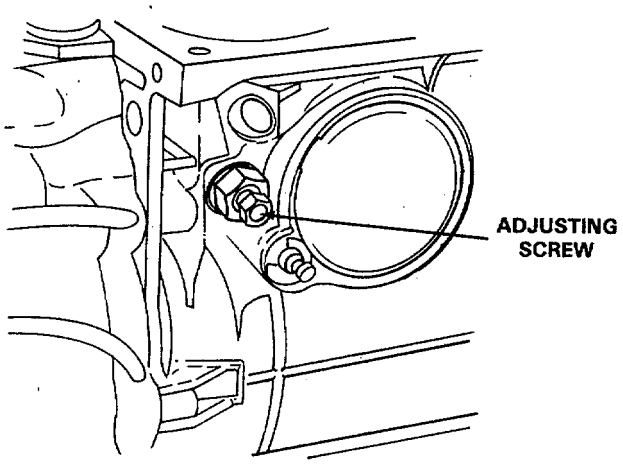


Step 97. Put new seal on B3 brake piston.
Step 98. Put spring and B3 piston into transmission housing.
Step 99. Put new preformed packing on piston cap.
Step 100. Put in fast filling valve.
Step 101. Put B3 piston cap on housing. Put in lockring.

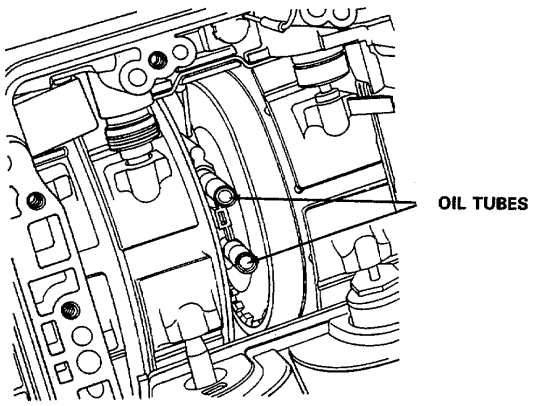


TA259650

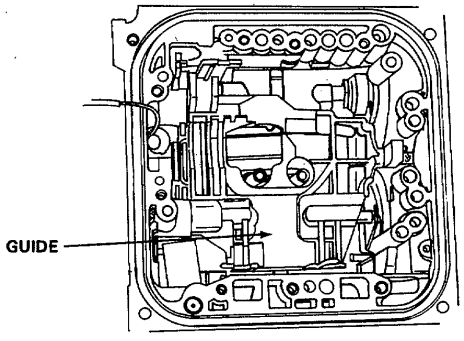
Step 102. Torque B3 brake band adjusting screw to 4 lb. ft. (5 Nm).
Step 103. Turn B3 brake band adjusting screw 1 3/4 turns counter-clockwise.
Step 104. Tighten adjusting screw locknut.
Step 105. Put new seal on plug.
Step 106. Put in plug. Tighten plug.



Step 107. Lubricate new oil tube seals with vaseline. Refer to appendix B, item 45.
Step 108. Install two oil tubes with new seals.

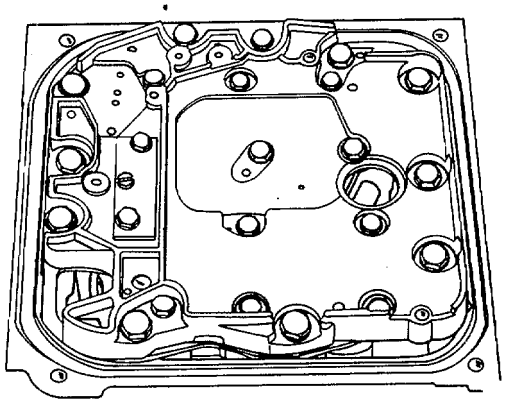


Step 109. Put on brake band guide. Guide must be of the same color as B2 brake band guide.



TA259651

Step 110. Put gear selector arm between P and R position.
Step 111. Put shift valve assembly into transmission. Range selector valve must engage gear selector.
Step 112. Put preformed packing, pick up tube, spacer and mounting bracket in place. Put in mounting screws. Torque screw to 10 lb. ft. (13 Nm).
Step 113. Connect electrical wire to first gear solenoid valve.
Step 114. Put solenoid valve with new gasket into transmission.

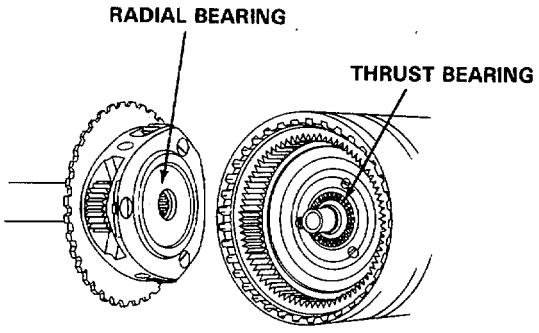


Step 115. Put in oil filter mounting screws. Torque screws to 3 lb. ft. (4 Nm).
Step 116. Put on new filter with preformed packing.
Step 117. Put on mounting nuts. Torque nuts to 3 lb. ft. (4 Nm).
Step 118. Put on oil pan with new gasket.
Step 119. Put on oil pan screw and washer. Torque screws to 5 lb. ft. (7 Nm).
Step 120. Remove transmission from stand.
Step 121. Remove fixture from transmission.
Step 122. Put on control pressure arm.

7-20. REPAIR PLANETARY GEARING.

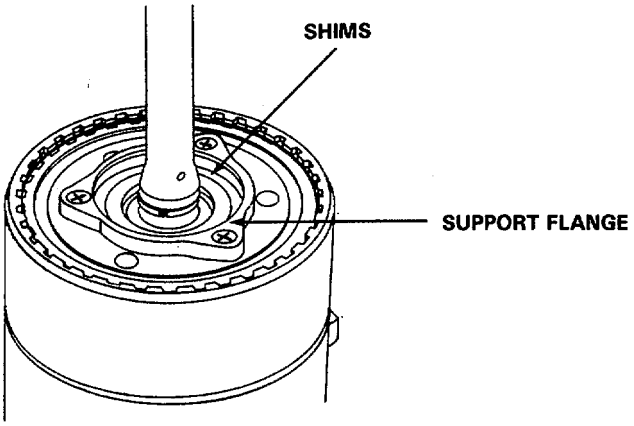
a. Disassemble Planetary Gearing.

Step 1. Remove output shaft with third planetary carrier.
Step 2. Remove radial bearing and thrust bearing.

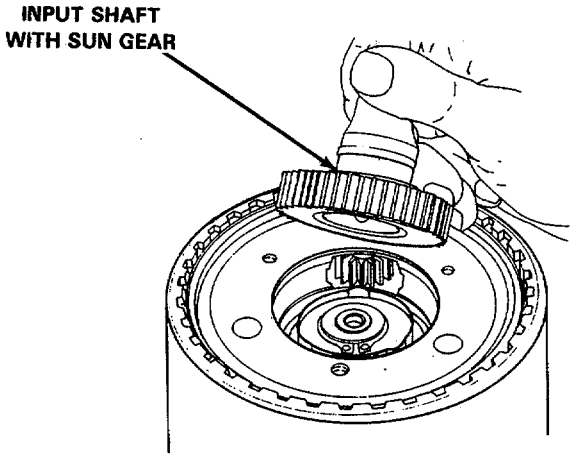


TA259652

Step 3. Stand gear assembly with input shaft up.
Step 4. Remove shims from support flange.
Step 5. Remove flange mounting screws.
Step 6. Remove support flange and thrust washer.

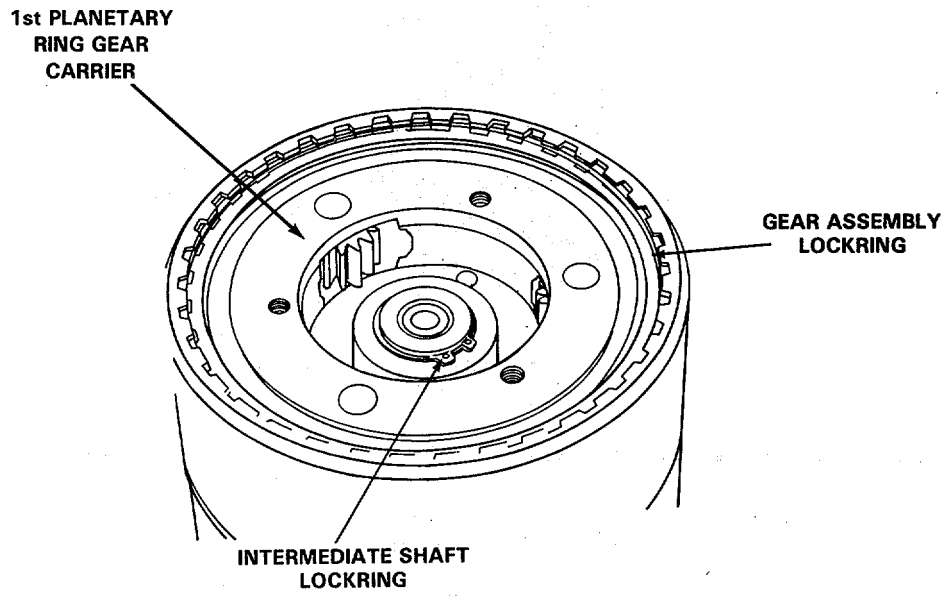


Step 7. Remove input shaft with sun gear.
Step 8. Remove thrust washer.

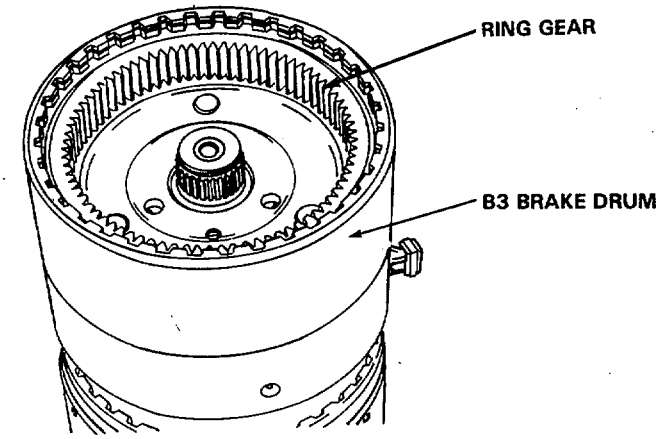


TA259653

Step 9. Remove intermediate shaft lockring.
Step 10. Remove gear assembly lockring.

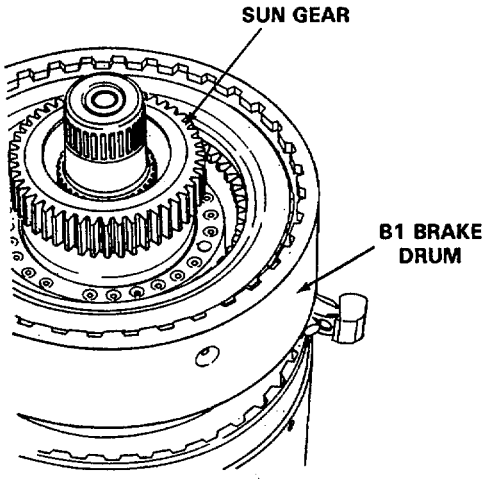


Step 11. Remove first planetary carrier.
Step 12. Remove thrust washer and shims.
Step 13. Remove first planetary ring gear with second planetary carrier.
Step 14. Remove thrust washer and shims.
Stop 15. Remove B3 brake drum.

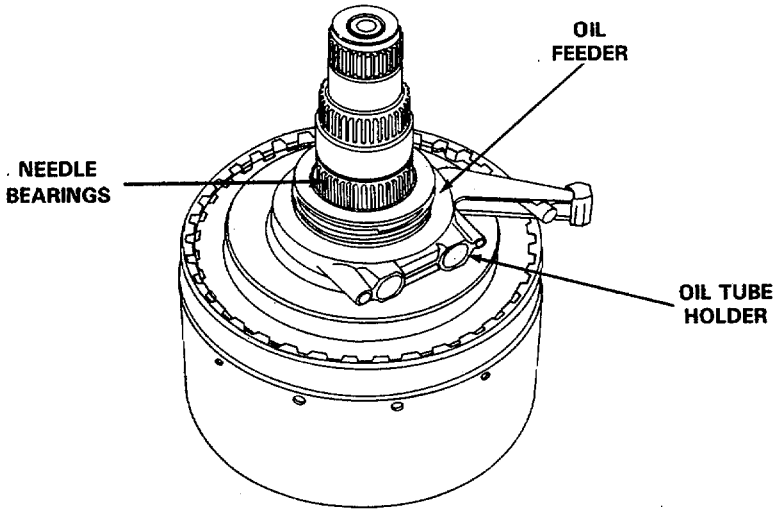


TA259654

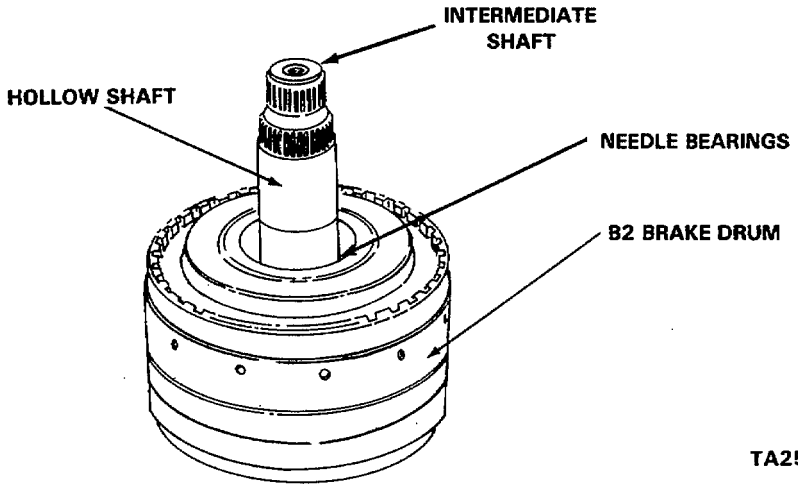
Step 16. Remove second planetary sun gear.
Step 17. Remove B1 brake drum.
Step 18. Remove needle bearing.



Step 19. Remove oil feeder with thrust washers and oil tube holder.



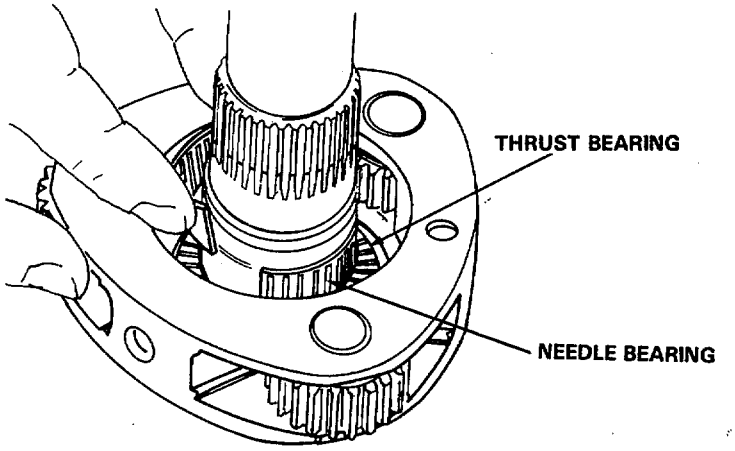
Step 20. Slide hollow shaft with B2 brake drum, K2 clutch and free wheeling clutch off intermediate shaft.



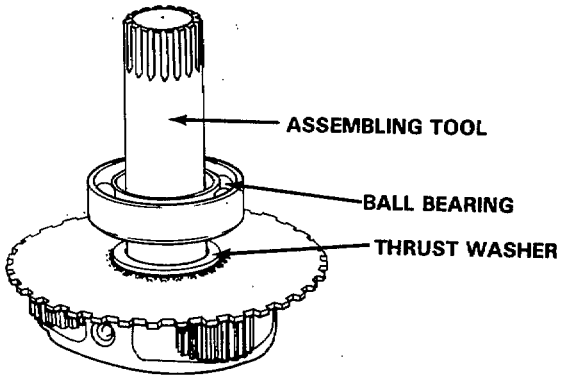
Step 21. Remove needle bearing from hollow shaft.
Stop 22. Remove needle bearing, thrust washer and shims from intermediate shaft.
Stop 23. Use puller. Remove bearing from output shaft.
Step 24. Remove thrust washer.
Step 25. Remove third planetary sun gear.
Step 26. Remove needle bearings.

b. Assemble Planetary Gearing.

Step 1. Inspect oil feeder assembly for damage, Replace damaged oil feeder assembly.
Step 2. Lubricate thrust and needle bearing with vaseline. Refer to appendix B, item 45.
Step 3. Put bearings on output shaft.

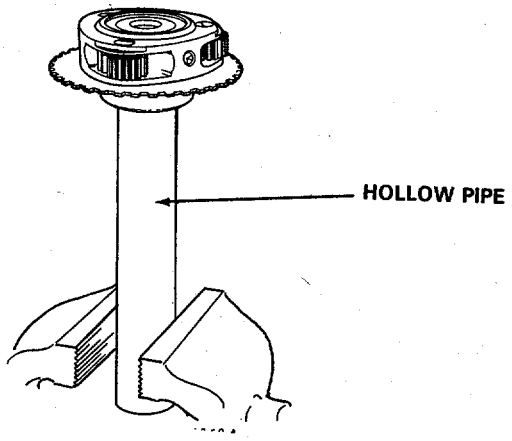


Step 4. Install sun gear on output shaft.
Step 5. Put on thrust washer. Beveled side toward sun gear.
Step 6. Press ball bearing on shaft.

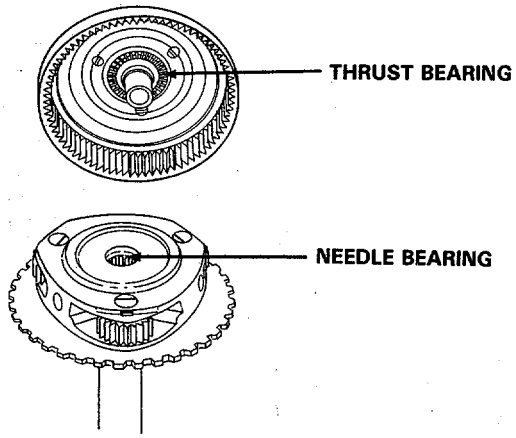


Step 7. Put output shaft in hollow pipe. Secure pipe in vise.

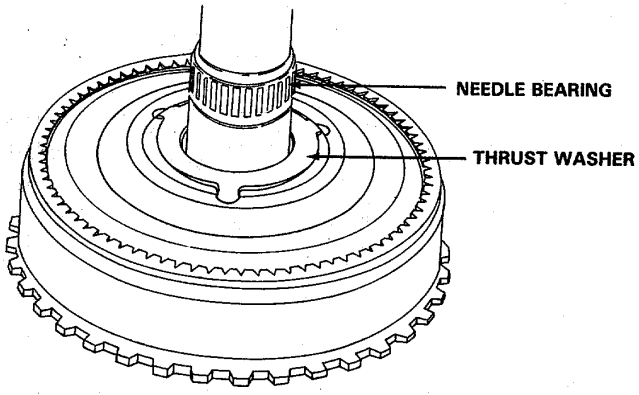
TA259656



Step 8. Lubricate needle bearing and thrust bearing with vaseline.
Step 9. Put needle bearing into output shaft.
Step 10. Put thrust bearing on intermediate shaft.
Step 11. Put intermediate shaft on output shaft.

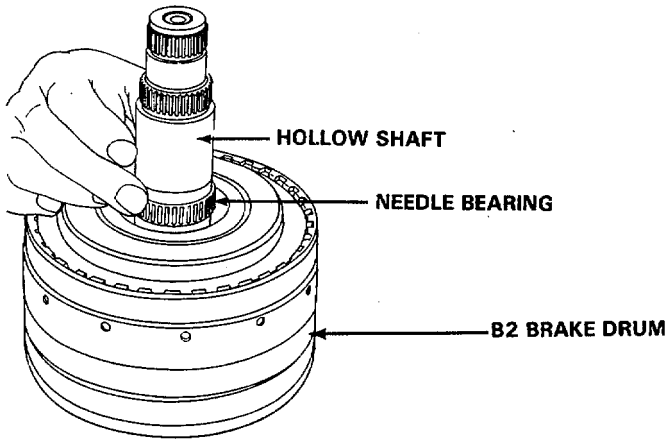


Step 12. Put thrust washer and needle bearing on intermediate shaft.

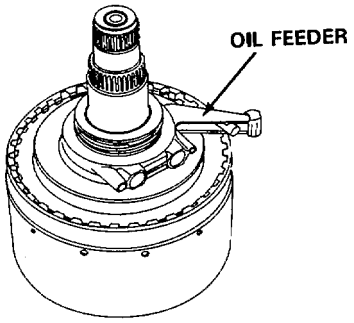


TA259657

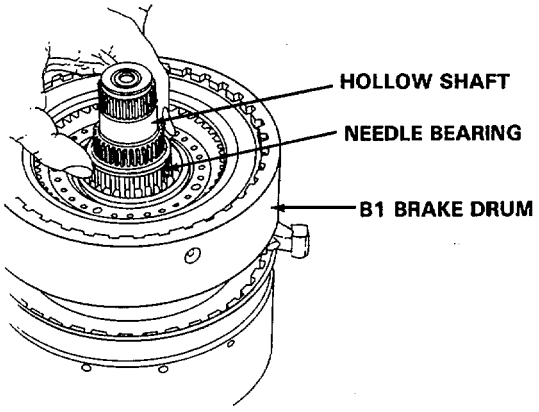
Step 13. Put hollow shaft with B2 brake drum on intermediate shaft.
Step 14. Put on needle bearing.



Step 15. Press oil feeder on B2 brake drum. Both seals must enter K2 clutch flange.

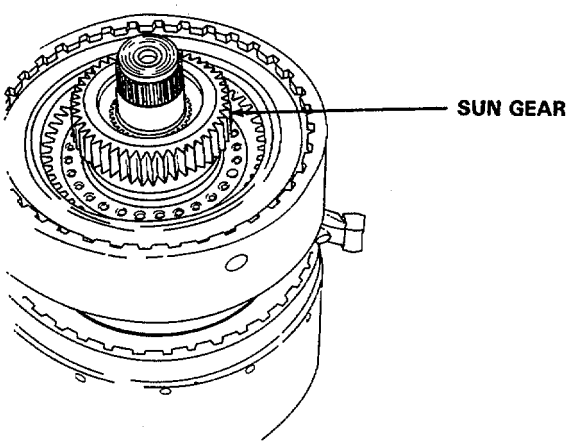


Step 16. Put on B1 brake drum with K1 clutch installed.
Step 17. Lubricate needle bearing with vaseline. Put on needle bearing.

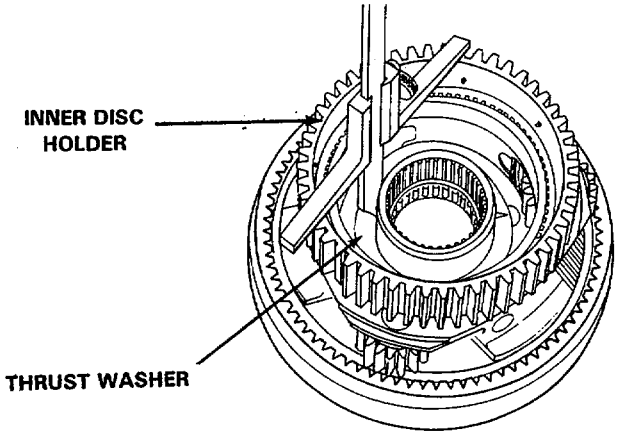


TA259658

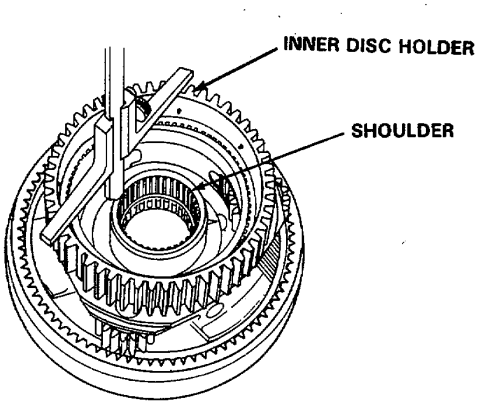
Step 18. Put on second planetary sun gear.



Step 19. Put thrust washer in inner disc holder.
Step 20. Measure and record distance A, K1 clutch inner disc holder to thrust washer.

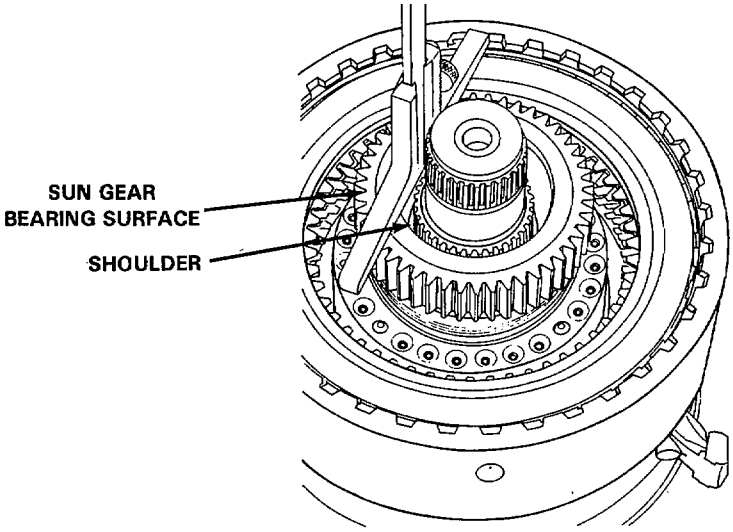


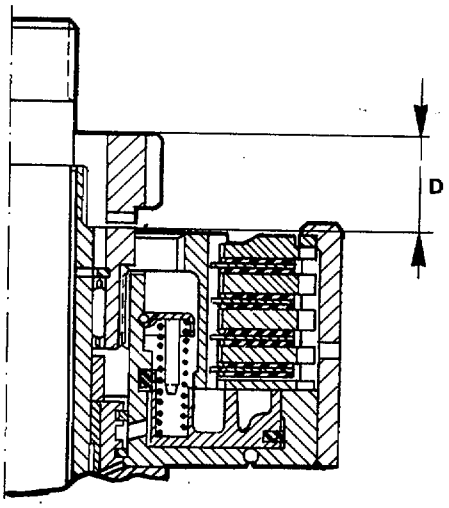
Step 21. Measure and record distance B, K1 clutch inner disc holder to shoulder.



TA259659

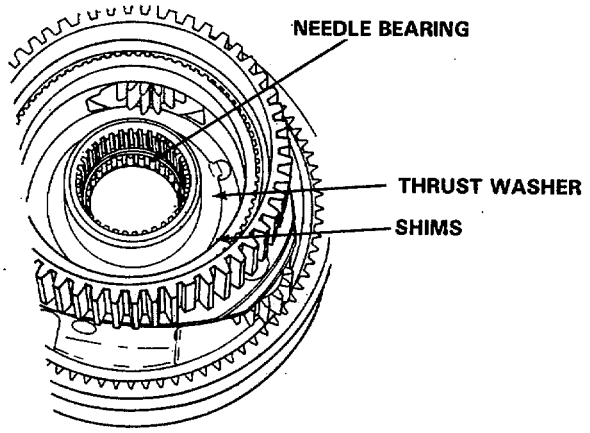
Step 22. Measure and record distance D, sun gear bearing surface to hollow shaft shoulder.





TA259660

Step 23. Determine clearance. S = A - B - D proper clearance is 0.0078 to 0.0118 in. (0.2 to 0.3 mm).
Step 24. Place shims under thrust washer in inner disc holder to get proper S clearance.
Step 25. Lubricate needle bearing and thrust washer with vaseline.
Step 26. Put needle bearing in gear carrier. Insure shims and thrust washer are in place.

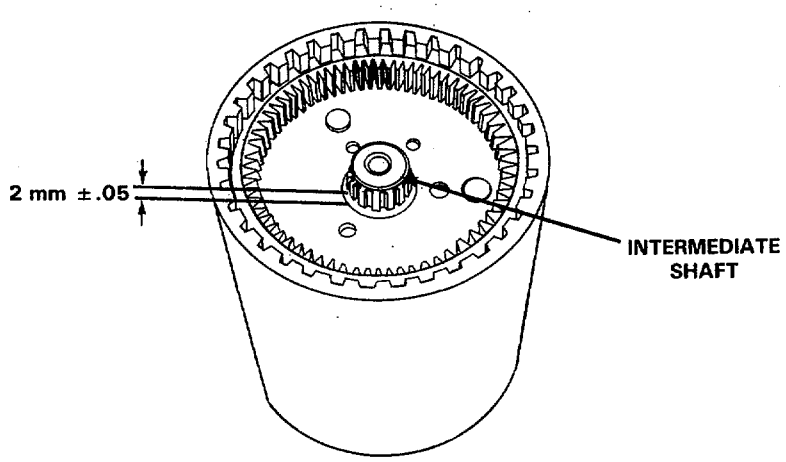


Step 27. Place B2 brake drum on top of gear assembly.

NOTE

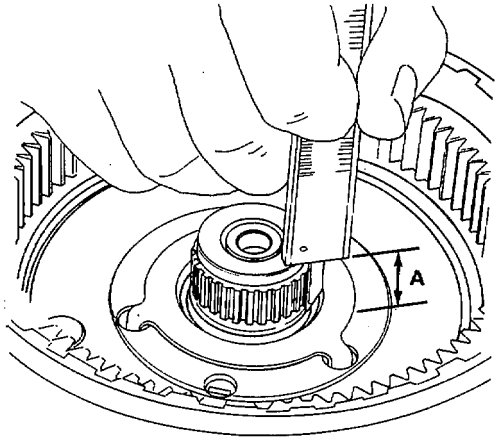
Second planetary gear and shoulder of hollow shaft must have 2 mm ±.05 distance.

Step 28. Put second planetary carrier with K1 disc holder and first planetary ring gear in place.

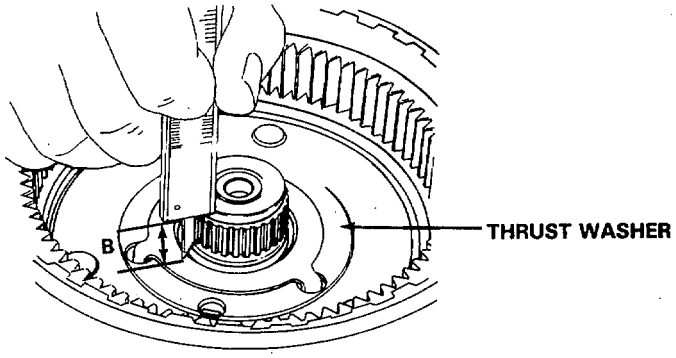


TA259661

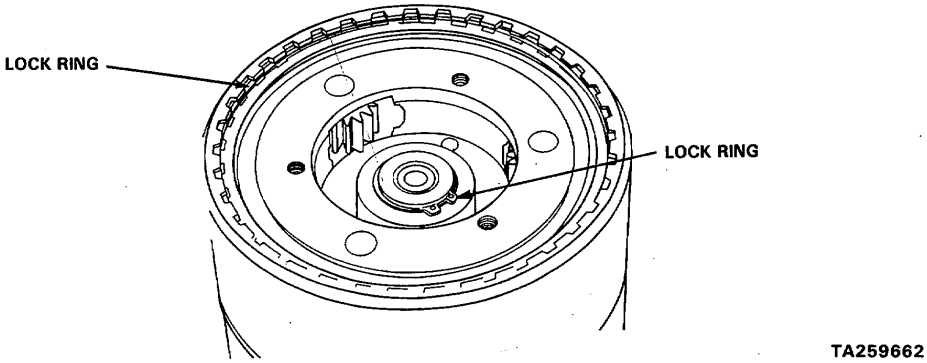
Step 29. Put in thrust washer.
Step 30. Measure and record distance A, upper edge of intermediate shaft to intermediate shaft shoulder.



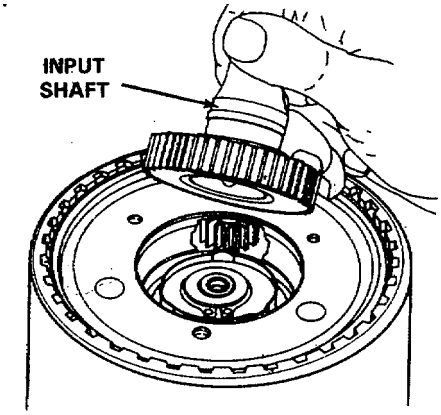
Step 31. Measure and record distance B, upper edge of intermediate shaft to thrust washer.



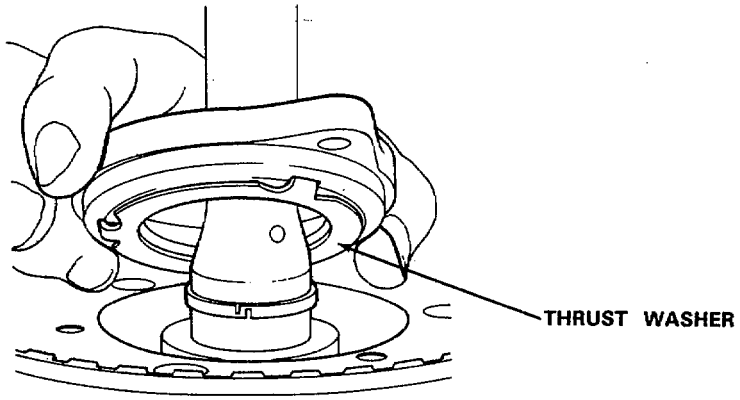
Step 32. Determine clearance S. S = B - A proper clearance is 0.0078 to 0.011 8 in. (0.2 to 0.3 mm).
Step 33. Place shims under thrust washer to get proper S clearance.
Step 34. Put in first planetary carrier.
Step 35. Put lockring on intermediate shaft.
Step 36. Press B3 brake drum upwards. Put in lockring.



Step 37. Put in thrust washer.
Step 38. Put in input shaft.

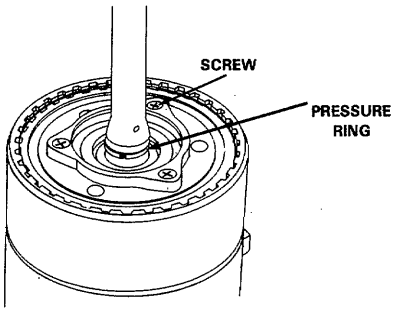


Step 39. Put on thrust washer and support flange.



TA259650

Step 40. Put in flange screws. Torque screws to 5 lb. ft. (7 Nm).
Step 41. Install new pressure ring in groove.

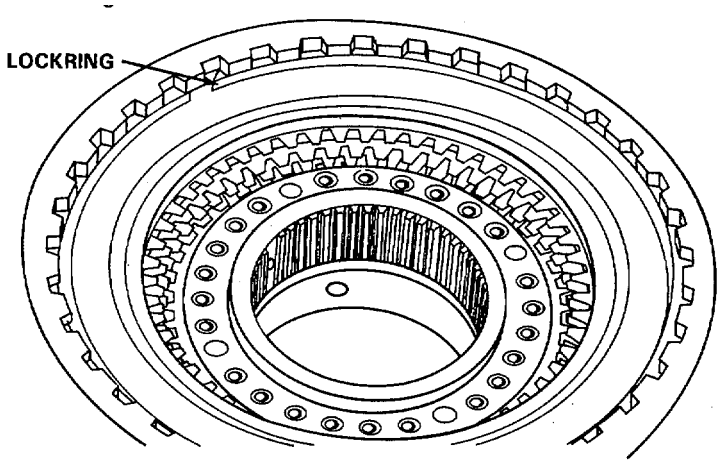


TA259663

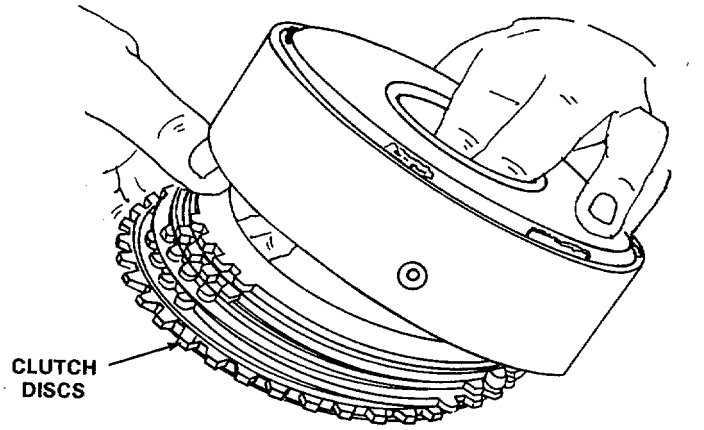
7-21. REPAIR K1 CLUTCH.

a. Disassemble K1 Clutch.

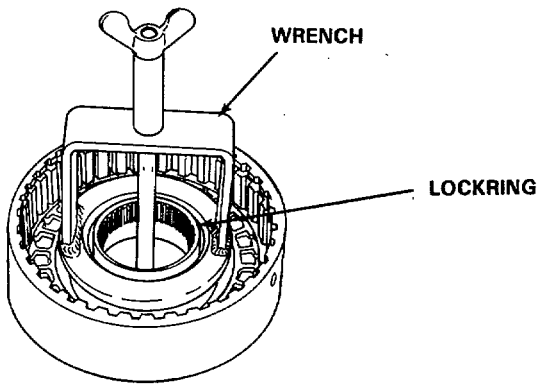
Step 1. Remove lockrinq.



Step 2. Remove clutch discs.
Step 3. Use automatic transmission fluid. Clean clutch discs. Refer to appendix B, item 4.

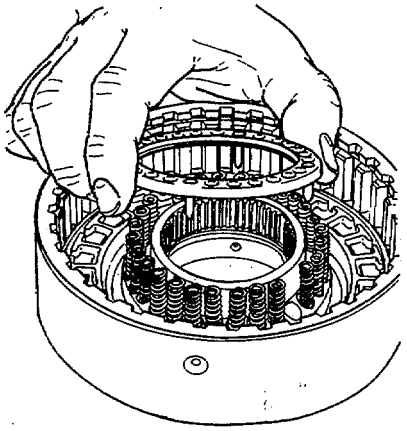


Step 4. Use wrench. Press down spring holder. Refer to table 2-1, item 1 9.
Step 5. Remove lockring.

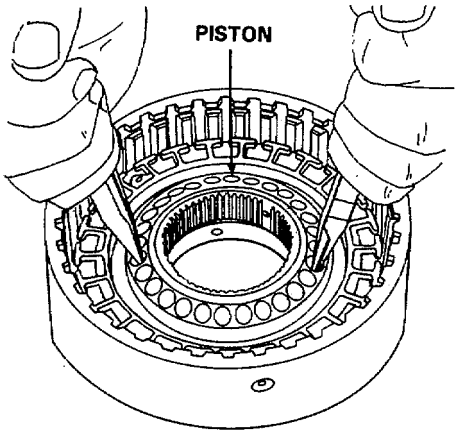


TA259664

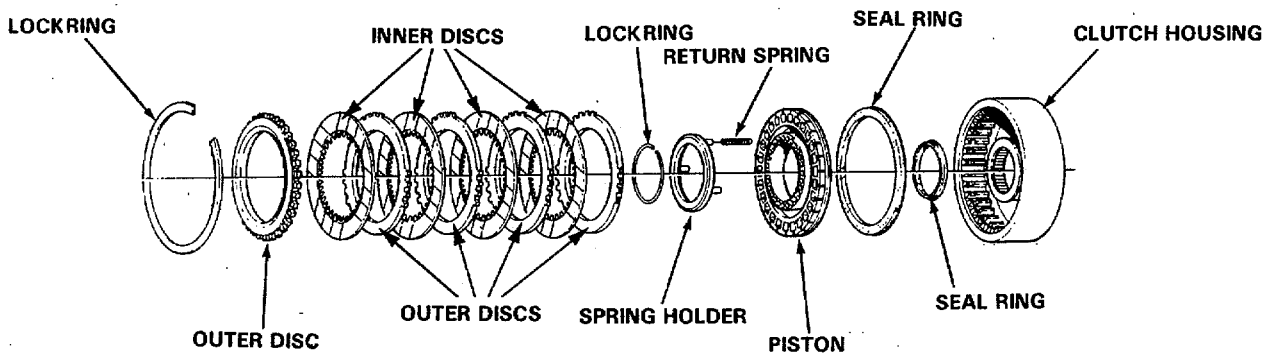
Step 6. Remove wrench. Remove spring holder.
Step 7. Remove springs.



Step 8. Pull clutch piston out of brake drum.
Step 9. Remove seals.

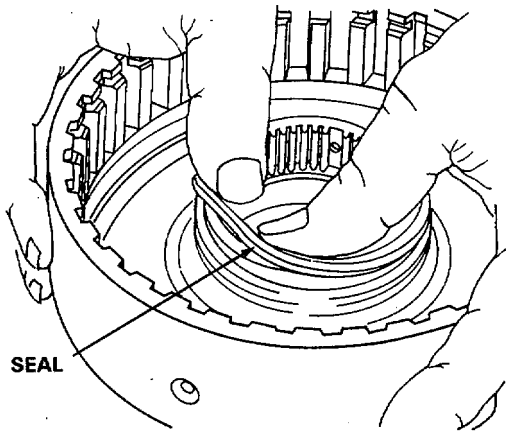


b. Assemble K1 Clutch.

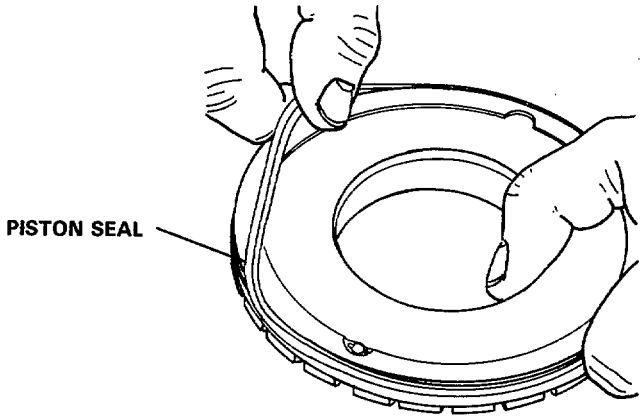


TA259665

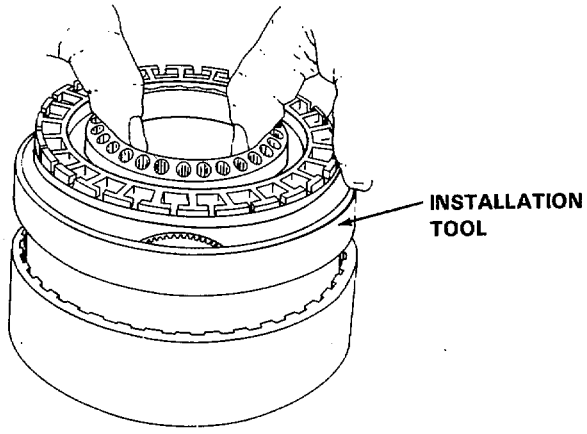
Step 1. Put new seal in groove. Sealing edge facing down.



Step 2. Put installation tool in support flange. Refer to table 2-1, item 24.
Step 3. Put on new piston seal. Sealing edge up.



Step 4. Lubricate piston and seal with vaseline. Refer to appendix B, item 45.
Step 5. Place piston in installation tool.
Step 6. Press piston into brake drum. Remove installation tool.

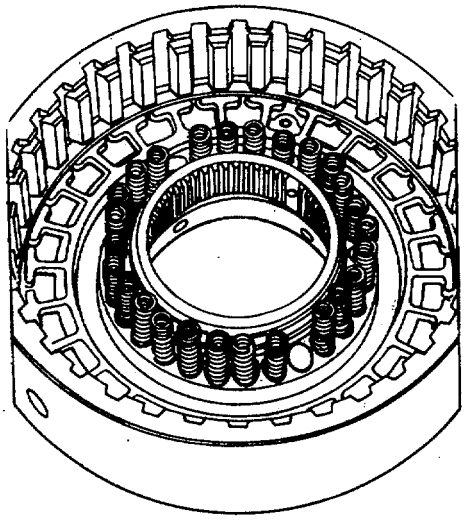


TA259666

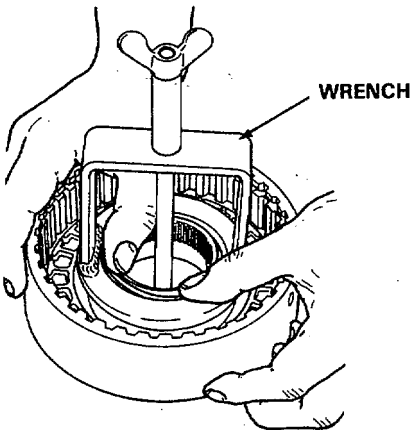
NOTE

There are 25 to 28 springs. They must be distributed evenly.

Step 7. Put springs in piston.



Step 8. Put on spring holder.
Step 9. Use wrench. Press down spring holder. Refer to table 2-1, item 1 9.
Step 10. Put in lockring.



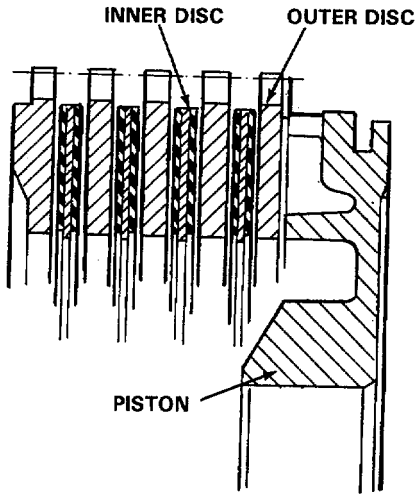
Step 11. Remove wrench.
Step 12. Inspect clutch discs. Replace burnt or bent discs with new discs.

NOTE

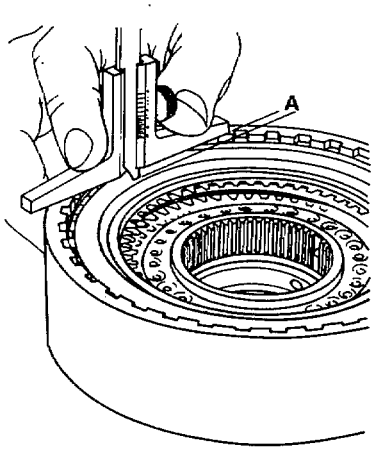
New discs must be soaked in automatic transmission fluid for one hour before assembling.

TA259667

Step 13. Place thin outer disc on piston.
Step 14. Alternately replace remaining inner and outer discs.

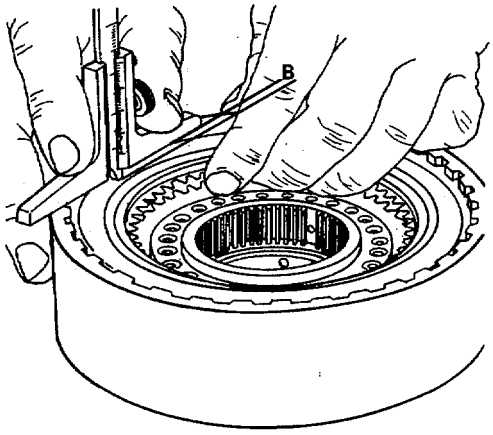


Step 15. Press lockring into groove.
Step 16. Measure and record distance A. Tip of depth gage resting tightly on clutch disc assembly.



TA259668

Step 17. Force outer disc up as far as possible.
Step 18. Measure and record distance B.

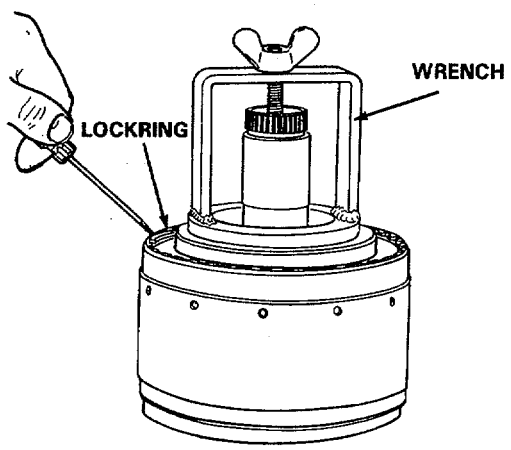


Step 19. Subtract measurement B from measurement A to get clearance. Clearance must be between 0.031 and 0.047 in. (0.8 and 1.2 mm).
Step 20. Adjust clearance by installing outer discs of a different thickness.

7-22. REPAIR K2 CLUTCH.

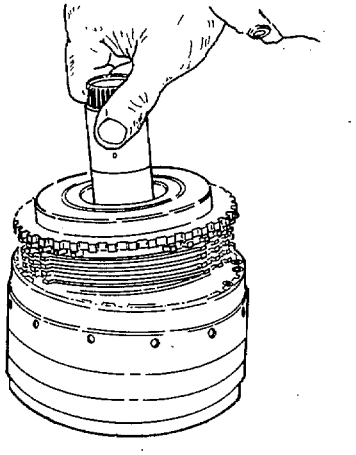
a. Disassemble K2 Clutch.

Step 1. Use wrench. Press down support flange. Refer to table 2-1, item 19.
Step 2. Remove lockring.
Step 3. Remove wrench.

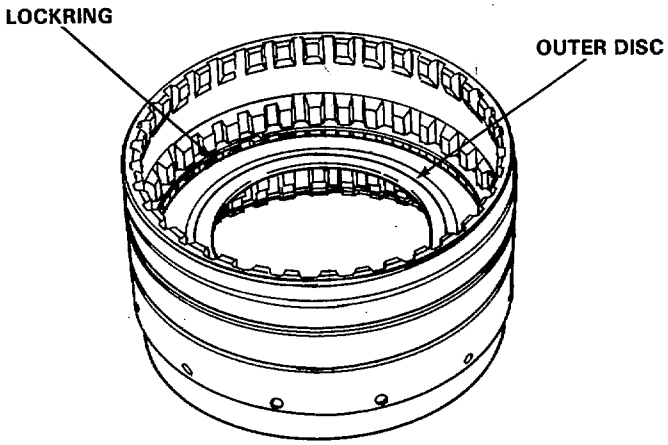


TA259669

Step 4. Remove hollow shaft with support flange, piston and clutch discs.

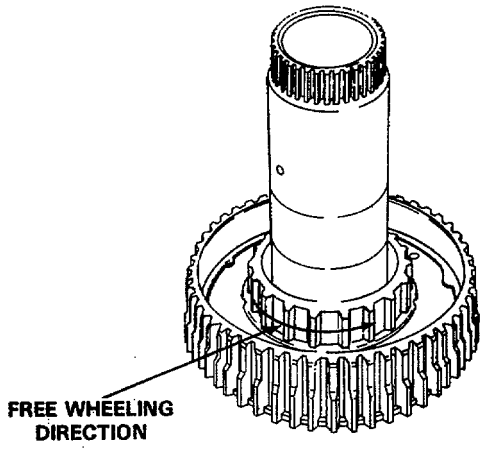


Step 5. Remove return springs.
Step 6. Turn brake drum over. Remove lockring.
Step 7. Remove outer disc and guide ring.

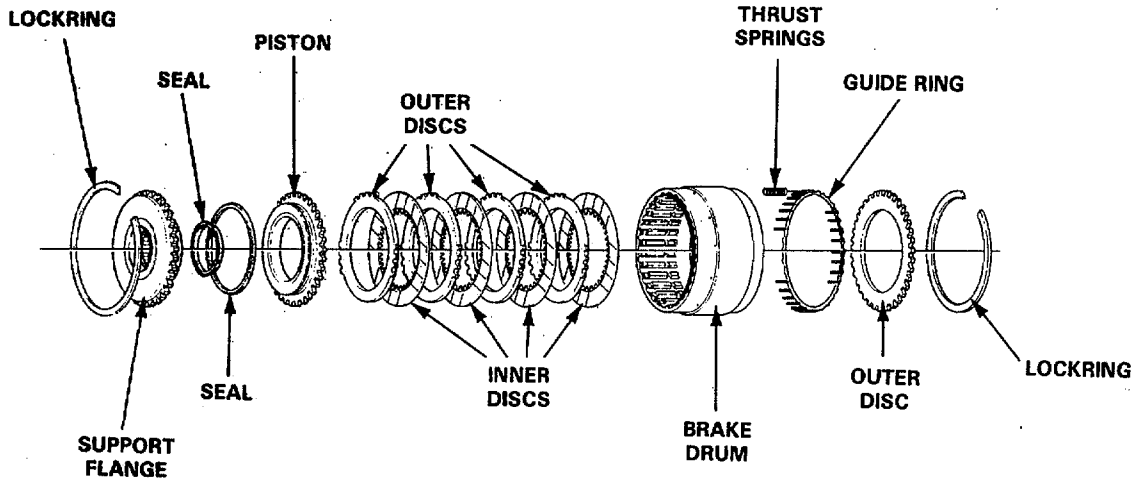


TA259670

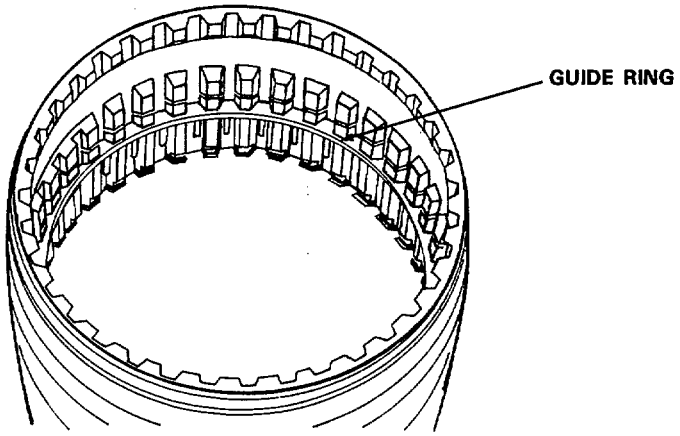
Step 8. Remove support flange and clutch piston from hollow shaft.
Step 9. Remove piston from support flange.
Step 10. Remove clutch discs.
Step 11. **I**nspect clutch discs. Replace burnt or bent discs with new discs. Soak new disc in automatic transmission fluid for one hour.
Step 12. Check rotation of freewheeling clutch. Clutch must only rotate counter-clockwise. If clutch is defective replace with new hollow shaft and clutch.



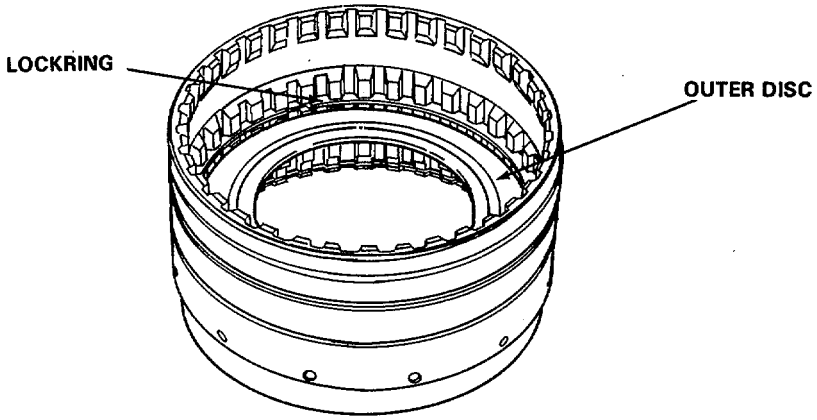
b. Assemble K2 Clutch.



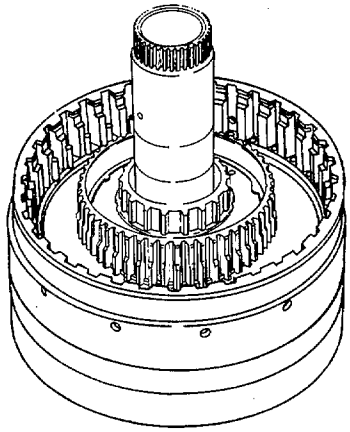
Step 1. Put guide ring in B2 brake drum. **TA259671**



Step 2. Put in outer disc with curved side up.
Step 3. Put in thick lockring.

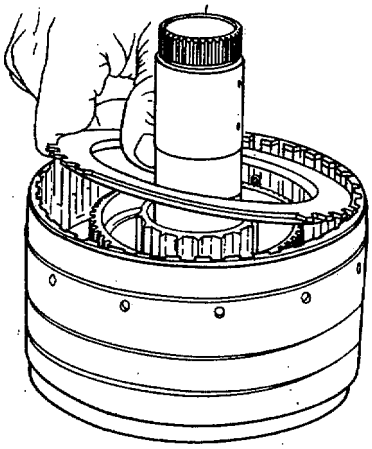


Step 4. Turn brake drum over. Put in hollow shaft.

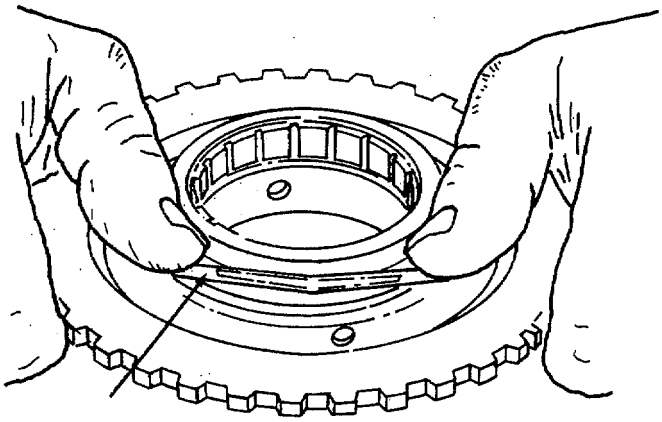


TA259672

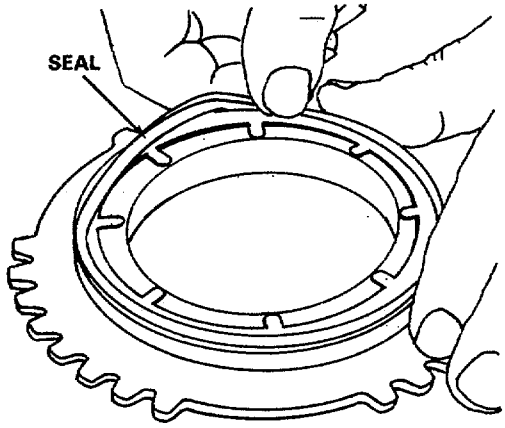
Step 5. Alternately install inner and outer brake discs.



Step 6. Put new seal on support flange. Sealing edge down.



Step 7. Put new seal on clutch piston. Sealing edge up.



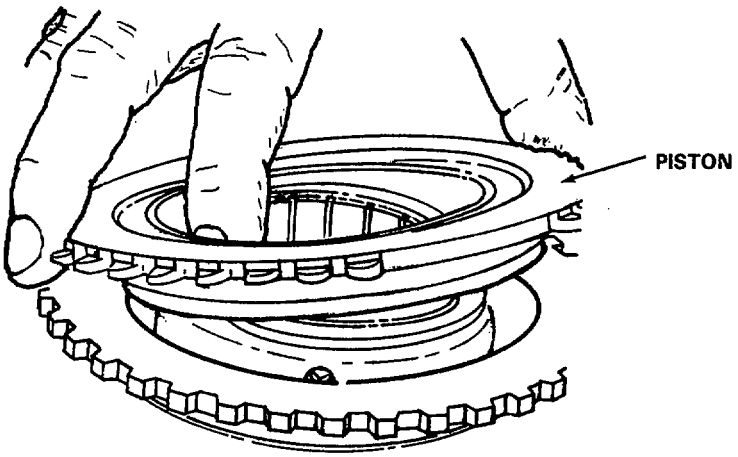
TA259673

Step 8. Lubricate seals with vaseline. Refer to appendix B, item 45.

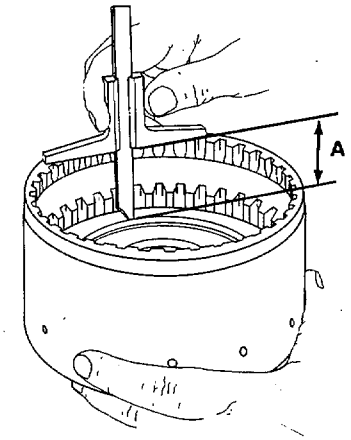
CAUTION

Do not damage preformed packing when installing piston into support flange. Do not use sharp, pointed tool to install preformed packing.

Step 9. Install piston into support flange.

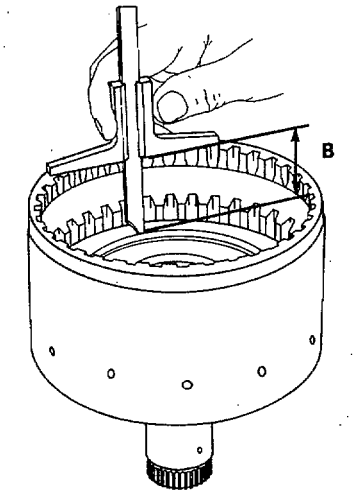


Step 10. Install piston and flange.
Step 11. Put in lockring.
Step 12. Hold clutch assembly with hollow shaft pointing down.
Step 13. Measure and record distance A. Edge of brake drum to clutch discs.

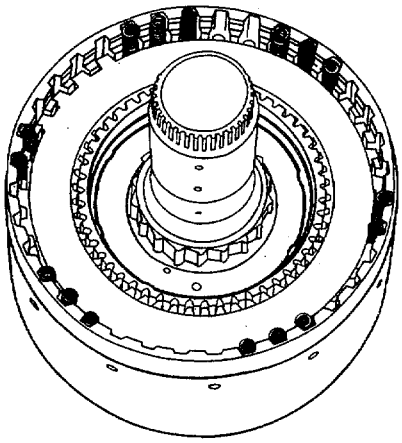


TA259674

Step 14. Stand clutch assembly on hollow shaft.
Step 15. Measure and record distance B. Edge of brake drum to clutch discs.

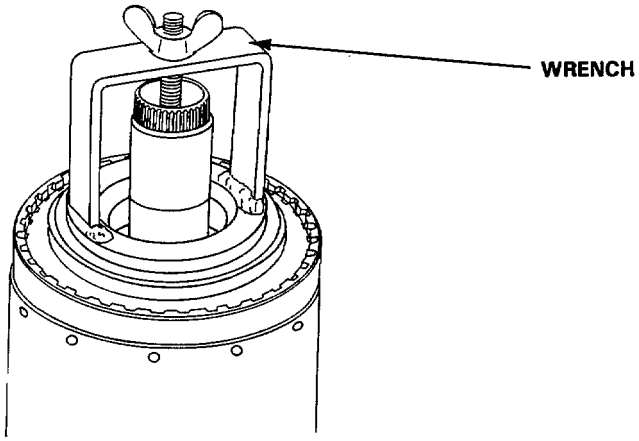


Step 16. Clearance = A - B. Clearance must be between 0.031 and 0.047 in. (0.8 and 1.2 mm).
Step 17. Adjust clearance by installing outer discs of a different thickness.
Step 18. Remove lockring, piston and support ring.
Step 19. Put in return springs. Springs must be distributed evenly. See figure below.



TA259675

Step 20. Use wrench. Press in piston. Refer to table 2-1, item 19.
Step 21. Put in lockring. Remove assembling tool.

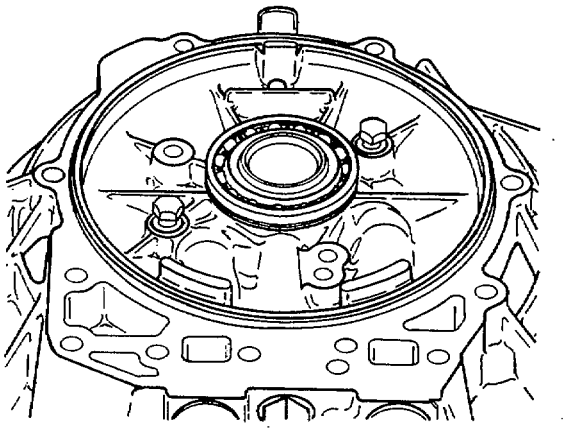


Step 22. Inspect oil feeder assembly for damage. Replace damaged oil feeder assembly.

7-23. REPAIR FRONT HOUSING AND PRIMARY OIL PUMP.

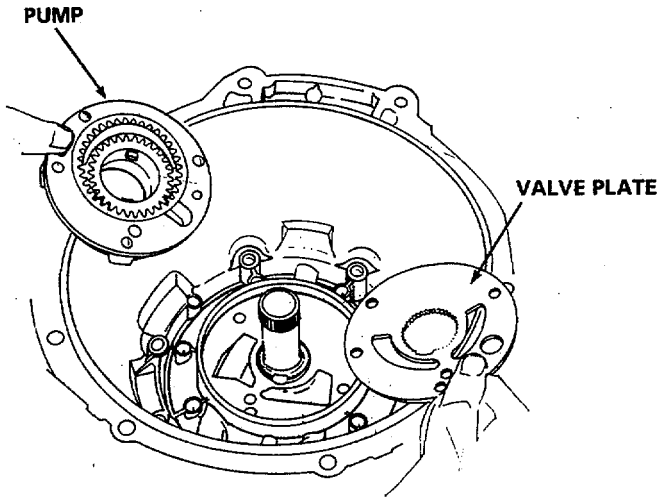
a. Disassemble Front Housing.

Step 1. Remove primary pump mounting screws.
Step 2. Use two screws 2 in. (50 mm) long. Put screws in mounting holes opposite each other.
Step 3. Tap screws until primary pump separates from housing.
Step 4. Remove screws.

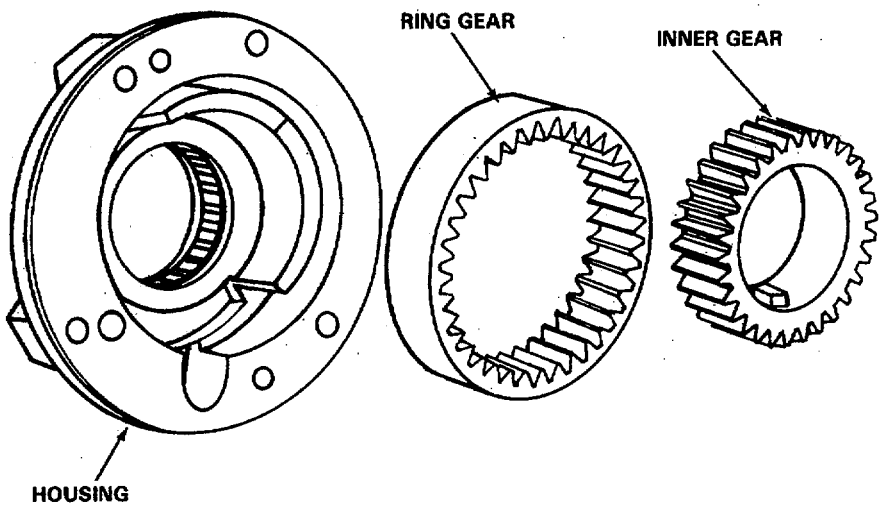


TA259781

Step 5. Remove primary pump.
Step 6. Remove pump valve plate.

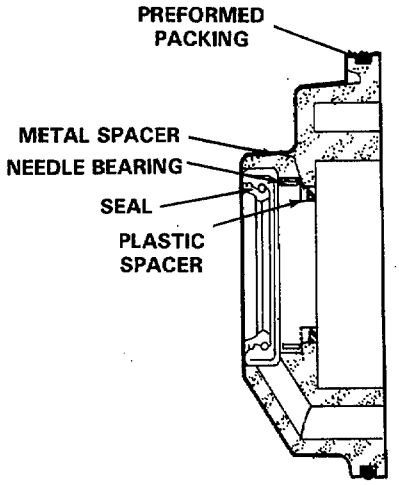


Step 7. Use marking pen. Put location mark on pump gear and pump housing. Remove gears from housing.



Step 8. Remove preformed packing from pump housing
Step 9. Remove seal.
Step 10. Remove needle bearing.
Step 11. Remove metal and plastic spacers.

TA259676



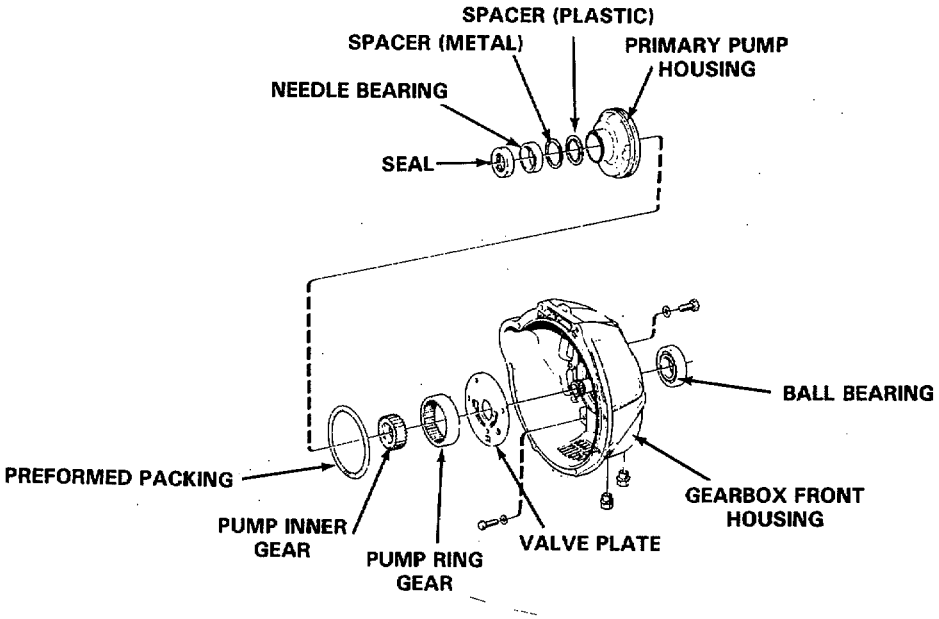
Step 12. Use puller and support plate. Pull ball bearing from front housing. Refer to table 2-1, item 1 7.

b. Assemble Front Housing.

WARNING

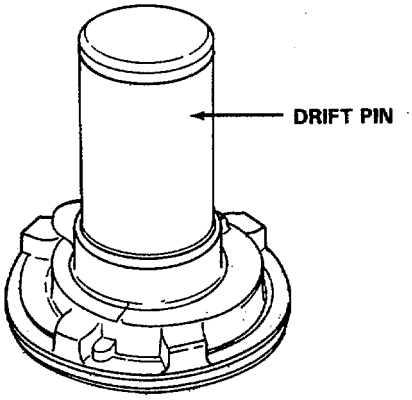
Cleaning solvent, federal specification P-D-680, Type II, is flammable and gives off harmful vapors. Use solvent only in a well ventilated area. Avoid prolonged breathing of solvent vapors. Keep solvent away from flame. Do not use solvent in excessive amounts.

Step 1. Clean all parts with solvent. Dry parts. Refer to appendix B, item 48.



TA259677

Step 2. Put in new plastic and metal spacers.
Step 3. Use drift pin. Press new needle bearing into pump housing. Refer to table 2-1, item 20.
Step 4. Put in new seal.
Step 5. Put new preformed packing on pump housing.

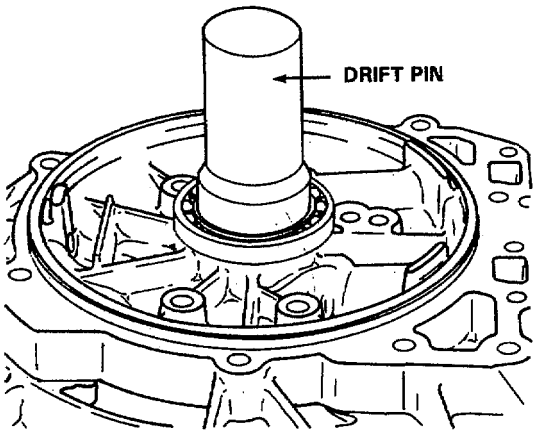


Step 6. Lubricate pump gears with automatic transmission fluid. Refer to appendix B, item 4.

NOTE

Beveled side of ring gear faces needle bearing.

Step 7. Align location marks. Put ring gear and inner gear into pump housing.
Step 8. Put valve plate on pump housing.
Step 9. Screw two guide pins into pump. Refer to Table 2-1, item 107.
Step 10. Put pump into front housing.
Step 11. Remove guide pins.
Step 12. Put in pump mount screws. Torque screws to 15 lb. ft. (20 Nm).
Step 13. Use drift pin. Press new bearing into front housing. Refer to Table 2-1, item 25.

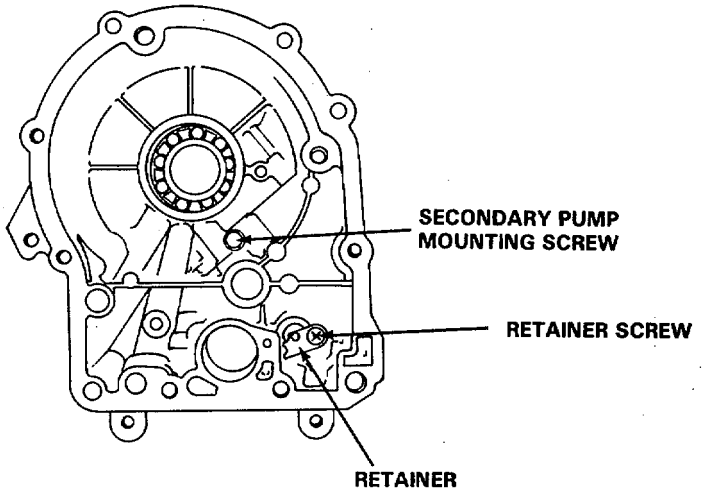


TA259680

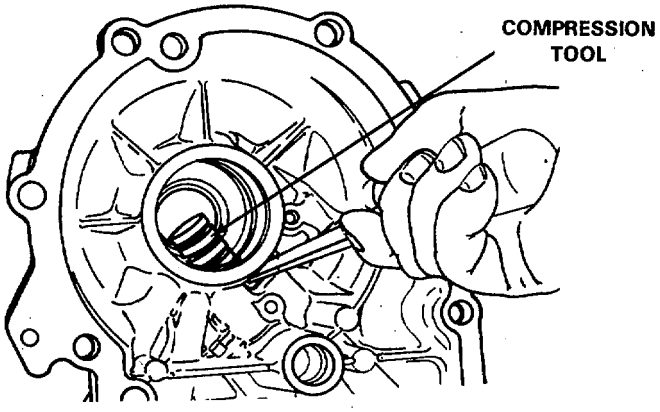
7-24. REPAIR REAR HOUSING.

a. Disassemble Rear Housing.

Step 1. Remove retainer screw and retainer.
Step 2. Remove spring and piston.
Step 3. Remove secondary pump mounting screw.

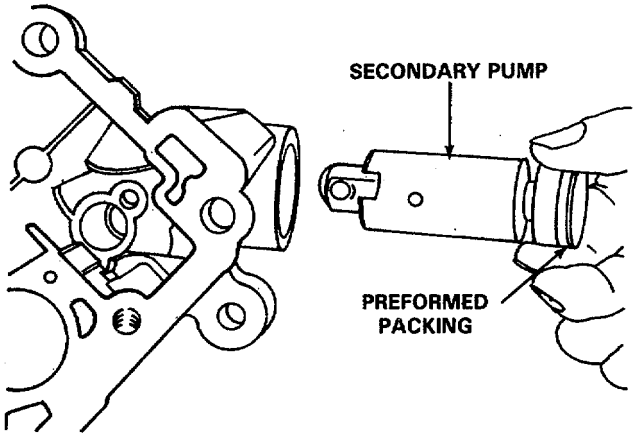


Step 4. Use compression tool. Remove secondary pump from rear housing. Refer to table 2-1, item 16.

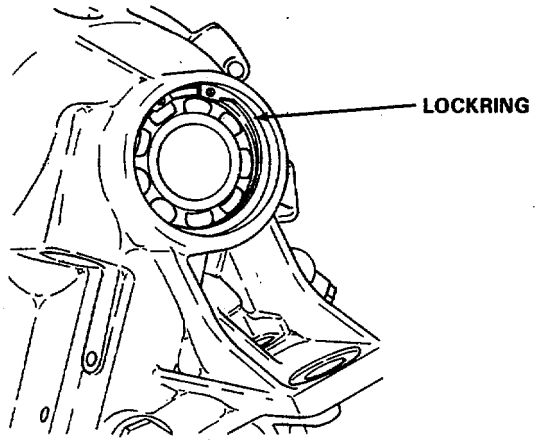


TA259678

Step 5. Remove preformed packing from secondary pump.

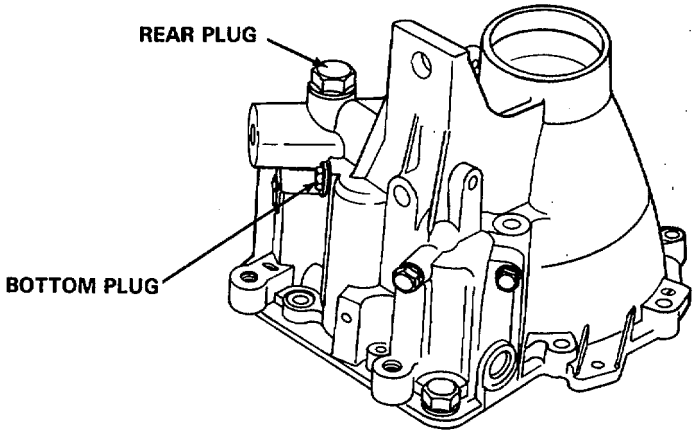


Step 6. Use extractor. Remove seal from rear housing. Refer to table 2-1, item 29.
Step 7. Remove lockring.
Step 8. Press ball bearing out of rear housing.



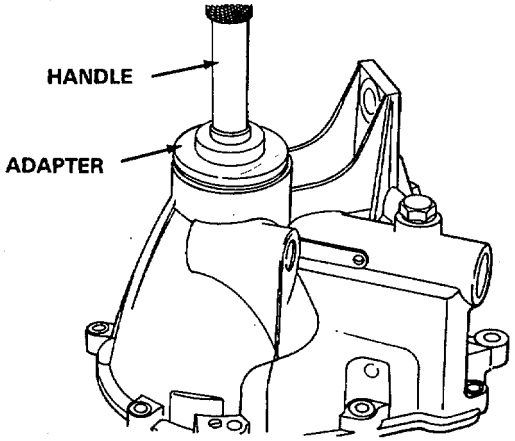
Step 9. Remove plug, ball, actuating pin and spring from bottom of housing.
Step 10. Remove plug, seal, spring and ball from rear of housing.

TA259679



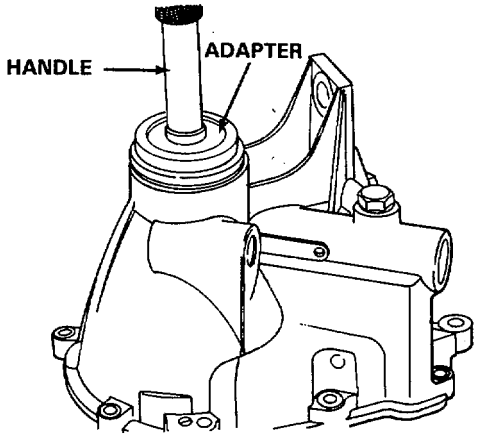
b. Assemble Rear Housing.

Step 1. Use adapter and handle. Press ball bearing into housing. Refer to table 2-1, items 18 and 54.



Step 2. Put in lockring.

Step 3. Use adapter and handle. Press in seal. Refer to table 2-1, items 1 8 and 54.



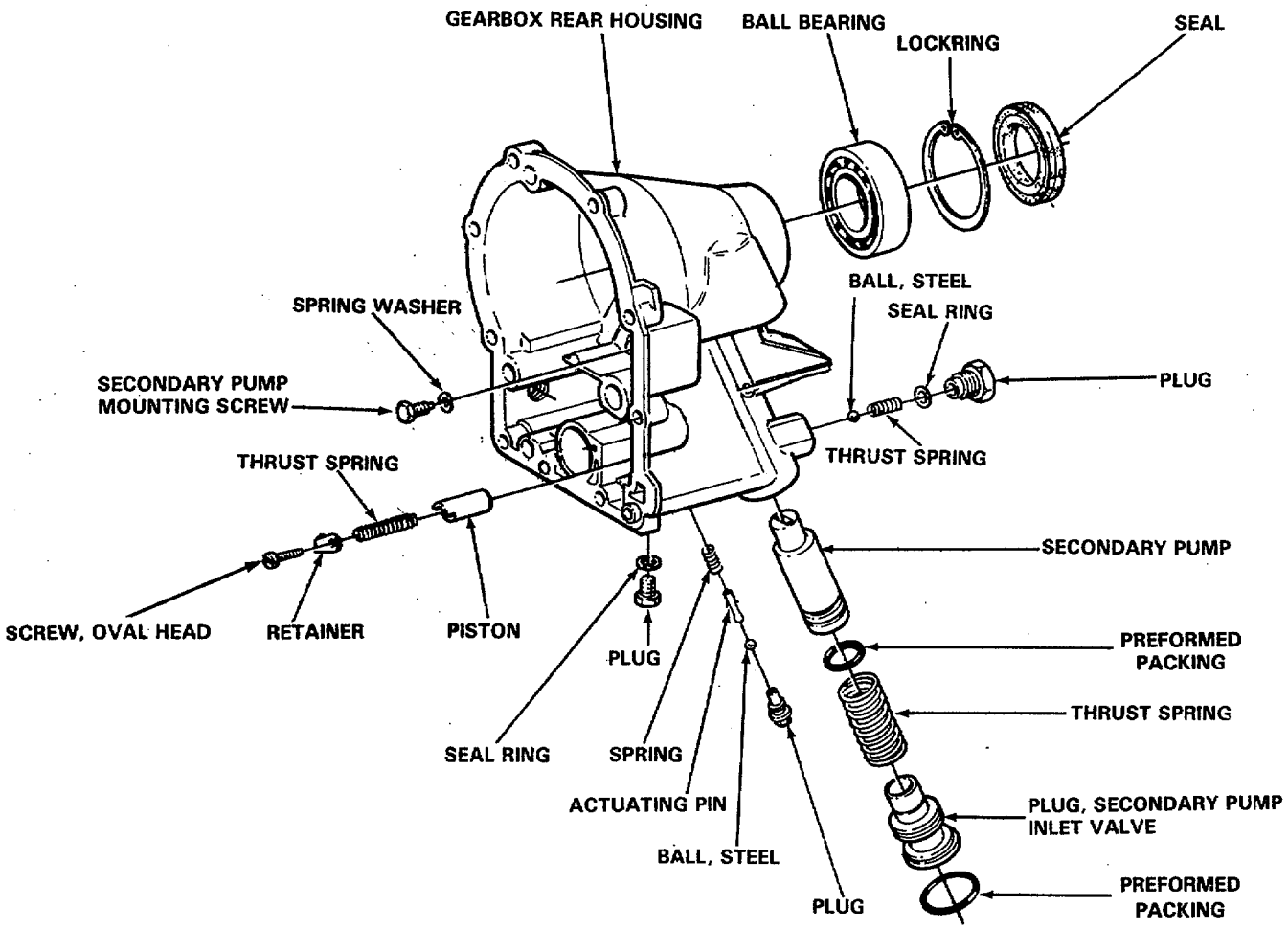
TA259681

Step 4. Put in piston and spring.
Step 5. Put in retainer and screw. Torque screw to 3 lb. ft. (4 Nm).
Step 6. Put new preformed packing on secondary pump.
Step 7. Put secondary pump into rear housing. Hole in pump must align with screw hole in rear housing.
Step 8. Put in pump mounting screw and washer. Torque screw to 6 lb. ft. (8 Nm).

NOTE

Actuating pin must be immersed in water for one hour before installing.

Step 9. Dry actuating pin. Put spring and actuating pin into bottom of rear housing.
Step 10. Put in steel ball and plug. Tighten plug.
Step 11. Put ball and spring in rear of housing.
Step 12. Put new seal on plug. Put in and tighten plug.



TA259682

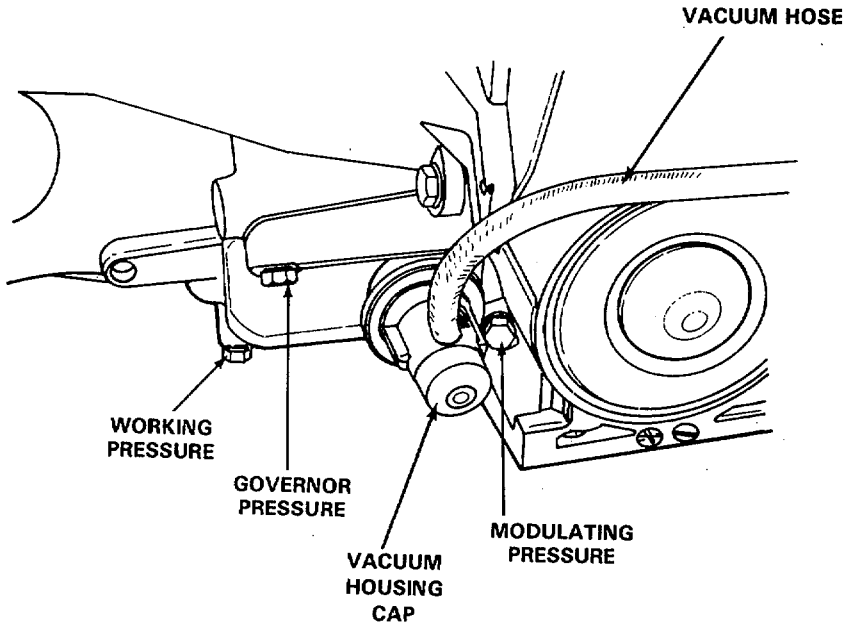
7-25. TEST AND ADJUST MODULATING AND WORK PRESSURES.

Step 1. Remove engine cover.
Step 2. Remove vacuum housing cap and hose from modulating valve.

CAUTION

Insure pressure gage exceeds the highest pressure being tested.

Step 3. Connect test gages to rear transmission housing at modulating and work pressure test points.
Step 4. Place gear selector in neutral (N) position.
Step 5. Start engine.
Step 6. Run engine at 1 800 RPM. Read gage connected for modulating pressure.
Step 7. Correct modulating pressure is 65 to 68 PSI (4.5 to 4.7 bar).



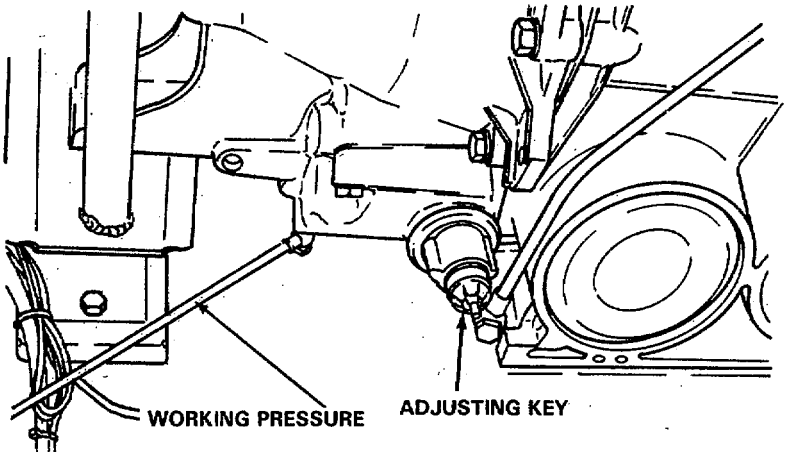
NOTE

Each graduated step in the adjustment equals approximately 3 PSI (0.2 bar).

Step 8. Use adjusting key in the modulator. Turn adjusting screw in modulator clockwise, to raise pressure and counter-clockwise to lower pressure.

TA259683

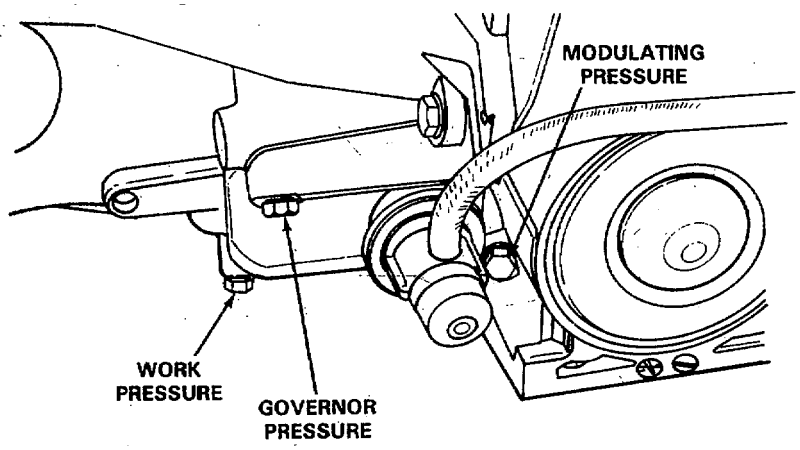
Step 9. Read pressure gage connected for work pressure.
Step 10. Correct work pressure is above 283 PSI (19.5 bar).
Step 11. If necessary, adjust work pressure by changing the modulating pressure.



Step 12. Replace vacuum housing cap and hose. Observe modulating pressure gage. Modulating pressure must drop approximately 29 PSI (2 bar).
Step 13. Stop engine.
Step 14. Disconnect pressure gages.
Step 15. Replace engine cover.

7-26. TEST GOVERNOR PRESSURE.

Step 1. Remove engine cover.
Step 2. Connect pressure gage to governor pressure connector.
Step 3. Place transfer in low range.
Step 4. Drive vehicle with gear selector in drive (D) position.
Step 5. Drive vehicle at 6 MPH (10 Km/h).
Step 6. Read pressure gage. Correct governor pressure is 22 PSI (1.5 bar).
Step 7. Drive vehicle at 12 MPH (20 Km/h).
Step 8. Read pressure gage. Correct governor pressure is 39 PSI (2.7 bar).
Step 9. Drive vehicle at 18 MPH (30 Km(h).
Step 10. Read pressure gage. Correct governor pressure is 67 PSI (4.6 bar).
Step 11. Park vehicle.
Step 12. Disconnect pressure gage**.**
Step 13. Replace engine cover.



TA259684

CHAPTER 8
REPAIR OF TRANSFER ASSEMBLY

Section I. DESCRIPTION AND DATA

8-1. GENERAL INFORMATION.

a. Description.

The transfer is located on the chassis beam at the rear of the front car. Drive power in either a high or low gear ratio is transmitted from the transfer to the differentials of both the front car and rear car. The input shaft has a high speed gear and a low speed gear. Power is transmitted from the input shaft to gears on the intermediate shaft. The gears on the intermediate shaft drive the output shaft to send power to the two differentials.

b. Operation.

The/transfer shift lever located on the right side of the driver's seat is used to shift the transfer into high or low range. The shift lever is connected to the transfer with a shift rod. The transfer should be operated in high range for on road driving and in low range for off road driving. The transfer should be shifted into neutral position only when the vehicle is being towed.

c. Technical Data.

Make	Hagglunds
Reduction ration, low gear	2.1 1:1
Reduction ration, high gear	1.28:1
Oil content	Refer to LO 9-2350-272-1 2
Oilgrade	Refer to LO 9-2350-272-12
Weight with oil	165 lbs. (75 kg)

TA259557

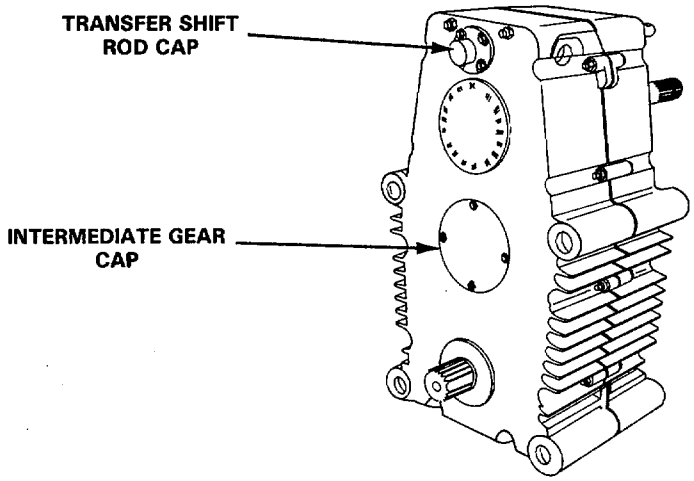
TIGHTENING TORQUES

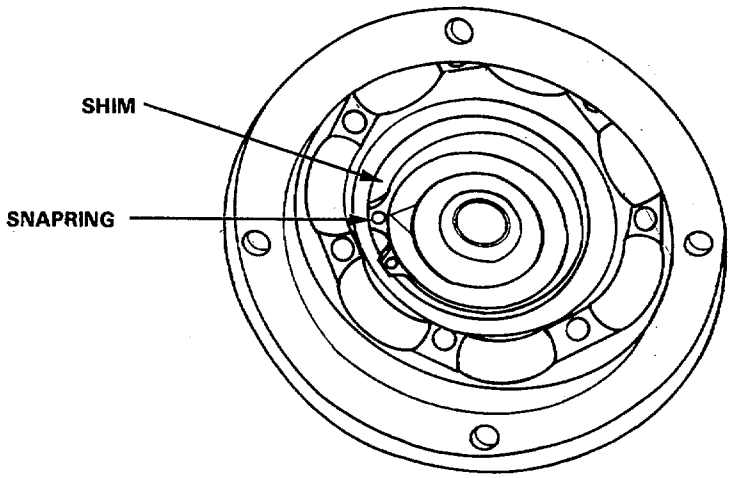
Screws, bearing covers ..... 8 lb. ft. (11 Nm)
Nuts, gearbox front and rear housing ..... 1 9 lb. ft. (26 Nm)

Section II. DISASSEMBLY OF TRANSFER

8-2. DISASSEMBLE TRANSFER.

Step 1. Drain oil from transfer case.
Step 2. Remove transfer shift rod cap.
Step 3. Remove intermediate gear shaft cap.
Step 4. Remove snapring and shim from intermediate gear shaft.





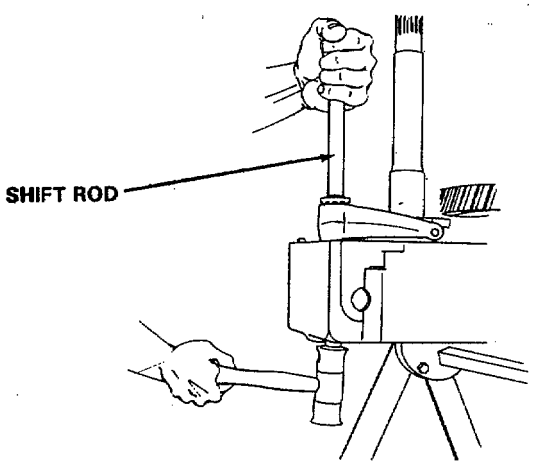
TA259507

Step 5. Attach transfer fixture to stand. Refer to table 2-1, item 64.
Step 6. Put transfer on stand.
Step 7. Remove housing assembly screws.
Step 8. Clean and lubricate extractor screw holes. Put in four extractor screws. Refer to table 2-1, item 67.

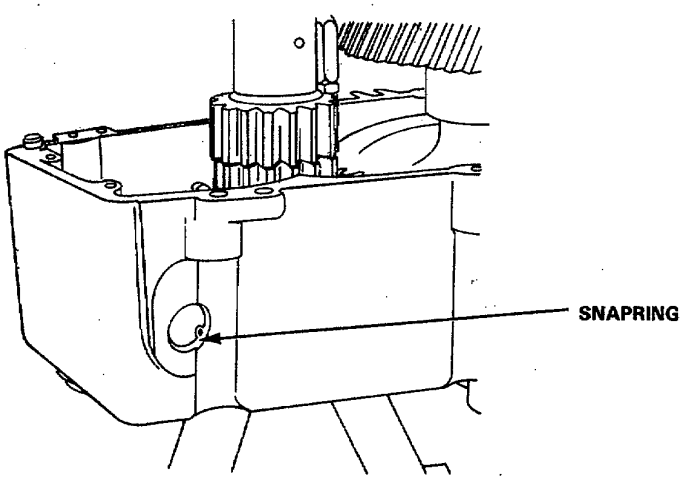
WARNING

To avoid burns after heating metal components wear insulated gloves or handle components with pliers.

Step 9. Heat transfer case around output shaft to 140°F (60°)
Step 10. Screw in extractor screws evenly.
Step 11. Remove front transfer case housing. Remove extractor screws.
Step 12. Remove shift rod with fork and sleeve.

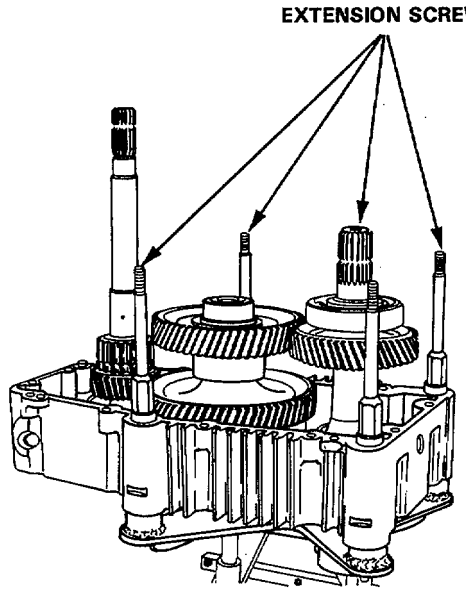


Step 13. Remove snapring, spring seat and spring.
Step 14. Remove preformed packing ball socket and ball.

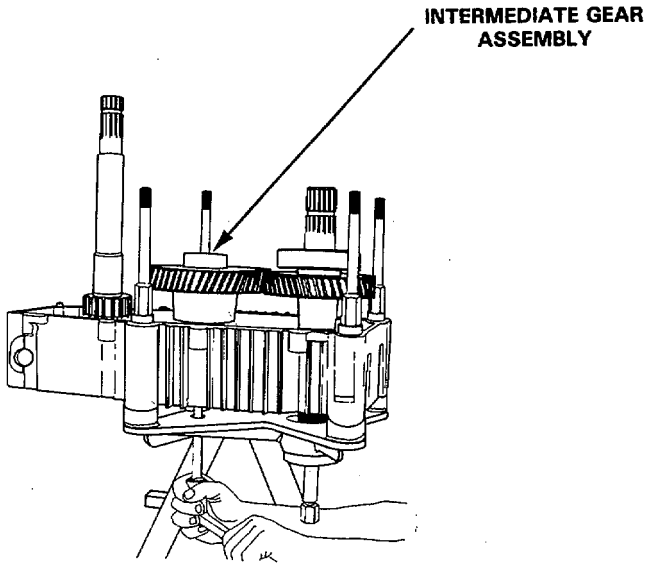


TA259508

Step 15. Put on and tighten extension screws. Refer to table 2-1, item 66.

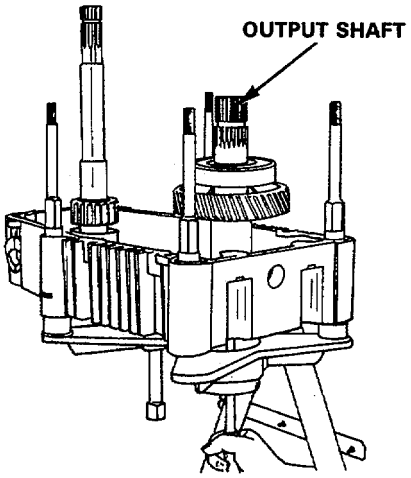


Step 16. Press out intermediate gear assembly.



TA259509

Step 17. Remove inner snapring on output shaft.
Step 18. Press out the output shaft. Remove dust guard.

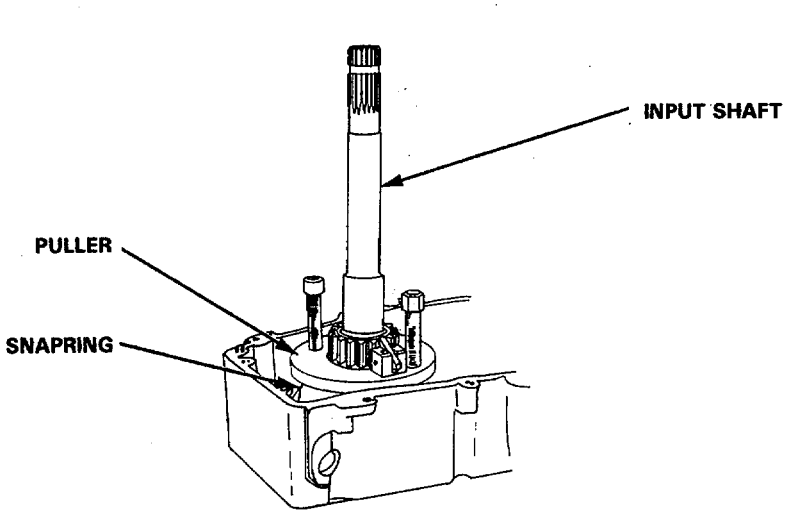


Step 19. Uft snapring from groove on input shaft. Remove snapring.
Step 20. Mount puller on input shaft. Refer to table 2-1, item 63.

WARNING

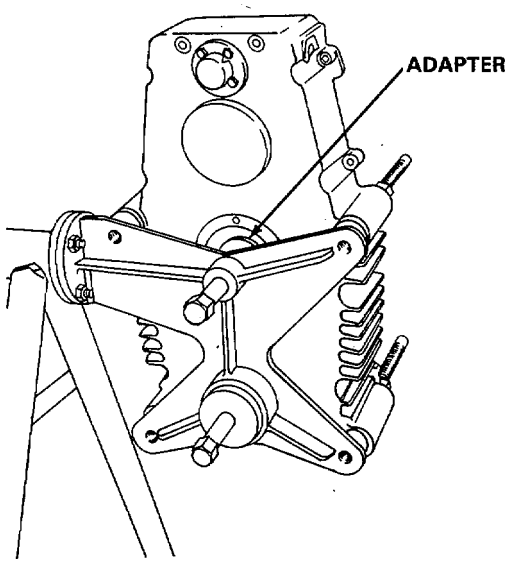
To avoid burns after heating metal components wear insulated gloves or handle components with pliers.

Step 21. Heat housing around input shaft to 140° F (60°C).
Step 22. Pull out input shaft.

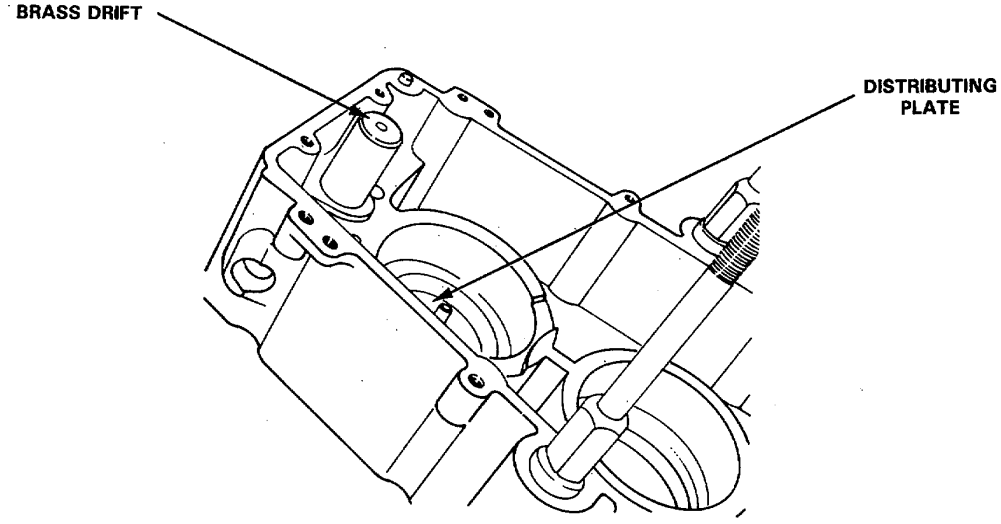


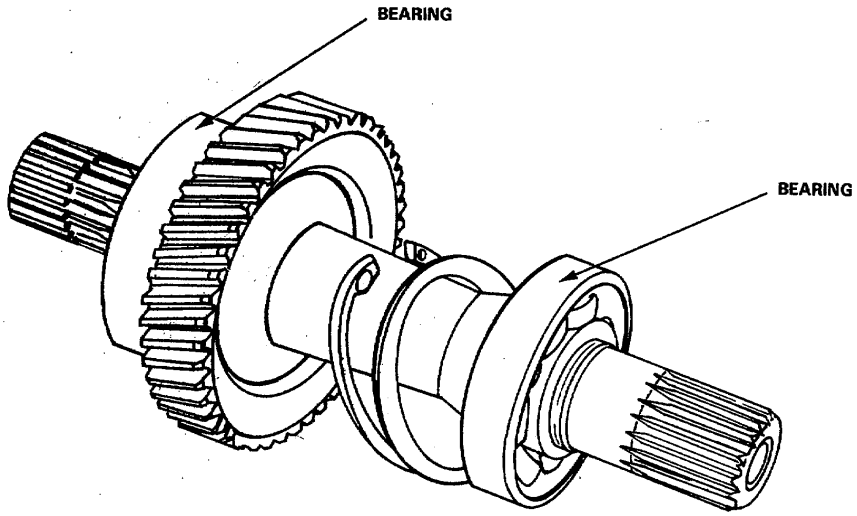
TA259510

Step 23. Remove snapring and shim from intermediate shaft bearing.
Step 24. Use adapter. Press out intermediate shaft bearing. Refer to table 2-1, item 61.

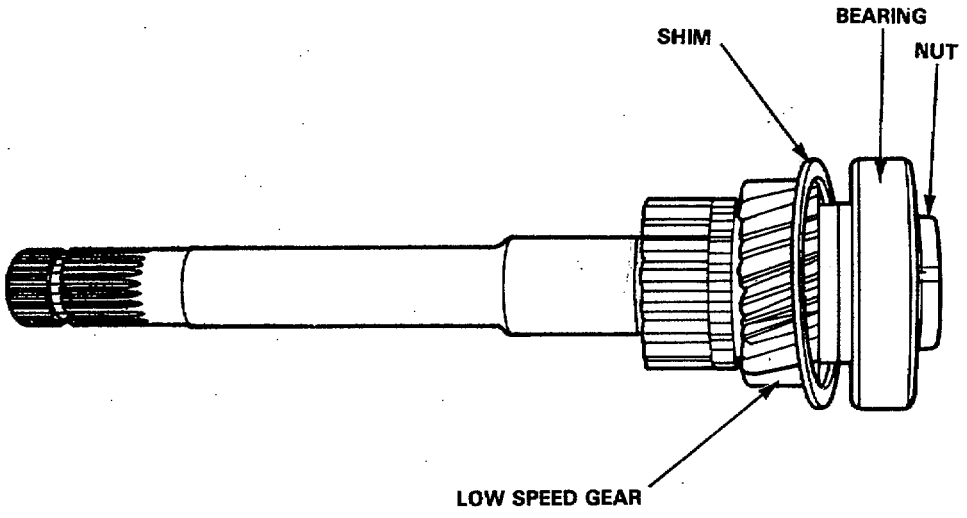


Step 25. Remove snapring holding shift rod bushing.
Step 26. Drive out shift rod bushing.
Step 27. Remove distribution plate.
Step 28. Remove output shaft seals from housing.
Step 29. Remove snaprings, shims and output shaft bearings.



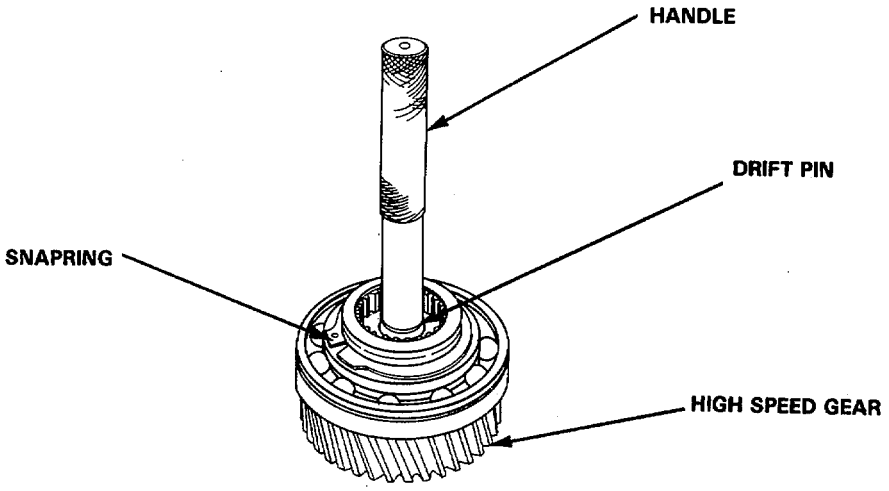


Step 30. Bend open tab of lock washer from input shaft.
Step 31. Remove shaft nut and washer.
Step 32. Remove input shaft bearing.
Step 33. Remove shims.
Step 34. Remove low speed gear.
Step 35. Remove two snaprings from low speed gear.
Step 36. Press needle bearings and spacer out of gear.

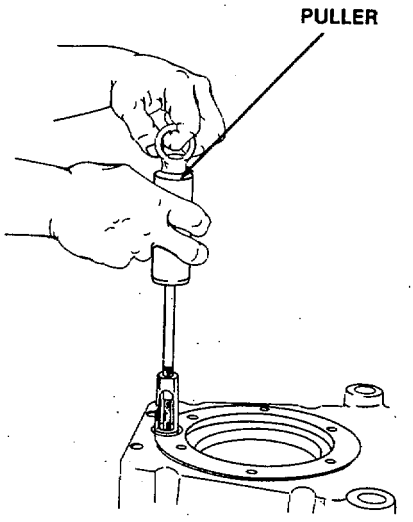


TA259512

Step 37. Remove snapring from ball bearing in front housing.
Step 38. Press high speed gear bearing out of housing.
Step 39. Remove snapring inside high speed gear.
Step 40. Use drift pin and handle. Refer to table 2-1, items 54 and 60. Press needle bearings and spacer out of high speed gear.
Step 41. Remove snapring and shims holding ball bearing to gear.
Step 42. Press bearing off gear.

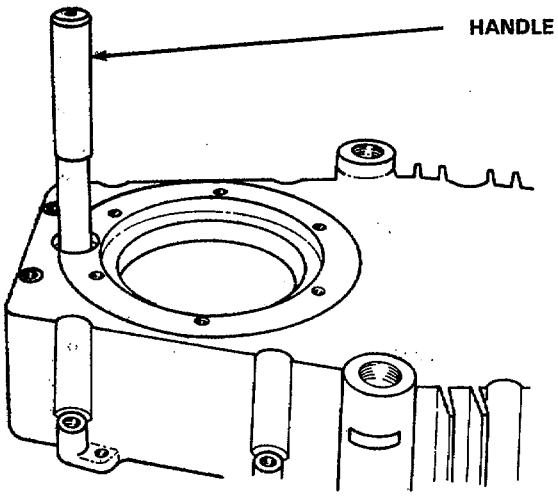


Step 43. Use puller. Pull shift rod seal out of front housing. Refer to table 2-1, item 28.



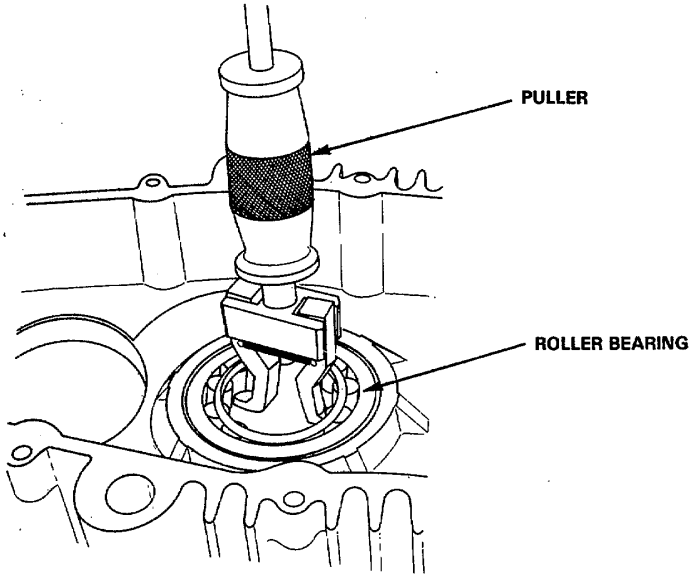
TA259513

Step 44. Remove shift bushing snapring. Use handle to drive out bushing. Refer to table 2-1, item 54.



REMOVING BUSHING SNAPRING

Step 45. Remove output shaft seal from front housing.
Step 46. Use puller. Remove intermediate shaft roller bearing. Refer to table 2-1, item 68.



TA259514

Section III. CLEANING, INSPECTION, AND REPAIR

8-3. CLEAN, INSPECT AND REPAIR TRANSFER.

a. Cleaning of Transfer.

Step 1. Remove gaskets and gasket material from housings.

WARNING

Cleaning solvent, federal specification P-D-680, Type II, is flammable and gives off harmful vapors. Use solvent only in a well ventilated area. Avoid prolonged breathing of solvent vapors. Keep solvent away from flame. Do not use solvent in excessive amounts.

Step 2. Clean transfer housing and internal components with dry cleaning solvent. Refer to appendix B, item 48.

Step 3 Dry housing and components.

b. Inspection.

Step 1. Inspect housing for cracks.

Step 2. inspect gears for chipped or broken teeth.

Step 3. Inspect bearings and bushings for damage.

c. Repair.

Step 1. Replace all seals with new seals

Step 2. Replace all damaged components with new component.

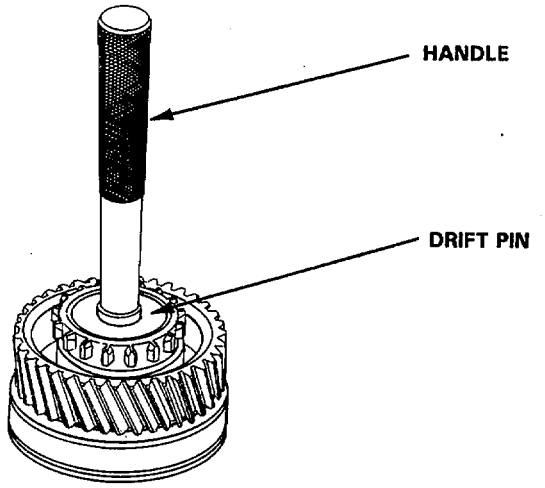
Section IV. ASSEMBLY OF TRANSFER

8-4. ASSEMBLE TRANSFER.

NOTE

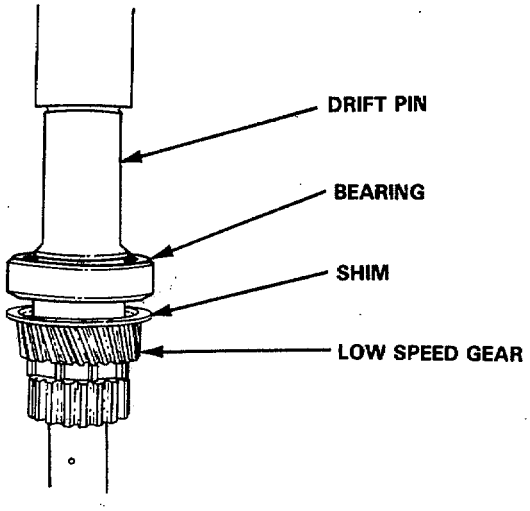
New needle bearings must be replaced in pairs.

Step 1. Press needle bearings and spacer into high speed gear. Install snapring.
Step 2. Use handle and drift pin. Press needle bearings and spacer into low speed gear. Refer to table 2-1, items 54 and 59.
Step 3. Install two snaprings in low speed gear.



TA25951 5

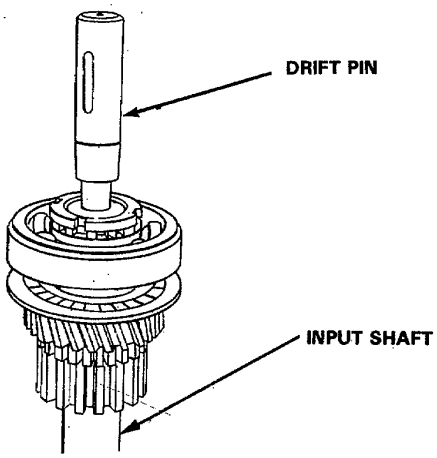
Step 4. Put low speed gear, washer and spacer on input shaft.
Step 5. Put snapring and large shim on input shaft.
Step 6. Use drift pin. Press ball bearing on input shaft. Refer to table 2-1, item 58.
Step 7. Put lock washer and nut on input shaft.
Step 8. Tighten nut and bend lock washer tabs.



NOTE

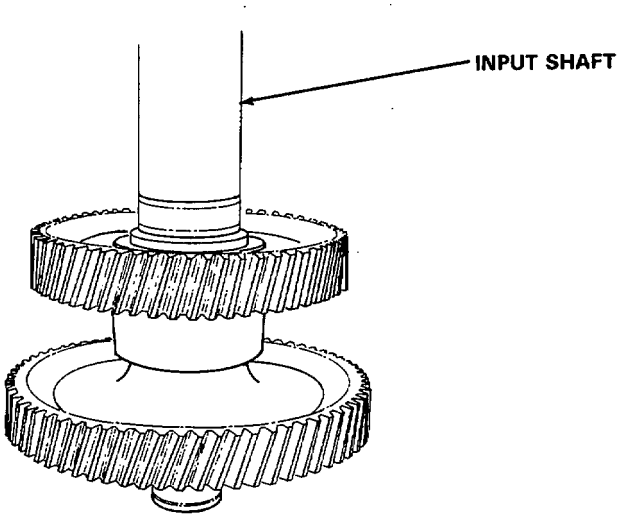
If new input shaft is being used, a bushing must be installed.

Step 9. Use drift pin. Press bushing into input shaft.

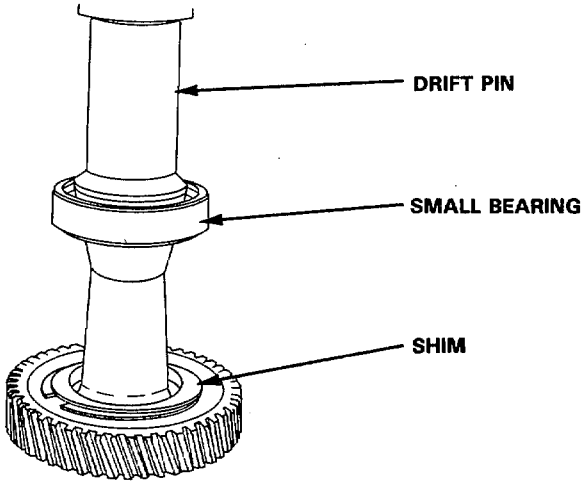


TA259516

Step 10. If bearing race was removed, press new race on intermediate shaft.



Step 11. Use drift pin. Press large bearing on output shaft. Refer to table 2-1, item 58.
Step 12 Put large snapring and shim on output shaft.
Step 13. Using drift, press small bearing on output shaft.
Step 14. Put on small shim and install small snapring.



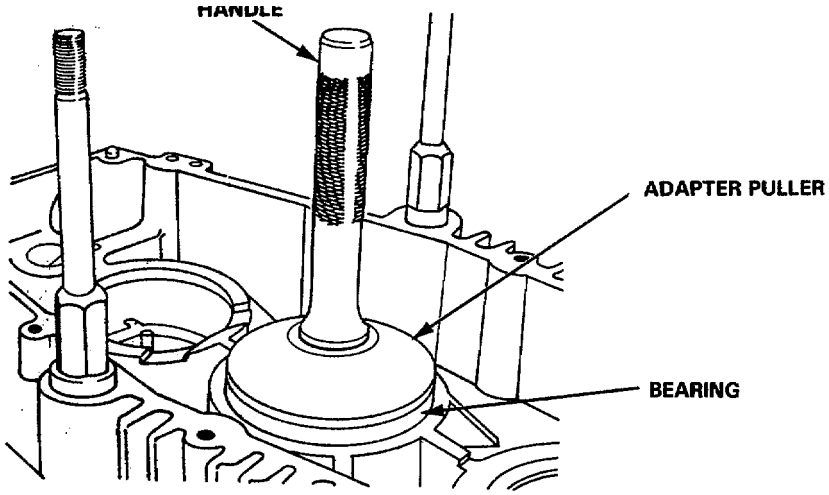
TA259517

Step 15. Place rear transfer housing on holder and stand.
Step 16. Put in distribution plate.

WARNING

To avoid burns after heating components wear insulated gloves or handle components with pliers.

Step 17. Heat housing around intermediate bearing to 140°F (60°C).
Step 18. Use adapter puller with handle. Press intermediate bearing into housing. Refer to table 2-1, items 55 and 62.
Step 19. Put in shim. Install snapring.



Step 20. Position input shaft in rear housing.
Step 21. Position intermediate shaft in bearing.
Step 22. Position output shaft in rear housing.
Step 23. Install fixture and screws. Refer to table 2-1, items 64 and 65.

WARNING

To avoid burns after heating metal components wear insulated gloves or handle components with pliers.

Step 24. Heat housing around input bearing to 140°F (60°C).

NOTE

Large snapring must be compressed while input shaft is being pressed down.

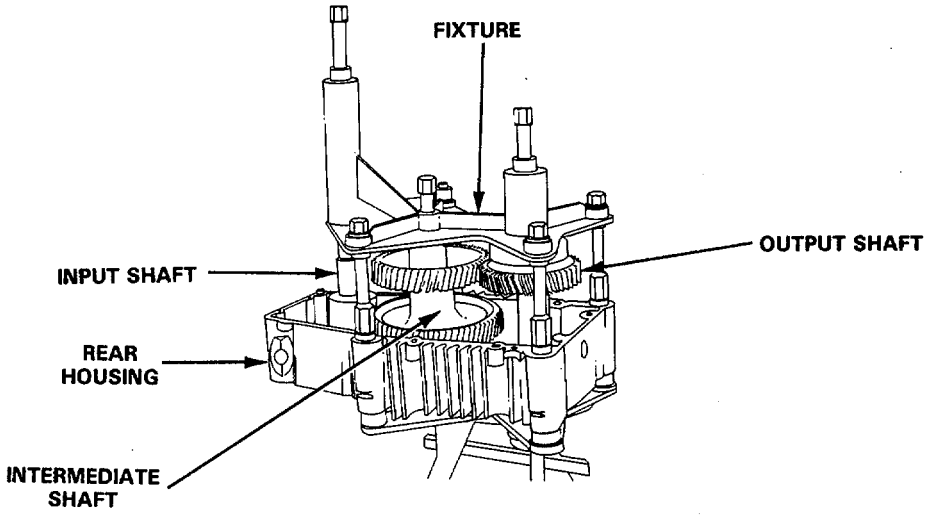
Step 25. Press down input shaft and compress snapring.
Step 26. Install snapring securely in groove. Loosen fixture screw.

TA259518

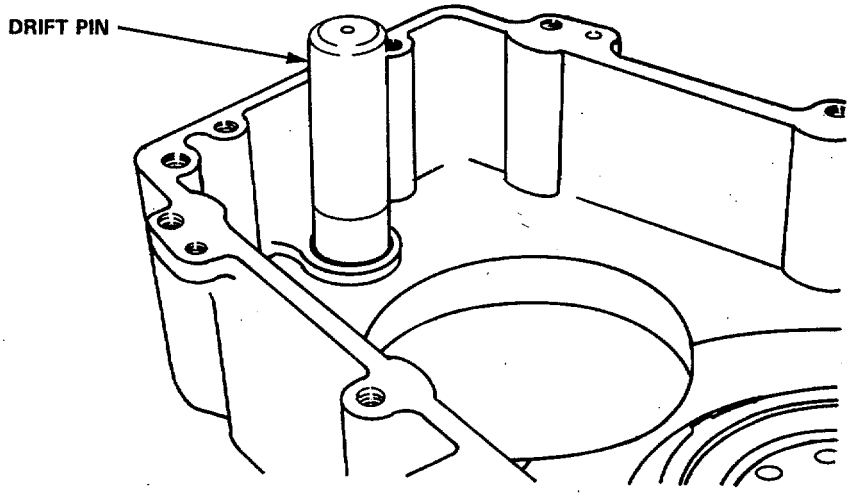
WARNING

To avoid burns after heating metal components wear insulated gloves or handle components with pliers.

Step 27. Heat housing around output bearing to 140°F (600C).
Step 28. Press down output shaft until bearing is seated.
Step 29. Install snapring securely in groove. Loosen fixture screw.
Step 30. Press down intermediate shaft until seated in bearing. Remove fixture.

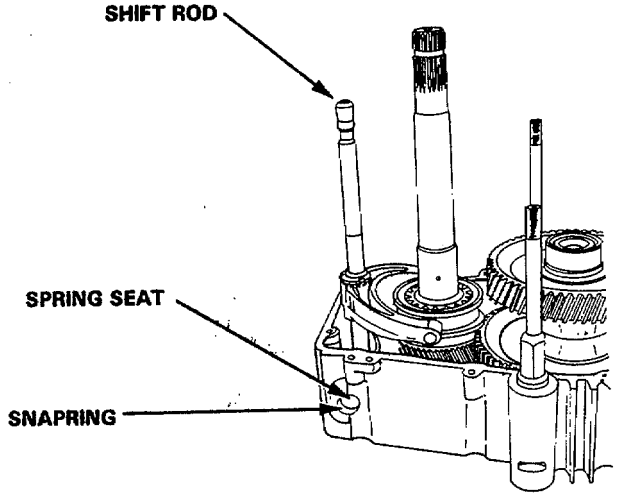


Step 31. Use drift pin. Install shift rod bushings into front and rear housing. Install snaprings..

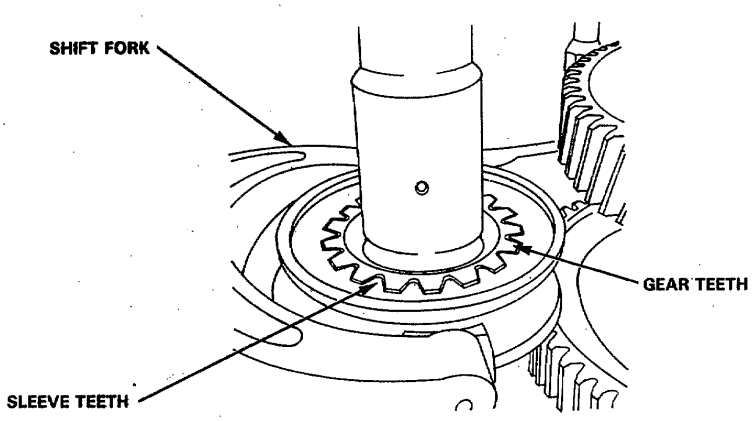


TA259519

Step 32. Install shift rod assembly.
Step 33. Put ball in ball socket. Install in housing.
Step 34. Put in performed packing and spring.
Step 35. Put in spring seat.
Step 36. Install snapring.
Step 37. Place shift rod in neutral position.



Step 38. Measure distance from top of sleeve teeth to top of input gear teeth. Sleeve teeth must be between 0.0056 in. (0.15 mm) and O.009 in. (0.25 mm).
Step 39. If measurement is correct go to step 41. If measurement is incorrect go to step 40.
Step 40. Add or subtract shims under shift fork to obtain correct measurement.



Step 41. Remove extension screws. Install gasket on rear housing. Secure gasket in position with light coat of grease.

WARNING

To avoid burns after heating metal components wear insulated gloves or handle components with pliers.

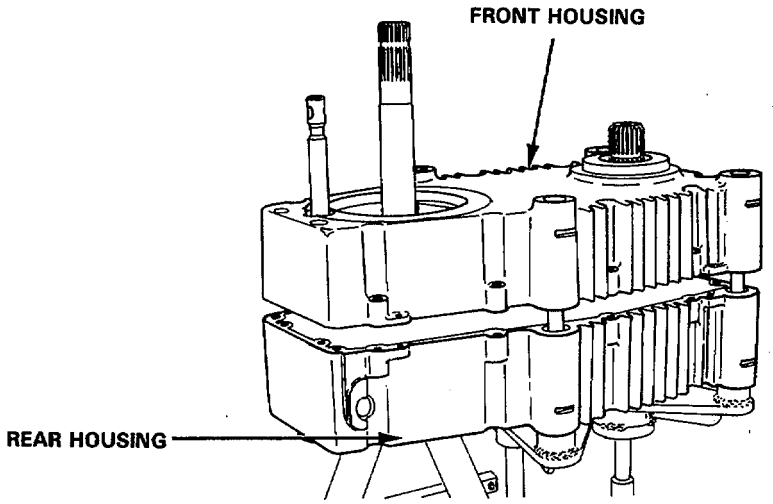
TA259520

Step 42. Heat front housing around intermediate bearing seat to 140°F (60°C).
Step 43. Use drift pin and handle. Press roller bearing into front housing. Refer to table 2-1, items 55 and 62.
Step 44. Position front housing on rear housing.

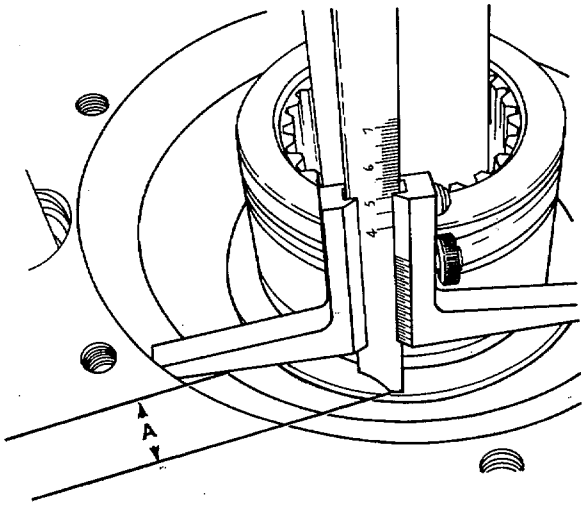
WARNING

To avoid burns after heating metal components wear insulated gloves or handle components with pliers.

Step 45. Heat output bearing seat of front housing to 140°F (60°C).
Step 46. Press front housing onto rear housing.
Step 47. Put in housing bolt and washers. Put on nuts.
Step 48. Start at middle of housing and work outward. Alternately and evenly tighten bolts until two housings are together.
Step 49. Working from middle of housing outward torque bolts to 19 lb. ft. (26 Nm).



Step 50. Position high speed gear on input shaft.
Step 51. Measure distance A.



TA259521

Step 52. Refer to chart below for required thickness of shims to be used.
Step 53. Put required thickness of shims on high speed gear.

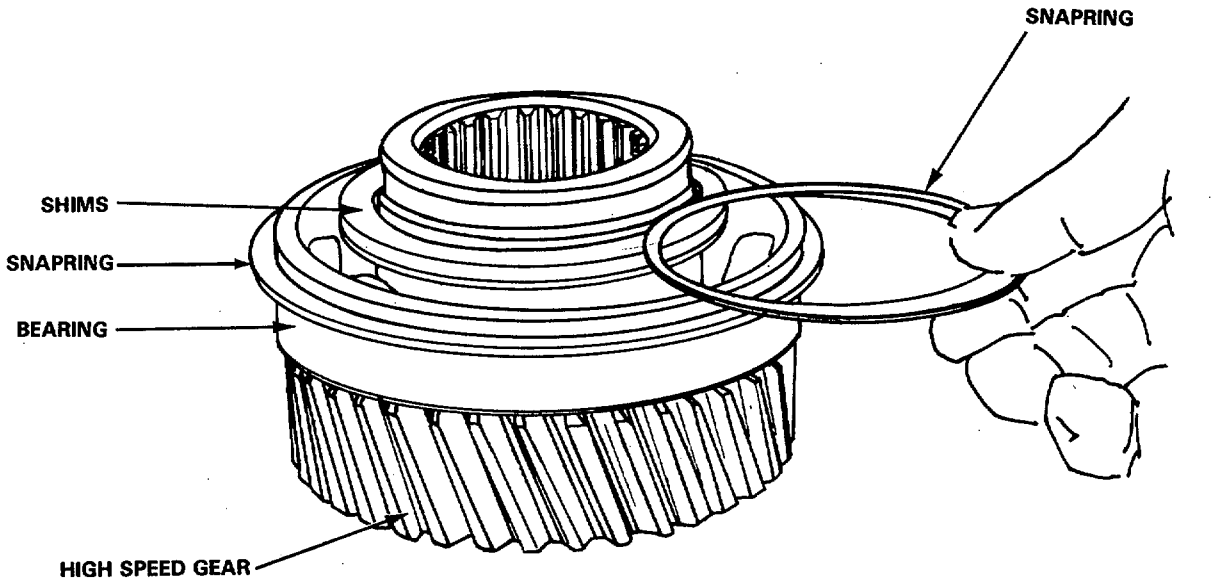
DISTANCE A MEASUREMENT		THICKNESS OF SHIMS NEEDED
in.	**(mm)**	**(mm)**
0.752	(19.1)	0
0.756	(19.2)	0.1
0.760	(19.3)	0.2
0.764	(19.4)	0.3
0.768	(19.5)	0.4
0.772	(19.6)	0.5
0.776	(19.7)	0.6
0.780	(19.8)	0.7
0.784	(19.9)	0.8
0.787	(20.0)	0.9
0.791	(20.1)	1.0
0.795	(20.2)	1.1
0.799	(20.3)	1.2
0.803	(20.4)	1.3
0.807	(20.5)	1.4
0.811	(20.6)	1.5
0.815	(20.7)	1.6
0.819	(20.8)	1.7
0.823	(20.9)	1.8
0.827	(21.0)	1.9
0.831	(21.1),	2.0
0.835	(21.2)	2.1
0.839	(21.3)	2.2
0.843	(21.4)	2.3
0.847	(21.5)	2.4
0.850	(21.6)	2.5
0.854	(21.7)	2.6

Step 54. Press bearing on high speed gear.

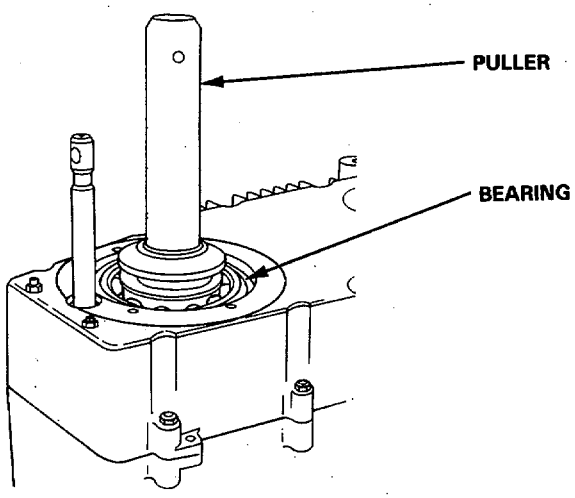
NOTE

Shims are installed until there is a tight fit between shims and snapring.

Step 55. Install correct number of shims. Install snapring in groove. Install snapring on bearing.

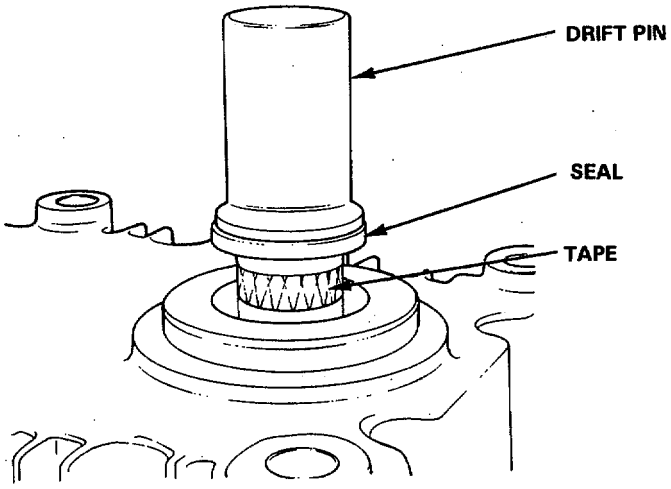


Step 56. Use puller. Press high speed gear and bearing into housing. Refer to table 2-1, item 69.

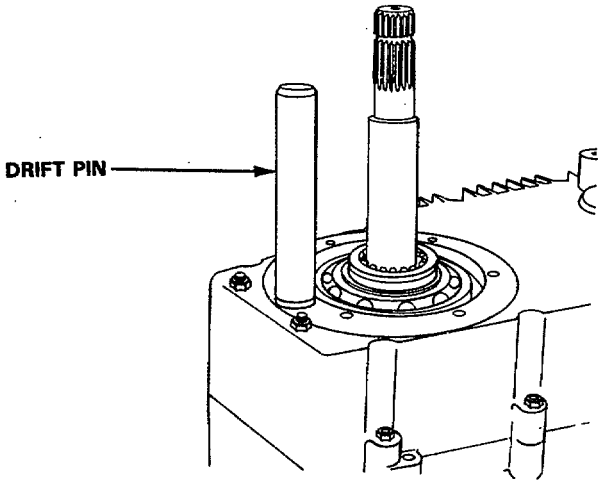


TA259522

Step 57. Put tape on splines of output shaft.
Step 58. Use drift pin. Refer to table 2-1, item 56. Install single lip output seal in housing. Remove tape.



Step 59. Use drift pin. Install rod seal in housing.



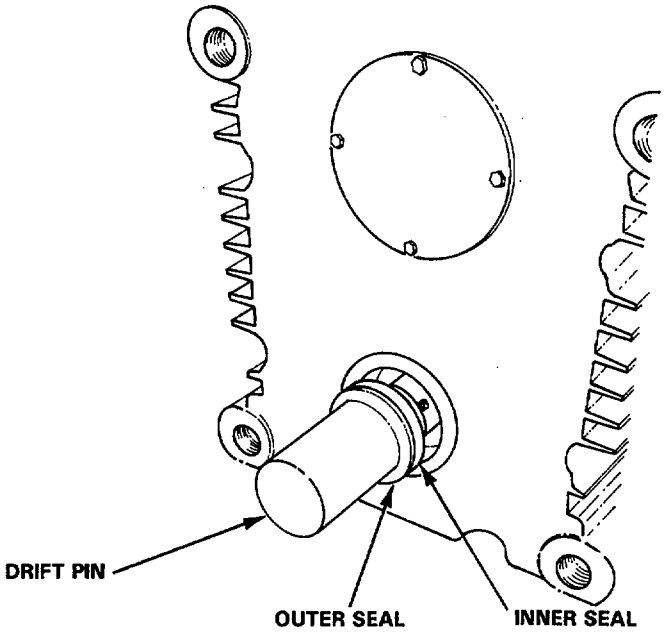
Step 60. Install drain plugs.
Step 61. Remove transfer from holder.
Step 62. Put shim and snapring on intermediate shaft.
Step 63. Install gasket and intermediate gear cap.
Step 64. Put tape on output shaft splines.
Step 65. Fill seals with grease. Refer to appendix B, item 8.

NOTE

Inner seal is single lip type. Outer seal is double lip type.

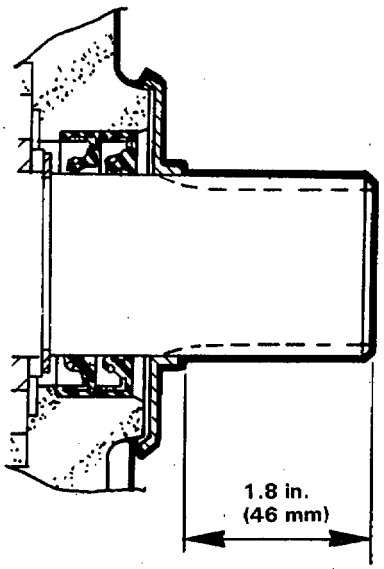
TA25978

Step 66. Use drift pin. Refer to table 2-1, item 56. Install seals. Remove tape.



Step 67. Use drift pin. Install output shaft dust guard. Refer to table 2-1, item 57. Distance between end of shaft and end of properly installed dust guard is 1.8 in. (46 mm).

Step 68. Install gasket and shift rod cap.



TA259523

8-5. TRANSFER OUTPUT SEALS.

a. Remove rear seal.

Step 1. Remove propeller shaft from output flange. Refer to TM 9-2350-272-20.
Step 2. Remove output flange.
Step 3. Remove dust guard.
Step 4. Use extractor tool. Remove outer seal. Refer to table 2-1, item 12.
Step 5. Use extractor tool. Remove inner seal. Refer to table 2-1, item 12.

b. Replace rear seal.

Step 1. Use drift pin. Put in inner single lip seal. Refer to table 2-1, item 56.
Step 2. Use drift pin. Put in outer double lip seal. Refer to table 2-1, item 56.
Step 3. Use drift. Put on dust guard. Refer to table 2-1, item 58.
Step 4. Put on flange.
Step 5. Replace propeller shaft. Refer to TM 9-2350-272-20.

c. Remove front seal.

Step 1. Remove transfer. Refer to TM 9-2350-272-20
Step 2. Use extractor tool. Pull out seal. Refer to table 2-1, item 12.

d. Replace front seal.

Step 1. Use drift pin. Put in new seal. Refer to table 2-1, item 56.
Step 2. Replace transfer. Refer to TM 9-2350-272- 20.

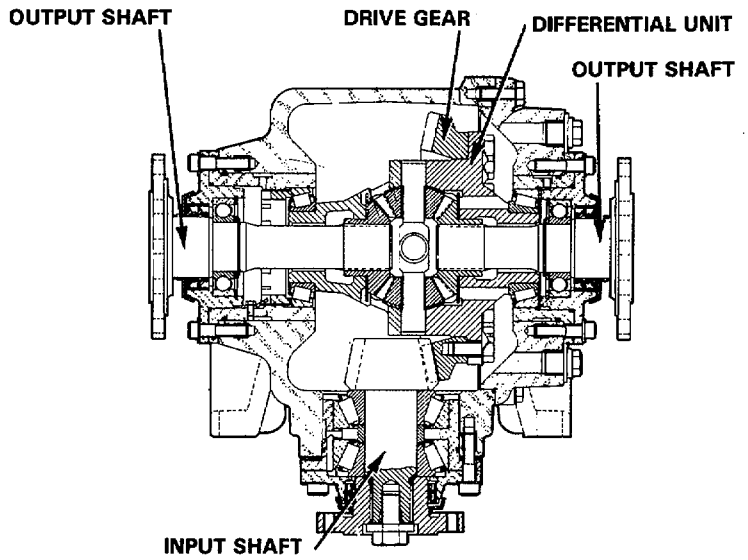
CHAPTER 9
REPAIR OF DIFFERENTIAL ASSEMBLY

Section I DESCRIPTION AND DATA

9-1. TECHNICAL DATA AND DESCRIPTION.

a. Description.

One differential is located on the chassis beam at the front of the front car. The other differential is located on the chassis beam at the front of the rear car. The two differentials are identical and can be interchanged. The input shaft and gear drives the drive gear mounted on differential unit. The differential unit drives the two output shafts transmitting power to the drive sprockets.



b. Technical Data.

Make	Hagglunds
Reduction ratio	4.8:1
Backlash, pinion/crown gear	0.0039 to 0.0059 in. (0.10 to 0.15 mm)
Oil content	LO 9-2350-272-12
Oil grade	LO 9-2350-272-12
Weight with oil	132 lbs (60 kg)

Tightening torques

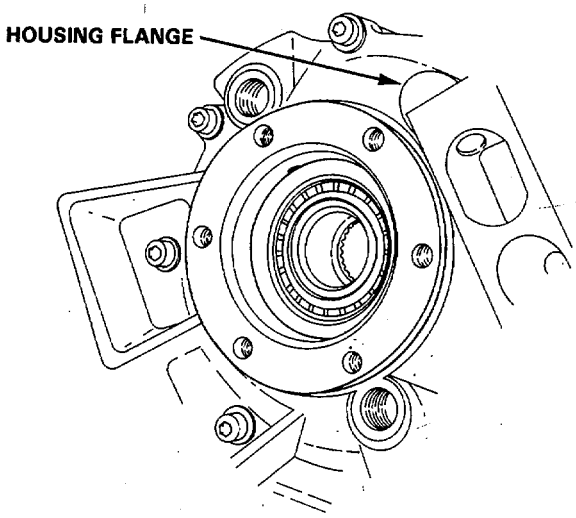
Screws bearing housing	38 lb. ft. (52 Nm)
Screws, crown gear	67 lb. ft. (91 Nm)
Screws, pinion flange	162 lb. ft. (220 Nm)
Screws mounting	325 lb. ft. (440 Nm)

TA259524

Section II. DISASSEMBLY OF DIFFERENTIAL.

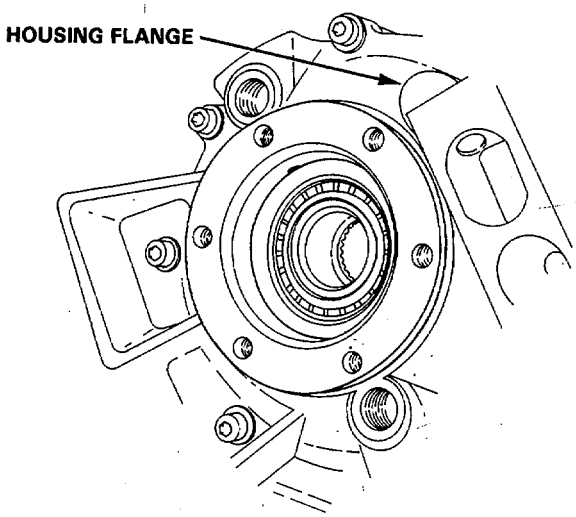
9-2. DISASSEMBLE DIFFERENTIAL.

Step 1. Attach fixture to differential. Mount differential on stand. See table 2-1, item 43.
Step 2. Drain oil from differential.



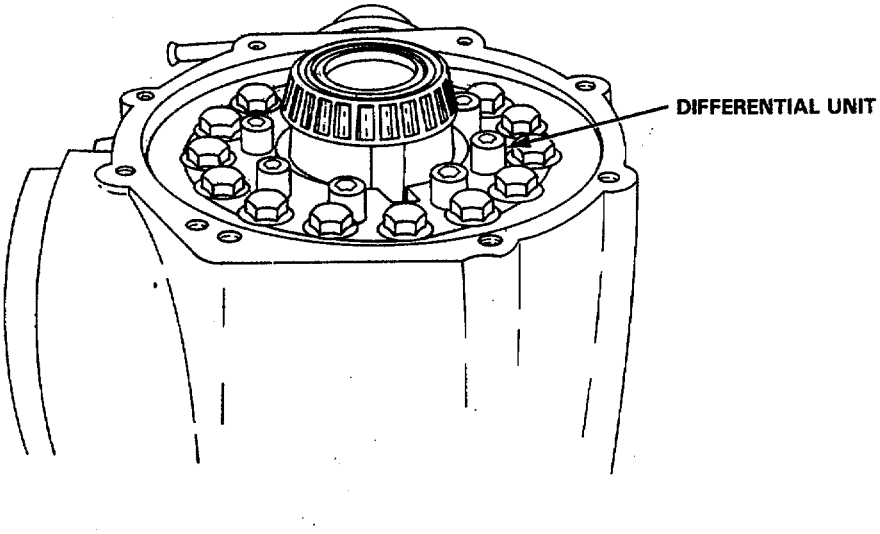
TA259525

Step 3. Rotate differential until housing flange is facing upward.
Step 4. Remove bearing housing screws.
Step 5. Remove output shaft and bearing housing.
Step 6. Remove housing flange screws. Remove flange.
Step 7. Remove preformed packing and shims.



TA259525

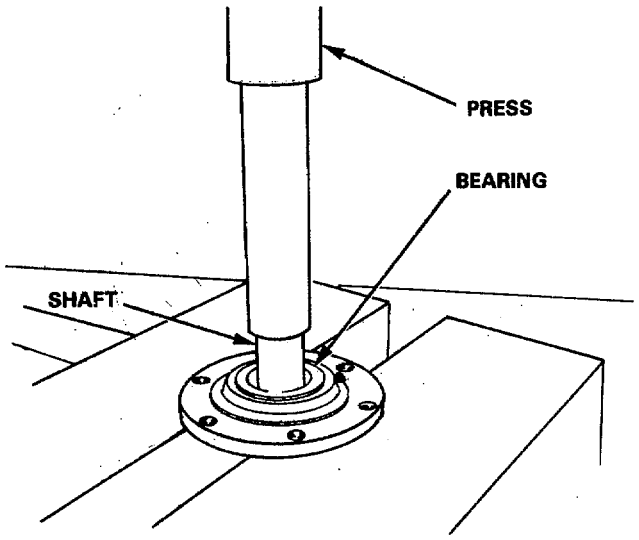
Step 8. Remove differential unit with drive gear and bearing.



Step 9. Rotate differential 180°.
Step 10. Remove screws from bearing housing.
Step 11. Remove output shaft with bearing housing.
Step 12. Remove preformed packing.
Step 13. Turn differential until input shaft faces upward.
Step 14. Remove bearing cover screws.
Step 15. Pull out input shaft with bearing assembly.
Step 16. Remove preformed packing and shims.

9-3. DISASSEMBLE OUTPUT SHAFT ASSEMBLY.

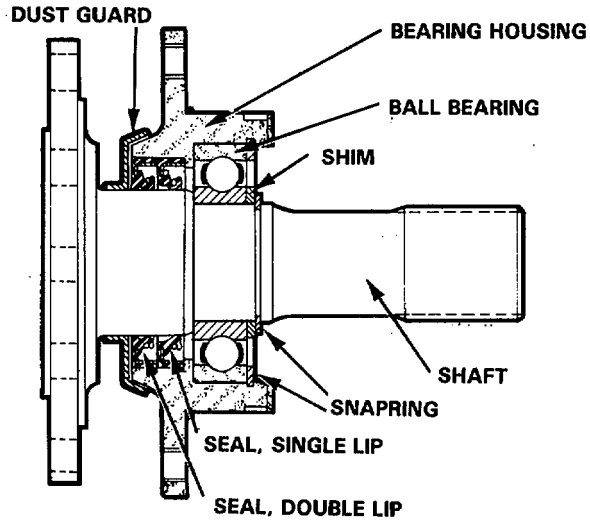
Step 1. Remove snapring and shim.
Step 2. Press out output shaft.



Step 3. Remove dust guard.
Step 4. Remove snapring.
Step 5. Press bearing out of bearing housing.

TA259526

Step 6. Remove shaft seals.
Step 7. Repeat steps 1 through 6 for other output shaft.



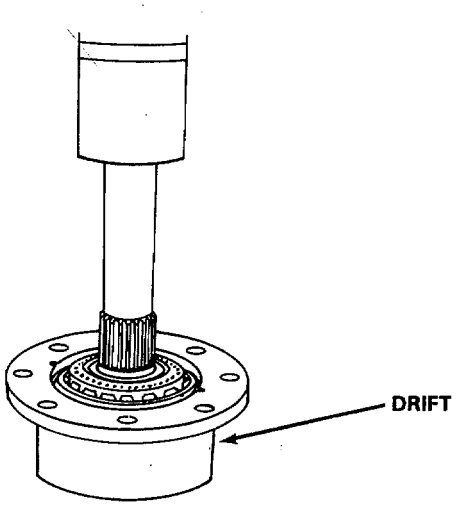
9-4. DISASSEMBLE INPUT BEARING ASSEMBLY.

Step 1. Remove screw and washer.
Step 2. Use screw without washer. Remove input gear and bearing. Remove screw.
Step 3. Remove dust guard.
Step 4. Remove bearing cover.
Step 5. Remove seals from cover.
Step 6. Put bearing assembly in drift pin. Refer to table 2-1, item 42.
Step 7. Press out gear.

NOTE

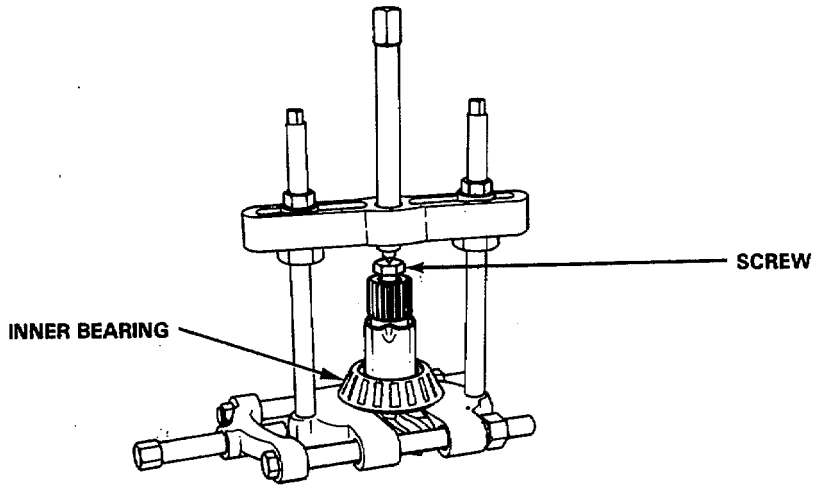
Record thickness of shims as they are removed.

Step 8. Remove bearing, spacer and shims.



TA259527

Step 9. Pull off inner bearing using screw and puller.
Step 10. Remove bearing outer races from bearing housing.

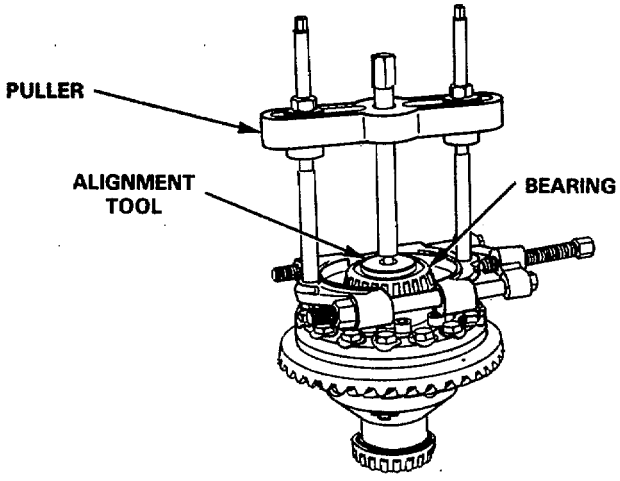


9-5. DISASSEMBLE DIFFERENTIAL HOUSING AND FLANGE.

Step 1. Remove lock plate from bearing housing.
Step 2. Use wrench. Remove adjusting nut. Refer to table 2-1, item 49.
Step 3. Press bearing housing from differential housing.
Step 4. Press bearing housing from flange.
Step 5. Remove preformed packings.
Step 6. Remove, bearing races.

9-6. DISASSEMBLE DIFFERENTIAL UNIT.

Step 1. Use puller and alignment tool. Pull off bearings. Refer to table 2-1, item 39.



Step 2. Remove screws and washers from gear.
Step 3. Remove drive gear.

TA259528

Section III. CLEANING, INSPECTION, AND REPAIR

9-7. CLEAN, INSPECT AND REPAIR DIFFERENTIAL.

a. Cleaning.

WARNING

Cleaning solvent, federal specification P-D-680, Type 11, is flammable and gives off harmful vapors. Use solvent only in a well ventilated area. Avoid prolonged breathing of solvent vapors. Keep solvent away from flame. Do not use solvent in excessive amounts.

Step 1. Clean housing and internal components with cleaning solvent. Refer to appendix B, item 48.
Step 2. Dry components and housing.

b. Inspection.

Step 1. Inspect housing for cracks.
Step 2. Inspect gear for chipped or broken teeth.
Step 3. Inspect bearings for damage.

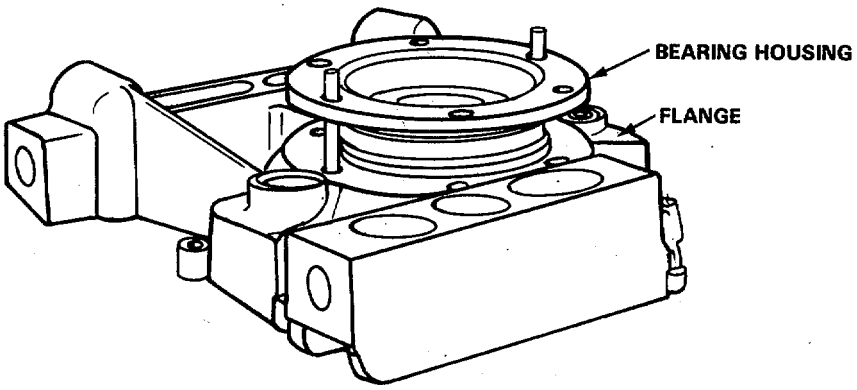
c. Repair.

Step 1. Replace cracked housing.
Step 2. Replace damaged gears. The input gear and drive gear can only be replaced as a set.
Step 3. Replace damaged bearings.
Step 4. Replace all seals and preformed packing with new seals and preformed packing.

Section IV. ASSEMBLY OF DIFFERENTIAL

9-8. ASSEMBLE DIFFERENTIAL HOUSING AND FLANGE.

Step 1. Put in preformed packings.
Step 2. Use guide pins. Press bearing housings into differential housing. Remove guide pins.
Step 3. Press bearing housing into flange.



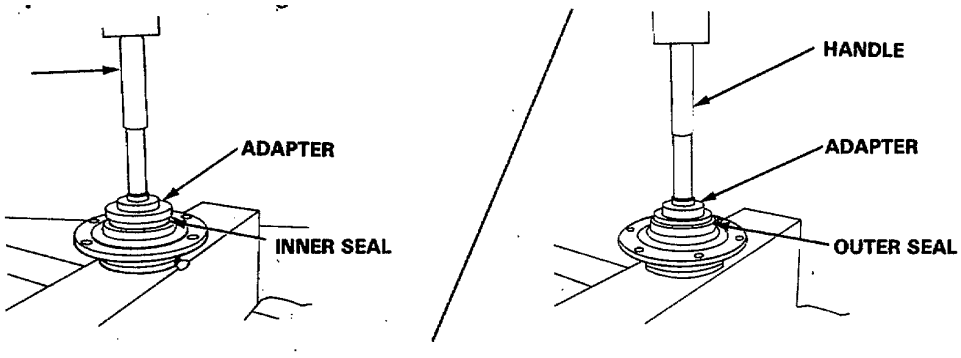
TA259529

9-9. ASSEMBLE OUTPUT SHAFT ASSEMBLY.

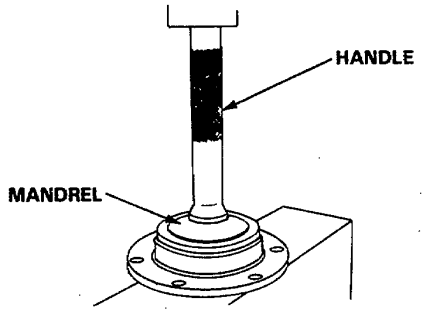
NOTE

The outer seal is a double lip seal.

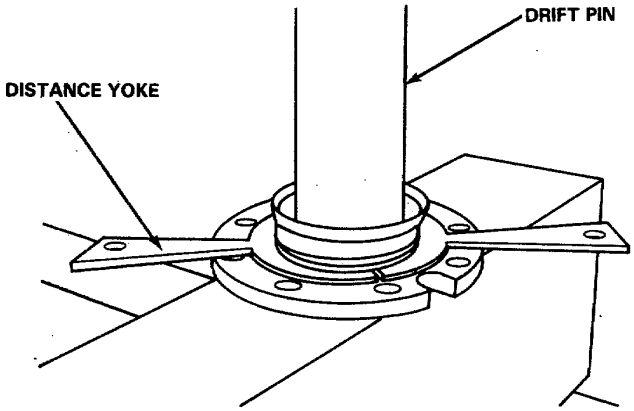
Step 1. Use handle and adapter. Press in inner seal. See table 2-1, items 31 and 54.
Step 2. Press in outer seal.
Step 3. Fill seals with grease.



Step 4. Use handle and mandrel. Press bearing into housing. See table 2-1, items 32 and 55.
Step 5. Put in snapring.

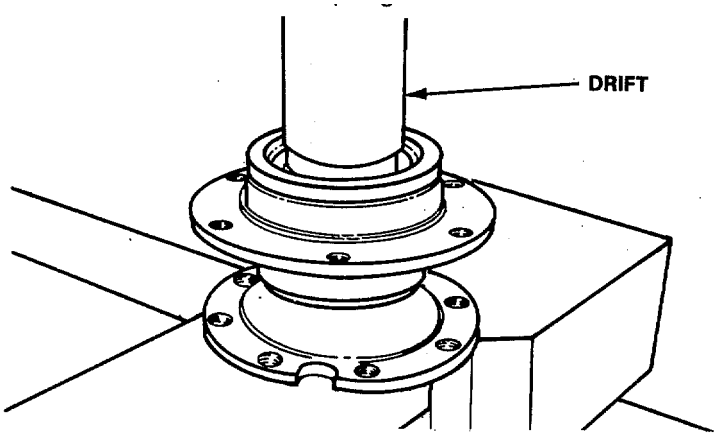


Step 6. Use drift pin and distance yokes. Press on dust guard. See table 2-1, items 33 and 35.



TA259530

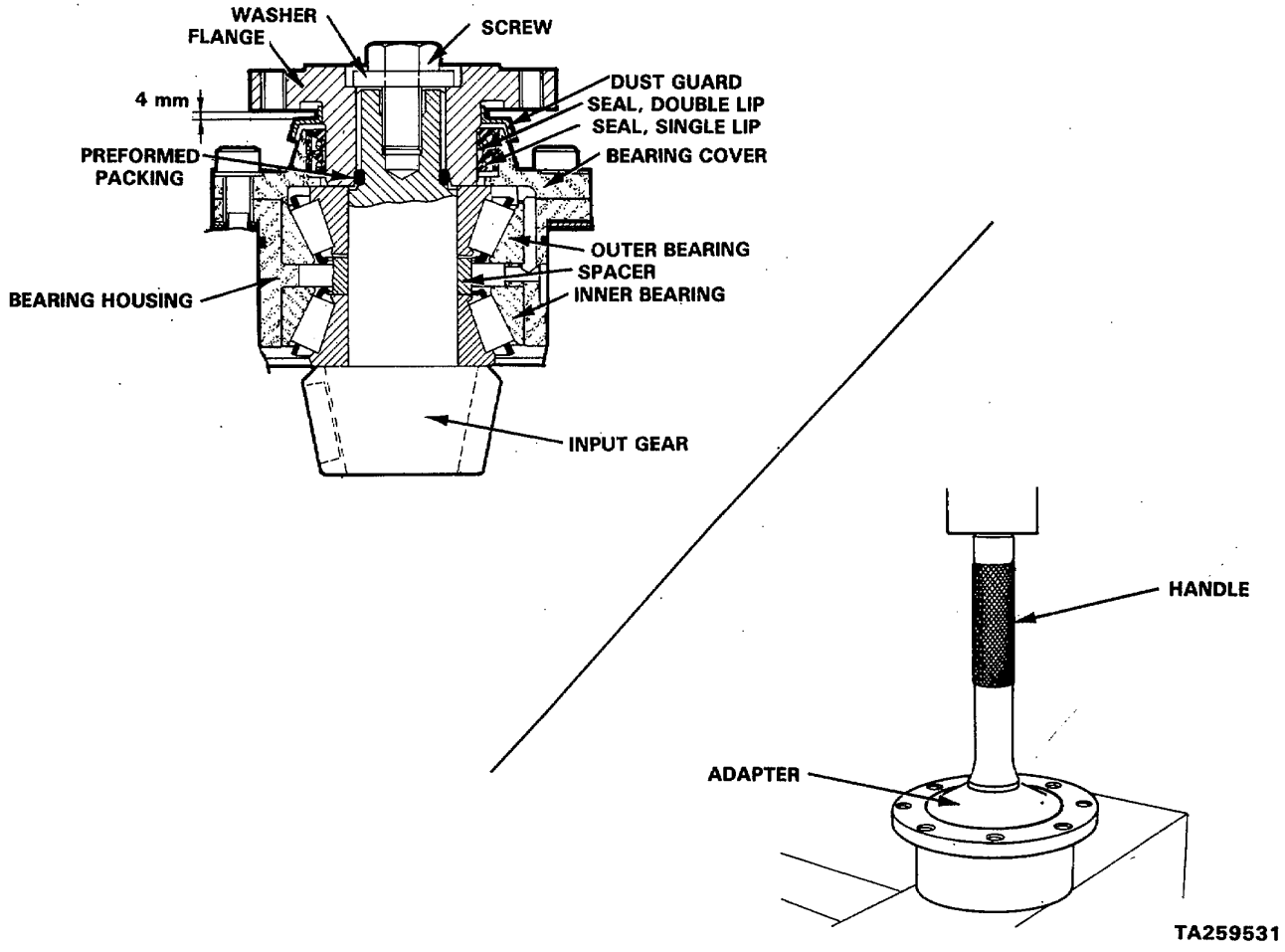
Step 7. Press bearing on shaft.
Step 8. Put on shim and snapring.



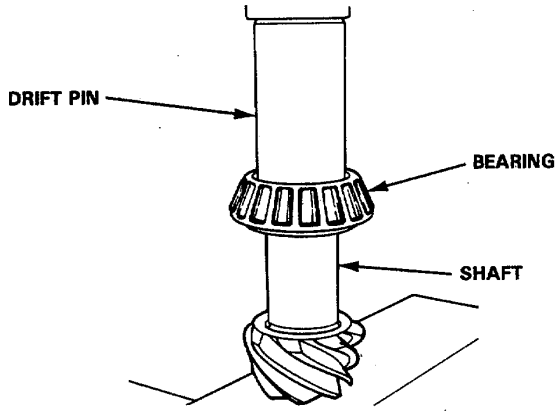
Step 9. Repeat steps 1 through 8 for other output shaft.

9-10. ASSEMBLE INPUT BEARING ASSEMBLY.

Step 1. Use adapter and handle. Press bearing outer races into bearing housing. See table 2-1, items 37 and 55.



Step 2. Use drift pin. Press inner bearing on shaft. See table 2-1, item 40.

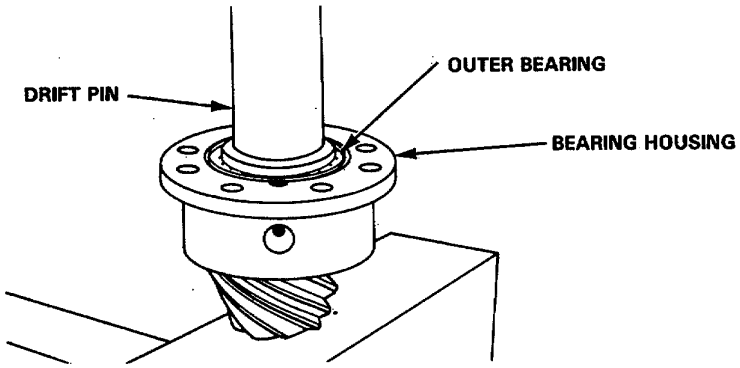


NOTE

Put on same shims that were removed.

Step 3. Put on spacer and shims.

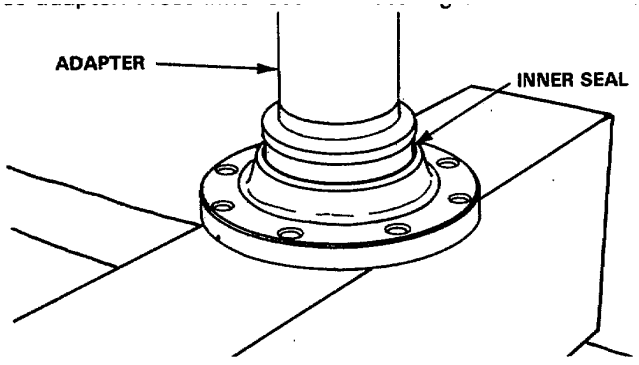
Step 4. Use drift pin. Press bearing housing and outer bearing on gear shaft. See table 2-1, item 40.



NOTE

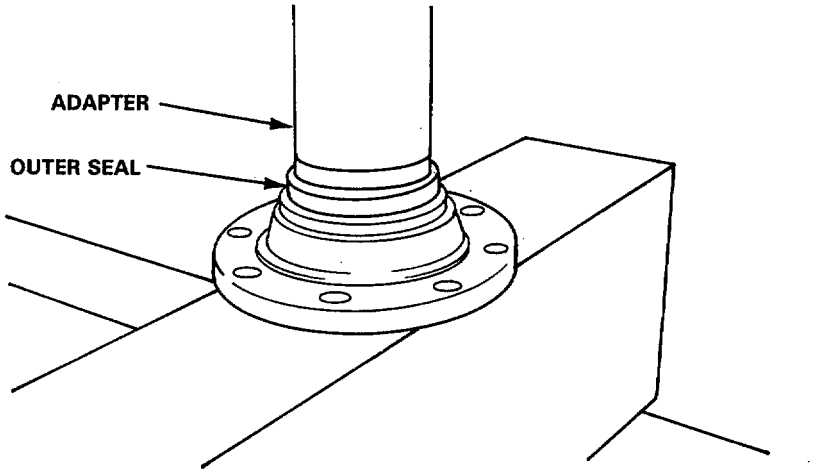
The outer seal is a double lip seal.

Step 5. Use adapter. Press inner seal into bearing cover. See table 2-1. item 30.



TA259532

Step 6. Use adapter. Press outer seal into bearing cover. See table 2-1, item 30.
Step 7. Fill seals with grease. Refer to appendix B, item B.



Step 8. Put preformed packing on gear shaft.
Step 9. Put bearing cover on shaft.
Step 10. Use drift pin. Press dust guard on shaft. See table 2-1, item 34.
Step 11. Put drive flange on gear shaft.
Step 12. Put on washer and screw.
Step 13. Oil the bearings.

NOTE

Bearing housing must be continuously rotated as screw is torqued.

Step 14. Use yoke. Torque screw to 162 lb. ft. (220 Nm). See table 2-1, item 36.
Step 15. Wind a length of cord around bearing housing.
Step 16. Attach tension gage to cord.
Step 17. Pull gage until bearing housing starts to turn.
Step 18. Reading should be 3 to 6 lb. ft. (14 to 27 Nm) with used bearings. Reading should be 6 to 12 lb. ft. 27 to 54 Nm) with new bearings.
Step 19. If reading is too high, disassemble input bearing assembly and add shims. Assemble bearing assembly and repeat measurement.
Step 20. If reading was too low, disassemble input bearing assembly and remove shims. Assemble bearing assembly and repeat measurement.

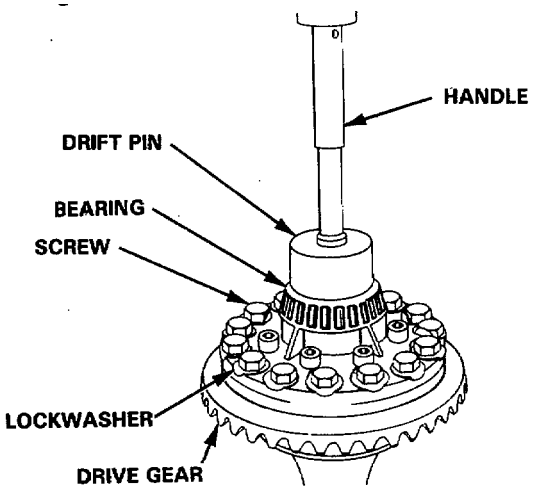
TA259533

9-1 1. ASSEMBLE DIFFERENTIAL.

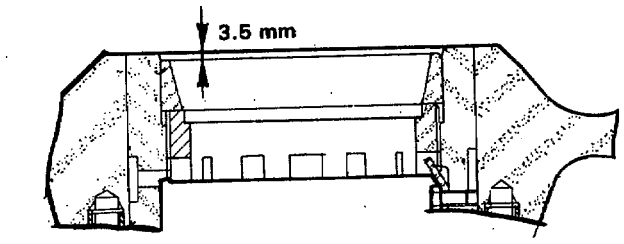
WARNING

To avoid burns after heating metal components wear insulated gloves or handle components with pliers.

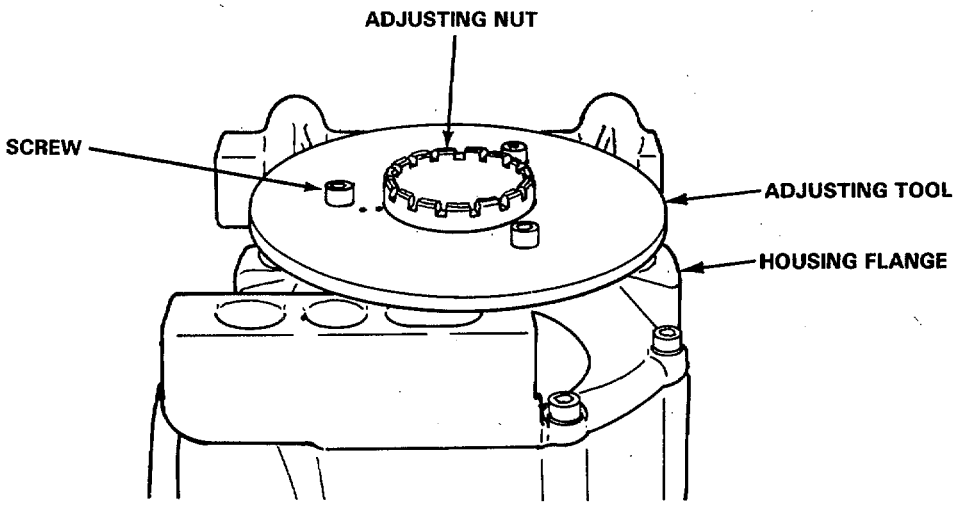
Step 1. Heat drive gear to 302°F (150°C).
Step 2. Put drive gear on differential unit.
Step 3. Put on lockwashers. Put in screws.
Step 4. Torque screws to 67 lb. ft. (91 Nm).
Step 5. Bend tabs on lockwashers.
Step 6. Use driftpin and handle. Press bearing on differential unit. See table 2-1, items 41 and 54.
Step 7. Oil bearings. Refer to appendix B, item 27.



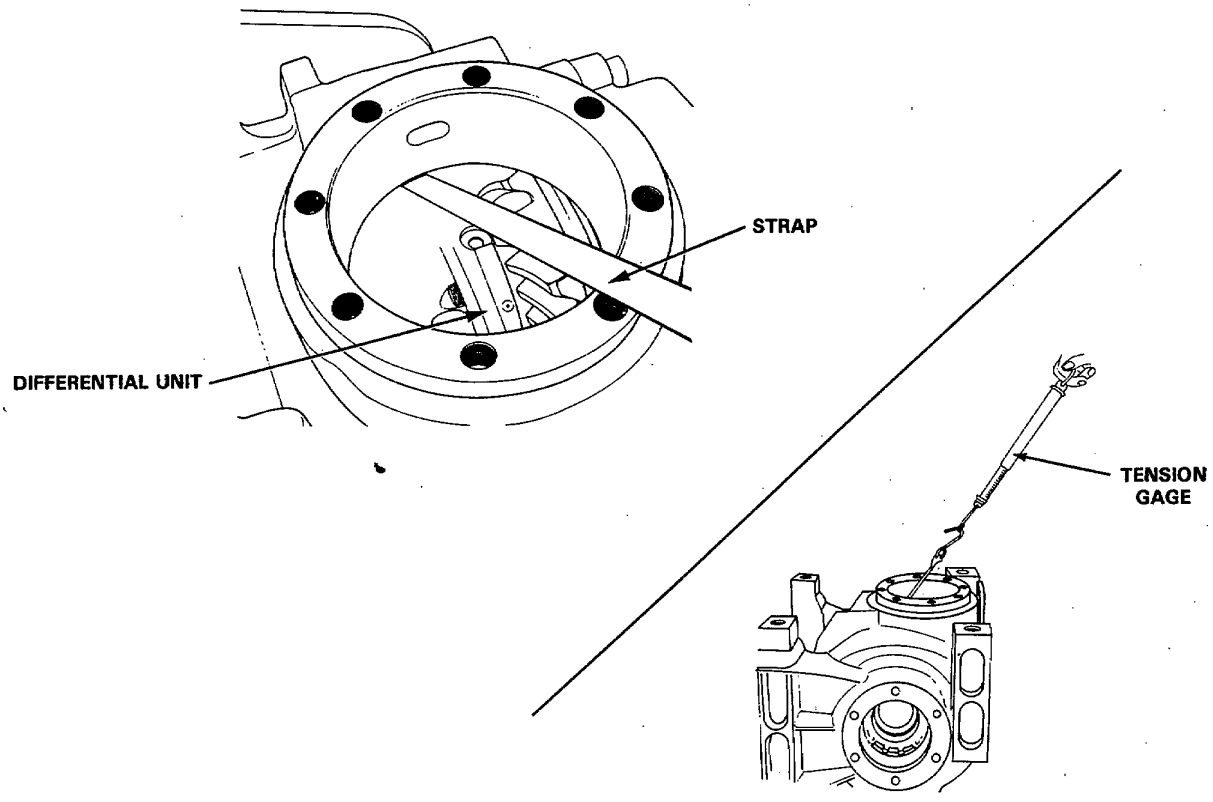
Step 8. Put in two screws on opposite sides of the bearing housing. Tighten screws.
Step 9. Put in bearing outer race.
Step 10. Put on adjusting nut.
Step 11. Screw in adjusting nut until bearing race is below surface of bearing housing.



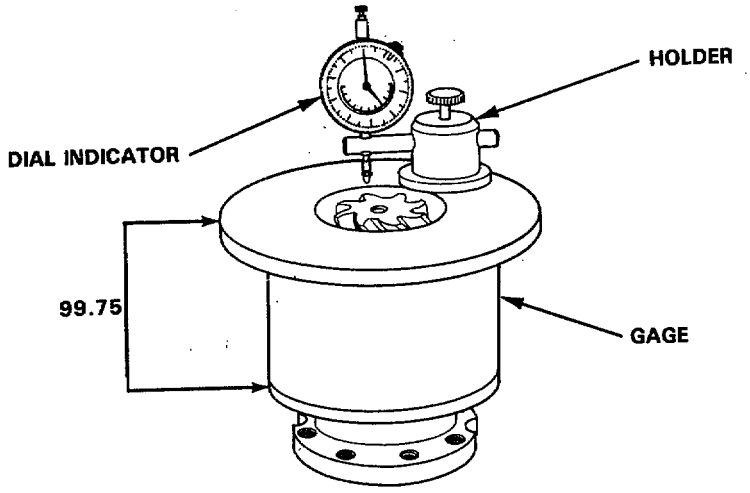
Step 12. Put differential unit into differential.
Step 13. Put outer bearing race into the bearing housing in the housing flange.
Step 14. Put preformed packing and housing flange on differential.
Step 15. Put in washers and screws.
Step 16. Torque screws to 38 lb. ft. (52 Nm).
Step 17. Put adjustment tool on housing flange. See table 2-1, item 53.
Step 18. Tighten three screws.



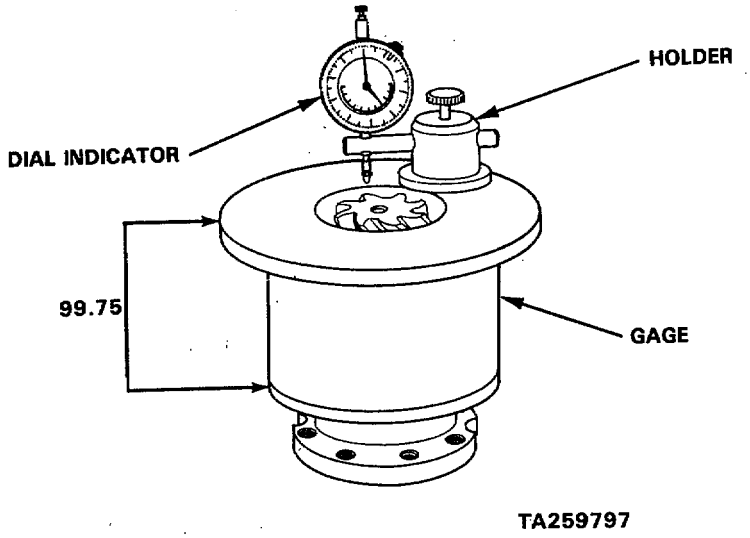
Step 19. Turn differential input to face upward.
Step 20. Wind a strap around differential unit. Attach tension gage to strap.
Step 21. Use adjusting tool. Pull on tension gage and tighten adjusting tool nut until gage reads 4.5 to 6.5 lb. ft (6 to 8 Nm) while turning differential unit. Refer to table 2-1, item 50.



Step 22. Use gage, holder and dial indicator to measure distance L. See table 2-1, items 52 and 45.
Step 23. Put gage on input bearing housing.
Step 24. Mount holder and dial indicator on gage.
Step 25. With dial indicator tip setting on gage, zero the indicator.



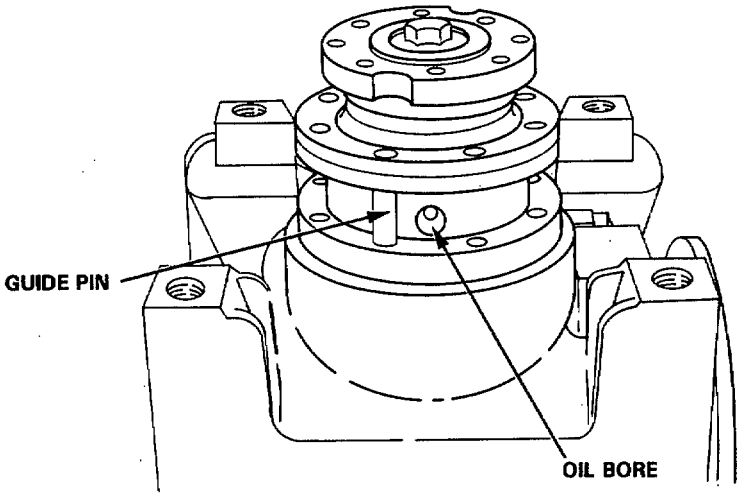
Step 26. Move tip of indicator to top of gear.
Step 27. Record distance L. L = 99.75 ± reading on dial indicator.



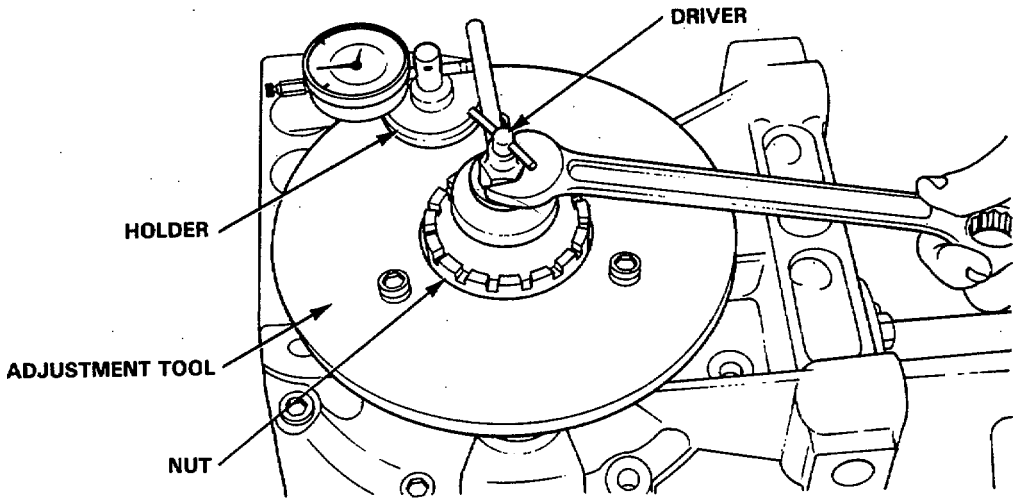
Step 28. Read and record measurement G. Measurement G is engraved on end of input gear.
Step 29. Read record measurement F. Measurement F is engraved on differential housing. Remove holder and gage.
Step 30. Determine thickness of shims to be used. L + G - F = Thickness of shims (±0.05 mm).
Step 31. Put correct thickness of shim on bearing housing.
Step 32. Put on preformed packing.
Step 33. Put two guide pins in differential housing. See table 2-1, item 38.
Step 34. Align oil bore and put input bearing assembly into differential housing. Remove guide pins.
Step 35. Put in washers and screws.

TA259536

Step 36. Alternately tighten screws until bearing assembly is tight.
Step 37. Torque screws to 40 lb. ft. (54 Nm).



Step 38. Rotate differential. Use driver, holder, dial indicator and adjustment tool. See table 2-1, items 51, 46, and 53.
Step 39. Measure backlash on drive gear. Correct backlash is 0.0039 to 0.0059 in. (0.10 to 0.15 mm).
Step 40. Use hook wrench and adjusting wrench. To increase backlash, screw out nut in adjusting tool and screw in adjusting nut in housing equal amounts. To reduce backlash screw out adjusting nut in housing and screw in nut adjusting tool equal amounts.
Step 41. Remove driver, holder and indicator.
Step 42. Secure adjusting nut with lockplate.



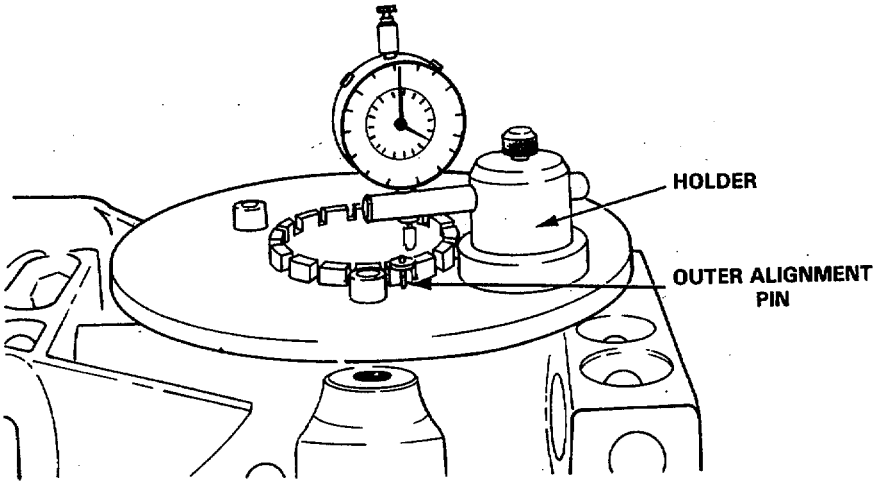
TA259537

NOTE

Long alignment pin is the inner pin.

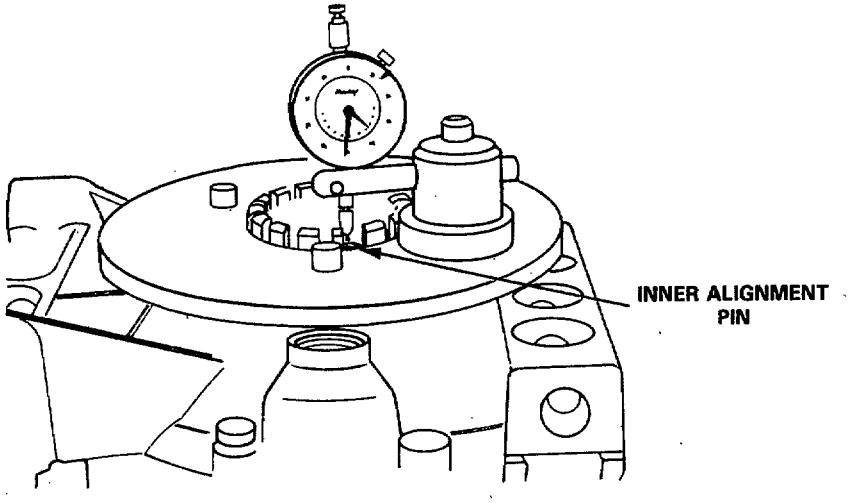
Step 43. Put alignment pins in adjusting tool. Position dial indicator and holder on adjusting tool. Refer to table 2-1, items 47, 48 and 44.

Step 44. Place dial indicator tip on outer alignment pin. Zero the dial indicator.



Step 45. Move tip of dial indicator to top of inner alignment pin.

Step 46. Reading on indicator is measurement C. Record measurement C.

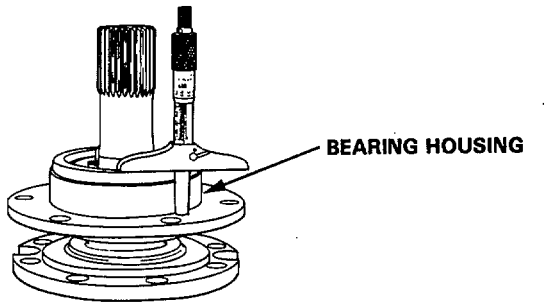


Step 47. 30.0 - C = D. Record measurement D.

Step 48. Measure height of bearing housing to get measurement A. Record measurement A.

Step 49. Determine thickness of shims to be used. D - A = Thickness of shims (± 0.05 mm).

TA259538



Step 50. Remove adjustment tool. Dial indicator, holder and alignment pins.
Step 51. Put on shims and preformed packing.
Step 52. Put short output shaft with bearing cover into differential.
Step 53. Put in washer and screws.
Step 54. Torque screws to 38 lb. ft. (52 Nm).
Step 55. Rotate differential. Remove two screws.
Step 56. Put preformed packing and long output shaft with bearing assembly into differential.
Step 57. Put in washers and screws.
Step 58. Torque screws to 38 lb. ft. (52 Nm).
Step 59. Put in drain plug.
Step 60. Torque drain plug to 38 lb. ft. (52 Nm).
Step 61. Refill with proper lubricant. Refer to LO 9-2350-272-12.

TA259539

CHAPTER 10
REPAIR OF BRAKE SYSTEM

Section I. DESCRIPTION AND DATA

10-1. DESCRIPTION.

The carrier has two independent brake systems: a service brake and a parking brake. The service brake is a two-circuit hydraulic disc brake. The parking brake is a mechanical brake operating on the same disc as the service brake.

10-2. TECHNICAL DATA

MASTER CYLINDER

Make	Lockheed 4222-171
Type	Tandem
Cylinder diameter	0.7 in. (17.8 mm)

BRAKE CALIPERS

Right Hand	Girling 67032 089
Left Hand	Girling 67032 088

BRAKE PADS

Make	Delcon Saab 899 4998
Quantity	4
Thickness of new pads, including backing plate	0.6 in. (1 6 mm)

BRAKE DISC

Outer diameter	6 in. (198 mm)
Thickness: new disc	0.50 in. (12.7 mm)
Thickness: overhauled, min	0.48 in. (12.2 mm)
Axial wobble: max	0.004 in. (0.1 mm)

BRAKE LINE TUBING

Outer diameter	0.2 in. (4.76 mm)

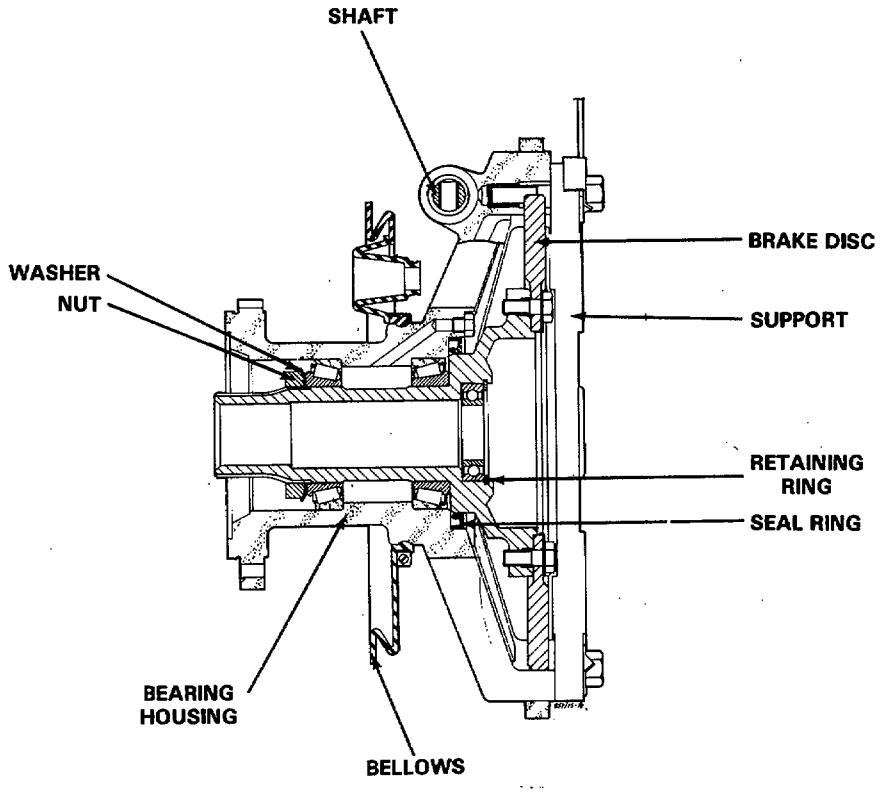
TIGHTENING TORQUES

Screws M6	7 lb. ft. (10 Nm)
Screws M8-8.8	19 lb. ft. (26 Nm)
Screws M8-10.9	23 lb. ft. (31 Nm)
Screws, brake disc	38 lb. ft. (52 Nm)
Screws, brake calipers	107 lb. ft. (145 Nm}
Screws anchor bars	67.1b. ft. (91 Nm)

Section II. REPAIR OF BRAKE COMPONENTS

10-3. GENERAL.

The brake disc of the carrier rotor disc brake assembly is mounted on a brake shaft at the front end of the transfer. The brake shaft is supported in a bearing housing and connects with both propeller shafts through the transfer high-speed gears. Braking action is available also when the transfer is in neutral. The brake shaft bearing housing supports two brake caliper assemblies with disc brake pads.



TA259540

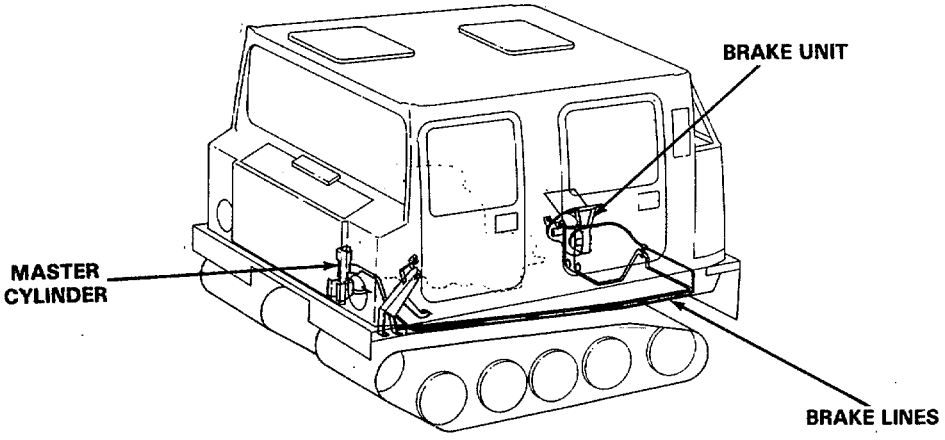
10-4. HYDRAULIC SERVICE BRAKE.

a. General

The service brake is a hydraulic disc brake, with two independent circuits, left and right brake calipers.

The main components of the hydraulic brake system are:

- Master cylinder with a pressure differential/warning valve
- Brake fluid reservoir
- Brake lines
- Two brake calipers.



HYDRAULIC SERVICE BRAKE

TA259541

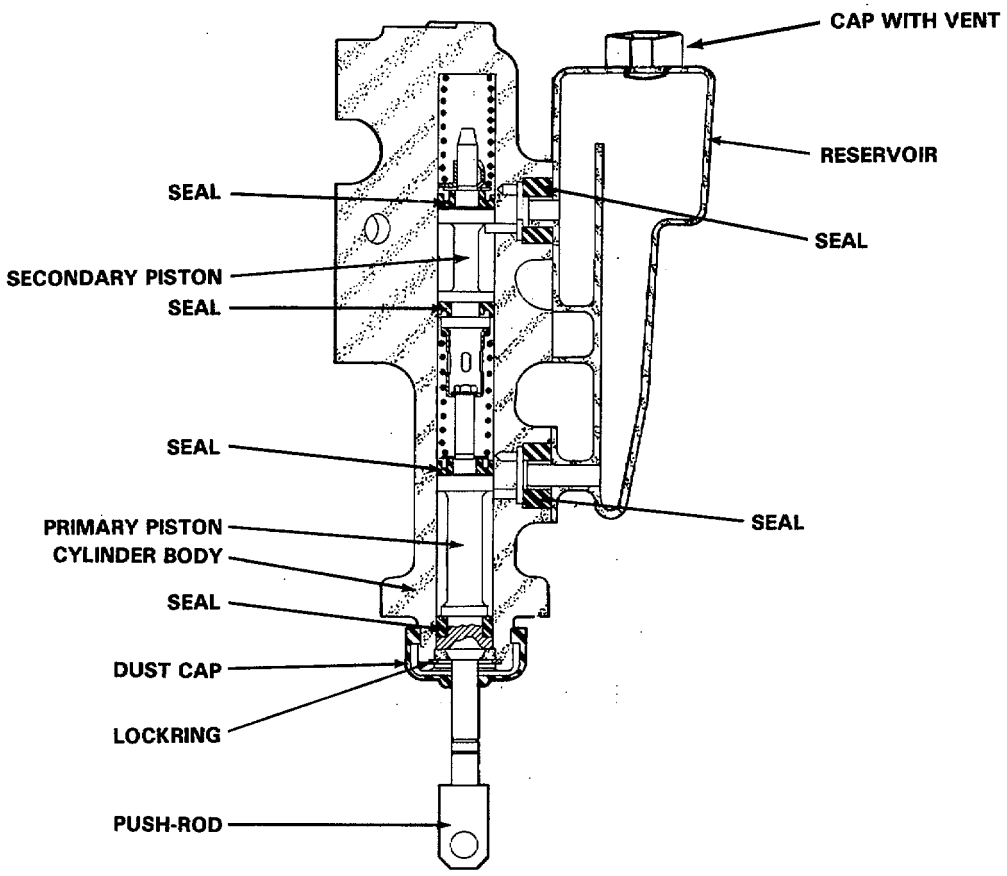
b. Master Cylinder.

When in the stationary position, the primary and secondary return springs push the pistons downward, establishing an open connection (port) between the brake fluid reservoir and piston cylinder of both circuits.

When applying the brakes the push rod forces the primary piston inward. After passing the port from brake fluid reservoir, the piston cup seals the brake fluid in the cylinder. The fluid pressure causes the secondary piston to move. The pressure increase developed by both pistons forces the fluid out into the brake lines to operate both brake calipers. When the brake pedal is released, the pistons return to their normal positions.

If a leak develops in the secondary circuit, no pressure will build up in front of the secondary piston. When braking, it will move inward until the piston extension comes in contact with the cylinder bottom. The hydraulic pressure in the cylinder between the two pistons increases, and acts upon the brake piston of the primary circuit caliper.

If there is a leak in the primary circuit, braking displaces the primary piston until it comes in contact with the secondary piston. Both pistons then move together. The pressure in the secondary piston area increases and acts upon the brake piston of the secondary circuit caliper.



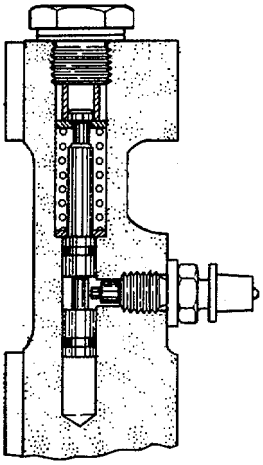
BRAKE MASTER CYLINDER

TA259542

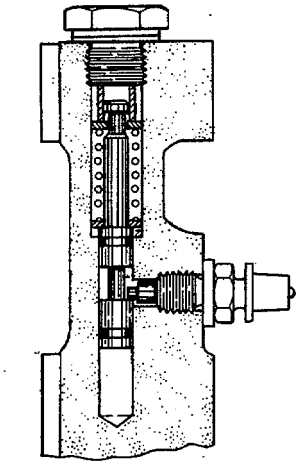
c. Pressure Differential/Warning Valve.

The pressure differential/warning valve operates a brake warning switch. It closes the circuit of the brake circuits/parking brake warning indicator at the instrument panel, if the pressure difference between the two brake circuits occur due to pressure loss.

The valve forms part of the master cylinder. The two sides of the valve piston connect with one brake circuit each, primary and secondary circuit. When braking, the pressure is equal on both sides of the piston. If one circuit tends to become greater, the piston will move towards the other circuit. A groove in the piston will come in contact with a pin that operates the brake warning switch. The switch closes the circuit and the brake circuits/parking brake warning indicator lights at the instrument panel.



PRESSURE DIFFERENTIAL/WARNING VALVE
EQUAL PRESSURE IN BOTH CIRCUITS.
VALVE IS CENTERED.



PRESSURE DIFFERENTIAL/WARNING VALVE
UNEQUAL PRESSURE, VALVE HAS MOVED
OFF CENTER TO CLOSE BRAKE WARNING SWITCH.

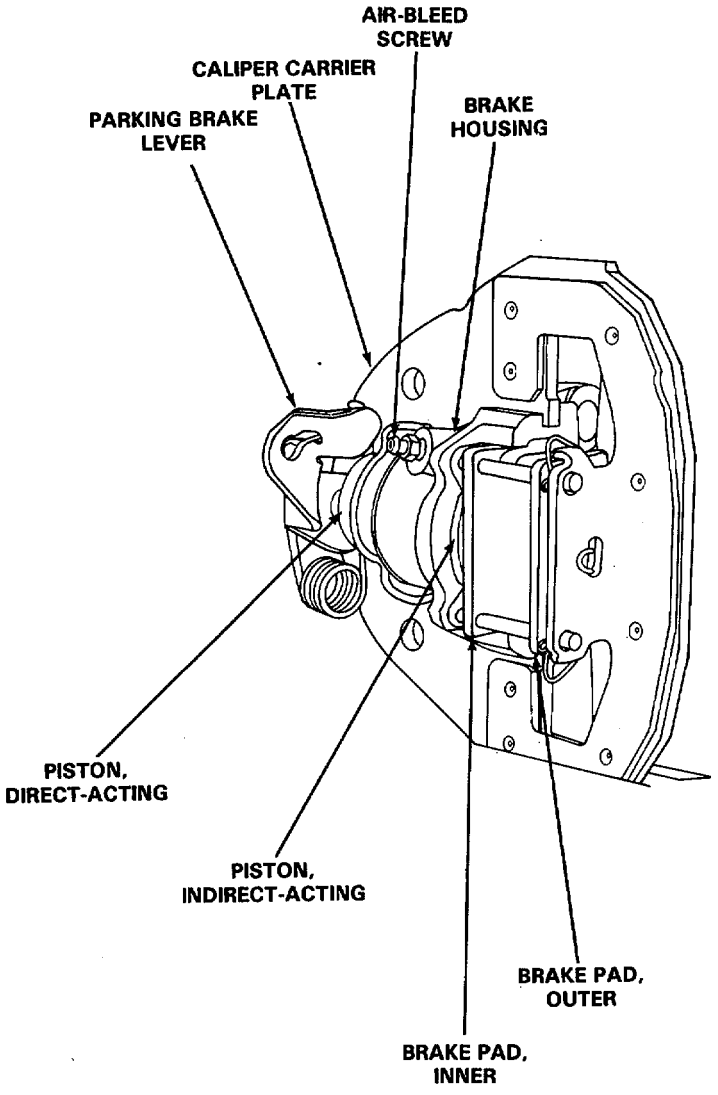
TA259784

d. Brake Calipers.

The rotor disc brake assembly has two brake calipers operating on the same brake disc. Each caliper has a brake cylinder housing with two pistons, a caliper carrier plate, and two brake pads. The brake housing has a parking brake mechanism attached.

When the brake pedal is depressed, the hydraulic pressure between the two pistons in the brake cylinder housing increases. One piston presses against one of the brake pads. The other piston presses against the caliper carrier plate which slides on the brake cylinder housing and transmits the braking force to the other brake pad. The braking forces on both sides of the brake disc are equal.

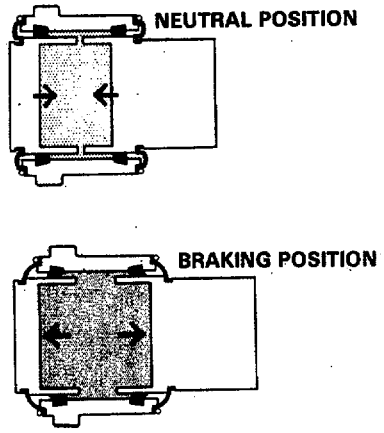
When the brake pedal is released, the piston seals in the brake cylinder housing act as springs and return the pistons to their neutral positions.



BRAKE CALIPER, LEFT HAND

TA259543

Auto-centering principle. As the piston seals return the pistons by the springiness of the rubber, the pistons will automatically return to its correct position when braking pressure is released.



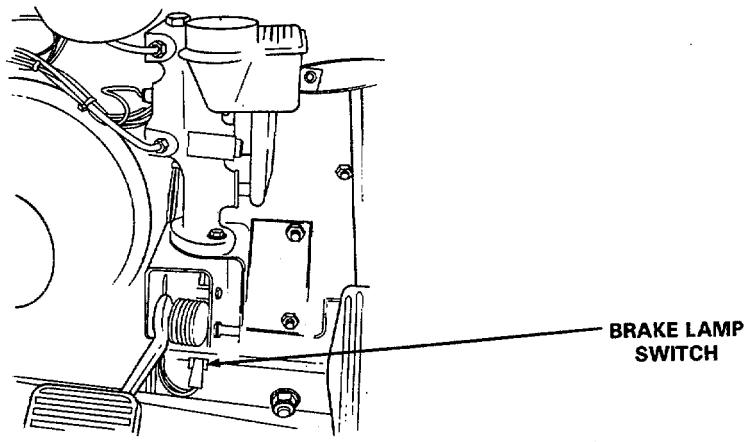
PISTON SEALS, AT NEUTRAL AND IN BRAKED POSITION

c. Brake Pedal.

The "hanging" brake pedal is supported on a shaft installed in the pedal unit bracket, An extension arm at the rear of the brake pedal actuates the master cylinder push-rod. A setting screw under the arm limits the return stroke of the pedal.

d. Service Brake Lamp Switch.

The brake lamp switch is placed beside the setscrew under the brake pedal rear arm which actuates the switch. The circuit is open when the brake pedal is released. Depressing the pedal closes the circuit of the brake lamps.

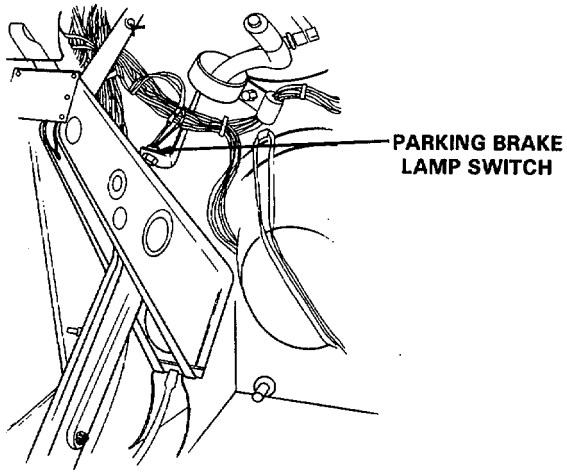


BRAKE LAMP SWITCH

TA259544

e. Parking Brake Lamp Switch.

This switch contact is operated by the parking brake pedal. When the pedal is free, the circuit is open. Depressing the pedal closes the lamp circuit.

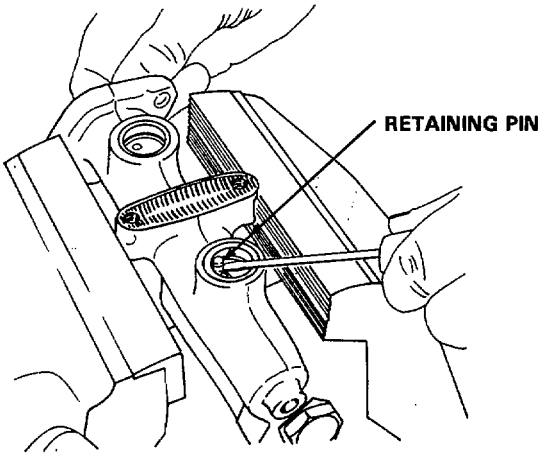


PARKING BRAKE WARNING LAMP SWITCH

10-5. MASTER CYLINDER.

a. Disassembly.

Step 1. Drain brake fluid.
Step 2. Place master cylinder in a vise.
Step 3. Remove brake warning switch.
Step 4. Remove reservoir and seals.
Step 5. Remove dust cap, snap ring and push rod.
Step 6. Press primary piston inward.
Step 7. Remove retaining pin from secondary piston.
Step 8. Remove primary piston.
Step 9. Remove secondary piston.
Step 10. Remove pressure differential/warning spool valve plug.
Step 11. Remove guide.
Step 12. Remove pressure differential/warning spool valve piston.



TA259545

b. Cleaning, Inspection, and Repair.

CAUTION

Do not clean brake master cylinder with dry cleaning solvent. Use brake fluid only. See LO 9-2350-272-12 for proper brake fluid.

(1) Cleaning.

Step 1. Clean master cylinder and other parts. Refer to appendix B, item 7.
Step 2. Dry master cylinder and other parts.

(2) Inspection.

Step 1. Inspect master cylinder for damage, cylinder wall scoring, pitting and rust.
Step 2. Inspect other parts for damage, bends cracks, or wear.

(3) Repair.

Step 1. Hone master cylinder walls, if needed.
Step 2. Replace seals with new seals.
Step 3. Replace all damage components with new components.

c. Assemble.

NOTE

See LO 9-2350-272-12 for proper brake fluid.

Step 1. Dip piston cup seals in clean brake fluid.

NOTE

When assembling piston cup seals on the primary or secondary pistons, be sure that a washer is under the piston cup seal in the front of each piston.

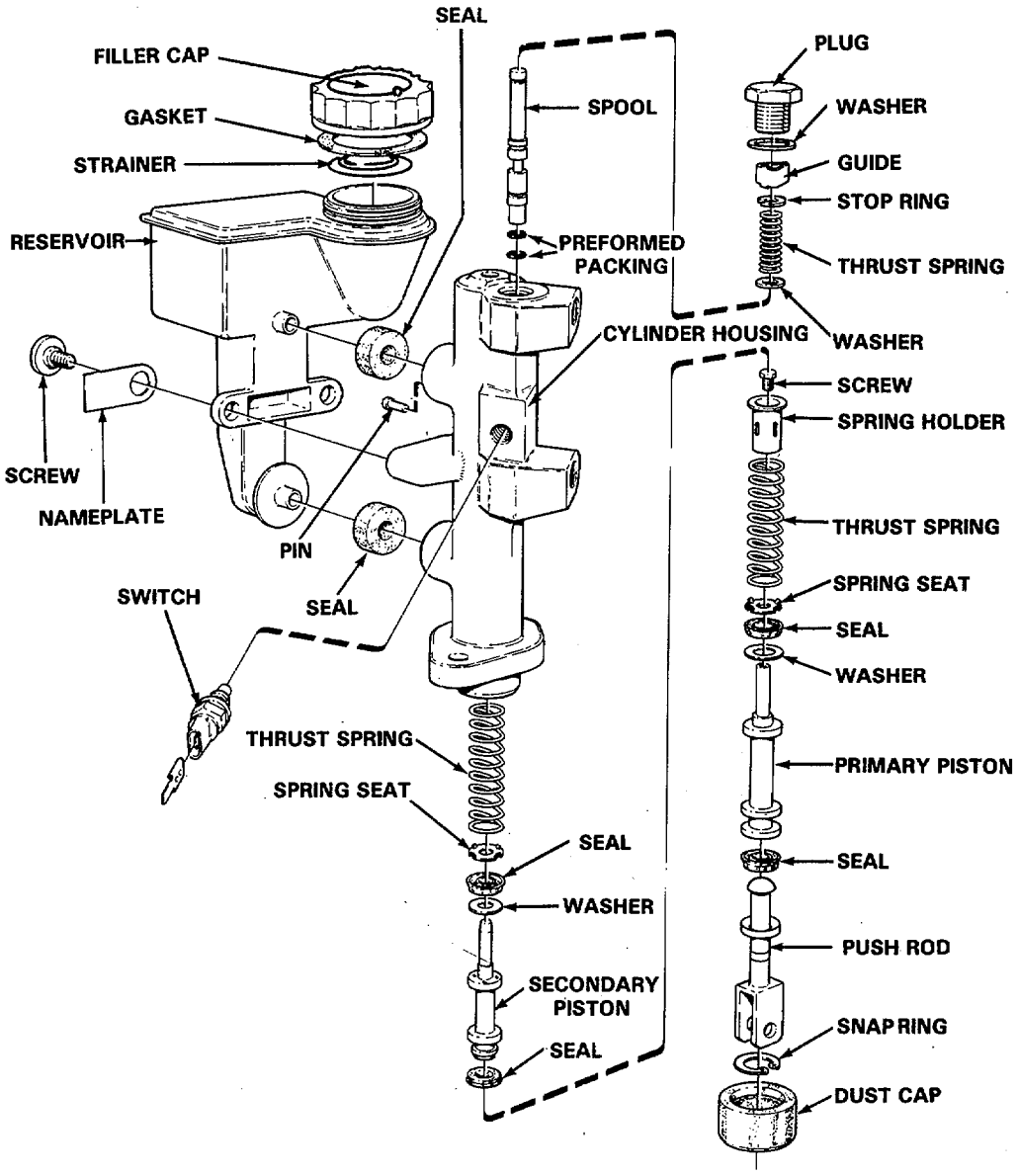
Step 2. Put piston cup seals in place on the primary and secondary pistons.
Step 3. Put thrust spring and spring seat on primary piston.
Step 4. Put spring holder and screw in thrust spring.
Step 5. Use a **14** inch thin wall socket wrench and tighten screw.
Step 6. Put thrust spring, spring seat and secondary piston in master cylinder housing.
Step 7. Put primary piston assembly in master cylinder housing.
Step 8. Depress primary piston at least 0.98 in. (25 mm) in master cylinder housing,
Step 9. Put in secondary piston retaining pin, release tension on primary piston.
Step 10. Put dust cap, and snap ring on push rod.
Step 11. Put push rod in master cylinder housing.
Step 12. Put in snap ring and dust cap.
Step 13. Put preformed packing on pressure differential/warning spool valve.
Step 14. Dip pressure differential/warning spool valve in brake fluid. Refer to appendix B, item 7.
Step 15. Put pressure differential/warning spool valve in master cylinder housing.

Step 16. Put in pressure differential/warning spool valve guide, washer and plug. Tighten plug.
Step 17. Put on seals and master cylinder reservoir.
Step 18. Put on name plate and screws. Tighten screws.

NOTE

Be sure pressure differential/warning spool valve is centered, or damage to valve and brake warning switch may result when switch is put in place.

Step 19. Put in brake warning switch. Tighten switch.
Step 20. Put on master cylinder reservoir strainer, gasket and cap.



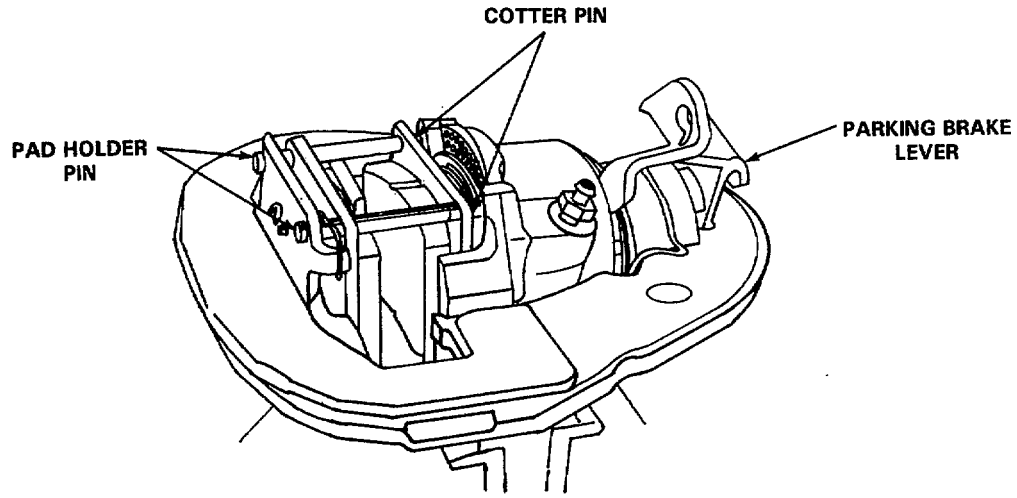
MASTER CYLINDER

TA259546

10-6. BRAKE CALIPERS.

a. Disassembly.

Step 1. Clean brake caliper.
Step 2. Place caliper in vise.
Step 3. Remove cotter pins. Drive out brake pad holder pins.
Step 4. Remove parking brake lever return spring.



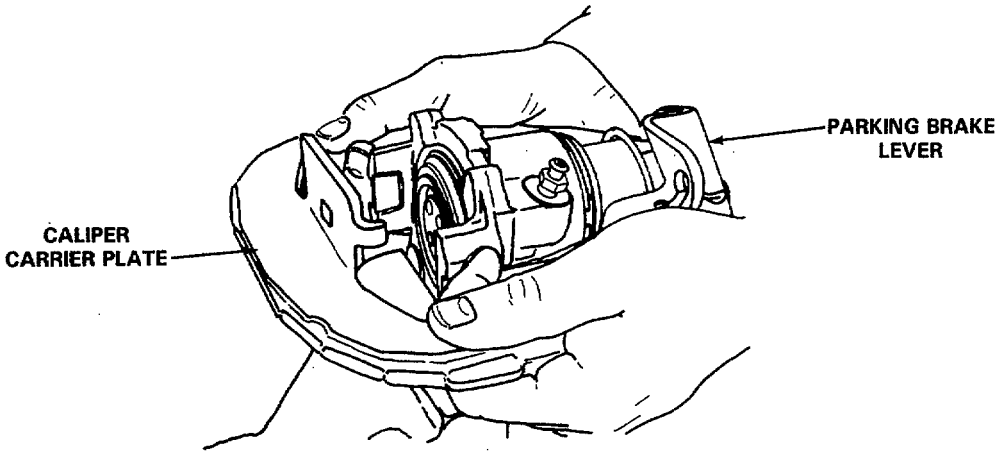
BRAKE CALIPER

Step 5. Remove caliper carrier plate from brake housing.

NOTE

Brake caliper retainer springs are different colors. The left side is GREEN. The right side is RED.

Step 6. Remove retainer spring.
Step 7. Remove parking brake lever.



REMOVING CALIPER PLATE

TA259547

Step 8. Remove dust cover retainer and dust covers.
Step 9. Remove bleeder screw.

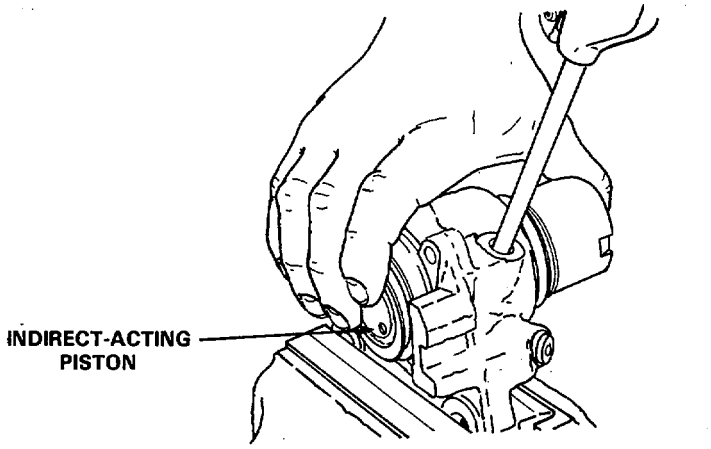
WARNING

Compressed air used for cleaning purposes will not exceed 30 psi. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

CAUTION

Use low pressure compressed air to remove indirect-acting piston.

Step 10. Use compressed air. Remove indirect-acting piston.



REMOVING INDIRECT ACTING PISTON

Step 11. Remove direct-acting piston.
Step 12. Remove preformed packing and piston seals from pistons and cylinder.
Step 13. Remove preformed packing from parking brake lever hole.

TA259785

b. Cleaning, inspection, and repair.

CAUTION

Do not clean brake calipers with dry cleaning solvent. Use brake fluid only. See LO 9-2350-272-12 for proper brake fluid.

(1) Cleaning.

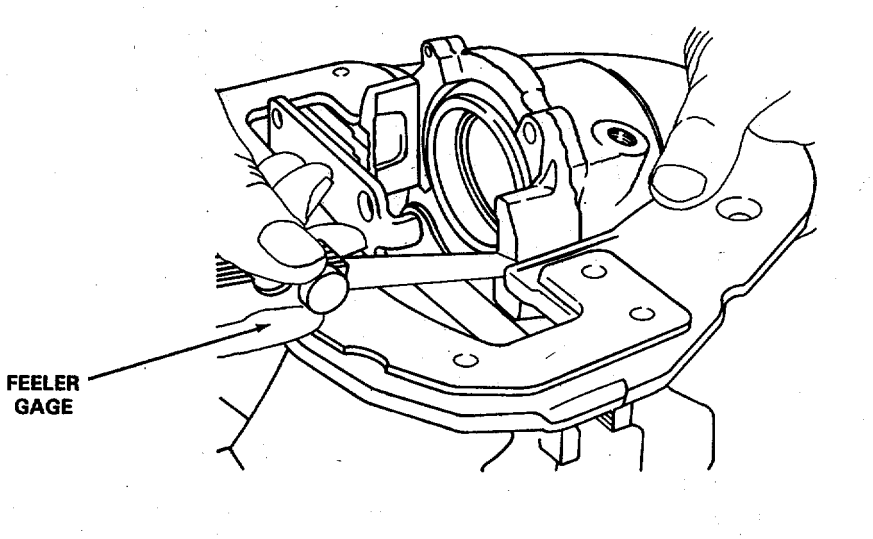
NOTE

The indirect-acting piston and inner components are one unit, and must only be wiped clean. Washing may remove lubricant for parking brake mechanism.

Step 1. Clean brake caliper and other parts. Refer to appendix B, item 7.
Step 2. Dry brake caliper and other parts.

(2) Inspection.

Step 1. Use a feeler gage. Measure clearance between the sliding surfaces of the brake housing and brake caliper carrier plate. Correct clearance 0.006-0.012 in. (0.15-0.30 mm).



MEASURING CLEARANCE

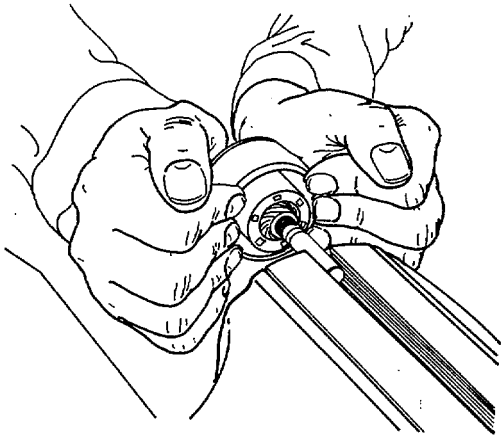
Step 2. Screw push rod into the direct-acting piston.

NOTE

Use vise jaw caps to avoid damage to push rod.

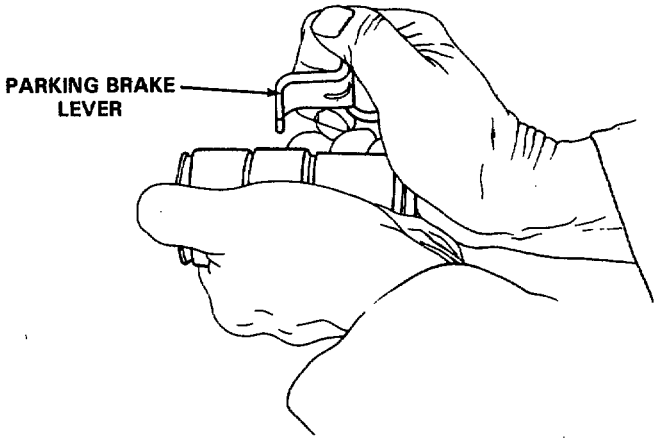
TA259548

Step 3. Place push rod in vise.
Step 4. Pull and push on piston to insure that the push rod moves out.



CHECKING ADJUSTING MECHANISM

Step 5. Assemble the two pistons and install parking brake lever.
Step 6. Operate parking brake lever. Pistons must move without binding or jerking at the parking brake lever.



CHECKING PISTON FUNCTION

Step 7. Inspect brake caliper for damage, cylinder wall scoring, pitting and rust.
Step 8. Inspect other parts for damage, bends, cracks and corrosion.

(3) Repair.

Step 1. Replace seals with new seals.
Step 2. Replace all damaged components with new components.

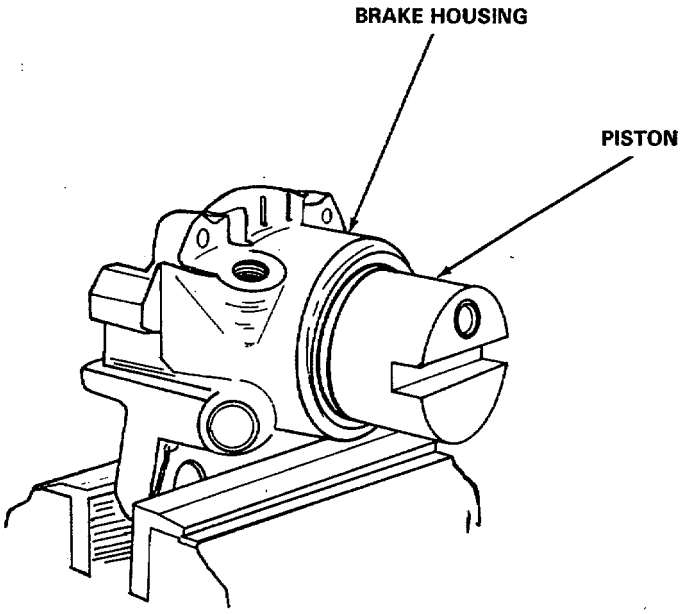
TA259547

c. Assemble.

NOTE

See LO 9-2350-272-12 for proper brake fluid.

Step 1. Place brake caliper housing in vise.
Step 2. Coat cylinder walls with brake fluid. Refer to appendix B, item 7.
Step 3. Put piston seals in brake caliper housing.
Step 4. Put clip on push rod. Screw push rod into direct-acting piston.
Step 5. Dip indirect-acting piston in brake fluid.
Step 6. Align the slot-for brake caliper with grooves in brake housing. Put indirect-acting piston in brake housing.



BRAKE HOUSING WITH PISTON

Step 7. Dip direct-acting piston in brake fluid. Refer to appendix B, item 7.

NOTE

Clip must grip pin in piston.

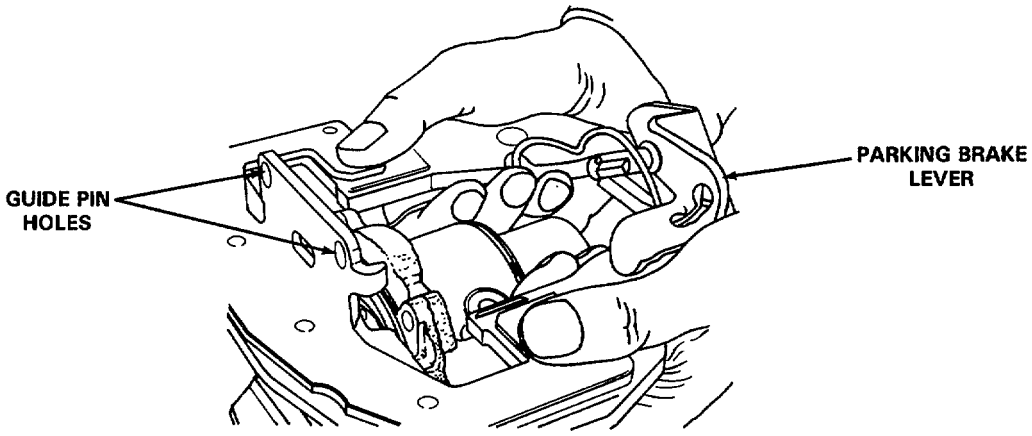
Step 8. Put direct-acting piston in cylinder.
Step 9. Put on new dust covers and retainers.

NOTE

See LO 9-2320-272-12 for proper lubricant.

TA259550

Step 10. Apply a light film of grease to brake caliper sliding surfaces, and brake pad guide pin holes. Refer to appendix B, item 8.
Step 11. Put parking brake [ever and retainer spring in place on caliper.

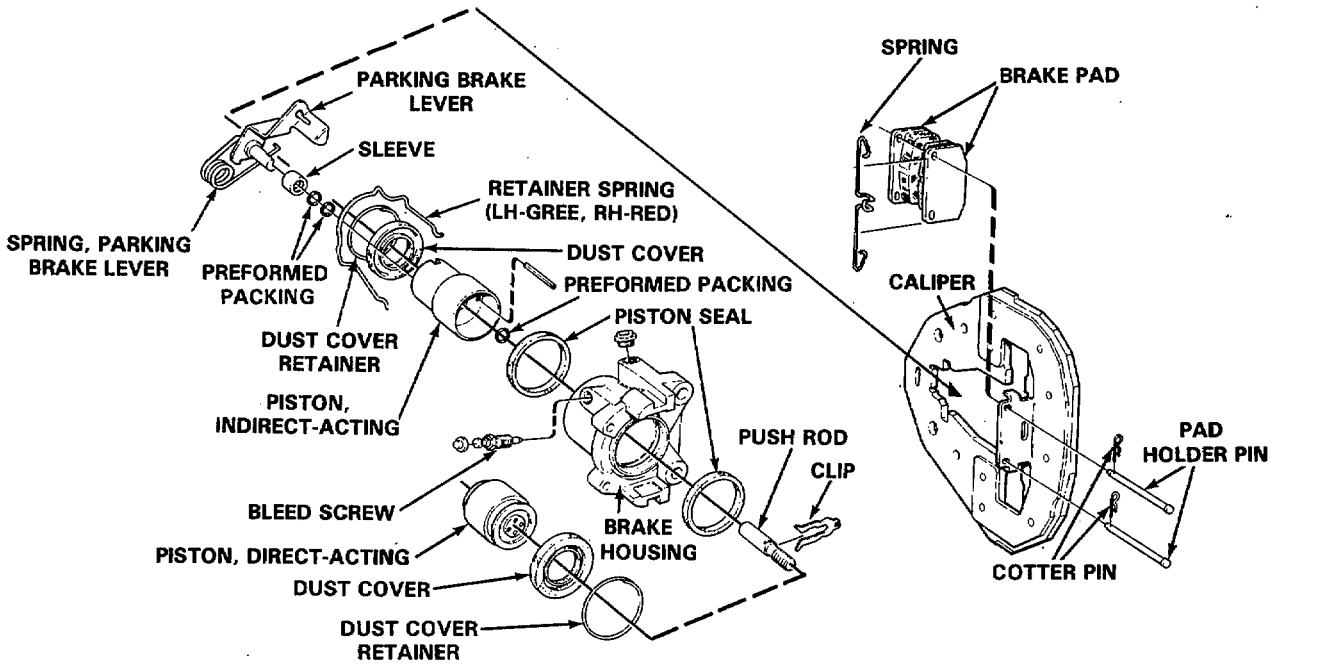


PARKING BRAKE LEVER AND RETAINER SPRING

NOTE

Brake caliper must fit in the groove in the direct-acting piston.

Step 12. Put preformed packing in parking brake lever hole. Put caliper carrier in place on brake housing.
Step 13. Put parking brake lever return spring in place.
Step 14. Put in brake pad holder and cotter pins.
Step 15. Put in bleed screw.



BRAKE CALIPER

TA259551

CHAPTER 11
REPAIR OF TRACK COMPONENTS

Section I. DESCRIPTION AND DATA

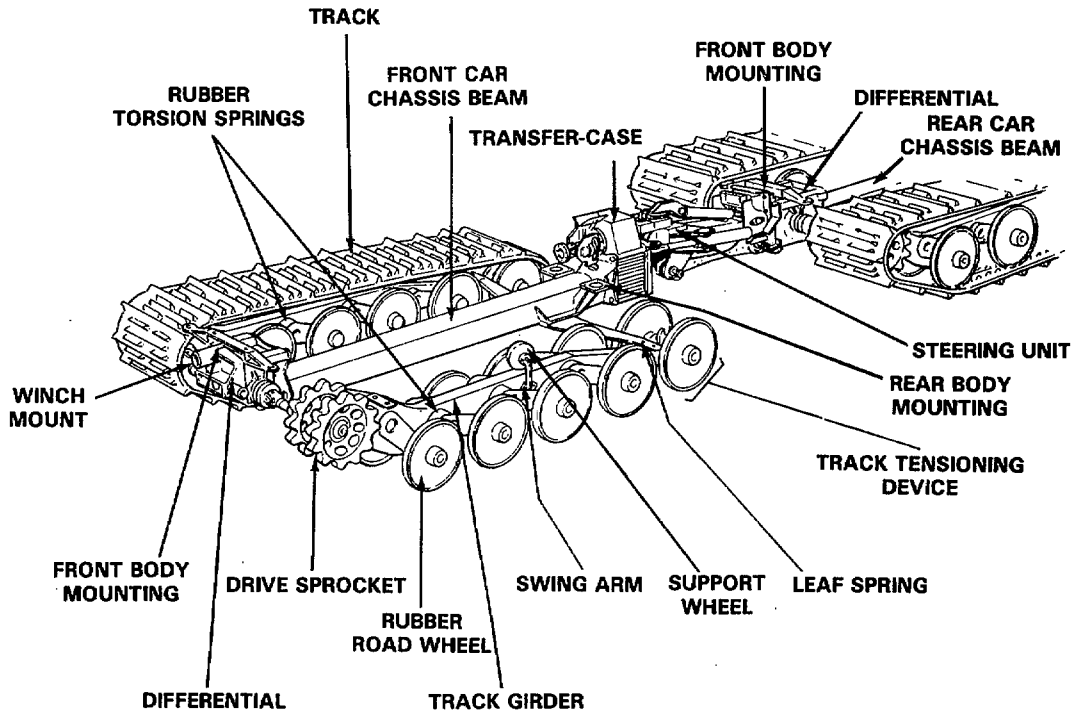
11-1 DESCRIPTION.

The chassis of the carrier consists of one central chassis beam for each car (front and rear). In the front car, the front end of the chassis beam supports a differential, on which is placed the front cross-member for mounting of the car body. The front tow-bracket houses the adapter for mounting the electric winch. The rear end of the chassis beam supports the transfer and steering unit. The front end of the rear car chassis beam supports a differential, on which is placed the front cross-member for the rear car body. The differential is also a supporting member for the steering unit. The tow hitch is mounted at the rear end of chassis beam.

The chassis beams have two leaf springs. The leaf springs ends are mounted to track assemblies. Each track assembly consist of a track girder with rubber torsion springs, pivot arms, drive sprockets, solid rubber road wheels, track support wheel, track tensioner wheels, and a preformed track assembly.

The chassis beams also provide mounting pad brackets for the rear mounting of each car body.

The front and rear cars are held together by the steering unit.



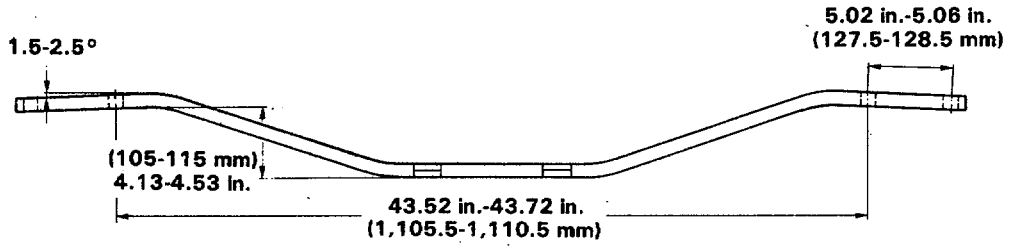
CHASSIS BEAM, SUSPENSION, WHEELS, AND TRACKS

TA259486

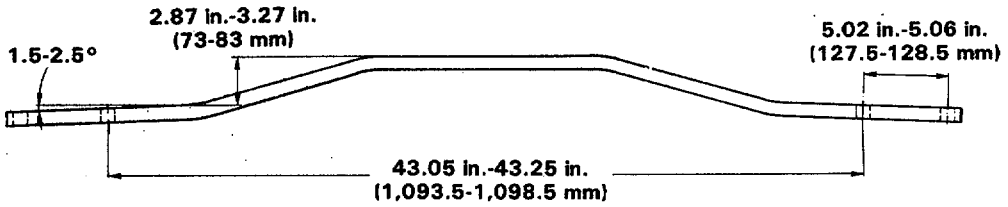
11 -2. TECHNICAL DATA.

CHASSIS BEAM

Quantity 2
Material ..... Steel SS 142144
Welding electrode grade ..... ISO E51B
Weight ..... 154 lbs. approximately (70 kg)



Weight . . . . . 64 lbs. approximately (29 kg)



TRACK GIRDERS

Quantity 4
Material ..... Steel SS 142144
Welding electrode grade ..... ISO E51B
Weight ..... 117 lbs. Approximately (53kg)

DRIVE SPROCKETS, WITH SUPPORT

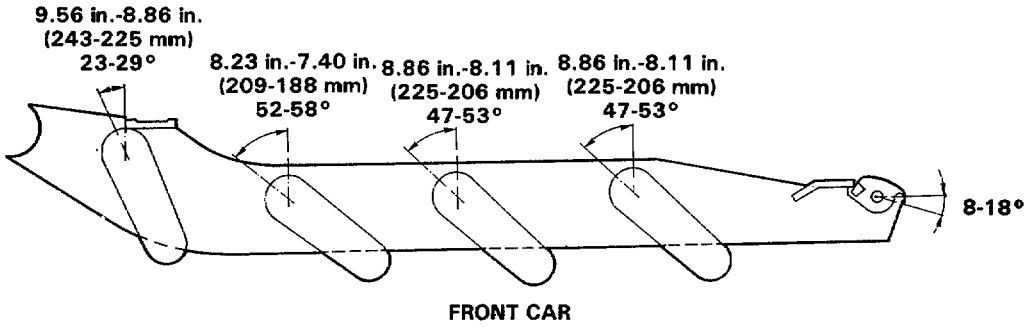
Pairs of sprockets 4
Number of teeth 12
Weight ..... 38 lbs. Approximately (17kg)
Weight sprocket only ..... 16 lbs. Approximately (7kg)

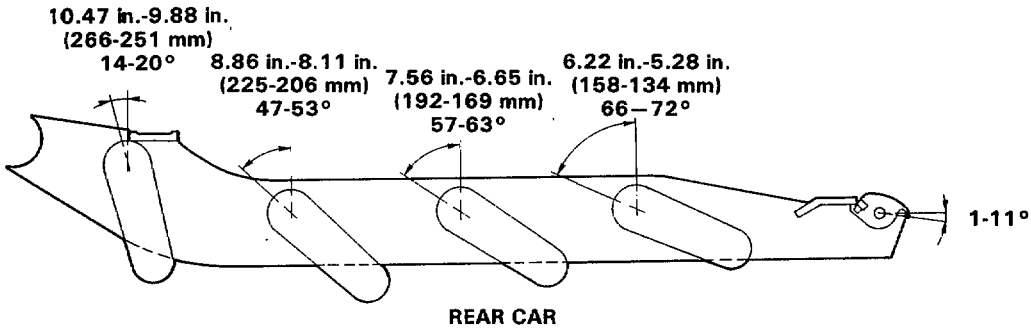
TORSION SPRINGS

Make.....Paulstra
Quantity per track assembly..... 5
Weight ..... 8.8 lbs. approximately (4 kg)

SWING ARMS

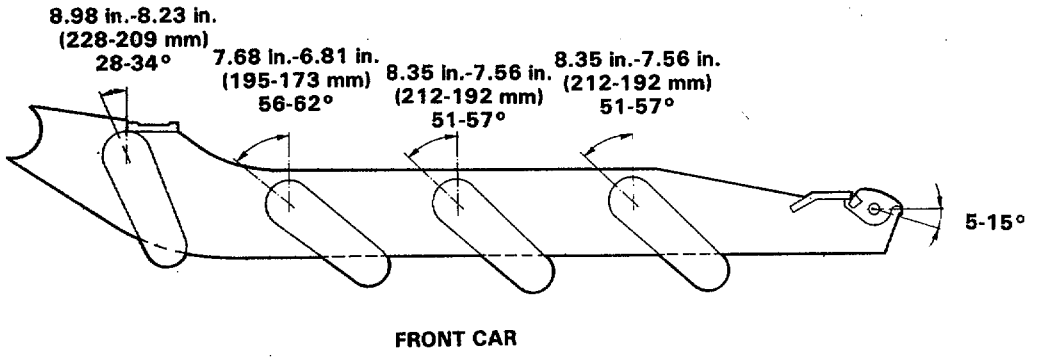
Quantity per track assembly..... 8
Material, arm proper ..... Steel SS 142144
Journal..... Steel SS 142225
Welding electrode grade, arm .....ISO E51B
Journal .....ISO E51B
Weight ..... 11 lbs. approximately (5 kg)



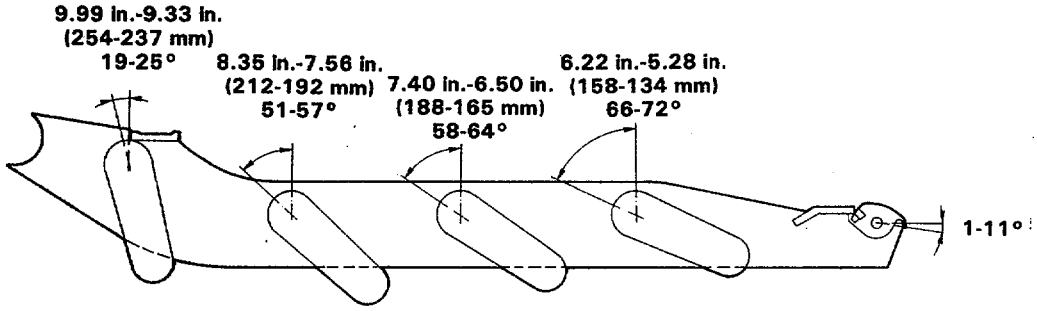


Swing arm settings angles and cam angles for pre-tensioning torsion springs, for cars driven less than 300 miles (500 km)

TA259488



FRONT CAR



REAR CAR

Swing arm setting angles and cam angles for pre-tensioning torsion springs, for cars driven more than 300 miles (500 km)

TA259489

TRACK TENSIONERS

Quantity 4
Material ..... Steel SS 142144
Welding electrode grade ..... ISO E51B
Weight ..... 55 lbs. approximately (25 kg)

CAMS

Quantity per tensioner 2

ROAD WHEELS AND TENSIONING WHEELS

Number of road wheels, per track assembly 8
Number of tensioning wheels, per track assembly 2
Weight ..... 11 lbs. approximately (5 kg)

SUPPORT WHEELS

Number per track assembly 1
Weight ..... 6.6 lbs. approximately (3 kg)

TRACKS

Make ..... SKEGA
Quantity 4
Cross-bars, number per track 64
Track guides, number per track 128
Material ..... Rubber
Length ..... 228.27 in. (620 mm)
Width ..... 24.41 in. (620 mm)
Weight ..... 418 lbs. approximately (190 kg)

TIGHTENING TORQUES

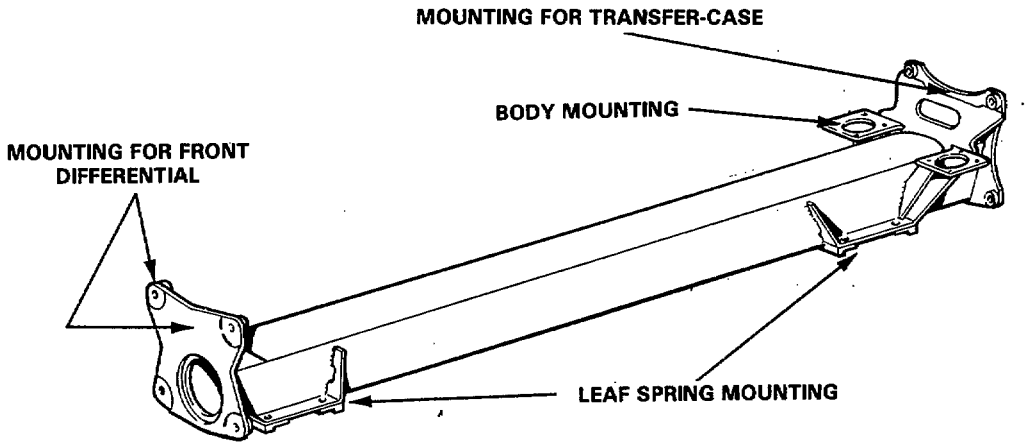
Leaf spring -- chassis beam ..... 236 lb. ft. (320 Nm)
Leaf spring -- track girder ..... 325 lb. ft. (440 Nm)
Drive sprocket -- drive shaft ..... 258 lb. ft. (350 Nm)
Swing arm -- torsion spring ..... 295 lb. ft. (400 Nm)
Solid rubber road wheel -- swing arm ..... 59 lb. ft. (80 Nm)
Track tensioner -- torsion spring ..... 110 lb. ft. (150 Nm)
Tensioning wheel holder arm -- tensioning wheel support arm ..... 2.295 lb. ft. (400 Nm)
Support wheel bracket -- track girder ..... 74 lb. ft. (100 Nm)
Support wheel -- bracket ..... 59 lb. ft. 180 Nm)

Section II. REPAIR OF CHASSIS BEAMS

11-3. FRONT AND REAR CAR CHASSIS BEAMS.

a. General - Front Car Chassis Beam.

The front car chassis beam is a closed box-type girder provided with supports for the differential at the front end and the transfer at the rear end. The chassis beam supports two leaf springs and provides mounting pad brackets for the rear mounting of the car body. Inside the beam is a support bearing for the propeller shaft connecting the transfer and differential.



FRONT CHASSIS BEAM

b. Removal - Front Car Chassis Beam.

Step 1. Place vehicle on level surface and block tracks.
Step 2. Remove front car body. Refer to paragraph 13-3.
Step 3. Support steering unit.
Step 4. Remove nuts holding steering unit and transfer to chassis beam.
Step 5. Remove blocks from car tracks.
Step 6. Pull front car away and block tracks.
Step 7. Remove transfer from chassis beam. Refer to TM 9-2350-272-20.
Step 8. Remove cotter pins, nuts, spacers and bolts holding leaf springs on chassis beam.
Step 9. Support differentia**l.**
Step 10. Remove nuts holding tow-bracket and differential to chassis beam.
Step 11. Remove tow-bracket.

NOTE

Observe position of preformed packing between chassis beam and differential.

Step 12. Pull chassis beam toward the rear. Remove and place chassis beam on cribbing.
Step 13. Remove propeller shaft from inside of chassis beam. Refer to TM 9-2350-272-20.

TA259490

c. Inspection.

NOTE

Chassis beam must be clean and free of dirt and grit. Insure that chassis beam contact surfaces for the leaf springs are perfectly clean.

Step 1. inspect chassis beam for cracks, bends, or misalignment.
Step 2. Inspect body mounting pad brackets for cracks and damage.
Step 3. Inspect screw stud for damage.
Step 4. Inspect bolt holes for elongation, cracks or damage.
Step 5. Inspect countersunk holes and wedge surfaces for cracks or damage.
Step 6. Inspect propeller shaft support bearing bracket for cracks or damage.
Step 7. Inspect propeller shaft support bearing for damage.
Step 8. Inspect studs, nuts, spacers, bolts, and other mounting hardware for damage.

d. Repairs.

(1) Straightening chassis beam. The front car chassis beam must be straightened precisely. Precision straightening is required, because the front chassis Beam houses the bearing seat for the transfer-to-differential propeller shaft.

CAUTION

Temperatures above 1324°F (700°C) may produce undesirable structural changes in the material and cause beam to be damaged or unserviceable.

(2) Use only cold-straightening methods when possible to straighten chassis beam. If hot-straightening is needed, to reduce pressing force, chassis beam must not be heated above 1324°F (700°C). The beam should show only a dark cerise (red) color when heated.

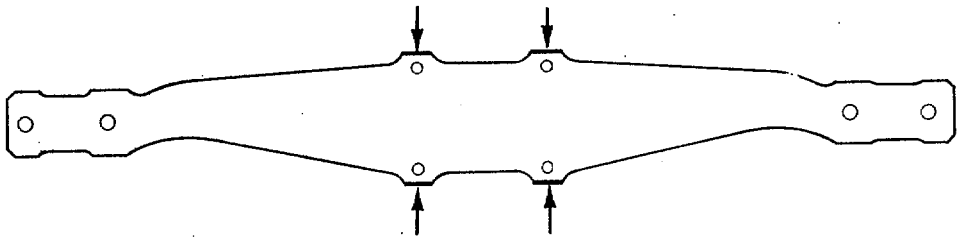
(3) Welding instructions. Use welding electrode grade ISOE51 B to weld chassis beam. Refer to TM 9-237 for proper welding techniques.

e. Replace - Front Car Chassis Beam.

NOTE

Leaf spring surfaces must be perfectly clean. Check all countersunk holes and wedge surfaces of springs.

Step 1. Check and clean leaf springs surfaces.



LEAF SPRING: SURFACES TO BE CHECKED TA259491

Step 2. Install propeller shaft inside of chassis beam. Refer to TM 9-2350-272-20.
Step 3. Put new preformed packing in front end of beam.

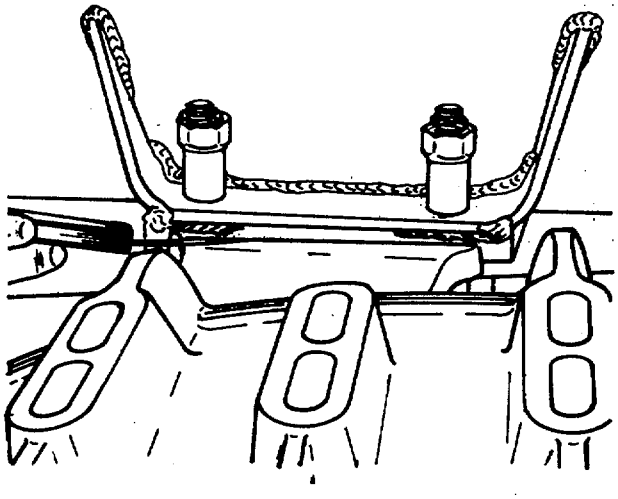
NOTE

When chassis beam is being put in place, check to see that preformed packing is correctly installed between the beam and differential.

Step 4. Lift chassis beam and align with differential and springs.
Step 5. Put bolts, spacers, and nuts in place in leaf springs and chassis beam.

NOTE

Leaf springs must be tightly seated against chassis beam.



TA259492

Step 6. Tighten and torque chassis beam mounting bolts to 236 lb. ft. (320 Nm).
Step 7. Put in cotter pins.
Step 8. Put on tow-bracket and nuts holding bracket and differential to chassis beam.
Step 9. Tighten and torque nuts to 325 lb. ft. (440 Nm).
Step 10. Remove support from under differential.
Step 11. Connect propeller shaft to differential pinion shaft. Refer to TM 9-2350-272-20.
Step 12. Put new preformed packing in place on rear of chassis beam.

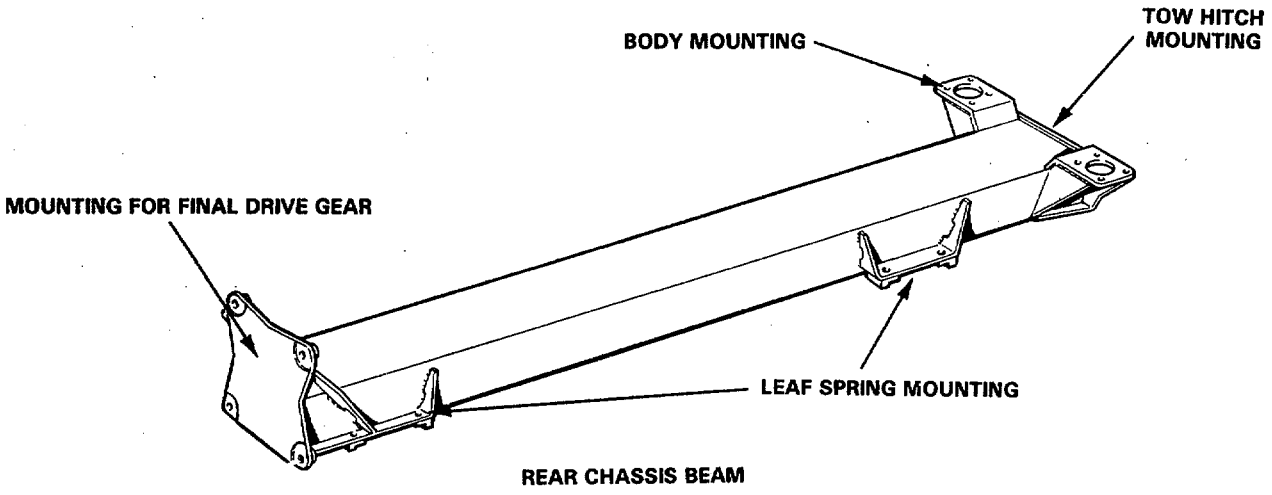
NOTE

When transfer is being put in place, check to see that preformed packing is correctly installed between the chassis beam and transfer.

Step 13. Install transfer on chassis beam. Refer to TM 9-2350-272-20.
Step 14. Remove blocks from car tracks.
Step 15. Push front car in place with steering unit.
Step 16. Put on nuts holding steering unit and transfer on chassis beam.
Step 17. Tighten and torque nuts to 325 lb. ft. (440 Nm).
Step 18. Remove support from under steering unit.
Step 19. Install front car body. Refer to paragraph 13-3.
Step 20. Remove blocks from tracks.

f. General - Rear Car Chassis Beam.

The rear car chassis beam is a closed box-type girder providing supports for the differential at the front end and the tow hitch at the rear end. The chassis beam supports two leaf springs and provides mounting pad brackets for the rear mounting of the rear car body.



g. Removal - Rear Car Chassis Beam.

Step 1. Place vehicle on level surface and block tracks.
Step 2. Remove rear car body. Refer to paragraph 13-4.
Step 3. Support steering unit.
Step 4. Support differential.
Step 5. Remove nuts holding steering unit and differential to chassis beam.

TA259493

Step 6. Remove bolts, nuts, cotter pin and castellated nut holding tow-hitch. Remove tow hitch.
Step 7. Remove cotter pins, nuts, spacers, and bolts holding leaf springs on chassis beam..
Step 8. Pull chassis beam toward the rear, remove and place beam on cribbing.
Step 9. Remove spacers from two bottom studs.
Step 10. Remove four studs from chassis beam.

h. Inspection.

NOTE

Chassis beam must be clean and free of dirt and grit. Insure that chassis beam contact surfaces for the leaf springs are perfectly clean.

Step 1. Inspect chassis beam for cracks, bends, or misalignment.
Step 2. Inspect body mounting pad brackets for cracks and damage.
Step 3. Inspect screw stud for damage.
Step 4. Inspect bolt holes for elongation, cracks or damage.
Step 5. Inspect countersunk holes and wedge surfaces for cracks or damage.
Step 6. Inspect studs, nuts, spacers, bolts and other mounting hardware for damage.

i**. Repairs.**

CAUTION

Temperatures above 1324°F (700°C) may produce undesirable structural changes in the material and cause beam to be damaged or unserviceable.

(1) Use only cold-straightening methods when .possible to straighten chassis beam. If hot-straightening is needed, to reduce pressing force, chassis beam must not be heated above 1324°F (700°C). The beam should show only a dark cerise (red) color when heated.

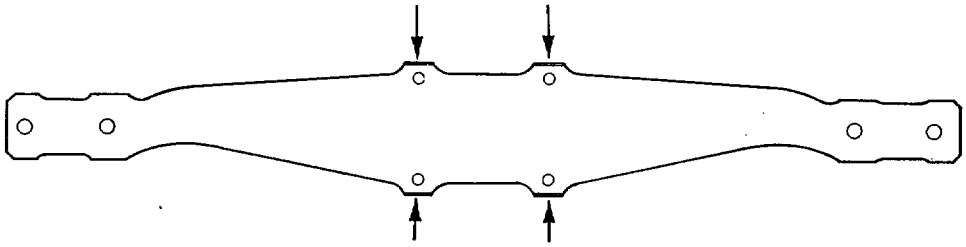
(2) Welding instructions. Use welding electrode grade ISOE51B to weld chassis beam. Refer to TM 9-237 for proper welding techniques.

j. Replace - Rear Car Chassis Beam.

NOTE

Leaf spring surfaces must be perfectly clean. Check all countersunk holes and beveled surfaces of springs.

Step 1. Check and clean leaf springs surfaces.



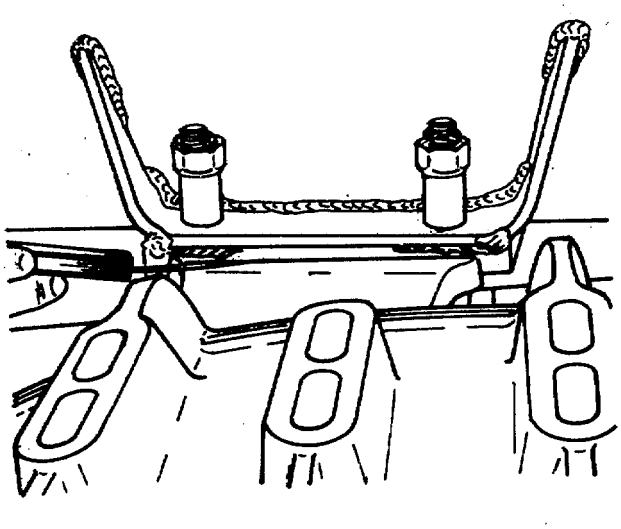
LEAF SPRING: SURFACES TO BE CHECKED

TA259494

Step 2. Put sealant on end of studs to be screwed in chassis beam.
Step 3. Screw four studs in place in chassis beam.
Step 4. Put spacers on two bottom studs.
Step 5. Lift chassis beam and align beam with differential, steering unit and springs.
Step 6. Put bolts, spacers, and nuts in place in leaf springs and chassis beam.

NOTE

Leaf springs must be tightly seated against chassis beam.



Step 7. Tighten and torque chassis beam mounting bolts to 236 lb. ft. (320 Nm).
Step 8. Put in cotter pins.
Step 9. Put on nuts holding differential and steering unit to chassis beam.
Step 10. Tighten and torque nuts to 325 lb. ft. (440 Nm).
Step 11. Put tow-hitch in place, put in bolts, screw on nuts.
Step 12. Tighten and torque nuts to 325 lb. ft. (440 Nm).
Step 13. Put on castellated nut and tighten so that tow-hitch will rotate freely without axial play.
Step 14. Put in cotter pin.
Step 15. Remove support from under steering unit and differential.
Step 16. Install rear car body. Refer to paragraph 13-4.
Step 17. Remove blocks from tracks.

TA259495

Section III. REPAIR OF TRACK COMPONENTS

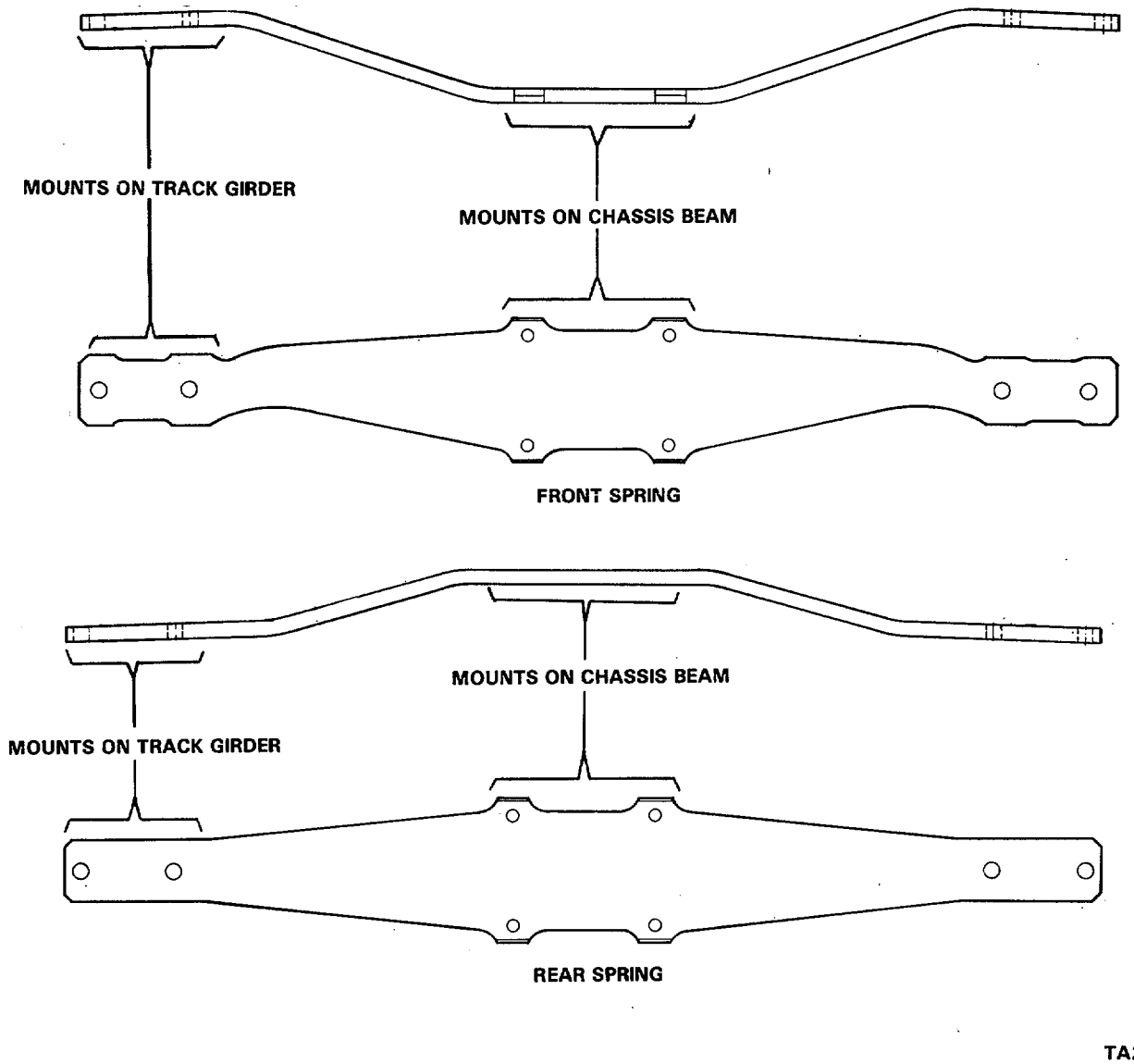
11-4. LEAF SPRINGS.

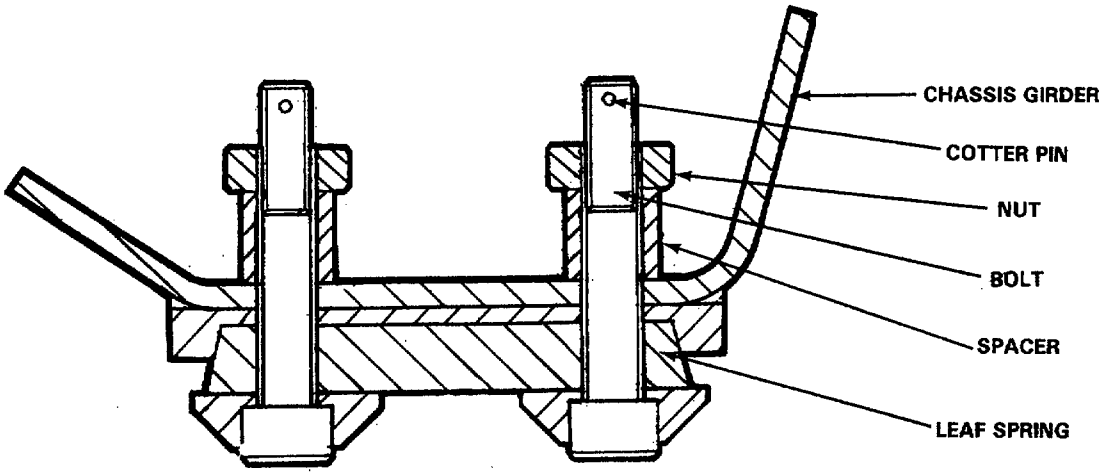
a. General.

The central chassis beams of both cars are assembled with front and rear leaf springs supporting the car body.

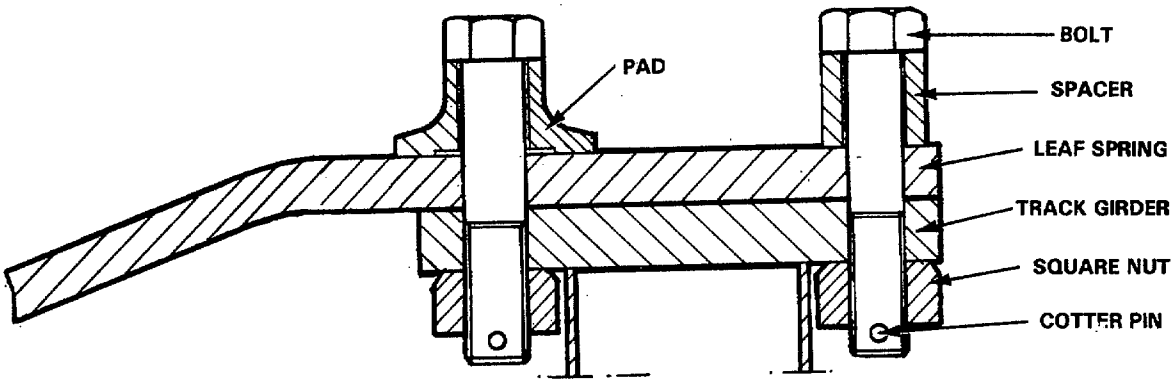
The springs also take up part of the lateral forces occurring when driving, and connect the chassis beam with the track girders.

Bolts hold each leaf spring to the chassis beam. There are two bolts to each of the track girders. To provide increased contact pressure a pad is placed between the inner bolt and the spring, and a spacer between the outer bolt and spring.

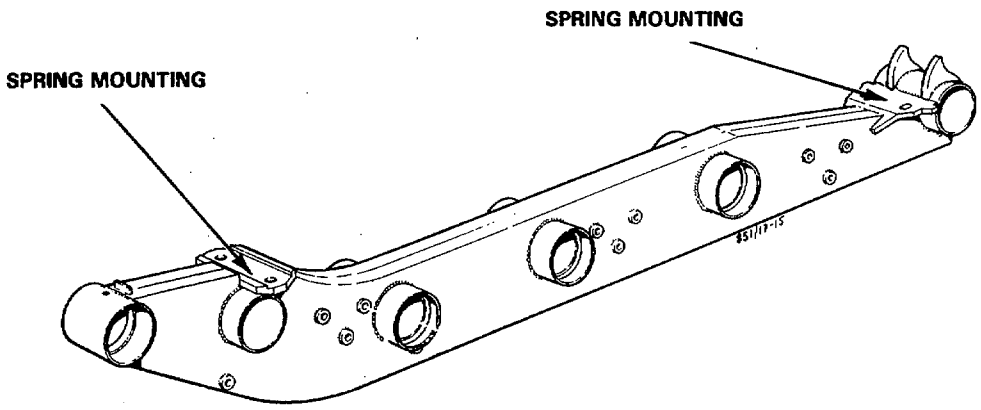




SPRING MOUNTING ON CHASSIS BEAM



SPRING MOUNTING ON TRACK GIRDER



TRACK GIRDER

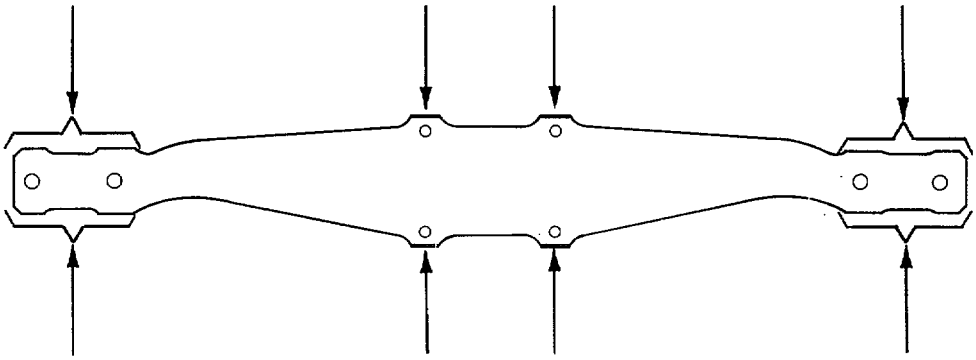
TA259497

b. Removal.

Step 1. Place vehicle on level surface.
Step 2. Move the car so that the spring mounting bolts can be reached.
Step 3. Block tracks.
Step 4. Raise and support the car under chassis beam with load completely off the spring.
Step 5. Remove cotter pins, nuts, bolts, pads and spacers holding spring at the track girders.
Step 6. Remove cotter pins, nuts, spacers, and bolts. Holding the springs at the chassis beam.
Step 7. Remove springs.

c. Inspection.

(1) General. Before installing the spring, inspect and clean the countersunk holes, beveled edges and wedge surfaces of the spring at the chassis beam mounting. Clean the contact surfaces at the track girder mounting. Surfaces must be free of paint and debris.



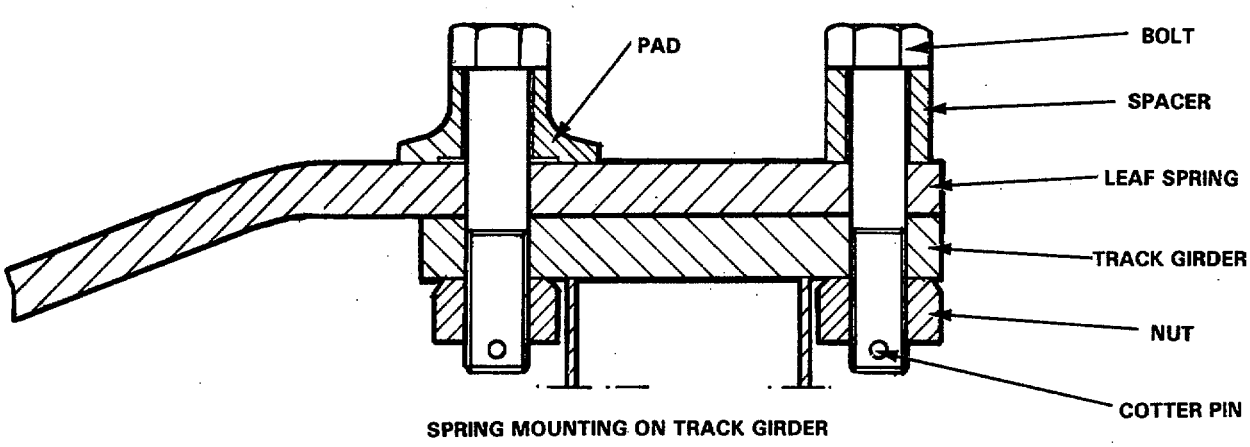
SPRING SURFACES TO BE CLEANED

Inspect and clean the mating surfaces of the chassis beam and track girders, they must be free of dirt and grit.

TA259498

d. Replace.

Step 1. Install leaf spring.
Step 2. Put spacers, pads, and bolts on track girders.

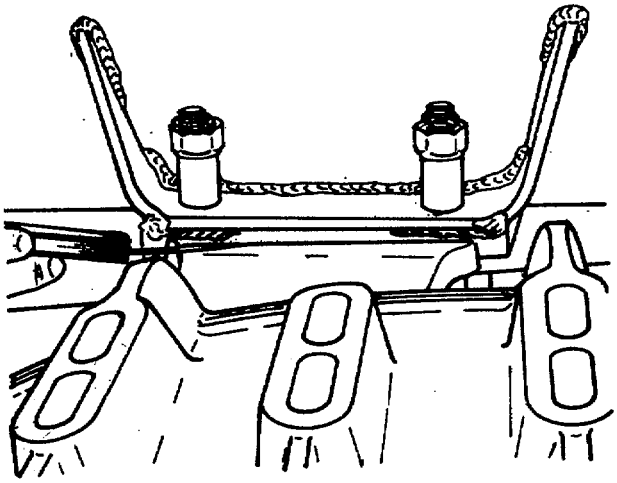


SPRING MOUNTING ON TRACK GIRDER

Step 3. Remove supports and lower the car onto leaf spring and chassis beam mounting.
Step 4. Put bolts, spacers, and nuts in leaf spring and chassis beam.

NOTE

Leaf spring must be tightly seated against chassis beam.



Step 5. Tighten and torque nuts to 236 lb. ft. (320 Nm).
Step 6. Put in cotter pins.
Step 7. Put nuts on bolts holding spring against track girders.

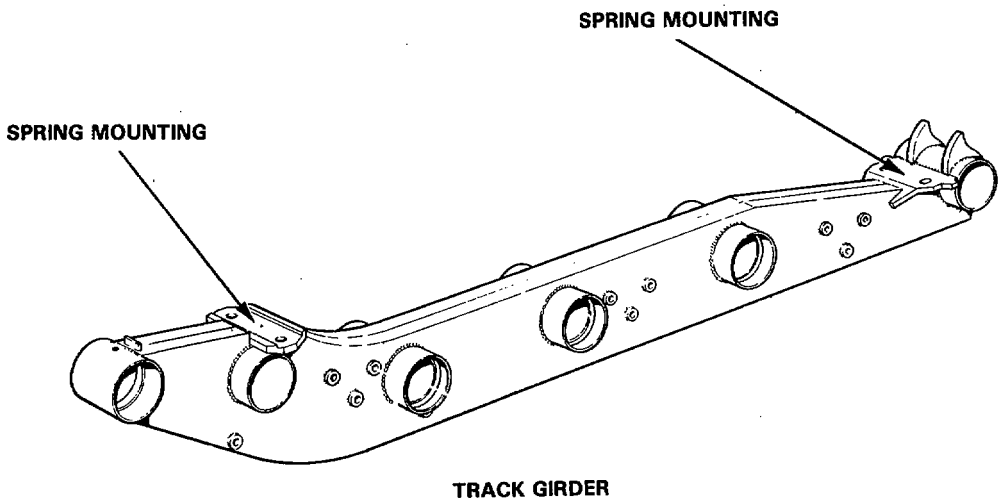
TA259499

Step 8. Tighten and torque nuts to 325 lb. ft. (440 Nm).
Step 9. Remove track blocks.
Step 10. Check and adjust track tension if necessary. Refer to TM 9-2350-272-1 0.

11-5. TRACK GIRDER.

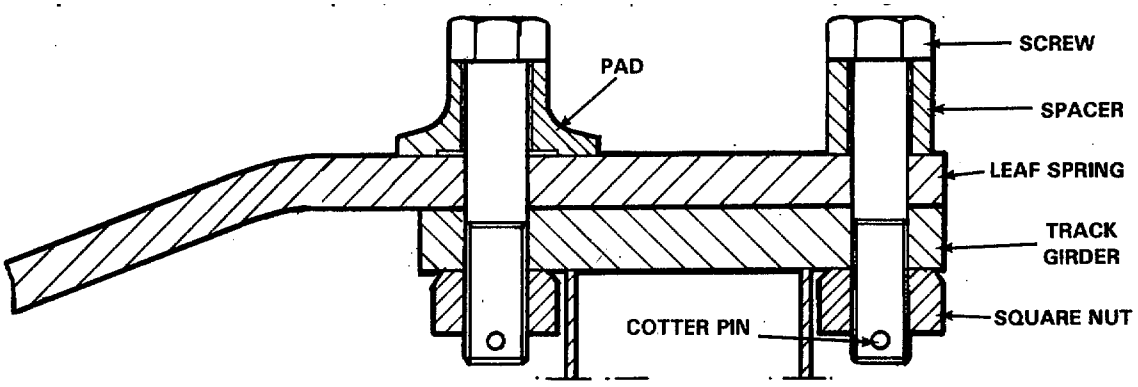
a. General.

The track girder is the same for all four track assemblies. The closed, box-type track girders are mounted at the ends of the leaf springs and support torsion springs, drive sprockets, solid rubber road wheels, support wheels, and track tensioners.



b. Remove,

Step 1. Remove track. Refer to TM 9-2350-272-10.
Step 2. Remove sprocket bearings. Refer to TM 9-2350-272-20.
Step 3. Remove track tensioner. Refer to TM 9-2350-272-20.
Step 4. Remove track tensioner cams. Refer to TM 9-2350-272-20.
Step 5. Remove pivot arms. Refer to TM 9-2350-272-20.
Step 6. Put jack under track girder. Raise and support girder.
Step 7. Remove cotter pins, screws, nuts, and pads from front spring.
Step 8. Remove cotter pins, screws, nuts, and Dads from rear spring. Remove track girder.



SPRING MOUNTING ON TRACK GIRDER

TA259500

Step 9. Remove torsion springs. Refer to paragraph 11-6.
Step 10. Remove track support wheel and bracket. Refer to TM 9-2350-272-20.

c. Inspection.

NOTE

The track girder must be clean and free of dirt and grit. Insure that the contact surfaces for the leaf springs and bearings are perfectly clean.

Step 1. Check and clean track girder.
Step 2. Inspect track girder for cracks, bends or misalignment.
Step 3. Inspect leaf spring mounts, sprocket, tensioner bearing and torsion spring housings for cracks and damage.
Step 4. Inspect bolt holes for elongation, cracks and damage.
Step 5. Remove plug and check for water inside track girder.

d. Repairs.

(1) Straightening Track Girder. The track girder must be straightened precisely. If precision straightening is not done rolling parts will not run true. This will cause excessive wear.

CAUTION

Temperatures above 1324°F (700°C) may produce undesirable structural changes in the material and cause girder to be damaged or unserviceable.

(2) Use only cold-straightening methods when possible to straighten girder. If hot-straightening is needed, to reduce pressing force, girder must not be heated above 1324°F (700°C). The beam should show only a dark cerise (red) color when heated.

(3) Welding instructions. Use welding electrode grade ISOE51B to weld girder. Refer to TM 9-237 for proper welding techniques.

e. Replace.

Step 1. Replace torsion springs. Refer to paragraph 11 -6.
Step 2. Put track girder on jack. Raise girder into place.
Step 3. Put pads, nuts, screws and cotter pins in place on rear spring mounting.
Step 4. Put pads, nuts, screws and cotter pins in place on front spring mounting.
Step 5. Raise jack pressing track girder firmly against springs.
Step 6. Torque screws to 324 lb. ft. (440 Nm).
Step 7. Replace pivot arms. Refer to TM 9-2350-272-20.
Step 8. Replace track tensioner cams. Refer to TM 9-2350-272-20.
Step 9. Replace track tensioner. Refer to TM 9-2350-272-20.
Step 10. Replace sprocket bearings. Refer to TM 9-2350-272-20.
Step 11. Replace track. Refer to TM 9-2 3 50-2 7 2-1 0.
Step 12. Replace track support wheel and bracket. Refer to TM 9-2350-272-20.

11-6. TORSION SPRINGS.

a. General.

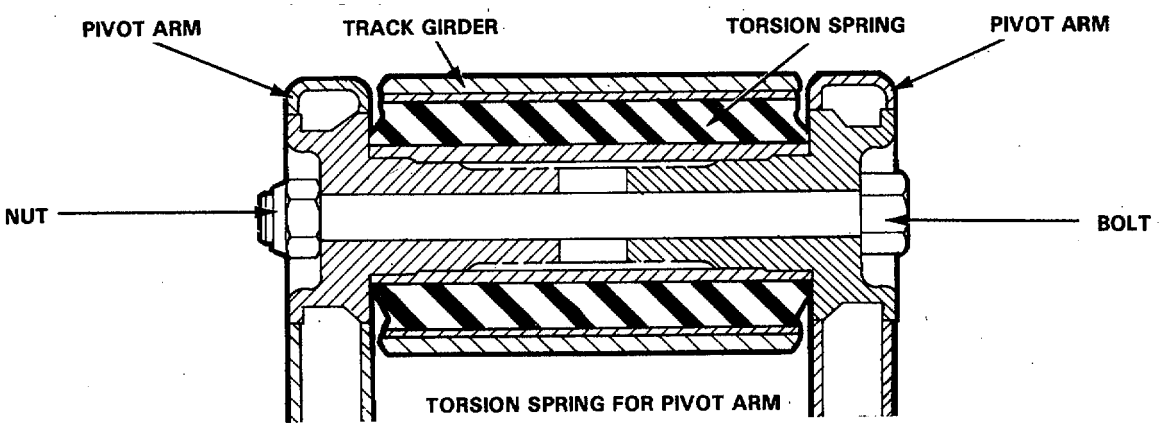
The track girder has five torsion springs. Four springs carry wheel pivot arms and the fifth carries track tensioner cams.

Torsion springs are made with an outer and inner steel tubes attached with a rubber element. Inner steel tube inside splines engage pivot arms and tensioner cams.

Torsion springs are press fitted in the track girder.

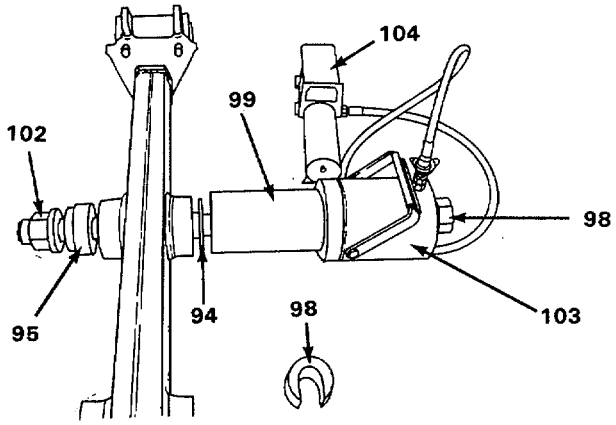
When a torque load is applied to the torsion spring, the inner tube is rotated, stretching the rubber element which returns to its initial position when torque load is removed.

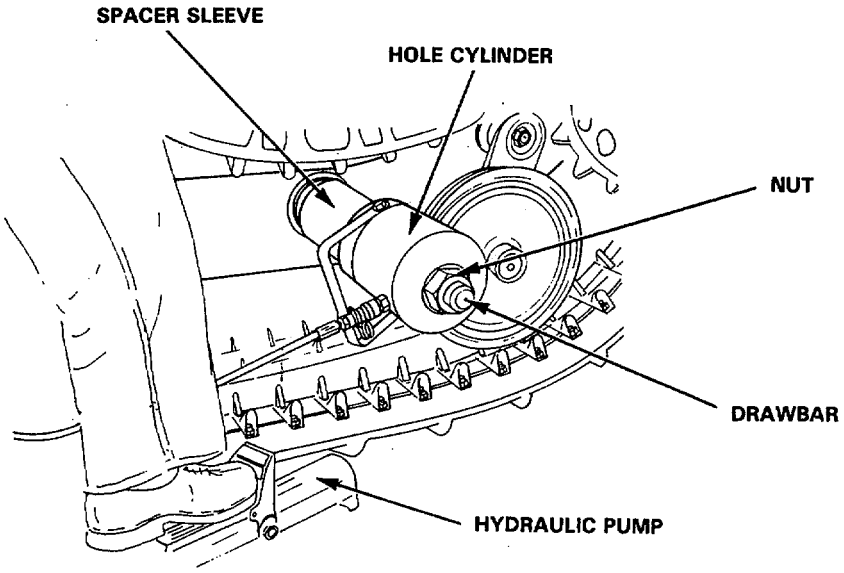
The movement of pivot arm torsion spring is limited by the track girder hitting the track, and track tensioner spring by the tensioning mechanism coming against stop pads on the girder.



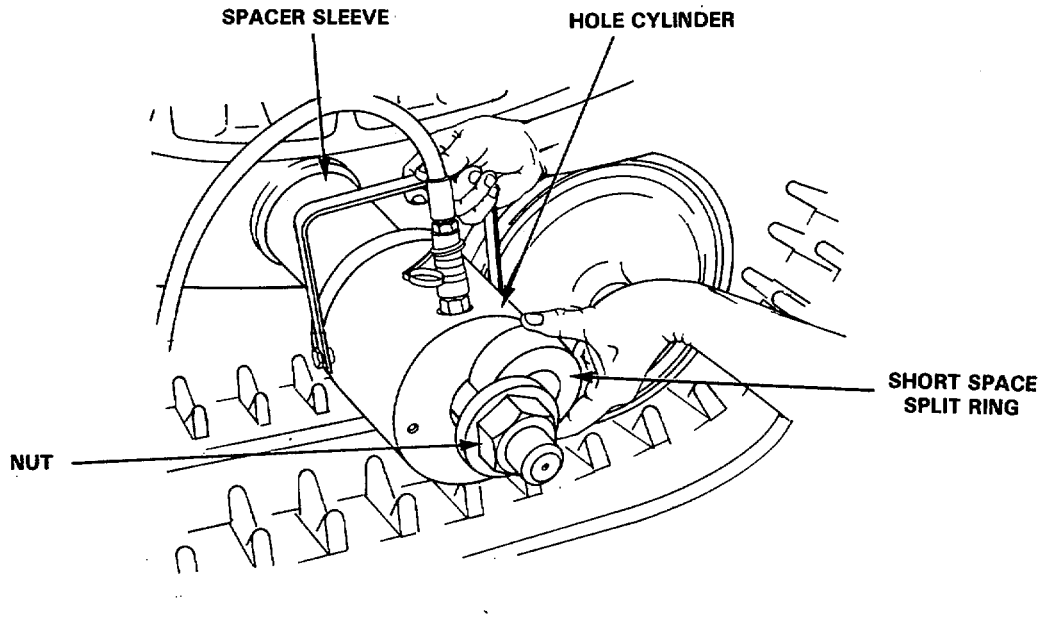
b. Remove.

Step 1. Remove pivot arm. Refer to TM 9-2350-272- 20.
Step 2. If torsion spring is to be re-installed mark position of torsion spring. If more than one spring is removed mark location of each spring.
Step 3. Using hydraulic pump, hole cylinder, drawbar, spacer sleeve, alignment tool, adapter and nut, press out torsion spring. See table 2-1, items 98, 99, 102, 103, 104, 94 and 95.





Step 4. Release pressure on hydraulic pump.
Step 5. Using short spacer split ring, press out torsion spring. See table 2-1, item 100.

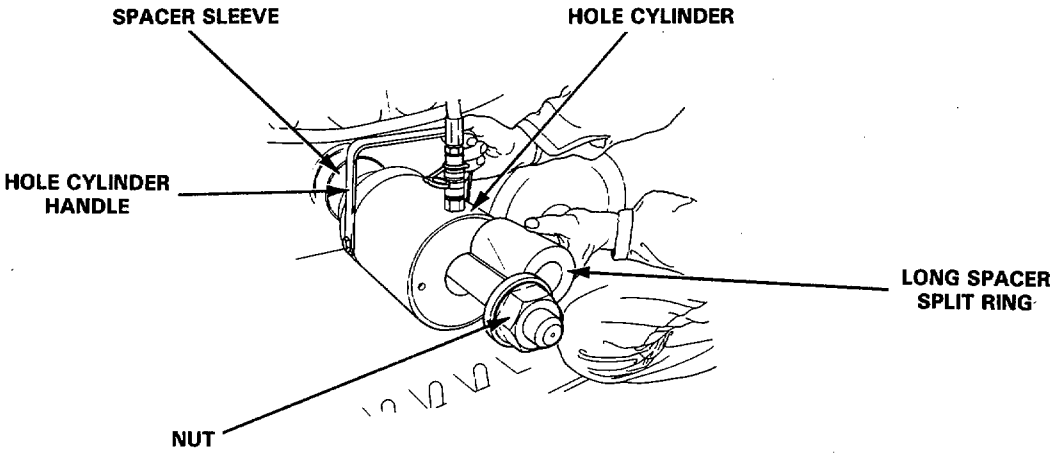


Step 6. Release pressure on hydraulic pump.

WARNING

Torsion spring and removal tool is heavy. Support at hole cylinder handle and spacer sleeve as you press out spring. Failure to do so may result in personnel injury and damage to equipment.

Step 7. Using long spacer split ring press out torsion spring. See table 2-1, item 101.



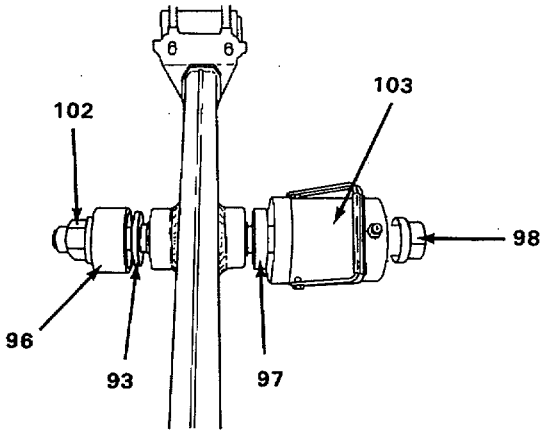
Step 8. Release pressure on hydraulic pump.

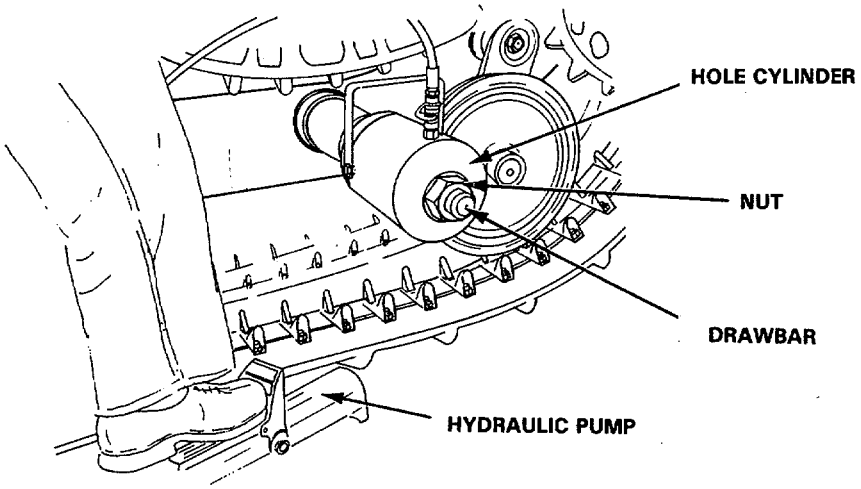
Step 9. Using long and short spacer split, rings, press out torsion spring. See table 2-1, items 100 and 101.

TA259504

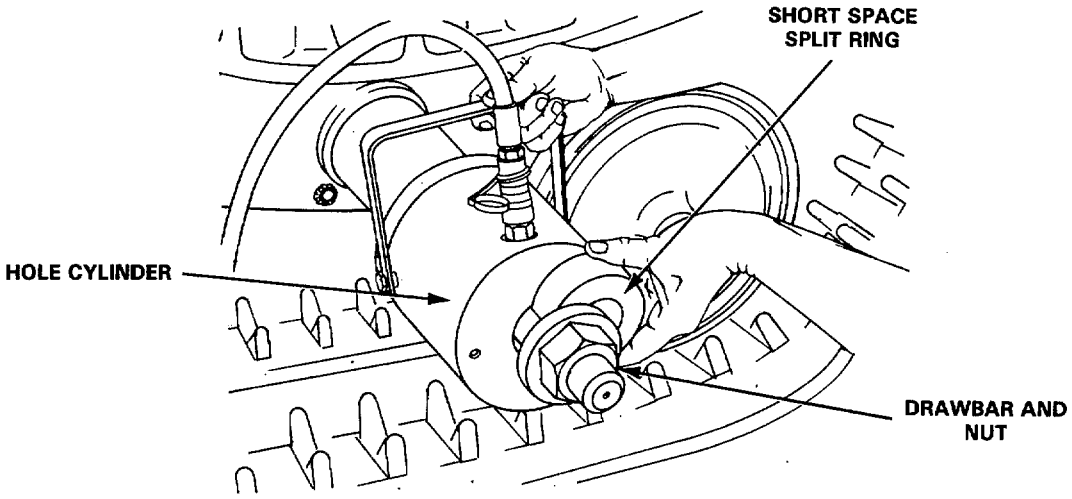
c. Replace.

Step 1. Clean and apply a light coat of oil to torsion spring housing. Go to step 2 if installing old torsion spring. Go to step 3 if installing new torsion.
Step 2. If installing old torsion spring put spring in place and align marks.
Step 3. Using hydraulic pump, hole cylinder, drawbar, adapter, alignment tool, spacer and nut press in torsion spring. Refer to table 2-1, items 93, 96, 97, 98, 102, 103 and 104.

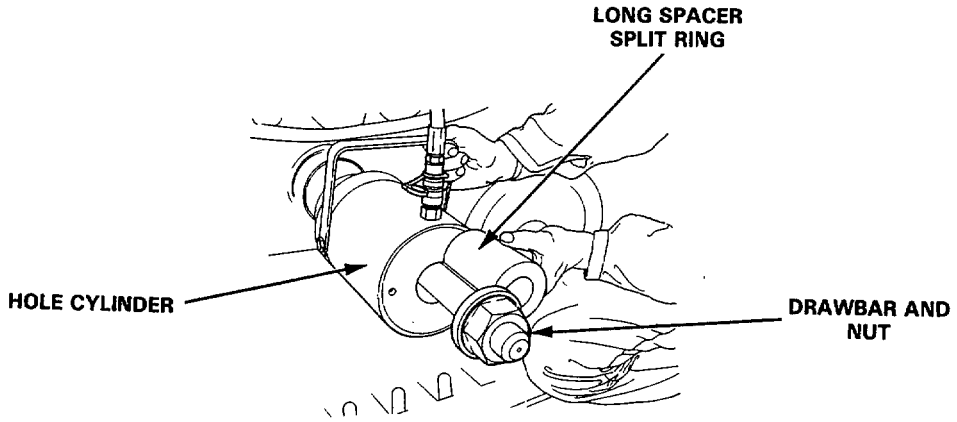




Step 4. Release pressure on hydraulic pump.
Step 5. Using short spacer split ring press in torsion spring. See table 2-1, item 100.



Step 6. Release pressure on hydraulic pump.
Step 7. Using long spacer split ring press in torsion spring. See table 2-1, item 101.



Step 8. Release pressure on hydraulic pump.
Step 9. Using long and short spacer split ring, press in torsion spring until flush with spring housing. See table 2-1, items 100 and 101.
Step 10. Remove hydraulic press.
Step 11. Replace pivot arm. Refer to TM 9-2350-272- 20.

CHAPTER 12
REPAIR OF STEERING SYSTEM

Section I. DESCRIPTION AND DATA

12-1. DESCRIPTION.

The hydraulic steering system is made up of the following components: hydraulic oil tank, hydraulic pump, main hydraulic valve with steering gear, servo valve, steering cylinders, hydraulic lines and a steering unit with damping cylinders. The steering cylinders are actuated by the pump and main hydraulic valve through the servo valve. The steering unit is designed to ensure the rear carrier tracks evenly behind the front carrier.

12-2. TECHNICAL DATA.

OIL TANK

Oil volume, maximum level	7.8 PT (3.71 liter)
Oil volume, minimum level	4.7 PT (2.21 liter)
Tank cover, make and type	UC-AB 1163-15

PUMP

Make	Bosch 0510525322
Type	Gear pump
Direction of rotation (as seen from driver's side)	CCW
Flow, constant above 38 r/s (2300 r/min) at 1740 PSI (120 bar) counterpressure-22.5-28.7 dm3/min	
Displacement	6.6 cu. in./r (11 cm3/r)

FILTER

Make and type	Pall HC 9800C12UTRBB
Cartridge	Pall 9800 F UT 4H
Type	Pressure filter
By-pass valve opening pressure	50.8 PSI (3.5 bar)

STEERING SHAFT

Make	ZF 8440 429 279

STEERING VALVE

Make	ZF8451955125
Type	Open-center
Rotor width	4 in. (11.1 mm)
Displacement	5.04 cu. in. (84 cm3/r)
Pressure relief valve-opening pressure	1740-1914 PSI (1 20-1 32 bar)
Surge damping valves-opening pressure	3045-3335 PSI (210-230 bar)
Check valve in pressure line-opening pressure	17.4 PSI (1 .2 bar)
Check valves (hand pump)-opening pressure	1 .5 PSI (0.1 bar)

SERVO VALVE

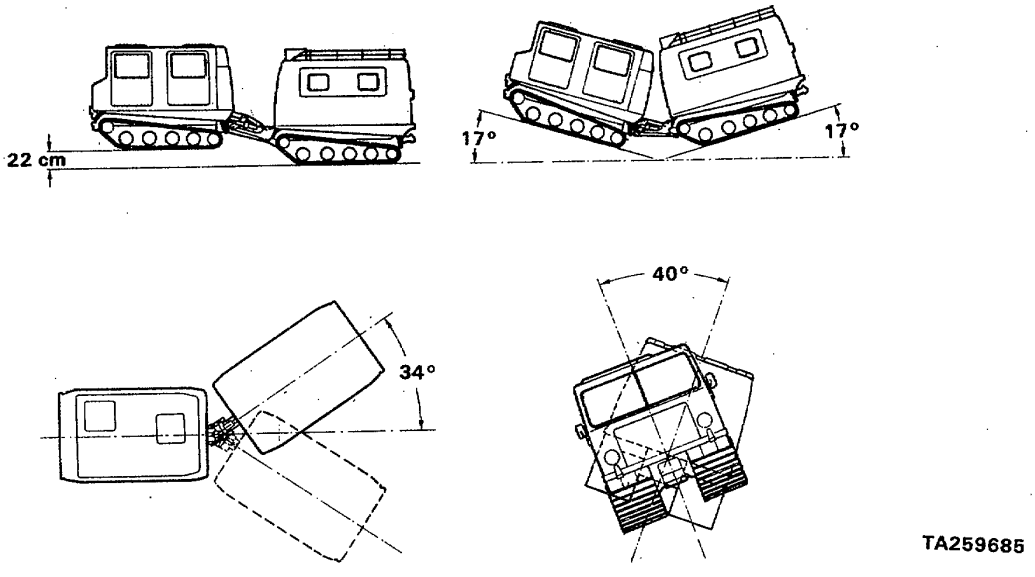
Make	ZF 7731 900 108
Check valves-opening pressure	7.25 PSI (0.5 bar)

STEERING CYLINDERS

Make	Hiab-Foco 635 31 00
Number	2
Cylinder diameter	2.5 in. (63 mm)
Piston rod diameter	8 .8 in. (45 mm)
Stroke	9.4 in. (240 mm)
Operating pressure, maximum	2103 PSI (145 bar)
Bench leakage testing pressure	3190 PSI (220 bar)

STEERING UNIT

Maximum deviation angles:



DAMPING CYLINDER

Make	Mecman 203150125
Cylinder dia	2.0 in. (50 mm)
Piston rod dia	1.0 in. (25 mm)
Stroke	6.7 in. (200 mm)
Operating pressure	2103 PSI (1 45 bar)
Bench leakage testing pressure	72.5-1 01.5 PSI (5-7 bar)

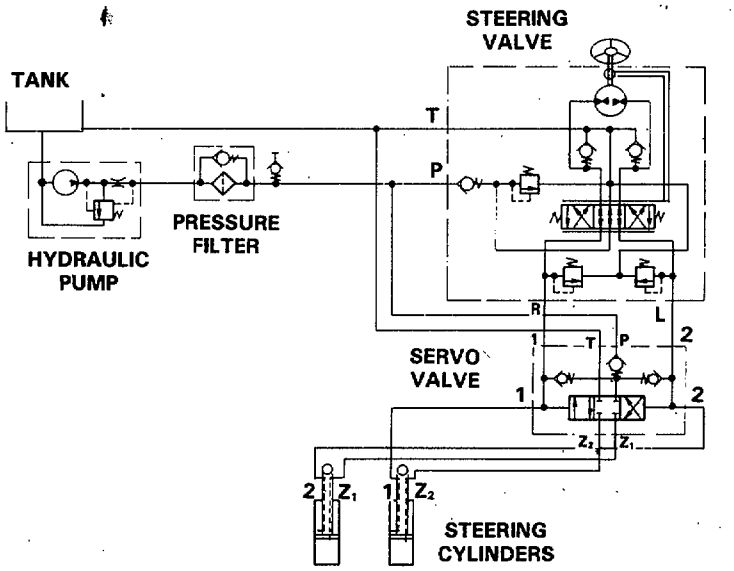
TIGHTENING TORQUES

Hydraulic pump pulley nut	18.5 lb. ft. (25 Nm)
Hydrauiic pump plugs	30 lb. ft. (40 Nm)
Hydraulic pump assembly screws	30 lb. ft. (40 Nm)
Filter housing, maximum	15 lb. ft. (20 Nm)
Steering valve cover screws	18.5 lb. ft. (25 Nm)
Steering valve pressure relief valve	22 lb. ft. (30 Nm)
Steering unit mounting nuts	325 lb. ft. (440 Nm)
Steering bar, journals, screws	258 lb. ft. (350 Nm)

12-3. FUNCTION

a. Neutral Position, Pump Stationary.

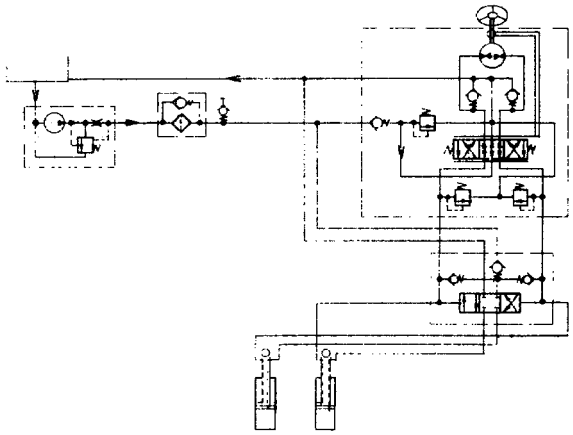
No pressure to any component in steering system.



TA259686

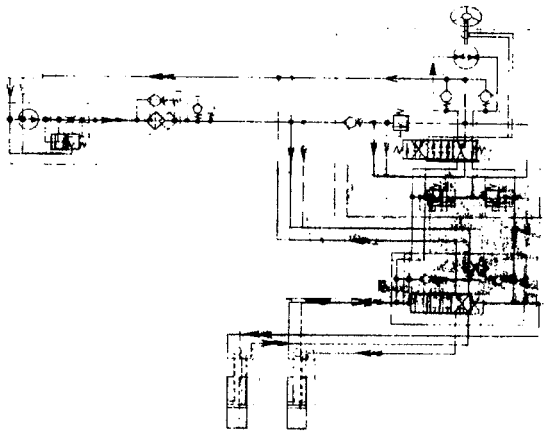
b. Neutral-Position, Pump Operating.

Oil flows from the tank to the pump. The pump forces the oil through the filter to the main hydraulic valve. The-oil flows around the spool in the valve back to the tank. Low pressure is present at the servo valve.



c. Steering Left

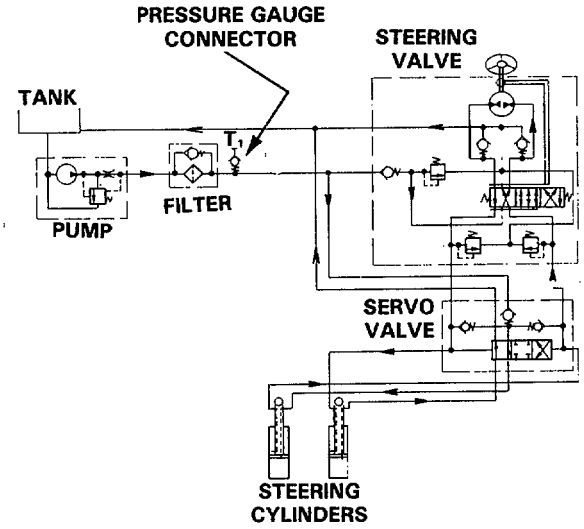
Turning the steering wheel counter-clockwise interrupts the free flow of oil through the steering valve, and the oil is routed to the hand pump where it is divided between the servo valve pilot port and the piston rod side of the left steering cylinder. The oil entering the servo valve forces the piston toward the piston side of the right steering cylinder; at the same time a direct connection from the hydraulic pump is opened. The spent oil from the left cylinder is returned to tank through the servo valve, that from the right cylinder through the steering valve.



TA259687

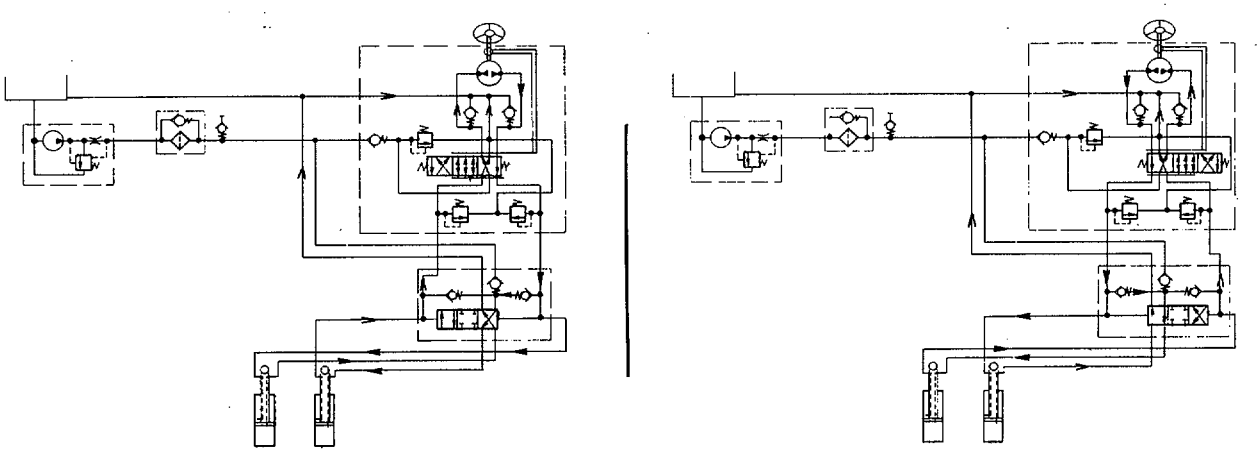
d. Steering Right.

Turning the steering wheel right interrupts the free flow of oil through the steering valve, and the oil is instead routed to the hand pump where it is divided between the servo valve pilot port and the right steering cylinder piston-rod side. The oil from the servo valve forces the piston toward the left steering cylinder piston side, and at the same time a direct passage is opened from the hydraulic pump. The spent oil from the right steering cylinder is returned to tank through the servo valve, that of the left cylinder through the steering valve.



e. Emergency Steering.

The oil flow for emergency steering is supplied by the hand pump located in the main hydraulic valve. The hand pump draws the oil from the return line. The oil flows from the hand pump through the servo valve to the piston side of one of the steering cylinders. Oil from the piston side of the other cylinder is returned to the suction side of the hand pump. The hand pump also supplies oil to the piston rod side of the active cylinder.



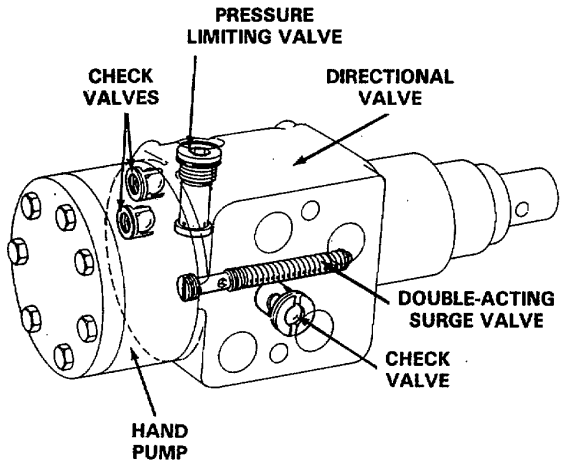
EMERGENCY STEERING LEFT **EMERGENCY STEERING RIGHT**

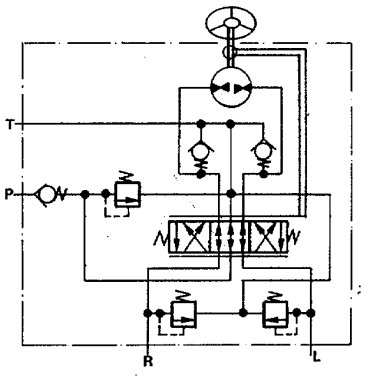
TA259688

12-4. POWER STEERING HYDRAULIC VALVE.

a. General.

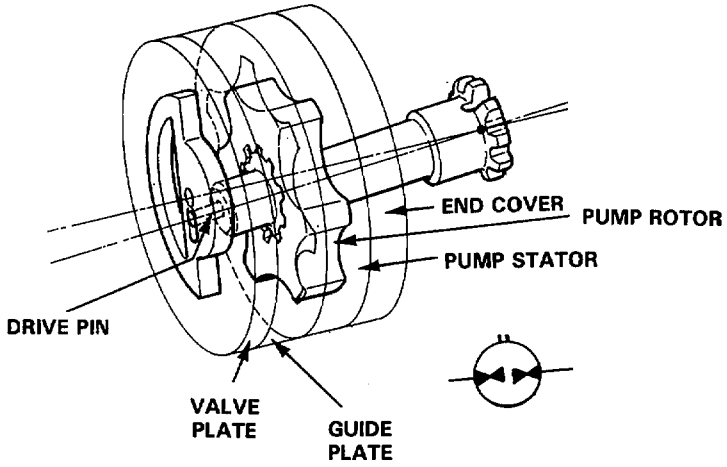
The steering hydraulic valve is made up of the following components: directional valve, hand pump, surge valve, check valves and pressure limiting valve.



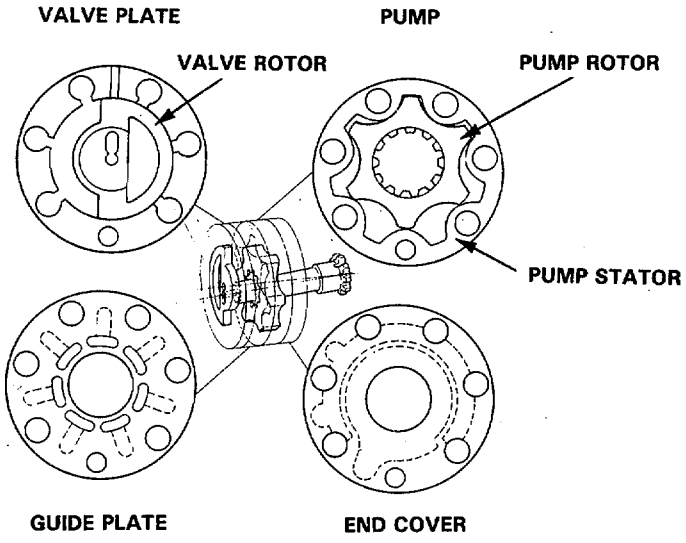


TA259689

(1) The hand pump provides oil flow to the servo valve and piston rod side of the steering cylinders. The hand pump also builds up pressure for emergency steering.

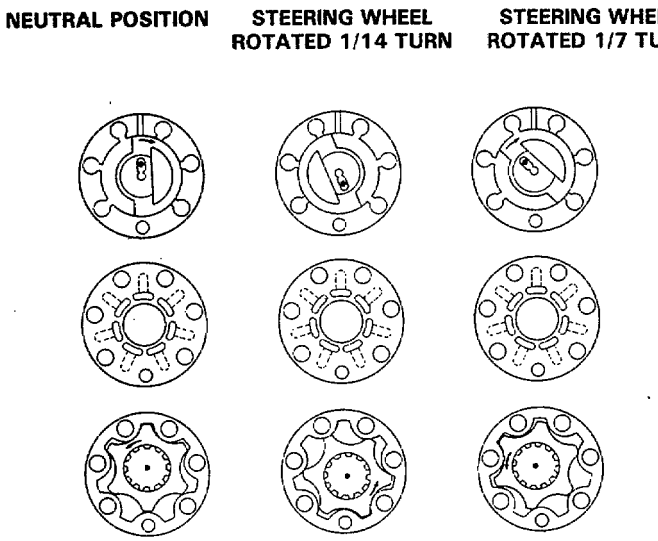


The hand pump is made up of the following components: end covers, pump stator and rotor, guide plate, and valve stator and rotor. The two moving components are the pump rotor and the valve rotor. The pump rotor has six teeth. The pump stator has seven tooth spaces. This causes the rotor to perform a planetary movement within the stator.



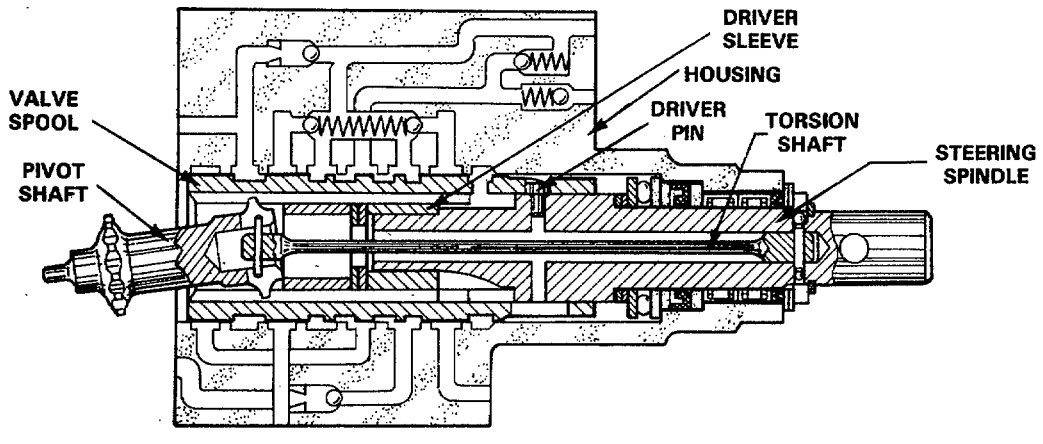
TA259690

The valve rotor is driven by a pin on the drive shaft. The valve rotor is driven in the opposite direction of the pump rotor. The valve rotor directs inlet oil to the tooth spaces which are increasing in size. It also directs the oil from the decreasing tooth spaces to the outlet port. When steering right, the assembly screw bores function as inlet channels. The shaft opening act as the outlet channel. When steering left, the shaft opening acts as the inlet and the screw bores as the outlet.



HAND PUMP OPERATING PRINCIPLE

(2) The directional valve is made up of the following components: housing, valve spool, steering spindle, driver pin, driver sleeve, torsion shaft and pivoting drive shaft.

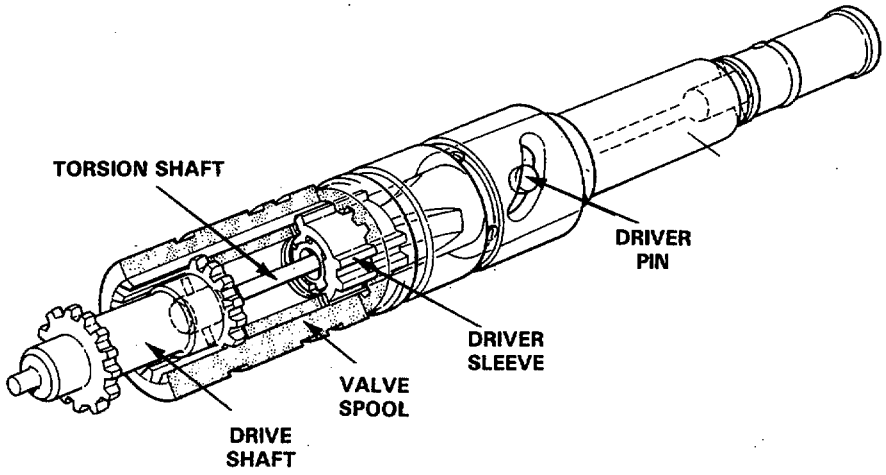


DIRECTIONAL VALVE

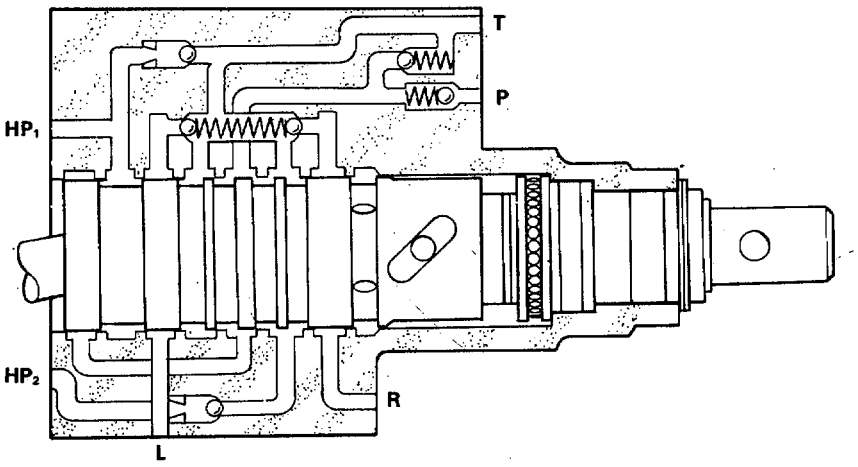
TA259691

The torsion shaft connects the steering spindle to the drive shaft. One end of the drive shaft is splined to the valve spool. The other end engages the hand pump rotor. Distortion of the torsion shaft is limited by the driver sleeve. The drive pin moves in a slot in the valve spool. As the steering spindle rotates, the torsion shaft, drive shaft and valve spool also rotates. When the hand pump is operating a resistance to the rotation is transmitted to the drive shaft and the torsion shaft is distorted. This causes the drive pin to rnove in the slot and the spool then moves axially.

DIRECTIONAL VALVE INTERIOR COMPONENTS



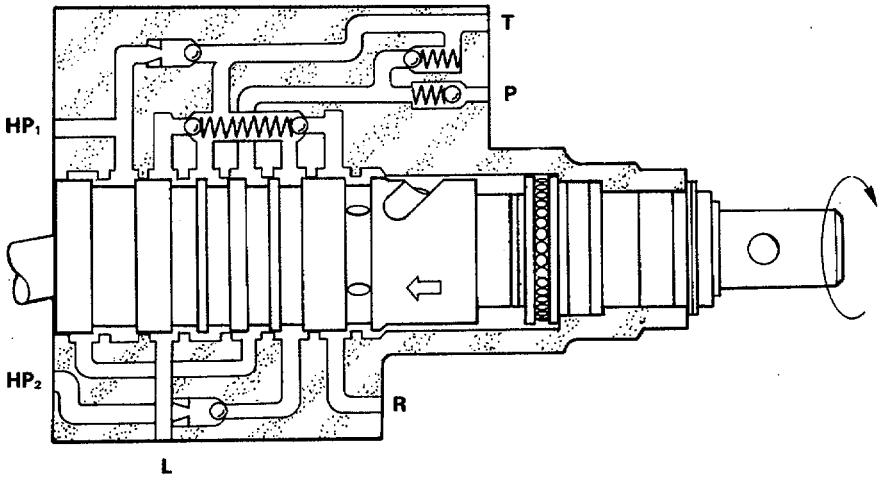
In the neutral position oil flows from the inlet, around the valve spool and back to the tank through port T.



DIRECTIONAL VALVE IN NEUTRAL

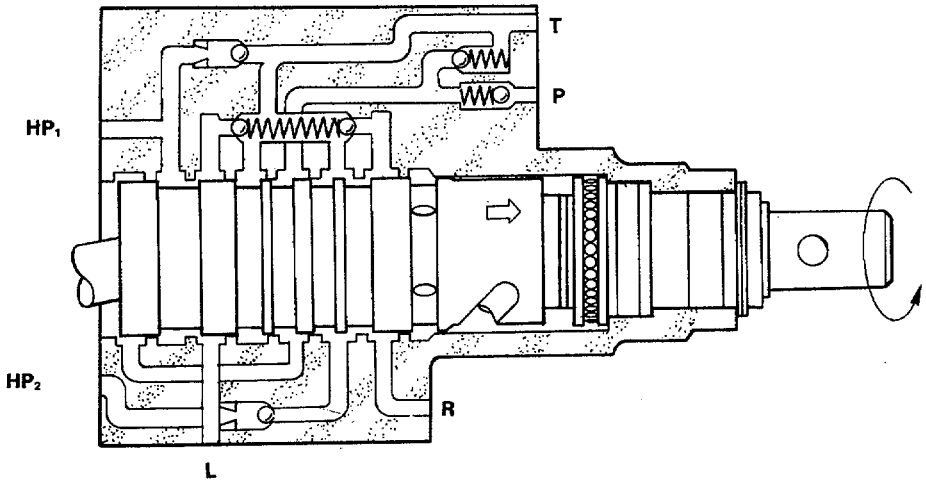
TA259692

Steering right shifts the valve spool to the left. This opens a path between inlet port P and hand pump inlet port HP(INSERT). Also a path is opened between return line L and outlet port T.



DIRECTIONAL VALVE, STEERING RIGHT

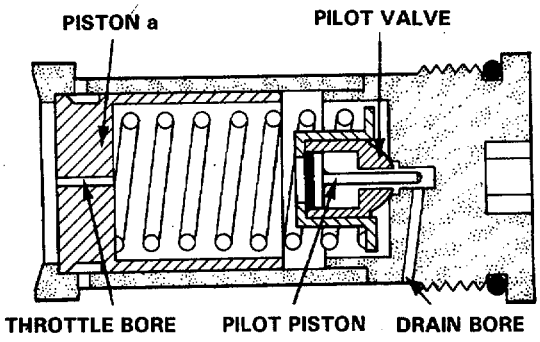
Steering left shifts the valve spool to the right. This opens a path between inlet port P and hand pump inlet port HP(INSERT). A path is also opened between return line R and outlet port T.



DIRECTIONAL VALVE, STEERING LEFT

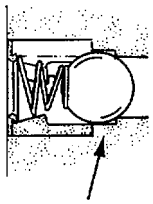
TA259693

(3) The pressure limiting valve is located between ports P and T. When pressure from the pump to the main hydraulic valve is to high; the pressure limiting valve will open allowing the oil to bypass back to the tank. The pressure comes in port P, through the throttle bore in piston "a" into the spring chamber and against the pilot piston forcing the piston rod to the bottom of the chamber. Where pressure becomes higher than the spring tension the pilot valve opens and oil is let out of the spring chamber. The pressure drop that results force piston "a" against the spring tension, opening a path back to the tank.

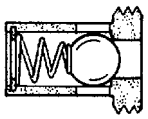


PRESSURE LIMITING VALVE

(4) The main hydraulic valve contains three check valves. Two of these check valves provide a path for oil to the hand pump when the hydraulic pump is not operating.



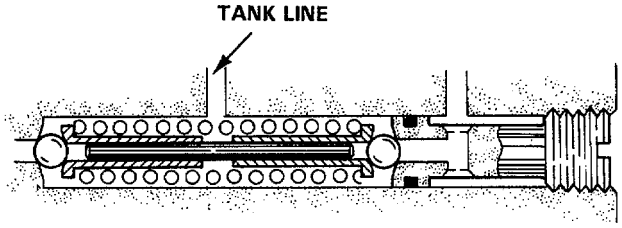
The third check valve prevents oil from flowing out through the pump line during emergency steering. It consists of a housing, ball and spring.



CHECK VALVE

TA259694

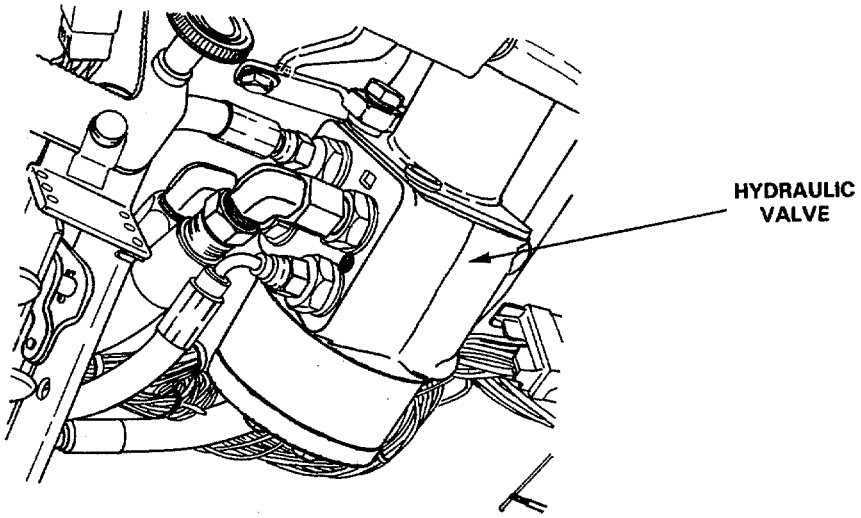
(5) A double surge valve is located between ports L and R. The surge valve acts to limit pressure. When the pressure between the ports rises to high the surge valve opens allowing oil to return to the tank. The valve is made up of the following components; two balls, two spring guides on a pin and a spring common to both balls.



DOUBLE SURGE VALVE

b. Remove.

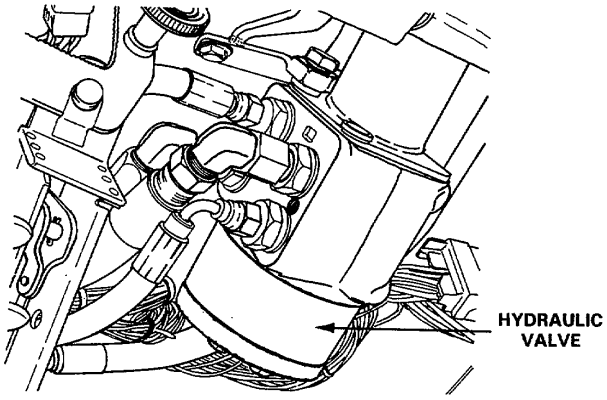
Step 1. Clean area around power steering hydraulic valve and the valve.
Step 2. Tag and disconnect hydraulic hoses from valve.
Step 3. Remove mounting screws.
Step 4. Remove valve.
Step 5. Remove driver pin.



TA259695

c. Replace.

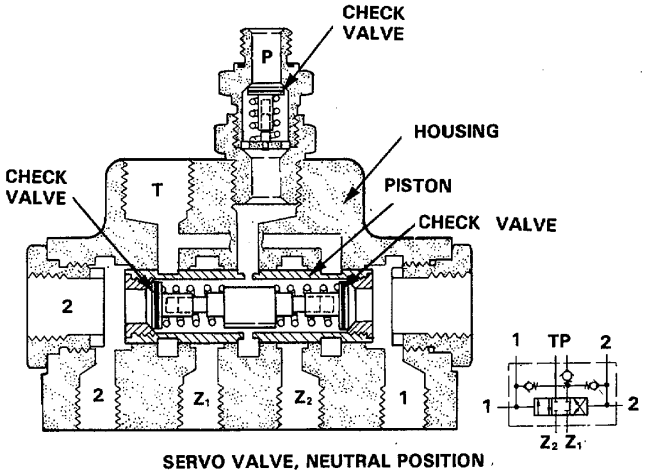
Step 1. Put driver pin in steering spindle. Grease pin.
Step 2. Put main hydraulic valve in place.
Step 3. Put in and tighten mounting screws.
Step 4. Put on and tighten hydraulic lines. Remove tags.
Step 5. Start engine. Turn steering wheel fully to left and right.
Step 6. Stop engine. Check for leaks par



12-5. SERVO VALVE.

a. General.

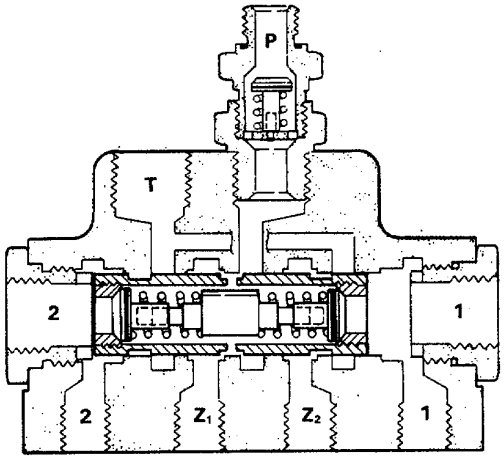
(1) The servo valve is made up of the following components: housing, check valve and a piston with check valves. The servo valve directs oil directly from the hydraulic pump to the piston side of the steering cylinders. The servo valve is actuated by the power steering hydraulic valve. Oil from hydraulic pump enters the servo valve through the check valve in port P. This oil leaves the servo valve through ports Z_1, and Z_2 to the piston side of the steering cylinders. Oil from the power steering hydraulic valve enters the servo valve at ports 1 and 2.



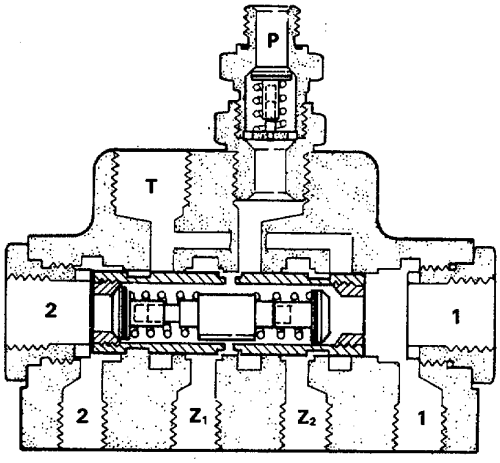
SERVO VALVE, NEUTRAL POSITION

TA259696

(2) The servo valve has three operating positions; neutral, steering left and steering right. Under normal steering to the right oil from the power steering valve enter through port 1. This oil pushes the piston toward port 2. Pressure from the hydraulic pump entering port P can now flow through the servo valve out port Z_2. A path is also opened so oil can return through port Z_1, out port T to return to the tank. Steering to the right under emergency conditions, the oil from the power steering valve enters at port 1 forcing the piston toward port 2. The check valve at port P closes. Pressure builds up causing the piston check valve to open. Oil from the power steering valve can now pass out of the servo valve at port Z_1, to the steering cylinder.



NORMAL STEERING RIGHT

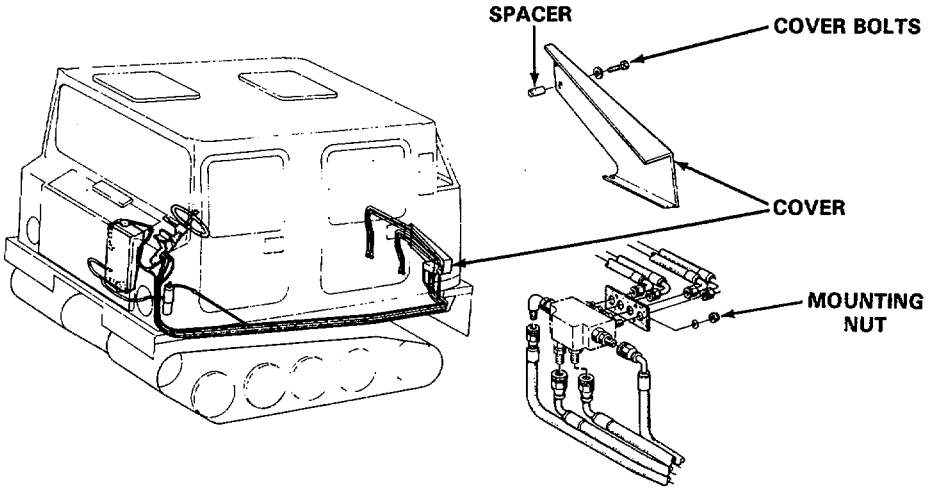


EMERGENCY STEERING RIGHT

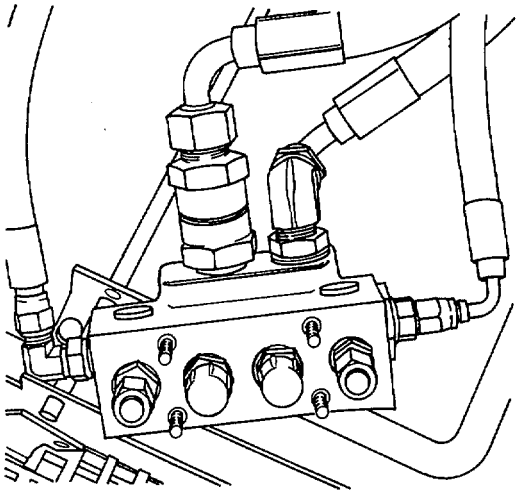
TA259697

b. Remove.

Step 1. Remove cover and spacers over hydraulic hoses.
Step 2. Clean hose connections and area surrounding servo valve.
Step 3. Tag hydraulic hoses.
Step 4. Disconnect and plug hydraulic hoses. Plug valve connectors.
Step 5. Remove servo valve mounting nuts.



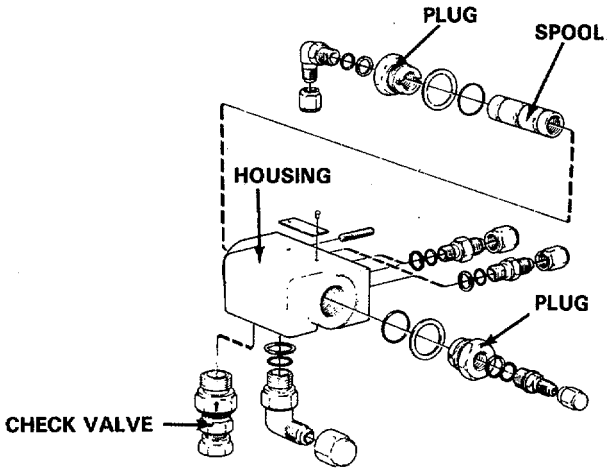
Step 6. Remove batteries. Refer to TM 9-2350-272-20.
Step 7. Pull servo valve forward. Clean valve and connections.
Step 8. Tag hydraulic hoses.
Step 9. Disconnect hoses. Plug hoses.
Step10. Remove servo valve.



TA259698

c. Disassemble.

Step 1. Remove check valve.
Step 2. Remove connectors, seals and plugs.
Step 3. Push spool from housing.
Step 4. Remove seals.



d. Inspect.

Step 1. Inspect housing, plugs and connectors for cracks and thread damage.
Step 2. Inspect spool for scratches and burrs.
Step 3. Replace all seals and damaged components.
Step 4. Oil components. Refer to appendix B, item 4.

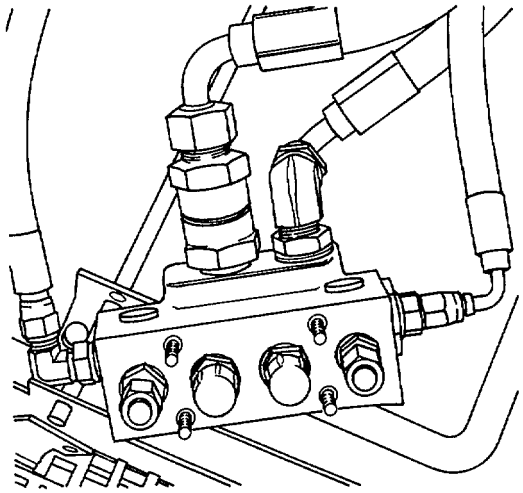
e. Assemble.

Step 1. Push spool into housing.
Step 2. Put plugs with seals into housing. Tighten plugs.
Step 3. Put in connector and seals. Tighten connectors.
Step 4. Tighten check valve.
Step 5. Put in check valve.

TA259699

f. Replace.

Step 1. Clean mounting surface.
Step 2. Put on new mounting gasket.
Step 3. Connect hydraulic hoses to servo valve. Remove tags.



Step 4. Hold servo valve in position.
Step 5. Put on mounting nuts. Tighten nuts.
Step 6. Connect hydraulic hoses. Remove tags.
Step 7. Replace batteries. Refer to TM 9-2350-272- 20.
Step 8. Start engine. Steer right and left. Stop engine.
Step 9. Check for leaks at connection. Tighten leaking connections.
Step 10. Replace cover over hydraulic hoses.

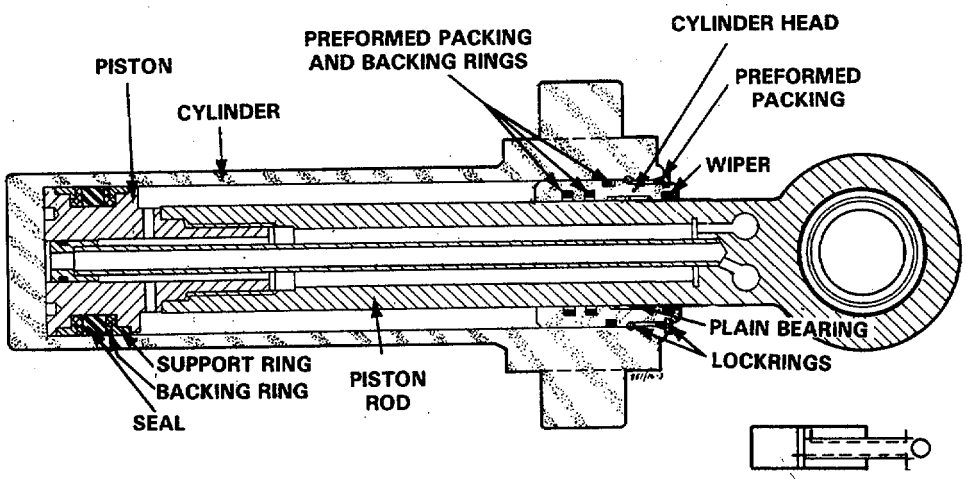
12-6. STEERING CYLINDERS.

NOTE

This paragraph applies to right and left steering cylinder.

a. General.

The steering cylinders are double acting hydraulic cylinders mounted on the steering unit. The steering cylinders are made up of the following components: cylinder, cylinder head, piston rod and piston. The cylinder head is secured to the cylinder with lockrings. The cylinder head is sealed with two packings and a backing ring, A bearing, wiper ring and two packings are placed between the cylinder head and piston rod. The hydraulic lines to the steering cylinders are connected to the piston rod. Oil flows through a bore to both sides of the piston.



b. Disassemble.

Step 1. Place steering cylinder in a padded jaw vise.
Step 2. Remove snapring and preformed packing.
Step 3. Press cylinder head inward.
Step 4. Remove lockring.
Step 5. Pull piston rod and piston out of cylinder.
Step 6. Remove hydraulic connectors from piston rod.

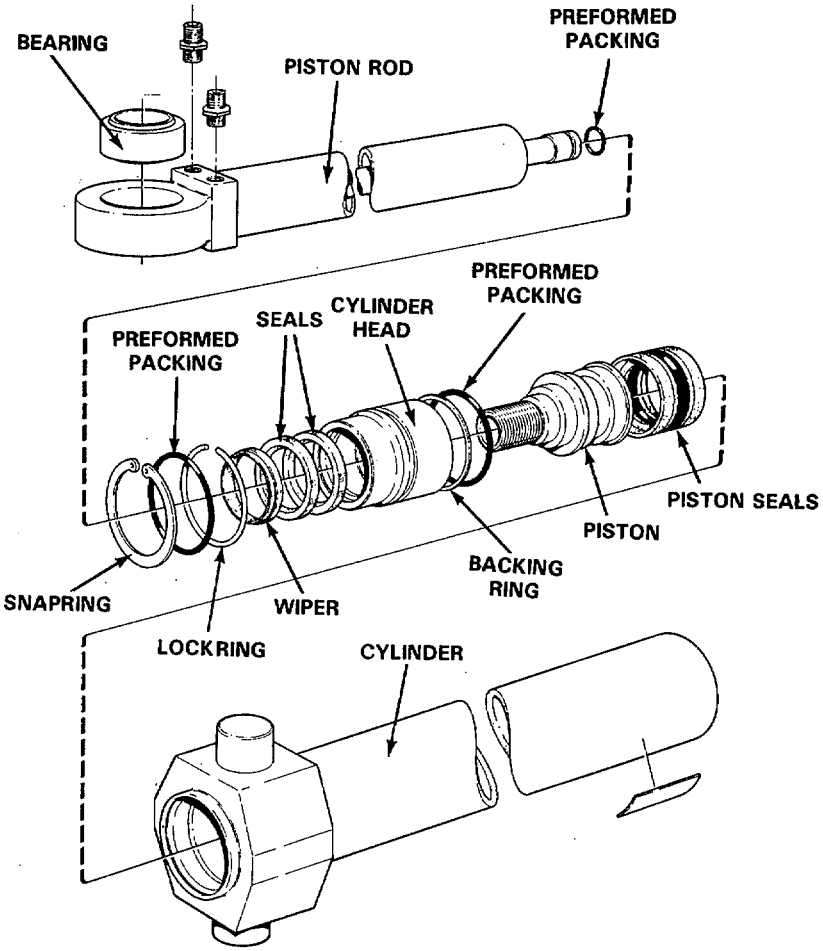
WARNING

Wear insulated gloves while heating piston rod. Hot piston rod can cause severe burns to personnel.

Step 7. Remove all seals, packings and backing rings.
Step 8. Heat threaded end of piston rod to 302°F (150°C).
Step 9. Unscrew piston from piston rod.
Step10. Remove screws from piston rod eye. Remove covers.

TA259701

Step 11. Use driftpin. Press bearing out of rod eye. Refer to table 2-1, item 73.



TA259702

c. Inspection.

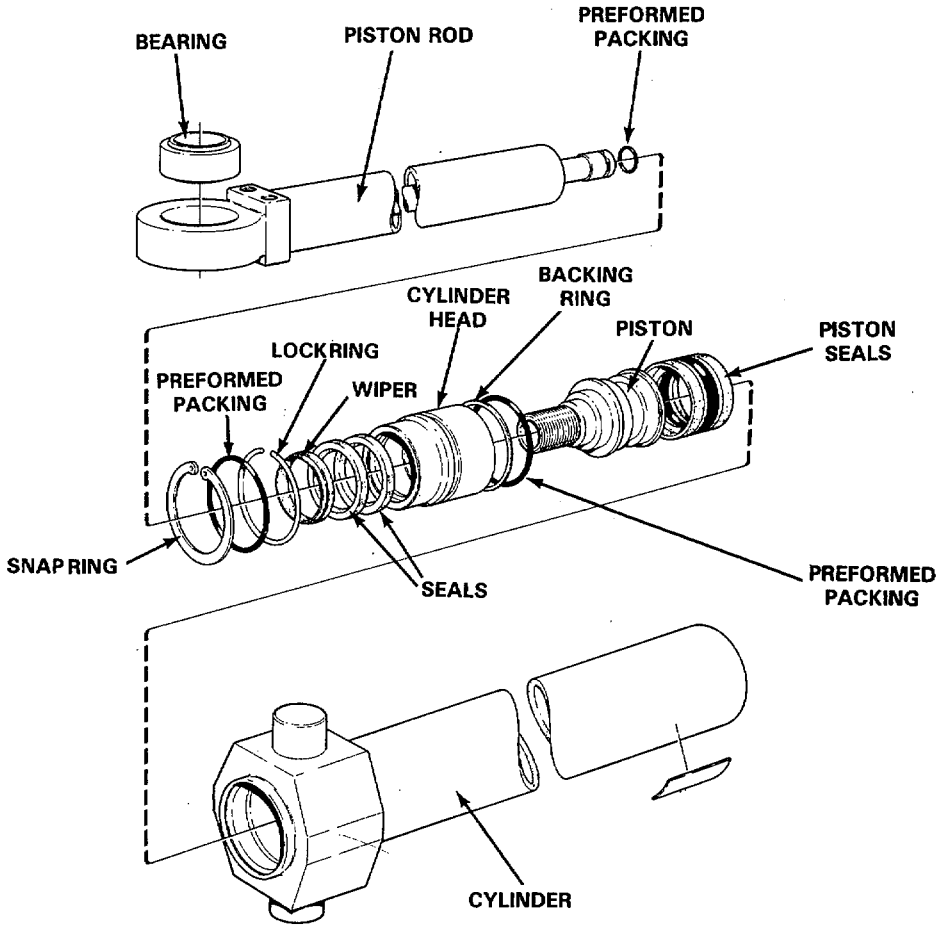
WARNING

Cleaning solvent, federal specification P-D-680 Type II, is flammable and gives off harmful vapors. Use solvent only in a well ventilated area. Avoid prolonged breathing of solvent vapors. Keep solvent away from flame. Do not use solvent in excessive amounts.

Step 1. Clean all components with solvent. Dry all components. Refer to appendix B, item 48.
Step 2. Inspect bearing for damage.
Step 3. Inspect piston rod for scratches and burrs. Remove burrs with oil and fine abrasive cloth.
Step 4. Inspect inner cylinder wall for scratches and burrs. Hone inside of cylinder if necessary.
Step 5. Replace all seals, packing and backing rings.

d. Assemble.

Step 1. Use drift pin. Press bearing into piston rod eye. See table 2-1, item 76.
Step 2. Put on covers. Put in lockscrews. Tighten lockscrews.
Step 3. Put seals in cylinder head.
Step 4. Put in backing rings for seals.
Step 5. Put in wiper.
Step 6. Assemble packing and backing ring.
Step 7. Cut backing ring.
Step 8. Install backing ring in groove. Use vaseline.
Step 9. Put snapring, packing and lockring over piston rod.
Step 10. Use drift pin. Put cylinder head on piston rod. Refer to table 2-1, item 58.
Step 11. Put packing on end of piston rod.
Step 12. Screw piston on piston rod.
Step 13. Torque piston to 295 lb. ft. (400 Nm).
Step 14. Assemble seals and backing rings on piston. Stagger ring gaps.
Step 15. Push piston rod into cylinder.
Step 16. Put in lockring.
Step 17. Pull cylinder head outward.
Step 18. Put in packing and snapring.
Step 19. Put fittings on cylinder piston rod.

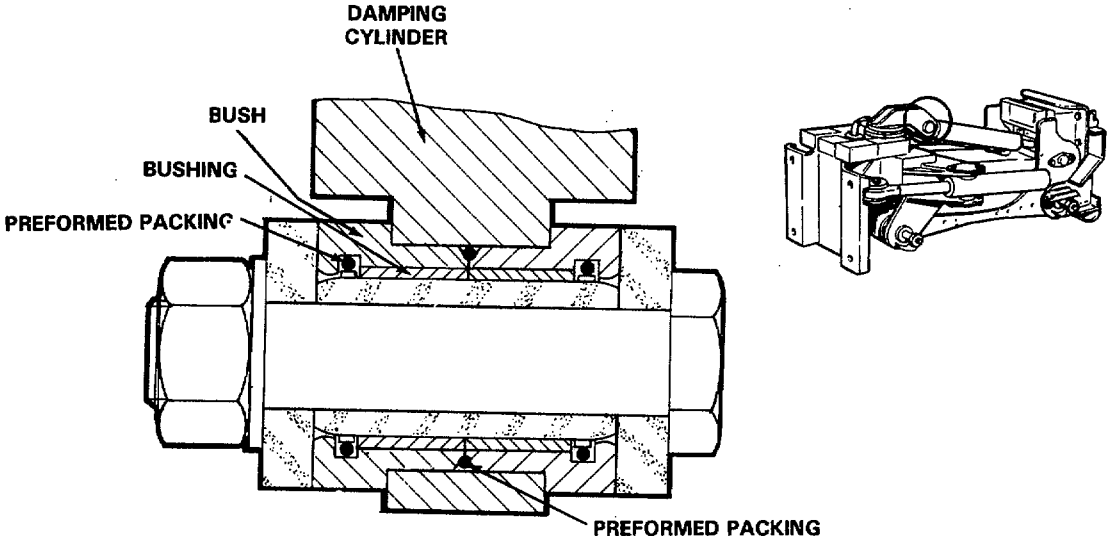

BEARING
PISTON ROD
PREFORMED PACKING
BACKING RING
CYLINDER HEAD
PISTON
PISTON SEALS
LOCKRING
PREFORMED PACKING
WIPER
SNAP RING
SEALS
PREFORMED PACKING
CYLINDER

TA259703

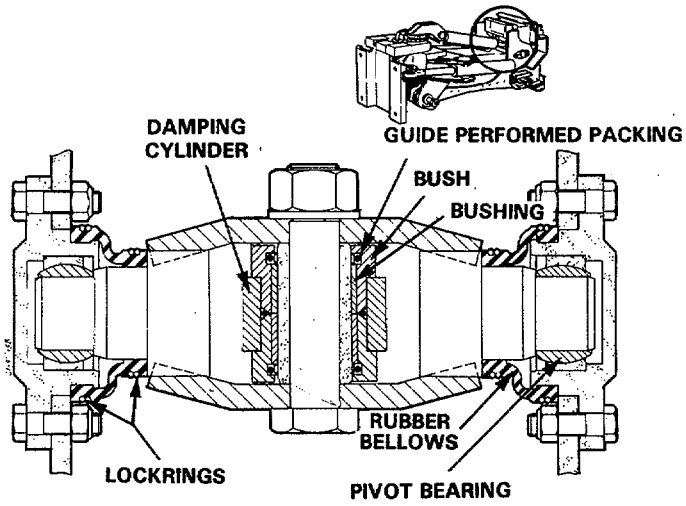
12-7. HYDRAULIC STEERING DAMPING MECHANISM.

a. General.

The damping cylinder is mounted between the pivot support and the rear support. A hydraulic hose connects the cylinder to a accumulator.



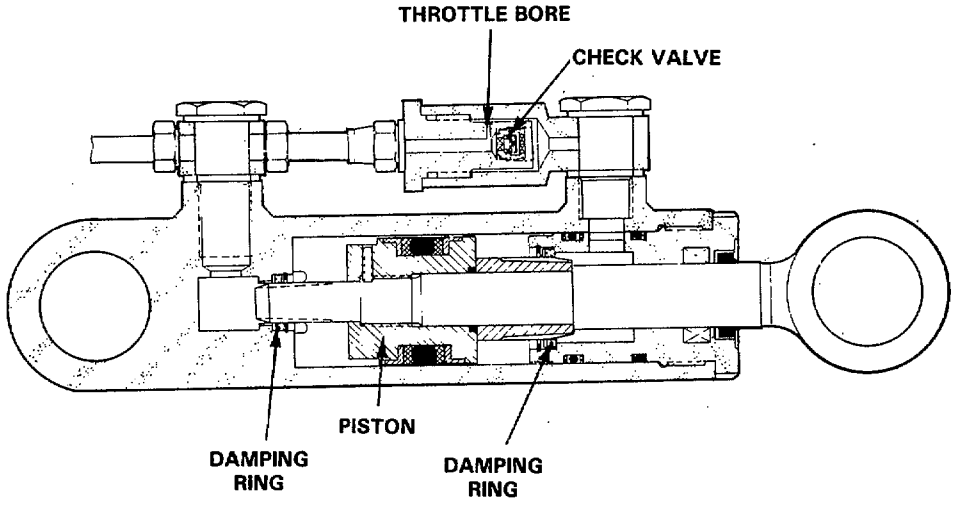
DAMPING CYLINDER MOUNTING



PISTON ROD EYE MOUNTING, DAMPING CYLINDER

TA259704

The accumulator is pressurized in order to rapidly supply oil to the piston side of the damping cylinder. When the steering unit moves vertically the cylinder piston rod will extend or retract. As the piston rod extends, oil from the rod side of the piston passes through a check valve to the piston side. Additional oil is also supplied to piston side from the accumulator. When the piston rod retracts, oil flows from the piston side to the rod side through a throttle bore and check valve. Excess oil returns to the accumulator. The damping cylinder is mechanically buffered at both end positions with damping rings.

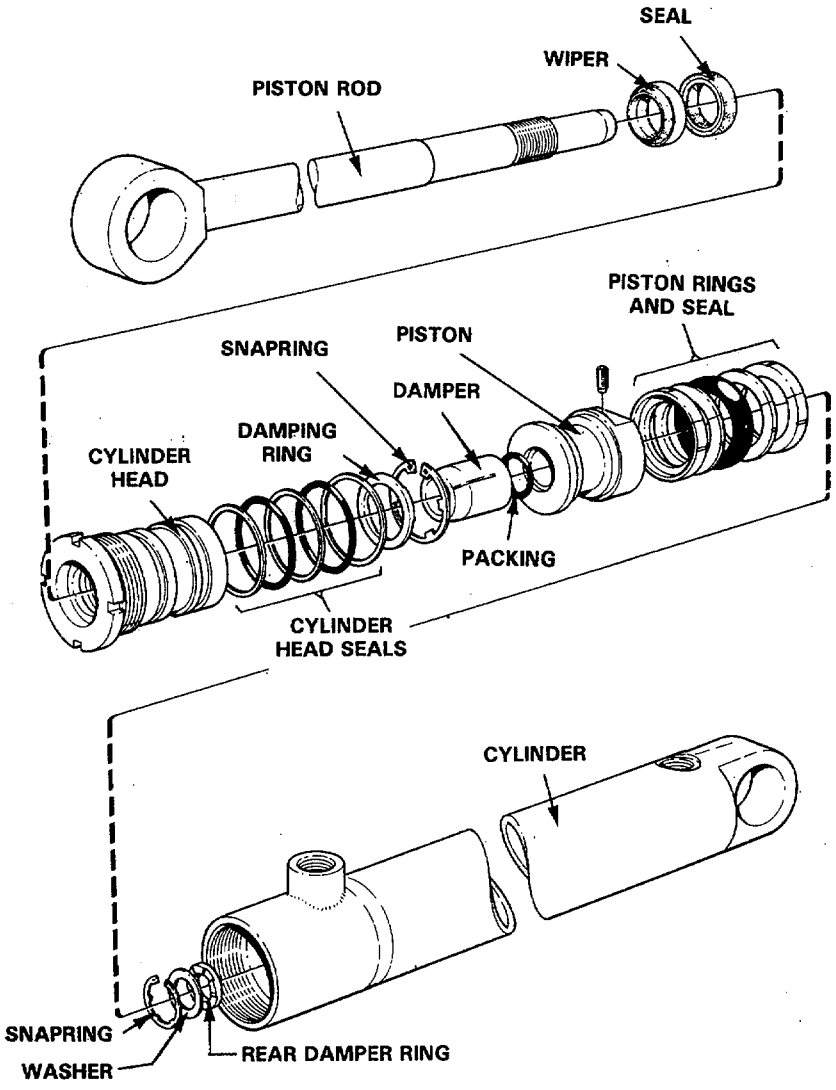


DAMPING CYLINDER

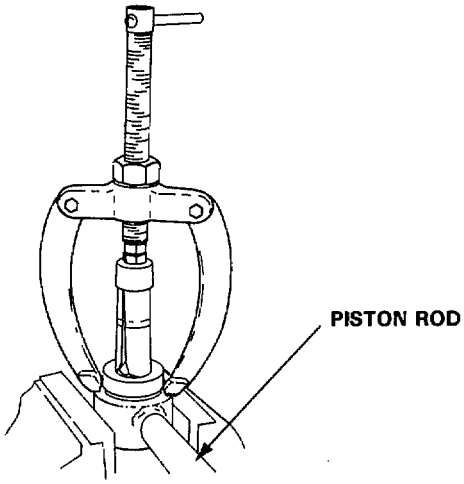
TA259705

b. Disassembly.

Step 1. Remove accumulator complete with check valve, hose and connectors.
Step 2. Drain oil from cylinder.
Step 3. Put cylinder in soft jaw vise.
Step 4. Use spanner wrench. Unscrew cylinder head.
Step 5. Pull piston rod and cylinder head out of cylinder.
Step 6. Put piston rod eye in soft jaw vise.
Step 7. Remove lockscrew.
Step 8. Unscrew piston from rod.
Step 9. Remove damper and cylinder head from piston rod.
Step 10. Remove seals from piston.
Step 11. Remove snapring, washer and rear damper ring.
Step 12. Remove snapring from cylinder head.
Step 13. Remove front damper ring and seals.
Step 14. Remove piston rod seal and wiper.



Step 15. Use puller and expander Remove bushing holders' from piston rod eye and cylinder eye.
Step 16. Remove bushings from holders.



c. Inspection.

WARNING

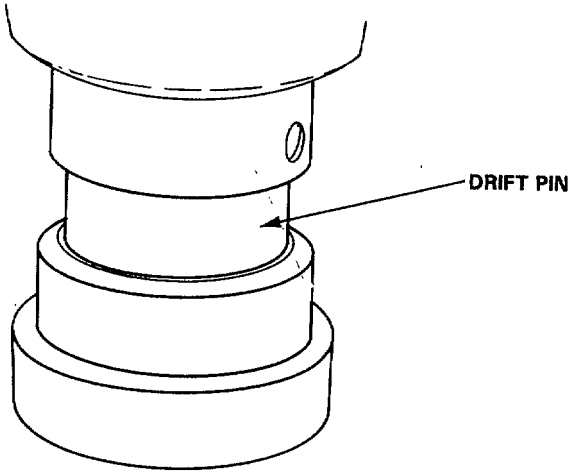
Cleaning solvent, federal specification P-D-680 Type II, is flammable and gives off harmful vapors. Use solvent only in a well ventilated area. Avoid prolonged breathing of solvent vapors. Keep solvent away from flame. Do not use solvent in excessive amounts.

Step 1. Clean all parts with solvent. Dry all parts. Refer to appendix B, item 48.
Step 2. Inspect piston rod and cylinder for scratches and burrs. Remove burrs as necessary.
Step 3. Inspect all parts for damage. Replace any damaged parts.
Step 4. Replace all seal, packing and bushings.

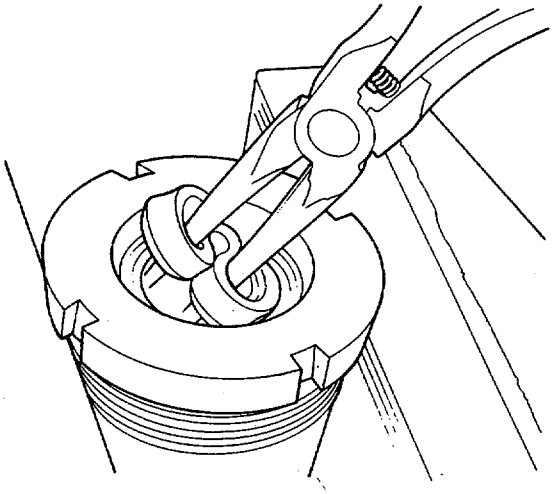
TA259707

d. Assembly.

Step 1. Use drift pin. Press bushings into bushing holders. Refer to table 2-1, item 72.
Step 2. Put packing between bushing holders and in holders. Put in spacers.
Step 3. Press bushing holders into piston rod eye and cylinder eye.

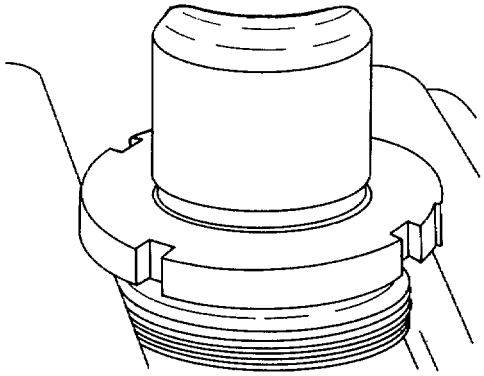


Step 4. Put seal in cylinder head.

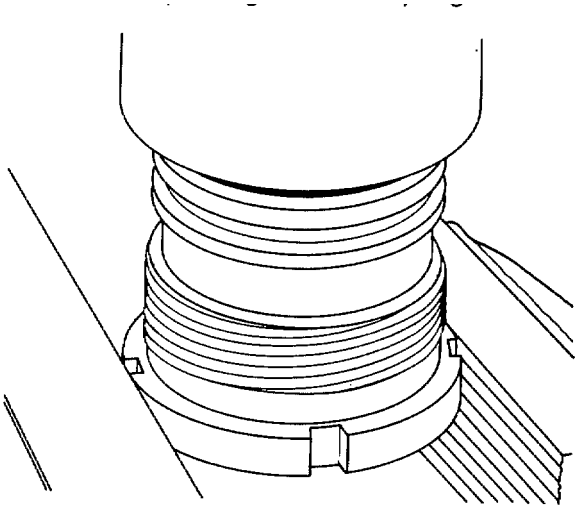


259708

Step 5. Install wiper ring. Press wiper ring in place.



Step 6. Lubricate cylinder head seals with vaseline. Refer to appendix B, item 45.
Step 7. Install seals and damper ring. Install snapring.



Step 8. Put cylinder head on piston rod. Install damper.
Step 9. Put seal assembly on piston.
Step 10. Put packing and piston on piston rod.
Step 11. Put in lockscrew. Tighten lockscrew.
Step 12. Put rear damper, washer and snapring in cylinder.
Step 13. Put piston rod into cylinder.
Step 14. Use spanner wrench. Screw in end tighten cylinder head.
Step 15. Fill and bleed damping cylinder. Refer to TM 9-2350-272-20.

12-8. DAMPING CYLINDER PIVOT BEARING.

a. Remove.

Step 1. Slide outer spring tension clips from rubber bellows.
Step 2. Remove bolts and nuts from bearing supports.
Step 3. Press cylinder support to one side. Remove bearing support.
Step 4. Use puller and expander. Pull out pivot bearings.
Step 5. Remove rubber seals.

b. Replace.

Step 1. Use drift pin. Press in pivot bearings. Refer to table 2-1, item 74.
Step 2. Put grease on bearing supports. Refer to appendix B, item 8.
Step 3. Install bearing supports and rubber seals.
Step 4. Put on spring tension clips.
Step 5. Put on bearing support bolts and nuts. Tighten nuts.

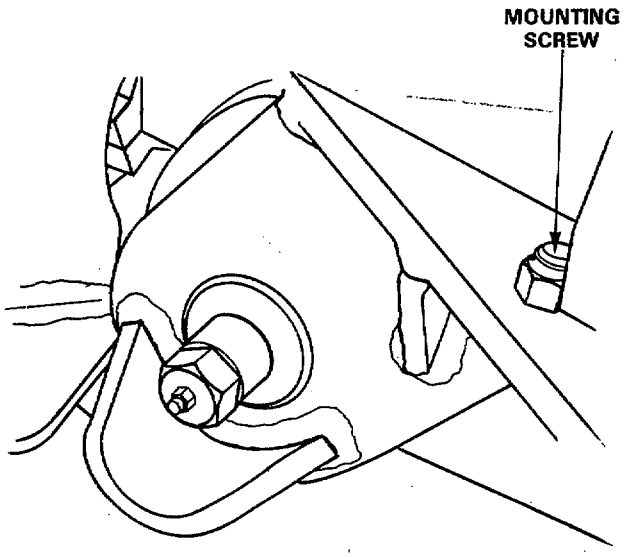
12-9. STEERING GEAR ARM.

a. General.

The steering gear arm permits horizontal and vertical movement between car.

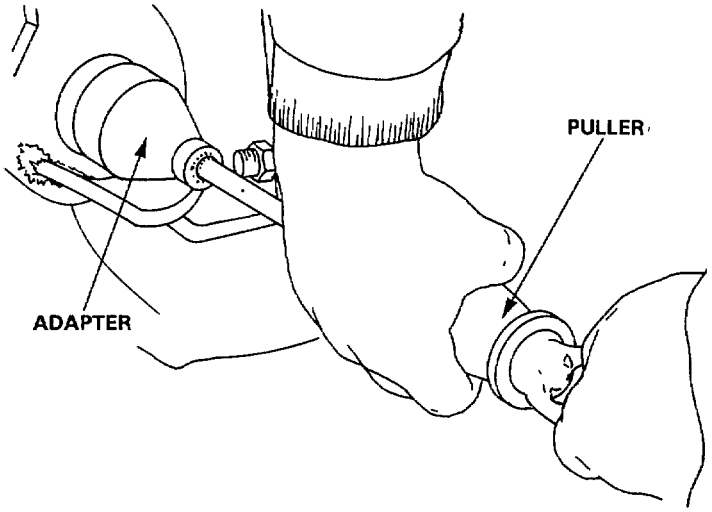
b. Remove.

Step 1. Remove transfer to rear differential propeller shaft. Refer to TM 9-2350-272-20.
Step 2. Drain air from accumulator. Disconnect damping cylinder piston rod from cylinder pivot support.
Step 3. Support steering gear arm with a jack.
Step 4. Remove steering gear arm mounting screws.



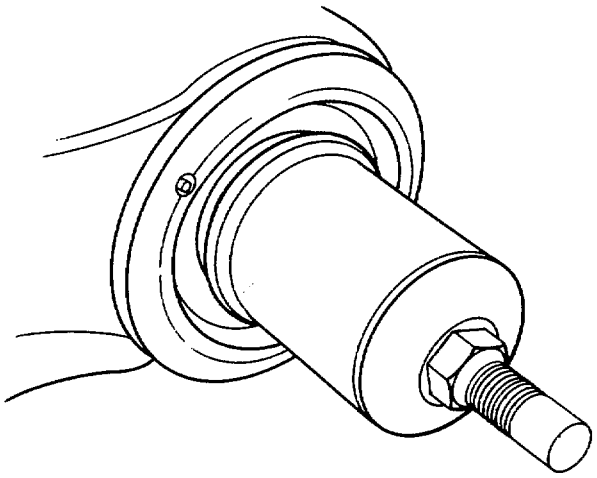
TA259710

Step 5. Use pullers and adapter. Remove sleeve spacers. Refer to table 2-1, items 68 and 77.
Step 6. Lower and remove steering gear arm.



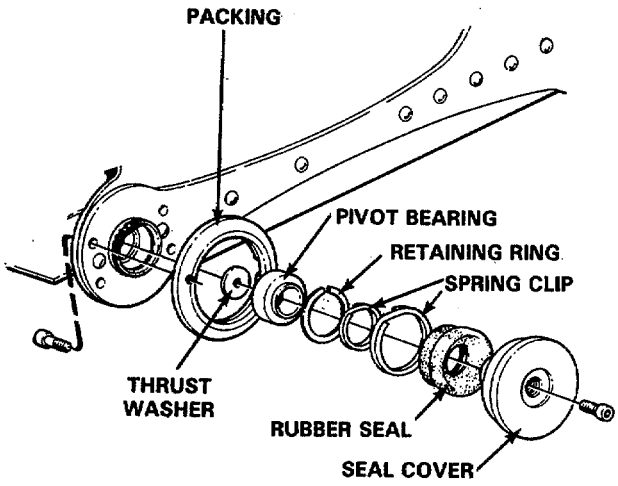
c. Disassemble.

Step 1. Remove seal cover center screw.
Step 2. Remove seal cover. Slide spring tension clip off rubber bellows.
Step 3. Remove rubber seal.
Step 4. Remove retaining ring.
Step 5. Use puller. Pull out bearing. Refer to table 2-1, item 81.



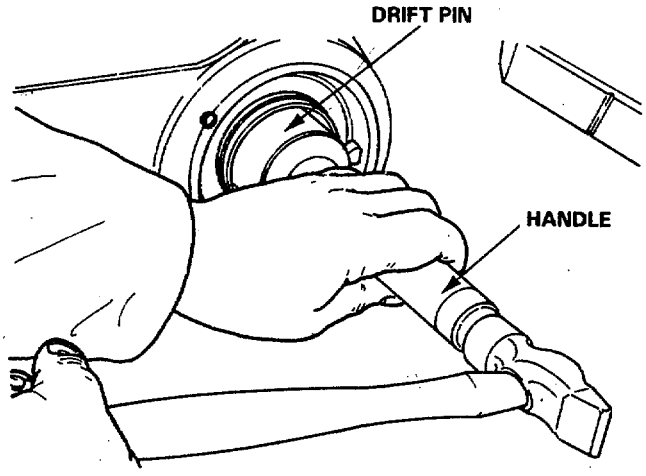
TA259711

Step 6. Remove thrust washer.
Step 7. Remove packing screws. Remove packing.



d. Assemble.

Step 1. Put new packing in place.
Step 2. Put in packing screws. Tighten screws.
Step 3. Put in thrust washer.
Step 4. Use fixture, drift pin and handle. Press in new pivot bearing. Refer to table 2-1, items 55, 75 and 80.



Step 5. Put in retaining ring.
Step 6. Fill rubber seal with grease. Refer to appendix B, item 8.
Step 7. Put rubber seal on seal cover. Put on outer spring clip.
Step 8. Put seal cover in place with inner spring clip.
Step 9. Put in and tighten center screw.

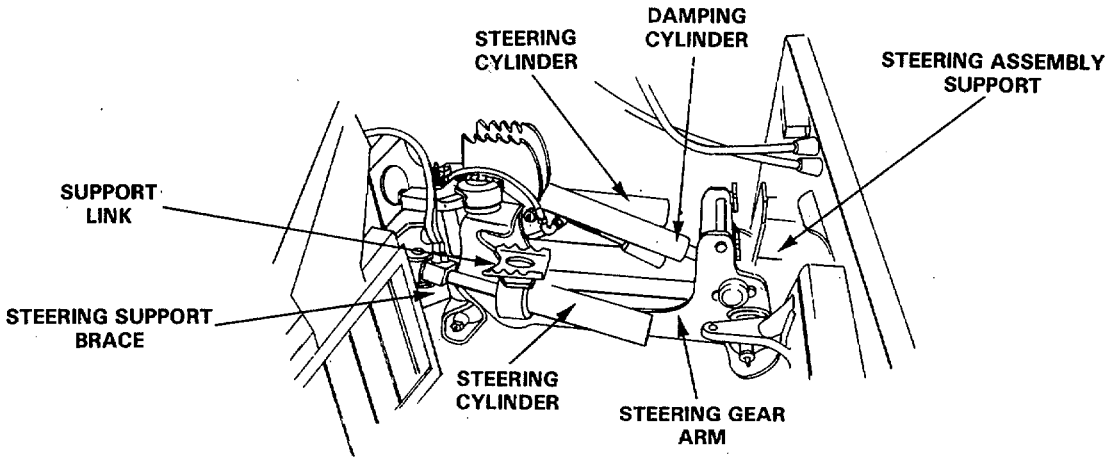
e. Replace.

Step 1. Put sleeve spacers in position. Do not tap spacers into place.
Step 2. Put packing and screws in spacers.
Step 3. Raise steering gear arm into position.
Step 4. Tap in sleeve spacers.
Step 5. Tighten mounting screws. Torque screws to 258 lb. ft. (350 Nm).
Step 6. Connect damping cylinder piston rod to cylinder pivot support.
Step 7. Install propeller shaft. Refer to TM 9- 2350-272-20.
Step 8. Pressurize accummulator. Refer to LO 9-2350-272-1 2.

12-10. STEERING UNIT

a. General.

The steering unit connects the front and rear car. It allows movement between the car. The steering unit is made up of the following parts: steering support brace, support link, steering gear arm, steering assembly support, steering damping mechanism and the steering cylinders.



b. Remove.

Step 1. Disconnect steering hoses from the steering cylinders.
Step 2. Plug hoses and cylinder connections.
Step 3. Disconnect propeller shaft from differential.
Step 4. Scribe alignment mark on propeller shaft. Separate shaft.
Step 5. Use support frame support steering unit. Refer to table 2-1, item 82.
Step 6. Remove mounting nuts which hold steering assembly support to rear car.

CAUTION

Do not stretch coolant hoses when moving rear car away for steering unit. Damage to hose can occur.

TA259713

Step 7. Move rear car away from steering unit.
Step 8. Remove nuts holding steering support brace to front car.
Step 9. Remove steering unit.

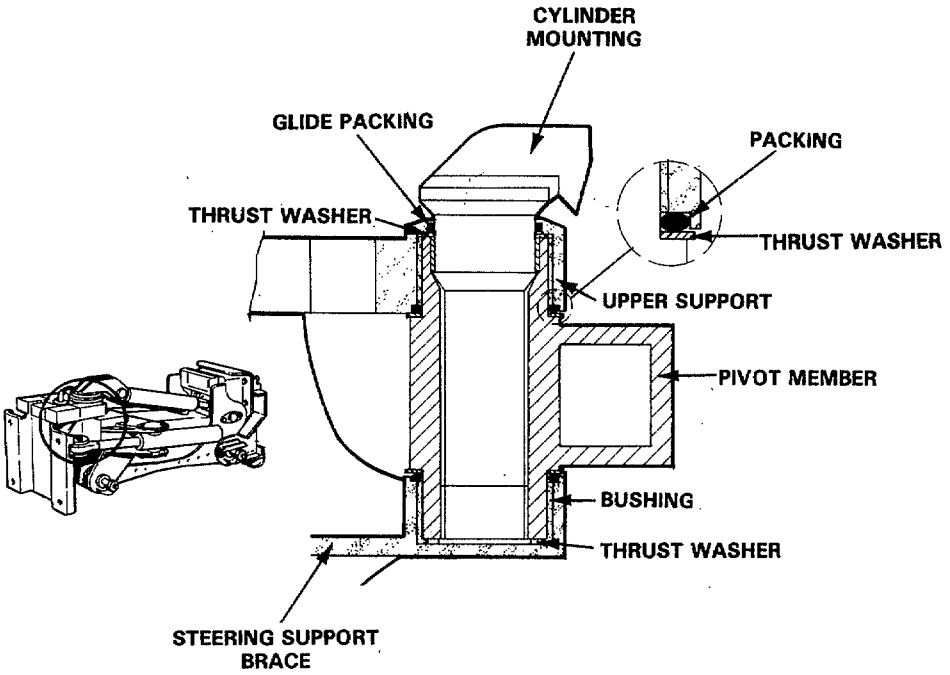
c. Replace.

Step 1. Position steering unit at rear of front car. Put nuts on steering support brace mounting screws.
Step 2. Align propeller shaft. Put shaft through steering unit.
Step 3. Move rear car against steering unit.
Step 4. Put nuts on steering assembly support mounting screws. Tighten nuts on rear and front supports. Torque nuts to 325 lb. ft. (440 Nm.
Step 5. Connect propeller shaft to differential.
Step 6. Remove plugs from hoses and connections. Connect hoses.
Step 7. Check oil level in steering hydraulic tank. Refer to TM 9-2350-272-10.
Step 8. Start engine. Steer right and left. Stop engine.
Step 9. Check for leaks at steering cylinder connections. Tighten loose connections.

12-11. STEERING UNIT SUPPORT LINK ASSEMBLY.

a. General.

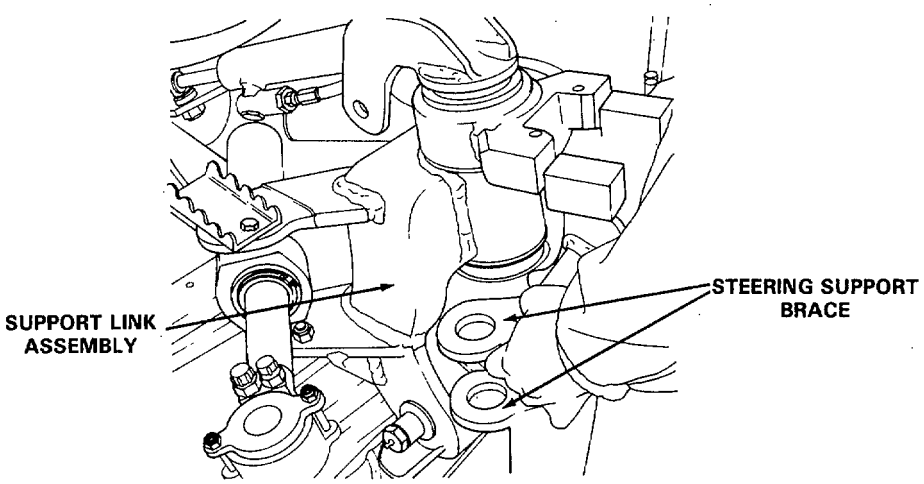
The steering unit support link allows the cars to move relative to each other in the horizontal plane. The support link is attached to the front support and the steering gear arm. The steering cylinders are mounted to the support link. The cylinder end of the damping cylinder is connected to the top of the support link assembly.



TA259714

b. Remove.

Step 1. Remove propeller shaft from differential.
Step 2. Remove steering cylinders. Refer to TM 9- 2350-272-20.
Step 3. Release accumulator pressure.
Step 4. Remove accumulator mounting screws. Move accumulator aside.
Step 5. Use puller. Disconnect damping cylinder from top support link. Refer to table 2-1, item 70.
Step 6. Put support frame under steering unit. Refer to table 2-1, item 82.
Step 7. Remove nuts holding steering support brace to front car. Push front car forward.
Step 8. Remove two steering support brace mounting screws.
Step 9. Remove steering support brace.
Step 10. Support the support link assembly.
Step 11. Remove two front steering gear arm mounting screws.
Step 12. Use puller and adapter. Remove sleeve spacers. Refer to table 2-1, items 68 and 77.
Step 13. Remove support link assembly.

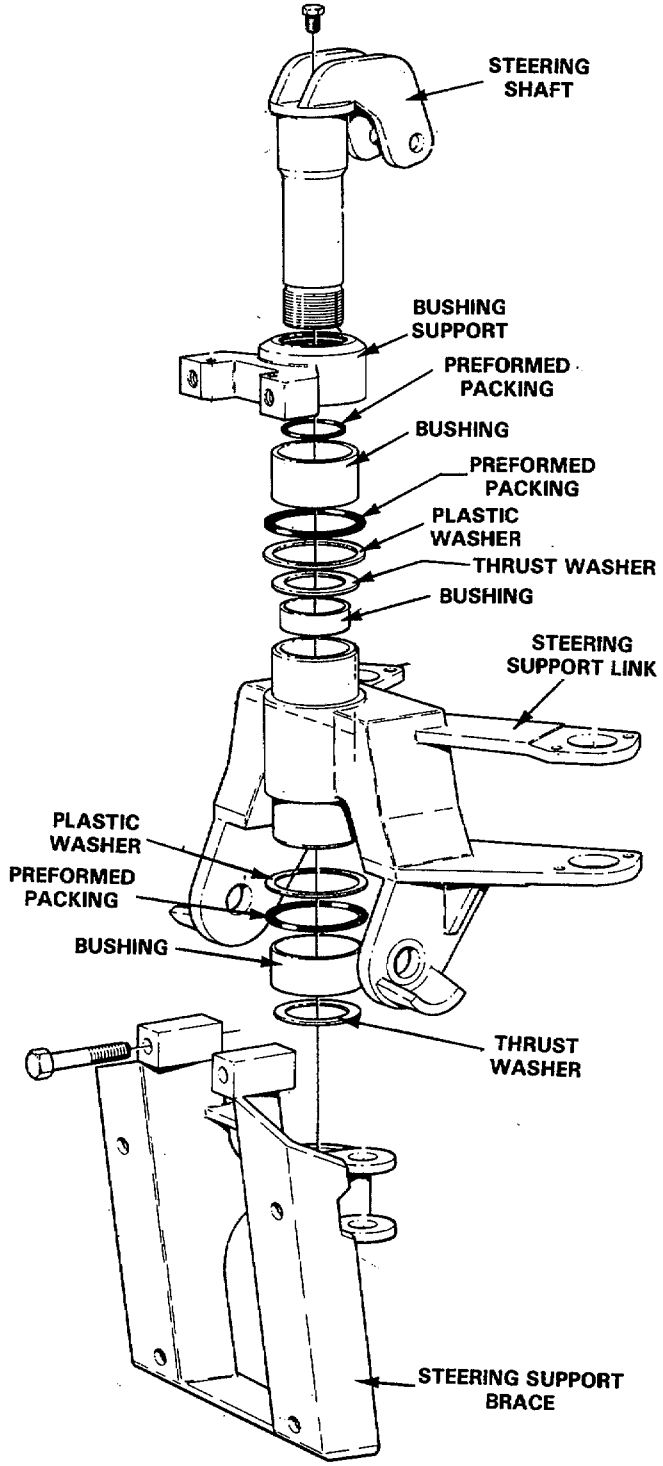


c. Replace.

Step 1. Put support link assembly in position.
Step 2. Put in sleeve spacers.
Step 3. Put in steering gear arm mounting screws. Torque screws to 258 lb. ft. (350 Nm).
Step 4. Put front support in position on support link.
Step 5. Use clamp. Install steering support brace. Refer to table 2-1, item 71.
Step 6. Tighten clamp screw until there is no play. Loosen clamp screw 1/4 turn.
Step 7. Put in steering support brace mounting screws. Torque screws to 258 lb. ft. (350 Nm).
Step 8. Position steering support brace on front car. Put on mounting nuts. Torque nuts to 325 lb. ft. (440 Nm).
Step 9. Connect damping cylinder to upper support link. Torque nut to 258 lb. ft. (350 Nm).
Step 10. Put accumulator in place. Put in mounting screws.
Step 11. Replace steering cylinders. Refer to TM 9- 2350-272-20.
Step 12. Replace propeller shaft to differential.
Step 13. Pressurize accumulator. Refer to TM 9-2350- 272-20.
Step 14. Lubricate steering unit. Refer to LO 9-2350-272-1 2.

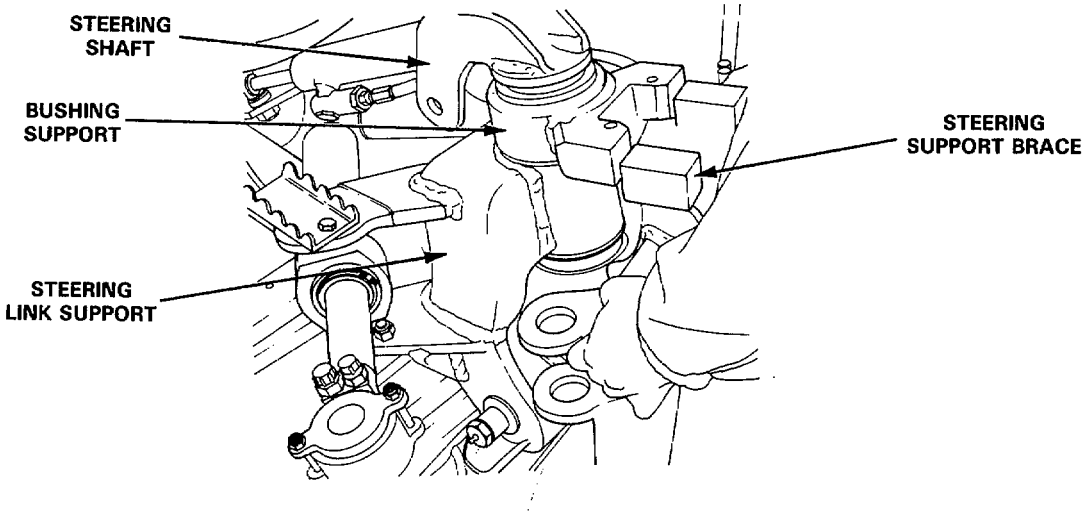
TA259715

12-12. REPLACE SUPPORT LINK BUSHINGS.

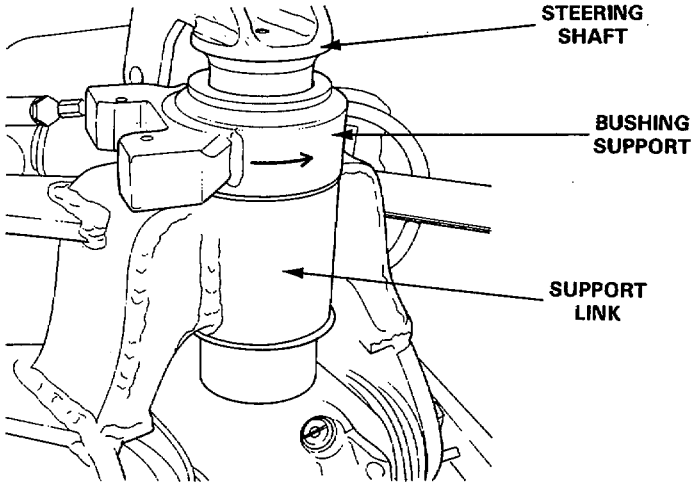


TA259716

Step 1. Remove propeller shaft from differential.
Step 2. Remove steering cylinders. Refer to TM 9- 2350-272-20.
Step 3. Release accumulator pressure.
Step 4. Remove accumulator mounting screws. Move accumulator aside.
Step 5. Use puller. Disconnect damping cylinder from steering shaft support. Refer to table 2-1, item 70.
Step 6. Put support frame under steering unit. Refer to table 2-1, item 82.
Step 7. Remove nuts holding steering support brace to front car. Push front car forward.
Step 8. Remove two steering support brace mounting screws.
Step 9. Remove steering support brace.

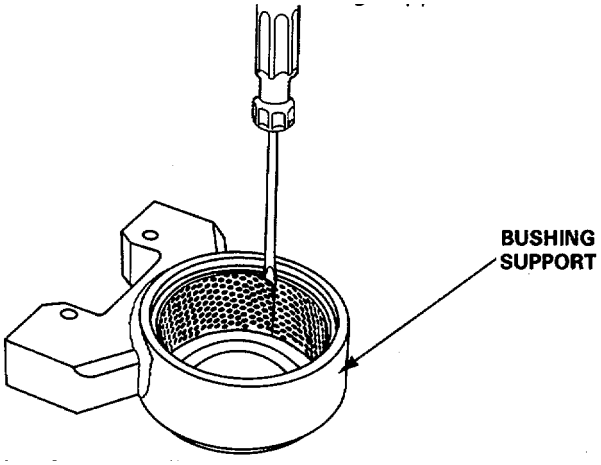


Step 10. Remove steering shaft and bushing support.
Step 11. Remove packings and plastic washers from top and bottom of support link and bushing support.

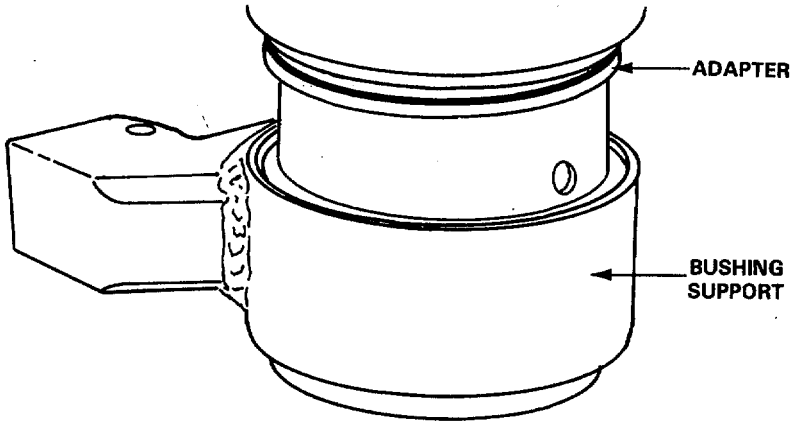


TA259717

Step 12. Remove thrust washers and bushing from support link.
Step 13. Remove bushings and washers from bushing support and steering support brace.



Step 14. Measure journals of support link for wear. Minimum diameter is 3.716 in. (99.4 mm). If journals are worn replace support link.
Step 15. Use handle and drift pin, press bushings into steering support brace and bushing support. Refer to table 2- 1, items 55 and 79.

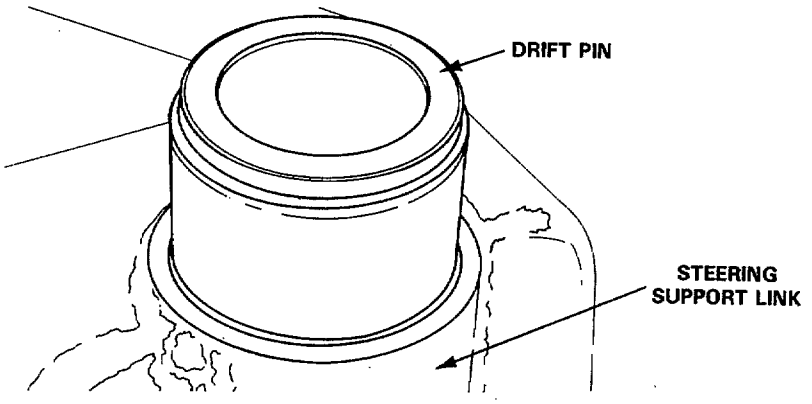


Step 16. Use handle and drift pin. Press in support link bushing. Refer to table 2-1, items 55 and 78.

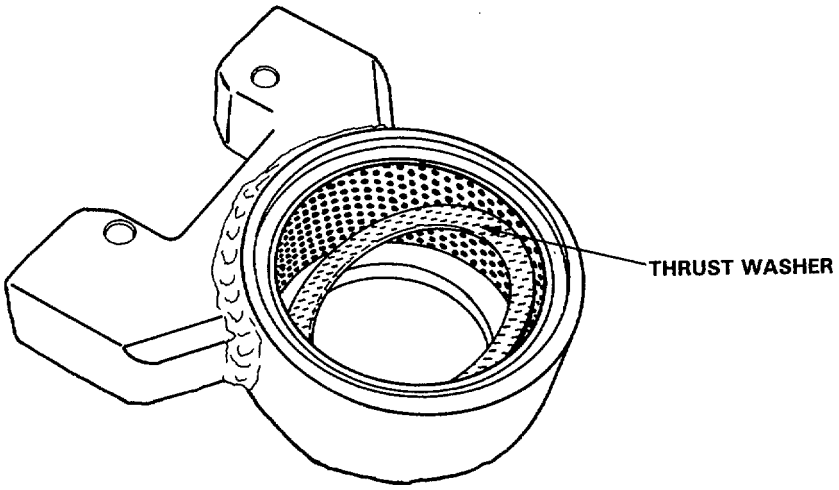
NOTE

Bushing must have a groove lined up with groove in steering support link.

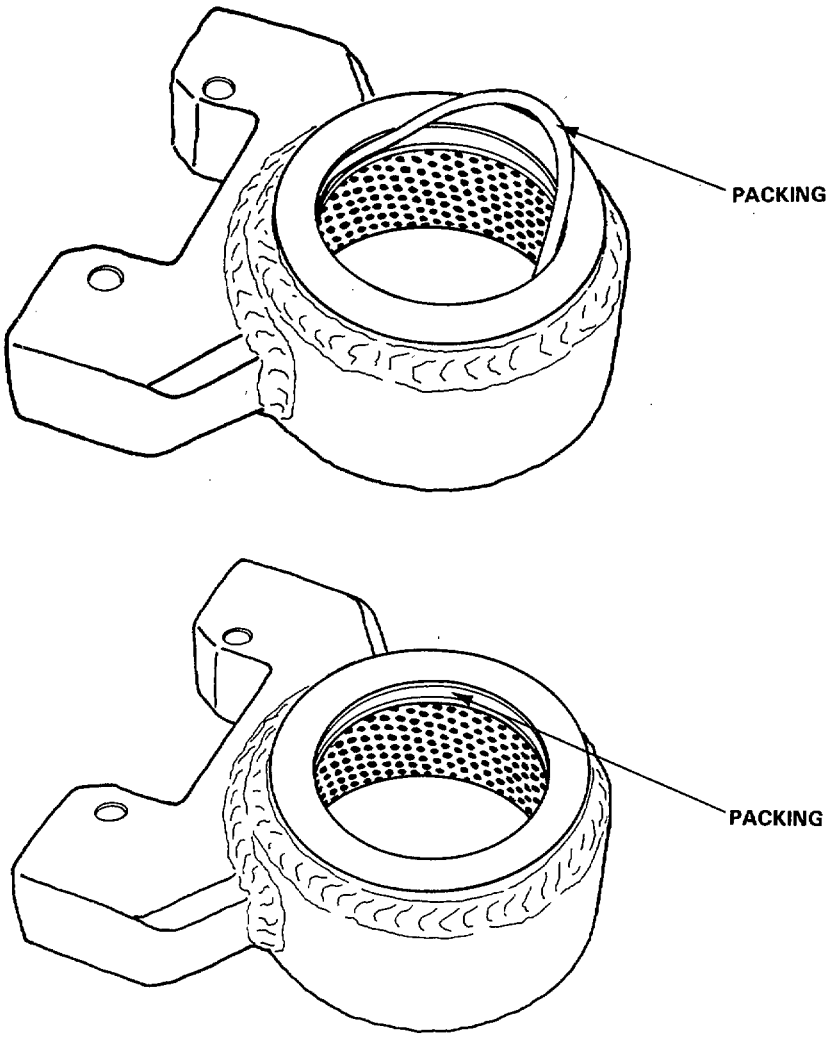
Step 17. File groove in bushing.



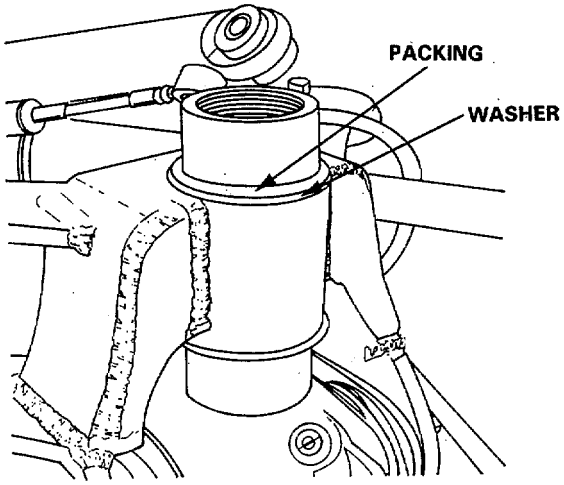
Step 18. Put new thrust washers in bushing support and steering support brace.



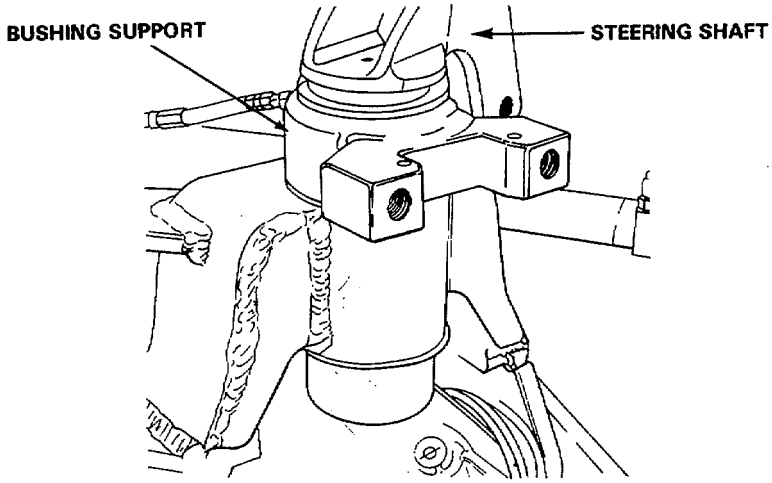
Step 19. Put new packing in bushing support.



Step 20. Put new plastic washer and packing on top of support link.

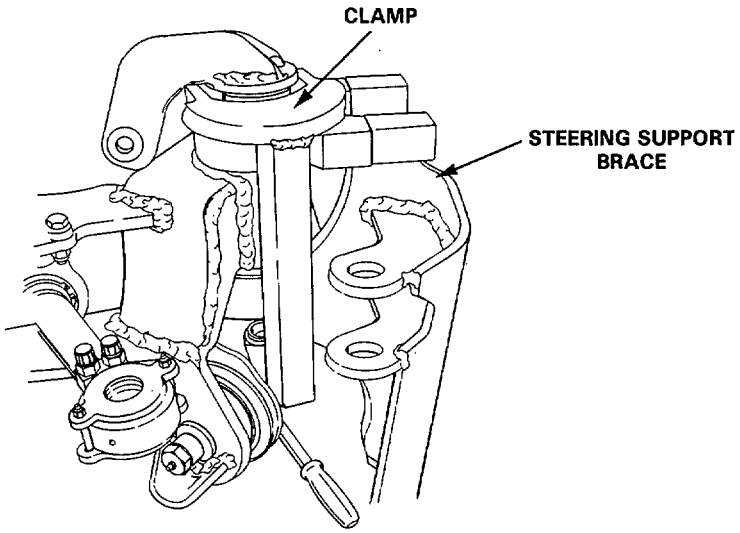


Step 21. Grease bushing. Put bushing support on support link. Refer to appendix B, item 8.
Step 22. Grease bushing. Put in steering shaft. Screw steering shaft all the way down. Refer to appendix B, item B.
Step 23. Unscrew steering shaft until it is pointing in the proper position. Steering shaft must be unscrewed at least 1 /8 turn and not more than 1 -118 turns.



TA259720

Step 24. Put new plastic washer and packing on bottom of support link.
Step 25. Grease bushings. Use clamp. Install steering support brace. Refer to table 2-1, item 71.
Step 26. Tighten clamp screw until there is no play. Loosen clamp screw .4 turn.
Step 27. Put in two steering support brace screws. Torque screws to 258 lb. ft. (350 Nm).



CAUTION

Make sure steps are mounted with long end toward rear car, to avoid cutting steering hoses.

Step 28. Put damping cylinder and accumulator in place.
Step 29. Put in and tighten accumulator mounting screws.
Step 30. Put in cylinder mounting bolt and nut. Torque nut to 258 lb. ft. (350 Nm).
Step 31. Install steering cylinders. Refer to TM 9- 2350-272-20.
Step 32. Position steering unit on front car.
Step 33. Put on mount nuts. Torque nuts to 325 lb. ft. (440 Nm).
Step 34. Replace propeller shaft to differential.
Step 35. Lubricate steering unit. Refer to LO 9-2350-272-12.
Step 36. Pressurize accumulator. Refer to TM 9-2350-272-20.

12-13. STEERING GEAR.

a. General.

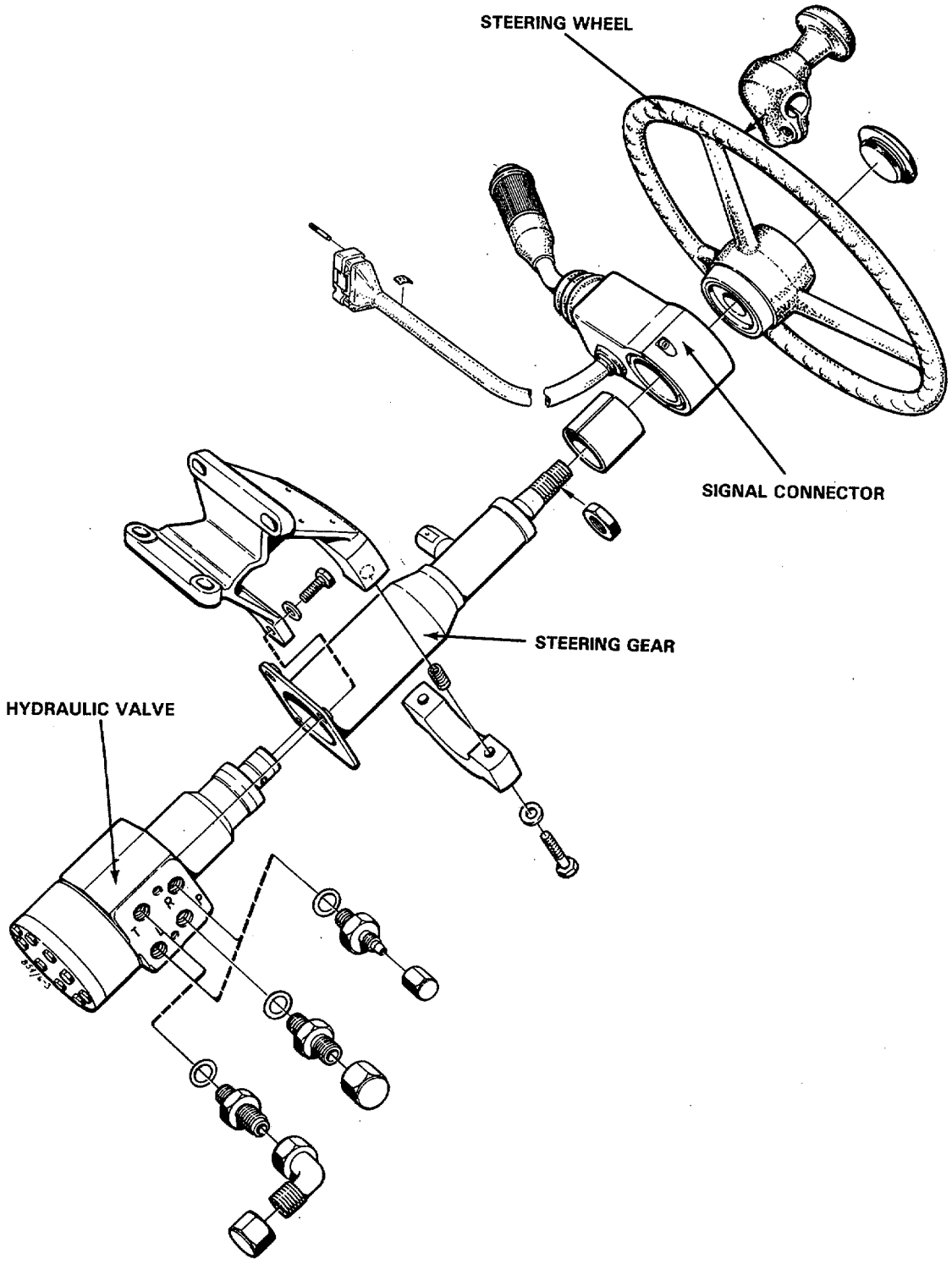
The steering wheel is mounted on splines to the end of the steering gear shaft. The shaft is supported by a housing attached to the top of the power steering valve.

b. Remove.

Step 1. Remove steering wheel.
Step 2. Remove turn signal connector assembly. Refer to TM 9-2350-272-20.
Step 3. Remove power steering hydraulic valve. Refer to paragraph 12-4.

TA259782

Step 4. Remove two support screws and washers.
Step 5. Remove steering gear.



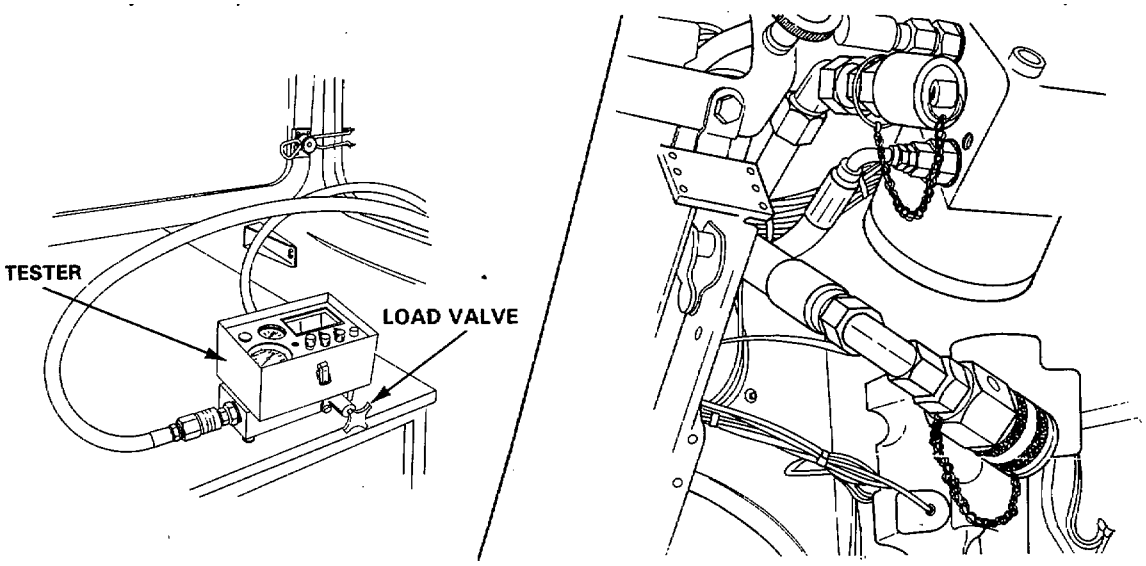
c. Replace.

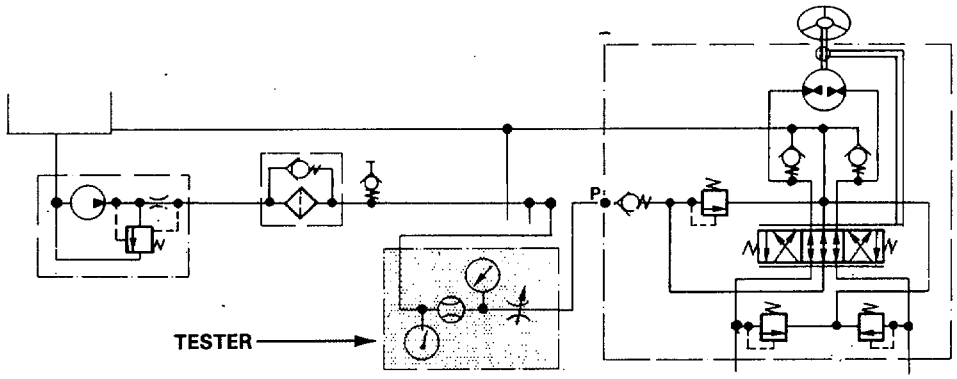
Step 1. Hold steering gear in position.
Step 2. Put support in place.
Step 3. Put in and tighten two support screws with washers.
Step 4. Replace power steering valve. Refer to paragraph 12-4.
Step 5. Replace turn signal connector assembly. Refer to TM 9-2350-272-20.
Step 6. Replace steering wheel.

12-14. STEERING SYSTEM TESTS.

a. Hydraulic Pump Test.

Step 1. Disconnect hose from port P of power steering hydraulic valve.
Step 2. Connect connector to port P. Refer to table 2-1, item 90.
Step 3. Connect connector to hose. Refer to table 2-1, item 92.
Step 4. Connect test hoses to connectors. Refer to table 2-1, item 85.
Step 5. Open load valve and connect test hoses to tester. Refer to table 2-1, item 84.





TA259722

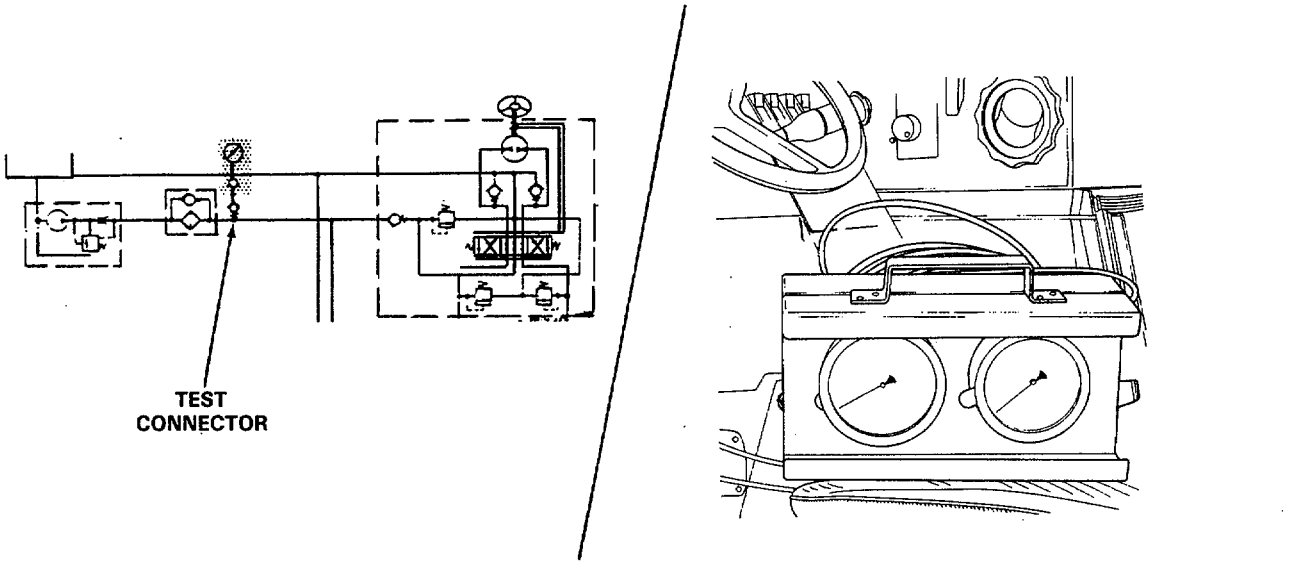
Step 6. Start engine. Run engine for two minutes.
Step 7. Check oil level in hydraulic tank. Fill as necessary. Refer to LO 9-2350-272-12.
Step 8. Operate engine at the following speeds to measure the pump flow:

ENGINE RPM	CORRECT FLOW
1000	8-12 dm^3/min
1500	15-19 dm^3/min
2000	18-22 dm^3/min
2500	22-27 dm^3/min
3000	22-29 dm^3/min

Step 9. Operate engine at 2600 RPM.
Step 10. Adjust load valve on tester until pump load reads 120 bar (1740 PSI).
Step 11. Read flow meter. Correct flow is 22 dm^3/min.
Step 12. Stop engine. Open load valve on tester.
Step 13. Disconnect test hoses and connectors.
Step 14. Connect steering hose to port P of steering hydraulic valve. Tighten hose.

b. Power Steering Valve Test (Pressure Limiting).

Step 1. Remove access cover on left side of engine compartment.
Step 2. Remove cap from tester connector.
Step 3. Use test hose. Connect a 0 to 2500 PSI (0 to 160 bar) pressure gage to the test connector. Refer to table 2-1, items 86 and 83.



TA259723

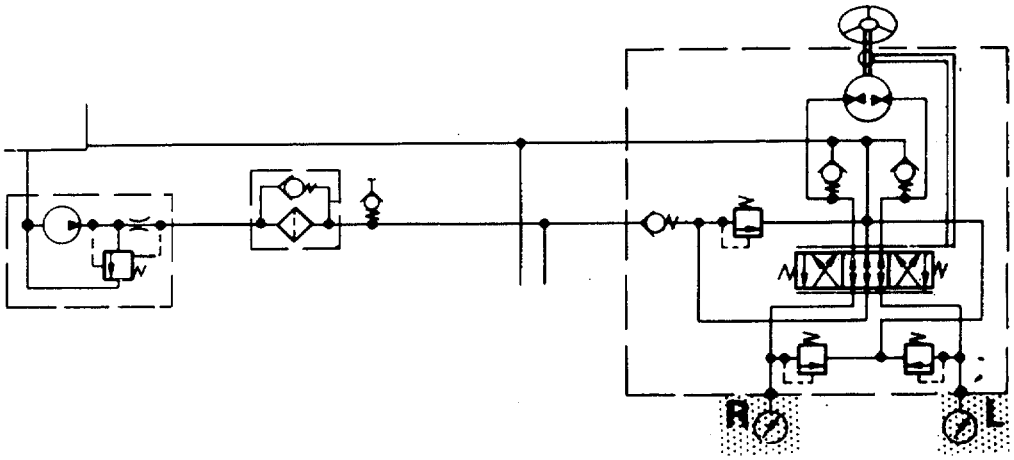
CAUTION

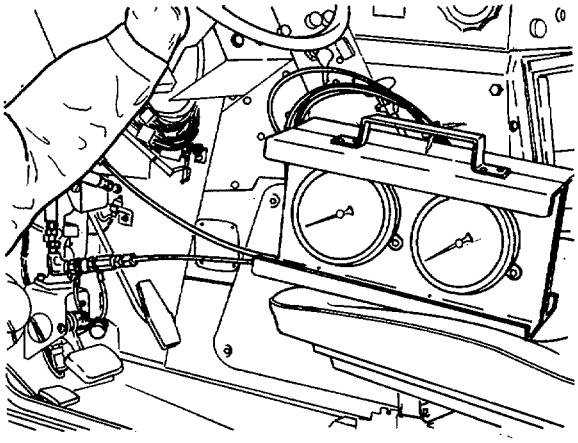
Do not hold steering wheel to the full stop position for more than 5 seconds.
Damage to equipment can occur.

Step 4. Start engine and turn steering wheel to right full stop position. Read gage. Correct reading is 1566 to 1914 PSI (108 to 132 bar).
Step 5. Turn steering wheel to left full stop position. Read gage. Correct reading is 1566 to 1914 PSI (108 to 132 bar).
Step 6. If pressure reading is not within the limits, the pressure limiting valve in the power steering valve is defective.
Step 7. Stop engine. Disconnect test hose from test connector.
Step 8. Put protective cap on test connector.
Step 9. Replace engine compartment cover.

c. Power Steering Valve. (Internal Leakage).

Step 1. Disconnect steering hoses form port L and port R on power steering valve. Plug hoses.
Step 2. Use measuring connectors. Connect 0 to 2500 PSI (O to 160 bar) pressure gages to ports L and R. Refer to table 2-1, items 86 and 83.





TA259724

Step 3. Engine shut off. Turn steering wheel left until pressure gage reads 145 PSI (10 bar).

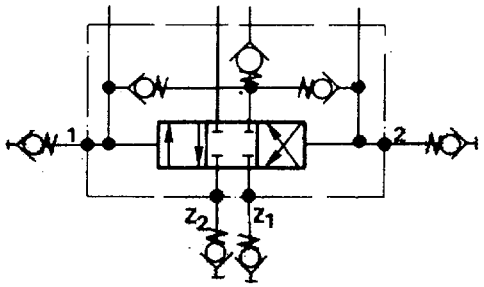
NOTE

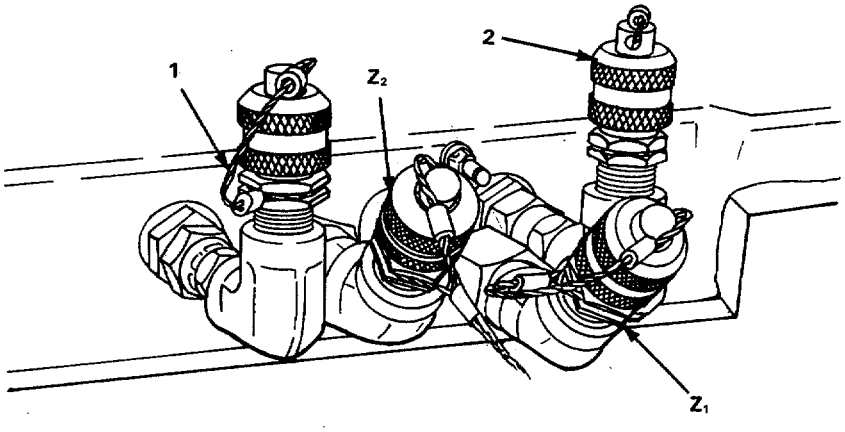
This is a timed procedure.

Step 4. Turn steering wheel slowly to left 1/2 turn. Keep a pressure of 145 PSI (10 bar) on pressure gage. Time to complete 1/2 turn must be more than 30 seconds.
Step 5. Release steering wheel.
Step 6. Turn steering wheel right until pressure gage reads 145 PSI (10 bar).
Step 7. Turn steering wheel slowly to right l/2 turn. Keep a pressure of 145 PSI (10 bar) on pressure gage. Time to complete M2 turn must be more than 30 seconds.
Step 8. Less than 30 seconds to complete 1/2 turn in either direction indicates internal leakage within power steering valve.
Step 9. Record times. Times will be need in servo valve test.
Step 10. Disconnect pressure gages and measuring connectors.
Step 11. Remove plugs from steering hoses. Connect and tighten hoses to ports L and R of power steering valve.

d. Servo Valve Test.

Step 1. Remove cover over servo valve outlet hoses.
Step 2. Tag and disconnect outlet hoses from servo valve. Plug hoses.
Step 3. Connect measuring connectors to the four outlet ports of servo valve. Refer to table 2-1, items 87 and 88.



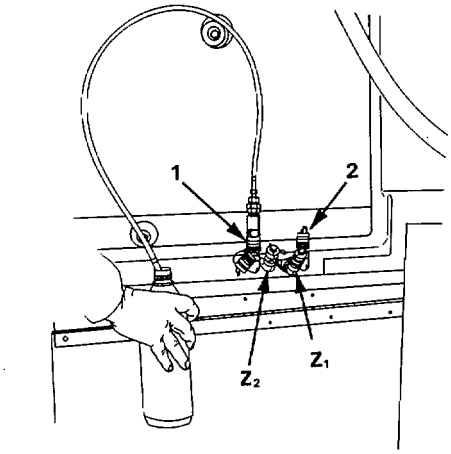


TA259725

NOTE

Hydraulic tank must be kept at proper oil level.

Step 4. Connect bleed hose to connector 1. Refer to table 2-1, item 91.
Step 5. Start engine.
Step 6. Turn steering wheel right until oil coming from bleed hose is free of air.
Step 7. Move bleed hose to connector Z1.
Step 8. Turn steering wheel right until oil coming from bleed hose is free of air.
Step 9. Move bleed hose to connector 2.
Step 10. Turn steering wheel left until oil coming from bleed hose is free of air.
Step 11. Move bleed hose to connector Z2.
Step 12. Turn steering wheel left until oil coming from bleed hose is free of air.
Step 13. Remove bleed hose.
Step 14. Stop engine.



Step 15. Use hoses. Connect 0 to 2500 PSI (O to 160 bar} pressure gauges to connectors 2 and Z2. Refer to table 21, items 86 and 83.
Step 16. Turn steering wheel left until pressure gages read 145 PSI (10 bar).

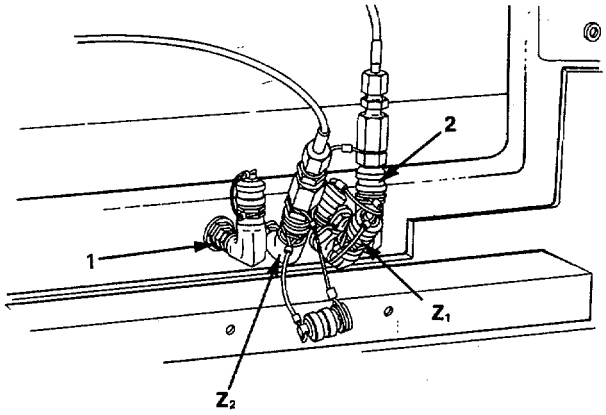
NOTE

This is a timed procedure.

Step 17. Turn steering wheel slowly to the left 1/2 turn. Keep a pressure of 145 PSI (10 bar) on pressure gages. Record time required to complete 1/2 turn.
Step 18. Move pressure gages to connectors 1 and Z1.
Step 19. Turn steering wheel right until pressure gages read 145 PSI (10 bar).
Step 20. Turn steering wheel slowly to the right 1/2 turn. Keep a pressure of 145 PSI (10 bar) on pressure gauge. Record time required to complete 1/2 turn.

TA259726

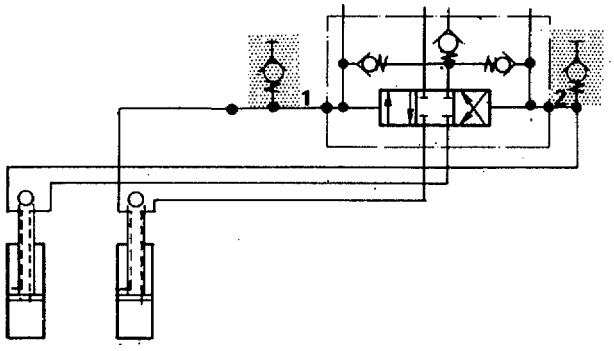
Step 21. Subtract times from the times recorded while testing power steering valve. Times for servo valve must be no more than 10 seconds less than times for power steering valve.
Step 22. If time difference is more than 10 seconds servo valve has internal leakage.



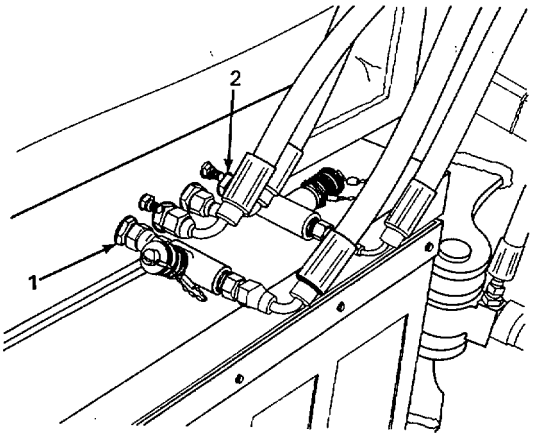
Step 23. Start engine.
Step 24. Turn steering wheel to right.
Step 25. Read pressure gages. Gages should read equal pressure.
Step 26. Release steering wheel. Read gage connected to connector 1. Gage must drop to zero.
Step 27. If gage does not drop to zero, servo valve is defective.
Step 28. Move pressure gages to connector Z2 and 2.
Step 29. Steer to the left.
Step 30. Read pressure gages. Gages should read equal pressure.
Step 31. Release steering wheel. Read gage connected to connector 2. Gage must drop to zero.
Step 32. If gage does not drop to zero servo valve is defective.
Step 33. Disconnect pressure gages, hose and connectors.
Step 34. Connect hydraulic steering hose to servo valve.
Step 35. Put hose cover in place.
Step 36. Put in cover screws and nuts. Tighten nuts.

e. Steering Cylinder Test.

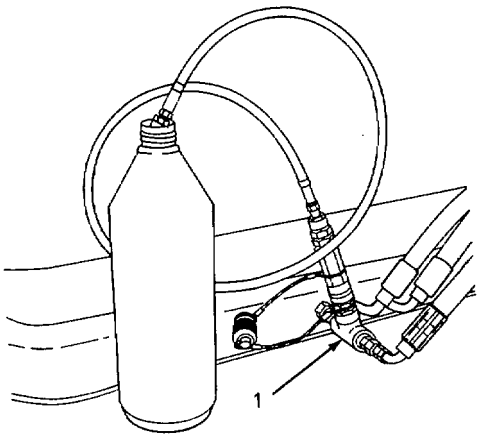
Step 1. Remove cover over servo valve outlet steering hoses.
Step 2. Disconnect steering hoses from servo valve connectors 1 and 2.
Step 3. Connect measuring connectors to servo valve connectors 1 and 2. Refer to table 2-1, item 89.
Step 4. Connect steering hoses to measuring connectors.



TA259727



Step 5. Connect air bleed hose to measuring connector at connector 1. Refer to table 2-1, item 91.
Step 6. Turn steering wheel right until oil coming from bleed hose is free of air.

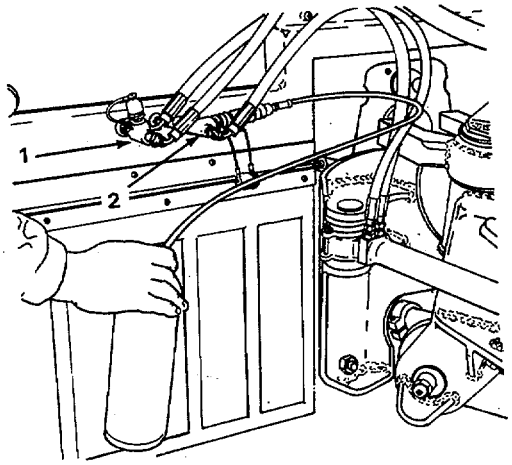


Step 7. Move air bleed hose to measuring connector at connector 2.
Step 8. Turn steering wheel left until oil coming from bleed hose is free of air.
Step 9. Remove cover from left side of engine compartment.
Step 10. Connect 0 to 2500 PSI (O to 160 bar) pressure gage to test connector in engine compartment. Refer to table 2-1, items 86 and 83.
Step 11. Start engine.
Step 12. Steer to the right until pressure gage reads 1450 PSI (100 bar). Maintain pressure at 1450 PSI (100 bar).
Step 13. Measure leakage coming from the bleed hose at connector 2. Leakage rate must not exceed 3.4 oz/min (0.1 liter/min).
Step 14. Release steering wheel.
Step 15. Move bleed hose to connector 2.
Step 16. Steer left until pressure gage reads 1450 PSI (100 bar). Maintain pressure at 1450 PSI (100 bar).

TA259728

Step 17. Measure leakage coming from bleed hose. Leakage rate must not exceed 3.4 oz/min (0.1 liter/min).

Step 18. If leakage from either connector is more than 3.4 oz/min (0.1 liter/min} steering cylinders are defective.



Step 19. Stop engine.

Step 20. Disconnect steering hoses from measuring connectors.

Step 21. Remove measuring connectors.

Step 22. Connect steering hoses to servo valve connectors 1 and 2.

Step 23. Put cover over servo valve outlet hose.

Step 24. Put in cover screws and nuts. Tighten nuts.

Step 25. Disconnect pressure gage from test connector. Replace cap.

Step 26. Put on engine access cover.

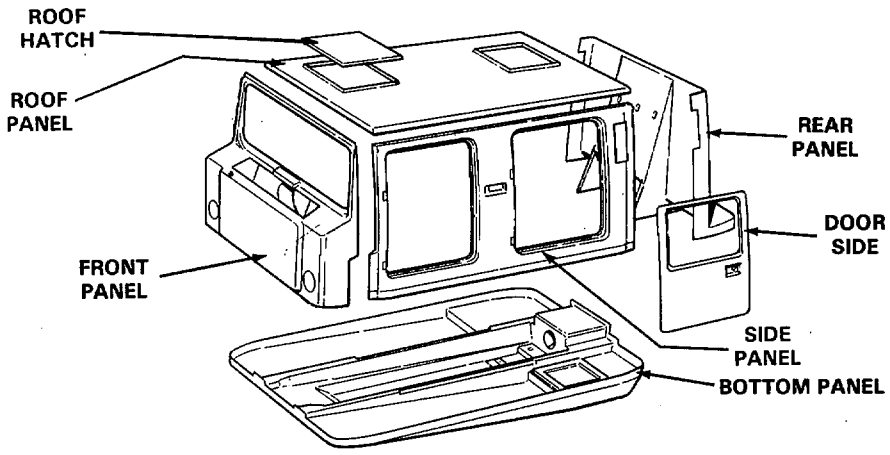
TA259729

CHAPTER 13
REPAIR OF CAR BODIES

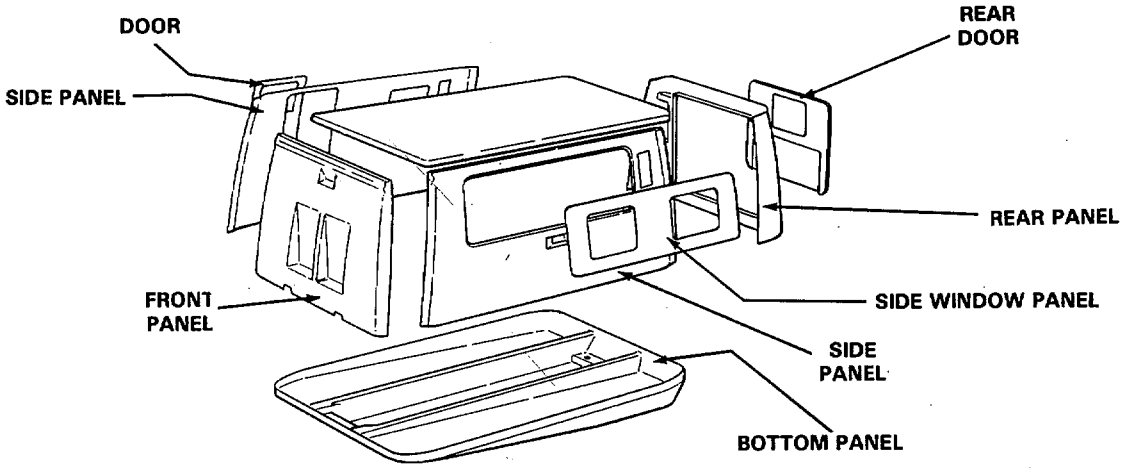
Section I. DESCRIPTION AND DATA

13-1. DESCRIPTION.

The car bodies are constructed of several molded panels. The car bodies are provided in one piece by the manufacturer.



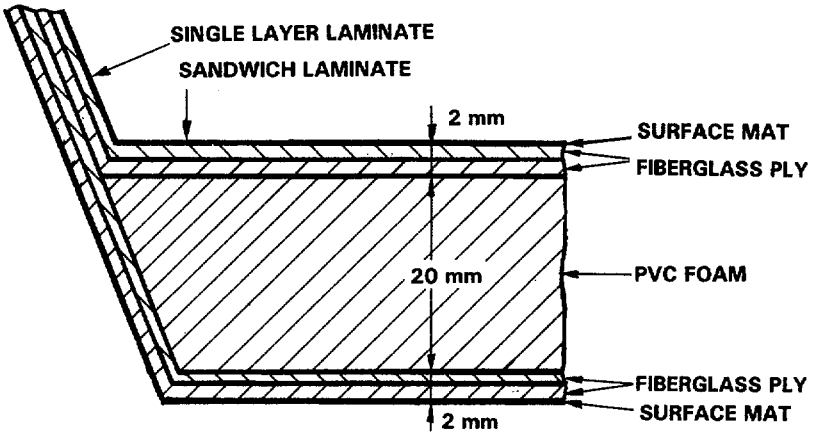
FRONT CAR BODY



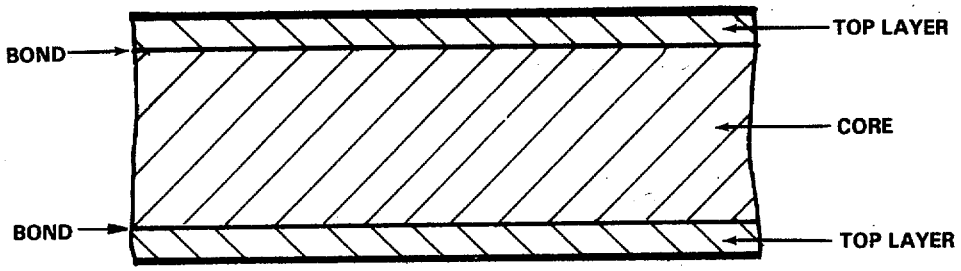
REAR CAR BODY

TA259730

The panels are made of colored, fiberglass-reinforced polyester plastic. The polyester is used to bond the glass fiber layers together for greater strength. The body panels are partly single layer construction and partly sandwich layer construction. The sandwich construction consists of three elements: hard plastic, foam and fiberglass reinforced polyester bonded together with a polyester adhesive. The surface mat is a colored synthetic resin which improves wear resistance of the panels.



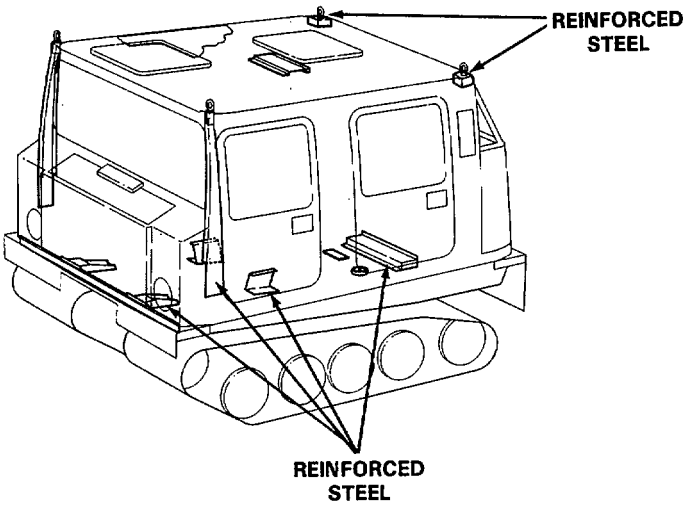
PANEL CONSTRUCTION

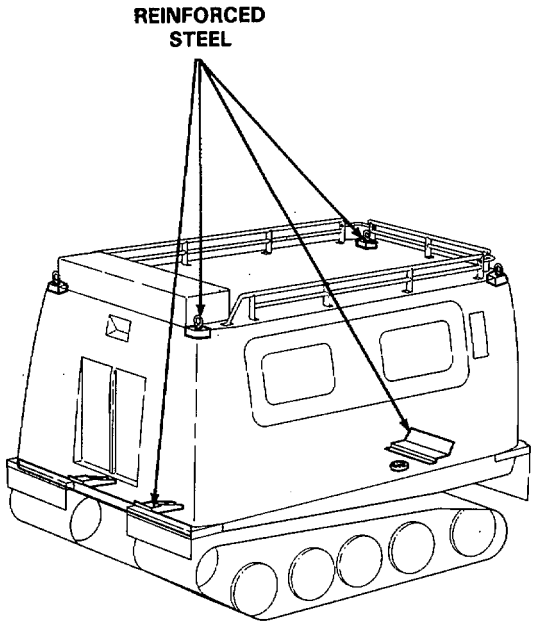


SANDWICH PANEL

TA259731

The panels are bonded together. Various panels have steel reinforcing elements. The reinforcing elements are used for: body mounting, power pack mounting, lifting eyes, bumpers and corner uprights.





TA259732

13-2. TECHNICAL DATA.

BODY

Make (Manufacturer) ..... Bofors Plast
Material ..... Fiberglass reinforced polyester (FRP)
Single-layer laminate ..... FRP
Sandwich laminate ..... FRP-PVC foam-FRP

Dimensions

Front car
- Length ..... 112.2 in. (2850 mm)
- Width ..... 72.8 in. (1850 mm)
- Height ..... 62.9 in. (I 600 mm)

Rear car
- Length ..... 111.4in. (2830 mm)
- Width ..... 72.8 in. (1850 mm)
- Height ..... 62.6 in. (1590 mm)

Body weight
Front car ..... 728 lbs.(330 kg)
Rear car ..... 573 lbs.(260 kg)

TIGHTENING TORQUES

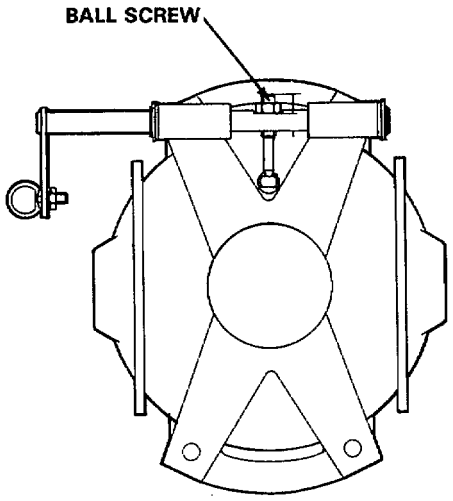
Body mountings ..... 66 lb. ft. (90 Nm)

Section II. REMOVE AND REPLACE CAR BODIES.

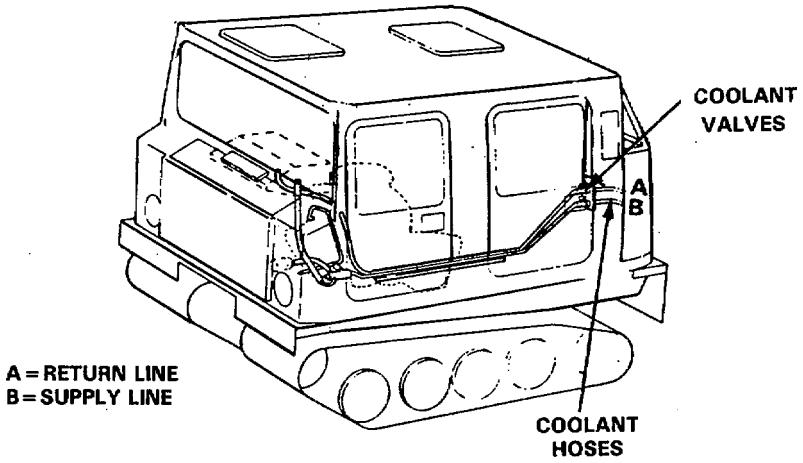
13-3. FRONT CAR BODY.

a. Remove.

Step 1. Remove battery cover.
Step 2. Disconnect battery chassis ground.
Step 3. Remove engine hood and cover.
Step 4. Remove propeller shaft between transmission and transfer. Refer to TM 9-2350-272-20.
Step 5. Loosen ball screw on transfer linkage

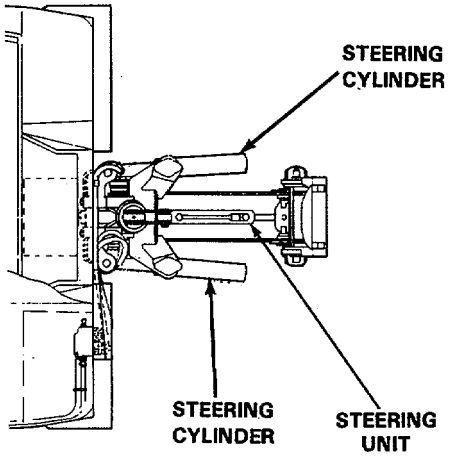


Step 6. Remove brake unit. Refer to TM 9-2350-272- 20.
Step 7. Close coolant valves at rear of front carrier.
Step 8. Tag and disconnect coolant hoses from rear of front car. Plug hoses.

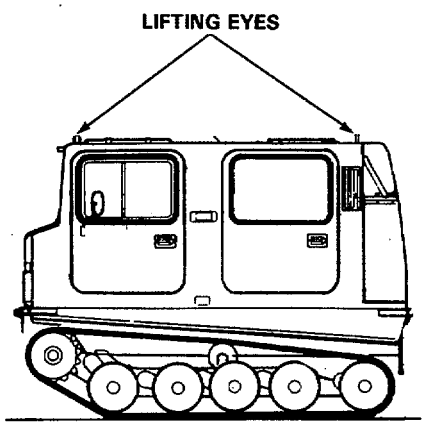


TA259733

Step 9. Tag hoses as indicated and disconnect hoses from steering cylinders.
Step 10. Plug steering hoses and connections on steering cylinders.

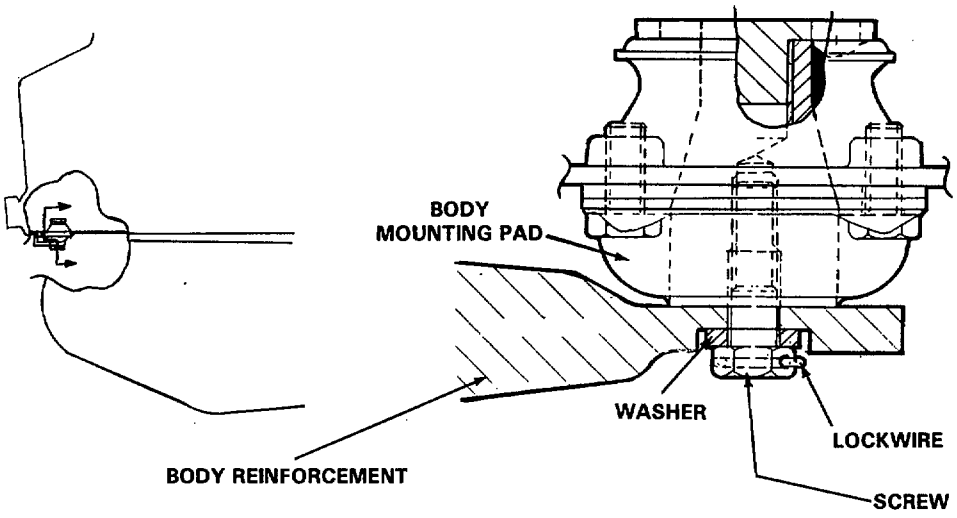


Step 11. Disconnect electric cable from rear of front car.
Step 12. Attach lifting slings to four carrier lifting eyes.

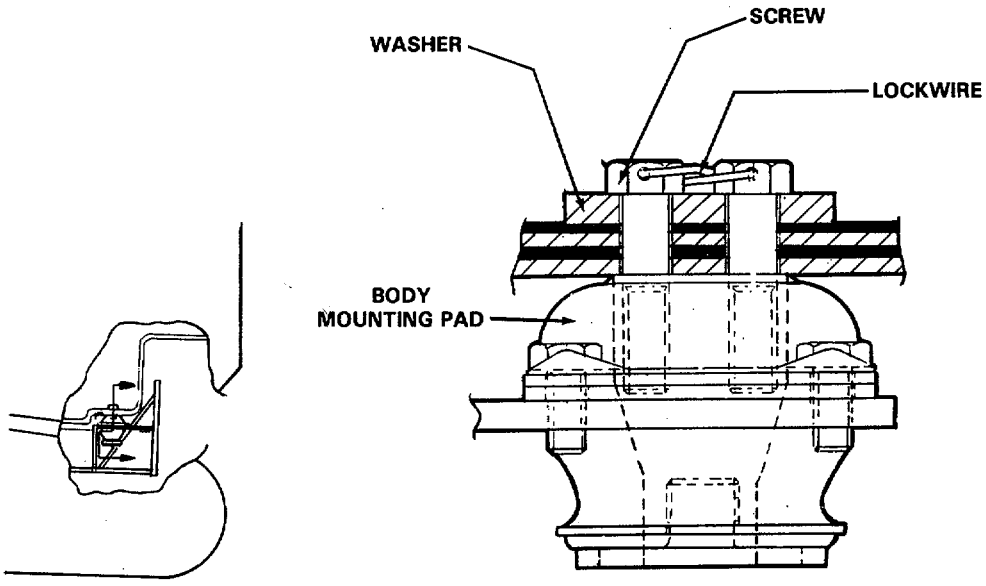


TA259734

Step 13. Disconnect vent hose from differential. Plug differential vent.
Step 14. Remove lockwire, four screws and washers from front body mount under front of car.



Step 15. Remove lockwire, four screws and washers from rear body mount inside rear of car.



Step 16. Lift car body and move body forward to clear transfer.
Step 17. Remove car body and set on support blocks.
Step 18. Remove lifting slings.

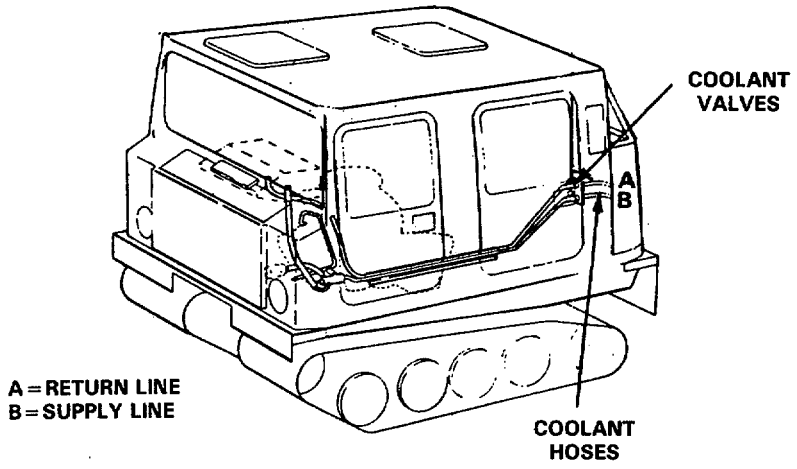
TA259735

b. Replace.

NOTE

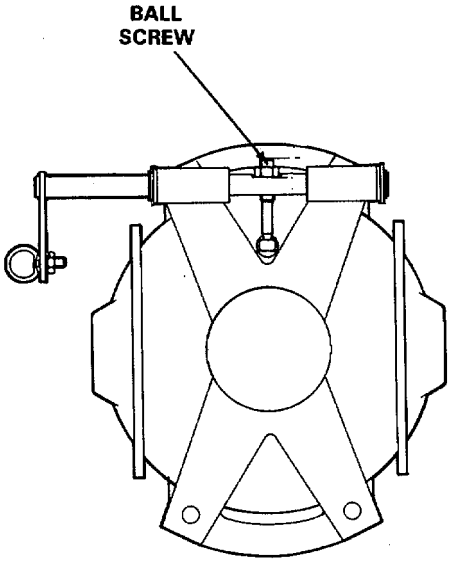
If a new body is being installed, transfer all serviceable components from unserviceable body to the new body.

Step 1. Attach lifting slings to four car lifting eyes.
Step 2. Lift car body into place on the chassis. Remove lifting slings.
Step 3. Put screws and washers into front and rear body mounts.
Step 4. Tighten screws in front body mount.
Step 5. Torque screws to 66 lb. ft. (90 Nm).
Step 6. Put lock wire on screws.
Step 7. Remove plug from differential vent. Connect hose to vent.
Step 8. Tighten screws in rear body mount.
Step 9. Torque screws to 66 lb. ft. (90 Nm).
Step 10. Put lock wire on screws.
Step 11. Remove plugs from coolant hoses. Connect hoses to rear of front car. Remove tags.
Step 12. Open coolant valves on rear of front car.



Step 13. Remove plugs. Connect steering hoses to steering cylinders. Remove tags.
Step 14. Connect electric cable to rear of front car.
Step 15. Adjust ball screw on transfer linkage so it extends 0.71 in. (18 mm) above lock nut. Tighten locknut.

TA259736

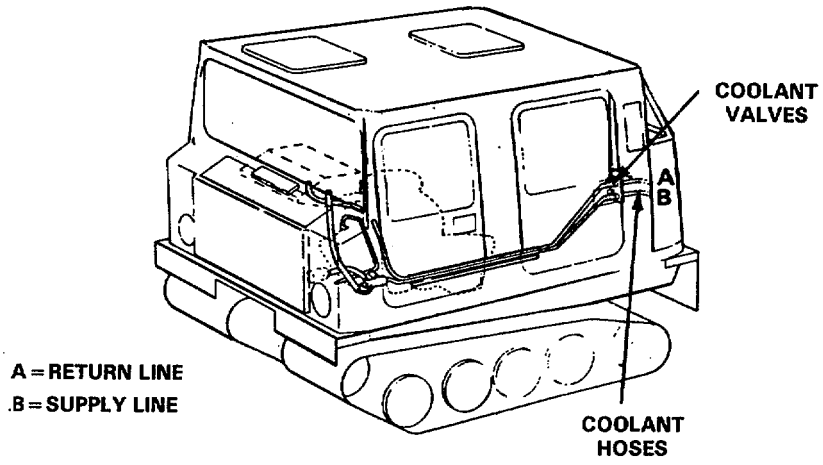


Step 16. Replace brake unit. Refer to TM 9-2350-272- 20.
Step 17. Replace propeller shaft between transmission and transfer. Refer to TM 9-2350-272-20.
Step 18. Connect chassis ground cable to battery.
Step 19. Replace battery cover.
Step 20. Fill and bleed cooling system. Refer to TM 9-2350-272-20.
Step 21. Replace engine hood and cover.

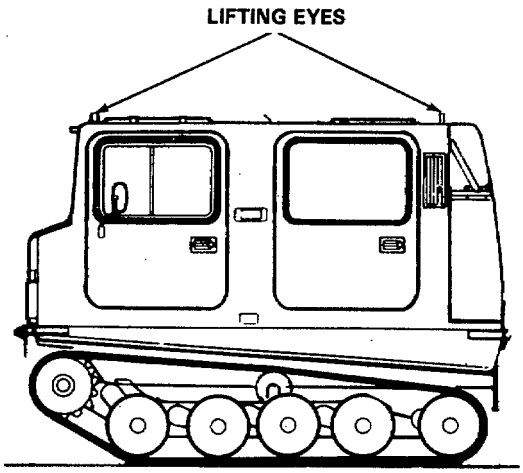
13-4. REAR CAR BODY.

a. Remove.

Step 1. Closed coolant valves at rear of front car.
Step 2. Tag and disconnect coolant hoses at rear of front car. Plug hoses.
Step 3. Secure coolant hoses to rear car body.

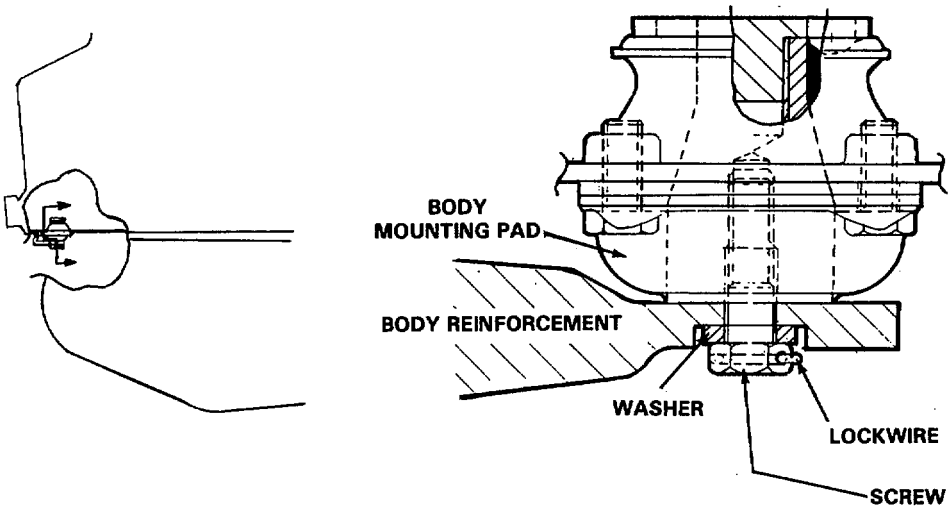


Step 4. Disconnect electric cable at rear of front car. Secure cable to rear car body.
Step 5. Remove equipment box from top front of rear car.
Step 6. Attach lifting slings to body lifting eyes.

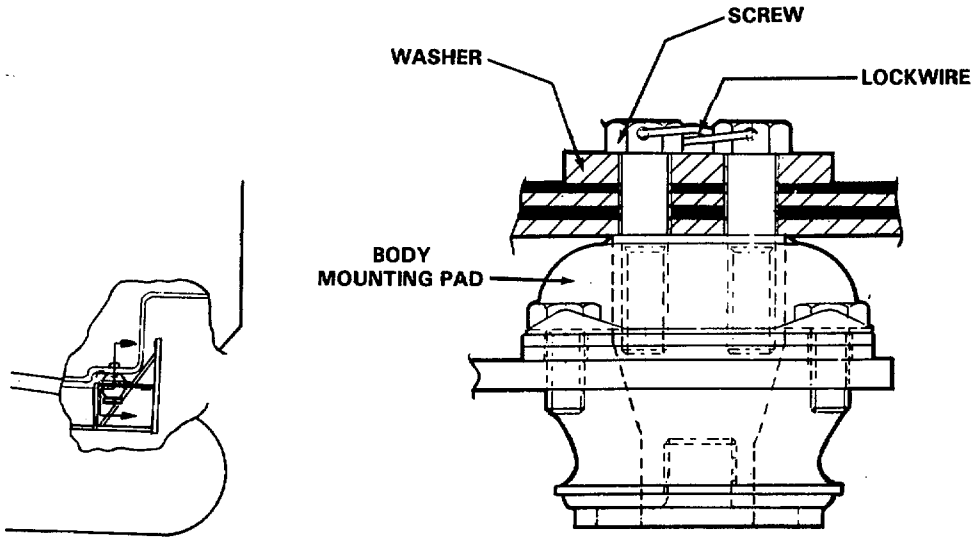


Step 7. Remove vent hose from differential. Plug differential vent.
Step 8. Remove front and rear splash guards.
Step 9. Remove lock wires, four screws and washers from body mount under front of rear car.

TA259738



Step 10. Remove lockwires, four screws and washers from rear body mount inside rear of car.



Step 11. Lift car body off chassis.
Step 12. Place car body on support blocks.

b. Replace.

NOTE

If a new body is being installed, transfer all serviceable components from unserviceable body to the new body.

TA259739

Step 1. Attach lifting sling to body lifting eyes.
Step 2. Lift body and position on chassis. Remove sling.
Step 3. Put screws into front and rear body mounts.
Step 4. Tighten screws in front body mount. Torque screws to 66 lb. ft. (90 Nm).
Step 5. Lockwire front mounting screws.
Step 6. Tighten screws in rear body mount. Torque screws to 66 lb. ft. (90 Nm).
Step 7. Lockwire rear mounting screws.
Step 8. Remove plug from differential vent. Install vent hose.
Step 9. Replace equipment box on top of car.
Step 10. Connect electric cable to front car.
Step 11. Unplug coolant hoses. Connect coolant hoses to rear of front car. Remove tags.
Step 12. Open coolant valve at rear of front car.
Step 13. Fill and bleed cooling system. Refer to TM 9-2350-272-20.
Step 14. Replace splash guards.

Section III. REPAIR CAR BODIES

13-5. TEMPORARY BODY REPAIR.

NOTE

Temporary body repair should be used as a field fix to cover the damaged area until complete repairs can be made.

Step 1. Clean damaged area of all loose material.
Step 2. Tuck in all fibers.
Step 3. Cut a piece of bitumen mat large enough to cover and overlap the damaged area.
Step 4. Use blowtorch. Heat around damaged area until surface coating begins making a crackling sound.
Step 5. Heat bitumen mat until surface turns shiney black.

NOTE

Put heated side of bitumen mat toward damaged area.

Step 6. Put bitumen mat over damaged area.
Step 7. Press around edges of mat until liquid bitumen seeps out.

13-6. TOP LAYER REPAIR.

NOTE

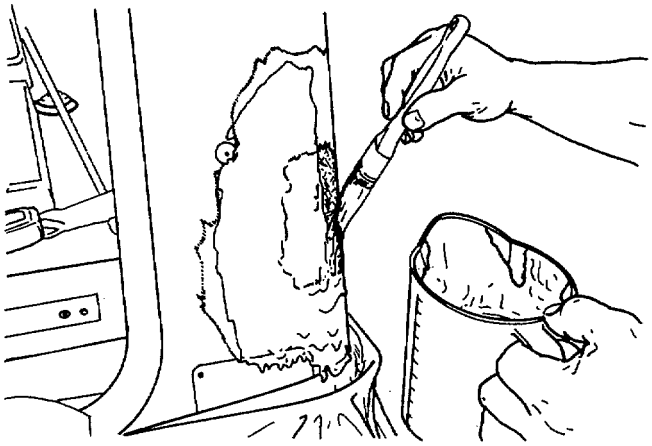
Top layer repair is the repair of the outer glass fiber layer.

Step 1. Scrap off loose particles in damaged area.
Step 2. Clean damaged area.
Step 3. Sand damaged area with coarse sandpaper.
Step 4. Clean dust from damaged area.
Step 5. Mix putty.
Step 6. Fill damaged area with putty.
Step 7. When putty becomes rubbery, trim off excess putty.
Step 8. When putty has completely dried, smooth damage area with sandpaper.

13-7. PENETRATING DAMAGE REPAIR (SINGLE LAYER CONSTRUCTION).

a. Damage Accessible From Both Sides.

Step 1. Clean surface around damage until all loose material has been removed.
Step 2. Camfer edges of damaged area. Camfer edge to a length of ten times the wall thickness. Clean camfered surface.
Step 3. Cut a piece of metal mesh and a sheet of plastic larger than damaged area.
Step 4. Place plastic sheet on metal mesh.
Step 5. Place metal mesh with plastic sheet against back of damaged area.
Step 6. Attach metal mesh with screws. Place screws as near hole as possible.
Step 7. Grind off points of screws sticking through body.
Step 8. Use fiberglass cloth of 0.039 in. (1 mm) thickness. Cut a piece of fiberglass cloth slightly larger than hole in damaged area.
Step 9 Cut several more pieces of fiberglass cloth. Cut each piece a little larger until a piece large enough to cover hole and camfer area is reached.
Step 10. Mix polyester resin and curing agent.
Step 11. Apply polyester mixture to plastic sheet and entire damaged surface.

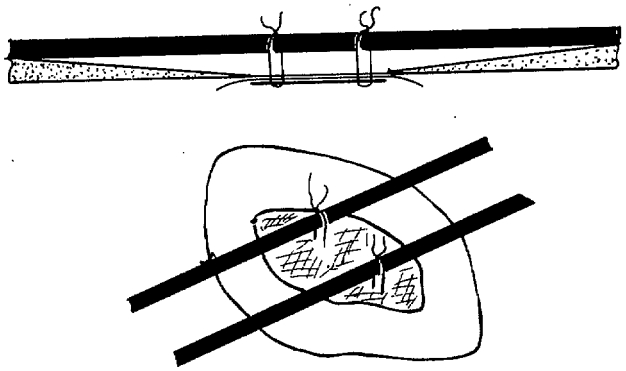


Step 12. Apply polyester mixture to smallest fiberglass piece.
Step 13. Place the piece of fiberglass on the hole.
Step 14. Prod the piece of fiberglass with brush until fibers are wet.
Step 15. Remove air bubbles with metal roller.
Step 16. Repeat steps 1 2 through 1 5 until all pieces of fiberglass cloth are used and until the correct wall thickness has been obtained.
Step 17. Allow patch to cure at room temperature or use heat lamp to speed up curing process.
Step 18. Remove metal mesh.
Step 19. Grind repaired surface until smooth.

TA259741

b. Damage Accessible from Only One Side.

Step 1. Clean surface around damage until all loose material has been removed. Enlarge hole if necessary to clean inner side of damaged area.
Step 2. Camfer edges of damaged area. Camfer edge to a length ten times the wall thickness. Clean camfered surface.
Step 3. Cut a backing plate of metal mesh or sheet aluminum. Plate must be large enough to cover hole yet small enough to be inserted through hole.
Step 4. Drill four small holes in backing plate.
Step 5. Mix polyester resin and curing agent.
Step 6. Cut two pieces of fiberglass cloth to fix backing plate.
Step 7. Apply polyester mixture to two pieces of fiberglass cloth. Put cloth on backing plate.
Step 8. Insert fine wire through holes in backing plate.
Step 9. Put backing plate through hole in body.
Step 10. Secure backing plate against back of hole with the wires and two rods.

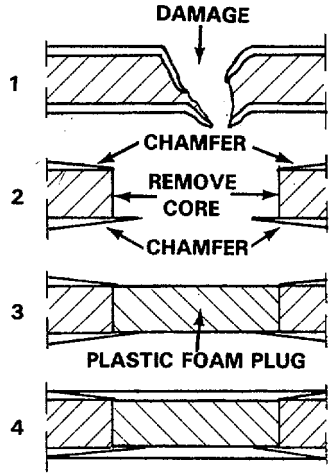


Step 11. Allow polyester to dry.
Step 12. Remove rods and wire.
Step 13. Cut several pieces of fiberglass cloth. Cut each piece a little larger until a piece large enough to cover hole and camfer area is reached.
Step 14. Apply polyester mixture to smallest fiberglass piece.
Step 15. Put fiberglass piece on hole.
Step 16. Prod the piece of fiberglass with brush until fibers are wet.
Step 17. Remove air bubbles with metal roller.
Step 18. Repeat steps 1 4 through 1 7 until all pieces of fiberglass cloth are used and until the correct wall thickness has been obtained.
Step 19. Allow patch to cure at room temperature or use heat lamp to speed up curing process.
Step 20. Grind repair surface until smooth.

13-8. SANDWICH LAYER CONSTRUCTION REPAIR.

a. Penetrating Damage.

Step 1. Clean damaged area of all loose material.
Step 2. Camfer edges of damaged area so that one panel extends out to support the foam block.
Step 3. Cut a block of plastic foam to fit damaged area. Install plastic foam block.
Step 4. Fiberglass front and rear of damaged area. Refer to paragraph 1 3-7.



b. Non-Penetrating Damage.

Step 1. Clean damaged area of all loose material.
Step 2. Cut away damaged plastic foam. Remove foam completely through to undamaged panel.
Step 3. Cut a block of plastic foam to fit damaged area.
Step 4. Refer to paragraph 1 3-7 for installing fiberglass cloth.

13-9. BODY CORNER DAMAGE REPAIR.

a. Prepare Mold.

Step 1. Locate a undamaged section of the carrier identical to the damaged area.
Step 2. Clean, wax and polish undamaged section.
Step 3. Cut a piece of fiberglass cloth large enough to overlap the damaged area.
Step 4. Prepare mixture of polyester resin and curing agent.
Step 5. Apply polyester mixture to waxed surface.
Step 6. Place fiberglass cloth on waxed surface.
Step 7. Prod fiberglass cloth with brush until cloth is saturated and clings to waxed surface.
Step 8. Roll out air bubbles with metal roller.
Step 9. Allow polyester to cure at room temperature.
Step 10. Remove cured mold and trim edges.

b. Repair Corner Damage.

Step 1. Place mold on damaged area as the backing plate.
Step 2. Refer to paragraph 1 3-7. Repair damaged area.

CHAPTER 14
REPAIR OF WINCH

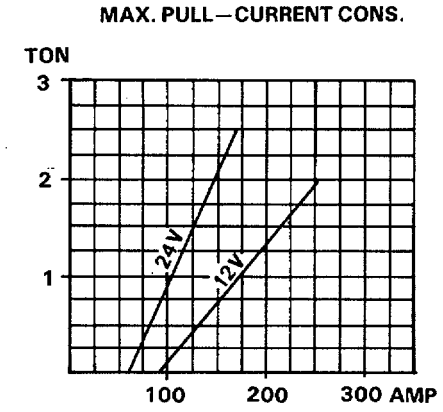
Section I. DESCRIPTION AND DATA

14-1. DESCRIPTION.

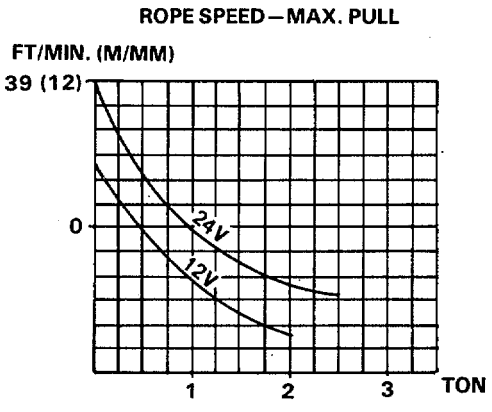
The winch consists of planetary gears and a cable drum driven by an electric motor. The planetary gears reduce the motor speed to a speed suitable for winching. The electric motor and one set of planetary gears are located on one end of the cable drum. Three sets of planetary gears are on the other end of the drum. A through shaft connects the planetary gear. The planetary gears are connected to the cable drum by a drum shaft. The electric motor is controlled by four relays operated by the remote control switch. The motor is protected from over heating by a thermoswitch. There is a overload switch located in the first set of planetary gears. If a overload occurs the electric motor will shut off. Located on the through shaft is a brake unit. The brake unit prevents the drum from turning under load when the remote control is switched to the off position.

14-2. TECHNICAL DATA

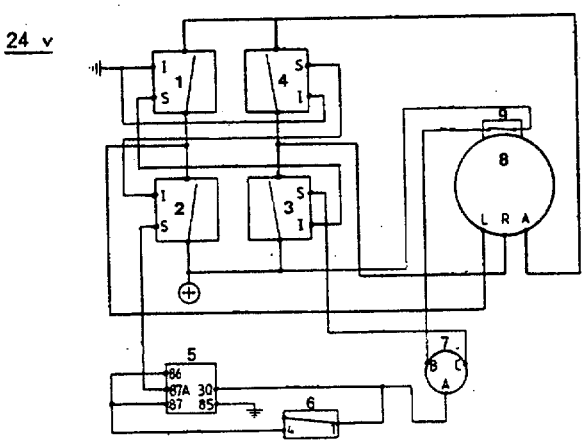
Voltage	24V
Maximum pull	
Full drum	2.5 ton
Bare drum (one or less cable winding)	1. 7 ton
Rope speed	See diagram
Current consumption	See diagram
Suitable rope: 1 71 strand, with steel-core, tensile	0.31 in. (8 mm) dia.
strength 1 60-1 80 kp/mm2	98.4 ft. (30 m) length
Drum diameter	3.5 in. (90 mm)
Gear ratio	1 61 :1
Weight	90 lbs (39 kg)



TA260638



TA259745



1. RELAY 1
2. RELAY 2
3. RELAY 3
4. RELAY 4
5. PROTECTIVE RELAY
6. MICROSWITCH
7. CHASSIS SOCKET
8. ELECTRIC MOTOR
9. MOTOR THERMOSWITCH

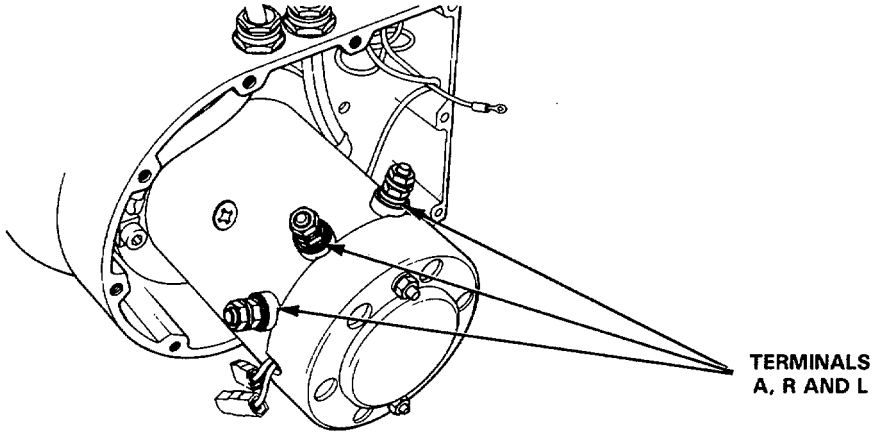
TA259746

Section II. REPAIR OF WINCH

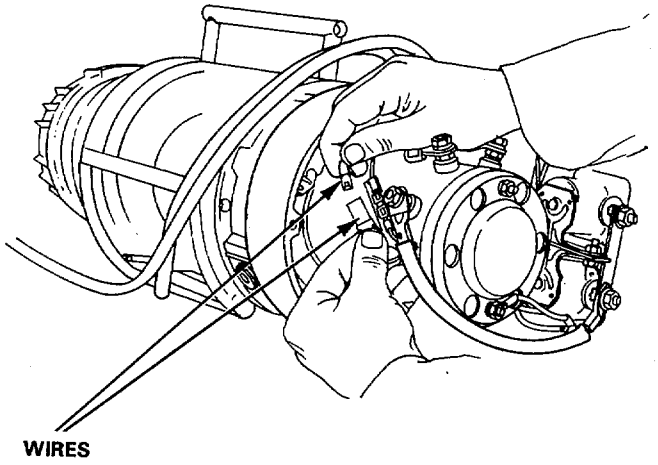
14-3. RELAY ASSEMBLY.

a. Remove Relay Assembly.

Step 1. Remove winch motor cover.
Step 2. Tag and remove three electric wires from terminals A, R and L of electric motor.



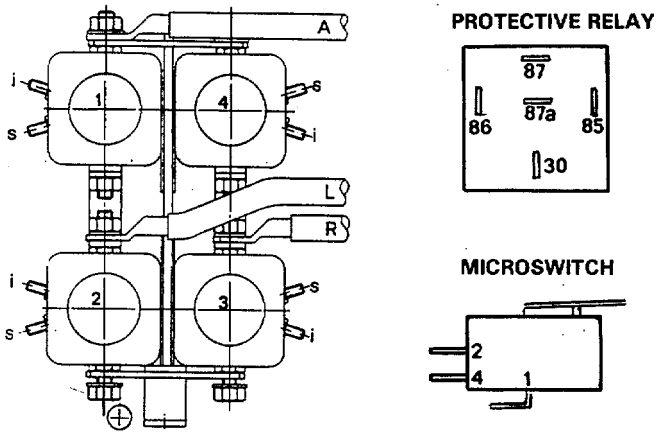
Step 3. Tag and disconnect two wires from motor thermoswitch.



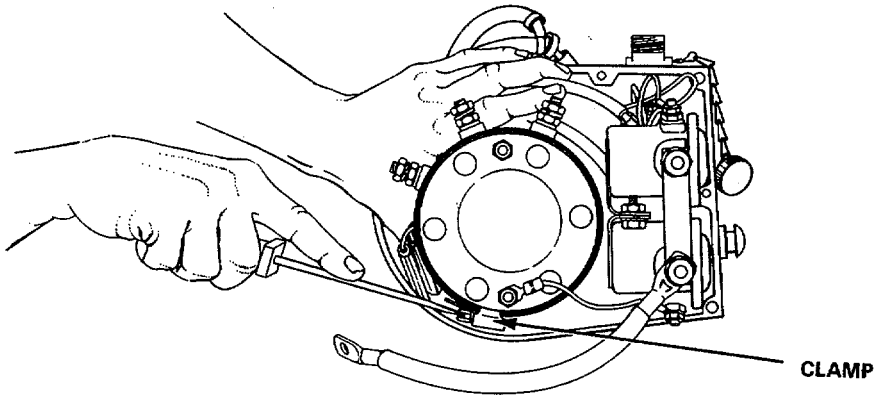
TA259747

Step 4. Tag and disconnect wire from terminals of relay 3.
Step 5. Tag and disconnect the wire from terminal S on relay 2.
Step 6. Tag and disconnect wire from terminal i on relay 1.

RELAY SET

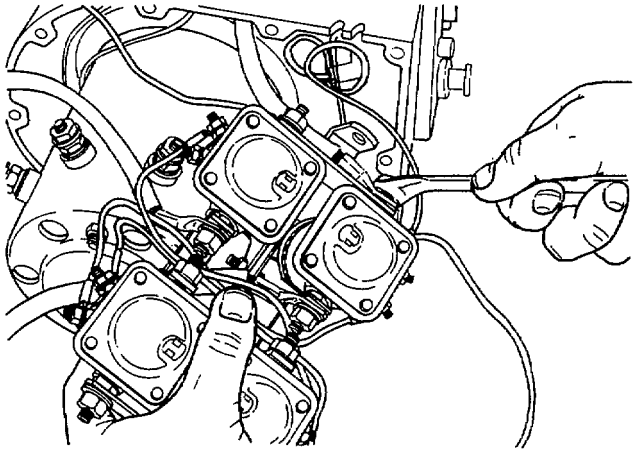


Step 7. Loosen clamp. Pull out relay assembly.



TA259748

Step 8. Tag and disconnect electrical wire from positive terminal of relay 2.



Step 9. Remove relay assembly.

b. Test Relay Assembly.

Step 1. Connect 24 VDC power source to relay assembly. Positive lead to positive terminal on relay 2. Negative lead to terminal i on relay 1.
Step 2. Connect jumper wire between positive terminal of relay 2 and terminal S of relay 2.
Step 3. Relays 2 and 4 should now be closed. Check designation with ohmmeter. If either relay is not closed test wires between relays.
Step 4. If wires test good then relay is defective.
Step 5. Disconnect jumper wire from terminal S of relay 2.
Step 6. Connect jumper wire to terminal S on relay 3.
Step 7. Relay 1 and 3 should now be closed. Check with ohmrneter. If either relay is not closed, test wires between relay.
Step 8. If wires test good, then relay is defective.
Step 9. Remove power sources.
Step 10. Remove jumper wire.

TA259749

c. Test Protective Relay and Microswitch.

Step 1. Remove protective relay and microswitch relay cover from winch.
Step 2. Tag and disconnect wire between terminal A of socket and terminal 30 of protective relay.
Step 3. Connect 24 VDC power source. Positive lead to terminal 30 of protective relay. Negative to ground.
Step 4. Test for voltage at terminal 87A of protective relay. If no voltage is present relay is defective.
Step 5. Press and release push button on microswitch.
Step 6. Check for voltage at terminal 87A press and hold button on microswitch.
Step 7. If voltage is present at terminal 87A press and hold button on microswitch.
Step 8. Test for voltage at terminal 4 of microswitch. If voltage is present either protective relay or wire between terminal 86 and terminal 87 is defective. If voltage is not present microswitch is defective.
Step 9. Release button on microswitch.
Step 10. Remove power source.
Step 11. Replace defective parts or wires.
Step 12. Connect wire between socket terminal A and terminal 30 of protective relay.
Step 13. Put on protective relay and microswitch cover.

d. Replace Relay Assembly.

Step 1. Connect positive wire to positive terminal of relay 2
Step 2. Mount relay assembly in position. Tighten clamp.
Step 3. Connect wire to terminal S on relay 2.
Step 4. Connect wire to terminal S on relay 3.
Step 5. Connect wire to terminal i on relay 1.
Step 6. Connect two wires to motor thermoswitch.
Step 7. Connect three wires to terminals A, R and L of electric motor.
Step 8. Replace winch motor cover.

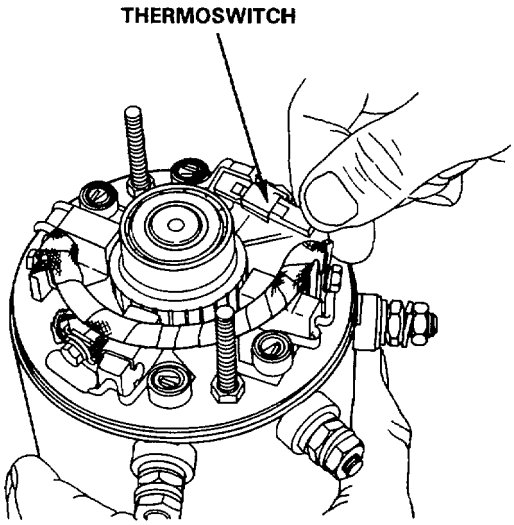
14-4. WINCH ELECTRIC MOTOR REPAIR.

a. Remove Motor.

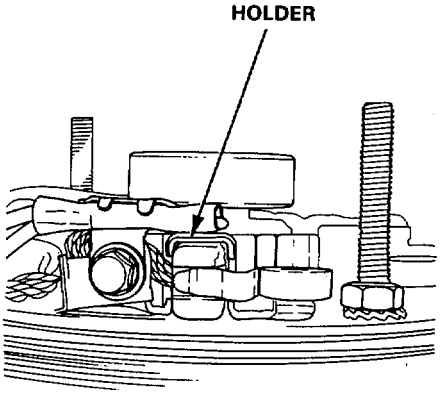
Step 1. Remove relay assembly. Refer to paragraph 14-3.
Step 2. Mark position of motor on gear housing.
Step 3. Remove motor from gear housing.
Step 4. Remove two nuts. Remove motor end cover.

b. Thermoswitch Replacement.

Step 1. Pull switch straight out of holder.



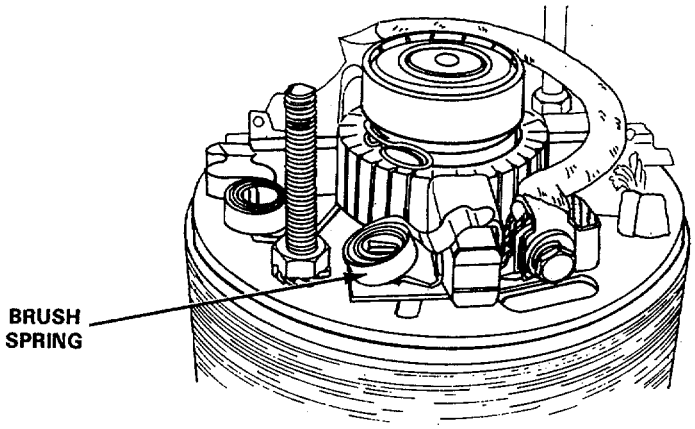
Step 2. Press new switch into holder. Position switch next to brush holder.



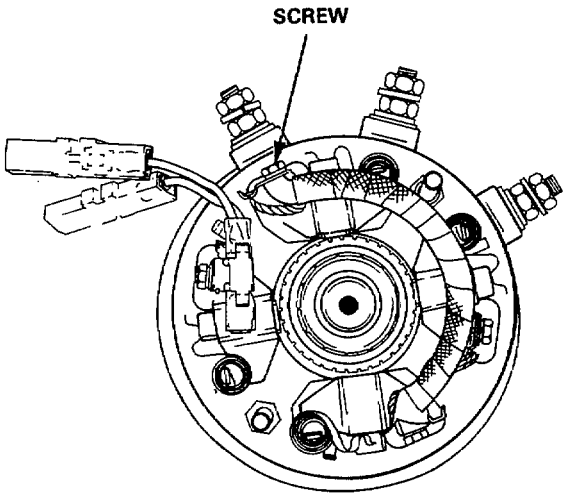
TA259751

c. Brush Replacement.

Step 1. Lift brush springs off brushes. Hook springs on side of holder.

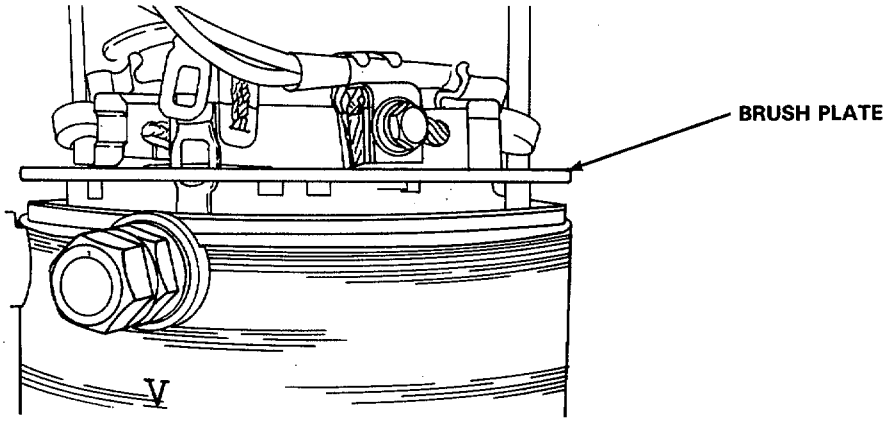


Step 2. Remove screw from connector A.



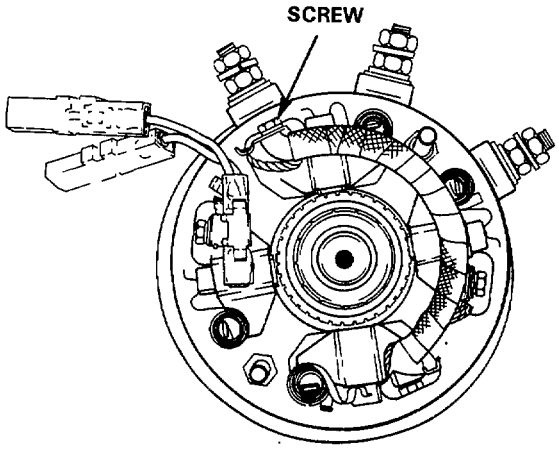
Step 3. Remove two nuts and washers from brush plate. Remove plate.
Step 4. Loosen nuts for connector cables.
Step 5. Remove brushes.
Step 6. Clean brush plate.
Step 7. Clean commutator.
Step 8. Put new brushes in place. Tighten connector cable nuts.
Step 9. Put brush plate in place on housing.
Step 10. Put on tow plate mounting nuts. Tighten nuts.
Step 11. Put springs on brushes. Insure brushes are touching commutator.
Step 12. Put screw in connection A. Tighten screw.
Step 13. Insure thermoswitch is in contact with brush holder.
Step 14. Replace motor end cover.

TA259752

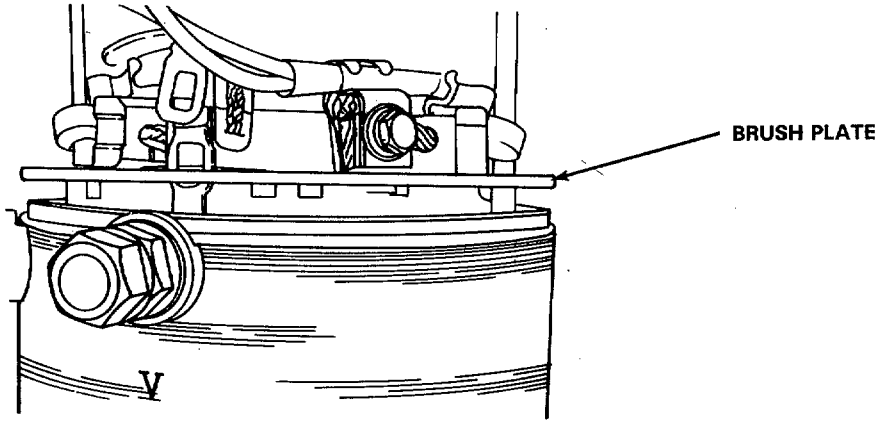


d. Bearing Replacement.

Step 1. Remove motor end cover.
Step 2. Remove screw from connector A.

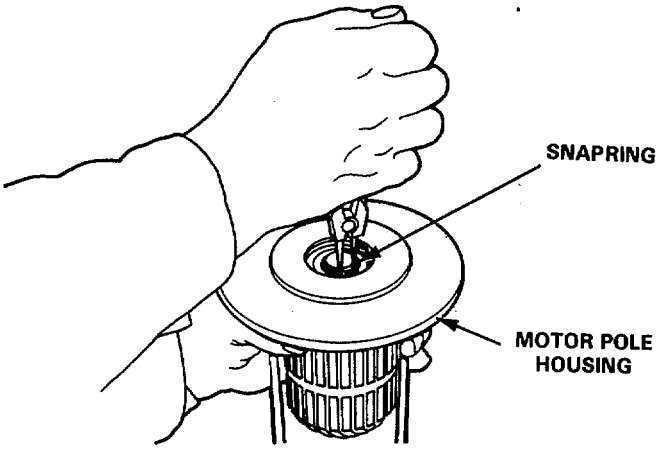


Step 3. Remove two nuts from brush plate. Remove plate.

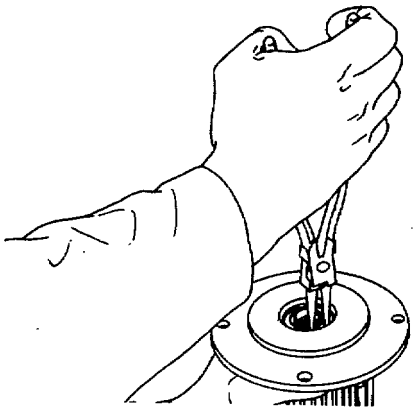


TA259753

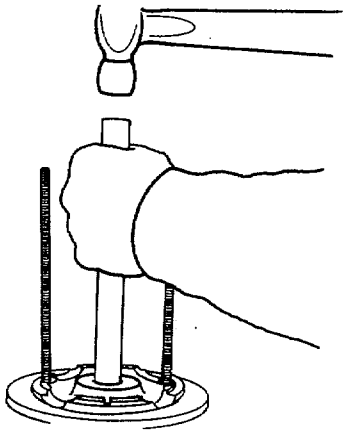
Step 4. Remove motor pole housing.
Step 5. Remove snap ring.
Step 6. Drive motor shaft out of bearing.



Step 7. Remove bearing snap ring.



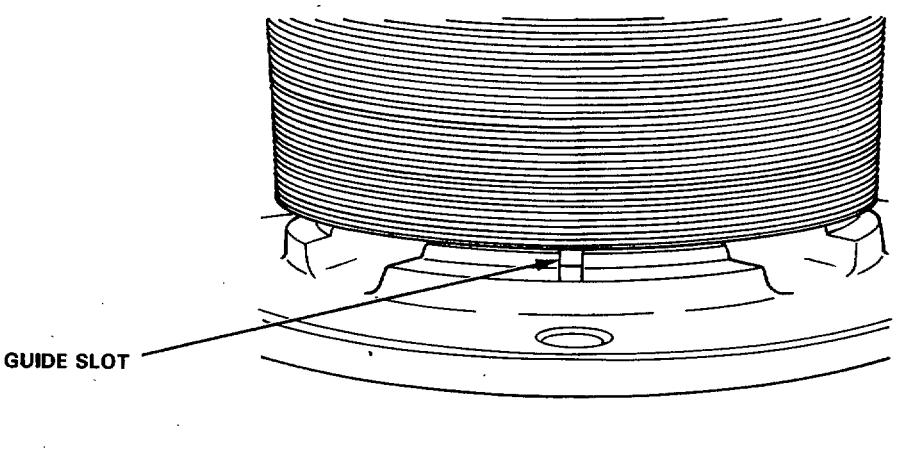
Step 8. Drive bearing out of mounting plate.



TA259754

Step 9. Pull bearing off rotor.

Step 10. Check rotor for damage. Replace damaged rotor.
Step 11. Check pole housing windings for damage. Replace damaged pole housing.
Step 12. Drive new bearing on rotor.
Step 13. Drive new bearing into mounting plate.
Step 14. Put on bearing snap ring.
Step 15. Mount rotor in mounting plate.
Step 16. Put on snap ring.
Step 17. Put pole housing over rotor. Note guide slot.



Step 18. Put brush plate in position.
Step 19. Put on two washers and nuts. Tighten nuts.
Step 20. Put screw in connection A. Tighten screw.
Step 21. Replace motor end cover.

TA259755

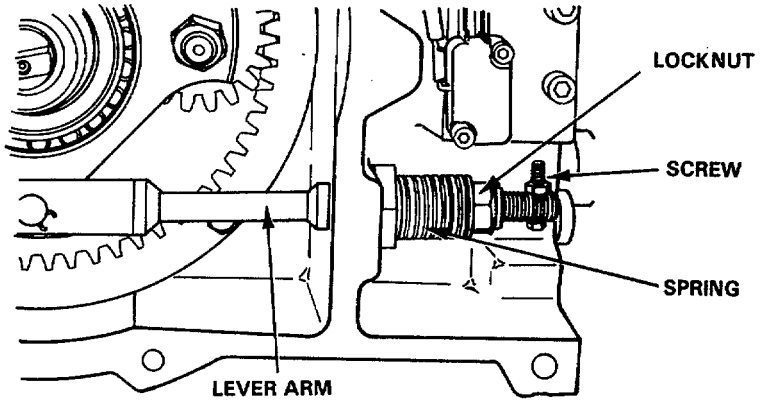
e. Replace Motor.

Step 1. Align motor with mark on gear housing. Put motor in place.
Step 2. Put in mounting screws. Tighten screws.
Step 3. Replace relay assembly. Refer to paragraph 15-3.

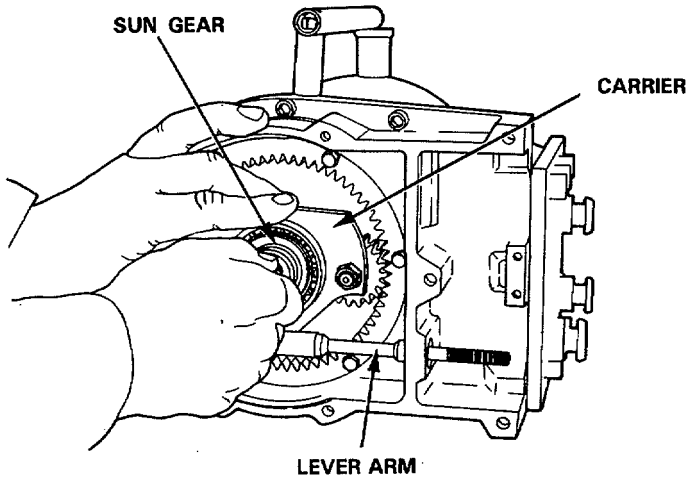
14-5. PLANETARY GEAR WITH LOAD LIMITING DEVICE.

a. Remove.

Step 1. Remove relay assembly. Refer to paragraph 14-3.
Step 2. Remove electric motor. Refer to paragraph 14-4.
Step 3. Drain oil. Refer to LO 9-2350-272-12.
Step 4. Remove winch back cover.
Step 5. Remove gear housing cover.
Step 6. Remove screw on lever arm.
Step 7. Remove locknut.
Step 8. Remove spring washers and performed packing.
Step 9. Remove nut, washer and lever arm.

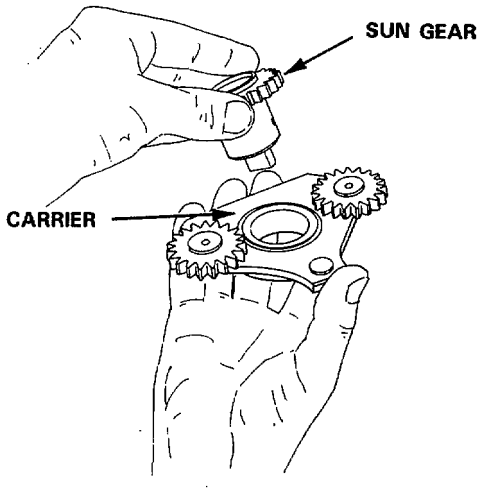


Step 10. Remove bearing from housing.
Step 11. Remove sun gear and carrier.

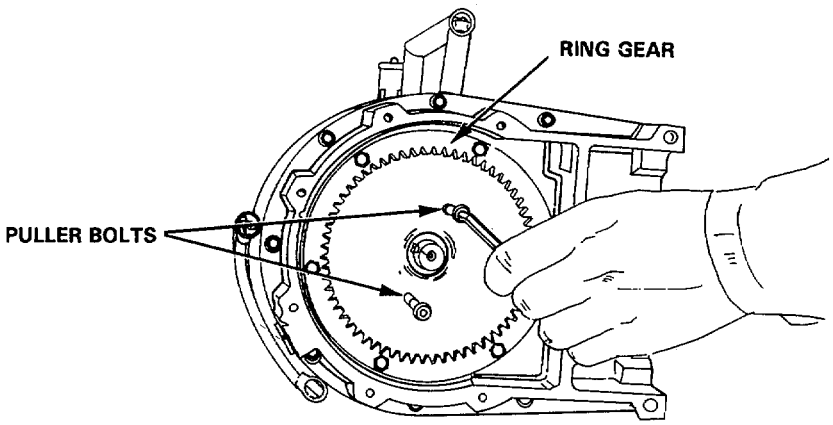


TA259756

Step 12. Remove sun gear from carrier.

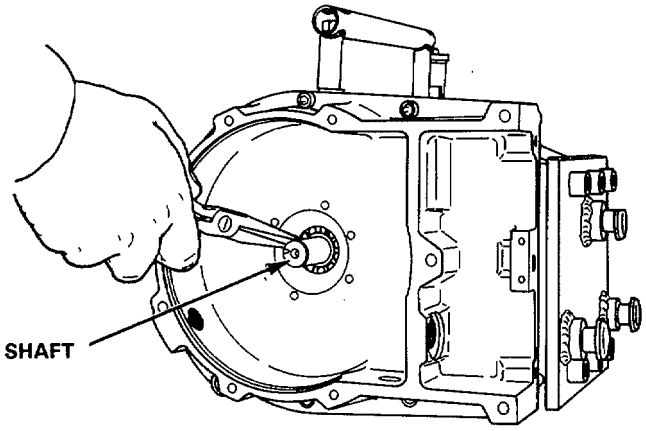


Step 13. Remove needle bearing.
Step 14. Remove planetary gears from carrier.
Step 15. Pull bearing from carrier.
Step 16. Remove brass washer from center shaft.
Step 17. Use two puller bolts. Pull off ring gear assembly.

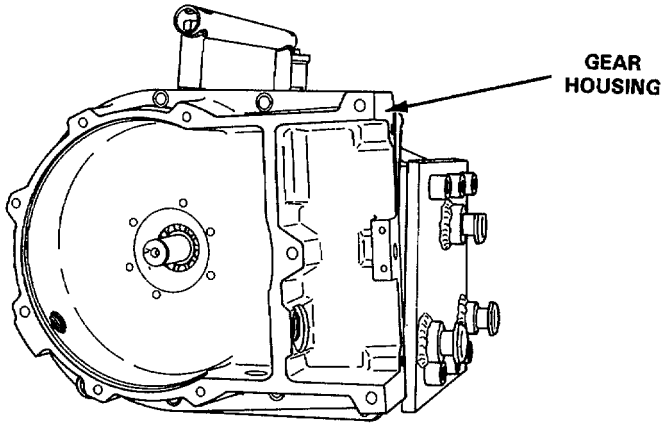


TA259757

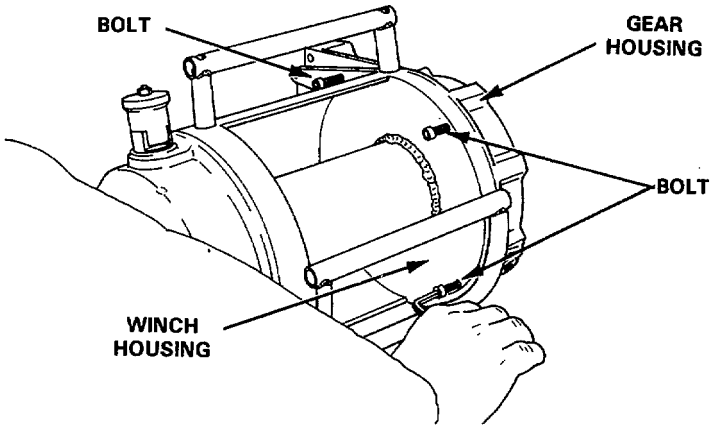
Step 18. Remove key from shaft.



Step 19. Loosen and remove gear housing screws. Turn gear housing 10° counter-clockwise.

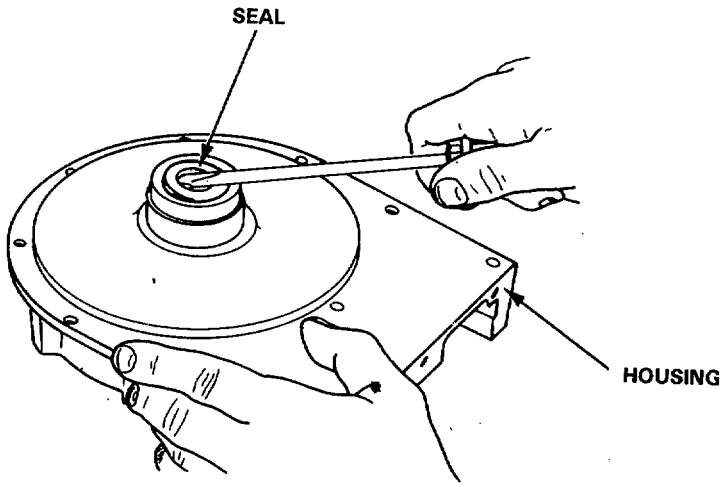


Step 20. Hold winch drum in-place.
Step 21. Put three bolts in winch housing. Screw in bolts.
Step 22. Remove gear housing.

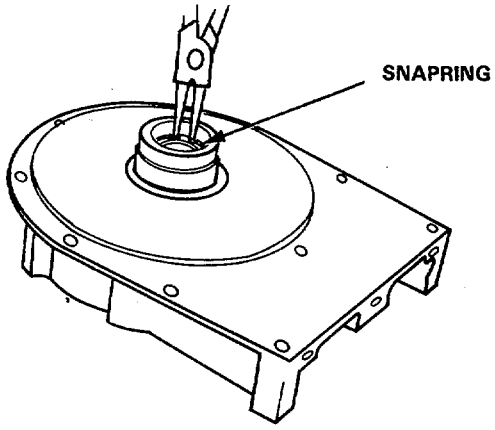


TA259758

Step 23. Remove seal from gear housing.



Step 24. Remove snap ring.
Step 25. Remove bearing.



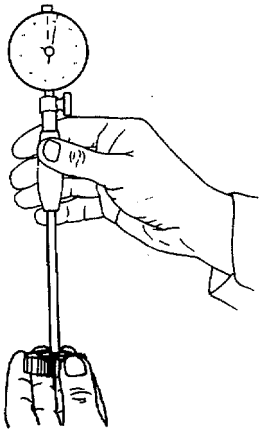
TA259759

b. Clean, Inspect and Repair.

WARNING

Cleaning solvent, federal specification P-D-680 Type II, is flammable and gives off harmful vapors. Use solvent only in a well ventilated area. Avoid prolonged breathing of solvent vapors. Keep solvent away from flame. Do not use solvent in excessive amounts.

Step 1. Clean all metal parts with solvent. Dry components. Refer to appendix B, item 48.
Step 2. Inspect housing for cracks or other damage. Replace cracked or damaged housing.
Step 3. Inspect gears for chipped or broken teeth. Replace defective gears.
Step 4. Inspect bearing for damage. Replace damaged bearings.
Step 5. Measure bores in planetary gears. Bore must not be larger than 0.473 in. (12.018 mm). Replace worn gears.

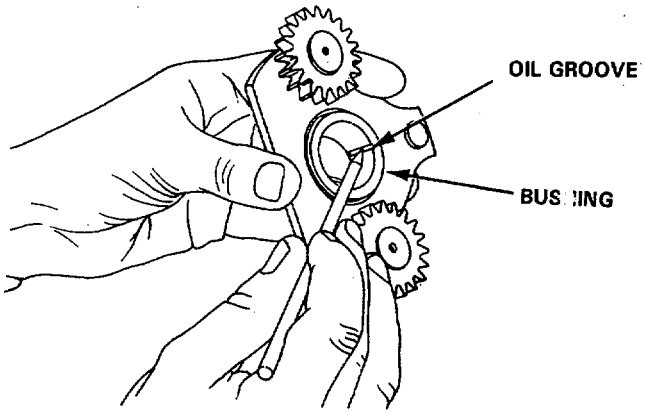


Step 6. Measure carrier bushing. Measurement must not be larger than 1. 183 in. (30.041 mm).

NOTE

Oil groove must be properly aligned.

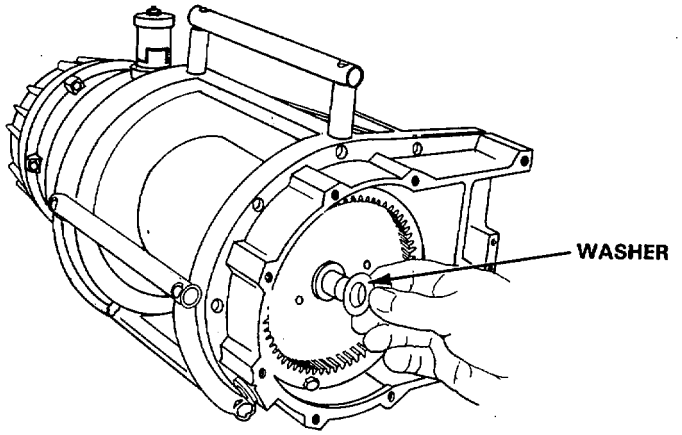
Step 7. Replace worn carrier bushing.



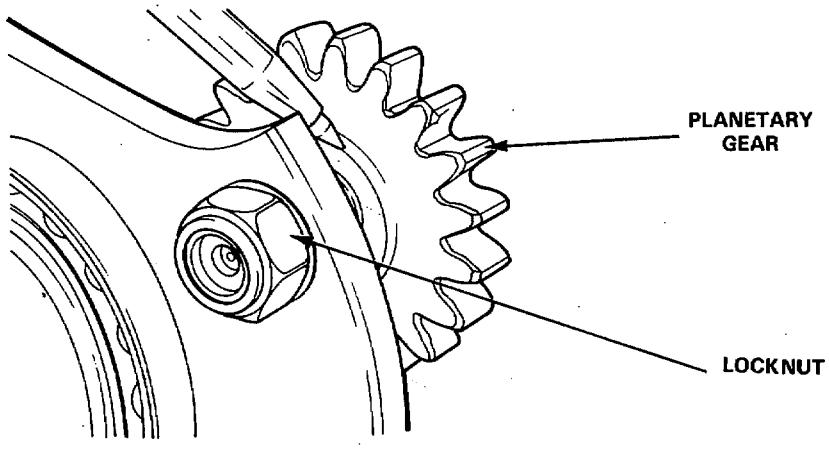
TA259760

c. Replace.

Step 1. Press bearing into gear housing.
Step 2. Put in snap ring.
Step 3. Press in new seal.
Step 4. Lubricate center shaft with oil. Refer to appendix B, item 36.
Step 5. Put new gasket on gear housing.
Step 6. Press gear housing on winch housing.
Step 7. Put key in shaft.
Step 8. Press in ring gear assembly.
Step 9. Put brass washer on center shaft.



Step 10. Press bearing into carrier.
Step 11. Install planetary gears on carrier. Use new locknuts.



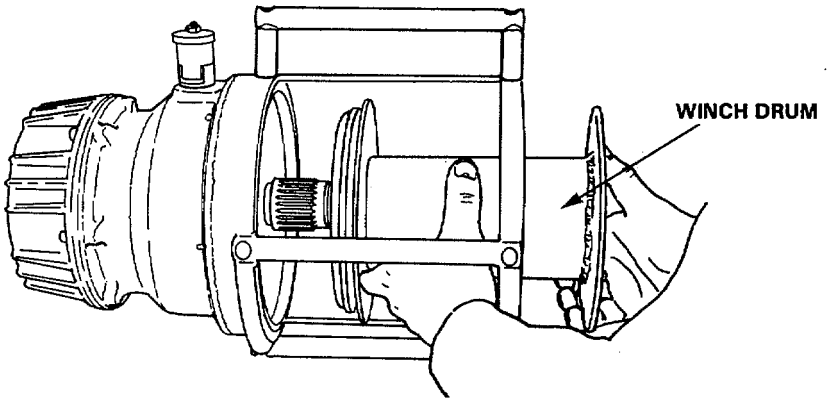
TA259761

Step 12. Press in needle bearing.
Step 13. Lubricate carrier. Install sun gear. Refer to appendix B, item 36.
Step 14. Put carrier on center shaft.
Step 15. Put lever arm on carrier.
Step 16. Put new copper washer on lever arm bushing.
Step 17. Install bushing into gear housing.
Step 18. Put on new packing.
Step 19. Put new washers and springs on lever arm.
Step 20. Put locknut on lever arm. Tighten locknut until it touches springs then tighten three complete turns.
Step 21. Put screw in lever arm. Put on and tighten nut.
Step 22. Put protective relay in place. Put ground wire in place. Put in and tighten screw.
Step 23. Put gear housing in place. Put in and tighten screws.
Step 24. Put protective relay cover and electrical connector in place. Put in and tighten screws.
Step 25. Replace electric motor. Refer to paragraph 14-4.
Step 26. Replace relay assembly. Refer to paragraph 14-3.
Step 27. Fill winch with oil. Refer to LO 9-2350- 272-12.
Step 28. Adjust load limiting device. Refer to paragraph 14-10.

14-6. WINCH DRUM.

a. Remove.

Step 1. Remove winch cable. Refer to TM 9-2350-272- 20.
Step 2. Remove relay assembly. Refer to paragraph 14-3.
Step 3. Remove electric motor. Refer to paragraph 14-4.
Step 4. Remove planetary gear with load limiter. Refer to paragraph 14-5.
Step 5. Pull winch drum straight out of winch housing.



Step 6. Remove large V-ring.
Step 7. Remove two end bearings.
Step 8. Remove seal from winch housing.

TA259762

b. Clean and Inspect.

WARNING

Cleaning solvent, federal specification P-D-680 Type II, is flammable and gives off harmful vapors. Use solvent only in a well ventilated area. Avoid prolonged breathing of solvent vapors. Keep solvent away from flame. Do not use solvent in excessive amounts.

Step 1. Clean bearings and winch drum with solvent. Dry bearing and winch drum. Refer to appendix B, item 48. .
Step 2. Inspect bearings for damage. Replace defective bearing.
Step 3. Inspect winch drum for cracks and other damage. Replace damaged winch drum.

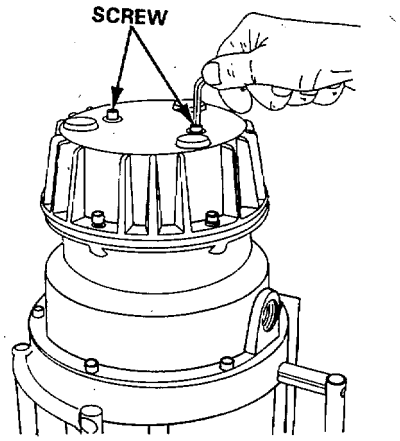
c. Replace.

Step 1. Pack large unsealed bearing with grease. Refer to appendix B, item 8.
Step 2. Press bearings into winch drum.
Step 3. Put new seal in winch housing.
Step 4. Put new V-ring on winch drum.
Step 5. Push winch straight into winch housing.
Step 6. Replace planetary gear with load limiting device. Refer to paragraph 14-5.
Step 7. Replace electric motor. Refer to paragraph 14-4.
Step 8. Replace relay assembly. Refer to paragraph 14-3.

14-7. WINCH BRAKE.

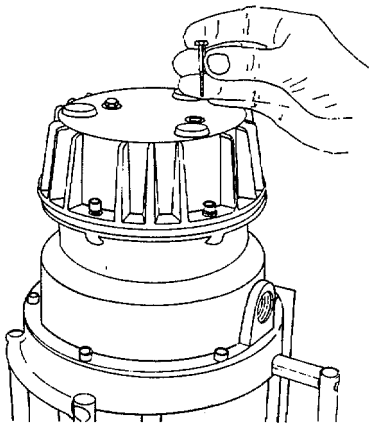
a. Remove.

Step 1. Position winch assembly with brake housing up.
Step 2. Remove two screws from end of brake housing.

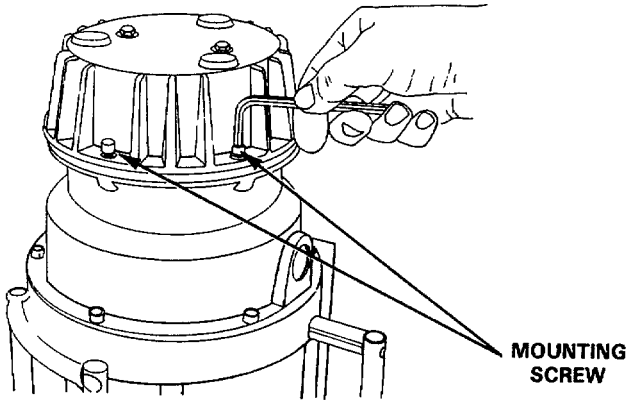


TA259763

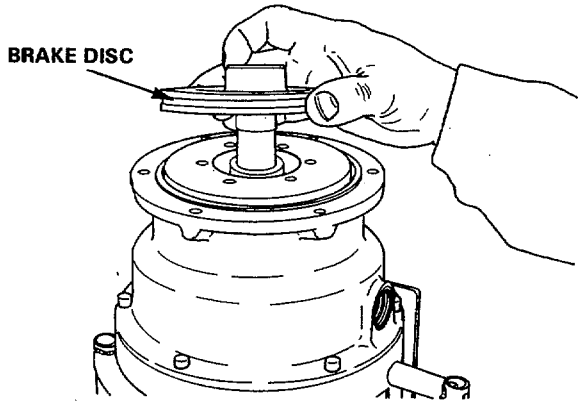
Step 3. Put two M5 x 35 screws into end of brake housing. Tighten finger tight.
Step 4. Tighten each screw three turns with wrench.



Step 5. Remove brake housing mounting screw. Remove housing.

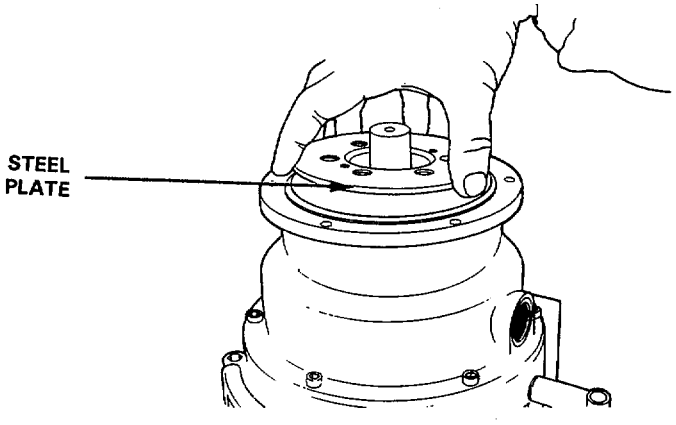


Step 6. Remove brake disc assembly.



TA259764

Step 7. Press clutch out of brake disc assembly.
Step 8. Remove two M5 x 35 screws from brake housing. Remove steel plate.
Step 9. Remove springs.
Step 10. Remove steel plate from planetary gear housing.

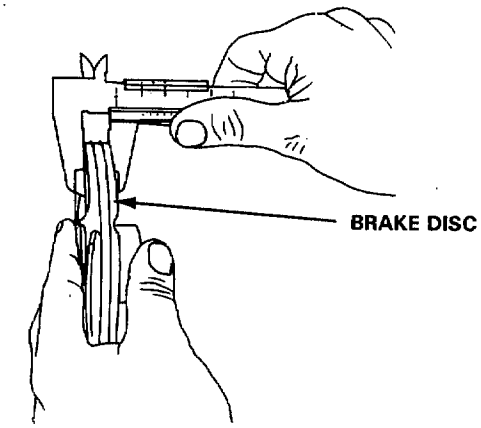


b. Clean, Inspect and Repair.

WARNING

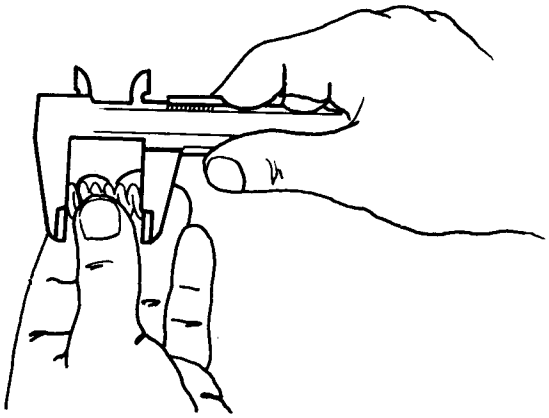
Cleaning solvent, federal specification P-D-680 Type II, is flammable and gives off harmful vapors. Use solvent only in a well ventilated area. Avoid prolonged breathing of solvent vapors. Keep solvent away from flame. Do not use solvent in excessive amounts.

Step 1. Clean all parts with solvent. Dry parts. Refer to appendix B, item 48.
Step 2. Inspect all parts for cracks and other damage. Replace damaged parts.
Step 3. Measure thickness of brake disc. Thickness must be 0.472 to 0.504 in. (12 to 12.8 mm). If correct measurement is not obtained, replace brake disc.



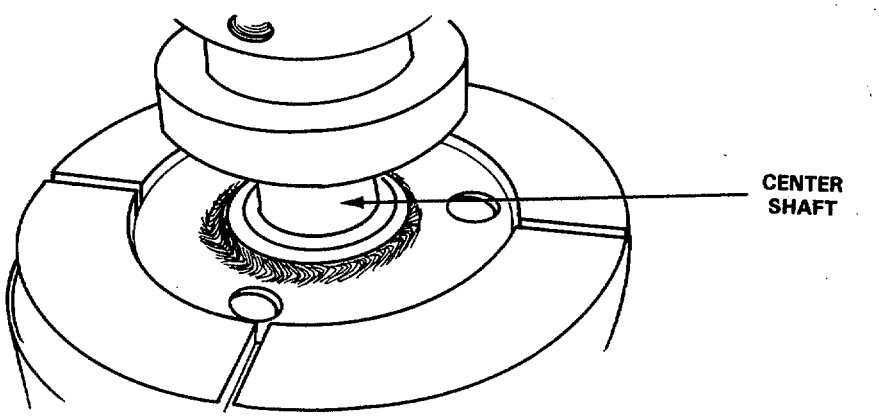
TA259765

Step 4. Measure length of springs. Correct length is 1 .17 to 1 .18 in. (29.8 to 30.2 mm). If correct measurement is not obtained replace springs.



c. Replace.

Step 1. Put steel plate in planetary gear housing. Beveled side must be up.
Step 2. Lubricate center shaft with oil. Refer to appendix B, item 36.
Step 3. Press new clutch into brake disc assembly. Side of clutch with writing must face up,
Step 4. Press brake disc assembly on center shaft.



Step 5. Put spring in position in brake housing.
Step 6. Put steel plate on springs. Beveled side must face toward brake disc assembly.
Step 7. Press on steel plate to compress springs.
Step 8. Put in two M5 x 35 screws. Tighten screws until spring pins are guided into housing.
Step 9. Put new gasket on brake housing.
Step 10. Put brake housing on winch.
Step 11. Put in housing mounting screws. Tighten screws.
Step 12. Remove M5 x 35 screws.
Step 13. Put in two housing screws with new copper washers. Tighten screws.

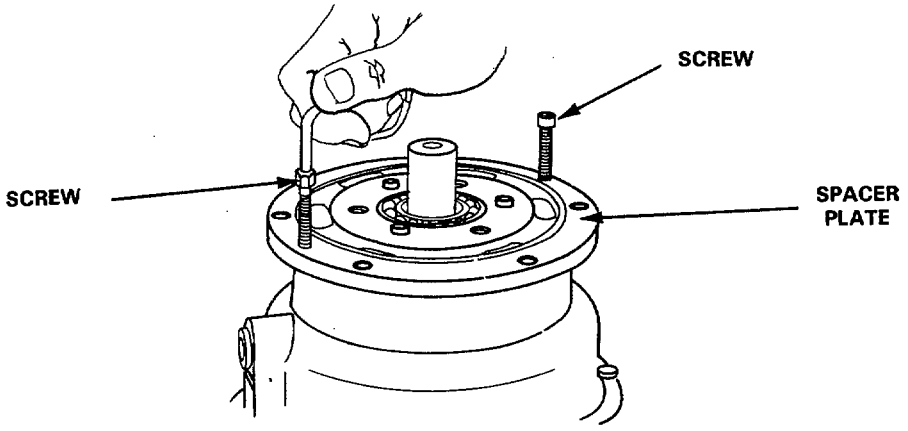
14-8. PLANETARY GEARS

a. Remove.

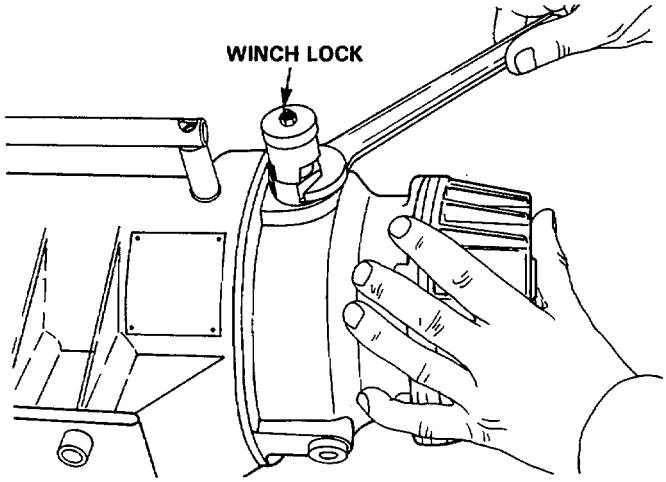
Step 1. Remove relay assembly. Refer to paragraph 14-3.
Step 2. Remove electric motor. Refer to paragraph 14-4.

TA259766

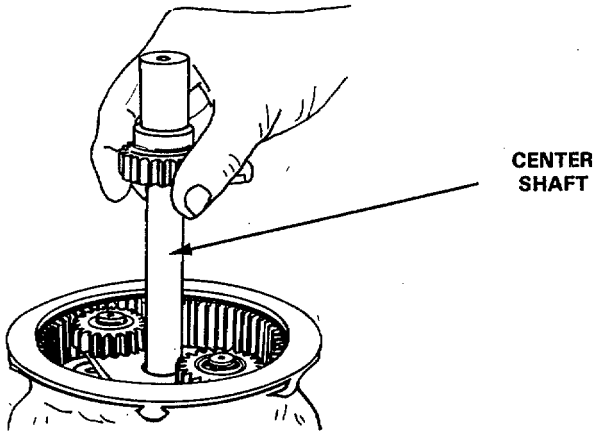
Step 3. Remove planetary gear with load limiter. Refer to paragraph 14-5.
Step 4. Remove winch drum. Refer to paragraph 14-6.
Step 5. Remove winch brake. Refer to paragraph 14- 7.
Step 6. Use two screws as pullers. Remove spacer plate. Remove bearing from plate.



Step 7. Unscrew and remove winch lock.

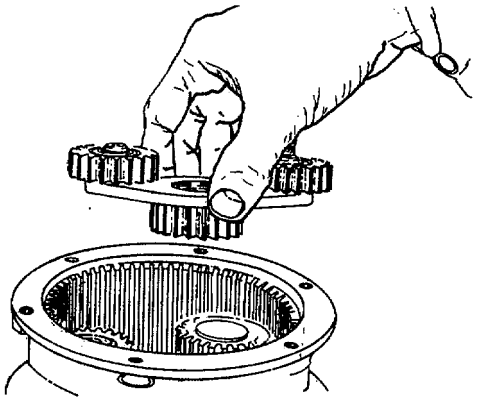


Step 8. Pull out center shaft.

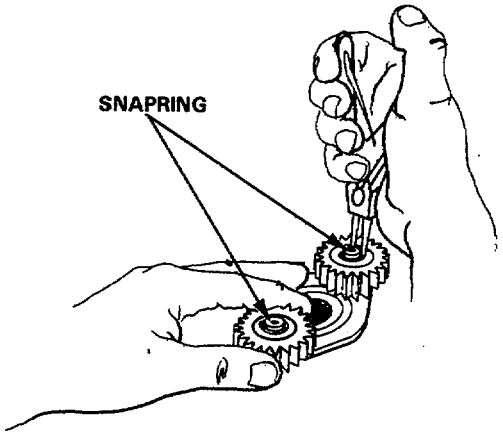


TA259767

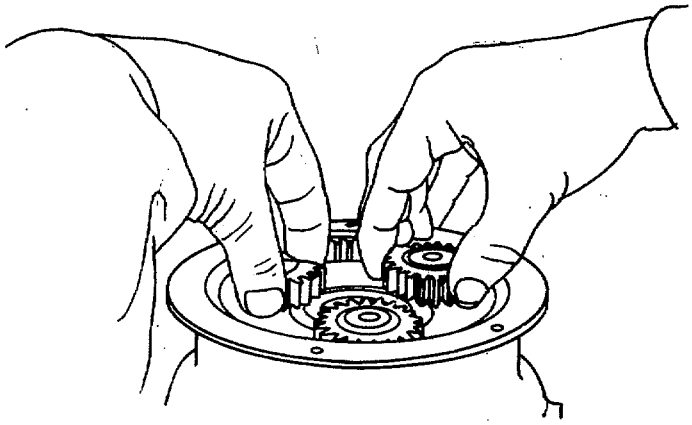
Step 9. Take out first set of planetary gears with carrier.



Step 10. Remove snap rings.
Step 11. Remove planetary gears from carrier.
Step 12. Remove needle bearing from sun gear.

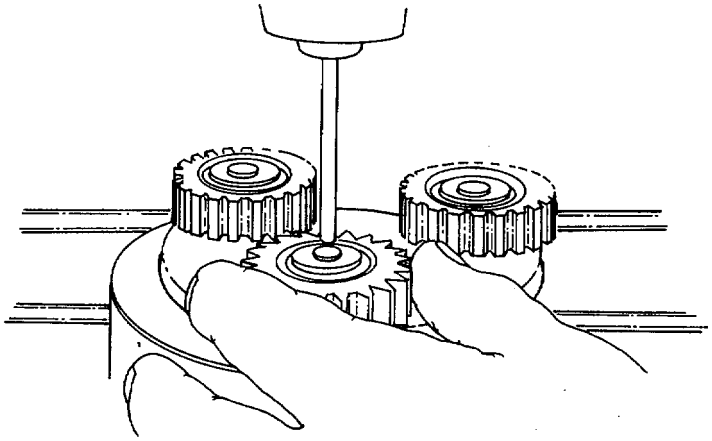


Step 13. Remove second set of planetary gears with carrier.

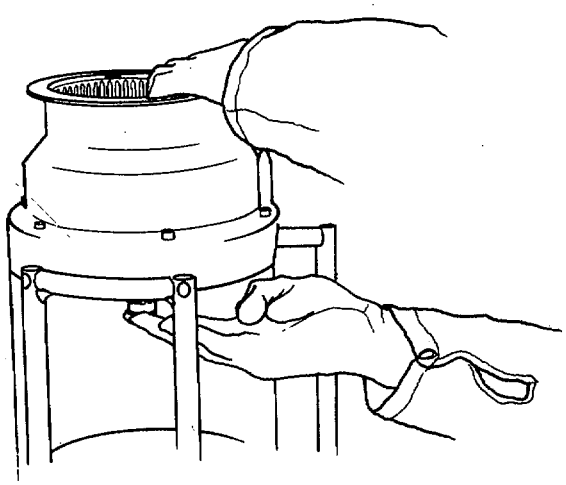


TA259768

Step 14. Drill out rivets holding planetary gears to carrier.
Step 15. Remove planetary gears.
Step 16. Remove needle bearing from sun gear.

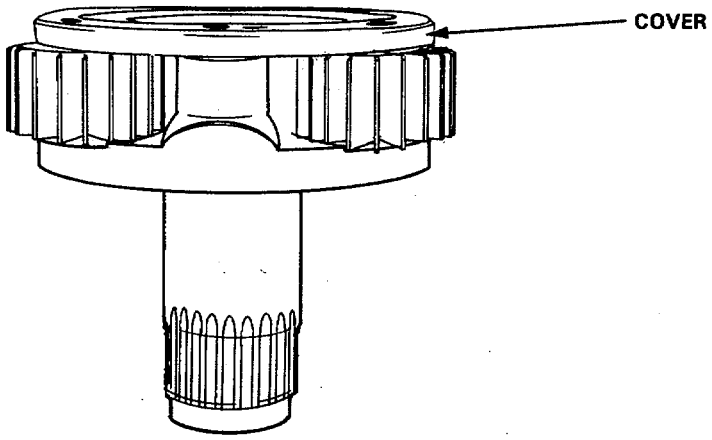


Step 17. Remove third set of planetary gears with carrier.

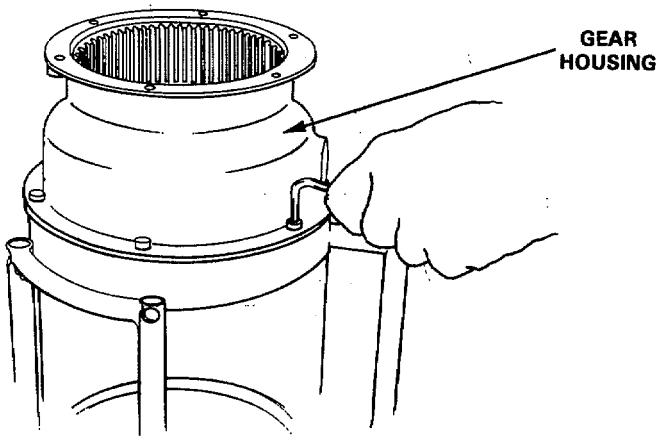


TA259769

Step 18. Remove three screws for cover on planetary gear cover. Remove cover.
Step 19. Remove planetary gears.
Step 20. Remove seal from drum shaft.
Step 21. Remove bearings from drum shaft.

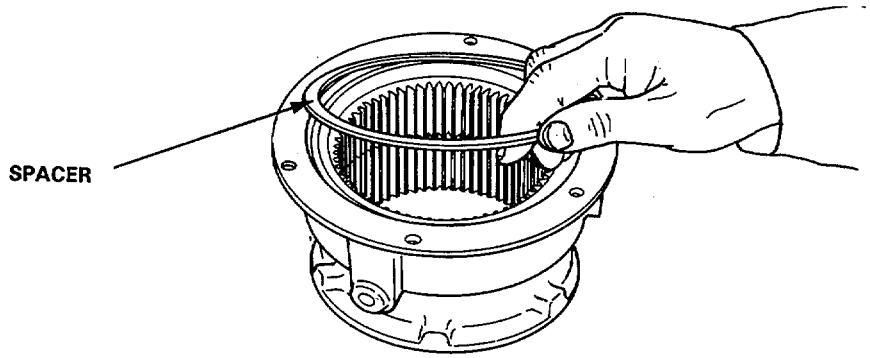


Step 22. Remove screws from gear housing. Remove housing.

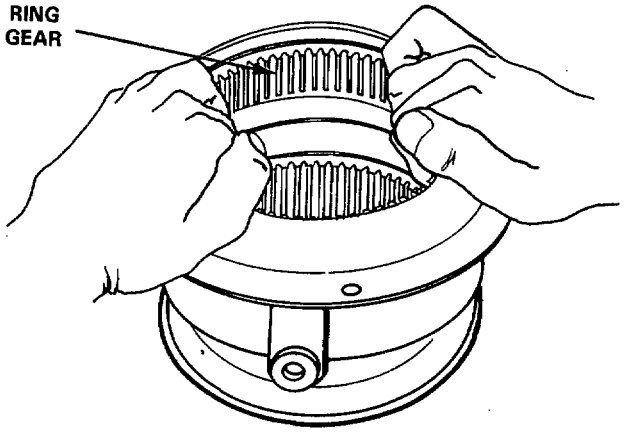


Step 23. Remove spacer from gear housing.

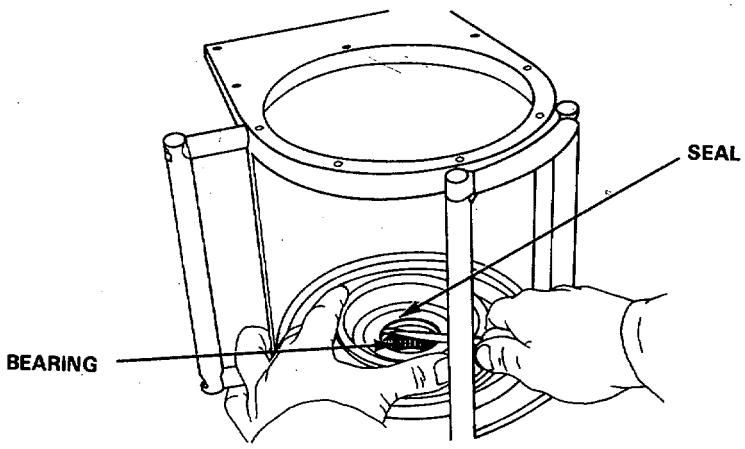
TA259770



Step 24. Remove ring gear from gear housing.
Step 25. Remove spacer.



Step 26. Remove seal from winch housing.
Step 27. Remove needle bearing from winch housing.



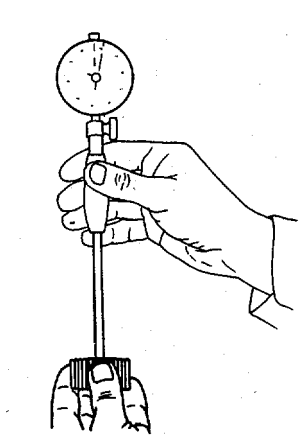
TA259771

b. Clean, Inspect and Repair.

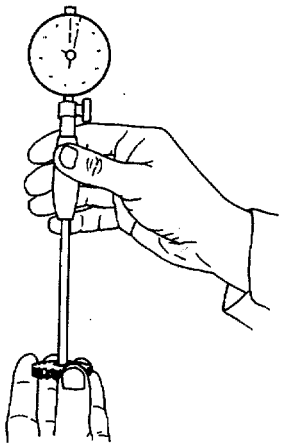
WARNING

Cleaning solvent, federal specification P-D-680 Type II, is flammable and gives off harmful vapors. Use solvent only in a well ventilated area. Avoid prolonged breathing of solvent vapors. Keep solvent away from flame. Do not use solvent in excessive amounts.

Step 1. Clean all parts with solvent. Dry parts. Refer to appendix B, item 48.
Step 2. Inspect housing for cracks and other damage. Replace damaged housings.
Step 3. Inspect all gears for chipped or broken teeth. Replace defective gears.
Step 4. Inspect all bearings for damage. Replace defective bearings.
Step 5. Measure bushings of the first and second set of planetary gears. If bushings do not measure 0.472 to 0.473 in. (12.016 to 12.034 mm) replace bushings.



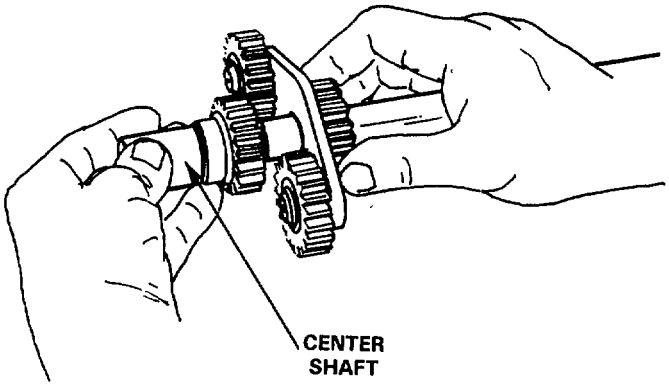
Step 6. Measure bushings of the third set of planetary gears. If bushing do not measure 0.591 to 0.592 in (15.016 to 15.034 mm) replace bushings.



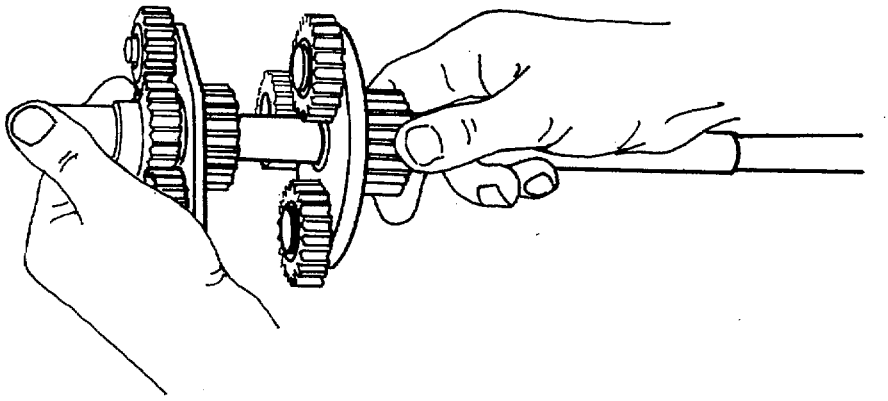
TA259772

c. Replace.

Step 1. Press needle bearings into sun gears of first and second set of planetary gears.
Step 2. Lubricate carrier of first set of planetary gears with oil. Refer to appendix B, item 36.
Step 3. Put first set of planetary gears on carrier.
Step 4. Put on snaprings.
Step 5. Lubricate carrier of second set of planetary gears with oil. Refer to appendix B, item 36.
Step 6. Put planetary gears in place. Put in rivet and washers.
Step 7. Lubricate carrier of third set of planetary gears with oil.
Step 8. Put planetary gear on carrier.
Step 9. Put on carrier cover. Put in and tighten three screws.
Step 10. Press needle bearing into winch housing.
Step 11. Put new seal in winch housing.
Step 12. Lubricate center shaft with oil. Refer to appendix B, item 36.
Step 13. Put brass spacer on center shaft next to gear.
Step 14. Put first set of planetary gear on center shaft.

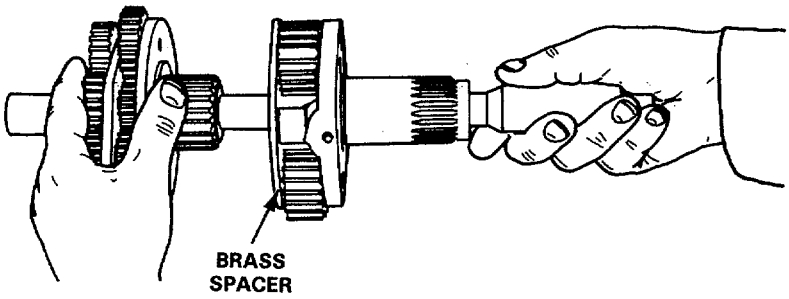


Step 15. Put brass spacer on center shaft.
Step 16. Put second set of planetary gears on shaft.

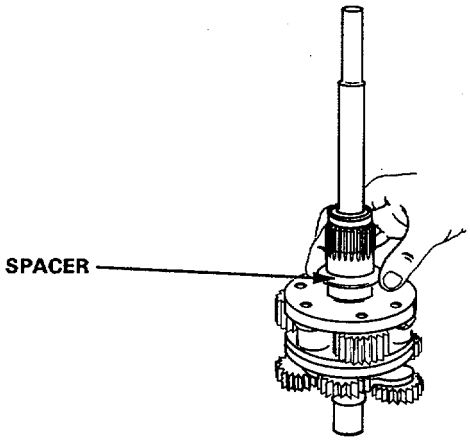


TA259773

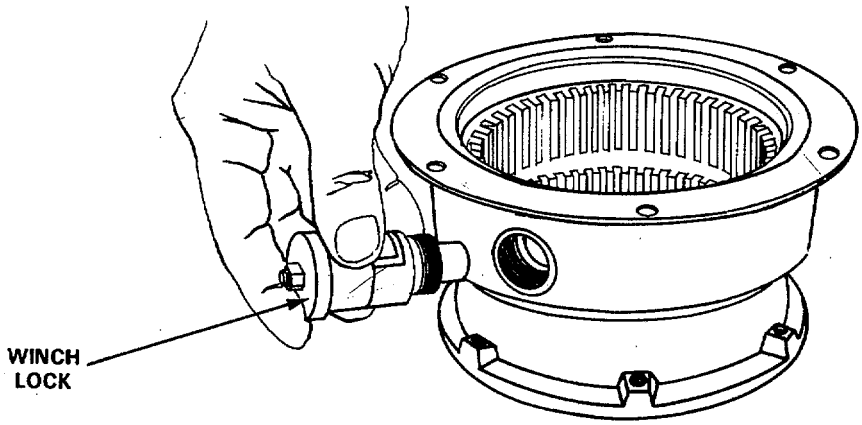
Step 17. Put brass spacer on center shaft
Step 18. Lubricate new seal with oil. Refer to appendix B, item 36.
Step 19. Put new seal in carrier of third set of planetary gears.
Step 20. Carefully push third set of planetary gears on center shaft.



Step 21. Put brass spacer on drum shaft.

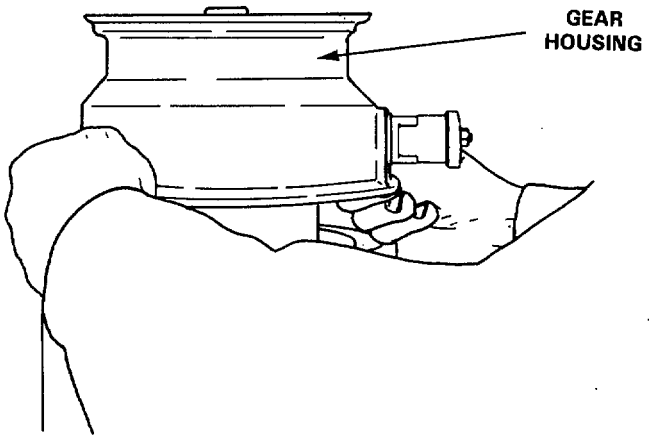


Step 22. Lubricate drum shaft and seal in winch housing. Refer to appendix B, item 36.
Step 23. Put shaft with planetary gear in winch housing.
Step 24. Put spacers and ring gear in gear housing.
Step 25. Screw, in winch lock to hold ring gear in position.



TA259774

Step 26. Put new gasket on gear housing.
Step 27. Put gear housing on winch housing.
Step 28. Put in housing screws. Tighten screws.

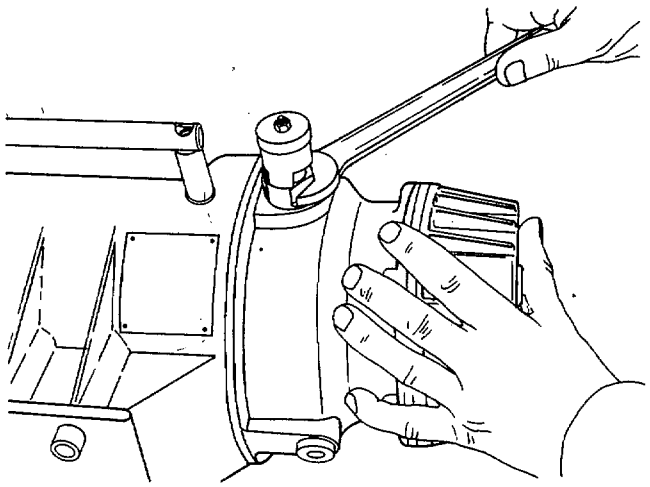


Step 29. Put new gasket and spacer plate on gear housing.
Step 30. Press bearing into spacer plate.
Step 31. Replace winch brake. Refer to paragraph 14- 7.
Step 32. Replace winch drum. Refer to paragraph 14-6.
Step 33. Replace planetary gear with load lirniter. Refer to paragraph 1 4-5.
Step 34. Replace electric motor. Refer to paragraph 1 4-4.
Step 35. Replace relay assembly. Refer to paragraph 1 4-3.

14-9. WINCH LOCK.

a. Remove.

Step 1. Disengage winch lock.
Step 2. Unscrew winch lock.
Step 3. Remove winch lock.



TA259775

b. Disassemble.

Step 1. Turn handle until pin sticks out of guide.
Step 2. Remove dome nut.
Step 3. Screw pin out of guide.
Step 4. Remove packing and spring.
Step 5. Remove copper washer from guide.

c. Assemble.

Step 1. Put grease on new packing. Refer to appendix B, item 8.
Step 2. Put packing on pin.
Step 3. Put on spring.
Step 4. Put pin into guide.
Step 5. Put handle on guide.
Step 6. Turn handle until pin extends 0.47 to 0.02 in. (1 2 to .5 mm) below guide. below guide.
Step 7. Put on dome nut. Tighten nut.

d. Replace.

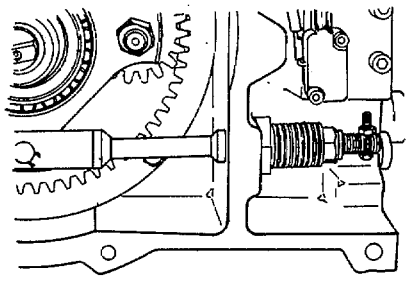
Step 1. Put new copper washer on guide.
Step 2. Screw winch lock into housing and tighten.

14-10. LOAD LIMITER ADJUSTMENT.

Step 1. Prepare winch for operation. Refer to TM 9- 2350-272-10.
Step 2. Disengage winch lock.
Step 3; Pull out cable until three coils are still on drum.
Step 4. Engage winch lock.
Step 5. Remove cover from planetary gears with load limiter.
Step 6. Connect load measuring device between cable and a stationary point.
Step 7. Wind in winch until load limiter cuts in or until winch load limit is reached.
Step 8. Turn adjusting nut on load limiter until load limiter cuts in at proper load limit.

- Turn nut clockwise to raise winch limit.
- Turn nut counter-clockwise to lower winch limit.
- M2 turn of nut equals 11 24 Ibs. 1500 kp) pull.

Step 9. Put on new gasket.
Step 10. Replace cover.



TA259776

APPENDIX A
REFERENCES

A-1. SCOPE

Appendix A has 5 lists:
- Forms.
- Departments of the Army Pamphlets.
- Field Manuals.
- Technical Manuals.
- Other Publications.

A-2. FORMS

Refer to DA Pamphlet 310-1 for index of blank forms. Refer to DA PAM 738-750 for required maintenance forms and explanation on use.

A-3. DEPARTMENT OF THE ARMY PAMPHLETS

Consolidated Index of Army Publications and Blank Forms ..... DA PAM 31 0-1
The Army Maintenance Management System (TAMMS) ..... DA PAM 738-750

A-4. FIELD MANUALS

Operation and Maintenance of Ordnance Material in Cold Weather (O0 to -65°F) ..... FM 9-207
Vehicle Recovery Operations ..... FM 20-22
Basic Cold Weather Manual ..... FM 31-70
Northern Operations ..... FM 31 -71

A-5. TECHNICAL MANUALS

Chemical, Biological and Radiological (CBR) Decontamination ..... TM 3-220
Painting Instructions for Field Use ..... TM 9-213
Use and Care of Hand Tools ..... TM 9-243
Principles of Automotive Vehicles ..... TM 9-8000
Operator Manual for Carrier, Cargo, Tracked, 1 1/2 Ton, M973 ..... TM 9-2350-272-10
Organizational Maintenance Manual for Carrier, Cargo, Tracked, 11/2 Ton, M973 ..... TM 9-2350-272-20
Repair Parts and Special Tools List for Carrier, Cargo Tracked, 1 **1/2** Ton, M973 ..... TM 9-2350-272-24P
Preservation, Packaging, and Packing of Military Supplies and Equipment ..... TM 38-230-2
Administrative Storage of Equipment ..... TM 740-90-1
Procedures for Destruction of Tank-Automotive Equipment to Prevent Enemy Use ..... TM 750-244-6

A-6. OTHER PUBLICATIONS

Lubrication Order for Carrier, Cargo, Tracked, 1 1/2 Ton M973 ..... LO 9-2350-272-12
Winterization Kits for, Army Tank-Automotive Material ..... SB 9-1 6
Color and Marking of Army Material ..... TB 746-93-1
Use of Antifreeze Solutions and Cleaning Compound in Engine
Cooling Systems ..... TB 750-651

APPENDIX B
EXPENDABLE SUPPLIES AND MATERIALS LIST

Section L INTRODUCTION

B-1. SCOPE.

This appendix lists expendable supplies and materials you will need to operate and maintain the M973 CARGO CARRIER. These items are authorized to you by CTA 50-970, Expendable Items (Except Medical, Class V, Repair Parts, and Insignia Items).

B-2. EXPLANATION OF COLUMNS.

a. Column (1).

Item number. This number is assigned to the entry in the listing and is referenced in the narrative instructions to identify the material (e.g., "Use Dry Cleaning Solvent, "Refer to appendix B item 48").

b. Column (2).

Level. This column identifies the lowest level of maintenance that requires the listed item.

C - Operator/Crew
O - Organizational Maintenance
F - Direct Support Maintenance

c. Column (3).

National Stock Number. This is the National Stock Number assigned to the item. Use it to request or requisition the item.

d. Column (4).

Description. Indicates the Federal item name and, if required, a description to identify the item. The last line for each item indicates the Federal Supply Code for Manufacturer (FSCM) in parentheses followed by the part number.

e. Column (5).

Unit of Measure (U/M). Indicates the measure used in performing the actual maintenance function. The measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in, pr). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

EXPENDABLE SUPPLIES AND MATERIALS LIST

(1) ITEM NO.	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) UIM
1	C	6850-00-181-7929	ANTIFREEZE: PERMANENT ETHYLENE GLYCOL (-650) INHIBITED (MIL-A-46153) 1 GAL. CONTAINER	GAL.
2	0	6850-00-181-7933	ANTIFREEZE: PERMANENT ETHYLENE GLYCOL (-650) INHIBITED (MIL-A-46153) 5 GAL. CONTAINER	GAL.
3	0	6850-00-174-1806	ANTIFREEZE: PERMANENT TYPE; ARCTIC GRADE (-900F) (0-1-490) (MIL-A-1 1755) 55 GAL. DRUM	GAL.
4	C	9150-00-698-2382	DEXTRON II (MIL-L-2104) 5 GAL. CAN	GAL.
5	F	6810-00-249-9354	ELECTROLYTE 1 GAL. CONTAINER	GAL.
6	C	6810-00-543-7415	ETHANOL, DENATURED (O-E-00760) 5 GAL. CAN	GAL.
7	C	9150-01-102-9455	FLUID, BRAKE SILICONE (MIL-B-6176) 1 GAL. PLASTIC	GAL.
8	C	9150-00-935-1017	GAA, GREASE, AUTOMOTIVE AND ARTILLERY (MIL-L-10924) 14 OZ. CARTRIDGE	OZ.
9	0	9150-00-190-0905	GAA, GREASE, AUTOMOTIVE AND ARTILLERY (MIL-L-10924) 5 LB. CAN	LB.
10	0	9150-00-t90-0907	GAA, GREASE, AUTOMOTIVE AND ARTILLERY (MIL-L-10924) 35 LB. PAIL	LB.
11	F	9150-00-530-7369	GAA, GREASE, AUTOMOTIVE AND ARTILLERY (MIL-L- 10924) 120 LB. DRUM	LB.
12	C	9130-00-559-2475	KEROSENE (MIL-R-25576) 55 GAL. DRUM	GAL.
13	C	9150-00-234-5200	LUBRICANT CHAIN AND WIRE ROPE, CWII (VV-L-751) 5 LB. CAN	LB.
14	C	9140-00-286-5295	OIL, FUEL, DIESEL DF-2, REGULAR (VV-F-800) 5 GAL. CAN	GAL.

EXPENDABLE SUPPLIES AND MATERIALS LIST

(1) ITEM NO.	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) UIM
15	0	9140-00-286-5296	OIL, FUEL, DIESEL DF-2, REGULAR (VV-F-800) 55 GAL. DRUM, 16 GAGE	GAL.
16	0	9140-00-286-5297	OIL, FUEL, DIESEL DF-2, REGULAR (VV-F-800) 55 GAL. DRUM, 18 GAGE	GAL.
17	0	9140-00-286-5294	OIL, FUEL, DIESEL DF-2, REGULAR (VV-F-800) BULK	GAL.
18	C	9140-00-286-5287	OIL, FUEL, DIESEL DF-1, WINTER (VV-F-800) 5 GAL. CAN	GAL.
19	0	9140-00-286-5288	OIL, FUEL, DIESEL DF-1, WINTER (VV-F-800) 55 GAL. DRUM, 16 GAGE	GAL.
20	0	9140-00-286-5289	OIL, FUEL, DIESEL DF-1, WINTER (VV-F-800) 55 GAL. DRUM, 18 GAGE	GAL.
21	0	9140-00-286-5286	OIL, FUEL, DIESEL DF-1, WINTER (VV-F-800) BULK	GAL.
22	C	9140-00-286-5282	OIL, FUEL, DIESEL, DF-A (ARCTIC} (VV-F-800) 5 GAL. CAN	GAL.
23	0	9140-00-286-5284	OIL, FUEL, DIESEL, DF-A (ARCTIC} (VV-F-800) 55 GAL. DRUM, 16 GAGE	GAL.
24	0	9140-00-286-5285	OIL, FUEL, DIESEL, DF-A (ARCTIC) (VV-F-800) 55 GAL. DRUM, 18 GAGE	GAL.
25	0	9140-00-286-5283	OIL, FUEL, DIESEL, DF-A (ARCTIC} (VV-F-800) BULK	GAL.
26	C	9 150-00-971-6643	OIL, LUBRICANT, INSTRUMENT AIRCRAFT (MIL-L-6085) 8 OZ. CAN	EA.
27	C	91 50-01-035-5392	OIL, LUBRICATING, GEAR GO 80/90 (MIL-L-2105) 1 QT. CAN	QT.
28	C	9150-01-035-5393	OIL, LUBRICATING, GEAR GO 80/90 (MIL-L-2105) 5 GAL. CAN.	GAL.
29	F	9150-01-035-5394	OIL,-LUBRICATING, GEAR GO 80/90 (MIL-L-2105) 55 GAL. DRUM, 16 GAGE	GAL.

EXPENDABLE SUPPLIES AND MATERIALS LIST

(1) ITEM NO.	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) UIM
30	C	9150-01-035-5390	OIL, LUBRICATING, GEAR GO 75 (MIL-L-2105} 1 QT.	QT.
31	C	9150-01-035-5391	OIL, LUBRICATING, GEAR GO 75 (MIL-L-2105) 5 GAL. CAN	GAL.
32	F	9150-01-035-5394	OIL, LUBRICATING, GEAR GO 75 (MIL-L-2105) 55 GAL. DRUM	GAL.
33	C	9150-01-152-4117	OIL, LUBRICATING OE/HDO 15/40 (MIL-L-2104) 1 QT. CAN	QT.
34	C	9150-01-152-4118	OIL, LUBRICATING OE/HDO 15/40 (MIL-L-2104) 5 GAL. DRUM	GAL.
35	0	9150-01-152-4119	OIL, LUBRICATING OE/HDO 15/40 (MIL-L-2104) 55 GAL. DRUM	GAL.
36	C	9150-00-189-6727	OIL, LUBRICATING, OE/HDO 10 (MIL-L-2104) 1 QT. CAN	QT.
37	C	9150-00-186-6668	OIL, LUBRICATING, OE/HDO 10 (MIL-L-2104) 5 GAL. CAN	GAL.
38	0	9150-00-186-6685	OIL, LUBRICATING, OE/HDO 10 (MIL-L-2104) 55 GAL. DRUM	GAL.
39	C	91 50-00-402-4478	OIL, LUBRICATION, ENGINE, ARCTIC (ICE, SUB-ZERO) (MIL-L-46167) 1 QT.	QT.
40	C	91 50-00-402-2372	OIL, LUBRICATION, ENGINE, ARCTIC, (ICE, SUB-ZERO) (MIL-L-46167) 5 GAL. CAN	GAL.
41	0	9150-00-491-7197	OIL, LUBRICATION, ENGINE, ARCTIC (ICE, SUB-ZERO) (MIL-L-46167} 55 GAL. DRUM, 16 GAGE	GAL.
42	C	7920-00-205-1711	RAGS, WIPING (58536) A-A-531	LB.
43	C	6810-00-356-4936	WATER, DISTILLED, 5 GAL. CONTAINER	GAL.
44	C	6850-00-926-2275	WINDSHIELD WASHER FLUID CLEANING, COMPOUND, WINDOW	PT.
45	C	9150-00-250-0926	PETROLATUM TECHNICAL (VASELINE, INDUSTRIAL) (V-V-P236)	PT.

EXPENDABLE SUPPLIES AND MATERIALS LIST

(1) ITEM NO.	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) UIM
46	0	8040-00-833-'9563	SEALANT, SILICON RUBBER, RTV (80244), MIL-A-46106, TYPE I, CLEAR, 6 OZ. TUBE	EA.
47	F	8030-00-873-4792	SEALING COMPOUND, PERMATEX, TYPE 11, (79225) 1 QT. CAN	QT.
48	C	6850-00-664-5685	SOLVENT, DRY CLEANING, SD (P-D-680, TYPE ll) 1 QT. CAN	QT.
49	C	6850-00-281-1985	SOLVENT, DRY CLEANING; SD (P-D-680, TYPE ll) 1 GAL. CAN	GAL.

INDEX

By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General, United, States Army
Chief of Staff

Official:

ROBERT M. JOYCE
Major General, United States Army
The Adjutant General

Distribution:

To be distributed in accordance with DA Form 1 2-37, Direct Support and General Support Maintenance requirements for Carrier, Cargo, Tracked, 1 1/2 Ton, M973.

THE METRIC SYSTEM AND EQUIVALENTS

LINEAR MEASURE

1 Centimeter = 10 Millimeters = 0 01 Meters = 0 3937 Inches
1 Meter = 100 Centimeters = 1000 Millimeters = 39 37 Inches
1 Kilometer = 1000 Meters = 0 621 Miles

WEIGHTS

1 Gram = 0 001 Kilograms = 1000 Milligrams = 0 035 Ounces
1 Kilogram = 1000 Grams = 2 2 Lb.
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1 1 Short Tons

LIQUID MEASURE

1 Milliliter = 0 001 Liters = 0 0338 Fluid Ounces
1 Liter = 1000 Milliliters = 33 82 Fluid Ounces

SQUARE MEASURE

1 Sq Centimeter = 100 Sq Millimeters = 0 155 Sq Inches
1 Sq Meter = 10,000 Sq Centimeters = 10 76 Sq Feet
1 Sq Kilometer = 1,000,000 Sq Meters = 0 386 Sq Miles

CUBIC MEASURE

1 Cu Centimeter = 1000 Cu Millimeters = 0 06 Cu Inches
1 Cu Meter = 1,000,000 Cu Centimeters = 35 31 Cu Feet

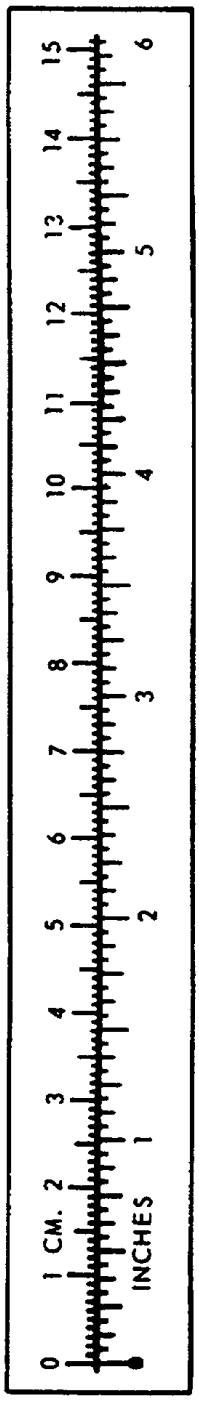
TEMPERATURE

$\frac{5}{9}(°F - 32) = °C$
212° Fahrenheit is equivalent to 100° Celsius
90° Fahrenheit is equivalent to 32 2° Celsius
32° Fahrenheit is equivalent to 0° Celsius
$\frac{9}{5}°C + 32 = °F$

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2 540
Feet	Meters	0 305
Yards	Meters	0 914
Miles	Kilometers	1 609
Square Inches	Square Centimeters	6 451
Square Feet	Square Meters	0 093
Square Yards	Square Meters	0 836
Square Miles	Square Kilometers	2 590
Acres	Square Hectometers	0 405
Cubic Feet	Cubic Meters	0 028
Cubic Yards	Cubic Meters	0 765
Fluid Ounces	Milliliters	29 573
Pints	Liters	0 473
Quarts	Liters	0 946
Gallons	Liters	3 785
Ounces	Grams	28 349
Pounds	Kilograms	0 454
Short Tons	Metric Tons	0 907
Pound-Feet	Newton-Meters	1.356
Pounds per Square Inch	Kilopascals	6 895
Miles per Gallon	Kilometers per Liter	0 425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0 394
Meters	Feet	3 280
Meters	Yards	1 094
Kilometers	Miles	0 621
Square Centimeters	Square Inches	0 155
Square Meters	Square Feet	10 764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0 386
Square Hectometers	Acres	2 471
Cubic Meters	Cubic Feet	35 315
Cubic Meters	Cubic Yards	1 308
Milliliters	Fluid Ounces	0 034
Liters	Pints	2 113
Liters	Quarts	1.057
Liters	Gallons	0 264
Grams	Ounces	0 035
Kilograms	Pounds	2 205
Metric Tons	Short Tons	1 102
Newton-Meters	Pound-Feet	0 738
Kilopascals	Pounds per Square Inch	0.145
Kilometers per Liter	Miles per Gallon	2 354
Kilometers per Hour	Miles per Hour	0 621



RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

THEN...JOT DOWN THE DOPE ABOUT IT ON THIS FORM. CAREFULLY TEAR IT OUT, FOLD IT AND DROP IT IN THE MAIL.

SOMETHING WRONG WITH PUBLICATION

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)

DATE SENT

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE

BE EXACT PIN-POINT WHERE IT IS

PAGE NO.	PARA-GRAPH	FIGURE NO.	TABLE NO.

IN THIS SPACE, TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT.

PRINTED NAME, GRADE OR TITLE AND TELEPHONE NUMBER	SIGN HERE

TEAR ALONG PERFORATED LINE

DA FORM 1 JUL 79 2028-2

PREVIOUS EDITIONS ARE OBSOLETE.

P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS.

PIN: 055002-000