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SAFETY NOTICE

This maintenance manual has been prepared in order to assist skilled mechanic's in the efficient repair and maintenance of PREVOST vehicles.

This manual covers only the procedures as of the manufacturing date.

Safety features may be impaired if other then genuine PREVOST parts are installed.

Torque wrench tightening specifications must be strictly observed. Locking devices must be installed or replaced by new ones, where specified. If the efficiency of a locking device is impaired, it must be replaced.

This manual emphasizes particular information denoted by the wording and symbols:

WARNING: Identifies an instruction which, if not followed, could cause personal injury.

CAUTION: Denotes an instruction which, if not followed, could severely damage vehicle components.

NOTE: Indicate supplementary information needed to fully complete an instruction.

Although, the mere reading of such information does not eliminate the hazard, your understanding of the information will promote its correct use.

01

ENGINE

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DESCRIPTION

This vehicle is powered by a 6V or 8V, series 92 two-cycle Detroit Diesel engine, provided with an electronic control system (DDEC II). Maintenance and repair information on the engine will be found in the current engine manufacturer's maintenance manual. Engine controls, accessories and related components are covered in the applicable sections of this maintenance manual. The engine removal/installation procedures are given at the end of this section. Summary information about the electronic control system is given hereafter, but for a complete description, refer to the *"DDEC II Troubleshooting Guide"* #6SE489 published by Detroit Diesel.

DDEC II ENGINE

General Description

DDEC II (**D**etroit **D**iesel **E**lectronic **C**ontrol) is a microprocessor-controlled electronic fuel injection and engine control system for Detroit Diesel engines.

DDEC II controls the timing and amount of fuel injected into the engine. The system also monitors several engine functions using various sensors which send electrical signals to the Electronic Control Module (ECM). The Electronic Control Module processes this information and sends high current command pulses for actuation of the injector solenoids. The Electronic Control Module has also the ability to limit and shut down the engine completely in the event of a potential engine damaging condition, such as low oil pressure or low coolant level or high engine temperature.

The DDEC II system is also self-diagnostic. It monitors itself, as well as all related wiring, to identify faulty components and other engine-related problems by illuminating the *"CHECK ENGINE"* light and/or the *"STOP ENGINE"* light. A fault code identifying the failed component is also logged in the Electronic Control Module's internal memory for later readout by maintenance personnel.

System components

The system components are divided in two categories: engine-mounted components and engine-related components.

1. Engine-mounted components

- Electronic Control Module (ECM)
- Electronic Unit Injector (EUI)
- Synchronous Reference Sensor (SRS)
- Timing Reference Sensor (TRS)
- Turbo Boost Pressure Sensor (TBS)
- Water Temperature Sensor (WTS)
- Oil Pressure Sensor (OPS)

Electronic Control Module (ECM)

The Electronic Control Module is a single fuel-cooled box which is mounted on top and to the front of the engine (see fig. 1). It is considered the *"Brain"* of the DDEC II system as it provides overall monitoring and control of the engine by comparing input from the various sensors to a set of calibration data stored in the EEPROM (**E**lectrically **E**rasable, **P**rogrammable, **R**ead-**O**nly **M**emory) within the Electronic Control Module. After processing the input and compared data, the ECM sends high current command pulses to the Electronic Unit Injectors (EUI) to initiate fuel injection. The ECM also receives feedback regarding the start and end of injection for a given cylinder.

Heat generated by the Electronic Control Module is dissipated by absorption in the fuel flowing through a plate on which the unit is fixed.

The Electronic Control Module controls basic engine functions such as:

- Rated speed and power
- Engine governing
- Torque shaping
- Cold start logic
- Transient fuel control (smoke control)
- Diagnostics of engine components and itself
- Engine protection

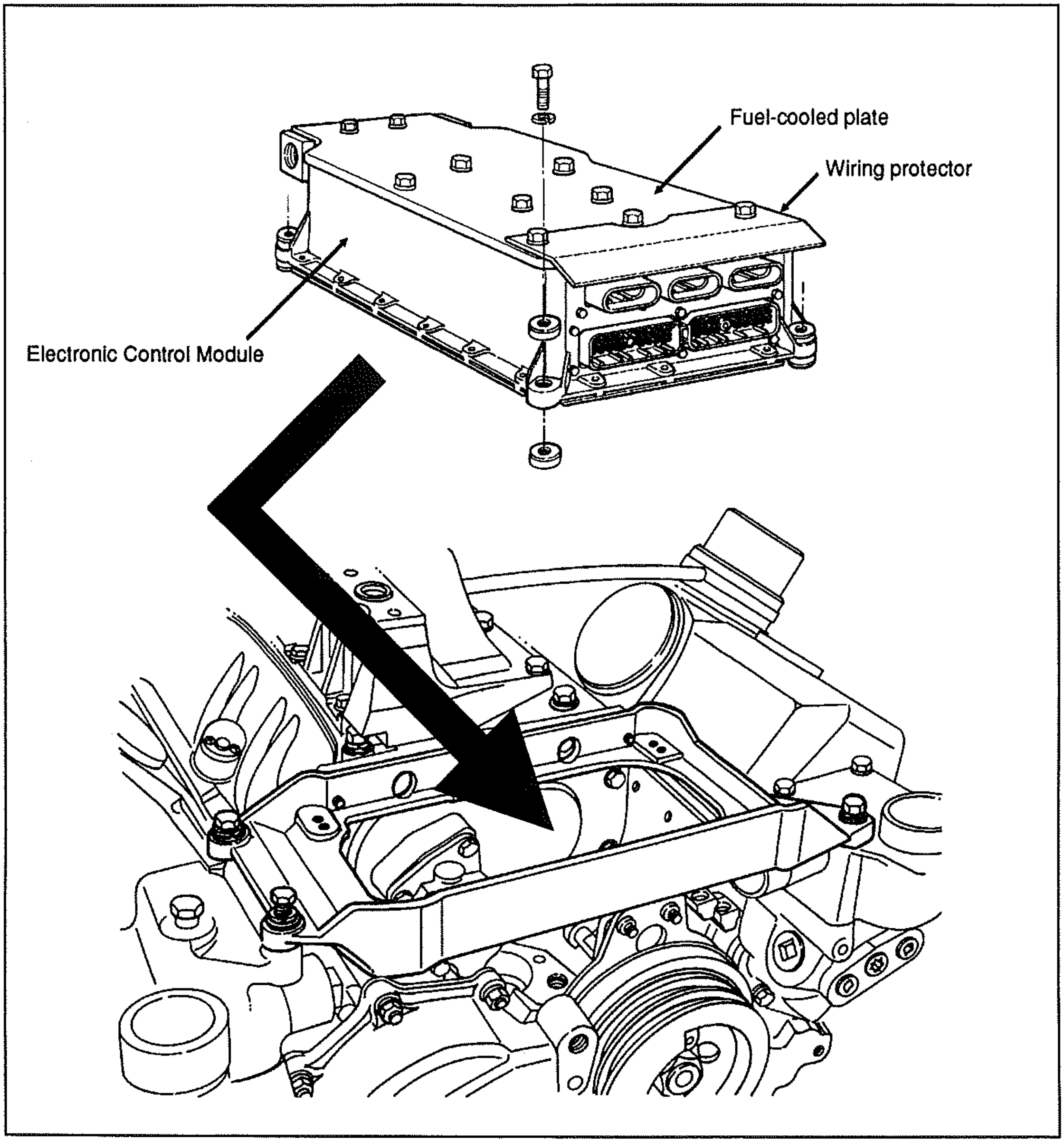

Fig. 1

MA3E01A1
MA3E01B1

The EEPROM (Electrically Erasable, Programmable, Read-Only Memory) within the Electronic Control Module is factory programmed by Detroit Diesel. The programming is determined by a specific engine/transmission/protection system combination. The reprogramming at a Detroit Diesel authorized service center will be required for changes related to these characteristics. Although, some changes may be performed to the cruise control and road speed limit using a digital reader.

NOTE: No parts within the ECM are serviceable. If the ECM is found defective, replace it as a unit.

CAUTION: If a welding procedure must be performed on vehicle, always disconnect Electronic Control Module connectors in order to protect this component from voltage surges.

Electronic Unit Injector (EUI)

The Electronic Unit Injector is located in the cylinder head and operates much the same way as a mechanical injector. A bolt-on fuel manifold is used to provide fuel inlet and return connections. A fuel inlet filter is also located in this manifold. Pressurization of the fuel in the injector is made by means of a conventional cam-operated plunger. The main difference with this new type of injector lies in the fuel metering and timing mechanism. A solenoid-operated poppet valve on each Electronic Unit Injector is used to perform injection timing and fuel metering functions (see fig. 2).

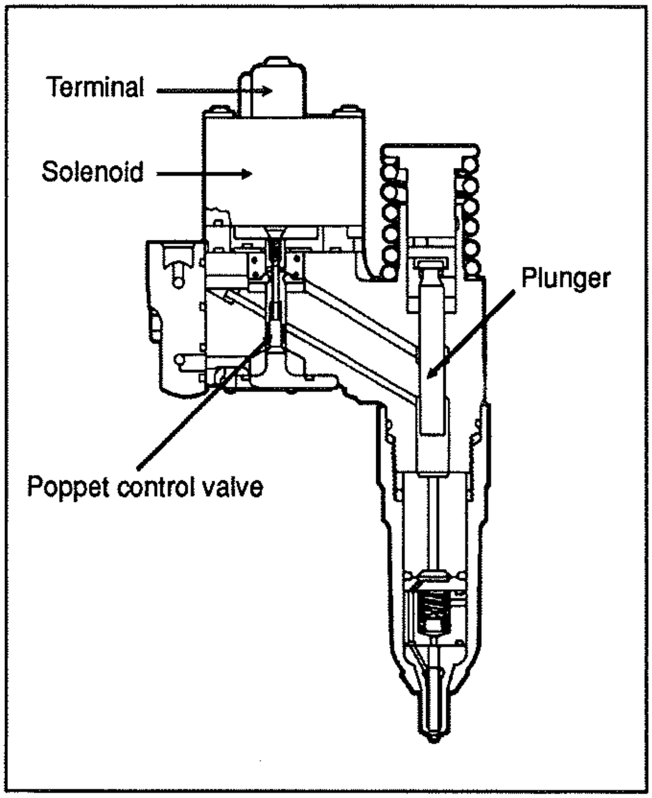

Fig. 2 - Electronic Unit Injector (EUI) MA3E0102

Synchronous Reference Sensor (SRS) and Timing Reference Sensor (TRS)

The Synchronous Reference Sensor (SRS) and Timing Reference Sensor (TRS) are electronic components that send a signal to the ECM. The SRS references firing position for the number one (1) piston. The TRS sends a signal to indicate the firing position for each piston. The SRS/TRS assembly is mounted through the engine front end plate at the top left corner of the engine (see fig. 3 and 4).

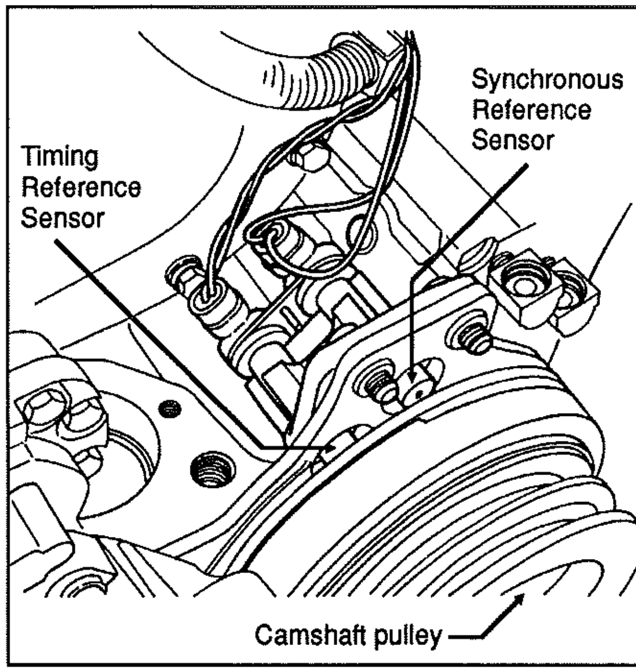

Fig. 3 - SRS/TRS Installation MA3E0103

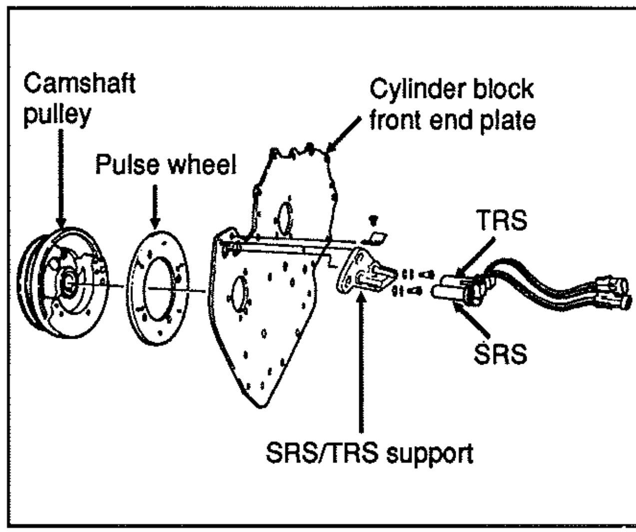

Fig. 4 - SRS/TRS exploded view MA3E0104

Turbo Boost Pressure Sensor (TBS)

The turbo boost pressure sensor is bracket mounted near the blower (see fig. 5). This device is a pressure sensor that sends an electrical signal to the ECM. The ECM uses this information to compute the amount of air entering the engine. Fuel supply is regulated by the TBS information to control engine smoke. The TBS is non-serviceable and should be replaced as an unit. No adjustment is required.

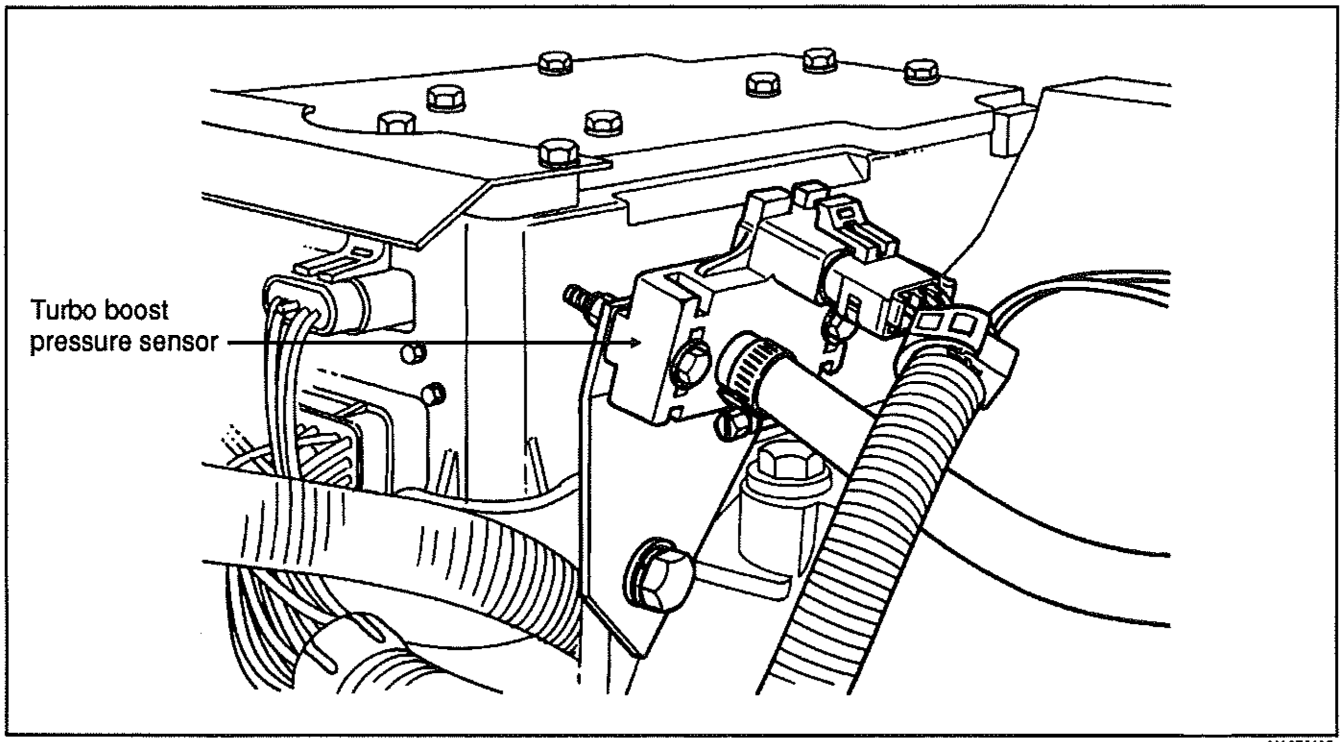

Fig. 5

Water Temperature Sensor (WTS)

The water temperature sensor (see fig. 6) is mounted in right hand thermostat housing (radiator side). The purpose of this sensor is to protect the engine in case of overheating. If engine water is only slightly over temperature (e.g. 212 °F (100 °C)), the following occurs: the *"Check Engine"* light turns on, and engine power will be progressively decreased down to 50% (minimum) at approximately 221 °F (105 °C); in case of overheating (over 221 °F (105 °C)), engine will shutdown.

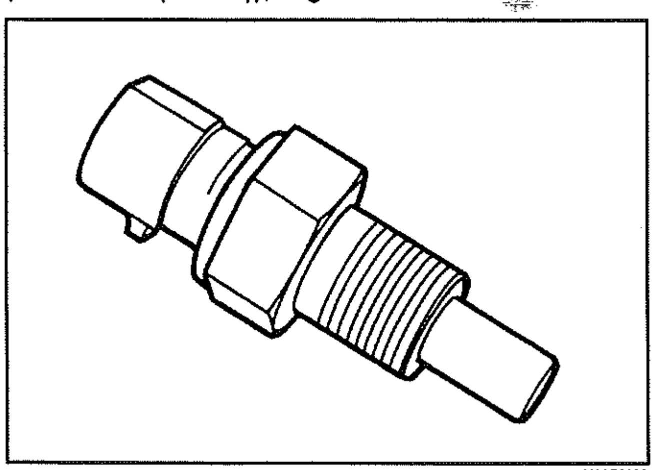

Fig. 6 - Water Temperature Sensor

Oil Pressure Sensor (OPS)

The oil pressure sensor sends an electrical signal to the ECM telling it what the engine oil pressure is at any given speed. Low oil pressure signals exceeding seven seconds are used by the ECM to begin the warning and stop engine functions. The OPS is non-serviceable and should replaced as a unit. No adjustment is required. The OPS is tapped into the main engine oil gallery and is mounted at left front corner of the engine (see fig. 7).

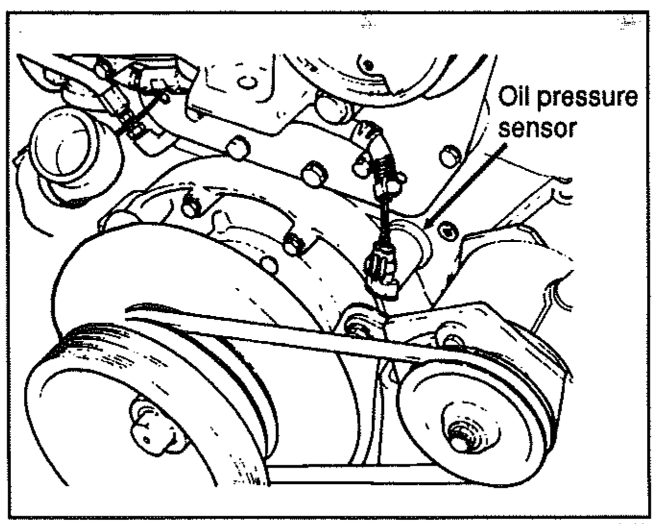

Fig. 7

2. Engine-related components

- Coolant Level System (CLS)
- Electronic Foot Pedal Assembly (EFPA)
- Control Throttle Position Module (CTPM)
- Cruise Control Switch (CCS)
- Diagnostic System Accessories (DSA)

Coolant Level System (CLS)

The coolant level system consists of a conductivity probe mounted in the surge tank and an electronic interface module located on top inside the rear junction box. Coolant level is determined by the change in impedance of the probe and its brass mount when it is immersed in coolant. The electronics in the module condition the signal to levels compatible with DDEC. Low coolant level may begin the warning and stop engine functions. The probe and the electronic interface module are non-serviceable items and if found defective, they should be replaced as units. No adjustment is required.

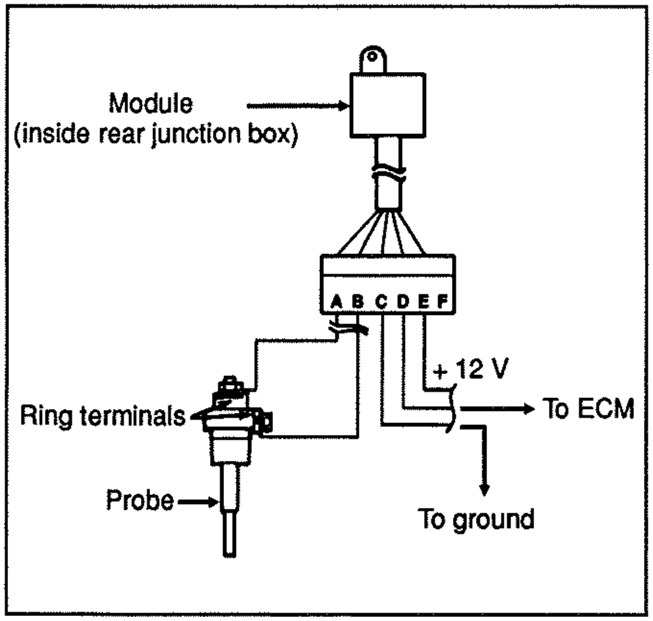

Fig. 8 - Coolant Level System components

Electronic Foot Pedal Assembly (EFPA)

The Electronic Foot Pedal Assembly, which is installed in the space normally occupied by the mechanical foot pedal, provides an input signal (0 to 5 volts) to the ECM to regulate engine fuel rate (power) proportional to the operator's throttle pedal position. The EFPA has maximum and minimum stops that are built into the unit while it is manufactured.

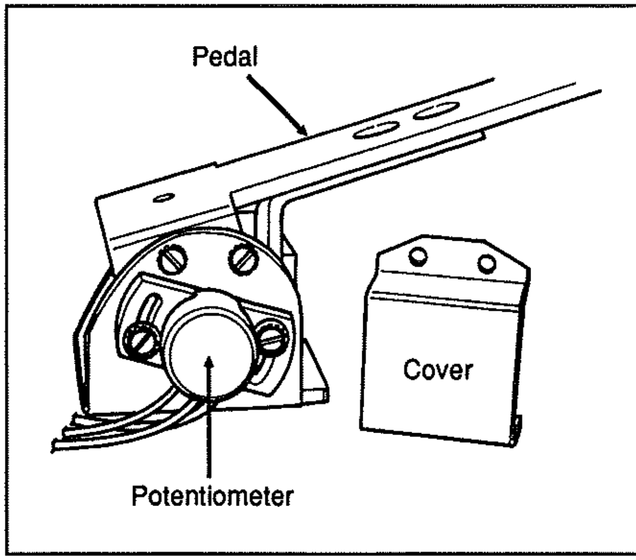

Fig. 9 - Electronic Foot Pedal Assembly

Control Throttle Position Module (CTPM)

The Control Throttle Position Module, which is provided only on vehicles equipped with an *"ATEC"* automatic transmission, is mounted on the L.H. side inner wall of the rear junction box. The purpose of this module is to translate DDEC II throttle position into an ATEC I signal. Additionally, it communicates the transmission output speed signal back to DDEC II for use in cruise control/road speed limiting logic. It also incorporates an integral engine speed switch which is sent to ATEC I as an input signal for the logic which prevents shifting into range above pre-set engine speeds.

Cruise Control Switches (CCS)

The four cruise control switches are located in driver's area on a L.H. side panel.

1. Cruise On/Off: This is the main switch that actuates the ECM memory in order to use the speed regulating mode.

2. Cruise set: This switch is used to set the cruise control speed.

NOTE: Cruise control system will not accept speed settings, nor will the *"Resume"* switch operate below approximately 35 mph (55 km/h).

3. Cruise resume: Each time this switch is actuated, the speed will be increased by 2 mph (3,5 km/h); this switch also allows to return to the last regulated speed following a brake or *"DECEL"* switch application.

NOTE: On\off switch must be to the "ON" position in order to return to the last regulated speed.

4. Cruise decel: Allows to reduce speed each time this switch is activated.

Diagnostic System Accessories (DSA)

The DDEC II engine Diagnostic System Accessories include the following:

1. ***"Check Engine"* warning light**
2. ***"Stop Engine"* warning light**
3. ***"Override"* switch**
4. ***"DDEC Test"* switch**
5. ***"Diagnostic Data Link"* (DDL) connector**

1. *"Check Engine"* warning light: This light, mounted on central dashboard panel, turns on to indicate that a fault is currently being detected and that a code has been stored in the ECM memory. This light also has a 5 second bulb check when the ignition is first turned on.

2. *"Stop Engine"* warning light: This light, also mounted on central dashboard panel, turns on to indicate that a major engine problem occurs (with the exception of a 5 second bulb check when the ignition is first turned on). The engine power will automatically begin to decrease gradually and will be followed by a shutdown after 30 seconds. This 30 second delay period may be repeated using the *"Override"* switch.

NOTE: Once engine is stopped, it can not restart until malfunction is corrected.

3. *"Override"* switch: This switch, mounted on the L.H. lower control panel, is used when the *"Stop engine"* warning light is turned on. Push down switch to allow a 30 second delay period (noncumulative) in the shutdown procedure in order to move vehicle out of traffic.

CAUTION: The *"Override"* switch must be used only in emergency cases, such as to move vehicle out of a traffic. Excessive use of this switch could cause serious damage to the engine.

4. *"DDEC Test"* switch: This switch is mounted on the front face panel of the alarm junction box which is located in the front service compartment (see fig. 10). This switch will illuminate the *"Check Engine"* warning light in dashboard in a series of flashes separated by a pause. For example, a code "43" consists of four flashes, followed by a short pause, then three flashes in quick sucession. A complete diagnostic code list is given later in this section.

NOTE: If the *"DDEC Test"* switch remains in the *"ON"* position, the accelerator pedal voltage will be cut off, thus rendering it inoperative.

5. *"Diagnostic Data Link"* (DDL) connector: This connector, which is mounted of the front face panel of the alarm junction box (see fig. 10), allows the use of the Diagnostic Data Reader (DDR) or the scanner (not supplied) to read the codes or the modes which are pertinent data on the engine condition. This enables a more complete analysis of any defect found in the DDEC system operation.

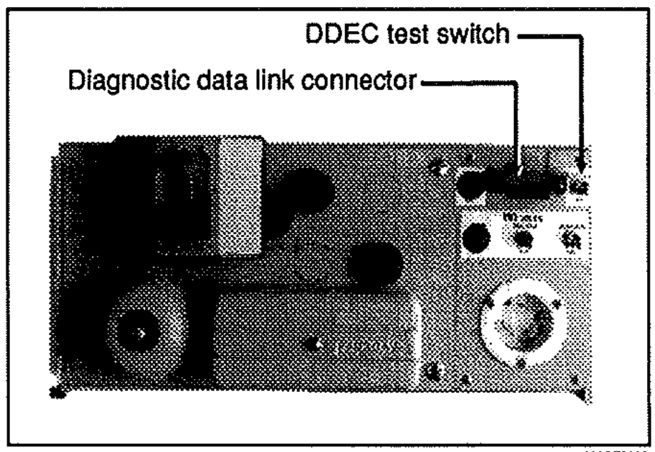

Fig. 10 - Alarm junction box

DDEC II Diagnostic Code List

Error Code #	Description	Error Code #	Description
11	Power Take-Off Sensor Lo Volt	38	Fuel Prs Sensor Lo Volt
12	Power Take-Off Sensor Hi Volt	41	Timing Reference Sensor
13	Coolant Sensor Lo Volt	42	Synchronous Ref Sensor
14	Eng Temp Sensor Hi Volt	43	Low Coolant Level
15	Eng Temp Sensor Lo Volt	44	Engine Overtemperature
16	Coolant Sensor Hi Volt	45	Low Oil Pressure
21	Throttle Pos Sensor Hi Volt	46	Low Battery Voltage
22	Throttle Pos Sensor Lo Volt	47	Hi Fuel Pressure
23	Fuel Temp Sensor Hi Volt	48	Lo Fuel Pressure
24	Fuel Temp Sensor Lo Volt	51	EEPROM Error
25	No Codes	52	ECM - A/D Fail
26	Power Control Enabled	53	EEPROM Memory Failure
31	Fault On Auxiliary Output	54	Vehicle Speed Sensor
32	ECM Backup System Fail	55	Proprietory Comm. Link
33	Turbo Bst Sensor Hi Volt	56	ECM - A/D Fail
34	Turbo Bst Sensor Lo Volt	58	Cruise Ctl Switches
35	Oil Prs Sensor Hi Volt	61-68	Inj Response Time Long
36	Oil Prs Sensor Lo Volt	71-78	Inj Response Time Short
37	Fuel Prs Sensor Hi Volt	85	Engine Overspeed

DDEC: Detroit Diesel Electronic Control

ECM: Electronic Control Module

EEPROM: Electrically Erasable Programmable Read-Only Memory

POWER PLANT ASSEMBLY REMOVAL

The vehicle power plant assembly must be removed as a whole unit by means of a slide-out cradle, thus providing access to the engine or its related components. The power plant assembly includes the engine, transmission (including retarder if so equipped), air compressor, alternator, and transmission oil cooler where applicable.

Follow the procedure hereafter to remove the power plant assembly.

CAUTION: All hoses and cables must be properly identified prior to their disconnection in order to ease their reinstallation. Plug all openings to prevent dirt from entering the system.

1. Set the battery main disconnect switches to the *"OFF"* position.

2. Remove both wing nuts securing engine belt guard in place, then lift and remove it from engine compartment.

3. Drain the engine cooling system as explained in section 05 *"Cooling system"* of this manual, under heading *"Draining cooling system"*.

WARNING: Due to the heavy load of rear bumper assembly, support it adequately before proceeding with the following step.

4. Unscrew fasteners retaining rear bumper assembly, then remove it from vehicle.

5. Locate the belt tensioner two-way control valve (see fig. 11), turn handle counterclockwise in order to reverse pressure in belt tensioner air cylinders, thus releasing tension on belts, then slip the belts off.

6. Exhaust all air from the air system (if required, refer to section 12 "Brakes & Air System").

7. Disconnect belt tensioner cylinder steel-braided air hoses from two-way control valve, then remove their retaining clips from vertical post in order to free the hoses (see fig. 11).

8. Unbolt the belt tensioner cylinder rod end from A/C compressor, then pivot it toward the engine.

9. Disconnect the steel-braided air hoses from shutterstat. The shutterstat is mounted in thermostat housing base, radiator side (see fig. 12).

10. Disconnect vent hose mounted close to the thermostat housing, radiator side (see fig. 12).

11. Disconnect and remove the section of the coolant pipe assembly mounted between the thermostat housings and the main upper coolant pipe (see fig. 13, item 1).

12. Disconnect and remove the section of the coolant pipe assembly mounted between the radiator outlet and the water pump inlet (see fig. 13, item 2).

13. Remove the mechanical water temperature gauge sending unit (see fig. 13, item 3) from thermostat housing base (engine air cleaner side), remove cable ties, then move sending unit away from power plant assembly.

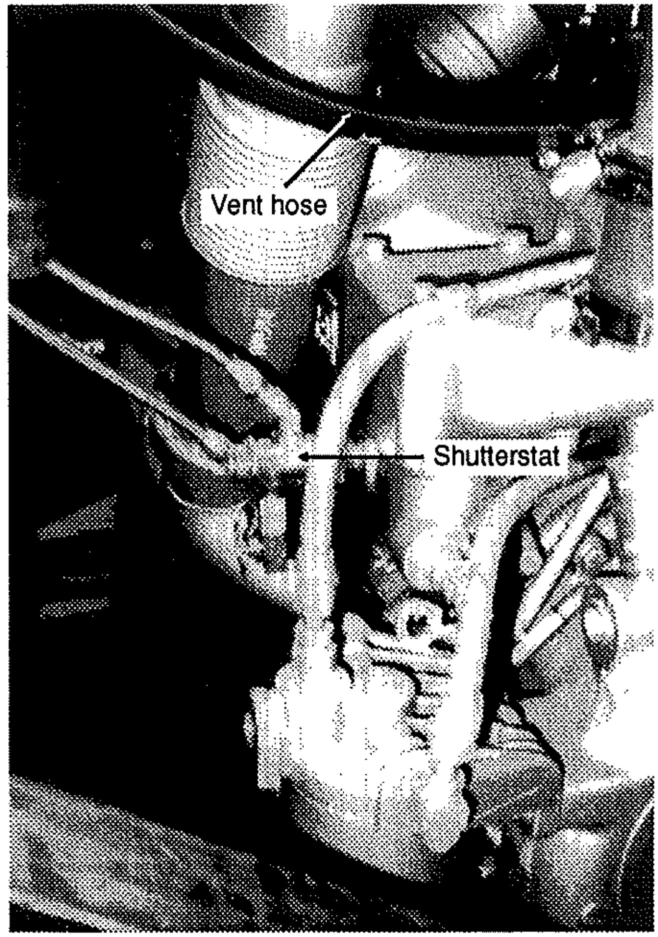

Fig. 12 MA3E0112

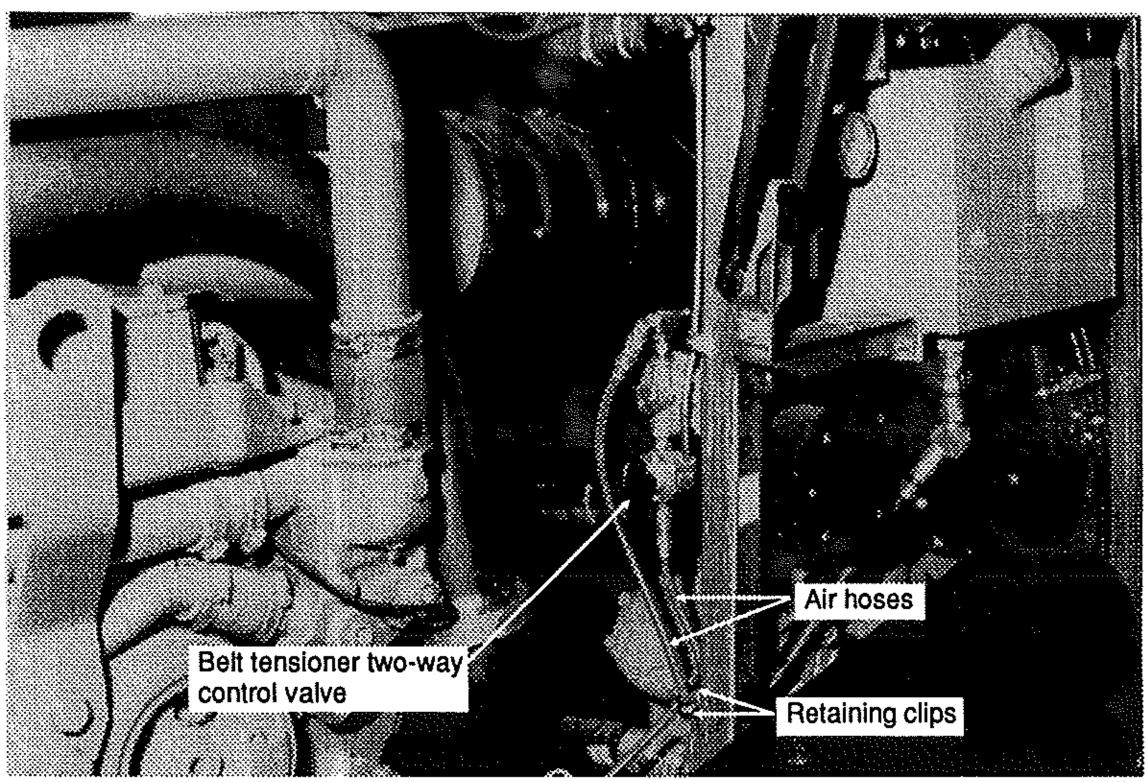

Fig. 11 MA3E0111

14. Disconnect engine oil pressure steel-braided hose from mechanical oil pressure gauge (see fig. 13, item 4), then remove retaining clips.

15. Disconnect the delivery hose(s) from the engine oil reserve tank (2 on vehicle equipped with manual transmission) (see fig. 13, item 5).

16. Disconnect the air compressor intake hose from engine air intake duct.

17. On vehicle equipped with an electrically operated cold starting aid, disconnect the ether discharge hose from air intake duct, then the delivery hose from the starting aid cylinder solenoid valve. Remove cable ties securing hoses.

18. Disconnect and remove the engine air intake duct mounted between air cleaner housing and turbo (see fig. 13, item 6).

CAUTION: Cover the turbocharger inlet opening to prevent foreign material from entering, as it could damage the parts.

19. Disconnect positive cable (red terminal) from starting motor solenoid, then remove cable ties securing it.

20. Disconnect ground cables from rear subframe ground stud (located close to the starting motor).

21. Close engine fuel supply shutoff valve on primary fuel filter, then disconnect the fuel line connected to inlet port, (on vehicle equipped with the optional primary fuel filter/water separator, disconnect fuel line from outlet port, see fig. 14).

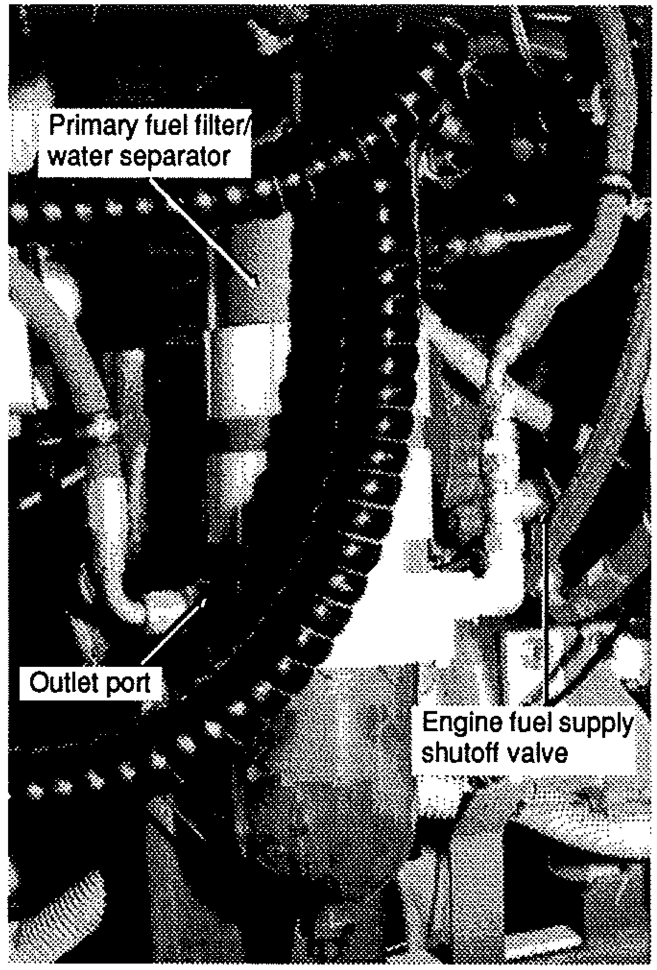

Fig. 14

MA3E0114

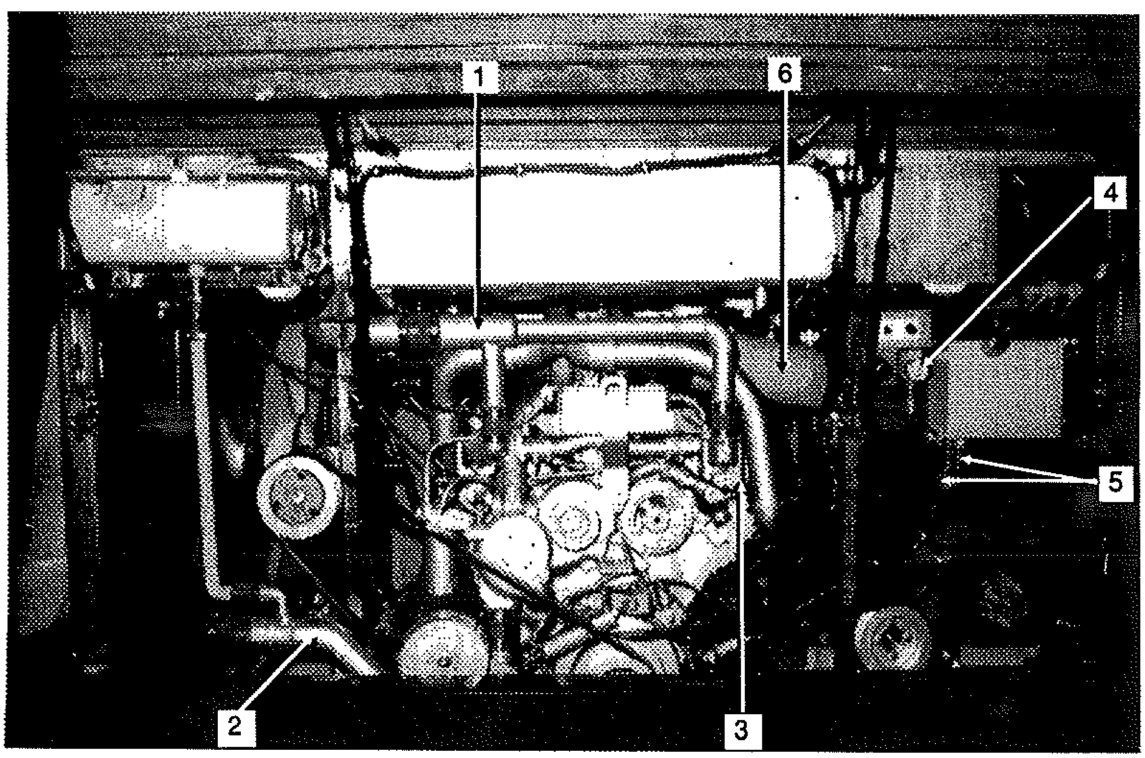

Fig. 13

MA3E0113

22. Disconnect fuel return line from bulkhead fixed on engine cylinder head end, close to power steering pump.

23. Disconnect the power steering pump supply and discharge hoses. Cap immediately hose openings to limit fluid loss.

24. On vehicle equipped with an automatic transmission provided with a hydraulic output retarder, disconnect steel-braided air line from solenoid valve outlet, then remove retaining clips. The solenoid air valve is mounted in the upper section of engine compartment back wall.

25. On vehicle equipped with a NON-ATEC automatic transmission, disconnect steel-braided air line from pressure regulator outlet, then remove retaining clips. The pressure regulator is mounted in the upper section of engine compartment back wall (see fig. 15).

26. Disconnect the power plant wiring harness main connectors from receptacle housing mounted on engine compartment ceiling (3 connectors for vehicles equipped with ATEC transmission and only 2 connectors for all other vehicles) (see fig. 15).

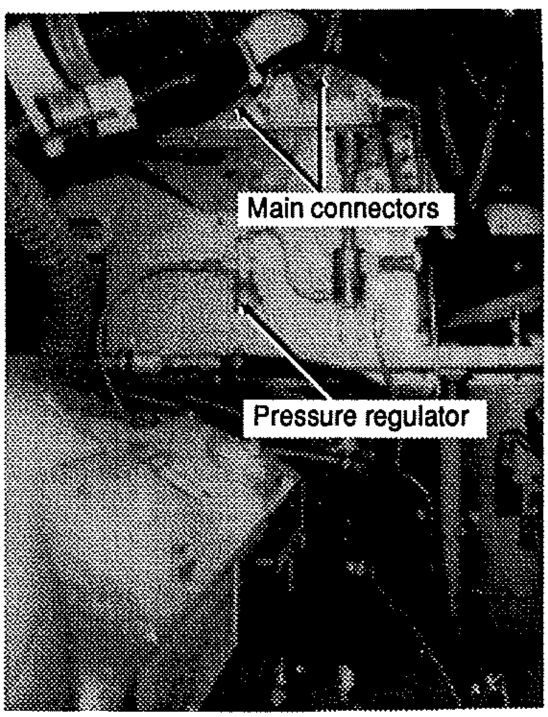

Fig. 15

27. From under vehicle, disconnect the propeller shaft as detailed in section 09 *"Propeller shaft"* of this manual.

28. Remove engine splash guards in order to obtain a better access to power plant assembly rear components.

29. Disconnect the air compressor discharge and governor steel-braided air lines.

30. On vehicle equipped with a manual transmission, disconnect shift linkage adapter from transmission shift lever pivot, then disconnect steel-braided hydraulic hose from the clutch operating cylinder. Cap immediatly hydraulic hose opening to limit fluid loss.

31. Disconnect the coolant delivery pipe located in side of engine, close to the alternator.

32. Disconnect and remove the exhaust pipe mounted between turbo outlet and the muffler (if required, refer to section 04 "Exhaust system").

CAUTION: Cover the turbocharger outlet opening to prevent foreign material from entering, as it could damage the parts.

33. Disconnect turbo boost pressure gauge air line (if vehicle is so equipped) from engine air inlet adaptor housing (connector between turbo and blower).

34. Inspect the power plant assembly to ensure that nothing will interfere when sliding out the cradle.

35. Remove the 6 retaining bolts, washers and nuts securing the power plant cradle to the vehicle rear subframe as detailed in figure 16.

NOTE: Check if any spacer(s) have been installed between power plant cradle and vehicle rear subframe, and if so, note position of each washer for reinstallation purpose.

36. Using a forklift which minimum capacity must be 4,000 lbs (1 800 kg), raise slightly the power plant cradle, then pull it out **slowly** from the engine compartment, while checking to see that all lines, wiring and controls are disconnected and are not tangled.

CAUTION: Due to the minimum clearance between the power plant equipment and the top of the engine compartment, extreme care should be used to raise the power plant cradle only enough to free the cradle. Clearance between power plant cradle and mounting rail should range between 1/4" and 1/2" (6 - 12 mm).

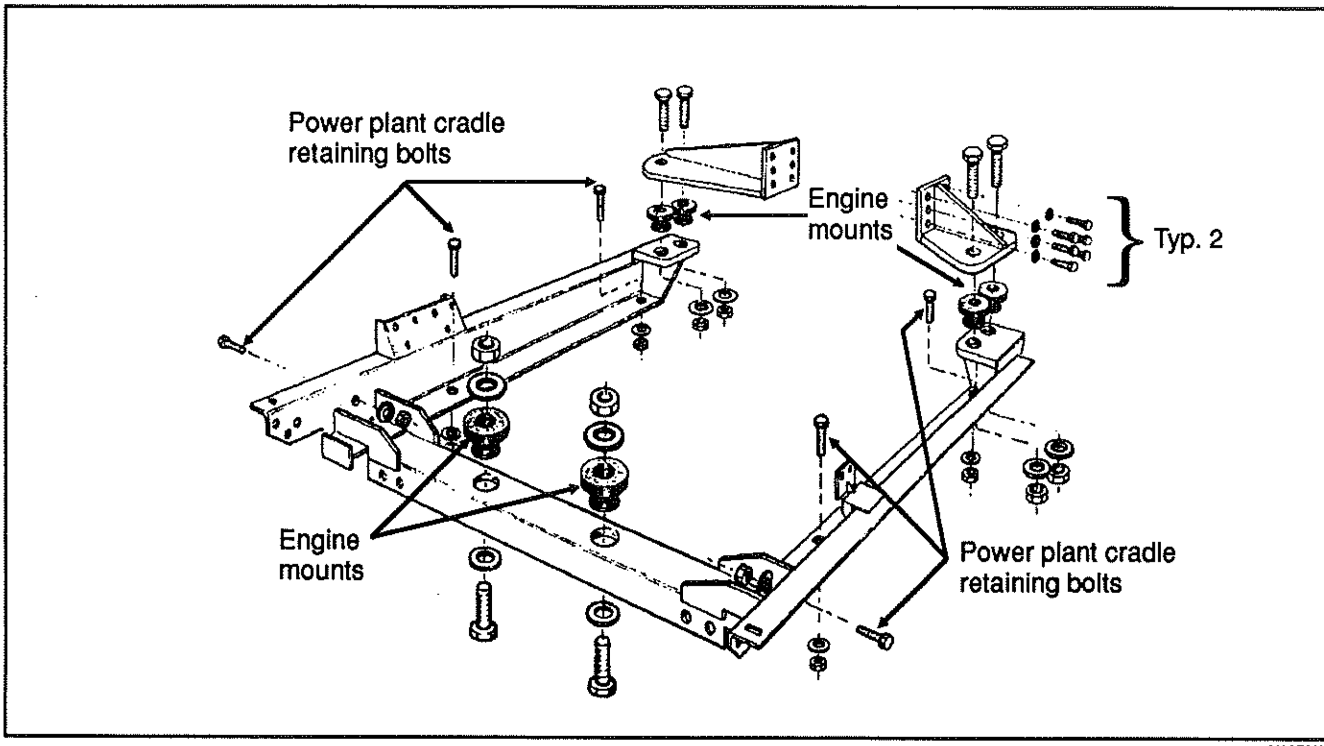

Fig. 16 - Power plant cradle (8V engine model)

POWER PLANT ASSEMBLY INSTALLATION

Installation of the power plant assembly is the reverse of the removal procedure described above plus the following:

1. Torque the power plant cradle mounting bolts to 145 - 175 lbf•ft (195 - 240 N•m).

2. Refill cooling system. If engine fuel system has been drained, it will aid restarting if fuel filters are filled with fuel oil. Remove vent plugs and pour clean fuel oil into filter housings until filters are full (refer to section 03 "Fuel system" for more details).

3. Start engine and check operation. Check fuel, cooling, pneumatic and hydraulic system connections for leakage. Test operation of engine controls and accessories.

ENGINE MOUNTS

The power plant assembly is mounted to the cradle by means of 4 rubber mounts on a vehicle powered with a 6V engine, and 6 rubber mounts on a vehicle with a 8V engine.

Two rubber mounts are used at front of engine while the 2 or 4 other ones are mounted each side of the transmission torque converter housing on vehicle equipped with automatic transmission, and each side of engine flywheel housing on vehicle equipped with manual transmission.

It is recommended that new rubber mounts be installed whenever the engine is removed from the vehicle.

Before installation of new rubber mounts, mounting and socket should be lightly lubricated with rubber lubricant or water only. A special rubber lubricant, P-80, is available from International Products Corporation, Trenton, New Jersey.

CAUTION: No other lubricant should be used.

Improper installation of the press fit type engine mounts can contribute to excessive engine vibrations. When new mounts are installed, mount bolts should be left loose until engine can be run for a short period of time. If engine is accelerated a few times, the rubber mount will find its correct position and then mount bolts can be torqued to 132 - 170 lbf•ft (180 - 230 N•m).

SERVICE BULLETINS AND
SERVICE INFORMATION LETTERS

Service Bulletins and Service Information Letters will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of publications pertaining to this section should be noted below as soon as received. These should then be filed for future reference.

NUMBER	DATE	SUBJECT

02

CLUTCH

CONTENTS OF THIS SECTION

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GENERAL DESCRIPTION

The vehicle equipped with a manual transmission is provided with the *"Spicer"* Easy-Pedal Angle-Spring clutch. The clutch assembly consists of a 15 1/2" dry disc two plate model. It is a pull-type design with riveted organic facings on driven discs, manually adjustable to compensate wear and hydraulically operated. A torque limiting clutch brake as well as a positive separator pin systems are also provided. Two types of clutch assembly (different internal springs) are used according to the engine model, whether it is a 6V or 8V engine.

RECOMMENDED OPERATION AND MAINTENANCE

Long clutch life requires that the clutch be properly installed, used and maintained.

EXCESS FRICTION HEAT, A CLUTCH'S WORST ENEMY

Almost every early failure of a clutch can be traced to excess friction heat. Proper operation and maintenance as outlined below will largely eliminate this source of clutch failure.

1. Do not *"ride"* or *"slip"* the clutch. Once a clutch is fully engaged, there is no heat generated and little or no wear. However, during the brief period when the clutch is picking up the load, considerable heat is generated. By riding or sliping the clutch, the period of partial engagement is lengthened - causing unnecessary heat and wear.

2. Always start in the proper gear. Obviously, an empty vehicle can be started in a higher gear than a fully loaded one. But starting in a gear too high for the load can cause clutch slippage, too much heat and unnecessary wear. Drivers should be trained to use a gear low enough to prevent excess wear on the clutch. A gear that will start the vehicle moving with the engine at idle speed is usually correct. If the engine must be revved up to prevent stalling, the gear selection is too high.

3. Do not shift until vehicle has reached proper speed. Upshifting before the vehicle has reached the right speed is almost as bad as starting off in too high a gear. When the difference between the vehicle speed and the engine speed is too great, the clutch is forced to slip. The result is extra heat and wear.

4. Match the proper clutch to the vehicle. The clutch provided by PREVOST is of the proper specification for the coach. Replacing the factory-installed clutch with one of different specifications may result in a clutch that is too light duty, resulting in early burn-out. Mismatching the clutch to the vehicle is not only bad for the clutch, it can cause early wear on the whole drive train.

5. Never hold a vehicle on a hill with the clutch. To hold on a hill with the clutch requires that the clutch be purposely slippped. By doing this enough heat can be generated to burn up the clutch.

6. Never coast with the clutch disengaged. This can cause clutch failure by the very high rpm encountered when coasting in gear with the clutch released. In this situation, the wheels are driving the clutch disc through the multiplication of the drive axle and transmission ratios. This can result in over 10,000 rpm, beyond the burst strength of the facing material. Something as simple as coasting down a long ramp can burst a driven disc.

7. Never engage the clutch while coasting. This should not even have to be said, since responsible drivers should never coast with clutch disengaged. Re-engaging a clutch after coasting causes tremendous shock to the clutch and the whole drive train. It can result in internal engine damage and/or clutch and flywheel failure.

8. Always report unusual clutch operation promptly. Proper maintenance, performed on time, will greatly extend the life of the clutch. The driver should report any change in free pedal (free travel), slippage or any strange *"feel"* to the clutch operation.

TRANSMISSION REMOVAL

NOTE: For more details, refer to section 07 *"Transmission"*.

Use a suitable transmission jack to properly support and maintain the engine/transmission alignment when removing transmission. Do not let the rear end of the transmission drop down and hang unsupported in the spline hubs of the clutch discs to avoid bending or distorting the friction discs. Disconnect the clutch operating cylinder external linkage and remove cylinder assembly (without disconnecting hydraulic hose), to permit the release yoke to turn up and pull free of the release bearing thrust pads, then disconnect the transmission shift linkage.

CLUTCH REMOVAL

Install the spline aligning tool into the release bearing assembly and the driven discs (see fig. 1). An old transmission input shaft may be used for this purpose. Insert two 5/8" (16 mm) spacers between the flywheel ring and the release bearing housing (see fig. 2), then loosen the mounting bolts around the flywheel.

NOTE: Be sure to progressively loosen the mounting bolts in a criss-cross pattern to prevent cocking and bending within the clutch and insure easy removal of the clutch mounting bolts. The spacers relieve the heavy internal spring load in the clutch assembly.

WARNING: Because of the weight of the clutch, install two guide studs in the top mounting bolt holes to facilitate removal (see fig. 3). Then remove the mounting bolts and carefully remove the clutch assembly.

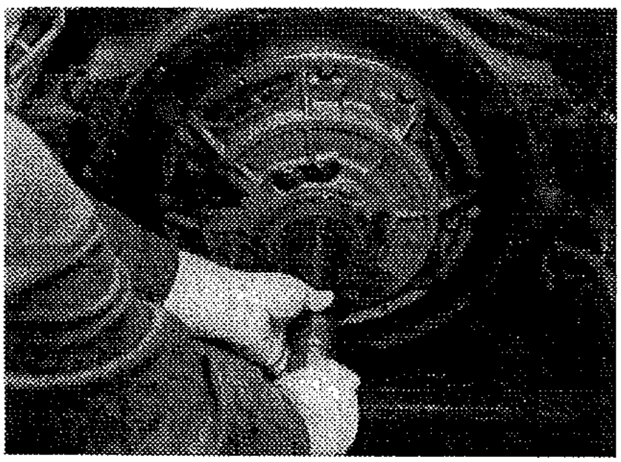

Fig. 1 MA3E0201

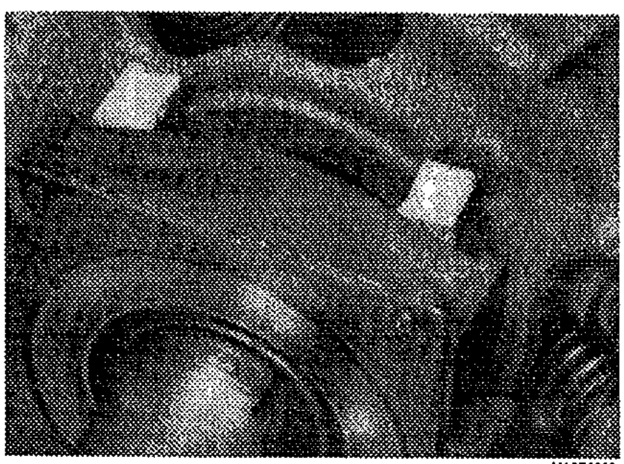

Fig. 2 MA3E0202

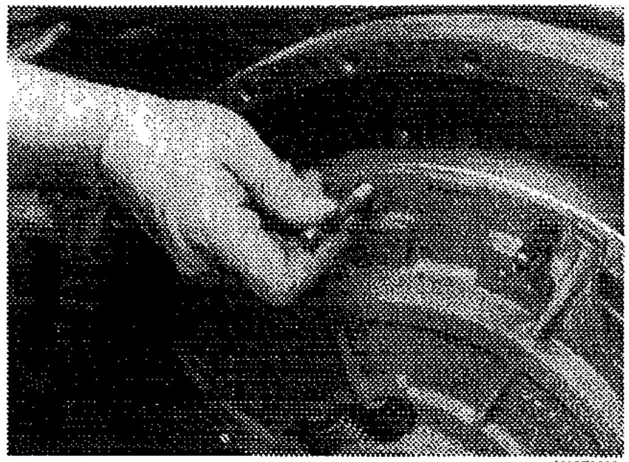

Fig. 3 MA3E0203

ENGINE AND TRANSMISSION ALIGNMENT

The engine and transmission must line up. To check for this, make the following checks or measurements. Surfaces being gauged or measured must be clean for accurate measurements.

Inspection

Inspect the mating faces of the transmission clutch housing and the engine flywheel housing (see fig. 4). Any appreciable wear on either housing will cause misalignment. Replace housing if worn. Most wear will be found on the lower half of the facings. Most common wear areas are between the 3 and 8 o'clock positions (see fig. 5).

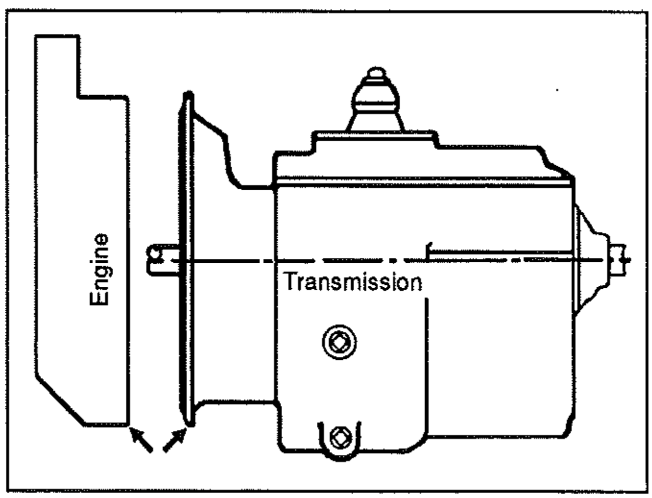

Fig. 4 MA3E0204

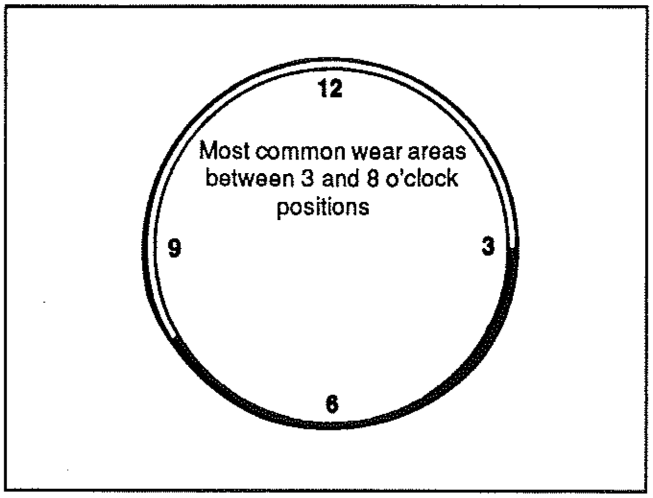

Fig. 5 MA3E0205

With dial indicator secured to engine flywheel or crankshaft (see fig. 6) and gauge finger against housing pilot, rotate flywheel by hand. With chalk or soapstone, mark high and low points. Total indicated difference between high and low points must be .008" (.203 mm) or less.

Now move gauge finger to contact face of engine flywheel housing (see fig. 7). Rotate flywheel and mark high and low points. Total runout should not exceed .008" (.203 mm).

Next, secure dial indicator to engine flywheel housing with gauge finger on face of flywheel near the outer edge (see fig. 8). Rotate flywheel. Maximum permissible runout is .008" (.203 mm).

Now move gauge finger to contact pilot bearing bore surface (see fig. 9). Rotate flywheel. Maximum total allowable runout is .005" (.127 mm).

If any of these limits are exceeded, the problem must be corrected or misalignment will cause premature wear to drive train components.

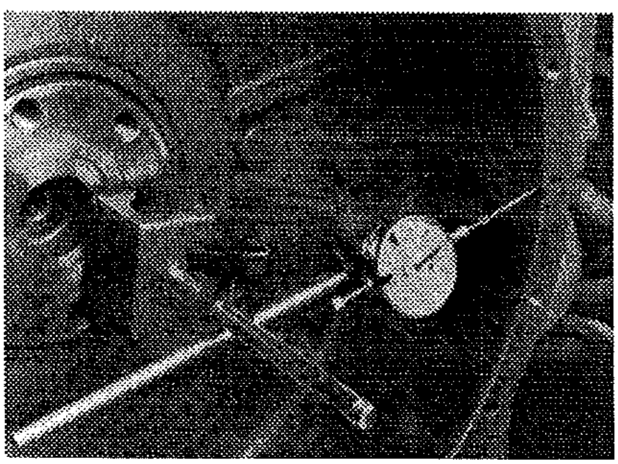

Fig. 6 MA3E0206

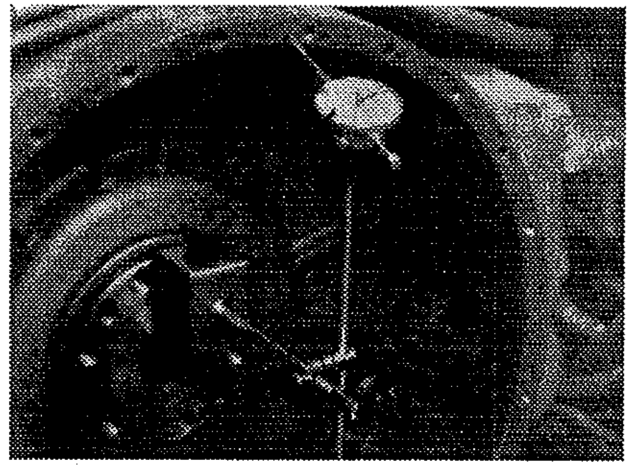

Fig. 7 MA3E0207

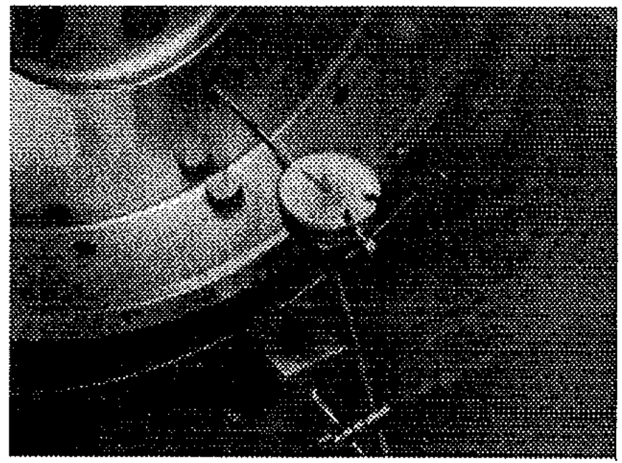

Fig. 8 MA3E0208

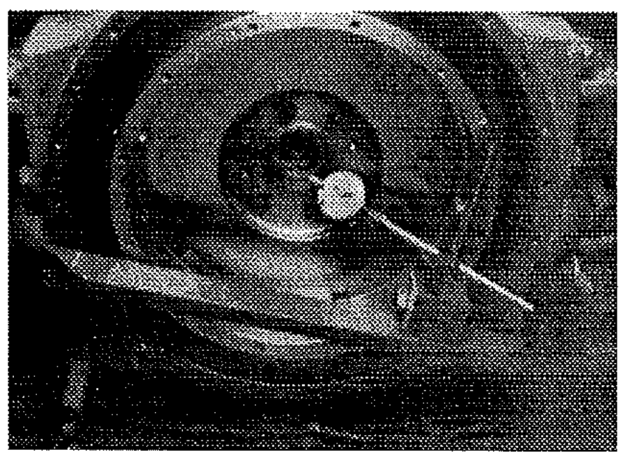

Fig. 9 MA3E0209

CLUTCH INSTALLATION

Insert two 7/16" - 14NC x 5" long (130 mm) guide studs into the two upper mounting holes of the flywheel (see fig. 10), rotate flywheel if necessary to level the guide studs. Insert the spline aligning tool through the release bearing sleeve (see fig. 11).

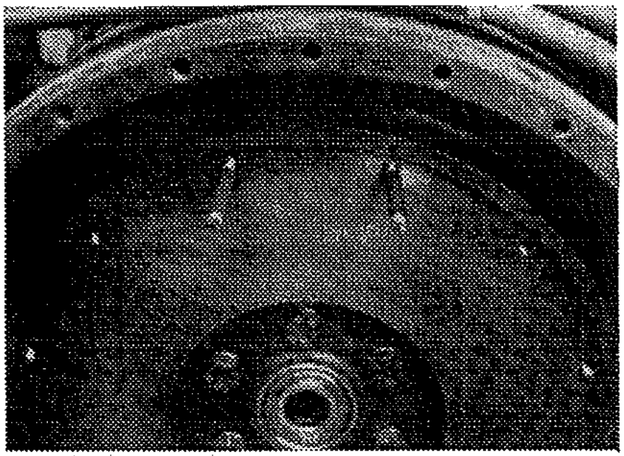

Fig. 10 MA3E0210

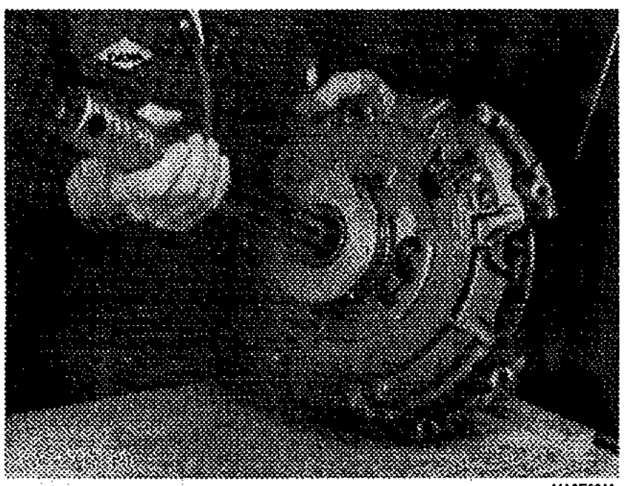

Fig. 11 MA3E0211

Install the rear driven disc on the tool with the side stamped *"pressure plate"* facing the pressure plate, position the intermediate plate so that the pins set toward the flywheel side. The pins should be flush on the pressure plate side (see fig. 12). Install the front driven disc on the aligning tool with the side stamped *"flywheel"* facing the engine.

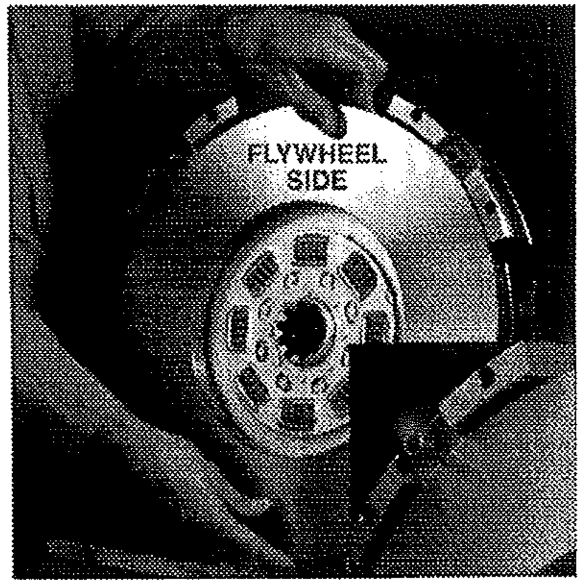

Fig. 12 MA3E0212

Position the clutch over the two guide studs and slide the assembly forward until it starts in the flywheel pilot. Start six 7/16" grade 5 (or better) mounting bolts with lock washers and tighten finger tight. Tap the spline aligning tool (see fig. 13) to make sure it is centered and seated in the pilot bearing, then remove the two guide studs and replace them with the 7/16" bolts and lock washers. Tighten the 8 bolts progressively in the sequence shown in figure 14. The final torque is 45 to 50 lbf•ft (61 to 68 N•m).

CAUTION: Remember that if the bolts are not tightened in sequence, it can cause permanent damage and/or an out of balance condition.

Fig. 13 MA3E0213

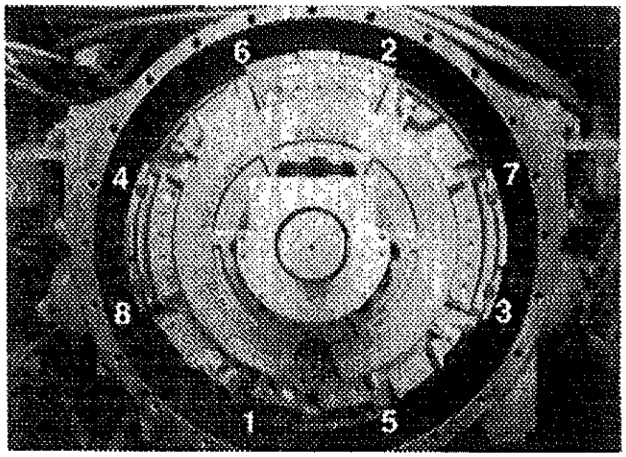

Fig. 14 MA3E0214

Locate the pin access holes by noting position of the arrows on figure 15. Using a 1/4" diameter flat-nosed drift, lightly tap each pin toward the flywheel through 5/16" diameter hole (see fig. 16). The pins should now be flush against the flywheel.

WARNING: Safety glasses must be worn during this procedure.

NOTE: The separator pin will allow the intermediate plate to move back when the clutch is released, giving constant gap on both sides of the intermediate plate.

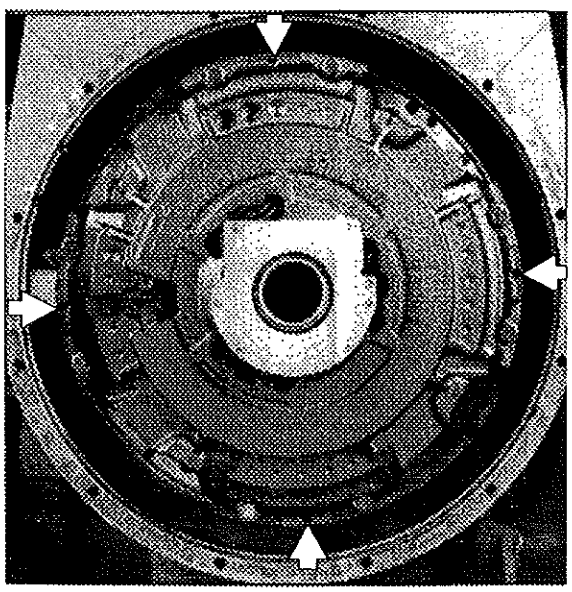

Fig. 15 MA3E0215

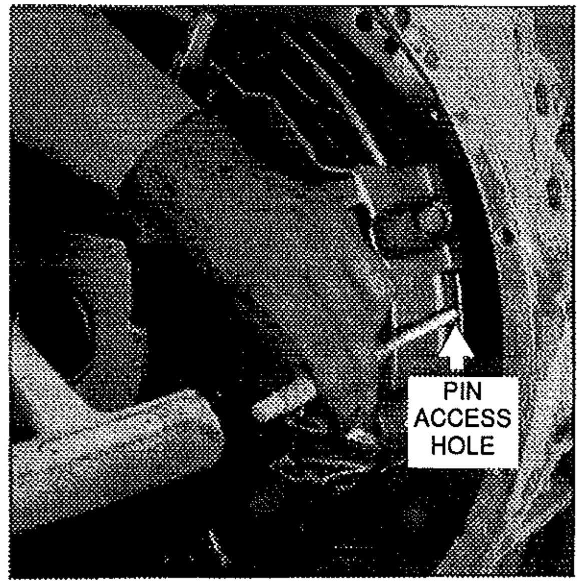

Fig. 16 MA3E0216

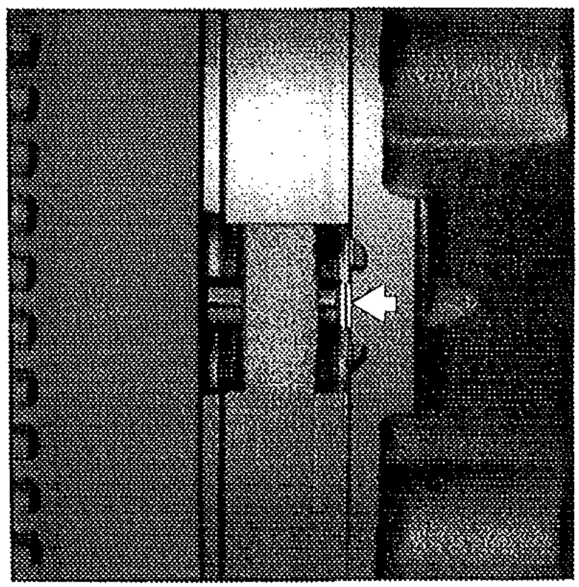

Fig. 17 MA3E0217

TRANSMISSION INSTALLATION

NOTE: For more details, refer to section 07 *"Transmission"*.

1. Position the torque limiting clutch brake on the main drive gear of the transmission (see fig. 18), then shift transmission into gear so that the input shaft can be rotated during assembly to align with clutch-driven disc hub splines.

2. Rotate clutch release bearing housing so that flat section is on top (see fig. 19).

3. Rotate clutch release yoke so that release yoke fingers clear the pads on the release bearing housing. Use a suitable transmission jack to support and maintain the engine-to-transmission alignment while installing the transmission. Use care to avoid hanging the weight of the transmission on the clutch or forcing the transmission into the clutch or flywheel housing. Either of these abuses can cause bent or *"sprung"* driven discs and prevent the clutch from releasing. Rotate clutch release yoke into proper position as transmission is moved into place (see fig. 20 & 21).

4. Start all transmission bell housing cap screws and tighten progressively around the housing to 45 lbf•ft (61 N•m).

5. Connect the transmission shift linkage. Install the clutch operating cylinder and its linkage, then proceed with the clutch adjustment as explained hereafter.

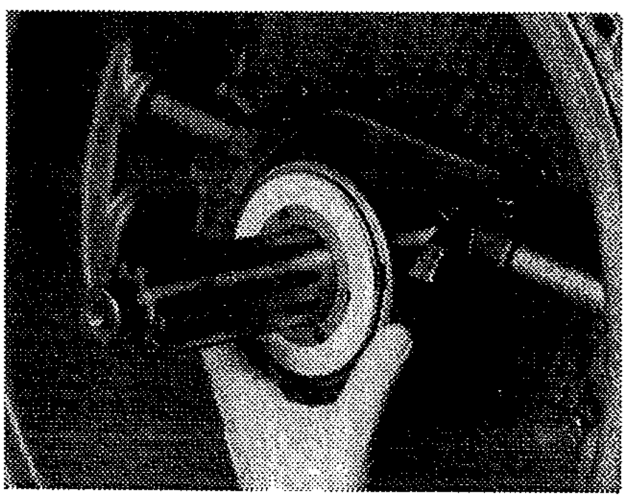

Fig. 18 MA3E0218

Fig. 19 MA3E0219

Fig. 20 MA3E0220

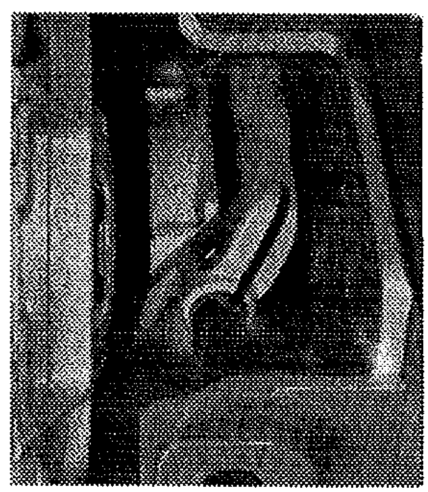

Fig. 21 MA3E0221

CLUTCH ADJUSTMENT

NOTE: If for any reason, air is present inside clutch hydraulic line, proceed with *"clutch bleeding"* as explained later in this section.

Pedal free play

1. Push the clutch pedal by hand, then referring to figure 22, note the clutch pedal free play. When free play ends, pedal resistance will increase abruptly.

2. The desired free play is 1/4" ± 1/8" (6 mm ± 3 mm); if free play is incorrect, loosen the adjustment bolt, reposition the stop "A" as needed to change free play, then tighten the adjustment bolt (see fig. 22).

NOTE: This adjustment is factory made and should not require any modification afterwards.

Internal clutch adjustment

1. Remove inspection cover at bottom of clutch housing.

2. Measure clearance between release bearing housing and clutch brake (refer to fig. 23). The clearance should range between 1/2" and 9/16" (13 and 14 mm).

3. If clearance is incorrect, release the clutch by depressing the clutch pedal to end of pedal travel, then insert a 3/4" socket (12 points) or a 3/4" box-end wrench through inspection hole and depress square-head bolt to adjust clutch (see fig. 24). The *"Kwik-Adjust"* will re-engage at a quarter of a turn. The flat on the bolt head will align with the flat edge of the bracket.

NOTE: If clearance between release bearing housing and clutch brake is less than 1/2" (13 mm), rotate the adjusting ring counterclockwise to move the release bearing toward the engine, and if clearance is greater than 9/16" (14 mm), rotate the adjusting ring clockwise to move the release bearing toward the transmission.

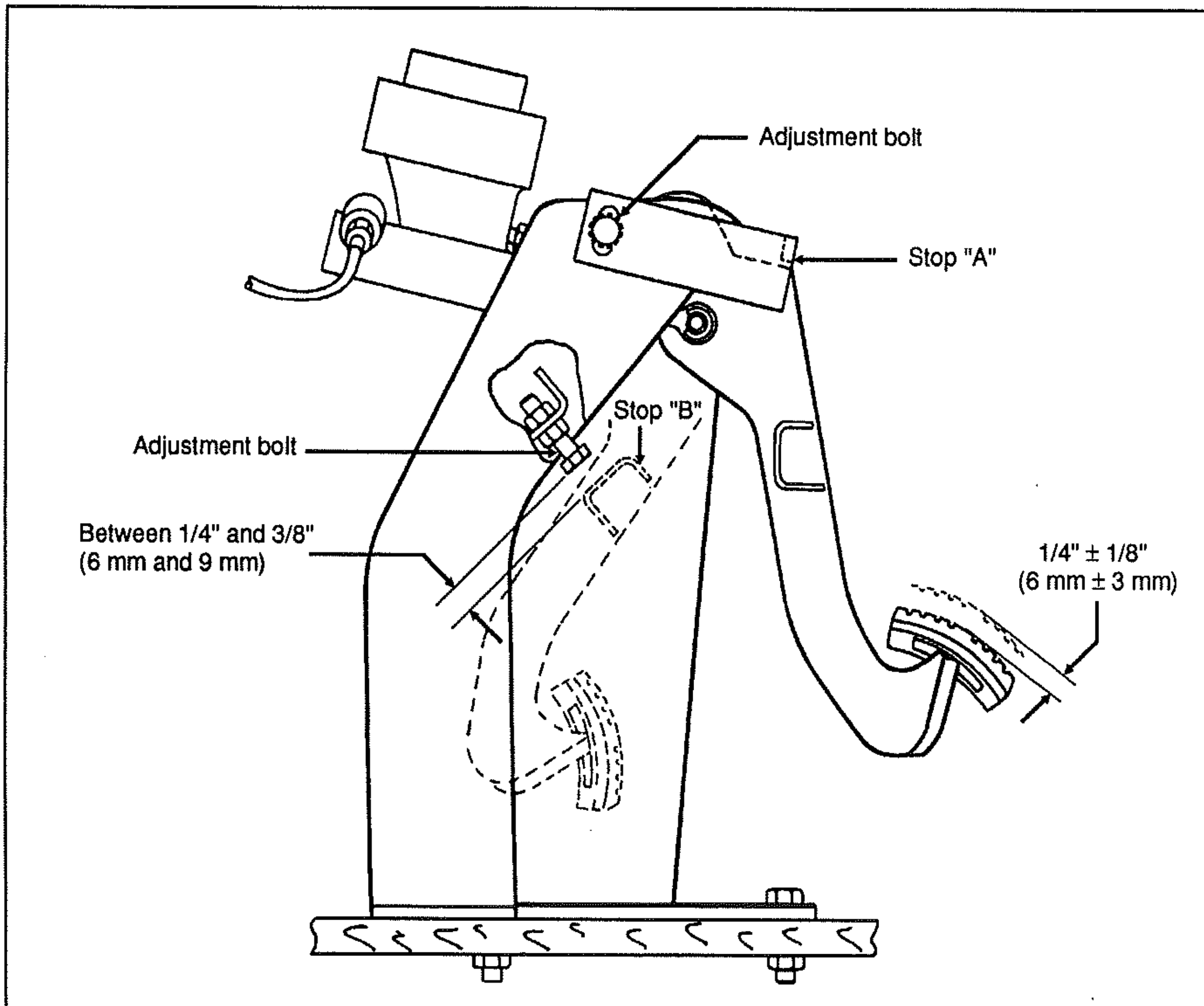

Fig. 22 - Clutch pedal installation

4. Ensure *"Kwik-Adjust"* is engaged in the locked position and release the clutch pedal to engage clutch.

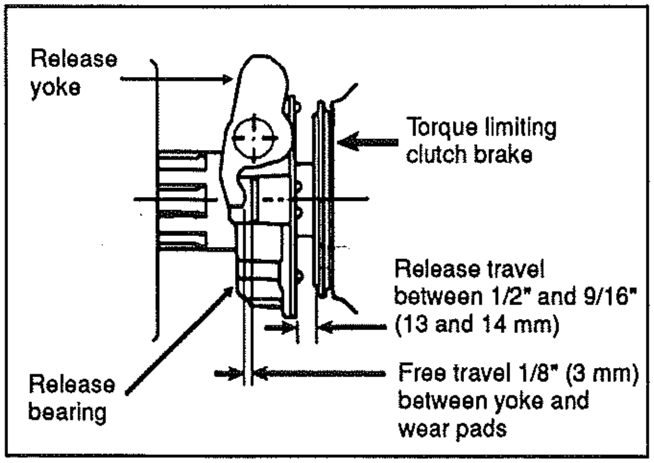

Fig. 23

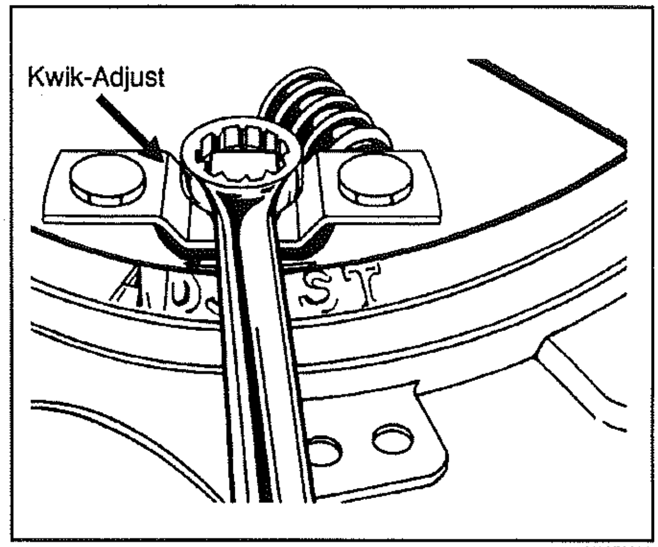

Fig. 24

Free travel setting

1. Check free travel (or clearance between the release yoke and release bearing wear pads as shown in fig. 23). The clearance should be 1/8" (3 mm).

2. If clearance is incorrect, readjust the operating cylinder linkage yoke (see fig. 25) until proper clearance is achieved.

Return spring tension adjustment

The return spring is mounted right over the operating cylinder (see fig. 25). Adjust spring so that it has a sufficient tension to return clutch yoke lever to its neutral position.

NOTE: Return spring tension must not be excessive as it will increase clutch pedal effort needlessly.

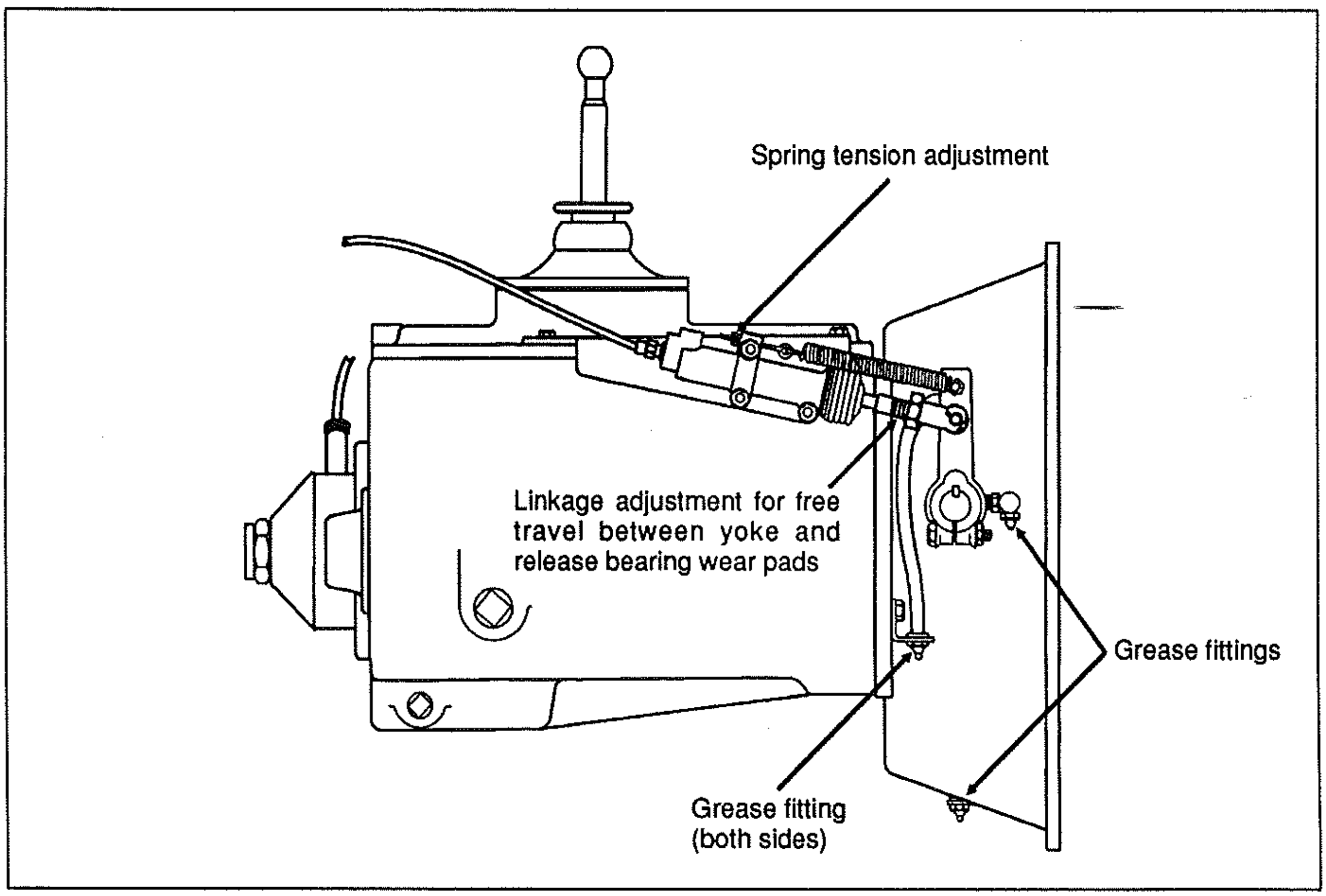

Fig. 25

Clutch brake setting

1. Depress clutch pedal. With correct release travel and free travel settings, the distance between stop "B" mounted on the clutch pedal linkage and the adjustment bolt should range between 1/4 and 3/8" (6 and 9 mm) at the beginning of the clutch brake *"squeeze"* (refer to previous fig. 22).

2. To check this, insert a .030" (0,8 mm) feeler gauge or business card between the release bearing and clutch brake. Depress the clutch pedal and squeeze the card. Let the pedal up slowly. Stop when the card can be pulled out, then measure clearance between stop "B" and adjustment bolt. If clearance is incorrect, reset the adjustment bolt adequately.

CLUTCH BLEEDING

The clutch hydraulic system must be bled whenever air enters it. Unlike hydraulic fluid, air is compressible. This means that instead of transmitting pedal pressure through the hydraulic line, the master cylinder will just compress the air in the line. The result is a mushy feeling pedal, incomplete clutch disengagement, and hard shifting.

Air can be bled by following one of the two methods outlined hereafter; however, **PREVOST recommends method #1 which is the most efficient for this vehicle.**

Method #1

1. Clean the bleed screw on the operating cylinder (slave cylinder).

2. Loosen slightly bleed screw (approximately 1/2 turn).

3. Force brake fluid (heavy duty meeting DOT 3 specs) through the bleed screw opening until fluid reaches the seam of the master cylinder reservoir.

NOTE: A 40 psi (275 kPa) pressure allows filling hydraulic system in a reasonable time.

4. Tighten bleed screw.

Method #2

1. Clean the bleed screw on the operating cylinder (slave cylinder).

2. Connect a plastic tube to the bleed screw. The tube should be fitted snugly. Immerse the other end of the tube in a clear glass jar containing several inches of clean brake fluid.

3. Top up the clutch master cylinder reservoir with heavy-duty brake fluid meeting DOT 3 specifications.

NOTE: Keep an eye on the master cylinder reservoir fluid level during bleeding. If fluid level drops too low, air will be drawn into the cylinder and bleeding will have to be repeated.

4. Have an assistant pump the clutch pedal several times, then hold it to the floor.

5. With the clutch pedal down, open the bleed screw to let air and fluid escape. Close the bleed screw while the pedal is still down.

6. Repeat steps 4 and 5 until the fluid entering the jar is free of air bubbles. Remove the tube, then fill the clutch master cylinder reservoir until fluid reaches the reservoir seam.

CAUTION: Never reuse brake fluid which has been bled from the system.

RECOMMENDED LUBRICATION

The clutch components should be lubricated every 5,000 miles (8 000 km) or twice a year, whichever occurs first (refer to previous fig. 25 to identify the clutch component grease fittings).

The clutch release bearing should be lubricated with a good quality lithium-base soap or equivalent E.P. grease having an operating temperature range of + 325 °F to + 10 °F (+ 163 °C to - 12 °C). In addition, the grease should meet the N.L.G.I. grades 1 or 2 specifications. The clutch control cross shaft, which is provided with three grease fittings (two on the operating cylinder side, and one on the other side), may be lubricated with molybdenum disulphide grease.

TROUBLESHOOTING

Poor clutch release or poor engagement

Probable cause	Correction
1. Clutch adjustment not correct.	1. Recheck adjustment per instructions.
2. Air in clutch hydraulic line.	2. Bleed clutch hydraulic line per instructions.
3. Flywheel pilot bearing too tight in flywheel or on end of drive gear.	3. Free pilot bearing to a light push. If bearing is rough, replace it.
4. Damaged clutch release bearing.	4. Replace bearing. Lubricate with recommended lube.
5. Clutch release shaft projecting through release yoke.	5. Relocate release shaft so that it does not project. Check bell housing bushings and release yoke for wear.
6. Release yoke contacting cover assembly at full release position.	6. Replace release yoke with proper yoke.
7. Release yoke not aligned properly with release bearing.	7. Check flywheel. Probably has been resurfaced more than the .060" (1,52 mm) recommended.
8. Intermediate plate sticking on drive lugs (AS-1402 only).	8. Check that drive pins are 90° square to flywheel surface and that there is a minimum .006" (0,152 mm) clearance between drive pins and intermediate plate slots.
9. Pressure plate not retracting.	9. a. Check pressure plate drive lugs for .006" (0,152 mm) clearance. b. Check pressure plate return springs for proper tension. c. Check amount of release travel. d. Lever nose out of groove.
10. Driven disc distorted.	10. Should be straight within .015" (0,381 mm). Replace if it can't be straightened.
11. Worn splines on drive gear of transmission.	11. Check drive gear and driven disc hubs for excess wear.
12. Disc facings gummed with oil or grease.	12. Replace facings or entire disc. Cleaning not recommended. Check for leak causing gumming.
13. Broken intermediate plate.	13. Replace entire intermediate plate/driven disc assembly. Damage such as this is almost always caused by abusive use of clutch.

Clutch slipping

Probable cause	Correction
1. No free pedal.	1. Re-adjust per instructions.
2. Release mechanism binding.	2. Check release mechanism and linkage. Lube if necessary.
3. Worn clutch facings.	3. Replace facings or complete disc, if necessary.
4. Grease or oil on facings.	4. Replace facings.
5. Weak pressure springs.	5. Replace springs.
6. Overloaded clutch.	6. Check to assure that proper clutch has been specified.

Noisy clutch

Probable cause	Correction
1. Clutch release bearing dry or damaged.	1. Lubricate bearings or replace.
2. Flywheel pilot bearing dry or damaged.	2. Lubricate bearings or replace.
3. Clutch release bearing housing striking flywheel ring.	3. Adjust clutch. Also check wear on cross shafts, bell housing bushings and release yoke fingers. Replace if necessary.
4. Improper clearance between drive slots and drive lugs on pressure plates.	4. Clearance should be no less than .006" (0,152 mm).

SPECIFICATIONS

CLUTCH ADJUSTMENT

Pedal free play . . . . 1/4 ± 1/8" (6 ± 3 mm)
Internal clutch adj. . . . . between 1/2 - 9/16" (13 - 14 mm)
Free travel setting . . . . 1/8" (3 mm)
Clutch brake setting (between stopper and adjusting bolt) . . . . between 1/4 - 3/8" (6 - 9 mm)

CLUTCH ASSEMBLY

Make . . . . DANA Corp. (Spicer)
Model . . . . Easy Pedal
Type . . . . Dry, two-plate, pull-type, manually adjustable (Kwik- Adjust)
Size . . . . 15 1/2" (394 mm)
Plate Load Capacity (with 8V-92 engine) . . . . 3600 lbs (16 013 N)
(with 6V-92 engine) . . . . 2800 lbs (12 454 N)
Maximum Torque Capacity (with 8V-92) . . . . 1250 lbf•ft (1695 N•m)
(with 6V-92) . . . . Approx. 975 lbf•ft (1322 N•m)
Disc & Organic Facing Thickness . . . . .463/.437" (11,76/11,09 mm)
Hub Spline Size (No. splines) . . . . 2" (10)
Disc Assembly Max. Runout (T.I.R.) . . . . .015" (0,381 mm)
Disc Assembly Max. Out-of-Flat . . . . .020" (0,508 mm)
Release Sleeve Bushing Dia. (new) . . . . 2.010/2.008" (51,054/51,003 mm)
Intermediate Plates, driving lugs to slot clearance (new min.) . . . . .006" (0,152 mm)
Intermediate Plates, driving lugs to slot clearance (max. worn) . . . . .015 to .020" (0,381 to 0,508 mm)
Pressure Plates, driving lugs to slot clearance (new) . . . . .003 to .010" (0,076 to 0,254 mm)
Pressure Plates, driving lugs to slot clearance (max. worn) . . . . .016/.021" (0,406/0,533 mm)
Intermediate Plates & Pressure Plates: Out-of-Flat . . . . .000 to .004 Concave (0,000 to 0,102 mm)
Scoring - Max. depth that can be re-used . . . . .015" (0,381 mm)
Release Sleeve Retainer, driving lugs to slot clearance (max. worn) . . . . .020" (0,508 mm)
Maximum Engine rpm 2600

MASTER CYLINDER

Make . . . . Ford
Supplier Number E6HZ-7A543-A
Prevost Number 52-0121

OPERATING CYLINDER (SLAVE CYLINDER)

Make . . . . Ford
Supplier Number E8HZ-7A508-A
Prevost Number 52-0122

SERVICE BULLETINS AND SERVICE INFORMATION LETTERS

Service Bulletins and Service Information Letters will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of publications pertaining to this section should be noted below as soon as received. These should then be filed for future reference.

NUMBER	DATE	SUBJECT

03

FUEL SYSTEM

CONTENTS OF THIS SECTION

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PRIMING FUEL SYSTEM . . . . 3 - 4
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FUEL TANK

The vehicle is equipped with a welded stainless steel fuel tank with a capacity of 235 US gal (890 liters). The tank is located next to the first baggage compartment, between condenser and HVAC unit compartments (Heating, Ventilation and Air Conditioning).

Dual filler necks are provided to refuel from either side of vehicle; the left side fuel filler neck is accesssible through a fuel filling access door, while access to the right filler neck is possible through the refrigerant dryer access door (see *"Operator's Manual"* for details). A pressure relief valve in the tank relieves high pressure buildup, and an air vent allows offset air in the tank to escape during filling.

Furthermore, a drain plug, accessible from under the vehicle, is fitted in bottom of the tank.

Figures 1 and 2 illustrate a schematic layout of the fuel system components.

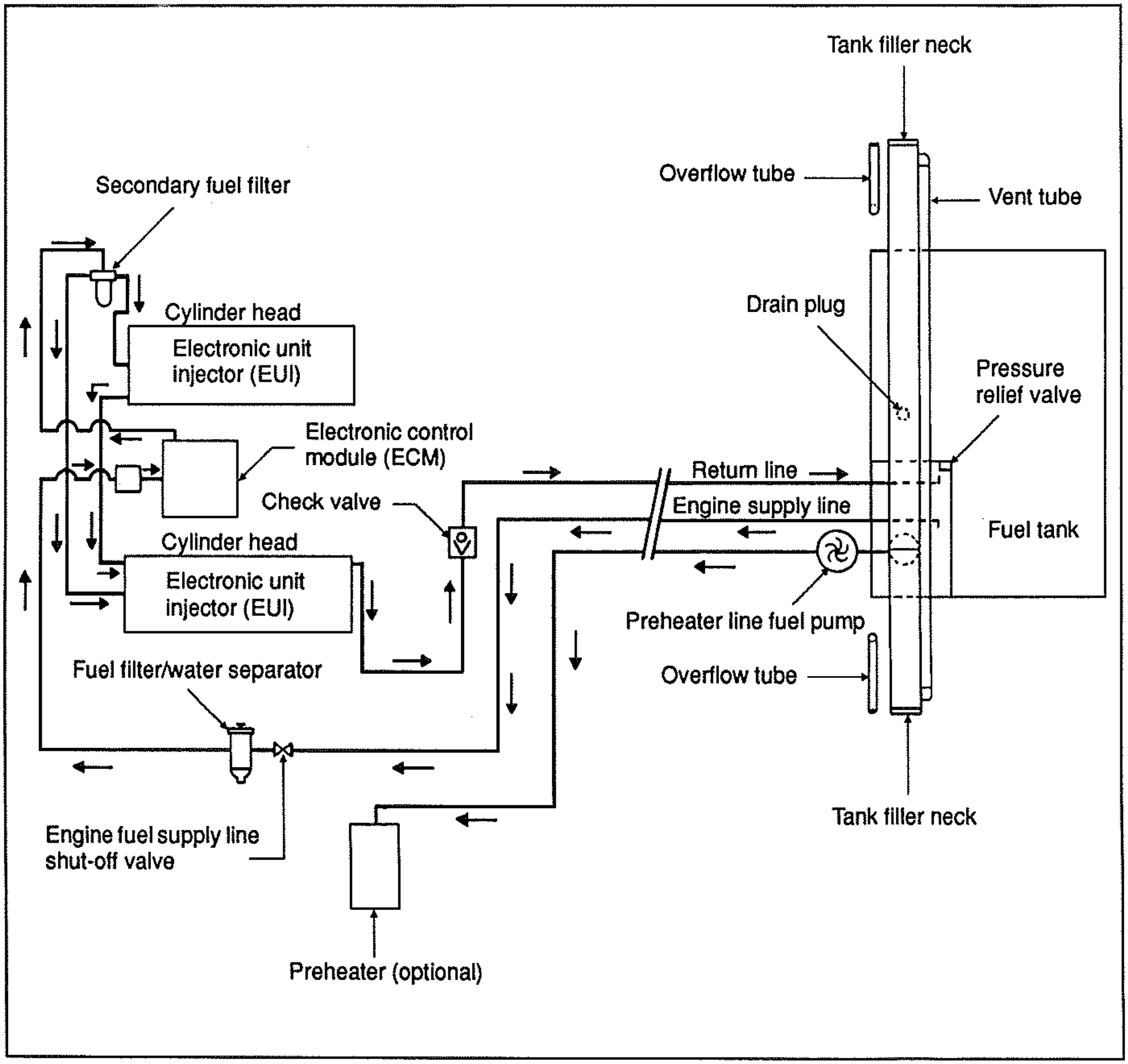


Fig. 1 - Fuel system schematic

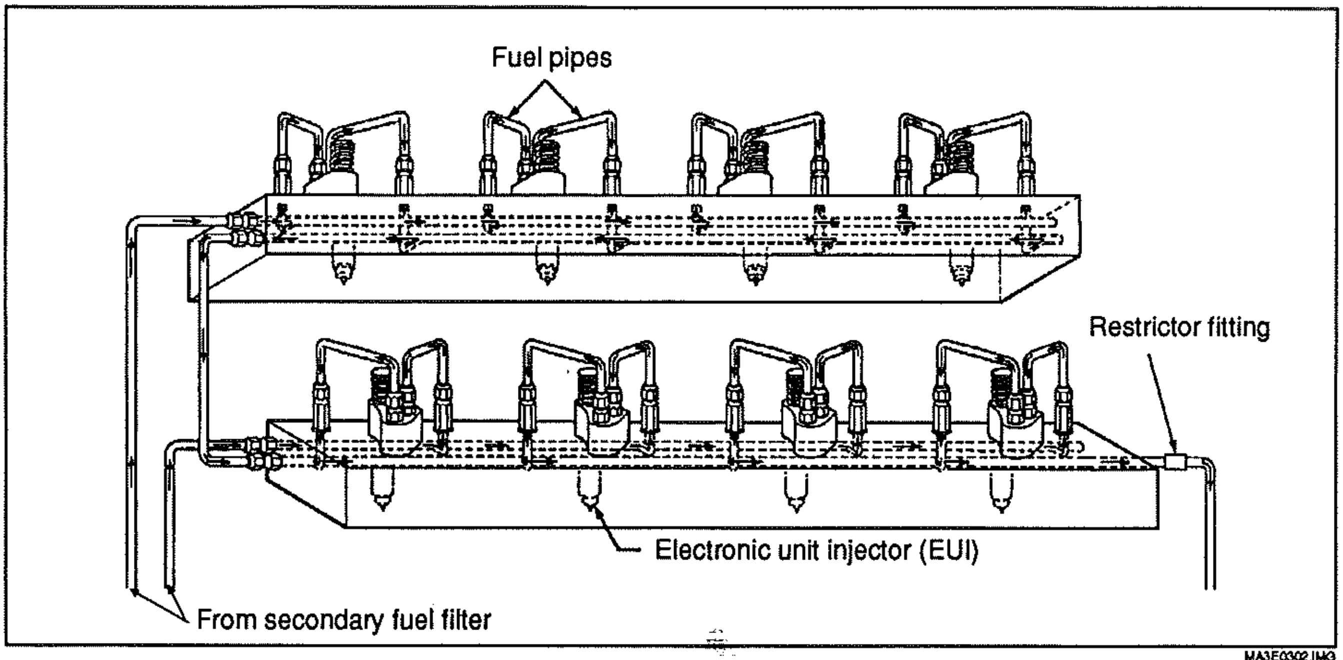


Fig. 2

TANK REMOVAL/INSTALLATION

NOTE: Prior to removal, the fuel tank should be completely drained by unscrewing the drain plug. Ensure that you have an adequate container which capacity is equal to the amount of the remaining fuel in the tank.

1. Open the condenser door (refer to *"Operator's Manual"* for details), then locate the fuel tank line connections along the L.H. corner of the tank.

2. Unscrew the fuel return line, supply line(s), and air vent clamps.

3. Disconnect all fuel and air vent lines, alarms and fuel gauge connectors.

4. Unscrew the fuel tank filler neck tube clamps, then disconnect tubes.

WARNING: Before proceeding with the following step, ensure that the tank is supported adequately. Failure to do so could result in personal injury as well as damage to the tank.

5. From under the vehicle, on the R.H. side, unscrew the four bolts (two on each side) retaining the tank support to the frame bracket.

6. From under the vehicle, on the L.H. side, unscrew the six bolts (three on each side) retaining the tank support to the frame bracket, remove the two mounting plates located between the tank support and frame brackets, then carefully remove tank from under the vehicle.

7. Reverse removal procedure to reinstall fuel tank.

FILTERS AND WATER SEPARATOR

The fuel system is equipped with a primary (strainer) and a secondary fuel filters for additional protection of the injectors. In addition, a fuel filter/water separator can be installed as an option. However, with this option, the primary filter is not used as it is replaced by the fuel filter/water separator.

The filter/water separator, as well as its brackets and fuel line connections, are illustrated in figure 3. Neither of their element or cartridge is cleanable and must be replaced when dirty or clogged. For maximum efficiency, service filters as follows.

NOTE: The service intervals of the filter/water separator element and the secondary fuel filter cartridge are determined by the operating conditions and cleanliness of the type of fuel used.

"Racor" fuel filter/water separator servicing

The *"Racor"* fuel filter/water separator, model 1000 FG, is located on R.H. side of engine compartment. The water separator must be drained periodically or when the indicator light on central dashboard panel turns on. Proceed as follows to drain the water separator.

1. With engine off, close the valve of the engine fuel supply line. Refer to figure 3 for valve location.

2. Turn drain valve under water separator a quarter of a turn counterclockwise to drain accumulated water and contaminants.

3. Close the drain valve.

4. Open the valve of the engine fuel supply line.

CAUTION: If the water separator continuously requires draining, it is possible that water or sediment is accumulated in the fuel tank. To correct this situation, open the drain plug under the tank when the fuel gauge indicates the tank is 1/4 full in order to drain any contaminant.

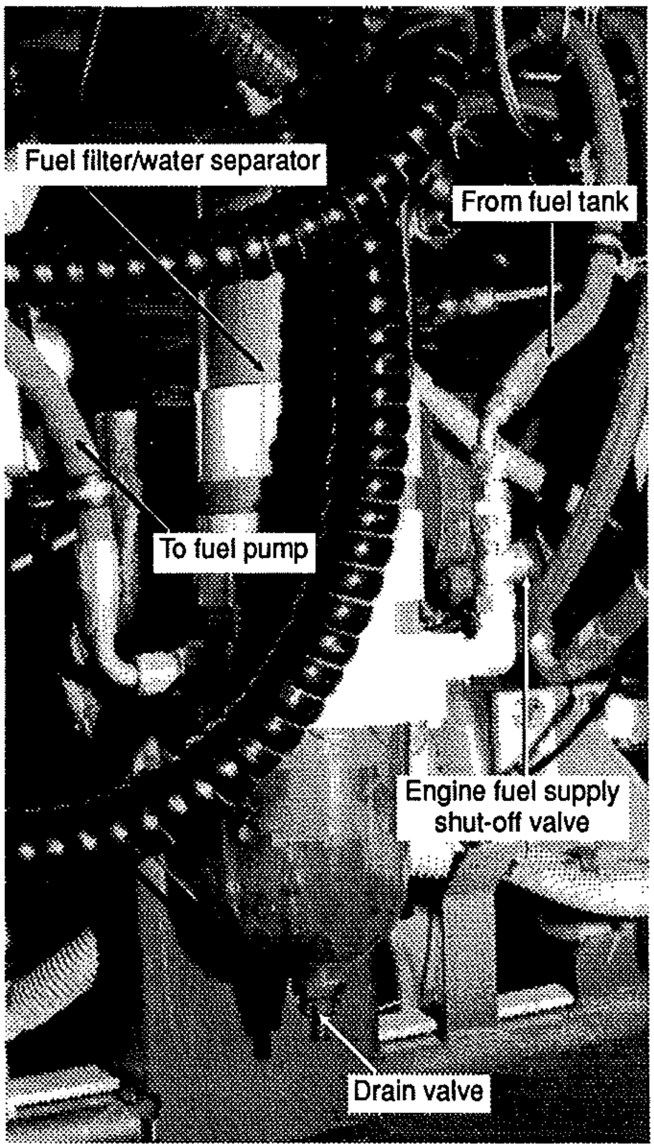


Fig. 3

Proceed as follows to replace the water separator element.

1. Drain the fuel filter/water separator as stated previously.

2. With engine off and the engine fuel supply line valve closed, remove T-handle and the water separator lid.

3. Twist and pull out element.

4. Install new element.

5. Prime unit by pouring clean fuel into filter/water separator housing until full.

6. Replace water separator lid and hand tighten T-handle.

7. Open the engine fuel supply line valve.

Refer to the *"Racor"* service manual annexed at the end of this section for instructions on disassembly, cleaning and other service procedure.

Fuel filter servicing (primary & secondary)

The primary filter is installed on the R.H. side of engine compartment below the booster block, while the secondary fuel filter is located on L.H. side of engine (facing the crankshaft pulley) and is fixed to the water pump housing. They are spin-on type, and must be replaced at 10,000 mile (16 000 km) intervals. Proceed as follows to change the filter cartridge(s).

1. Stop engine, shut-off the engine fuel supply line valve located near the primary fuel filter, then unscrew and discard filter(s).

2. Fill new filter replacement cartridge(s) about two-third (2/3) full with clean fuel oil, then apply a thin coat of clean fuel oil on gasket.

3. Install the new filter assembly and tighten it to one-half (1/2) turn after gasket contact.

4. Open the engine fuel supply line valve.

5. Start the engine and check for leaks.

NOTE: To improve starting of DDEC engines, have replacement filter(s) filled with fuel and ready to install *"immediately"* after used filters are removed. This will prevent possible siphoning, causing fuel system aeration.

If the engine fails to start after replacement of the fuel filter cartridge(s), the fuel system will require priming with Detroit Diesel tool #J5956, or equivalent.

PRIMING FUEL SYSTEM

The problem with restarting an engine that has run out of fuel, is that after the fuel is exhausted from the tank, it is pumped from the primary fuel filter or the fuel filter/water separator if vehicle is so equipped, and sometimes partially removed from the secondary filter before the fuel supply is insufficient to sustain engine firing. The primary fuel filter or fuel filter/water separator and secondary filter must be free of air in order for the systems to provide adequate fuel for the injectors. When the engine runs out of fuel, the following operations must be performed before restarting.

1. Fill the fuel tank with the recommended fuel oil. If only partial filling is possible, add a minimum of 10 gallons (38 liters) of fuel.

2. Prime or purge the system by blocking or disconnecting the line from the fuel pump, then direct fuel under pressure (60-80 psi (413-552 kPa)) to the inlet of the secondary filter. If the system is to be purged of air as well, allow fuel to flow freely from the fuel return line until a solid stream without air bubbles is observed.

3. Start the engine and check for leaks.

NOTE: It may be necessary to remove a rocker cover and loosen a fuel pipe nut in order to bleed any trapped air from the fuel system. Ensure the fuel pipe nut is retightened before installing the rocker cover.

FUEL VALVE

A manual shut-off valve on engine fuel supply line is located on the R.H. side of engine compartment below the booster block and near the primary fuel filter (fuel filter/water separator if vehicle is so equipped). This valve is provided for the servicing and maintenance of the fuel system. To close valve, turn the red button a quarter of a turn (1/4) clockwise. No manual valve is required on preheater fuel supply line, as the positive-displacement fuel pump (located close to the fuel tank) will shut off the line when it is not activated.

FUEL LINE MAINTENANCE

The three fuel lines (two only if vehicle is not provided with a preheating system) and their connectors must be checked periodically to prevent leaks or loose connections. There are two supply lines routed from the tank to the engine and the preheater, while the other works as a return line.

For further details, refer to the schematic diagram of the fuel system in figure 1.

FUEL JUMPER LINE MAINTENANCE AND REUSE

Maintenance and service personnel should be aware that severe engine damage could result from fuel oil leakage into the lubricating oil, and should therefore follow proper procedures when removing, handling and installing fuel jumper lines (fuel pipes).

The fuel jumper lines which carry fuel to and from the fuel injectors must be handled and installed very carefully to prevent line damage that can result in fuel leaks and subsequent dilution of the lubricating oil. Fuel diluted lubricating oil can result in severe engine damage. Severe fuel leakage, if not detected, can also result in an overfilled crankcase (oil pan) which can cause an abnormal amount of fuel and lubricating oil vapor to escape from the engine and crankcase breathers. An abnormal concentration of fuel and lube oil vapors is flammable and could ignite in a closed engine compartment.

The following are some of the conditions that can result in fuel jumper line leakage:

1. Improper handling and storage of jumper lines when servicing the engine can result in physical damage and contamination.

2. Careless use of special tool (socket) during removal or installation can cause a jumper line to bend and be permanently distorted.

3. Reuse of a bent or distorted jumper line can result in excessive stress and cause the line to crack or fracture at or above the flared ends of the jumper line. A fuel leak will ultimately result.

4. Excessive tightening of the jumper line nut will distort and fracture the flared end of the jumper line, resulting in a fuel leak. (See NOTE following step 6.)

5. Damaged threads and flare seats on the injector and cylinder head jumper line connectors can also result in fuel leakage.

6. Leaks can also occur at injector filter nut gaskets and/or cylinder head connector washers due to distortion, damage, or incorrect torque.

Fuel jumper lines are preformed to facilitate easy installation on the injector and cylinder head jumper line connectors. Do not attempt to straighten distorted or bent jumper lines for reuse, because the straightening process may cause the jumper line to weaken or fracture and result in fuel leakage.

NOTE: When installing fuel jumper lines, use Detroit Diesel special tool socket (J8932-01). Do not exceed the following torque: 12-15 ft•lbs (16-20 N•m) on standard jumper lines. Damage to the jumper line flares and connector seats can result from excessive tightening, causing fuel leakage into the lubricating oil.

On DDEC engines provided with a *"Jacobs"* engine brake system, tighten the fuel pipe nuts to 140 in•lbs (16 N•m).

CAUTION: This torque specification is very important and should be strictly adhered to. Overtightening or undertightening may cause fuel pipe failure and engine lube oil dilution. Serious engine damage may result. Be careful not to contact the fuel pipe with the fuel pipe nut wrench as this may cause dammage to the flare.

Figure 4 depicts specific conditions which servicing personnel should look for when determining if a fuel jumper line is suitable for reuse.

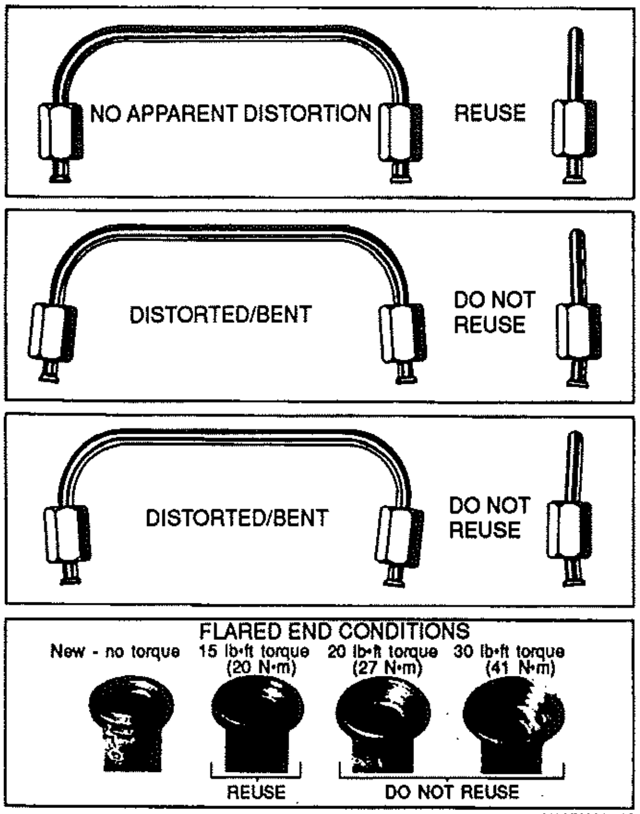


Fig. 4 - Fuel pipe conditions

The following troubleshooting procedure is recommended after installation of fuel jumper lines and/or connectors to determine if fuel leakage is present.

Checking for fuel leaks

Always check the fuel system for leaks after injector or fuel jumper line replacement and any time the fuel connections under the rocker cover are suspected for leaking. Failure to correct a fuel leak in this area can lead to dilution of the lube oil. **Use one of the following methods to check for leaks.**

Method A

Use when the engine has been operating 20-30 minutes. After operating the engine, shut it off and remove the rocker covers. Inspect the lube oil puddles that normally form where the fuel connectors join the cylinder head and where the fuel jumper lines join the fuel line nuts. If there is any leakage at these connections, the lube oil puddles will be smaller or thinner than the puddles on the connectors that are not leaking. Disassemble, inspect and correct or replace the suspect part (connector washer, connector, injector or jumper line). Test and reinspect.

Method B

Use when the engine is not operating such as during or after repairs. Remove the rocker covers. Pour clean lube oil over the fuel jumper lines and connectors which would normally be splashed with oil during engine operation. This will cause oil puddles to form at the joining surfaces as mentioned in Method A. Plug the fuel return line at a convenient location (e.g. cylinder head or fuel tank). Disconnect the fuel pump supply line at the inlet of the secondary filter. Connect an external source of pressurized fuel (60-80 psi (413-551 kPa)) to the inlet of the secondary filter cover. Install a pressure gauge (0-100 psi (0-689 kPa)) at the outlet of the filter cover.

Gauge installation can be accomplished by installing a "T" fitting between the filter cover and outlet line or by removing the pipe plug at the outlet in the cover. Use of a gauge will allow ready reference to the fuel pressure being maintained for this test. Severe leaks are immediately visible and minor leaks take longer to appear. It may be necessary to maintain fuel pressure for a period of 20 to 30 minutes in order to find minor leaks. Leaks may be repaired by replacing damaged parts or determining if the part is loose and below torque specifications. Test and reinspect.

If injectors are suspected of leaking and contributing to dilution of the lube oil, they should not be tested by pressurizing the fuel system as in Method B. Injectors should be removed from the engine and high pressure tested as outlined in the *"Detroit Diesel Service Manual"*.

Method C

Use while the engine is operating at 400-600 rpm. Apply an outside fuel source capable of 60-80 psi (413-551 kPa) to the outlet side of the secondary filter. Pour lube oil over the fuel jumper lines and connectors so that oil puddles form where jumper lines and connectors meet. Install a valve and a pressure gauge in the fuel return line. With the engine idling, close the valve enough to raise the engine fuel pressure to 60-80 psi (413-551 kPa). After 10-20 minutes, inspect the oil puddles to see if any have become smaller or run off completely. The undiluted oil will hang the same as when the oil was poured on. Repair and retest.

Slightly worn injector plungers may leak more under these conditions. This leakage will not occur while the engine is running because of the dynamic and pressure conditions that exist.

Method D

Fluorescent dye fuel leak testing. When testing an engine that has been in service, it will be preferable to use the fluorescent dye and black light method of testing. Proceed as follows.

1. Mix 4 oz (120 ml) of fluorescent additive (Detroit Diesel #J28431) with 4 US gallons (15 liters) of clean diesel fuel (#1 or #2) in a clean container. The container should be marked *"Test Fuel"* and be resealable so that it won't be contaminated when not being used.

2. Isolate the engine fuel system so that the supply and return fuel lines are connected only to the test fuel container. It will be necessary to intermittently check the fuel level to maintain an adequate supply.

3. Warm up the engine by operating it at maximum no-load speed for approximately 15 minutes.

4. With the engine idling and the rocker covers removed, shine the black light over the head assembly. The lube oil will show a dull blue. If a fuel leak is present, the fuel with the fluorescent dye will glow a bright yellow.

5. After the cause of the fuel leak has been determined and corrected, wipe the area and fuel connections clean and recheck with the black light. When no leaks are present, reassemble the unit with the original fuel lines and normal fuel source. It is not necessary to change the fuel filters. Run the engine to purge the air from the fuel system.

With the engine at rest, all injectors will leak to some extent when pressurized. The leakage occurs because there is no other place for the pressurized fuel to go. When the low and high pressure cavities in the injector are subjected to the high test pressure, fuel is forced past the plunger into the rack and gear cavity. Result: Droplets of fuel form at the rack and drip off. Special consideration must be given to this weepage. If considered to be excessive, the injector should be removed and tested for pressure holding capacities.

NOTE: Since all leakage or spillage of fuel during leak detection testing dilutes the lube oil, the final step in maintenance of this type should include lube oil and lube oil filter changes.

Points to remember

1. Lube oil puddle inspection is one method of testing the fuel system for internal leaks. The missing puddles show where the leaks are. This test can be performed any time the rocker covers are removed, after the fuel jumper lines and connectors have been splashed with clean lube oil and there is normal fuel pressure in the system.

2. All leakage or spillage of fuel during leak detection testing further dilutes the lube oil.

3. The final step in maintenance of this type should include lube oil and lube oil filter changes if a fuel leak is detected.

4. Oil level above the dipstick **full** mark or a decrease in lube oil consumption may indicate internal fuel leaks.

5. Improper storage, handling, or installation of jumper lines can cause fuel leakage, resulting in lube oil dilution and severe engine damage.

FUEL PUMP FITTING INSTALLATION

Before installing inlet or outlet fittings on the fuel pump, coat the threads lightly with "Gasoila, Permatex II", or an equivalent non-hardening sealant. To prevent sealant from entering the fuel system, do not apply sealant on the first two (2) threads of the fittings. Torque fittings to 20-25 ft•lbs (27-34 N•m).

CAUTION: Do not install fittings with Teflon tape or paste, since this can result in fuel pump cover damage (cracking) before the required torque is reached.

FUEL OIL SPECIFICATIONS

The quality of fuel oil used for high speed diesel engine operation is a very important factor in obtaining satisfactory engine performance, long engine life, and acceptable exhaust emission levels.

The fuel oil should meet ASTM designation D-975. Grade 1-D is recommended, but grade 2-D is also acceptable. Note that these grades are very similar to grade DF-1 or DF-2 of Federal Specifications VV-F-800.

For detailed fuel recommendations, refer to *"Detroit Diesel Service Manual"*.

AIR CLEANER (DRY TYPE)

The H3-40 vehicle is equipped with a two stage, dry-type, replaceable element air cleaner, located in the engine compartment. To service the air cleaner, open the R.H. side engine compartment door. Engine air enters the air cleaner through an intake duct integrated to the R.H. side of rear cap, next to the last window of vehicle, then flows through a pre-cleaner and finally, through the air cleaner. The pre-cleaner consists of a centrifugal air cleaner in series with a replaceable impregnated paper filter element (air cleaner). Dust and moisture will be drained by means of a discharge tube at the bottom of pre-cleaner.

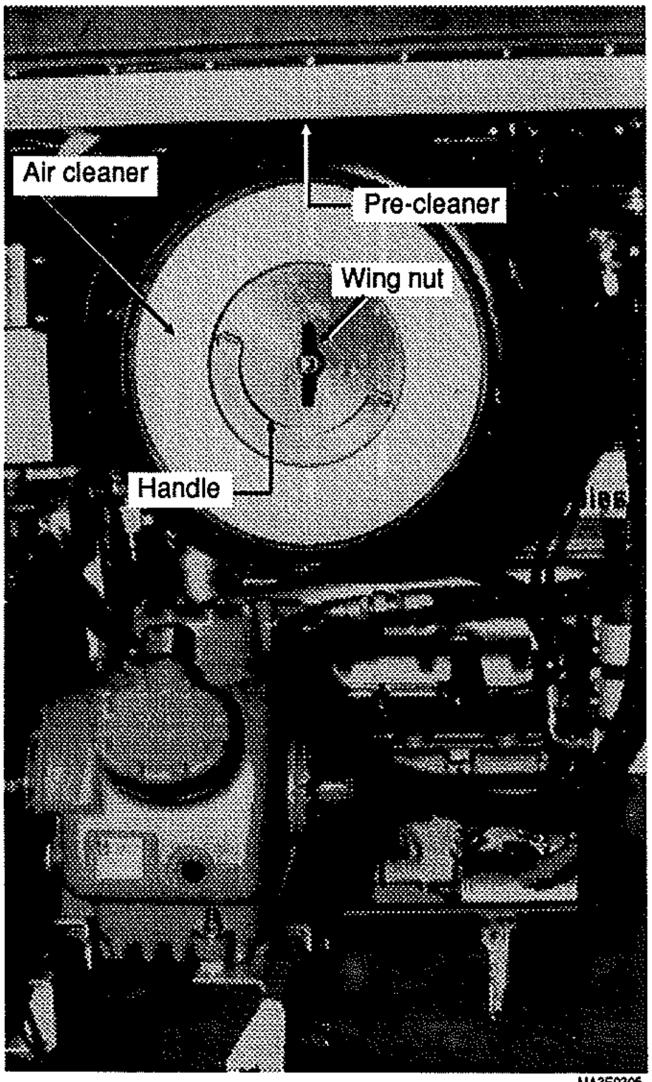


Fig. 5

Pre-cleaner servicing

The first stage centrifugal air cleaner tends to be self-cleaning; however, it should be inspected and any accumulated foreign material removed during the periodic replacement of the impregnated paper filter element.

Air cleaner servicing

Stop the engine, open the R.H. side engine compartment door, and loosen the wing nut retaining the air cleaner element to the air cleaner. Remove the element by pulling on handle in center of air cleaner element.

Installation of new element

1. Inspect the gasket sealing surface inside the air cleaner. It must be smooth, flat and clean.
2. Install the air cleaner element.
3. Check that element seals securely.
4. Inspect element cover gasket and replace if necessary.

AIR CLEANER ASSEMBLY REMOVAL

Whenever it becomes necessary to remove the air cleaner assembly (dry type) for maintenance or other repair in this area, great care should be taken when installing air cleaner assembly. The pre-filter should be installed snugly in the air duct and clamped tightly to the air cleaner inlet to prevent any dust infiltration into air cleaner.

GENERAL RECOMMENDATIONS

1. Never operate the engine without an element in the air cleaner assembly.
2. Use only original equipment filter elements.
3. Whenever element has been removed from air cleaner housing, inside surface of housing must be cleaned with a soft clean cloth.
4. Do not ignore the warning given by the air restriction indicator, as this could result in serious engine damage.
5. Store new elements in a closed area free from dust and possible damage.
6. Use recommended air cleaner element when replacement is required.

AIR CLEANER RESTRICTION INDICATOR

A resettable restriction indicator is installed on engine air intake duct near the turbocharger in engine compartment, to constantly monitor the level of vacuum between the air cleaner and engine, in order to detect and indicate an abnormal increase in vacuum due to a dirt-laden and therefore restricted air cleaner element.

When red signal locks in full view, the air cleaner element must be replaced and the indicator must be reset by pressing on its extremity.

SPECIFICATIONS

FUEL FILTER/WATER SEPARATOR (OPTIONAL)

Make . . . . .Racor
Type . . . . 1000 FG
Fuel filter Prevost number 53-0150
Element cartridge Prevost number 53-0194

PRIMARY FUEL FILTER

Make . . . . AC
Type . . . . .Spin-on
Element & gasket supplier number 25010776 (T-915)
Element Prevost number 51-0137
Element torque . . . . 1/2 turn after gasket contact

SECONDARY FUEL FILTER

Make . . . . AC
Type . . . . .Spin-on
Element & gasket supplier number 25010778 (TP-916)
Element Prevost number 51-0128
Element torque . . . . 1/2 turn after gasket contact

FUEL TANK

Capacity . . . . .235 US gal/890 liters

AIR CLEANER

Air cleaner

Make . . . . Nelson
Air cleaner Prevost number 53-0206
Element cartridge supplier number 70337-N
Element cartridge Prevost number 53-0197

Pre-cleaner

Make . . . . Donaldson
Model PVH001220
Pre-cleaner Prevost number 53-0207

AIR RESTRICTION INDICATOR

Make . . . . Donaldson
Model RAX00-2320
Indicates . . . . .at 20" (508 mm) of water
Restriction indicator Prevost number 53-0161

SERVICE BULLETINS AND SERVICE INFORMATION LETTERS

Service Bulletins and Service Information Letters will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of publications pertaining to this section should be noted below as soon as received. These should then be filed for future reference.

NUMBER	DATE	SUBJECT

RACOR®

Installation, Operation, Parts and Service Data

Parker Filtration

DIESEL FUEL FILTER/WATER SEPARATORS

Racor Industries is an international company marketing products in 60 countries through a network of over 2,000 distributors and dealers. Founded in 1969 to manufacture and market innovative diesel fuel filter/water separator systems, Racor has extended its product line to include:

- 20 Series Spin-on Diesel Fuel Filter/Water Separators
- Recycling and Recycle/Blender Systems
- Air Dryers for vehicular compressed air systems
- Diesel Fuel Heaters
- Fuel Additives
- Hydraulic Filtration Systems

The precision fuel metering components of diesel engines are especially vulnerable to damage by liquid and solid contaminants in fuel. Airborne dust and dirt, rust and algae induced by the presence of water in storage tanks through condensation and mishandling, all contribute to:

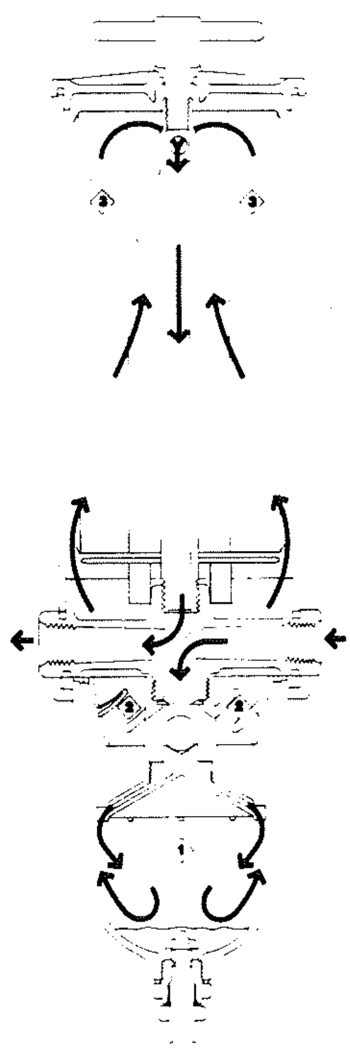
- blown injector tips
- fouled injector nozzles
- excessive pump, injector and ring wear
- loss of power and poor performance

Racor's patented filter/separator design and process removes virtually 100% of the damaging water and solid contaminants from diesel fuel. There is a Racor unit for engine systems with flow rates from 10 gph to 9000 gph. There are no moving parts and maintenance is minimal.

The installation of a Racor fuel filter/water separator in a diesel fuel system will bring the following benefits:

- less pump and injector wear
- more complete combustion
- less exhaust emi
- lower fuel consumption
- less down time and maintenance
- increased operating profits

The industries we serve include on-highway automobile, busses and trucks; off-highway construction, logging and mining; marine workboat, off-shore drilling and exploration and pleasure boat; agriculture; stationary power equipment and fuel storage tanks; railroad; recreational vehicles as well as industrial applications.



Racor diesel fuel filter/water separators and related products have become the standard for all of these industries.

HOW THE RACOR FILTER/SEPARATOR WORKS

The three stages of the Racor filter/separator work in series to progressively clean the diesel fuel. Because virtually all water and particles of solid contamination are removed in the primary and secondary stages, the effective life of the fine micron replaceable element (the third stage) is 2-3 times longer than standard filters.

Primary Stage (Separation)

In the primary stage, liquid and solid contamination down to 30 micron are separated out by centrifugal action created by the turbine centrifuge. There are no moving parts in this highly efficient design. Because the contamination is heavier than the fuel, it falls to the bottom of the clear bowl.

Secondary Stage (Coalescing)

This stage functions when minute particles of liquid contamination (lighter than the fuel) remain in suspension and flow up with the fuel into the lower part of the filter/separator shell. Here the minute particles tend to bead on the inner wall of the shell and the bottom of the specially treated replacement element. As the beads accumulate, they become larger and heavier and eventually fall to the bottom of the filter/separator bowl.

Final Stage (Filtration)

In this stage, the fuel flows through the replacement element where the minute solids are removed.

Use only GENUINE RACOR Replacement Elements, Parts and Fuel Additives for maximum operating efficiency. The use of other than GENUINE RACOR products may void your Racor unit warranty.

INSTALLATION

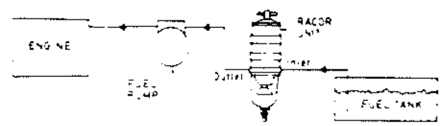
PLEASE NOTE FOR AUTOMOBILE APPLICATIONS: Racor manufactures a complete line of mounting bracket kits for installing Racor Filter Separators on automobiles. The kits contain the Racor mounting bracket specifically designed for the year, make and model automobile and all the necessary hardware with complete mounting instructions for correct installation.

1. Remove vacuum side filters in fuel line between fuel tank and fuel pump. Cast-in-head or non-removable housing should be adapted with primary spin-on adaptor, (Racor part no. 11548) where applicable. Otherwise, service and leave in place.
2. Mount Racor Filter/Separator vertically on the vacuum side of the fuel pump or transfer pump -- whichever comes first -- in a convenient location for servicing.
3. Install fuel line from fuel tank to inlet side of the Racor Filter/Separator. USE MAXIMUM FUEL LINE SIZE AVAILABLE IN ORDER TO REDUCE RESTRICTION. Appropriate fittings are available from your Racor distributor. (See Fittings Chart, page 3.)
4. Install fuel line from the outlet side of the Racor Filter/Separator to the inlet of the fuel pump or transfer pump with appropriate fittings and maximum size fuel line.
5. Remove lid and prime the system by pouring clean fuel into filter/separator housing until full. Replace lid and hand tighten t-handle.
6. Start engine and test system.

NOTE: See back page for installation of butt splice connectors for electrical options.

WHEN POSITIONING THE UNIT:

- Locate the unit between the horizontal planes of the bottom of the fuel tank and pump inlet for minimum restriction to the pump.
- Do not remove the lid and t-handle.
- Do not overtorque the clamp bolts. Overtorquing will distort housing and seal leaks will occur.
- Maintain vertical clearance above the filter/separator housing for servicing of elements. (See Specfications Chart on Page 10.)



OVERHEAD STORAGE TANK APPLICATION:

Head pressure will be placed on the Racor Filter/Separator when it is installed in conjunction with an overhead storage tank. A valve must be installed on the INLET SIDE of the Racor Filter/Separator for use when servicing replaceable elements.

COLD WEATHER APPLICATION:

If the Racor Filter/Separator is used in cold weather, the unit should be located behind the engine, in engine compartment, near manifold or wherever heat flow is available to strike unit. A Racor In-Filter Heater is recommended to ease cold starts and the Racor Thermoline Diesel Fuel Line Heater is available for efficient cold weather operation.

NOTE: Methanol, ethanol and alcohol-based additives will cause damage to non-metal parts in the Racor unit and the entire diesel engine system. When use of an additive is determined to be necessary, use only genuine RACOR FUEL ADDITIVES. RACOR FUEL ADDITIVES provide preventive maintenance protection all year long, helps cold weather starts, protect against damaging foulants and extend element life.

Racor additives are specially formulated to be completely compatible with engines, fuel filters and water separators. They contain no damaging alcohol and keep fuel in the best possible condition for all diesel engine applications.

RACOR FUEL ADDITIVES ARE SUPER CONCENTRATED. COMPARE TREATMENT COST PER GALLON OF FUEL.

SERVICE

a) REPLACEMENT ELEMENTS

Racor manufactures a complete line of high quality replacement elements for all Racor products. All genuine Racor replacement elements contain a specially-formulated resin-impregnated media designed to repel water and perform the ultra-fine filtration necessary to protect the engine system. An exclusive "lip" seal, designed to prevent element by-pass, contains a molded handle for ease of element removal.

1. Element should be changed at 8 to 15 inches of Mercury restriction. (See Vacuum Gauges on Page 11.) Measurement is made at the pump inlet.
2. On 75/ and 79/ Series models with valving, all valves are in the open position for normal operation. For continuous operation, one unit may be shut down while under power to change element. During element change, reduce fuel flow rate to idle condition.
3. Remove t-handle and lid. Inspect seals and replace if necessary. SEAL SERVICING KITS ARE AVAILABLE FROM YOUR RACOR DISTRIBUTOR.
4. Remove element by holding molded handle and slowly pulling upward with a turning motion.
5. Insert Genuine Racor Replacement Element over center tube with downward turning motion. (See Specifications Chart for replacement element part number on Page 10.)
6. Top off by pouring clean diesel fuel into filter/separator housing until full. Replace lid and hand tighten t-handle.

b) DRAINING THE FILTER/ SEPARATOR BOWL

Bowl must be drained at or before contaminants reach the bottom of the turbine centrifuge assembly. Water Sensor Kits are available as options for Racor Filter/Separators. (See Page 13 for description of kits.)

1. If fuel tank is BELOW filter/separator:
   a. To break vacuum lock, remove t-handle and lid. Inspect seals and replace if necessary. SEAL SERVICING KITS ARE AVAILABLE FROM YOUR RACOR DISTRIBUTOR.
   b. Open drain valve. Drain accumulated water and contaminants. Close drain valve.

c. Prime the system by pouring clean fuel into filter/separator housing until full. Replace lid and hand tighten t-handle.

2. If fuel tank is ABOVE filter/separator:
   a. Open drain valve.
   b. Drain accumulated water and contaminants.
   c. Close drain valve.

c) CLEANING THE FILTER/ SEPARATOR

IMPORTANT: INSPECT ALL SEALS AND REPLACE IF NECESSARY. SEAL SERVICING KITS ARE AVAILABLE FROM YOUR RACOR DISTRIBUTOR. CLEAN UNIT AND LUBRICATE ALL SEALS BEFORE INSTALLATION WITH CLEAN DIESEL FUEL **ONLY.**

1. Remove t-handle and lid. Inspect for damage and contamination. Clean.
2. Remove and discard replaceable element.
3. Drain unit completely through drain valve. Remove drain valve.
4. Flush unit with clean diesel fuel.
5. If an excessive amount of contamination is present in the bowl:
   Remove bowl retainer screws and lift retainer ring off over bowl. Remove bowl and clean with diesel fuel **ONLY.**
   Replace bowl gasket, place bowl on base, put bowl retaining ring over bowl and tighten retainer screws. (40 inch lbs. max. torque)
6. Install drain valve to bowl (30 inch lbs. max torque) and close.
7. Replace element with new Genuine Racor Replacement Element.
8. Prime the system by pouring clean diesel fuel into the unit until full. Replace lid w/gasket and t-handle w/gasket and hand tighten t-handle.

FITTINGS CHART

When installing fittings to the Racor filter/separator, apply clean diesel fuel to the o-ring of the fitting.

FITTING	RACOR PART NO.	UNIT USAGE	UNIT PORT (STRAIGHT THREAD W/O-RING)	FUEL LINE
Male JIC37 ° 90 ° Elbow 	9010-4-4 9010-6-4 9010-6-6 9010-10-8 9010-10-10	200 220/225/500 220/225/500 900/1000 900/1000	7/16-20 9/16-18 9/16-18 7/8-14 7/8-14	7/16-20 7/16-20 9/16-18 3/4-16 7/8-14
Male JIC37 ° Straight 	9020-4-4 9020-6-4 9020-6-6 9020-10-6 9020-10-8 9020-10-10	200 220/225/500 220/225/500 900/1000 900/1000 900/1000	7/16-20 9/16-18 9/16-18 7/8-14 7/8-14 7/8-14	7/16-20 7/16-20 9/16-18 9/16-18 3/4-16 7/8-14
Female Pipe Straight 	9040-4-4 9040-6-4 9040-6-6 9040-10-4 9040-10-6 9040-10-8 9040-10-8DT 9040-10-12	200 220/225/500 220/225/500 900/1000 900/1000 900/1000 900/1000 900/1000	7/16-20 9/16-18 9/16-18 7/8-14 7/8-14 7/8-14 7/8-14 7/8-14	1/4-18 Pipe Thd. 1/4-18 Pipe Thd. 3/8-18 Pipe Thd. 1/4-18 Pipe Thd. 3/8-18 Pipe Thd. 1/2-14 Pipe Thd. 1/2-14 Pipe Thd. 3/4-14 Pipe Thd.
Progressive Barb Hose Fitting 90 ° Elbow 	9010-HF-4-5/6 9010-HF-6-5/6	200 220/225/500	7/16-20 9/16-18	5/16 (8mm) Hose and 3/8 (10mm) Hose
Progressive Barb Hose Fitting Straight 	9020-HF-4-5/6 9020-HF-6-5/6	200 220/225/500	7/16-20 9/16-18	5/16 (8mm) Hose and 3/8 (10mm) Hose
Barbed Hose Fitting 90 ° Elbow 	9010-HF-10-6 9010-HF-10-8 9010-HF-10-10 9010-HF-10-12	900/1000 900/1000 900/1000 900/1000	7/7-14 7/8-14 7/8-14 7/8-14	3/8 1/2 5/8 3/4
Barbed Hose Fitting Straight 	9020-HF-10-6 9020-HF-10-8 9020-HF-10-10 9020-HF-10-12	900/1000 900/1000 900/1000 900/1000	7/8-14 7/8-14 7/8-14 7/8-14	3/8 1/2 5/8 3/4

TROUBLE SHOOTING PROCEDURES

RESTRICTION

Normal vacuum reading can be 1" to 5" Hg at full governed RPM, depending on the hose I.D., length, elbows, pump efficiency, and height of lift from tank.

Idle RPM should be "0" reading with clean element where pump capacity is dictated by engine RPM.

If vacuum reading does not return to 1" to 5" Hg after element change, check for the following:

- collapsed fuel lines
- tank shut-off valves closed
- plugged fuel lines

If the inlet to the Racor filter/separator is plugged, disconnect inlet line, open drain valve, and blow out with compressed air. In case of severe stoppages, remove bowl and centrifuge and clean with compressed air.

AIR LEAKS

Racor filter/separator systems eliminate the need for "sight glasses" to check air suction leaks. If air bubbles are rising from centrifuge action in the clear bowl, the air leak is between inlet side of the Racor system and tank.

Check for:

- loose fittings
- pin holes in lines
- cracked tank stand pipe
- out of fuel condition
- O-ring not seating
- improper flare angles on hose fittings. *

If no bubbles are noted in bowl and air. suction is still evident, check outlet side of Racor system to fuel pump.

Check for:

- loose fittings
- pin holes in line
- O-ring not seating
- improper flare angles on hose fittings. *
- fuel pump seals
- bleed-off fitting on top of Cummins fuel pump
- top gaskets on Racor filter/separator.

*(For example, a 37° flared female hose fitting pulled up tightly to a 45° male fitting sometimes causes a hair line crack, resulting in air suction.)

If Racor filter/separator is sucking air at bowl drain fitting gasket or T-handle and top and cannot be stopped by wetting gasket with fuel and *hand tightening only*, **replace the gasket(s).**

BLEED BACK

If fuel in the filter/separator bleeds back to the tank an air leak or check valve seating problem is indicated. To inspect check valve seat, remove bowl ring, bowl and turbine centrifuge, turning counterclockwise. (See Parts Diagram for identification of parts.)

Inspect check valve and seat. Clean or replace seat and check valve and reinstall centrifuge *hand tight*. Overtightening causes gasket to warp. Replace bowl ring gasket and reinstall bowl and ring. Fill unit with fuel.

In cold weather operation, installation of a Racor Fuel Heater in the Racor filter/separator is recommended to ease starting. Racor's Thermoline Diesel Fuel Line Heater is available for extreme cold weather operations. (See Options and Accessories Section.)

Read and follow the Installation Instructions on Page 2 carefully to insure proper performance of your Racor filter/separator.

Model 200FG

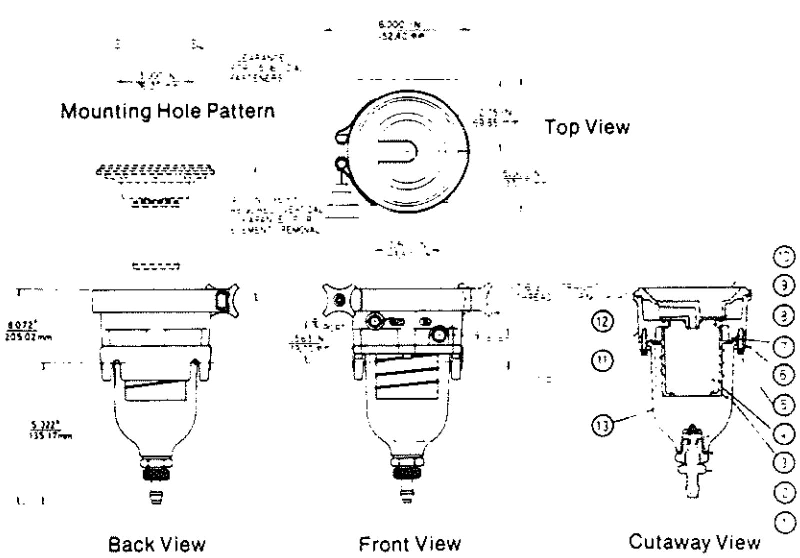
Maximum Rated Flow .53 gpm (2 lpm)
Port Size: 7/16" x 20; UNF Str Thd w/O-ring

Parts List

Item	Part No.	Qty.	Description
1	11780	1	Drain Valve
2	11340	1	Bowl Drain O-Ring
3	12008A	1	Flow Director
4	2000SM	1	Element
5	15081	4	Bowl Retainer Screw (#10-24 x 7/8" long)
6	12006	1	Bowl Ring Bracket
7	12014	1	Bowl O-Ring
8	12013	1	Lower Lid O-Ring
9	12003	1	Upper Lid O-Ring
10	12075	1	Lid
11	12004A	1	Base
12	12002	1	Retainer Clamp
13	12007	1	Clear Bowl

Note: Use 200FGM for non-automotive gasoline applications.

Parts Diagram



Automotive Mounting Bracket Kits

A complete line of mounting bracket kits are manufactured for installing Racor filter/separators on automobiles. They contain the Racor mounting bracket specifically designed for the year, make and model automobile and all the necessary hardware with complete mounting instructions for correct installation.

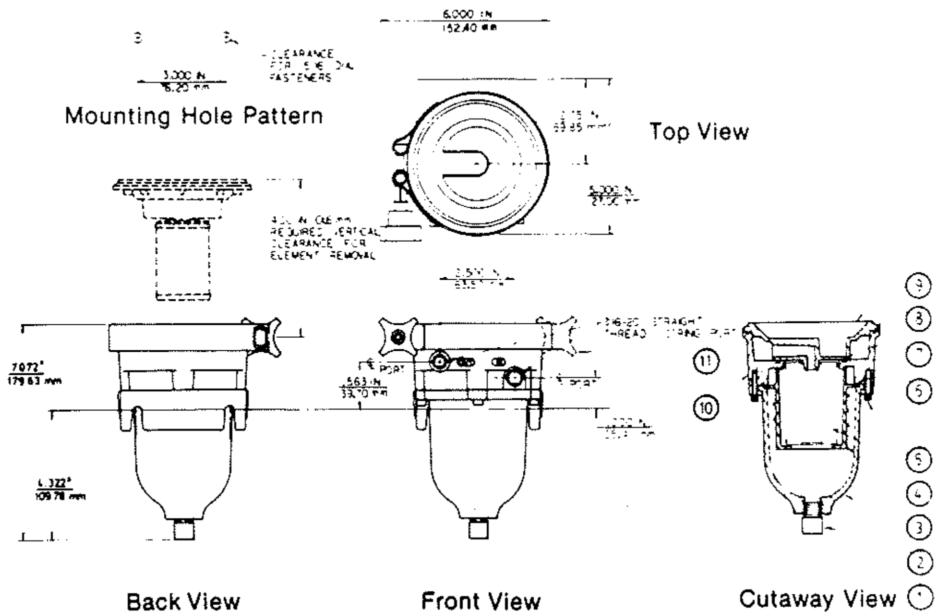
Model 200FGM

Maximum Rated Flow .53 gpm (2 lpm)
Port Size: 7/16" x 20; UNF Str Thd
w/O-ring

Parts List

Item	Part No.	Qty	Description
1	12041	1	Bowl Plug, 1/4" N.P.T.
2	12021	1	Metal Bowl/Bracket
3	12008A	1	Flow Director
4	2000SM	1	Element
5	15081	4	Bowl Retainer Screw (#10-24 x ⅞" long)
6	12014	1	Bowl O-Ring
7	12013	1	Lower Lid O-Ring
8	12003	1	Upper Lid O-Ring
9	12001	1	Lid
10	12004A	1	Base
11	12002	1	Retainer Clamp

Parts Diagram



Model 500FG*

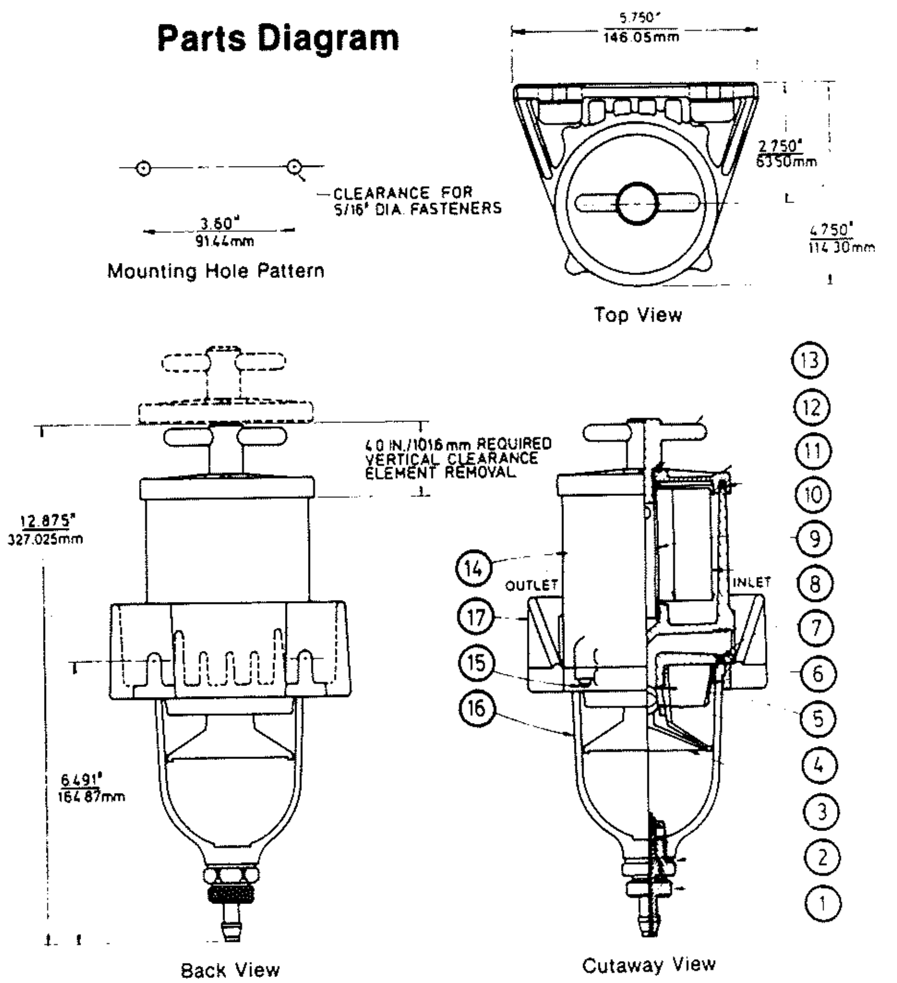
Maximum Rated Flow 1.05 gpm (4 lpm)
Port Size: 9/16" x 18 UNF Str Thd
w/O-ring

Parts List

Item	Part No.	Qty.	Description
1	11780	1	Drain Valve
2	11340	1	Bowl Drain O-Ring
3	15013D	1	Turbine Centrifuge
4	15011	1	Check Ball
5	15010C	1	Check Ball Gasket
6	15012C	1	Conical Baffle
7	15009	1	Bowl O-Ring
8	2010SM	1	Element
9	15079	1	Return Tube
10	15005	1	Lid Gasket
11	15078	1	Lid
12	11350	1	O-Ring
13	11888	1	T-Handle
14	15082	1	Body
15	15081	4	Bowl Retainer Screw (#10-24 x 7/8" long)
16	15014A	1	Clear Bowl
17	5090	1	Ring/Bracket

*For (UL) listed applications, order model 500MA

Parts Diagram



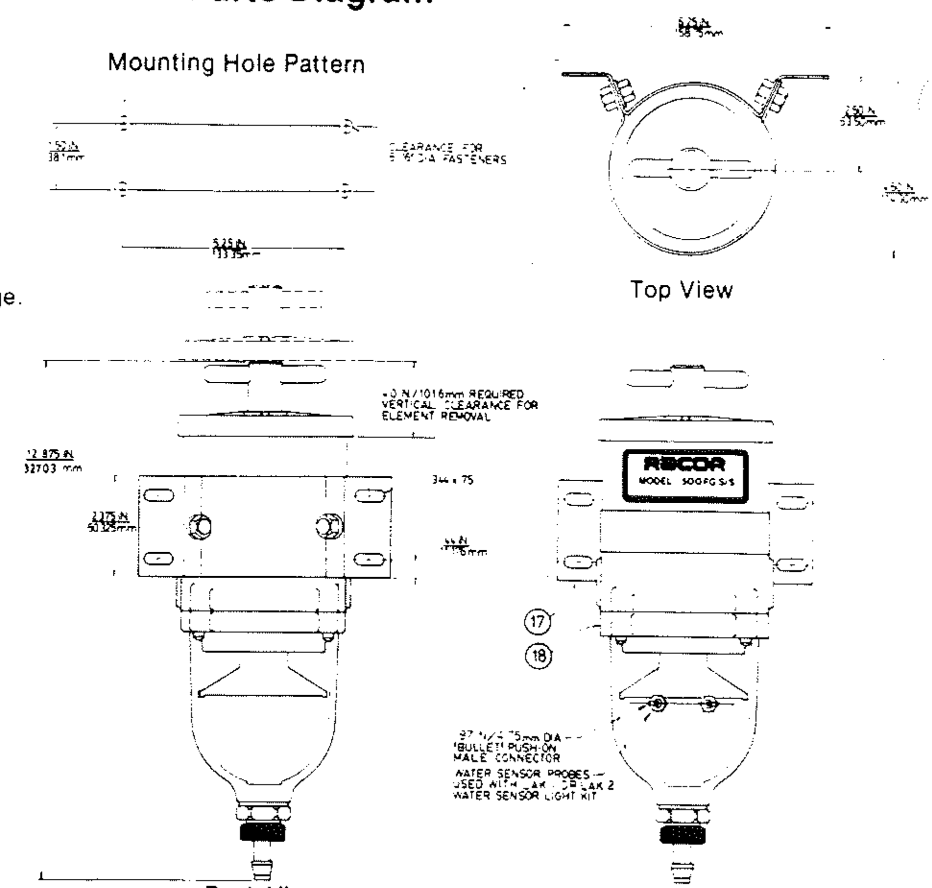
Model 500FG S/S

Maximum Rated Flow 1.05 gpm (4 lpm)
Port Size: 9/16" x 18 UNF Str Thd w/O-ring

Parts List

Item	Part No.	Qty.	Description
Items 1-16 — Same as 500FG on previous page.			
17	15098	1	Bracket Assembly
18	15035	1	Bowl Ring
19		1	Metal Bowl (optional)

Parts Diagram



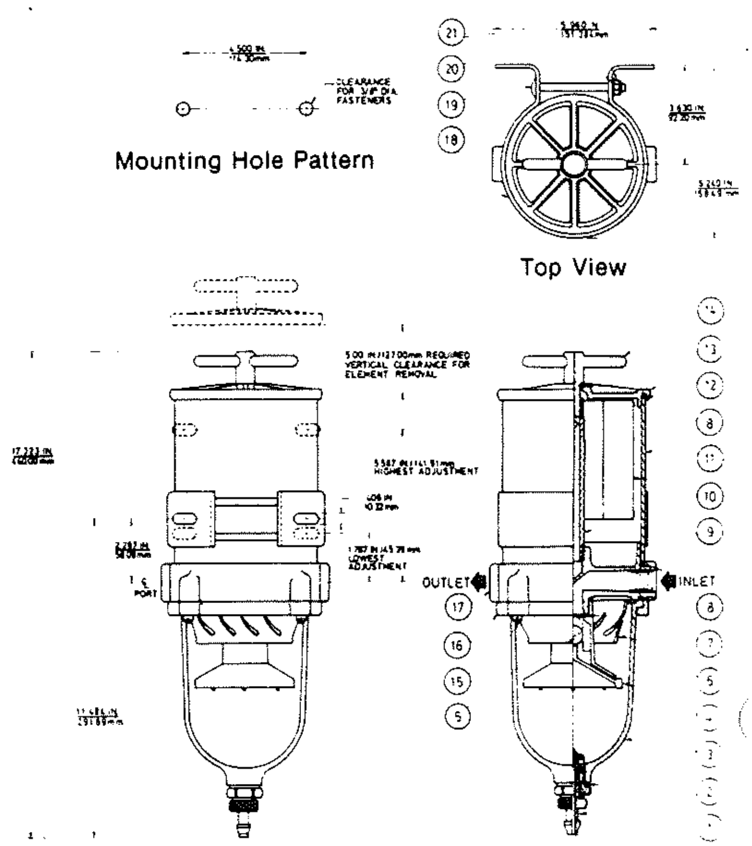
Model 900FG*

Maximum Rated Flow 1.59 gpm (6 lpm)
Port Size: 7/8" x 14 UNF Str Thd w/O-ring
Replacement Elements: 2040SM-OR

Parts List

Item	Part No.	Qty.	Description
1	11780	1	Drain Valve
2	11340	1	Bowl Drain O-Ring
3	11-1606	1	Amber Bowl
4	11026C	1	Turbine Centrifuge
5	11027	1	3/4" Check Ball
6	11025C	1	Conical Baffle
7	11028B	1	Check Ball Gasket
8	11007	3	Gasket
9	19001	1	Return Tube
10	2040SM	1	Element
11	19002	1	Outer Cylinder
12	11005B	1	Lid
13	11350	1	O-Ring
14	11888	1	T-Handle
15	11542	4	Bowl Retaining Screw
16	11037A	1	Bowl Ring
17	11023B	1	Base
18	11919	1	Bracket Clamp
19	11838	2	5/16" Carriage Bolt
20	12049	2	5/16" Flat Washer
21	11841	2	5/16" Lock Nut
22		1	Metal Bowl (optional)

Parts Diagram



* For (UL) listed applications, order model 900MA.

Model 75/900FG*

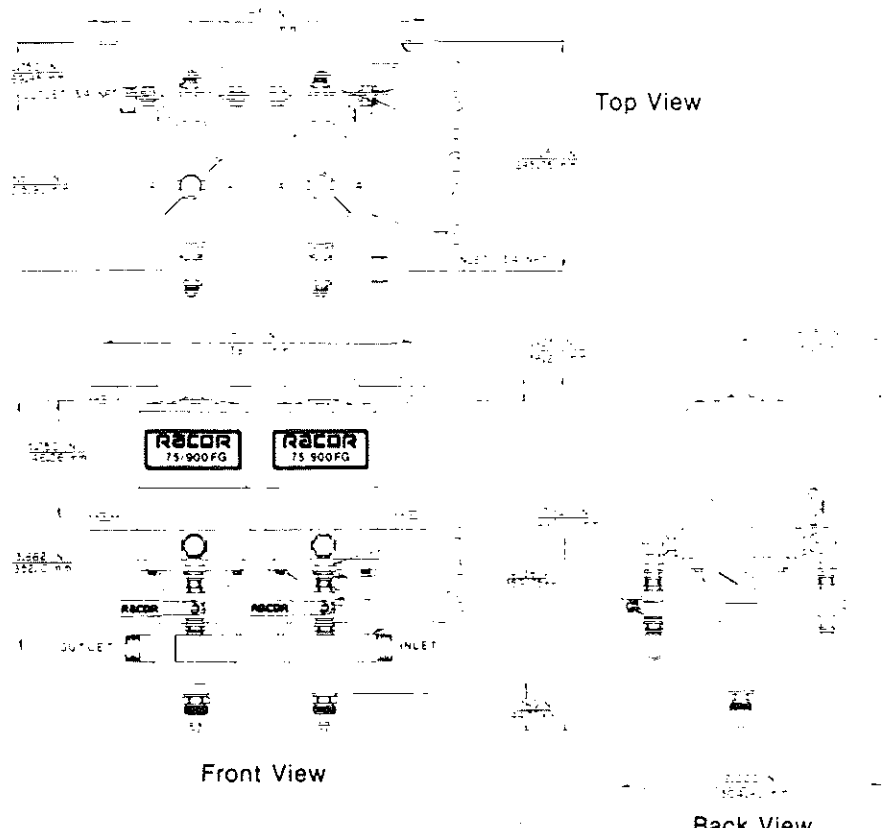
Maximum Rated Flow 1.59-3.16 gpm (6-12 lpm)
Port Size: 3/4" NPT
Replacement Elements: 2040SM-OR
*Valves permit servicing under continuous operation. See above for individual Model 900FG Parts List.

Parts List

Item	Part No.	Qty	Description
1	11892	2	3/4" Manifold
2	11073	4	Ball Valve Assm. ½" NPT
3	11074	4	Strt. Ftg. - ½" NPT x ½"-14 NPSM
4	11072	4	Elbow Fitting
5	900FG	2	Filter/Separator
6	11078	4	3/8" Hex-Bolt
7	11080	4	3/8" Washer Flat
8	11102	4	3/8" Washer-Lock
9	11079	4	3/8" Hex-Nut
10	11065	1	Double Bracket

*For (UL) listed applications, order model 75/900MA.

Parts Diagram



Valves shown in closed position.

Model 1000FG*

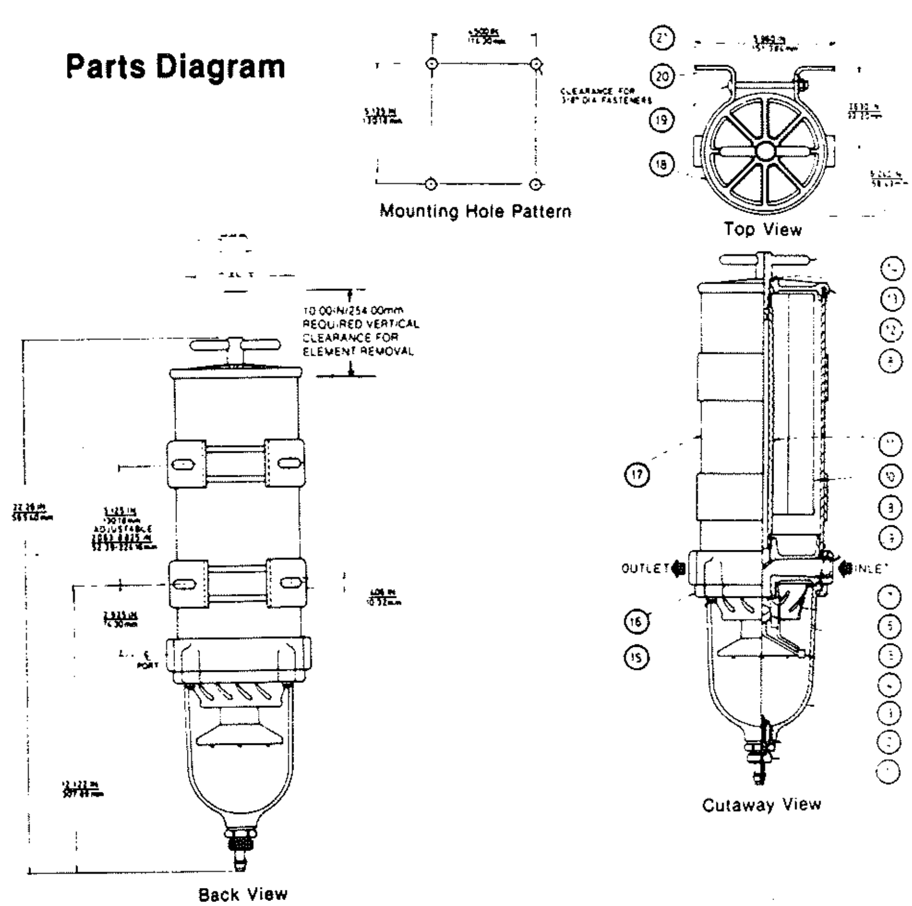
Maximum Rated Flow 3.16 gpm (12 lpm)
Port Size: 7/8" x 14 UNF Str Thd w/O-ring
Replacement Elements: 2020SM-OR

Parts List

Item	Part No.	Qty.	Description
1	11780	1	Drain Valve
2	11340	1	Bowl Drain O-Ring
3	11-1606	1	Amber Bowl
4	11026C	1	Turbine Centrifuge
5	11027	1	3/4" Check Ball
6	11025C	1	Conical Baffle
7	11028B	1	Check Ball Gasket
8	11007	3	Gasket
9	11023B	1	Base
10	2020SM	1	Element
11	11008	1	Return Tube
12	11005B	1	Lid
13	11350	1	O-Ring
14	11888	1	T-Handle
15	11542	4	Bowl Retaining Screw
16	11037A	1	Bowl Ring
17	11021	1	Outer Cylinder
18	11919	2	Bracket Clamp
19	11838	4	5/16" Carriage Bolt
20	12049	4	5/16" Flat Washer
21	11841	4	5/16" Lock Nut
22			Metal Bowl (optional)

*For (UL) listed applications, order model 1000MA

Parts Diagram



Model 73/1000FG*

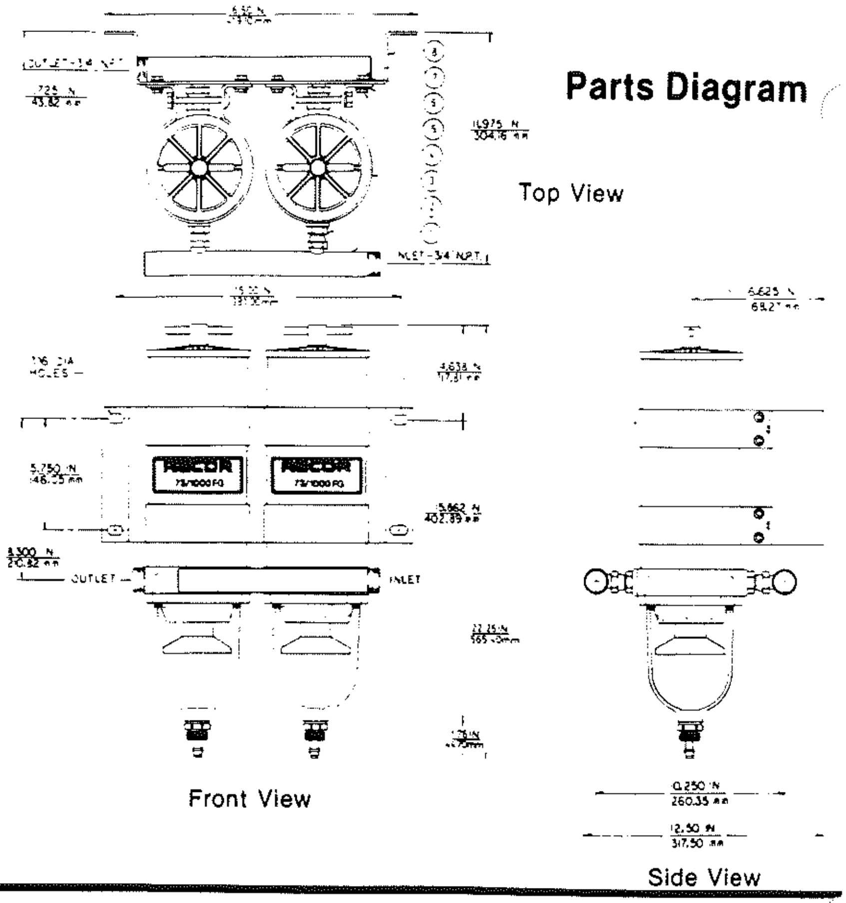
Maximum Rated Flow 6.32 gpm (24 lpm)
Port Size: 3/4" NPT
Replacement Elements: 2020SM-OR
See Page 8 for Individual Model 1000FG Parts List.

Parts List

Item	Part No.	Qty	Description
1	11892	2	3/4" Manifold
2	11071	4	Fittings
3	1000FG	[illegible]	Filter/Separator
4	11078	8	3/8" Hex-Bolt
5	11080	8	3/8" Washer-Flat
6	11102	8	3/8" Washer-Lock
7	11079	8	3/8" Hex-Nut
8	11065	1	Double Bracket

*For (UL) listed applications, order model 73/1000MA.

Parts Diagram



Model 75/1000FG*

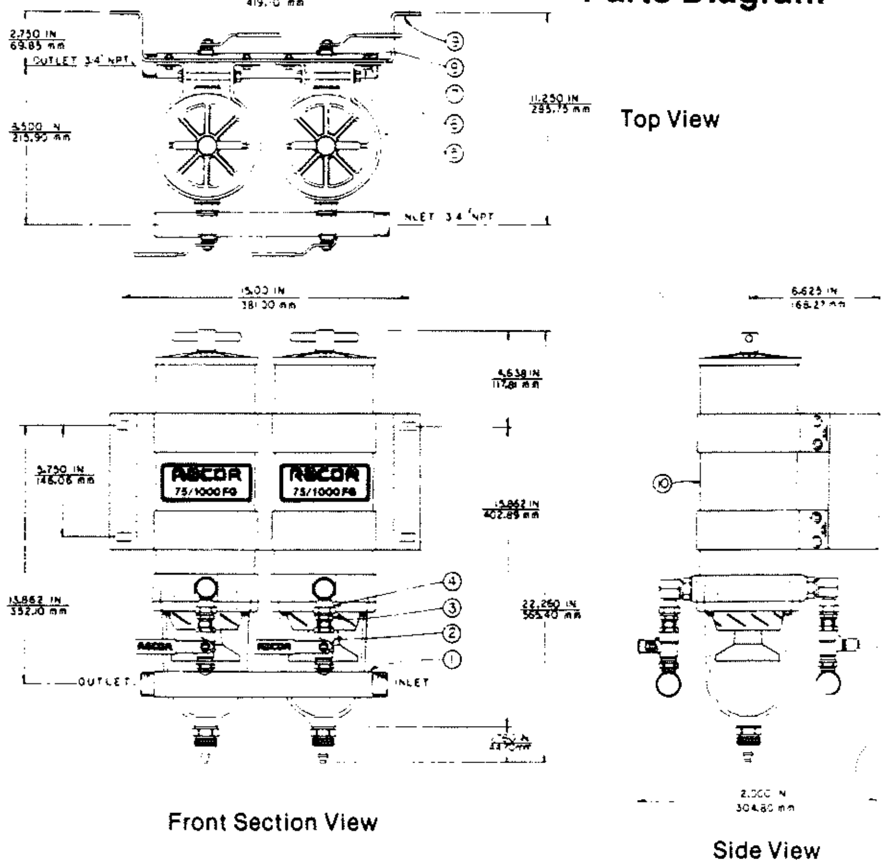
Maximum Rated Flow 3.16-6.32 gpm (12-24 lpm)
Port Size: 3/4" NPT
Replacement Elements: 2020SM-OR
*Valves permit servicing under continuous operation. See Page 8 for individual Model 1000FG Parts List.

Parts List

Item	Part No.	Qty	Description
1	11892	2	3/4" Manifold
2	11073	4	Ball Valve Assm. ½" NPT
3	11074	4	Strt. Ftg. - ½" NPT x ½"-14 NPSM
4	11072	4	Elbow Fitting
5	11078	8	3/8" Hex-Bolt
6	11080	8	3/8" Washer-Flat
7	11102	8	3/8" Washer-Lock
8	11079	8	3/8" Hex-Nut
9	11065	1	Double Bracket
10	1000FG	2	Filter/Separator

*For (UL) listed applications, order model 75/1000MA.

Parts Diagram



Valves shown in closed position.

Model 77/1000FG*

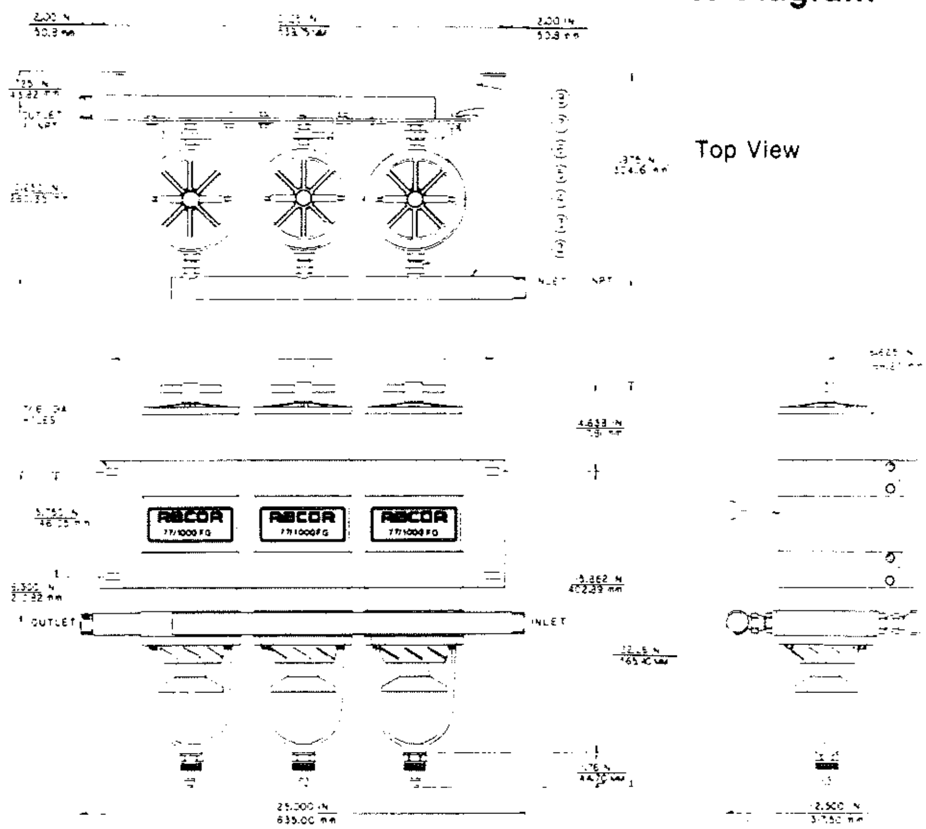
Maximum Rated Flow 9.48 gpm (36 lpm)
Port Size: 1" NPT
Replacement Elements: 2020SM-OR
See Page 7 for Individual Model 1000FG Parts List.

Parts List

Item	Part No.	Qty	Description
1	1000FG	3	Filter/Separator
2	11076	2	1" Manifold
3	11071	6	Fittings
4	11078	12	3/8" Hex-Bolt
5	11080	12	3/8" Washer-Flat
6	11102	12	3/8" Washer-Lock
7	11079	12	3/8" Hex-Nut
8	18998	1	Triple Bracket

*For (UL) listed applications, order model 77/1000MA.

Parts Diagram



Front Section View

Side View

Model 79/1000FG*

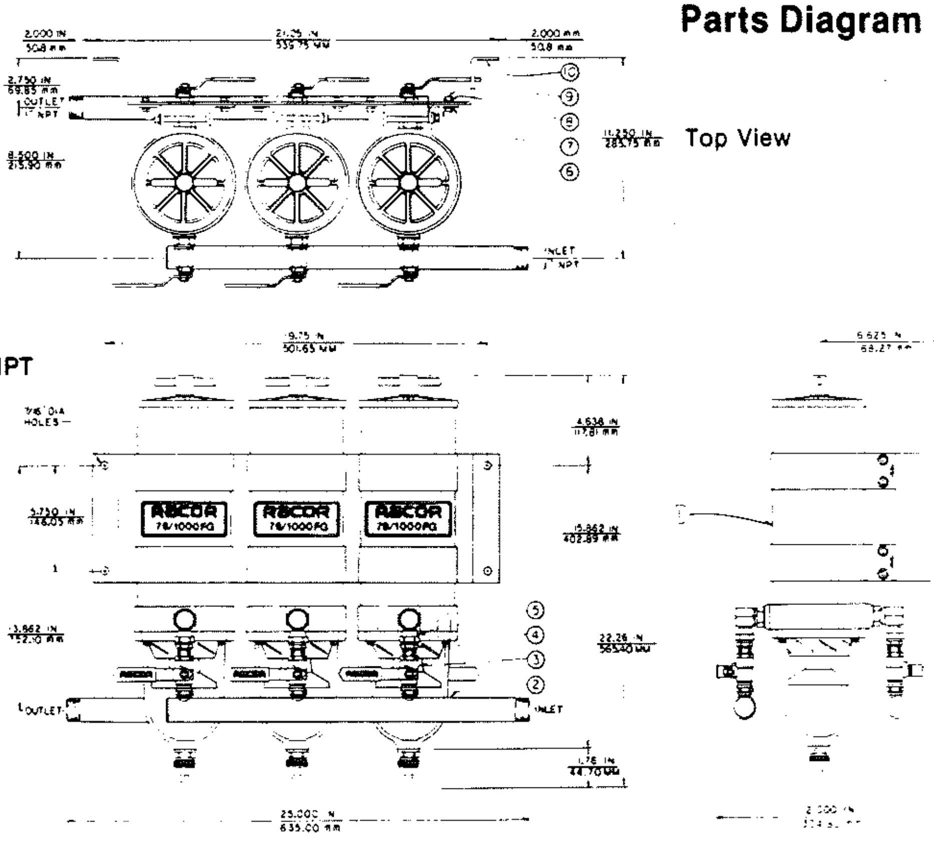
Maximum Rated Flow 3.16-6.32-9.48 gpm (12-24-36 lpm)
Port Size: 1" NPT
Replacement Elements: 2020SM-OR
*Valves permit servicing under continuous operation. See Page 7 for individual Model 1000FG Parts List.

Parts List

Item	Part No.	Qty	Description
1	1000FG	3	Filter/Separator
2	11076	2	1" Manifold
3	11073	6	Ball Valve Assm. - ½" NPT
4	11074	6	Strt. Ftg. - ½" NPT x ½"-14 NPSM
5	11072	6	Elbow Fitting
6	11078	12	3/8" Hex-Bolt
7	11080	12	3/8" Washer-Flat
8	11102	12	3/8" Washer-Lock
9	11079	12	3/8" Hex-Nut
10	18998	1	Triple Bracket

*For (UL) listed applications, order model 79/1000MA.

Parts Diagram



Front Section View

Side View

Valves shown in closed position.

SPECIFICATIONS *

MODEL NO.	200	500	900	1000	75/900	73/1000[1] 75/1000[2]	77/1000[3] 79/1000[4]
		FG AND MA SERIES					
MAXIMUM FLOW RATE							
GPM	5	1.0	1.5	3.0	3.0	6.0[1] 3.0 6.0[2]	9.0[3] 6.0 9.0[4]
LPM	2	4	6	12	12	24[1] 12 24[2]	36[3] 24 36[4]
CLEAN VACUUM DROP							
in Hg	1.25	1.25	1.5	3.0	2.0	3.5[1] 5.0[2]	3.5[3] 5.0[4]
kgs sq cm	.043	.043	.052	.104	.069	.121[1] .173[2]	.121[3] .173[4]
PROOF PRESSURE							
psi	100	100	100	100	100	100	100
bars	6.90	6.90	6.90	6.90	6.9	6.90	6.90
MAXIMUM VACUUM							
in Hg	28.5	28.5	28.5	28.5	28.5	28.5	28.5
kgs sq cm	.984	.984	.984	.984	.984	.984	.984
ELEMENT MODEL NO.	2000SM	2010SM	2040SM	2020SM	2040SM	2020SM	2020SM
ELEMENT MATERIAL	RESIN IMPREGNATED CELLULOSE						
DIRT REMOVAL RATING	2 micron nominal						
DIRT CAPACITY (AC Fine Dust)*	10gms	20gms	150gms	500gms	300gms	1000gms	1500gms
ELEMENT REMOVAL CLEARANCE							
in	4	4	5	10	10	10	10
mm	102	102	127	254	254	254	254
WATER REMOVAL EFFICIENCY	less than 25 ppm free water						
TEMPERATURE RATINGS							
Fahrenheit	−50 255						
Centigrade	−46 107						
HEIGHT							
in	8	13	17	22	17	22	22
mm	203	330	432	559	432	559	559
WIDTH							
in	6	6	6	6	16	16	23
mm	152	152	152	152	406	406	584
DEPTH (FG Series)							
in	5	5	6	6	12	13[1] 12[2]	13[3] 12[4]
mm	127	127	152	152	305	330[1] 305[2]	330[3] 305[4]
DEPTH (MA Series)							
in	—	6	7	7	10	9[1] 10[2]	9[3] 10[4]
mm	—	152	178	178	254	229[1] 254[2]	229[3] 254[4]
WEIGHT (FG Series)							
lbs	3	4	7	9	27	35	47
kgs	1.5	2	3	4	12	16	21
WEIGHT (MA Series)							
lbs	—	4	6	10	23	25	32
kgs	—	2	3	5	10	11	15
PORT SIZE							
in	7/16"-20 UNF	9/16"-18 UNF	7/8"-14 UNF	7/8"-14 UNF	3/4" NPT	3/4" NPT	1" NPT
mm		14mm x 1.5	22mm x 1.5	22mm x 1.5			
PORT SIZE (MA Series)							
in		9/16"-18 UNF	7/8"-14 UNF	7/8"-14 UNF	3/4" NPT	3/4" NPT	3/4" NPT
mm		14mm x 1.5	22mm x 1.5	22mm x 1.5			

*Specifications shown are the result of tests conducted at the optimum flow rate for each unit (equal to ½ the maximum flow rate)

FOOTNOTES: ① Model 73-1000FG w/o Shut-Off Valves

② Model 75-1000FG w/Shut-Off Valves

③ Model 77-1000FG w/o Shut-Off Valves

④ Model 79-1000FG w/Shut-Off Valves

Fuels and additives containing alcohol will cause damage to the non-metal parts of the Racor unit and the entire engine system

Racor Filter Separators are available with metal bowl for applications where required Add M to part number Metal bowl units are one inch (25.40 mm) shorter than clear bowl units All other specifications are the same

Racor Filter Separators available with metric tapped ports are so noted Specify metric ports when ordering

Simplified Flow Rate Formula for Medium Range Diesel Engines

Hp × .006 = Approximate gpm pump flow rate

(This formula is an approximate flow rate for engines below 600 H P Consult your engine manufacturer for accurate flow rate specifications)

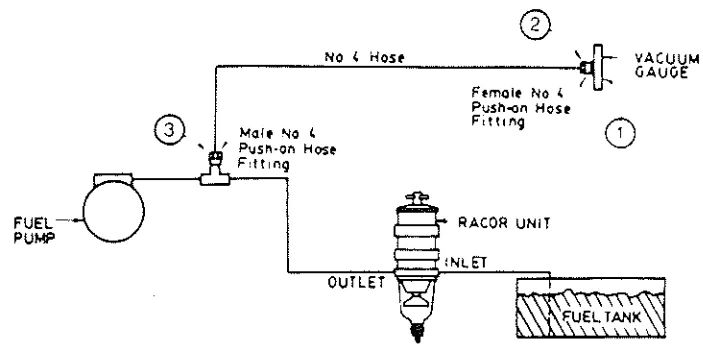
OPTIONS AND ACCESSORIES

Vacuum Gauge

The Racor Vacuum Gauge permits accurate monitoring of the vacuum level in the outlet line of a Racor filter/separator.

Installing a Racor Vacuum Gauge increases troubleshooting efficiency, eliminates guess work and lengthens element change periods.

The 9-15 scale 2" color-keyed face gauge is remotely mounted, using a No. 4 hose and T-fitting, into the line between the filter/separator and pump.



INSTALLATION INSTRUCTIONS

NOTE: For severe service, use liquid-filled vacuum/pressure gauge, Racor Part No. 18-1551.

1. Drill and tap ⅛" pipe hole or install "T" in fuel line between outlet port of Racor filter/separator and inlet port of pump. (See Fittings & Accessories Chart, page 14, for adaptor fitting.)
2. Install male hose fitting into tapped hole or "T"
3. Attach low pressure No. 4 hose to push-on hose fitting (available as an option).
4. Install 2" gauge in panel or bracket.
5. Connect female push-on hose fitting to gauge.
6. Connect hose to gauge hose fitting.

NOTE: Seal all connections with Teflon tape or an equivalent sealant.

1606B KIT

Parts List

1. (1) 11233 Vacuum Gauge
2. (1) 7234-4 Female fitting
3. (1) 7232-4 Male fitting
4. (1) 18-1202 Vacuum Gauge Label

Optional:

No. 11268 No. 4 Hose (Specify length)
No. 9040-10-8DT Filter/Separator port fitting for gauge
No. 11369 ¼" or ⅛" brass adaptor

VACUUM/PRESSURE GAUGES

The Racor "compound" gauges provide measurement of both vacuum and pressure over a wider range in applications that may be exposed to both vacuum and pressure (i.e., installations with a positive head pressure on the filter/separator).

Pressure and vacuum readings are expressed in both the familiar English measurements and the international standard of Kg/cm^2.

PART NO. 18-1104 VACUUM/PRESSURE GAUGE for Light Service Applications

For light service where the features of waterproof, weatherproof, hermetically sealed and vibration/pulsation resistant are not required.

- 2" Gauge
- Drawn steel case -- phosphatized for rust resistance. Black enamel finish
- Clear window
- Brass socket
- Kit includes gauge and mounting hardware

PART NO. 18-1551 VACUUM/PRESSURE GAUGE for Severe Service Applications

For severe service requiring a waterproof, steamproof or weatherproof gauge, with the added problem of pulsation and vibration. Rustproof hermetically sealed case with polycarbonate crystal provides external shock protection. Gauge has shock absorbing movement plus liquid filling to absorb effect of vibration and pulsation.

- 2½" Gauge
- Stainless Steel Case w/ stainless steel ring gasketed and crimped to case for positive leakproof seal.
- Polycarbonate window
- Brass threaded socket with internal o-ring for positive leakproof seal to case
- Kit includes gauge and mounting hardware

RACOR IN-FILTER DISC HEATERS

Racor's in-filter disc fuel heater is a cold weather starting aid connected to the power source by sealed, weather-proof terminals in the bowl. The internal automatic thermostat turns the heater on if the fuel temperature drops below 35 °F (1.7 °C). Heat is supplied in the unit just below the replacement element to melt the wax crystals and allow fuel to pass through the element for quick, easy starts.

When the engine is not running, the heater is operated by turning on the ignition switch for a minimum of five minutes prior to starting the engine. The Racor in-filter heater may be installed on positive or negative ground and is available in 12V or 24V. RACOR FILTER/SEPARATOR ELECTRICAL OPTIONS ARE FOR DIESEL APPLICATIONS ONLY. DO NOT USE WITH GASOLINE OR OTHER VOLATILE LIQUIDS.

INSTALLATION

The In-Filter Disc Heater supplys heat to the fuel filter just below the replaceable element. This critical placement provides increased fuel temperature as the fuel passes through the fine micron filtering element. The power rating of the 500 Disc Heater is 100 watts maximum, 10 amperes for the 12V heater, 5 amperes for the 24V heater. The power rating of the 900/1000 Disc Heater is 200 watts maximum, 15.5 amperes for the 12V heater, 7.8 amperes for the 24V heater.

To Prepare Heater Terminals for Electrical Connections

1. Unpack the insulated butt connectors.
2. Connect to two lengths of 14 gauge wire. The length of wire depends on which option you are using for electrical connection.
3. Connect wire lengths to feed thru wires. Either wire may be used as ground.
4. All electrical connections must be made to accommodate the power of the heater using appropriate lug and terminal connections.

CAUTION: Loose or improper connections will cause electrical arcing, shorts and corrosion.

NOTE: See back page for installation of butt splice connectors for electrical options.

Do not allow the water to reach the level of the disc heater. Water level reaching the disc heater will cause damage to the heater. Drain accumulated water as necessary.

The chart below is to be used only as a guide for 900/100 Disc Heater installation. Electrical checks must be made to determine if your truck's electrical system is capable of handling an additional amperage load.

Guide to Optional 12V and 24V Relay

Truck Manufacturer	Relay Required	
	Yes	No
Ford	x	
Freightliner		x
GMC—Chevrolet		x
International Harvester		
"S" Series		x
1600—2600	x	
Iveco	x	
Kenworth		x
Mack		x
Marmon	x	
Mercedes	x	
Peterbilt		x
Volvo	x	
White	x	

An optional Racor relay replacement kit can be ordered which includes specific instructions for relay installation. Refer to chart below for ordering information:

SYSTEM VOLTAGE	RACOR PART NUMBER	
	500	900/1000
12V	15156	11861
24V	15157	11862

An equivalent relay is available through the following manufacturers:

Manufacturer	Part No.
Nartron	1300-1
Cole-Hersee	24059
Bosch	36-002
Delco-Remy	1114223

For flexibility, three different electrical system connections are possible. An electrical check must be performed for each option before final installation is made.

OPTION A:

Ignition Switch Electrical Connection 500 Disc Heater

Prior to installation, determine if your vehicle's ignition switch is capable of an additional 10 amperage load for a 12V system, 5 amps for a 24V system. If the ignition switch proves capable of the additional load, proceed with final electrical connection.

900/1000 Disc Heater

Prior to installation, determine if your truck's ignition switch is capable of an additional 15.5 amperage load for a 12V system, 7.8 amps for a 24V system. If the ignition switch prove capable of the additional load, proceed with final electrical connection. SEE "PREPARING HEATER TERMINALS FOR ELECTRICAL CONNECTION" ON PAGE 12 AND DIAGRAM A BELOW.

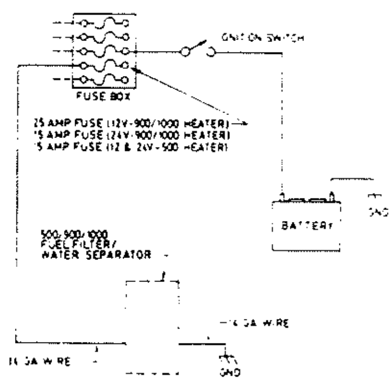


DIAGRAM A

OPTION B:

Existing Heavy-Duty Electrical Connection

Prior to installation, determine if your vehicle's existing heavy-duty relay is capable of the additional amperage load as stated in Option A. If the heavy-duty relay proves capable of the additional amperage load, proceed with final electrical connection. SEE "PREPARING HEATER TERMINALS FOR ELECTRICAL CONNECTION" ON PAGE 12 AND DIAGRAM B BELOW.

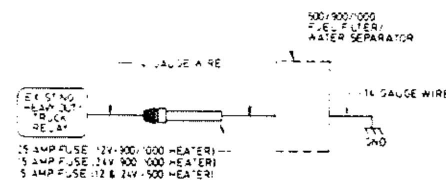


DIAGRAM B

OPTION C:

Optional Relay Electrical Connection

If after running the electrical checks in Option A & B, the ignition switch and/or existing heavy-duty relay proves incapable of an additional amperage load, an optional relay must be installed. SEE "PREPARING HEATER TERMINALS FOR ELECTRICAL CONNECTION" ON PAGE 12, AND DIAGRAM C BELOW.

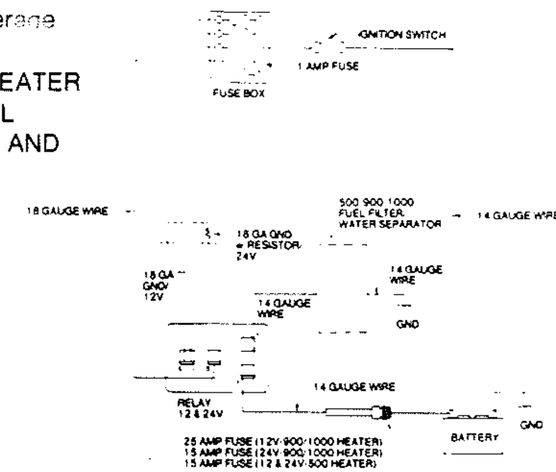


DIAGRAM C

WATER SENSORS

You must specify Racor unit with optional probes in the bowl for use with water sensors.

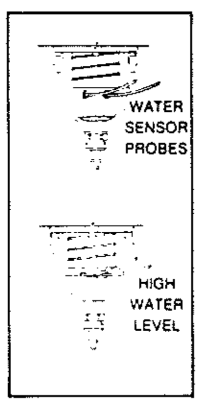
A functional accessory for all Racor filter/separators, all solid-state Water Sensors alert the operator when liquid contaminants filtered out of the system should be drained from the collector bowl, thereby maintaining maximum filter/separator efficiency.

In the primary stage of the Racor filter/separator, water and solid contaminants are separated out of the fuel by centrifugal action. The water and solids fall to the bottom of the bowl. When the water in the bowl reaches the level of the sensor probes, a low voltage circuit is completed and a warning light and/or alarm are activated. (See **Water Level Diagram.**) When the warning light and/or buzzer comes on, the bowl must be drained to remove the trapped contaminants and water, insuring maximum engine protection and filtration efficiency. Engine must be off before draining.

RACOR FILTER/SEPARATOR ELECTRICAL OPTIONS ARE FOR DIESEL APPLICATIONS ONLY. DO NOT USE WITH GASOLINE OR OTHER VOLATILE LIQUIDS.

INSTALLATION

Sealed, weather-proof sensor probes in the bowl detect water and, by LED readout, a solid-state Water Sensor alerts the operator to drain the bowl. A Water Sensor with light and audio alarm is also available. Both models come in 12VDC or 24VDC.

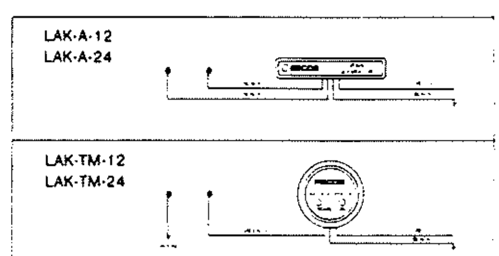


Water Level Diagram

LAK-T/M-12V or 24V Water Sensor Light/Alarm for dash or panel mount

Green LED illuminates to indicate circuit is on. Red LED lights and alarm sounds to indicate water must be drained from Racor Filter/Separator bowl. Kit includes:

(1) 2¼" Diameter Water Sensor
(4) Splice Connectors
(10) Cable Ties
Installation Instructions



LAK-A-12V or 24V Water Sensor Light for dash mount

Green LED illuminates to indicate circuit is on. Black out panel illuminates red to indicate water must be drained from Racor Filter/Separator bowl. Kit includes:

(1) 3" x 1¼" x ½" Water Sensor with pressure sensitive tape mounting
(4) Splice Connectors
(10) Cable Ties
Installation Instructions

ALSO AVAILABLE FROM RACOR:

RACOR THERMOLINE® DIESEL FUEL LINE HEATER

The Racor Thermoline Diesel Fuel Line Heater is a self-regulating heating device that prevents wax buildup during cold weather permitting easy starts and smooth engine operation. The Thermoline heater permits the use of less expensive, higher BTU No. 2 diesel fuel all year round. Overnight engine idling to keep fuel warm is no longer needed.

Easy Installation

The Thermoline heater replaces the existing line between the fuel tank and primary fuel filter. Installation time is approximately one hour. No modification to the cooling system is required.

Simple Operation

The Racor Thermoline heater contains no moving parts. It is controlled by a switch installed in the dash or control panel. By pre-heating the in-line fuel, the Thermoline heater assists with cold starts down to −40 °F (−40 °C). A typical prestart heating time of five minutes consumes less than 2% of available battery capacity. The Thermoline allows fast-idling of an engine to warm it and eliminates the chance of power loss or stalling due to wax buildup during operation.

Self-regulating Performance

The Thermoline heater is constructed of a conductive polymeric core extruded between two parallel copper bus wires. At low temperatures, electrical current flows through the core between the conductors, generating heat. As the temperature rises, the electrical resistance of the core material increases, reducing current flow and decreasing heat output. This infinitely reversible process occurs independently at each point along the heater strips and prevents overheating.

RECYCLE/BLENDER SYSTEMS

Racor's 800-OF6 stationary system and the mobile 800-5 "Filter Buggy" not only remove water and solid contamination from diesel fuel, but these recycle/blenders also provide fleet operators with a steady supply of FREE diesel fuel by blending waste engine lube oil at a 20:1 ratio (5%) with the diesel fuel. Every gallon of waste engine lube oil now becomes a gallon of no-cost diesel fuel and at the same time solves a major environmental problem—the disposal of the waste oil.

The 800-OF6 stationary units for both overhead and underground storage tanks and has a built-in 33 gallon storage tank for the waste lube oil. This oil is automatically blended into the diesel fuel during the recycling operation. The mobile "Filter Buggy" draws oil from the crankcase or other container to blend this oil into the diesel fuel being recycled from the vehicle's fuel tank.

RD-3 AIR DRYERS

The RD-3's superior efficiency is based on an exclusive design that features a unique "chimney" or center tube which allows cool outside air to flow upward through the center of the unit to provide additional cooling and drying action. Racor's exclusive Electromatic Drain (EMD) is electronically controlled by a solid-state Timer/Driver. The Timer/Driver initially fires the EMD once upon ignition and 3.25 minutes later. The EMD is then activated every 7.5 minutes later for ½ second to eliminate accumulated water and contaminants. The red LED light on the side of the Timer/Driver flashes continually to indicate power is being supplied to the circuit.

The RD-3 is easy to install and virtually maintenance free.

The RD-3 operates on compressor systems up to 15 cfm and is available in 12- or 24- volt negative ground. A 100 watt heater is standard in the RD-3 for efficient cold weather operation.

Where electrical installation is not available or advisable, Racor offers the RD-3AIR with automatic "Air Drain Valve." The ADV is activated by the compressor governor to eliminate water and contaminants from the air system.

RD-3

Height 15" (381 mm)
Width: 7" (180 mm)
Depth: 7¾" (200 mm)
Proof Pressure: 625 psi (43.1 bars)
Maximum Flow Rate: 15 cfm (425 lpm)
Clean Pressure Drop: .5 psi (.03 bars)
Seal Material: Buna-N
Working Pressure: 150 psi (10.3 bars)
Weight: 16 lbs. (7.26 kgs.)

802 HYDRAULIC FILTER BUGGY

The 802 Hydraulic Filter Buggy represents the application of Racor's filtration expertise to the cleaning of hydraulic fluids. A dual filtration system removes damaging solids and water in a multipass operation. The portable buggy comes ready-to-operate with heavy-duty pump and motor, pressure and vacuum gauges, hoses and motor control.

The 802 is standard with one cleanable element in the primary pre-filter to remove larger solids and free water. Two fine filtration replaceable elements in the secondary system remove minute solid contamination.

Emulsified water can be removed by using two filtration/absorption elements (optional) in the secondary system. The replaceable filtration/absorption elements cannot be used with water-based fluids.

SPIN-ON FILTER/SEPARATORS

THE RACOR 20 SERIES SPIN-ON FUEL FILTER/WATER SEPARATORS CAN SOLVE DIESEL FUEL PROBLEMS UNDER ANY OPERATING CONDITIONS IN THE WORLD.

Advanced Filtration/ Separation Technology

The unique design of the 20 Series directs the fuel flow to the expanded center core of the unit. The reduced velocity causes heavy liquid and solid contaminants to accumulate in the inner chamber of the filter/separator bowl. Then they are drained off through a positive seal drain valve. This primary separation or pre-cleaning stage gives extended element life.

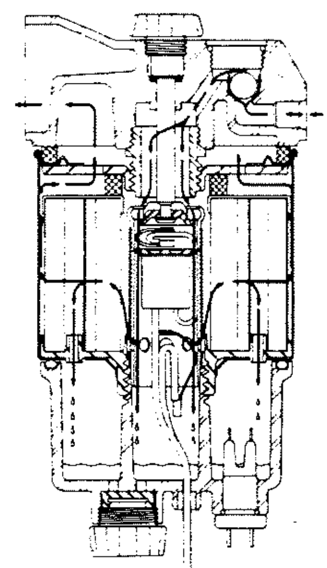
The 20 Series Filter/Separator units are compact and easy to service.

Vacuum (Suction) Applications

The *Dual Media Replacement Filter Element* uses a new Racor two-stage process of Dual Phase Repelling Action and Dual Phase Filtration to remove virtually 100% of the remaining free water and damaging solid particulate contaminants from diesel fuel. Primer pump, vent cap and check valve are standard.

Pressure Applications

The *Multi-Media Coalescer Replacement Filter Element* is for pressure side installations where the fuel has passed through a transfer pump and a coalescing filtration action is necessary for a high degree of water removal effectiveness. With the coalescer replacement filter element, 99+% of free and emulsified water an damaging solid particulate contaminants are removed. Vent cap is standard.



Options

Electrical in-filter heater
Metal Bowl
Service Indicator Package
(water sensor and element change monitor)

220
Height 8" (203 mm)
Width 4" (102 mm)
Depth 4" (102 mm)
Max. Flow Rate 30 gph (114 lph)
Weight 1.75 lbs. (.79 kgs.)

Element Model No.	R24 Dual Media	C25 Coalescer
Dirt Capacity (Soft C-2A)	80 gms.	75 gms.
Dirt Removal Rating	96% at 2 micron w/A.C.F.T.D	
Water Removal Efficiency Effluent:	less than 10ppm free water	less than 30ppm free water

225
Height 9.5" (241 mm)
Width 4" (102 mm)
Depth 4" (102 mm)
Max. Flow Rate .45 gph (170 lph)
Weight 2 lbs (.90 kgs.)

Element Model No.	R26 Dual Media	C27 Coalescer
Dirt Capacity (Soft C-2A)	117 gms.	107 gms.
Dirt Removal Rating	96% at 2 micron w/A.C.F.T.D	
Water Removal Efficiency Effluent:	less than 10ppm free water	less than 30ppm free water

FUEL ADDITIVES

Racor additives are specially formulated to be completely compatible with engines, fuel filters and water separators. They contain no damaging alcohol and keep fuel in the best possible condition for all diesel engine applications.

SUPER CONCENTRATED.
COMPARE TREATMENT COST PER GALLON OF FUEL.

Racor RX-100
Cold Weather Diesel Additive

- Contains a pour point depressant fuel conditioner
- Keeps fuel flowing down to −40°F (−40°C).
- Improves engine performance reduces engine wear
- Eases starting, aids combustion, prevents corrosion
- Eliminates waxing and clogged filters
- Cleans fuel lines, pumps and injectors

Part No.	Type	Size	Treatement
11-1179	RX-100	10 oz.	15-30 Gallons
11-1180	RX-100	32 oz.	150-200 Gallons
11-1181	RX-100	1 gal.	1,000 Gallons
11-1264	RX-100	2.5 gal.	5,000 Gallons
11-1265	RX-100	20 gal.	55,000 Gallons

(Continued on Page 16)

Racor RX-200
Diesel Treatment

- Improves engine performance
- Cleans fuel lines, pumps and injectors
- Eases starting and prevents corrosion

Part No.	Type	Size	Treatment
11-1270	RX-200	10 oz	One 10 oz. Can Per Tankful
11-1274	RX-200	32 oz.	150-200 Gallons

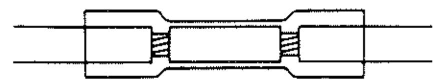
Racor RX-300
Marine Diesel Treatment

Formulated for diesel fuel in a marine environment, RX-300—

- Contains a biocide and fuel conditioner
- Prevents fungi, bacteria and algae growth
- Cleans fuel lines, pumps and injectors
- Improves engine performance
- Provides rust protection and lubrication throughout the entire system

Part No.	Type	Size	Treatment
11-1266	RX-300	10 oz.	50 Gallons
11-1267	RX-300	32 oz.	500 Gallons
11-1268	RX-300	1 gal.	5,000 Gallons
11-1269	RX-300	20 gal.	100,000 Gallons

BUTT SPLICE
Installation Instructions



1.
Select splice of appropriate size. Strip wires 0.3". Insert into crimp barrel.

2.
Crimp using crimp tool for preinsulated crimps.

3.
Heat splice with heat gun until tubing recovers and adhesive flows.

WARNING

FAILURE OR IMPROPER SELECTION OR IMPROPER USE OF THE PRODUCTS AND/OR SYSTEMS DESCRIBED HEREIN OR RELATED ITEMS CAN CAUSE DEATH, PERSONAL INJURY AND PROPERTY DAMAGE.

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In Alaska, California and Hawaii, call 1-209-521-7860

INSTALLATION INSTRUCTIONS
Racor Part No. 7091FG
1-92/18M

04

EXHAUST SYSTEM

CONTENTS OF THIS SECTION

MAINTENANCE . . . . 4 - 1
MUFFLER REMOVAL/INSTALLATION . . . . 4 - 2

MAINTENANCE

Exhaust system should be inspected periodically for restrictions and leaks. Restrictions such as kinked or crimped pipes result in excessive back pressure which can lead to increased fuel consumption, power loss, and possible damage to engine combustion chamber components. Exhaust leaks are commonly the result of loose clamp bolts, corroded pipes, or a punctured muffler. In addition to objectionable noise, a leaking exhaust system could allow toxic gases to enter the vehicle. It is recommended to inspect the exhaust system as follows:

- At vehicle inspection interval
- Whenever a change is noticed in the sound of the exhaust system
- Whenever the exhaust system is damaged.

Damaged or corroded exhaust system components should be replaced without delay.

When operating the engine in a service garage or in a closed area, the exhaust must be vented to the outside. Place the shop vent hose over the exhaust outlet pipe.

WARNING: Avoid breathing exhaust gases as they contain carbon monoxide which by itself is odorless and colorless, but harmful. Carbon monoxide is a dangerous gas which can cause unconsciousness and can be lethal. If at any time you suspect that exhaust fumes are entering the vehicle, locate and correct the cause(s) as soon as possible.

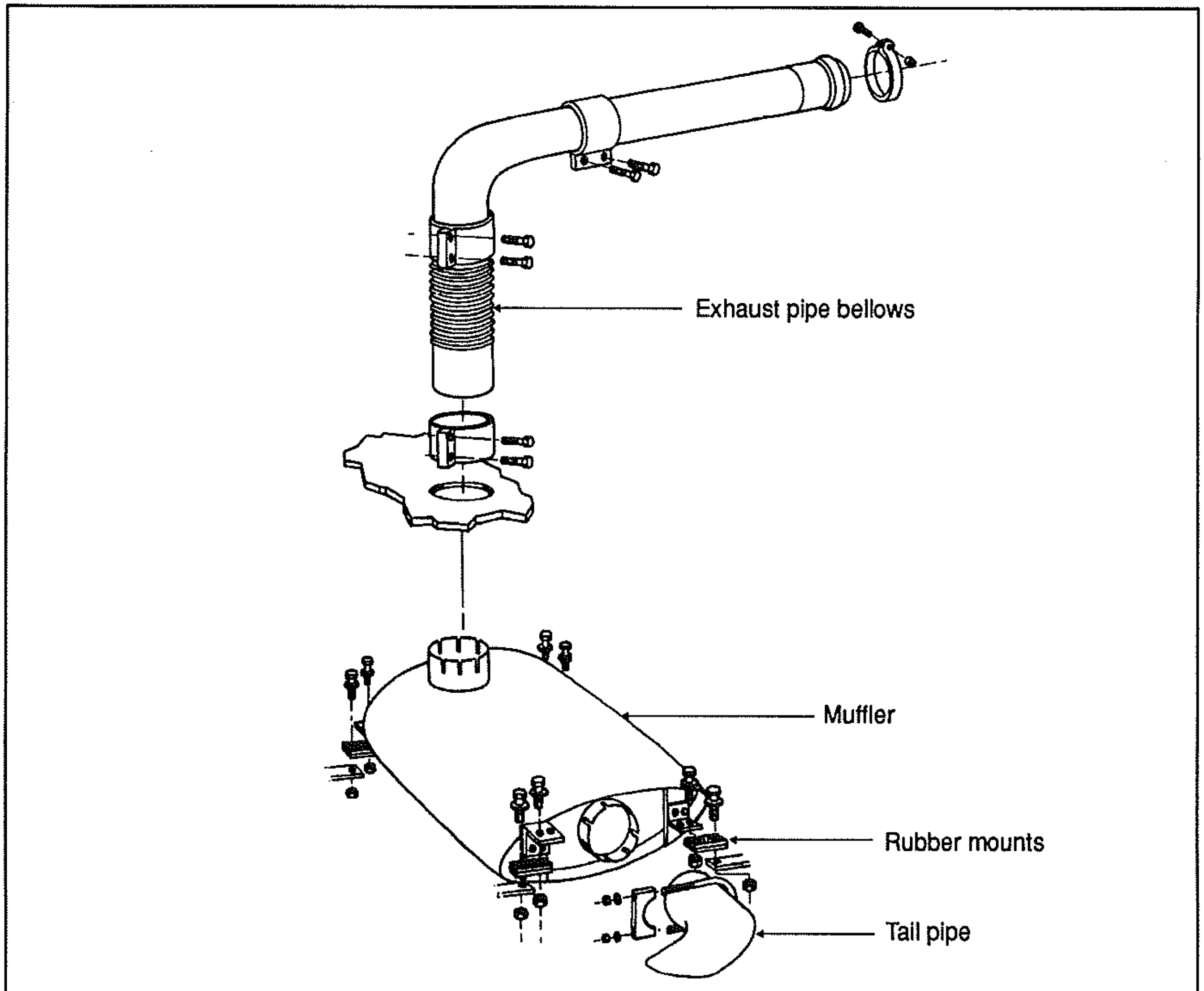

Fig. 1 - Exhaust system

MUFFLER REMOVAL/INSTALLATION

WARNING: Ensure that muffler and components are cold before performing any work procedure on these parts.

1. Remove bolts and clamp which secure the exhaust pipe bellows to the muffler (see fig. 1).
2. Support the muffler from under the vehicle.
3. Remove the fasteners holding the four rubber mounts to the frame brackets, then those retaining the rubber mounts to muffler brackets.

NOTE: The front retaining bolts are accessible from the L.H. side tag axle wheelhousing.

4. Remove rubber mounts then lower muffler from under vehicle.
5. Remove parts which are fixed to the muffler such as brackets, U-clamp, tail pipe, inspect and replace if necessary; reinstall parts on the new muffler.
6. Reverse removal procedure to install the muffler on vehicle.

SERVICE BULLETINS AND
SERVICE INFORMATION LETTERS

Service Bulletins and Service Information Letters will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of publications pertaining to this section should be noted below as soon as received. These should then be filed for future reference.

NUMBER	DATE	SUBJECT

05

COOLING SYSTEM

CONTENTS OF THIS SECTION

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DESCRIPTION

The heat generated by the engine is dissipated by liquid which is circulated within the system. The cooling system includes the water pump, radiator, surge tank, pressure cap and the engine thermostats.

A belt-driven radiator fan, mounted in L.H. side of engine compartment, pulls air through the radiator cores for cooling. A thermostatically controlled radiator fan may be installed as optional equipment.

The cooling system is filled through a filler cap on the surge tank (see fig. 1). A pressure cap at right of the surge tank is used to maintain pressure within the cooling system. Two thermostats are located in the housings at front of the engine. They are designed to maintain a minimum coolant temperature of 180 °F (82 °C).

When a cold engine is started or when the coolant temperature is below operating temperature, the coolant flow to the radiator is blocked or restricted by the thermostats. A bypass provides coolant circulation within the engine during the warm-up period.

The engine cooling system is also used to provide hot coolant for the vehicle heating system. Refer to section 22 *"Heating and Air Conditioning"* in this manual for information relating to heating system water circulation.

A *"loss of coolant"* warning device, consisting of a level probe and an electronic module (to amplify signal), is designed to trigger the automatic engine shutoff process when coolant level drops below the probe. If the engine keeps on running with coolant level below the probe during a few seconds, it will cause both the *"Check engine"* and *"Stop engine"* lights to turn on, and will power down (and eventually shutdown) the engine. The level probe is mounted in the R.H. side of the surge tank while the electronic module is mounted inside the rear electric junction box. Furthermore, a water temperature sensor, mounted in thermostat housing (radiator side), is also provided to protect the engine. If engine water is only slightly overtemperature, e.g. 212 °F (100 °C), the following occurs: the *"Check engine"* light turns on, and engine power will be progressively decreased down to 40% at approximately 221 °F (105 °C); in case of overheating (over 221 °F (105 °C)), engine will shutdown.

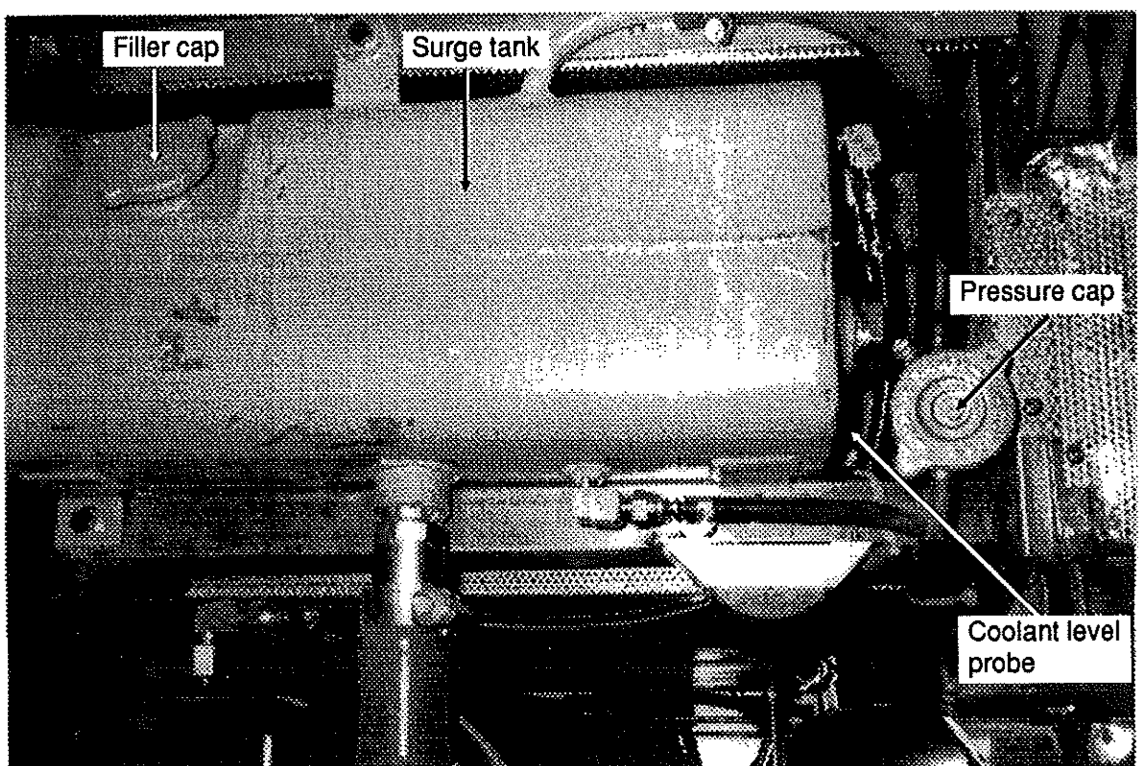


Fig. 1

ROUTINE MAINTENANCE

A systematic routine inspection of cooling system components is essential to ensure maximum engine and heating system efficiency.

Check coolant level in the surge tank daily, and correct if required. Check antifreeze strength.

Rustproof the cooling system twice a year; drain, flush and refill the system each two years with a properly inhibited water/antifreeze solution.

Check belts for proper tension; adjust as necessary and replace any frayed or badly worn belts.

Check radiator cores for leaks and ensure that the cores are not clogged with dirt or insects. Clean cores with a low pressure air hose to avoid damaging the fins. Steam clean if required.

Inspect the water pump operation. A leaky pump sucks in air, increasing corrosion.

Repair all leaks promptly. Unchecked leaks can lead to trouble. Inspect and tighten radiator mounts periodically. Test and replace thermostats regularly.

Leaks at the thermostat housing hose connections may be caused by deformation and rough surfaces on the castings of the hose mounting surfaces. It is recommended that *"Dow Corning RTV-102 Compound"* or any equivalent product be applied on cast surfaces prior to hose installation.

CAUTION: Castings should be clean and free of oil and grease before applying compound. No other sealer should be used with RTV-102 compound.

Hose inspection

Rotten, swollen, and worn out hoses or loose connections are frequent causes of cooling system problems.

Serious overheating is often caused by old hose collapsing or from rotten rubber shedding from hoses and clogging the coolant passages.

Connections should be inspected periodically and hose clamps tightened. Replace any hose found to be cracked or swollen. When installing a new hose, clean pipe connections and apply a thin layer of a non-hardening sealing compound. Replace worn out clamps or clamps that pinch hoses.

Constant-torque hose clamps

Description

All hose clamps of 1 3/8" I.D. and over, used on the heating and cooling systems, are of the *"constant-torque"* type. These clamps are worm-driven, made of stainless steel, and provided with a series of Belleville spring washers. They also feature an extended integral liner that covers the band slots to protect soft/silicone hoses from damage, and help maintain consistent sealing pressure.

This type of clamp is designed to automatically adjust its diameter to compensate for the normal expansion/contraction of a hose and metal connection that occurs during vehicle operation and shutdown. The constant-torque clamp virtually eliminates coolant losses due to *"cold flow"* leakage and greatly minimizes clamp maintenance.

Installation

A torque wrench should be used for proper installation. The recommended torque is 90 to 100 lbf•in. (10 to 11 N•m). The Belleville spring washer stacks should be nearly collapsed flat and the screw tip should extend 1/4" (6 mm) beyond the housing (see fig. 2).

CAUTION: The hose clamps will break if overtorqued. Do not overtighten, especially during cold weather when hose has contracted.

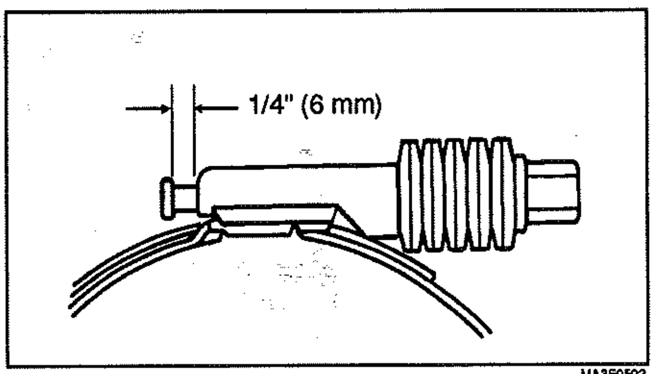


Fig. 2 - Constant-torque clamp

Maintenance

The constant-torque clamps contain a *"Visual torque check"* feature. When the tip of the screw is extending 1/4" (6 mm) out of the housing, the clamp is properly installed and maintains a leak-proof connection. Since the constant-torque clamp automatically adjusts to keep a consistent sealing pressure, there is no need to retorque hose clamps on a regular basis. During vehicle operation and shutdown, the screw tip will adjust according to the temperature and pressure changes. Proper installation torque should be checked at room temperature.

Testing antifreeze solutions

Always test the solution before adding water or antifreeze. The engine should be warmed up to operating temperature. Fill and empty the tester several times to warm before using. Keep the tester clean inside and out. Some testers will indicate correct freezing point only when the test is made at a specific temperature. Other testers are provided with thermometers and tables, and indicate freezing points corresponding to readings made at various temperatures. Disregarding temperature of the solution may cause an error as large as 30 °F (16,6 °C). Read and follow the instructions furnished by the tester manufacturer.

Thawing cooling system

If the cooling system becomes frozen solid, place the coach in a warm area until the ice is completely thawed. Under no circumstances should the engine be operated when the cooling system is frozen, as it will result in engine overheating due to insufficient coolant.

COOLANT REQUIREMENTS

Successful engine operation depends on the correct selection and maintenance of the coolant. A suitable coolant must meet the following requirements:

1. Provide for adequate heat transfer.
2. Provide a corrosion-resistant environment within the cooling system.
3. Prevent formation of scale or sludge deposits in the cooling system.
4. Be compatible with cooling system hose and seal materials.
5. Provide adequate freeze protection during cold weather operation and boil-over protection in hot weather.

For a complete overview of engine coolants used with Detroit Diesel engines, refer to section 13.3 *"Coolant specifications"* in the applicable Detroit Diesel Engine manual.

Standard-type ethylene glycol base antifreeze, meeting GM specification 6038-M should be used. Ethylene glycol solutions have several advantages over other solutions. They boil at a higher temperature, so that overheating is less likely to occur. It should be noted, however, that coolant temperature may be 6 to 8 °F higher than with a water solution.

Ethylene glycol solutions will be properly inhibited for corrosion protection pH balance and water softness, if a minimum concentration of 30% per volume is used. Solutions of less than 30% concentration do not provide sufficient corrosion protection. Concentrations over 67% adversely affect freeze protection and heat transfer rates (see fig. 3).

A non-chromate water filter (supplemental coolant conditioner unit) should be used with ethylene glycol solutions to prevent the formation of chromium hydroxide, commonly called *"green slime"*, within the system. The inhibitors in the antifreeze solution will break down over a period of time, and should be replenished at approximately 500 operating hours or 20,000 miles (32 000 km) intervals. Commercially available, non-chromate inhibitors (borates, nitrates, nitrites, etc.,) provide corrosion protection in the cooling system and can be used to re-inhibit the antifreeze solution. Losses through leakage or foaming must be replaced by additional antifreeze solution.

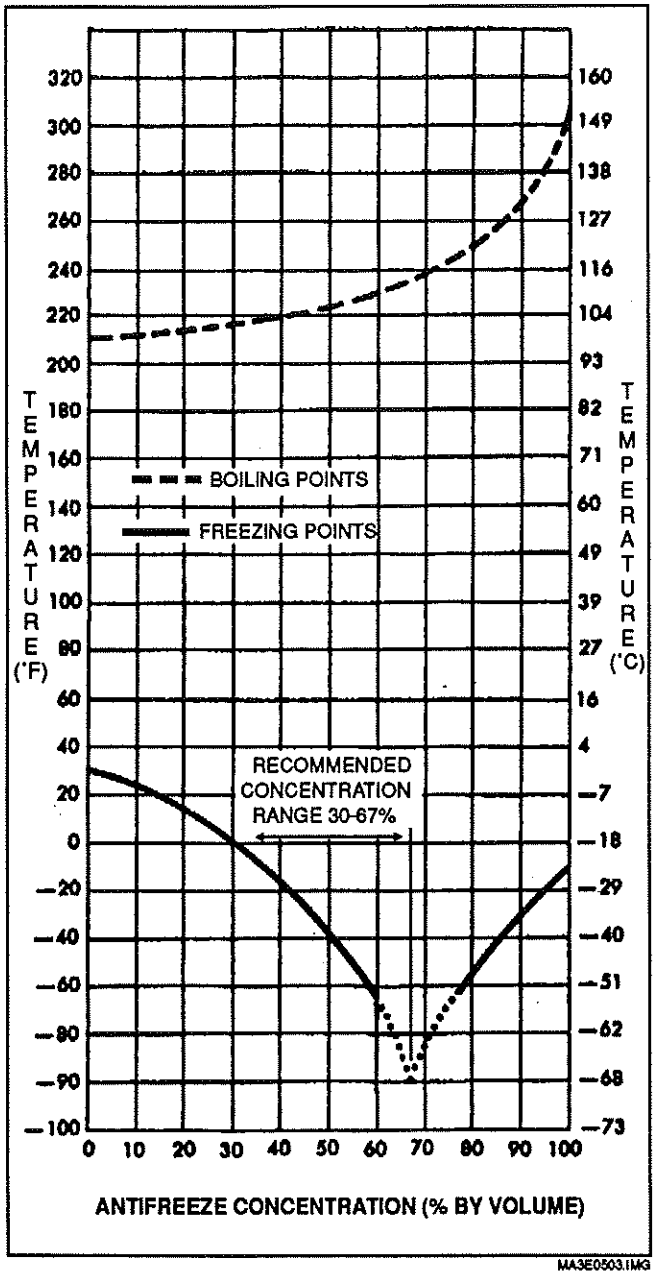


Fig. 3 - Coolant freezing and boiling temperature vs antifreeze concentration (sea level)

DRAINING COOLING SYSTEM

The cooling system may be completely or partially drained by using the following procedures.

To drain only the engine and related components, proceed as follows:

1. Stop engine and allow engine to cool. Close both heater line shutoff valves. One is located in engine compartment under the radiator fan gearbox, while the other one is located in the L.H. ski compartment (small compartment between the last baggage compartment and rear electric compartment).

WARNING: Before proceeding with the following step, make sure that coolant has cooled down. The sudden release of pressure from a heated cooling system can result in loss of coolant and possible personal injury (scalding) from the hot liquid.

2. Remove the pressure cap. Removal of the pressure cap permits air to enter the cooling passages and the coolant to drain completely from the system.
3. Remove drain plug on each cylinder head thermostat block (see fig. 4).
4. Open both engine side drain cocks (see fig. 5 and 6).
5. Open engine oil cooler drain cock (see fig. 7).
6. Open the water pump inlet line drain cock (see fig. 8).
7. Remove radiator drain plug (see fig. 9).

To drain the entire system, resume the previous steps while maintaining the shutoff valves in their *"open"* position, and follow the procedure under the heading *"Draining Heating System"* in section 22, to drain simultaneously the heating units.

LOCATION OF COOLING SYSTEM DRAIN POINTS

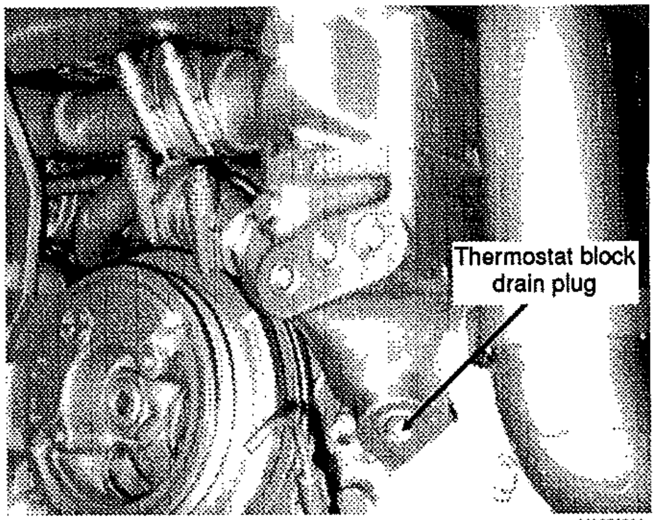


Fig. 4 MA3E0504

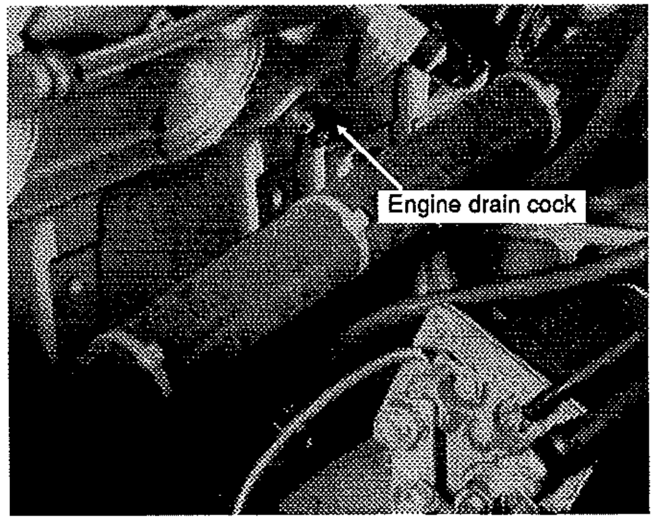


Fig. 5 MA3E0505.IMG

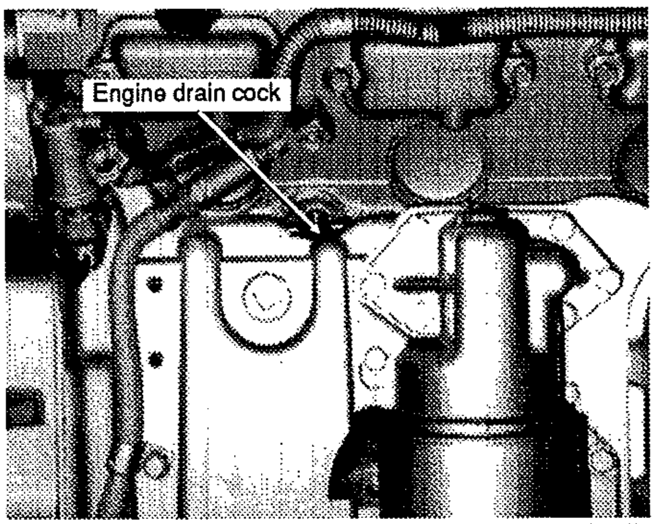


Fig. 6 MA3E0506

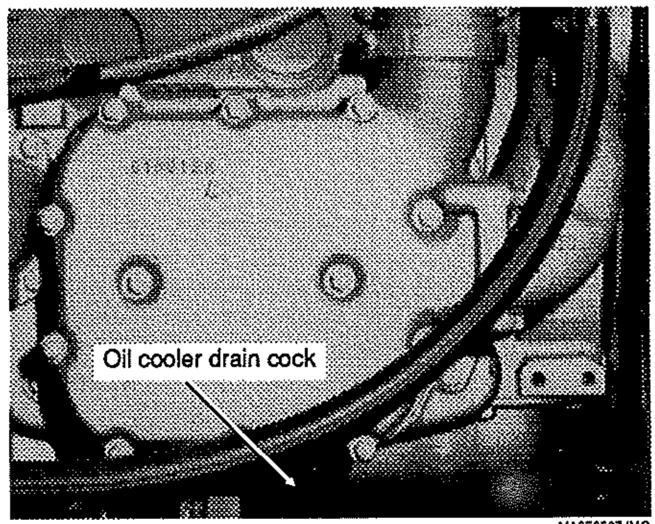


Fig. 7 MA3E0507.IMG

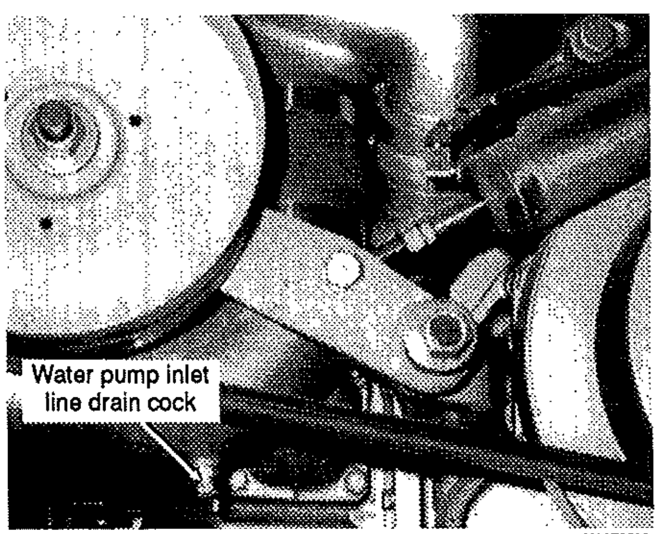


Fig. 8 MA3E0508

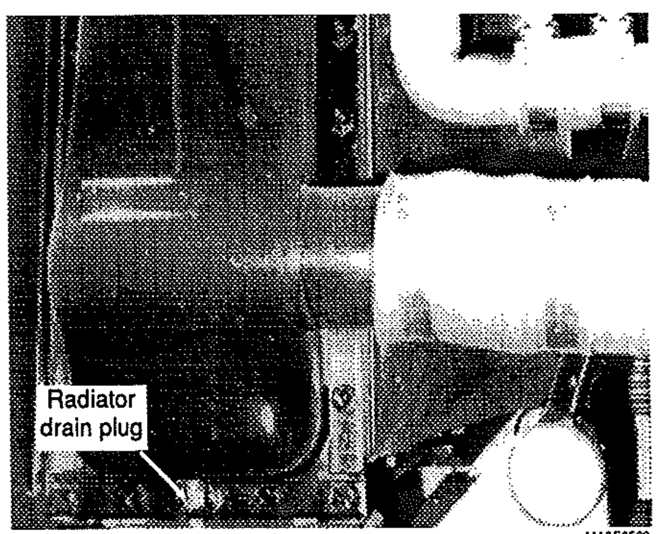


Fig. 9 MA3E0509

REFILLING COOLING SYSTEM

If only the engine and related components have been drained, maintain the two heater line shutoff valves in their *"close"* position, then proceed as follows.

1. Close all drain cocks and install the drain plugs referring to the draining procedure for the location of drain points.

2. From the surge tank filler cap opening, slowly fill the system to level of filler neck.

NOTE: The cooling system is completely filled when coolant reaches the surge tank filler neck.

3. Install the filler and pressure caps, then start the engine and run it at fast idle until normal operating temperature is reached.

NOTE: If for any reason, the coolant level drops below the surge tank level probe, the automatic engine shutoff device will be actuated.

4. Stop engine and allow it to cool.

5. Open the two heater line shutoff valves, check the coolant level in the surge tank, then add as required.

CAUTION: Never pour cold coolant into a hot engine. The sudden change in temperature may crack the cylinder heads or block.

If the entire system has been drained, resume the previous steps while maintaining the two heater line shutoff valves in their *"open"* position. With engine running, activate the driver's and central heating systems to permit coolant circulation, then complete the procedure by bleeding the heater cores as explained in section 22 under heading *"Bleeding Heating System"*.

SPIN-ON TYPE COOLANT FILTER

Description

Two spin-on type coolant filters, located close to the engine water pump inlet elbow, are available as optional equipment (see fig. 10). The filters should be replaced every 500 hours or every 20,000 miles (32 000 km). PREVOST recommends the use of *"Perry"* filter #PFC-24A (Prevost part #55-0276).

Replacement

Close the two shutoff cocks at the filter mounting heads and unscrew the old filters from under the vehicle.

Clean the areas around the mounting heads and screw the replacement filters on. Be sure to follow the manufacturer's instructions when installing a new filter. Open the two shutoff cocks at the filters.

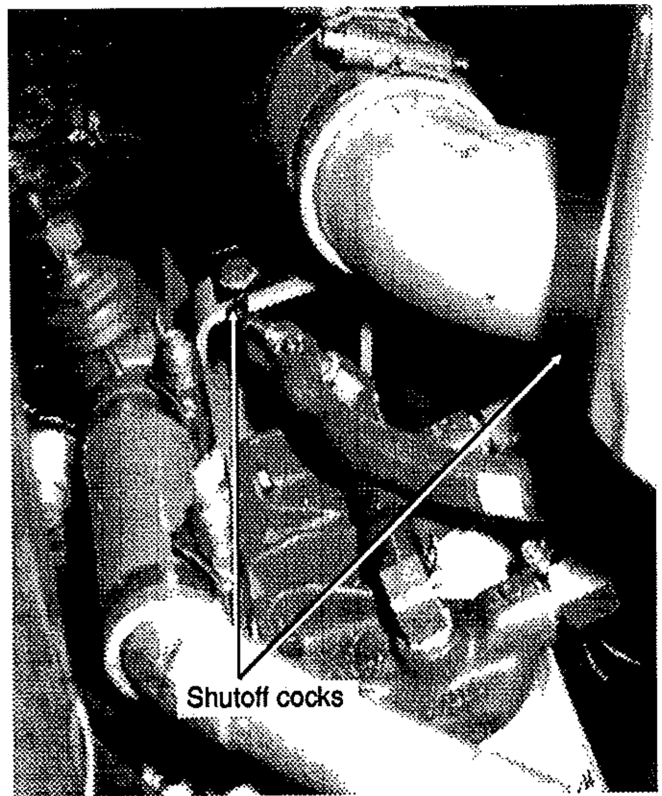


Fig. 10

RADIATOR

The radiator is mounted at the L.H. side of engine compartment. The radiator is designed to reduce the temperature of the coolant under all operating conditions. It is essential that the radiator core be kept free from corrosion and scale at all times in conjunction with the regular maintenance of the other components of the cooling system.

RADIATOR SHUTTER

Description

An air-operated shutter assembly is provided on the intake side of the radiator core. The shutter assembly is controlled by an air cylinder (see fig. 11). The air supply to the cylinder is controlled by the shutterstat, which is mounted on the thermostat housing.

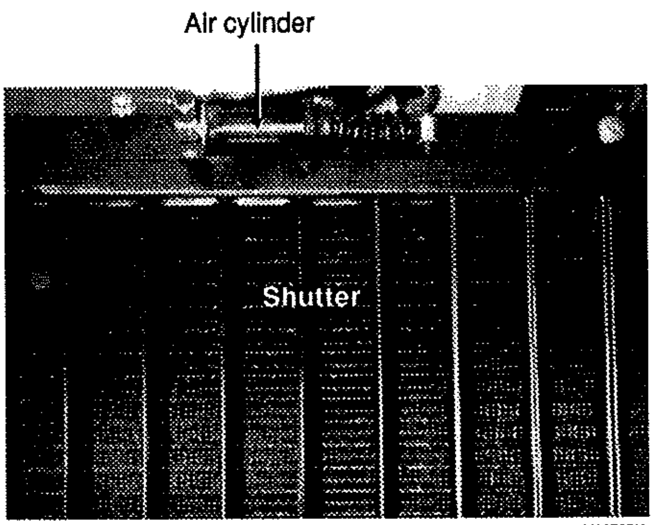


Fig. 11

Operation

When the engine coolant temperature reaches 180 °F (82 °C), the shutterstat cuts off the compressed air supply to the radiator air cylinder and exhausts air from the air cylinder; the shutter opens, allowing cool air to flow through the radiator fins. When the engine coolant temperature is below the setting of the shutterstat, compressed air is allowed to flow to the radiator air cylinder, thus closing the shutter.

The radiator shutter can be opened manually by using the following procedure:

1. Close the cock (mounted near engine compartment ceiling) on the shutterstat air supply line.

2. Open the drain cock installed at the bottom of the shutterstat.

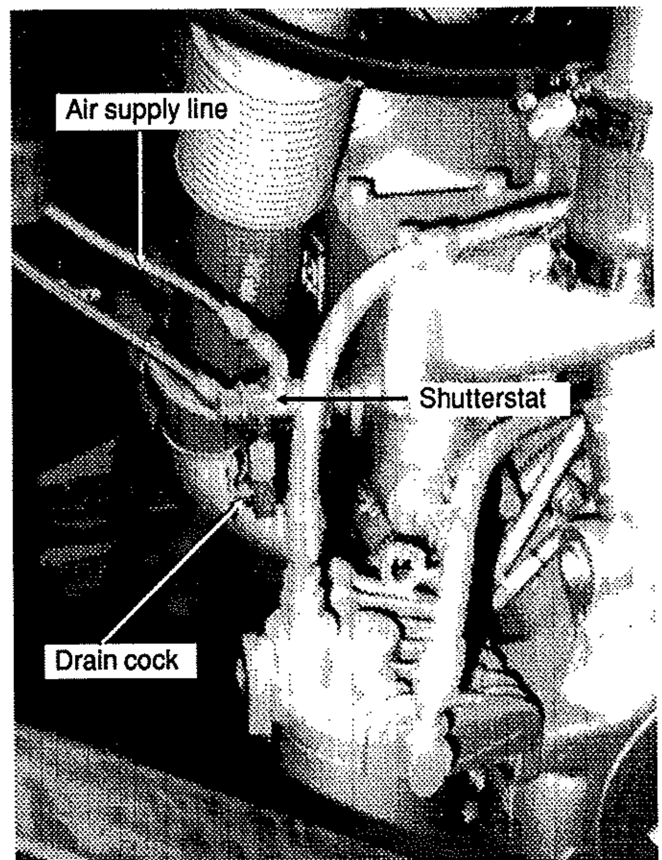


Fig. 12

SHUTTERSTAT

Description & operation

The shutterstat controls the supply of compressed air to the radiator shutter air cylinder. The shutterstat is mounted on the thermostat housing (radiator side).

When the engine coolant reaches the temperature of the shutterstat setting (180 °F (82 °C)), the shutterstat cuts off the air supply to the radiator shutter air cylinder, exhausts air from the air cylinder allowing shutter to opens. When the coolant temperature is below the setting of the shutterstat, air is allowed to enter the radiator shutter air cylinder, closing the shutter.

Maintenance

Ensure that the air exhaust holes are kept free of dirt, then twice a year, disconnect the shutterstat air supply line (upper one) and inject a few drops of special *"KYSOR"* shutterstat fluid.

Removal

Before removing the shutterstat, it is necessary to lower the coolant level in the engine; refer to *"Draining Cooling System"* outlined previously in this section.

1. When the coolant level has been lowered, disconnect the shutterstat air lines and plug or tape them to prevent the entry of dirt.
2. Unscrew and remove the shutterstat.
3. The shutterstat is non-serviceable, and if it is found to be defective, it should be discarded and replaced with a new one.

After replacing the shutterstat, connect the air lines and refill the cooling system. Refer to *"Refilling Cooling System"* outlined previously in this section.

RADIATOR VARIABLE SPEED FAN

Description & operation

A radiator variable speed fan (thermostatic) is available as optional equipment. The fan drive clutch is a fluid coupling containing silicone oil. Fan speed is regulated by the torque-carrying capacity of the silicone oil. The more silicone oil in the coupling the greater the fan speed, and the less silicone oil the slower the fan speed.

A bi-metallic strip (see fig. 13) regulates the amount of oil entering the fluid coupling, and consequently, the speed of the fan. Both extremities of the bi-metallic strip are held on the fan drive by fasteners. The bi-metallic strip bows outward with an increase in surrounding temperature and allows a control piston to move outward. This outward movement of the control piston allows a greater flow of oil into the fluid coupling, thus increasing the fan speed and engine cooling. As the surrounding temperature decreases, the bi-metallic strip bows inward, thus forcing the control piston inward. This drives the oil out of the fluid coupling, thus decreasing the fan speed.

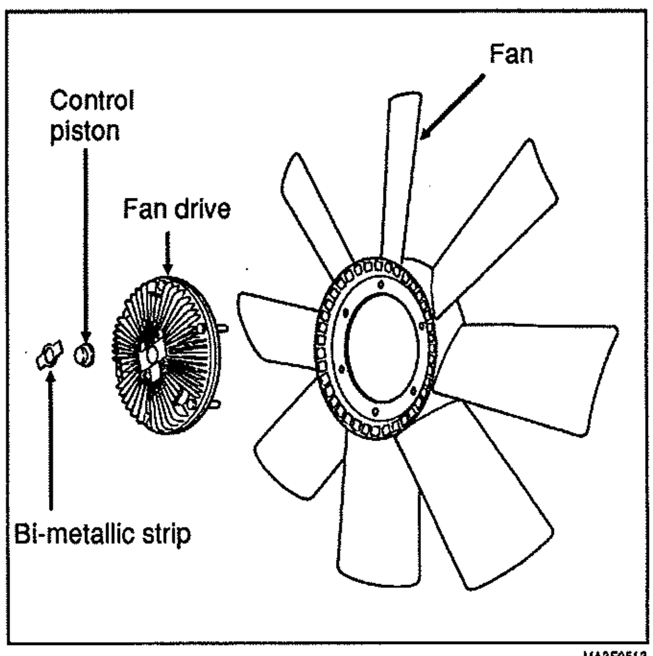


Fig. 13

Function test

1. Start the engine, allow to run at fast idle until its operating temperature is reached.

2. The radiator being provided with shutter, opening should occur at 180 °F (82 °C). Check temperature on gauge in engine compartment, then note opening temperature of shutter.

3. With strobe light, note input shaft and output fan speeds as coolant temperature approaches an indicated 195 °F (91 °C). Fan speed should reach 85% of input shaft speed.

CAUTION: Indicated coolant temperature should not exceed 215 °F (102 °C) under any engine operating condition.

4. Return engine to idle condition. Allow to cool while running for at least three minutes before shutdown.

Maintenance & use

1. **Do not** clean around drive with steam or high pressure jet.

2. **Do not** add any fluids or lubricants to the fan drive.

3. **Do not** restrict fan rotation during engine operation for **any reason**.

4. **Do not** operate a drive with a damaged fan assembly. Replace a damaged fan as soon as the fault is noted.

5. **Do not** disassemble **any** drive that is still within the warranty coverage period.

6. **Immediately** investigate and correct **any** operator complaint involving drive or cooling system perfomance.

7. When questions arise, obtain answers **before** proceeding. Assistance is available through the authorized Field Sales distributor serving your area.

25,000 miles (40 000 km) routine inspection

WARNING: Set the starter selector switch in engine compartment to the *"Off"* position to prevent accidental starting of the engine.

1. Check security of fasteners holding fan blade assembly to fan drive.

2. Check coupling installation to gearbox output shaft.

3. Visually inspect fan drive, fan blade assembly, shroud, radiator, and surrounding area for evidence of contact between rotating and non-rotating parts.

4. Check fan transfer belt for fraying, cracking, and proper tension.

5. Turn fan through at least 360° of rotation. It should turn smoothly, although with some resistance. The amount of resistance varies depending on coolant temperature at the time of engine shutdown. If there is any binding, jerkiness, or if the fan spins freely, the fan drive should be replaced.

6. Grasp one blade tip and move alternately toward and away from radiator. Allowable fore and aft movement is 1/16" (1,6 mm) at 10" (25,4 cm) radius from the centerline. If movement greater than this is evident and it cannot be traced to loose fasteners or fan gearbox wear, the fan drive is defective and should be replaced.

CAUTION: When making this check, do not use force sufficient to cause deflection of blade assembly as this will give a distorted measurement.

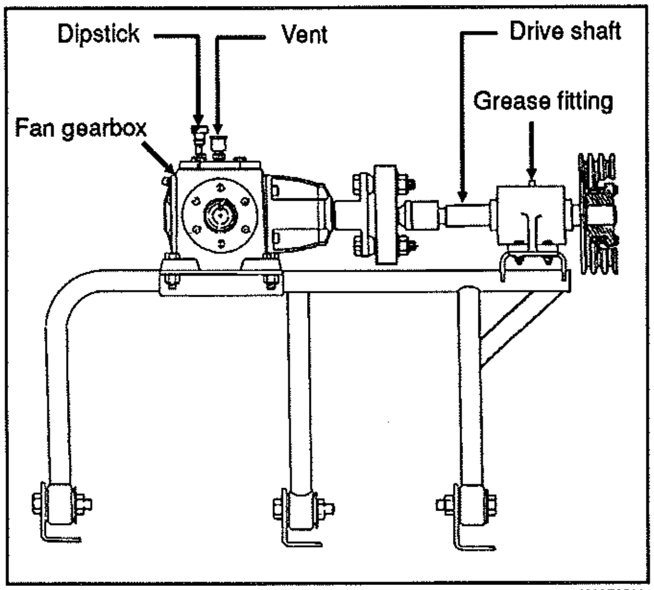
7. Check fan drive for fluid leakage. It is normal to have very slight misting and dust accumulation around the pin in the center of the front cover. Any other leakage is abnormal and will result in impaired performance.

FAN GEARBOX

Description

The radiator fan is belt driven from the engine crankshaft pulley through a drive shaft and a gearbox. The gearbox standard assembly is provided with the output shaft rotating counterclockwise, while the gearbox assembly used on vehicles equipped with a thermostatic fan, requires a relocation of its inside components in order to reverse the rotation of the output shaft as required by the thermostatic fan assembly.

As for belt tension, it is achieved by the use of a tensioner which is described later in this section under heading *"Belt Tensioners"*.



MA3E0514

Fig. 14

Oil verification

The gearbox is equipped with a knurled knob dipstick, which is close fitted on top, to allow oil verification. Check oil level with the engine stopped and be sure that all engine stopping safety precautions have been observed. Maintain the oil level between the marks on the dipstick and if adding is necessary, use SAE 90 general purpose lubricant.

Maintenance

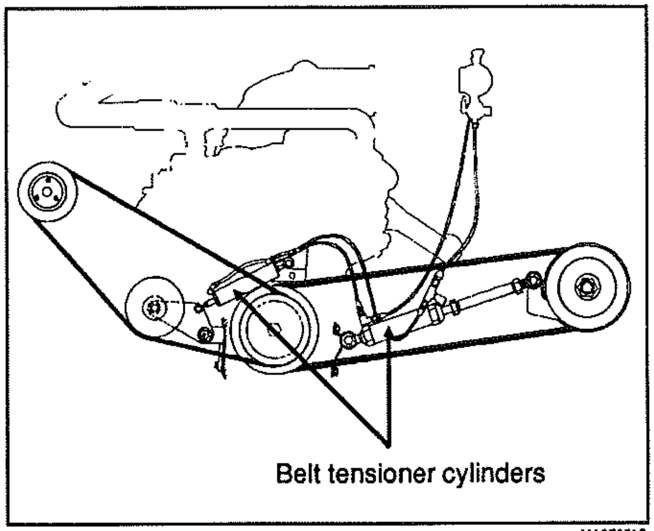
Under normal conditions, the gearbox should be relubricated at intervals of 2500 hours of operation or six months, whichever occurs first.

Furthermore, a grease fitting is provided on top of the drive shaft pillow block. Grease should be added every 5,000 miles (8 000 km) or twice a year, whichever occurs first. Only high melting point, water resistant, lithium-base grease should be used.

BELT TENSIONERS

Description

The radiator fan and air conditioning compressor are driven by V-belts, each provided with an air-operated tensioner cylinder (see fig. 15).



MA3E0515

Fig. 15

Adjustment

To maintain the proper tension on belts, the two following adjustments are required:

1. Cylinder air pressure
2. Cylinder shaft length

Cylinder air pressure adjustment

Refer to the procedure described in section 12 *"Brakes and Air System"* in this manual under heading *"Belt tensioner pressure regulating valve"*.

Cylinder shaft length adjustment

WARNING: Set the engine starter selector switch in engine compartment to the *"Off"* position to prevent accidental starting.

1. Remove both wing nuts securing belt guard in place, then lift and remove it from engine compartment.

2. With the pneumatic system under normal pressure and the belt tensioner pressure regulating valve properly adjusted, adjust the cylinder rod to provide a 1" - 1 1/2" (25 - 38 mm) extension as shown in figure 16. To perform adjustment, proceed as follow:

a. Loosen the jam nut on the shaft end of the cylinder.

b. Rotate the shaft to obtain the specified length.

c. Tighten the jam nut.

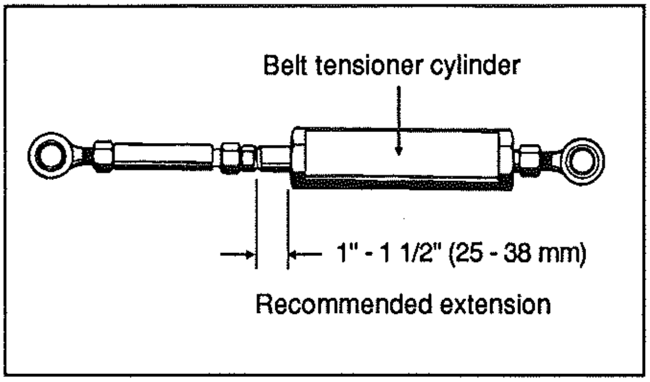


Fig. 16

RADIATOR FAN BELT REPLACEMENT

WARNING: Set the engine starter selector switch in engine compartment to the *"Off"* position to prevent accidental starting.

1. Remove both wing nuts securing belt guard in place, then lift and remove it from engine compartment.
2. Locate the belt tensioner two-way control valve (see fig. 17), then turn handle counterclockwise in order to reverse pressure in belt tensioner air cylinders, thus releasing tension on belts.
3. Slip the old fan belt off and the new one on.
4. Turn clockwise the two-way control valve to its initial position to apply tension on the new belt.
5. For proper operation of the belt tensioner cylinder, adjust the belt tensioner cylinder rod to provide a 1" - 1 1/2" (25 - 38 mm) extension as outlined previously.
6. Reinstall the belt guard, then secure in place with the two wing nuts.

NOTE: As new belt stretch with normal wear, check the belt tensioner cylinder rod length and readjust if necessary after a run-in period of 500 miles (800 km).

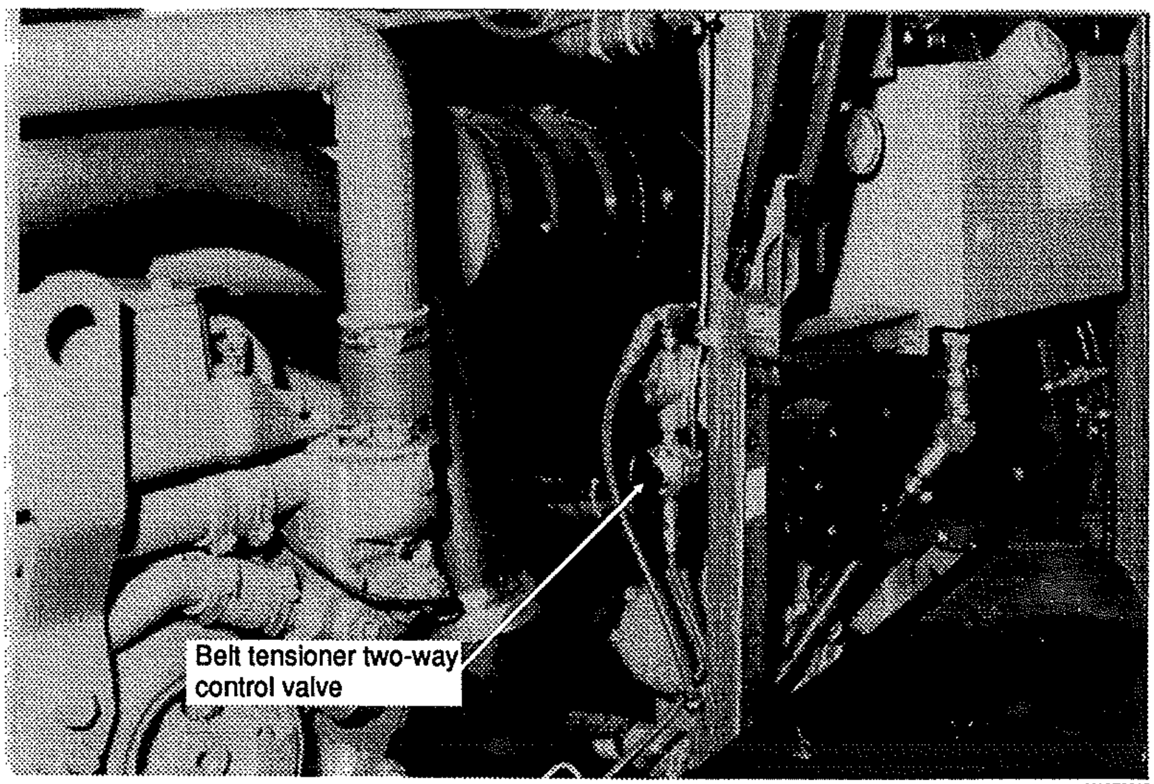


Fig. 17

SPECIFICATIONS

COOLING SYSTEM CAPACITY (Approx.)

Includes heating system . . . . 24 US gallons (91 liters)

THERMOSTAT

Number used 2
Start to open . . . . 180 °F (82 °C)
Fully open . . . . 197 °F (92 °C)

RADIATOR

Make . . . . Long
Type . . . . Fins & Tube
Location . . . . Rear L.H. side of coach
Prevost number 55-0609

SURGE TANK FILLER CAP

Make . . . . Stant
Model R3
Prevost number 53-0191

PRESSURE CAP

Make . . . . Stant
Pressure setting . . . . 14 psi (96,53 kPa)
Supplier Number R12
Prevost Number 55-0606

SHUTTERSTAT

Make . . . . .Kysor
Opening temperature . . . . 180 °F (82 °C)
Supplier Number 1047-36000-28
Prevost Number 55-0023

THERMOSTICALLY-CONTROLLED RADIATOR FAN DRIVE (OPT)

Make . . . . .Schwitzer
Type . . . . Variable speed
Supplier Number (with 30" fan) 187604
Supplier Number (with 32" fan) 187739
Prevost Number (with 30" fan) 55-0570
Prevost Number (with 32" fan) 55-0604

FAN GEARBOX

Make . . . . Boston Gear
Ratio 1:1
Supplier Number . . . . R 146-1-J-79
Prevost Number 55-0027

FAN BELT

Make . . . . Gates
Type . . . . V-belt
Model (with thermostatic fan) 3A-92
Model (without thermostatic fan) 3A-94
Prevost Number (with thermostatic fan) 50-6333
Prevost Number (without thermostatic fan) 50-6612

COOLANT FILTER

Number used 2
Make . . . . Perry Filter
Type . . . . Spin-on
Supplier Number PFC-24A
Prevost Number 55-0276

TEMPERATURE GAUGE (in engine compartment)

Make . . . . Stewart Warner
Operating Range . . . . .100-265 °F (40-130 °C)
Supplier Number 491-BS-72
Prevost Number 56-1011

TEMPERATURE GAUGE (on instrument panel)

Make . . . . .Sentry
Operating range . . . . .100-280 °F (38-138 °C)
Supplier Number 07177-01
Prevost Number 56-1594

SERVICE BULLETINS AND SERVICE INFORMATION LETTERS

Service Bulletins and Service Information Letters will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of publications pertaining to this section should be noted below as soon as received. These should then be filed for future reference.

NUMBER	DATE	SUBJECT

06

ELECTRICAL SYSTEM

CONTENTS OF THIS SECTION

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GENERAL DESCRIPTION

This vehicle uses a dual voltage system to obtain two different voltages (12 & 24 volts) for various electrical controls and accessories. The main power source incorporates four maintenance-free *"Delco"* model 1150 batteries connected in series-parallel. All batteries are kept uniformly charged by means of two 50 amp battery equalizers (standard), giving a maximum possible output supply of 100 amps on the 12 volt system. Both the 12 and 24 volt systems are controlled through individual main disconnect switches. A 24 volt self-rectified alternator is gear driven from the engine, and can be reached through the tag axle wheelhouse after removal of the engine splash guard.

WIRING AND MISCELLANEOUS ELECTRICAL

Wiring diagrams

A master wiring diagram of the electric circuits, covering standard and optional accessories and systems, is annexed to this section. Usually, a separate wiring diagram page is provided for each major function or system. In some cases, more than one circuit may appear on one wiring diagram page; when it occurs, each circuit covered in this page is listed in the wiring diagram index. Moreover, a circuit may appear on several pages; in such case, the number(s) at the extremity of diagram title will indicate the sheet reference number. Refer to the *"Wiring diagram index"* to ensure the correct diagram is being used to trace the circuit in question.

Wiring diagram symbols

Various symbols are used on the wiring diagrams to depict different types of electrical components. It is essential to become familiar with these symbols in order to understand the diagrams. The major symbols shown on the diagrams are identified under *"Wiring Diagram symbols"* (page I of wiring diagrams).

Wire sizes and colors

Each wire in the electrical system has a specific size as designated on the wiring diagram. When replacing a wire, the correct size must be used. Never replace a wire with one of a smaller size.

On vehicle, taking into account that the electric system is provided with different voltages, the insulation on each wire is distinctly colored in order to determine visually the wiring voltage and to assist in making connections. The wires are color coded as follows:

Red	24 volt system
Yellow	12 volt system
Black	grounded wire
Blue	110 V ac system (live)
White	110 V ac system (neutral)
Green	110 V ac system (ground)
Orange	speakers (+)
Brown	speakers (-)
Grey	spare wire

NOTE: In addition, the wires are identified at each 4-6 inch intervals by a printed number.

Each wire on a diagram is patterned to assist in tracing and testing circuits; the wire number is designed in order to identify at first, the voltage rating, then the wire identification number, and finally the basic wire gauge as illustrated in figure 1.

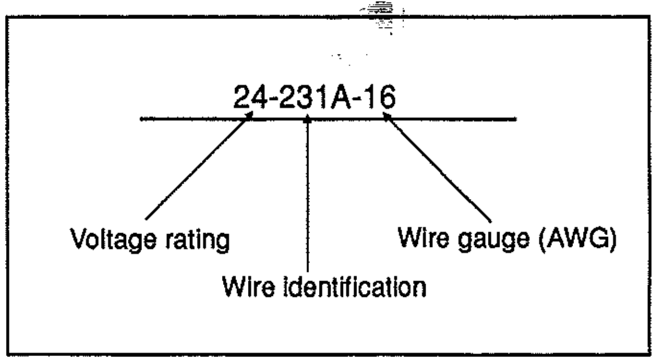


Fig. 1

Spare wires

When vehicle leaves factory, and even in the case of a full-equipped vehicle, an important number of unconnected spare wires are routed between the junction boxes. Consequently, for any connection of an additional accessory, refer to page C *"Spare wires"* in master wiring diagram to determine the number, the gauge and location of these wires.

NOTE: In addition to the number, the letters *"SP"* are printed on each spare wire.

Using the wiring diagrams

Two methods are used to *"work"* with electric wiring diagrams.

1. You have identified the defective part (breaker, diode, relay, etc.), and you wish to locate its corresponding circuit.

Problem: Circuit breaker #56 is released (open circuit) and you don't know which circuit is affected.

a) Refer to wiring diagram index, and look for *"Circuit breaker code"*, pages D and D-1.

b) You will find that circuit breaker #56 is on page D; refer to this page.

c) At item C.B #56, you will find in the first column, the breaker amperage, in the second column the breaker voltage, and in the third column, the page on which you will find the corresponding diagram. The other columns give you the location and the function of the breaker.

d) Refer to page 10 keeping in mind the function of the breaker, i.e. emergency exit lights.

e) When you have located *"emergency exit lights"*, follow wiring until you come across C.B #56 and its circuit.

2. You have a problem with a specific system and you want to find the corresponding diagram.

Problem: The three (3) last speakers on R.H. side of vehicle are inoperative and you must trace their electric circuit.

a) Refer to wiring diagram index and look for *"Sound system"*, page 21.

b) You will find on page 21 the components as well as the electric wiring, thus providing you with a complete understanding of this circuit.

Testing circuits

A careful study of the wiring diagrams should be made to determine the source and flow of current through each circuit. When a circuit is thoroughly understood, a point-to-point check can be made with the aid of the applicable wiring diagrams. Any circuit can be tested for continuity or short circuits with a multimeter or a suitable voltmeter.

All electrical connections must always be kept clean and adequately tight. Loose or corroded connections can result in discharged batteries, difficult starting, dim lights and improper functioning of other electric circuits. Inspect all wiring connections at regular intervals. Make sure knurled nuts on all amphenol-type plugs are securely tightened. Knurled nuts on the plastic amphenol-type connectors will click into a detent when properly tightened. Line connectors, which have the side locking tabs, must have the locks latched in place to ensure a proper electrical connection.

Cleaning connectors with a Freon-based solvent

When the pins and sockets of connectors become dirty, clean them with a good quality solvent containing at least 90% Freon as its active ingredient. Freon has two qualities that recommend it. First, it does not conduct electricity and therefore, will not cause shorting between connector pins and sockets. Second, it evaporates quickly, eliminating the possibility of condensation within the connectors.

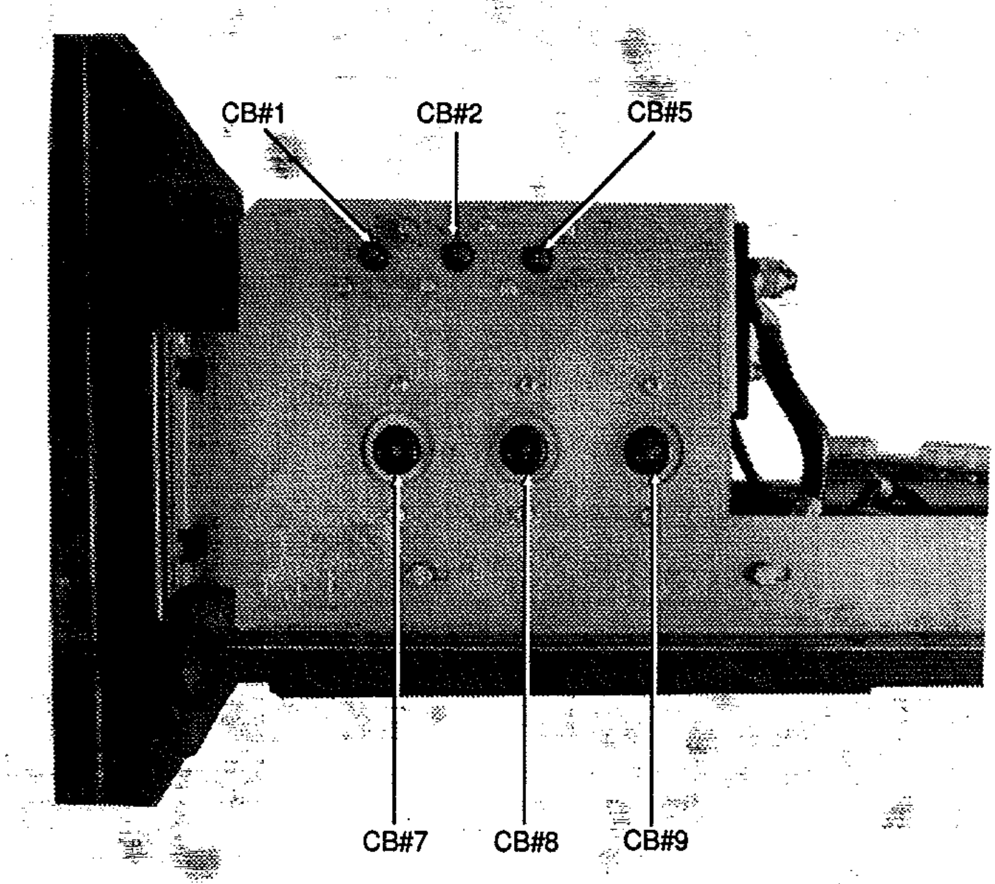
Always shake out or gently blow out any excess Freon before assembling a connector to its mating connector or hardware. Freon trapped in the connector can affect the connector seal.

WARNING: Freon-based compounds should always be used in a naturally well-ventilated area, never in a confined space.

Circuit breakers

All electric circuits are protected by circuit breakers of the *"Manual reset"* type. The main circuit breakers, as well as those protecting the evaporator and condenser fan motors, are located in a small compartment called *"Main power junction sliding support"* located on rear R.H. side of vehicle over the tag axle (beside the battery compartment). The circuit breakers are installed each side of sliding support as illustrated in figures 2 and 3. To slide out drawer, refer to instructions given under heading *"Main power junction sliding support"* later in this section under *"Junction Boxes"*.

The smaller circuit breakers are accessible in all junction boxes. This type of circuit breaker deenergizes the circuit without disconnecting any wire. Simply press down the red tab on breaker to open circuit, repair defective circuit, and afterwards depress black button in center of breaker to close circuit.



CB#1 Radio and PA system	30 amps - 12 volts
CB#2 Hot wire (12 volts)	30 amps - 12 volts
CB#5 Hot wire (24 volts)	30 amps - 24 volts
CB#7 Front junction box (24 volt feed)	90 amps - 24 volts
CB#8 Condenser fan motors & A/C junction box	150 amps - 24 volts
CB#9 Evaporator fan motor	150 amps - 24 volts

FIG. 2 - Main power junction sliding support (R.H. side)

MA3E0602

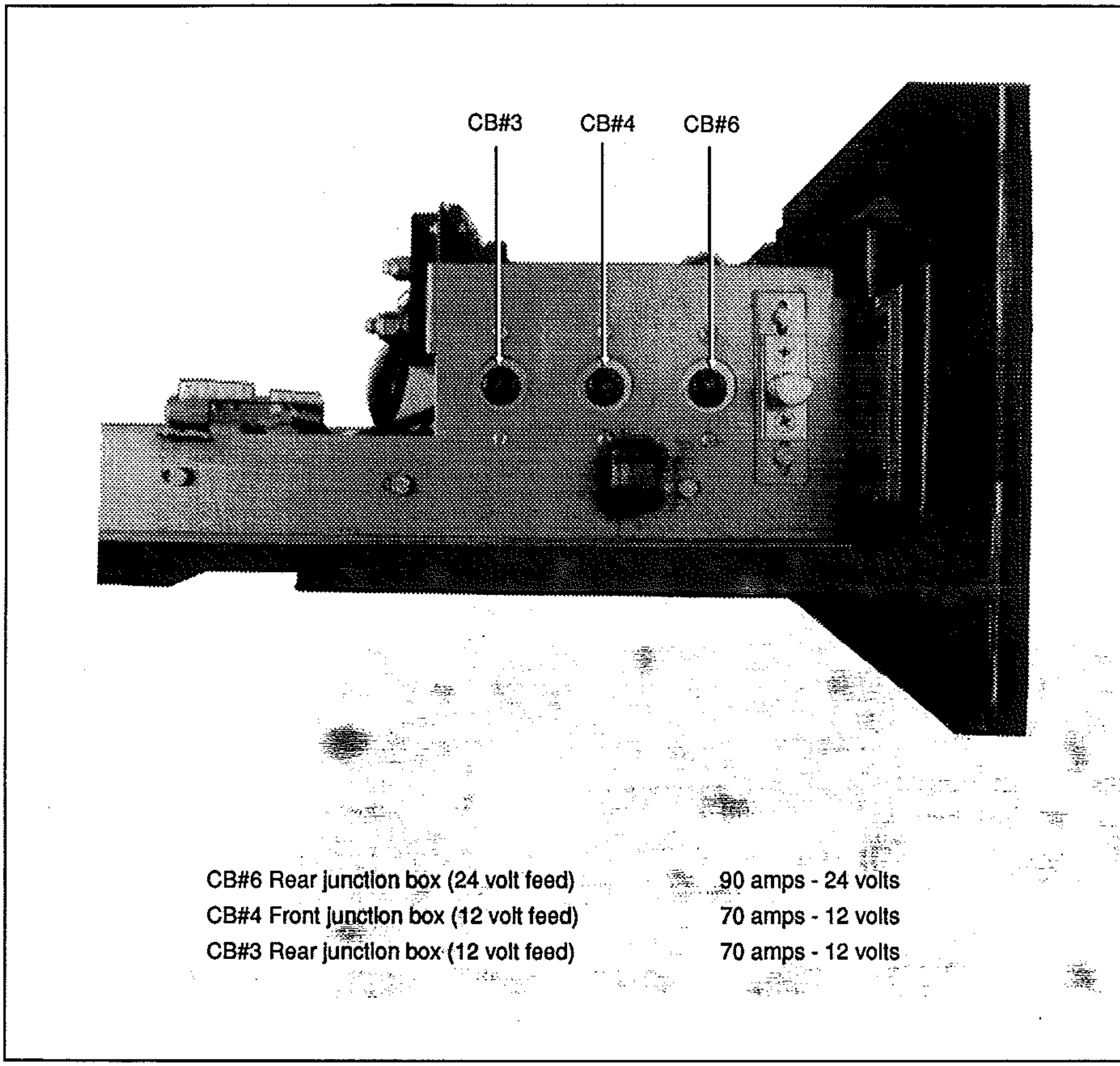


FIG. 3 - Main power junction sliding support (L.H. side)

Relays

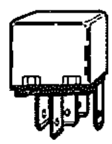
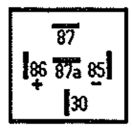
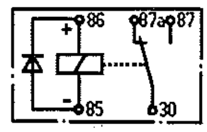
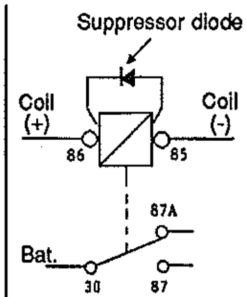
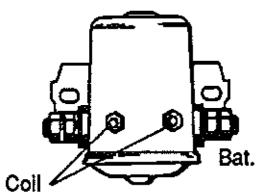
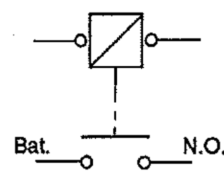
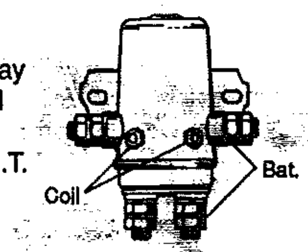
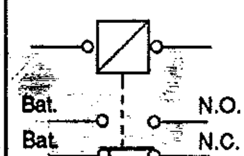
Relays are used to automatically energize or deenergize a circuit from a remote location. The relay draws a very low current to energize its coil. Once the coil is energized, it develops a magnetic field which pulls a switch arm closed or open, to either energize or deenergize a given component. As the control current required for the coil is very low, the relay allows a remote station to control a high energy circuit without running great lengths of costly high capacity cable, and also eliminates the need for high amperage switches and heavy connectors.

Many systems on this vehicle are provided with control relays, which are all located in or on the junction boxes.

NOTE: Each relay is identify with a 12 V or 24 V printed on its casing in order to identify the coil operating voltage.

CAUTION: The magnetic relays for the starting motor, evaporator and both condenser motors and condenser speed controls should have the 5/16" stud nuts torqued to 50 ± 5 inch.lbs (5,5 ± 0,5 N•m).

Types of relays used on this vehicle

<table>
<tr><th></th><th>Configuration on base</th><th>Key printed on casing</th><th>Key used on wiring diageam</th><th>Example</th></tr>
<tr><td>Cubic relay
(Steel or plastic casing)
Type: S.P.D.T.
</td><td>
</td><td>
</td><td>
</td><td>R #5</td></tr>
<tr><td colspan="5">NOTE: This relay is provided with an internal suppressor diode; never reverse wiring terminals #85 and 86 at base as a direct short circuit will result.
The relay coils connected to the alternator "relay terminal" should never be provided with a suppressor diode as the output current at this terminal is not rectified, thus rendering relay inoperative.</td></tr>
<tr><td>Magnetic relay
(Round steel casing)
Type: S.P.S.T.

</td><td>None</td><td>None</td><td>
</td><td>R #4</td></tr>
<tr><td>Magnetic relay
(Round steel casing)
Type: D.P.D.T.

</td><td>None</td><td>None</td><td>
</td><td>R #40</td></tr>
</table>

LEGEND

Bat.	Battery
N.O.	Normally Open
N.C.	Normally Closed
S.P.D.T.	Single Pole Double Throw
S.P.S.T.	Single Pole Single Throw
D.P.D.T.	Double Pole Double Throw

JUNCTION BOXES

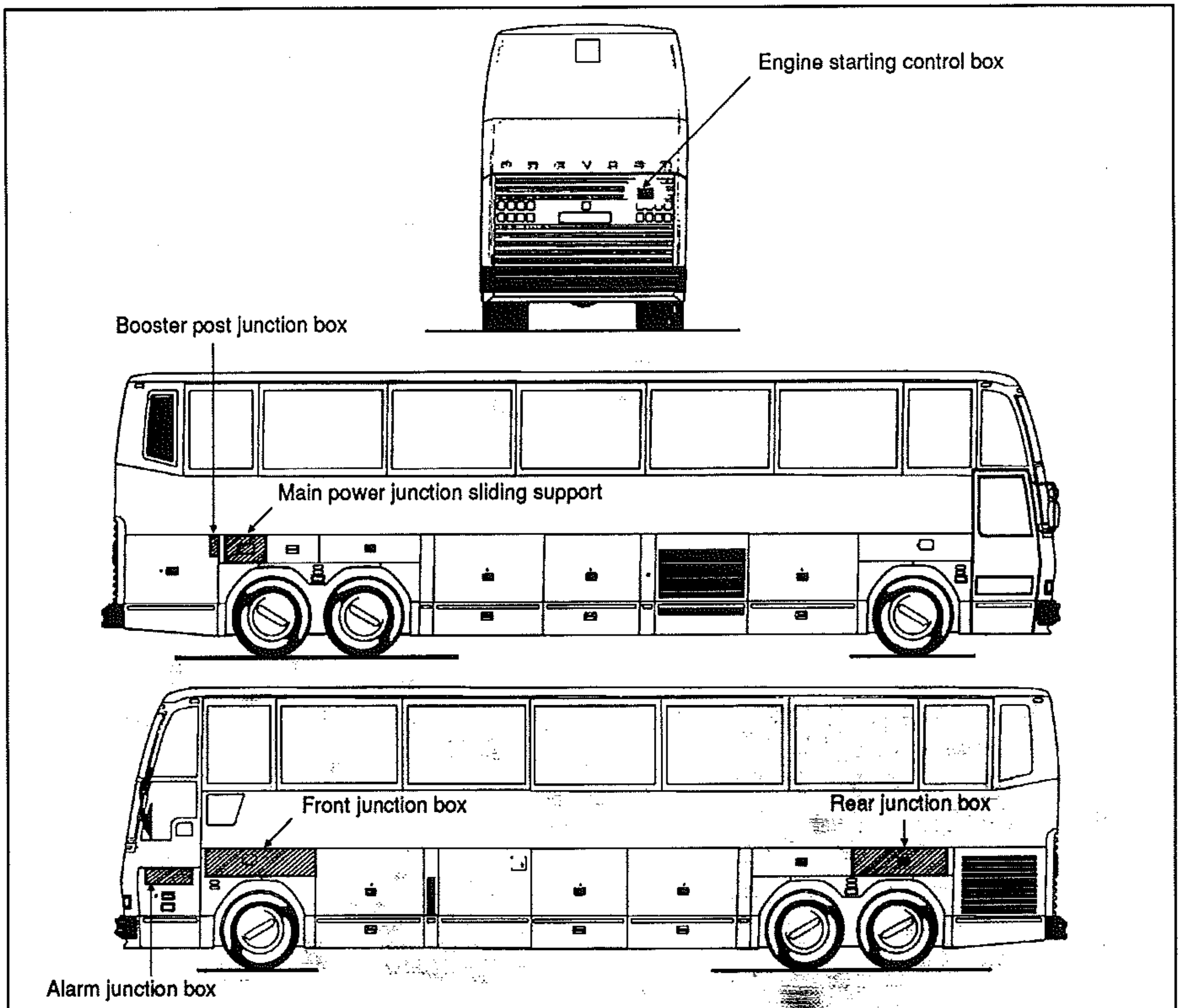


Fig. 4 - Junction box locations

Alarm junction box

The alarm junction box is located in the front service compartment, under the driver's window. To gain access, open the front service compartment door. This junction box contains the following items:

- Circuit breakers
- All alarm units
- ATEC test switch
- DDEC test switch
- ATEC-DDEC DDL reader connector
- 110 volt in-station connector receptacle
- 110 volt engine block heater switch
- 110 volt in-station lighting switch
- 110 volt immersion heater switch for the lavatory fresh water reservoir

Unscrew the 1/4 turn screws (2) and open the hinged panel to gain access to the following components located inside the alarm junction box.

- The pulse generator for the intermittent mode of the upper windshield washer motor.

NOTE: The pulse generator for the intermittent mode of the lower windshield washer motor is located under the dashboard.

- The 12 to 5 volt transformer for the back-up camera TV monitor
- The module for the dashboard brightness setting
- The junction terminals

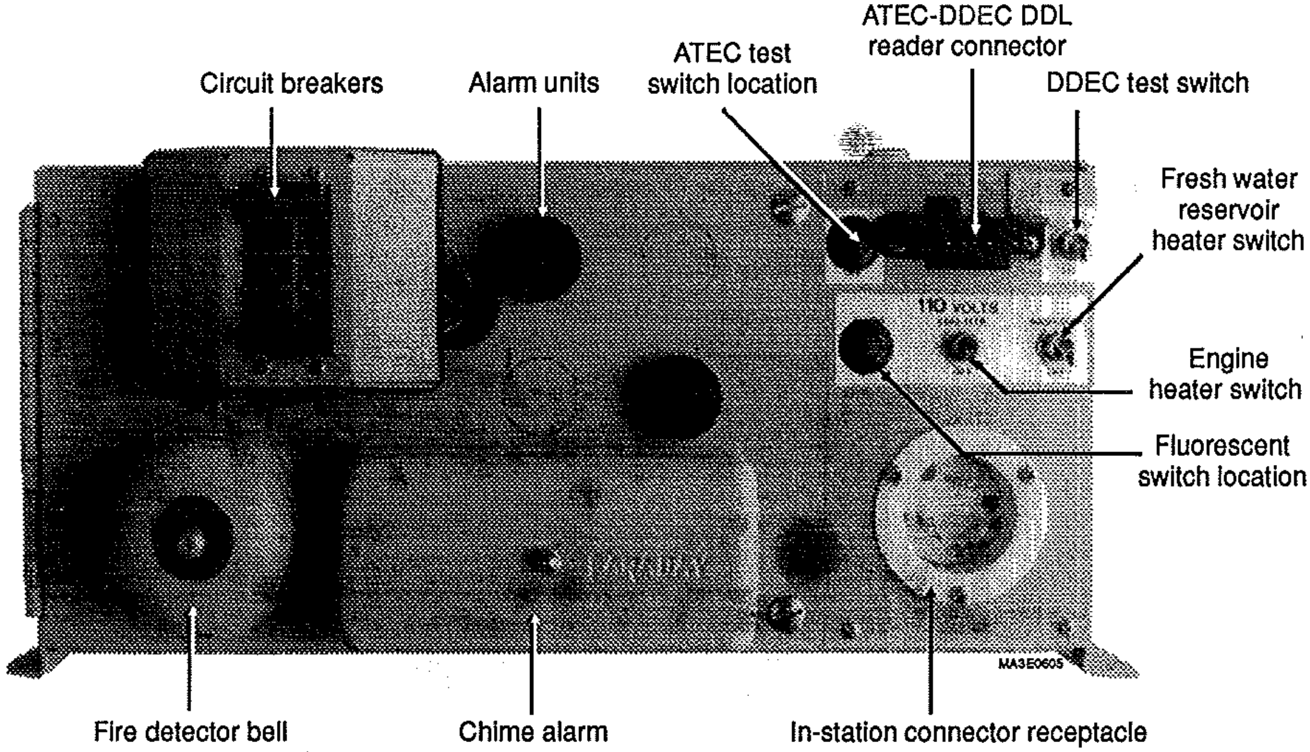


Fig. 5 - Alarm junction box

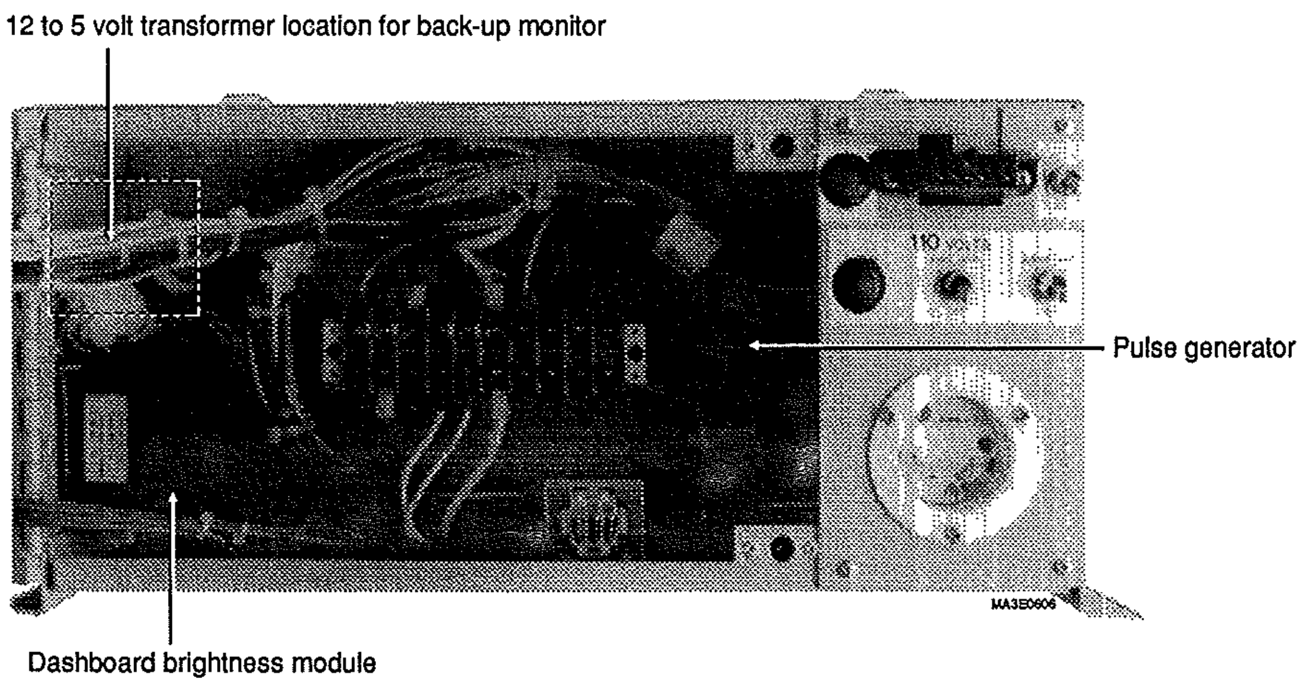


Fig. 6 - Inside of alarm junction box

Front junction box

The front junction box is located in the front electric compartment over the front axle on the left side of vehicle. This compartment is divided in two sections: the left section includes the electronic control unit of the ABS system (**A**ntilock **B**raking **S**ystem) plus junctions and connectors, while the right section includes the front junction box.

The front junction box is also divided; the R.H. side panel includes the electronic flasher unit, front engine run relays (12 & 24 volts) and two resistors for the daytime running lights while the L.H. side hinged panel consists of circuit breakers, cubic relays, and two sets of paralleled resistors for the cornering lights (one set for each side). To gain access inside junction box, unscrew the turn screws (2). There are many spare terminals for connecting optional or additional accessories, diodes, sound system relay and the speed switch.

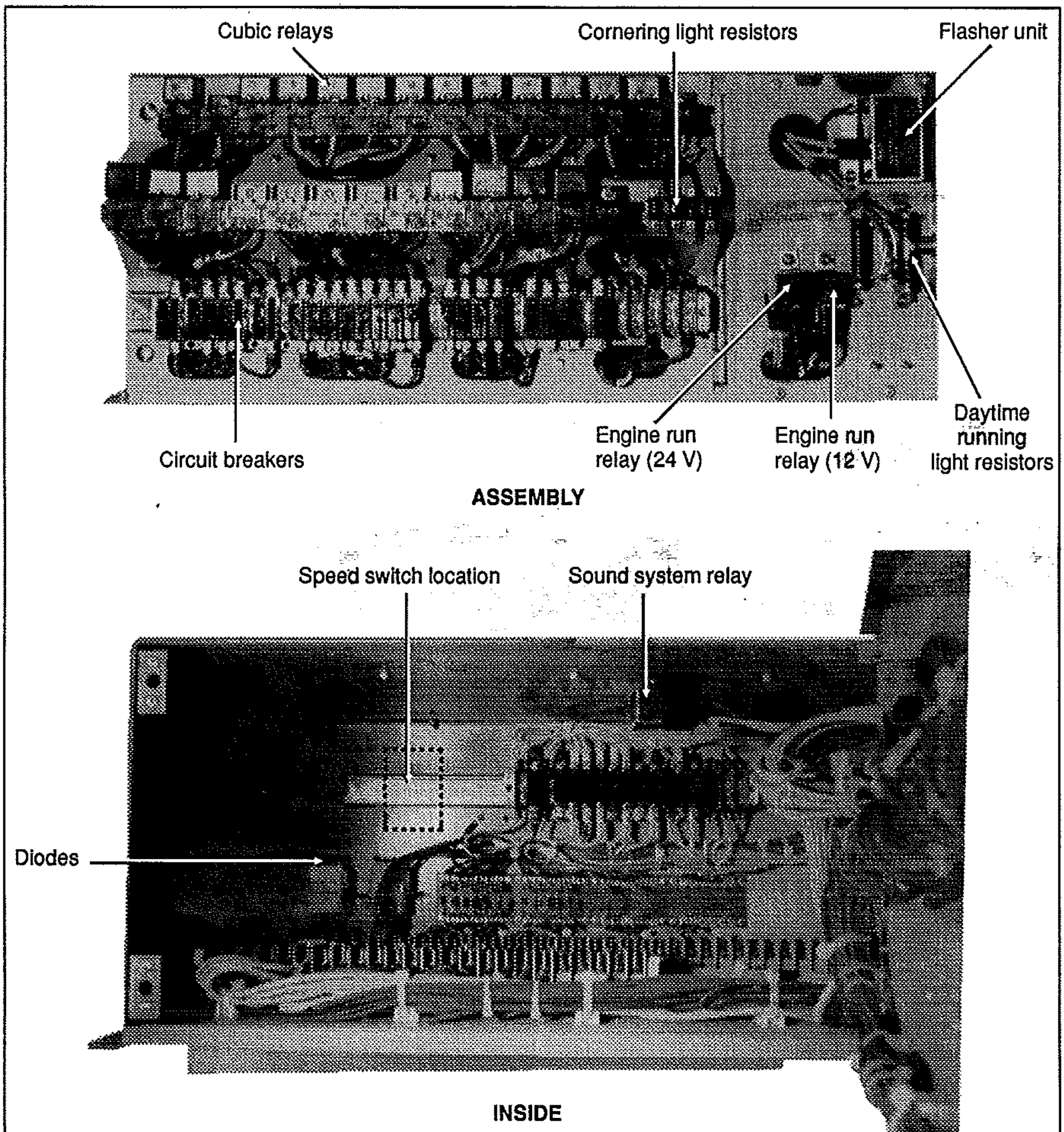


Fig. 7 - Front junction box

Rear junction box

The rear junction box is located inside the rear electric compartment on the left side of vehicle over the tag axle. The main components of rear junction box consist of circuit breakers, cubic relays, starting motor magnetic relay, parking brake stoplight resistors, rear engine run relays (12 & 24 volts) and the door lock relays if vehicle is equipped with the optional baggage compartment door electric locks.

Furthermore, on the R.H. side of rear junction box, a switch is installed for servicing of back-up camera, if vehicle is so equipped. The rear junction box is also provided with two connectors, one to feed the lavatory and the other to feed the parcel racks.

NOTE: On the V.I.P. vehicle, these two connectors are not used and are protected by plastic threaded caps.

To gain access inside the junction box, open the hinged panel by rotating 1/4 turn counterclockwise the two retaining screws. This panel opens on the following components:

- Junction terminals
- Circuit breakers
- Coolant level system module
- Various diodes
- ECM circuit breakers of DDEC system
- Fast idle DDEC control resistors

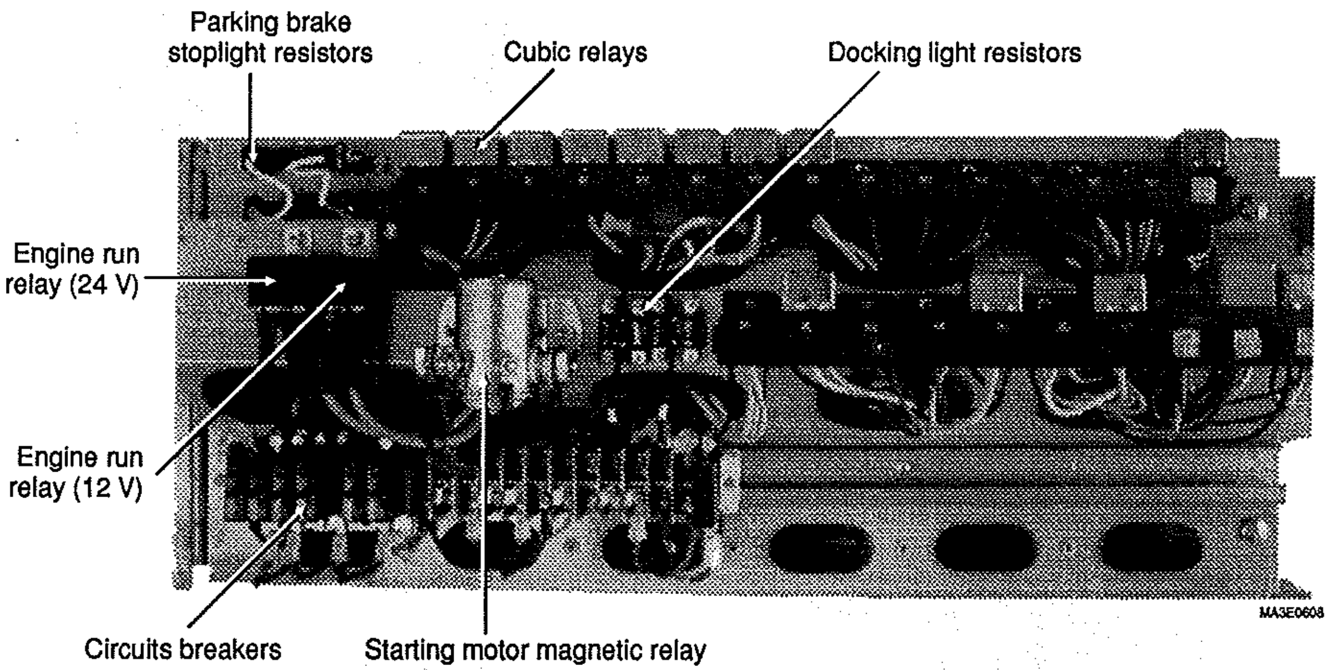


Fig. 8 - Rear junction box

Main power junction sliding support

The main power junction sliding support is located on rear R.H. side of vehicle over the tag axle (beside the battery compartment). To have access, open the engine compartment R.H. side door; pull the button in the upper R.H. corner, then pull out the sliding support using the 24 V main battery disconnect switch handle. This sliding support gives access to the following components:

- two battery voltage equalizers
- 12 and 24 volt main circuit breakers (for details of each breaker, see previous heading *"Circuit breakers"* in this section)
- 12 volt main battery disconnect switch
- 24 volt main battery disconnect switch

Engine starting control box

This control box is located in the R.H. side of engine compartment near the engine oil reserve tank. This junction box includes the engine starter selector switch, as well as the rear start push button switch to start engine from engine compartment.

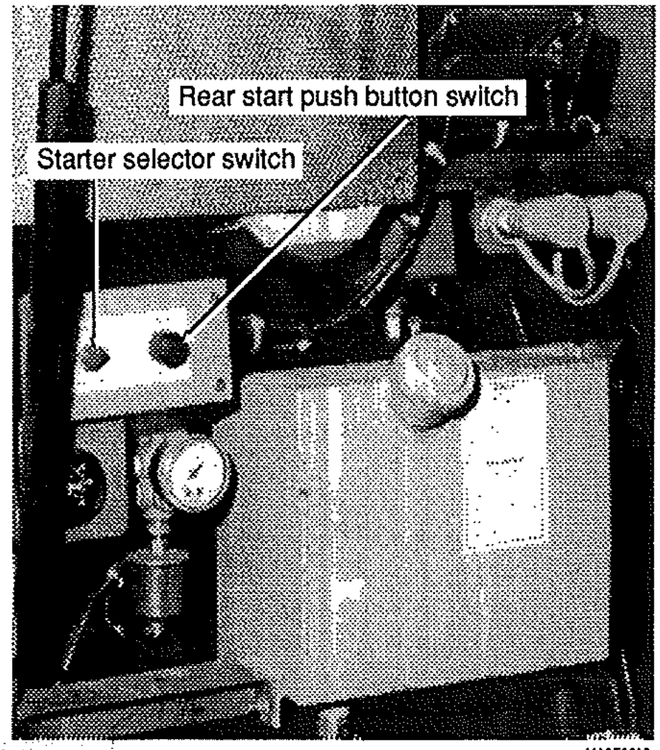


Fig. 10 - Engine starting control box

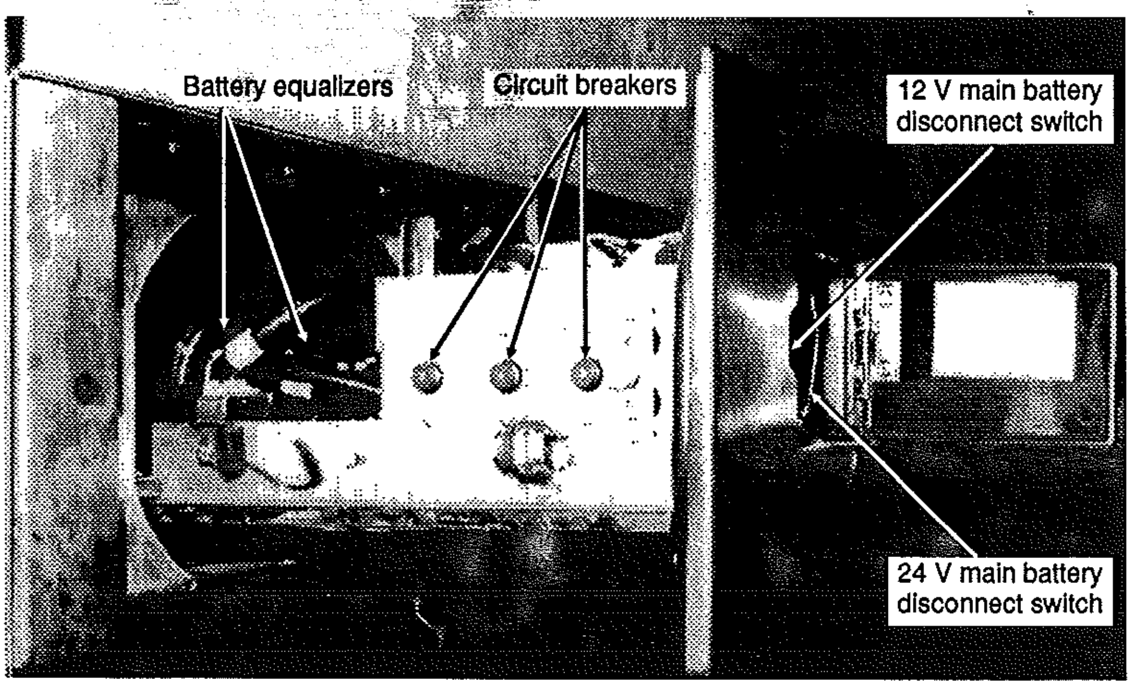


Fig. 9 - Main power junction sliding support

Booster post junction box

This junction box is located in the upper R.H. side corner of engine compartment and is accessible by the engine compartment R.H. side door. It includes the booster posts, power plant cable junction terminal and a ground junction terminal. Furthermore, it includes three junction terminals for the optional battery equalizers if vehicle is so equipped (V.I.P. models only).

NOTE: The two standard battery equalizers are located on the main power junction sliding support.

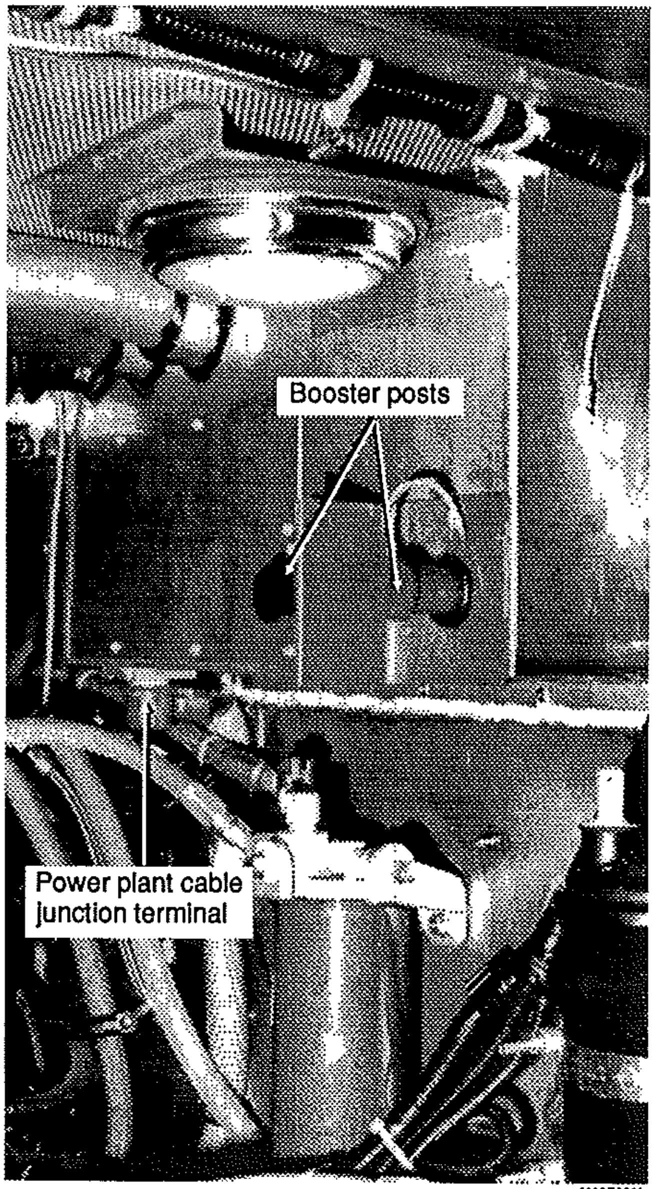


Fig. 11 - Booster post junction box

A/C and heating junction box

The A/C and heating junction box is located inside condenser compartment. For maintenance purpose, this junction box has a sliding drawer which includes the A/C logic panel (W973B module), the electronic transmitter (T7067B printed circuit board), the A/C logic and control modules and some fuses. Open the first R.H. baggage compartment door then, unscrew the quarter turn screw and slide open the drawer. Refer to figure 12 for details.

NOTE: It is important when checking the A/C and heating system to keep the condenser compartment door closed in order to avoid faulty readings. Open the sliding drawer as indicated to verify the system.

The complete junction box is accessible by opening the condenser compartment door. Remove the four (4) rubber latches, then remove the cover. This junction box includes the relays of the evaporator fan motor and condenser speed controls, as well as the circuit breakers and relays of the A/C logic panel, A/C compressor clutch, water pump and condenser fan motors. Furthermore, a diode for the preheater water pump signal is installed in this junction box, no matter if the vehicle is provided with or without this optional system.

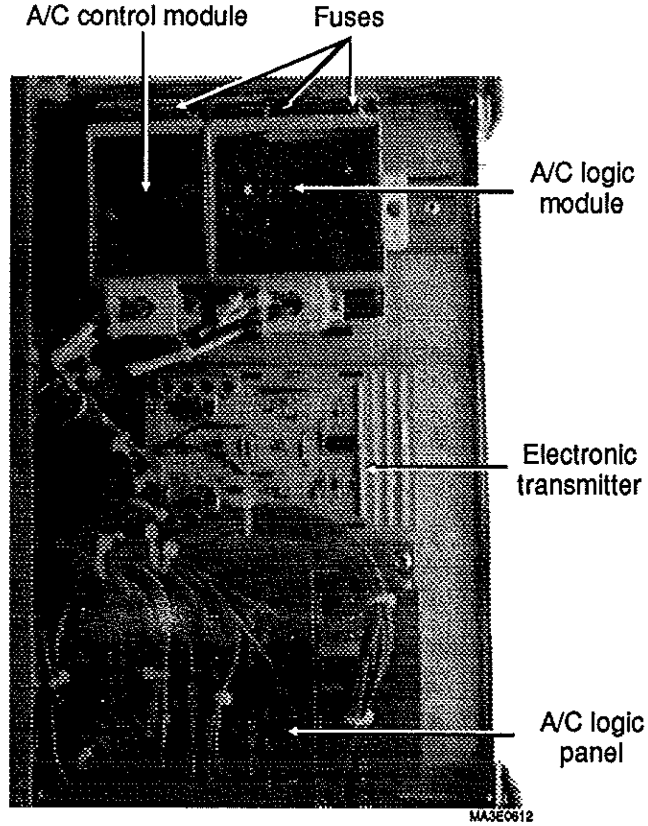


FIG. 12 - A/C and Heating junction box sliding drawer

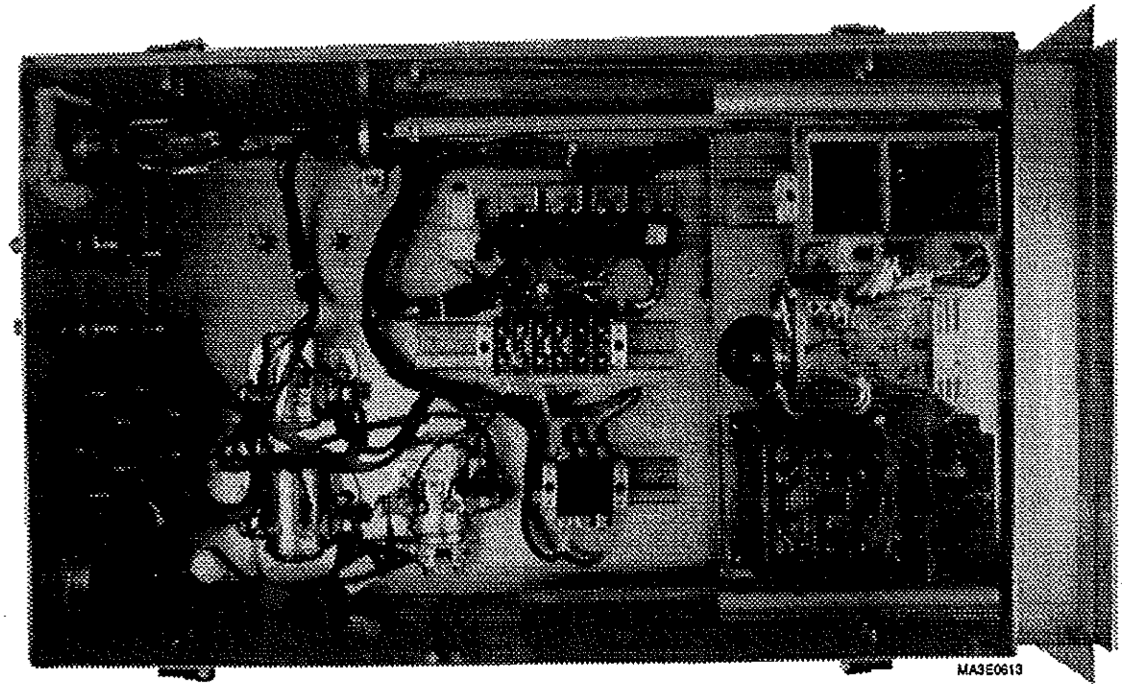


FIG. 13 - A/C and Heating junction box with cover removed

BATTERIES

General description

The vehicle is provided with four (4) maintenance-free 12 volt heavy-duty batteries connected in series-parallel. The top- mounted negative and positive terminals are tightly sealed to prevent leaks. Water never needs to be added to this type of battery. There are no filler caps in the cover. The battery is sealed, except for small vent holes in the cover. The vents must not be restricted as they allow small amount of gases that are produced in the battery to escape. The special chemical composition inside the battery reduces gassing to a very small amount at normal charging voltages. Besides reducing gassing, the special chemistry greatly reduces the possibility of overcharge damage.

The vents require keeping the battery in an upright position to prevent electrolyte leakage. Tipping the battery beyond a 45° angle in any direction can allow a small amount of electrolyte to leak out the vent holes.

WARNING: DO NOT exceed this 45° angle when carrying or installing the battery.

Evidence of electrolyte leakage does not necessarily mean the battery is defective.

With special cables properly attached to batteries, the metal surfaces that carry the current are completely sealed from the atmosphere. This prevents terminal oxydation and corrosion that may cause starting and charging problems. If new cables are required, sealed terminal cable replacements should be used to retain the reliability of the original maintenance-free connections.

WARNING: All lead-acid batteries generate hydrogen gas which is highly flammable. If ignited by a spark or flame, the gas may explode violently, causing spraying of acid, fragmentation of the battery, and result in possible severe personal injuries. Wear safety glasses when working near batteries. In case of contact with acid, flush immediately with water.

The battery has four (4) major functions which consist in:

1. Providing a source of current for starting the engine.
2. Stabilizing the voltage in the electrical system.
3. Supplying current for a limited time, when electrical demands of the equipment exceed the power output of the alternator.
4. Providing a limited source of power for connected accessories, when the engine is not running.

Battery mounting

All batteries are mounted side by side in a sliding tray. The battery compartment, which is always locked, is located on the right side of vehicle, over the tag axle along the main power junction sliding support. Ventilation is provided by two openings inside the compartment. To gain access, open the third R.H. side baggage compartment door; pull and hold the lever in the upper L.H. corner, and with the other hand pull the compartment door, which will slide outwards. To close, push in sliding tray completely, and the door will lock automatically.

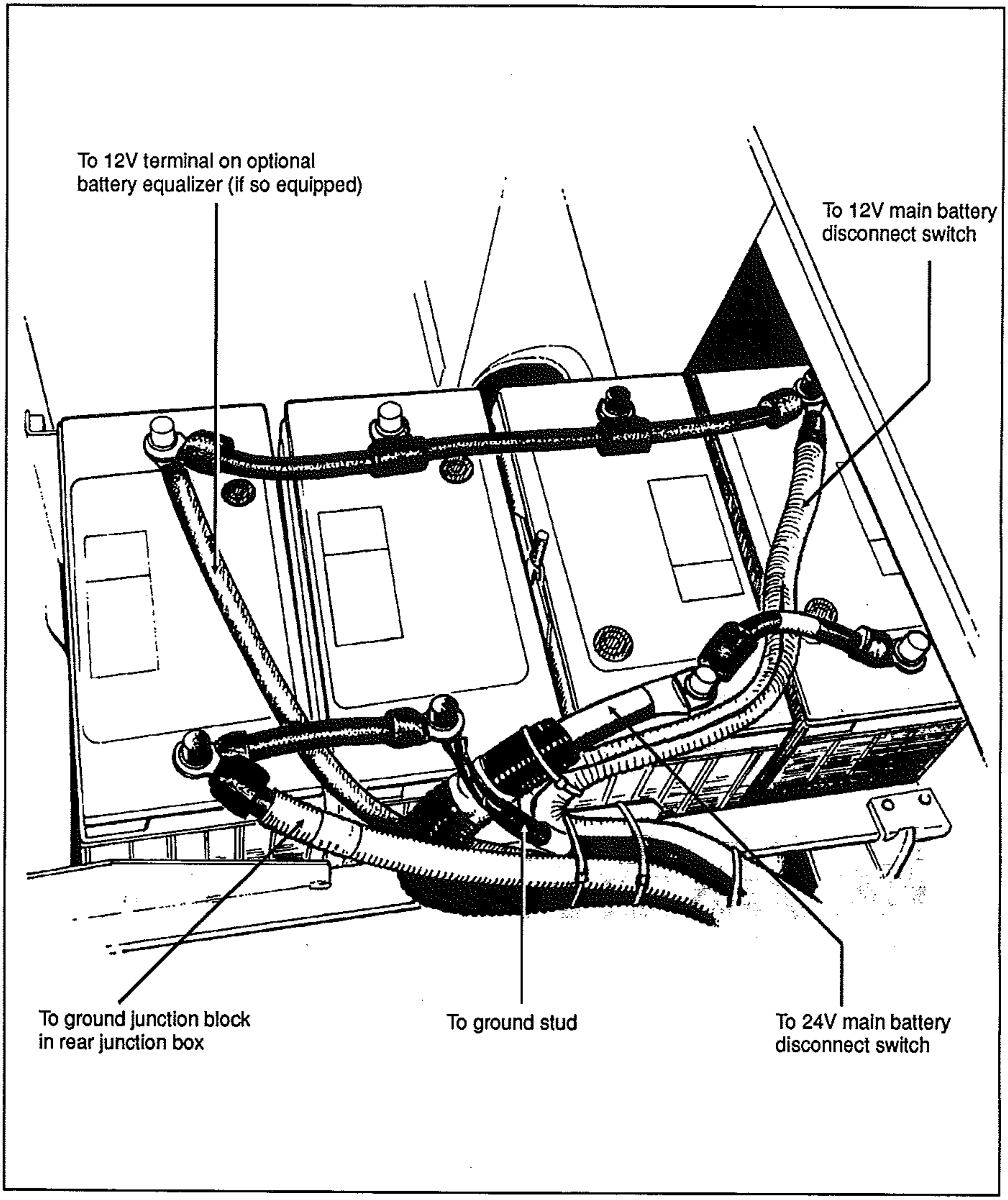


Fig. 14 - Battery Installation

Main battery disconnect switches

Two main disconnect switches are provided for this vehicle: one for the 12 volt system and one for the 24 volt system. The two switches are located in main power junction sliding support over the tag axle on the R.H. side of vehicle (for more details, refer to previous heading *"Main power junction sliding support"*). The 24 and 12 volt systems operating independently from each other, it is **NECESSARY** to move the two disconnect switches to the *"OFF"* position to deenergize both systems.

NOTE: When the main battery disconnect switches are turned to the *"Off"* position, all electrical supply from the batteries is cut off, with the exception of the following items:

- Tachograph clock
- Battery equalizer check module
- ECU and ECM ignition power supply
- ECU memory (ATEC transmission)
- Preheater electronic timer
- Preheater and water recirculating pump
- Radio programming memory.

To disconnect the batteries from the electrical system, rotate counterclockwise the 24 volt disconnect switch handle to the *"Off"* position, and rotate counterclockwise the 12 volt disconnect switch lever to the *"Off"* position.

Battery removal/installation

1. Open the battery compartment by pulling and holding the lever in the L.H. upper corner of R.H. ski compartment, while pulling with the other hand the compartment door, which will slide outwards.
2. Unscrew and remove the nut on top of sliding tray.
3. Remove the support, and unscrew terminal nuts of each defective battery.

NOTE: Both battery main disconnect switches (handle & lever) should be in the *"Off"* position before disconnecting cables from the batteries.

4. Remove battery cables from the batteries.

NOTE: When the battery cables have been removed from the batteries, wrap the battery terminals and cable ends with electric tape to prevent accidental grounding. The ground cables should always be disconnected first and replaced last.

5. Remove batteries.
6. Reverse the previous step to install the batteries.

NOTE: In replacing batteries, only batteries of the same specification should be used. Refer to *"Specifications"* at the end of this section for further details.

CAUTION: Ensure that connections are not reversed when reinstalling batteries, since damage to electrical system components will result.

When reinstalling batteries, battery connections must be torqued to 10-15 ft•lbs (13-20 N•m) and the nut on top of sliding tray to 45-55 in•lbs (5-6 N•m). A torque wrench is required to ensure an accurate tightening torque.

WARNING: To prevent possible electric shocks or sparking, the battery main switches must be set to the *"Off"* position before tightening an electrical connection.

NOTE: A protective coating should be applied on all terminals that have been disconnected, and this coating should be clear of silicone. We recommend the use of *"Clear Flex Guard"* (Prevost #68-0545) on all electrical connections of the vehicle.

Battery rating

Each of the 12 volt batteries used on the vehicle has the following rating:

- Reserve capacity: 180 minutes
- Cold cranking (amps): 625 @ 0 °F (-18 °C)
  490 @ -20 °F (-29 °C)
- Weight filled: 60 lbs (27,2 kg)

The reserve capacity is defined as the number of minutes a new, fully charged battery at 80 °F (26,6 °C) can be discharged at 25 amperes and maintain a minimum of 1.75 volts per cell (10.5 volts total for one 12 volt battery). This rating can be used as a basis for determining how long a vehicle might run after an alternator failure.

The cold cranking rating is defined as the minimum discharge current a battery will deliver in amperes for 30 seconds at 0 °F (-18 °C) while maintaining a minimum of 1.2 volts per cell (7.2 volts total for one 12 volt battery). This rating can be used as a basis for comparing starting performance.

Battery test indicator

The maintenance-free battery has a strong ability to withstand the damaging effects of overcharge. The test indicator in the cover is used only to determine if the battery can be tested in case of a cranking problem.

The test indicator in the battery cover is to be used with accepted diagnostic procedures only. It must not be used to determine if the battery is good or bad, or charged or discharged. The test indicator is a built-in hydrometer in one cell which provides visual information for battery testing. Refer to heading *"Testing the maintenance-free battery"* later in this section.

It is important when observing the test indicator, that the battery be relatively level and has a clean indicator top to see the correct indication. A light may be required in some poorly lit areas. Under normal operation, two indications can be observed.

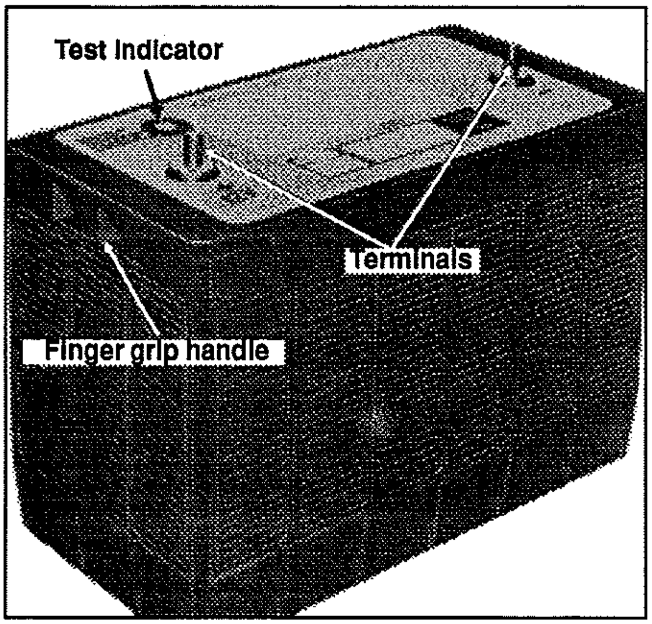


Fig. 15

Green dot visible

Any green appearance is interpreted as a *"green dot"*, and the battery is ready for testing. On rare occasions, following prolonged cranking, the green dot may still be visible when the battery is obviously discharged. Should this occur, charge the battery as described under *"Battery Charging Procedure"* in *"Battery maintenance"* later in this section.

Dark - green dot not visible

If a cranking complaint is encountered, the battery should be tested as described under *"Testing maintenance-free battery"* later in this section. On rare occasions, the test indicator may turn light yellow. In this case, the integral charging system should be checked. Normally, the battery is capable of further service; however, if a cranking complaint has been reported, replace the battery. **DO NOT CHARGE, TEST, OR JUMP-START.**

Testing maintenance-free battery

Visual inspection

1. Check the outside of the battery for a broken or cracked cover or case that could permit loss of electrolyte. If obvious physical damage is noted, replace the battery.

2. Check for loose terminal posts, cable connections, damaged cables, and for evidence of corrosion; correct conditions as required before proceeding with tests.

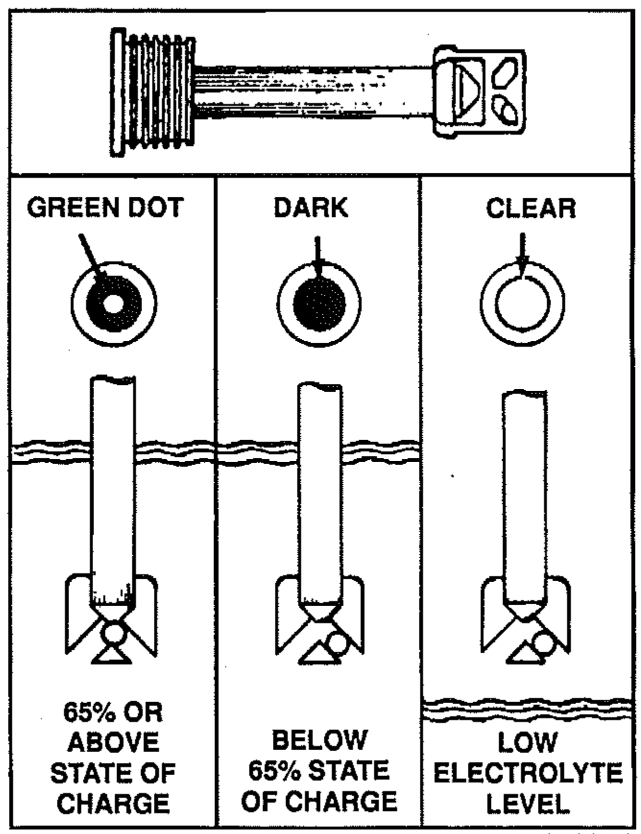


Fig. 16 - Hydrometer operation

Test Indicator

Green dot visible

If the indicator is dark and has a green dot in the center, the battery is ready for testing. Proceed with *"Removing surface charge"* as described later in this section.

NOTE: On rare occasions, such as after prolonged cranking, the green dot may still be visible when the battery is obviously discharged. Should this occur, charge the battery as described under *"Battery charging procedure"* in *"Battery maintenance"* later in this section.

Dark - green dot not visible

If the indicator is dark and the green dot is not visible, charge the battery as described under *"Battery charging procedure"* later in this section. Remove surface charge as explained under *"Removing surface charge"* hereafter.

Removing surface charge

Disconnect cables from the battery and attach alligator clamps to the contact lead pad on the battery as shown in figure 19. Connect a 300 ampere load across the terminal for 15 seconds to remove surface charge from the battery.

Load test

This test is one means of checking the battery to determine its ability to function as required in the vehicle.

To make this test, use test equipment that will withstand a heavy electrical load from the battery, such as a carbon pile resistor or other suitable means.

1. Connect a voltmeter, ammeter, and a variable load resistance as illustrated in figure 17.

CAUTION: Observe polarity of the meters and the battery when making connections, and select the correct meter range.

2. Apply a 290 ampere load to the battery for 15 seconds.

3. With an ammeter reading specified load, read voltage. The voltage should be at least 9.6 volts. Disconnect the load.

If the voltmeter indicates 9.6 volts or more, the battery is good. If the volmeter reading is less than 9.6 volts, replace the battery.

This voltage is to be used for battery ambient temperatures of 70 °F (21 °C) and above. For temperatures below 70 °F (21 °C), refer to the following *"Voltage and Temperature Chart"*.

NOTE: The accuracy of this test procedure is dependent upon close adherence to the proper load, time and temperature specifications.

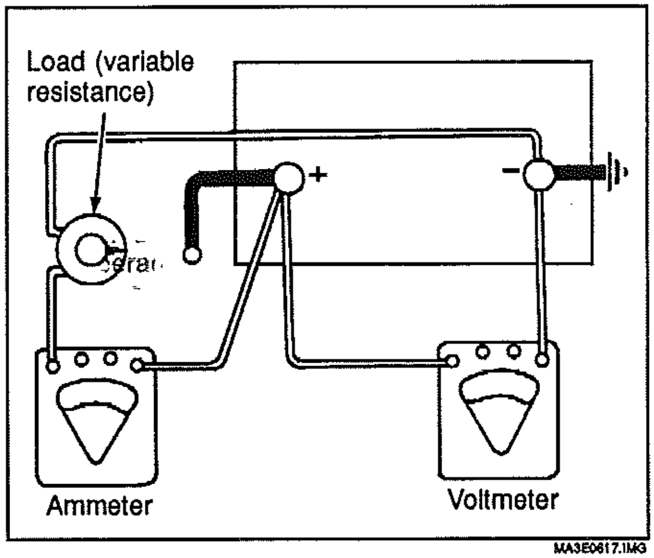


Fig. 17 - Connections for battery load test

VOLTAGE AND TEMPERATURE CHART

Ambient Temperature	Minimum Voltage
70 °F (21 °C) and above	9.6
60 °F (16 °C)	9.5
50 °F (10 °C)	9.4
40 °F (4 °C)	9.3
30 °F (-1 °C)	9.1
20 °F (-7 °C)	8.9
10 °F (-12 °C)	8.7
0 °F (-18 °C)	8.5

Fig. 18

Battery precautions

During charging of the batteries, an explosive gas mixture forms in each cell. Part of this gas escapes through the vent holes and may form an explosive atmosphere around the battery itself if ventilation is poor. This explosive gas may remain in or around the battery for several hours after it has been charged. Sparks or flames can ignite this gas causing an internal explosion which may shatter the battery.

1. Do not smoke near a battery which is being charged or which has been recently charged.

2. Do not break live circuits at battery terminals because a spark usually occurs at the point where a live circuit is broken. Care must always be taken when connecting or disconnecting booster leads or cable clamps on chargers. Poor connections are a common cause of electric arcs which cause explosions.

3. The electrical system on this vehicle is **negative ground**. Installing the batteries with the positive terminals grounded or incorrect use of the booster battery and jumper cables will result in serious damage to the alternator, batteries and battery cables.

Common causes of battery failure

When a battery fails, the cause of failure may be outside the battery. For this reason, when a battery failure is encountered, do not be satisfied with merely recharging or replacing battery. Locate and correct the cause of the failure to prevent recurrence. Some common external causes of battery failure are as follows:

1. Defect in charging system such as high resistance or a faulty alternator or regulator.

2. A malfunction within the 12 volt system (equalizers).

3. Overloads caused by a defective starter or excessive use of accessories.

4. Dirt and electrolyte on top of the batteries causing a constant drain.

5. Hardened battery plates, due to battery being in a low state of charge over a long period of time.

6. Shorted cells, loss of active material from plates.

7. Driving conditions or requirements under which the vehicle is used only for short drives.

8. A constant drain caused by a shorted circuit such as an exposed wire or water infiltration in junction boxes causing ground fault.

9. Extended operation of preheating system without engine running.

10. Ommission of closing disconnect switches during overnight.

BATTERY MAINTENANCE

Cleaning and inspection

The external condition of the battery and the battery cables should be checked periodically. The top of the battery should be kept clean and the battery hold-down clamp bolts should be kept properly tightened. For best results when cleaning the battery, wash first with a diluted solution of ammonia or soda to neutralize any acid present, then wash out with clean water. The battery hold-down bolts should be kept tight enough to prevent the batteries from moving, but they should not be tightened to the point that excessive strain is placed on the battery hold-down cover (proper tightening torque: 45-55 in•lbs (5-6 N•m)).

To insure good contact, the battery cable ring terminals should be tight on the battery posts. If the posts or cable ring terminals are corroded, the cables should be disconnected and the posts and clamps cleaned separately with a soda solution and a wire brush. Install cable ring terminals on battery posts and tighten to a torque of 10-15 ft•lbs (13-20 N•m), then replace protective caps to prevent corrosion and sparks.

Battery cables

Check all cable ring terminals and connections to determine if they are in good condition. Excessive resistance, generally caused by poor connections, produces an abnormal voltage drop which may lower voltage at the starting motor to such a low value that normal operation of the starting motor will not be obtained. An abnormal voltage drop can be detected with a low-reading voltmeter as follows:

WARNING: To prevent the engine from starting, the DDEC engine circuits, which are protected by breakers (CB-19 and CB-20) located in the rear junction box, must be deenergized during these tests; afterwards, depress black button to close circuit.

1. Check voltage drop between grounded (negative) battery terminal and vehicle frame by placing one prod of the voltmeter on the battery terminal and the other on a good ground (unpainted surface) on the vehicle. With the starting motor cranking the engine at a temperature of 70 °F (21 °C), voltage reading should be less than 0.3 volt. If the voltage reading exceeds 0.3 volt, there is excessive resistance in this circuit.

2. Check voltage drop between the positive battery terminal and the starting motor positive terminal stud while the motor is operated. If the reading is more than 2.5 volts, there is excessive resistance in this circuit.

NOTE: If it is necessary to extend the voltmeter lead for this test, use a #16 (AWG) or larger wire.

3. Check voltage drop between the starting motor housing and a good ground on the vehicle. The reading should be less than 0.2 volt.

WARNING: Any procedure other than the following could cause personal injuries or damages to the charging system resulting from battery explosion or electrical burns.

Wear adequate eye protection when working on or near the batteries. Ensure that metal tools or jumper cables do not contact the positive battery terminal (or a metal surface in contact with it) as a short circuit will result.

Do not attempt to jump start a vehicle suspected of having a frozen battery because the battery may rupture or explode.

Both the booster and discharged batteries must be treated carefully when using jumper cables. Follow exactly the procedure outlined later in this section, being careful not to cause sparks.

Battery charging procedure

The batteries used on this vehicle can be charged either on or off the vehicle; however, when they are removed from the vehicle, it is recommended that an adapter kit, which is available from any *"A/C DELCO"* dealer, be used in charging sealed-terminal batteries. Use the booster block to charge the batteries when they are left on vehicle and **be sure the 24V main battery disconnect switch is set to the *"On"* position.**

The alligator clamps of the tester or charger must be placed between the terminal nuts and the lead pads of the terminal studs (figure 19) after the vehicle cables are detached.

The alligator clamps should make firm contact with the lead pads.

NOTE: If this connection cannot be made because of the alligator clamp design, the load value for testing must be reduced from 290 to 260 amperes.

On rare occasions, such as those that occur following prolonged cranking, the green dot in the test indicator may still be visible when the battery is obviously discharged. Should this occur, a boost charge of 20 ampere-hours is recommended. Under normal operating conditions, do not charge battery if the green dot is visible. The battery should never be charged if the test indicator (hydrometer) is clear or light yellow. If this occurs, replace the battery.

A charge rate between 3 and 50 amperes is generally satisfactory for any maintenance-free battery as long as spewing of electrolyte does not occur or the battery does not feel excessively hot (over 125 °F (52 °C)). If spewing or violent gassing of electrolyte occurs or battery temperature exceeds 125 °F (52 °C), the charging rate must be reduced or temporarily stopped to allow cooling and to avoid damaging the battery.

Battery temperature can be estimated by touching or feeling the battery case. The battery is sufficiently charged when the green dot in the built-in hydrometer is visible. No further charging is required. Shake or tilt the battery at hourly intervals during charging to mix the electrolyte and see if the green dot appears.

WARNING: Always turn off the charger before connecting or disconnecting it to or from a battery.

NOTE: The charge rate must be doubled when the batteries are charged by the booster block, since we have a series-parallel circuit.

Battery charging consists of a charge current in amperes for a period of time in hours. Thus, a 25 ampere charging rate for 2 hours would be a 50 ampere-hour charge to the battery. Most batteries, whose load test values are greater than 200 amperes, will have the green dot visible after at least a 75 ampere-hour charge. In the event that the green dot does not appear, replace the battery.

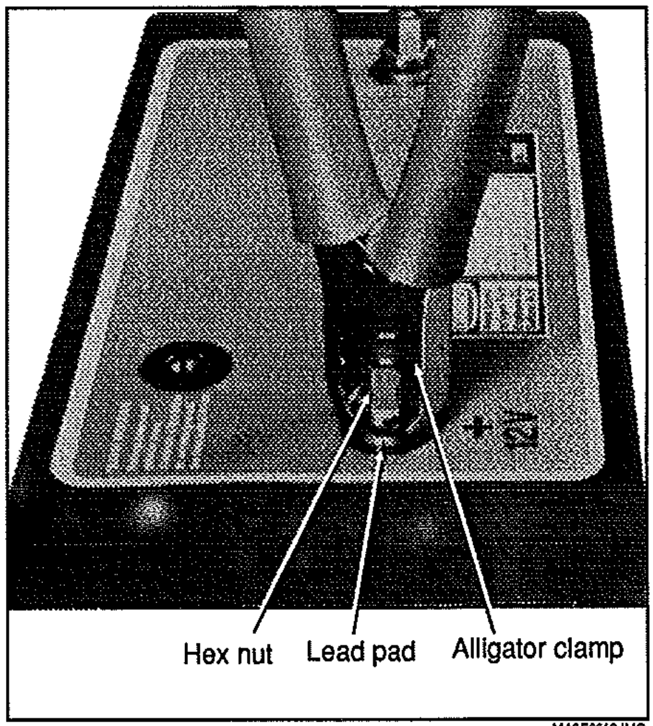


Fig. 19 - Testing and charging terminal adapter

Battery charging guide

Fast charging rate

20 amps @ 3-3/4 hours

30 amps @ 2-1/2 hours

40 amps @ 2 hours

50 amps @ 1-1/2 hours

Slow charging rate

5 amps @ 15 hours

10 amps @ 7-1/2 hours

The time required for a charge will vary according to the following factors:

Size of battery

For example, a completely discharged large heavy-duty battery requires more than twice the recharging time of a completely discharged small passenger car battery.

Temperature

For example, a longer time will be needed to charge any battery at 0 °F (-18 °C) than at 80 °F (27 °C). When a fast charger is connected to a cold battery, the current accepted by the battery will be very low at first, then in time, the battery will acccept a higher rate as it warms.

State of charge

For example, a completely discharged battery requires more than twice as much charge than a half-charged battery. Since the electrolyte is nearly pure water and a poor conductor in a completely discharged battery, the current accepted is very low at first. Later, as the charging current causes the electrolyte acid content to increase, the charging current will likewise increase.

Charger capacity

For example, a charger which can supply only 5 amperes will require a much longer period of charging than a charger that can supply 30 amperes or more.

Emergency jump starting with auxiliary (booster) battery

WARNING: Do not jump start vehicles equipped with maintenance-free batteries if the test indicator is light yellow.

Both booster and discharged batteries should be treated carefully when using jumper cables. A vehicle with a discharged battery may be started by using energy from a booster battery or the battery from another vehicle.

WARNING: Jump starting may be dangerous and should be attempted only if the following conditions are met.

- The booster battery or the battery in the other vehicle must be of the same voltage than the battery in the vehicle being started, and must be negative grounded.

- If the booster battery is a sealed-type battery without filler openings or caps, its test indicator must be dark or a green dot must be visible. Do not attempt jump starting if the test indicator of the booster battery or the discharged battery has a light or bright center.

WARNING: Follow exactly the procedure outlined hereafter, being careful not to cause sparks.

1. Wear eye protection and remove rings, watches with metal bands and other metal jewelry.

2. Apply parking brake and place the transmission shift lever or push-button pads in Neutral (N) position in both vehicles. Turn off lights, heater and other electrical loads. Observe the charge indicator. If the indicator in the discharged battery is light, replace the battery. **Do not** attempt jump starting when indicator is light. If the test indicator is dark and has a green dot in the center, failure to start is not due to a discharged battery and the cranking system should be checked. If charge indicator is dark but the green dot does not appear in center, proceed as follows:

3. Connect one end of one red jumper cable to the positive (+) terminal of the booster power source and the other end to the positive (+) post of the booster power block, located in the engine compartment, and accessible by the R.H. engine access compartment door (refer to *"Booster post junction box"* under previous heading *"Junction boxes"*).

4. Connect one end of the remaining negative jumper cable (black) to the negative (-) terminal of the booster power source, and the other end of the black jumper cable to the negative (-) post of the booster power block.

5. Take care that the clips from one cable do not inadvertently touch the clips on the other cable. Do not lean over the battery when making connections. The ground connection must provide good electrical conductivity and current carrying capacity.

6. Start the engine in the vehicle that is providing the jump start. Let the engine run for a few minutes, then start the engine in the vehicle that has the discharged batteries.

7. When removing the jumper cables, perform the above procedure exactly in reverse order, and replace protective caps on booster block terminals.

WARNING: Any procedure other than the above could result in personal injury, property damage due to battery explosion, or damage to the charging system of the booster vehicle or of the boosted vehicle.

NOTE: Jumper cables must withstand 500 cranking amperes. If cable length is 20 feet (6 m) or less, use 2/0 (AWG) gauge wires. If cable length is between 20-30 feet (6-9 m), use 3/0 (AWG) wires.

Troubleshooting

If a battery has tested good and then has not performed satisfactorily in service for no apparent reason, the following factors may point to the cause of trouble:

1. Vehicle accessories and disconnect switches inadvertently left on overnight.

2. Defects in the charging system, such as high wiring resistance, faulty alternator, regulator or battery equalizer.

3. A vehicle electrical load exceeding the alternator (or battery equalizer) capacity, with the addition of electrical devices, such as CB radio equipment, a cellular phone or additional lighting system.

4. Defects in the electrical system, such as shorted or pinched wires.

5. Extended slow speed driving with many accessories turned on.

6. Loose or poor battery cable-to-post connections, previous improper charging of a run-down battery, or loose hold-down clamp bolts.

7. High-resistance connections or defects in the cranking system.

ELECTRICAL SYSTEM MONITOR

This vehicle is equipped with an electronic device that monitors and detects abnormal alternator, voltage regulator, battery banks or battery equalizers conditions. The monitor is installed in the L.H. side corner of the rear electric compartment. The *"Battery balance"* and *"Battery Hi/Lo"* warning lamps connected to this module are mounted in dashboard (refer to *"Operator's Manual"* for location). If a malfunction should occur, the monitor sends a signal to the driver by means of the appropriate warning light according to the malfunctioning component. If the *"Battery Hi/Lo"* warning light is illuminated, check the 24 volt voltmeter to determine if battery voltage is too high or too low.

NOTE: According to battery charging condition, it is normal that *"Battery Hi/Lo"* warning light illuminates upon starting the engine and stays illuminated a few seconds. This is caused by the battery normal voltage drop during starting.

Warning lamp definitions

Battery Hi/Lo

Voltmeter drops below 24 V dc

- Check alternator output
- Check voltage regulator
- Check battery connections
- Check battery cells
- Check battery equalizers connections

Voltmeter exceeds 30 V dc

- Check alternator output
- Check voltage regulator
- Check battery connections

Battery balance

NOTE: Allow at least 15 minutes to balance batteries after corrective measure has been taken.

1. Batteries out of balance (difference greater than 1.5 volts between the two battery banks)

- Check circuit breaker on each battery equalizer; if sound, perform equalizer troubleshooting as explained later in this section
- Check battery equalizer connections
- Check equalizer cables for proper gauge
- Check battery connections

2. Demand for 12 volt power exceeding rated amperage output of battery equalizers causing batteries to go out of balance

- Reduce 12 volt load or install additional battery equalizer(s)

"Battery" warning light

This warning light is not controlled by the electronic monitor, but by the "R" terminal of the alternator using the normally- closed contact of the relay "R-33". If a voltage drop should develop in the charging system, the *"Battery"* warning light will immediately light up to warn the driver and will be followed by the illumination of the *"Battery Hi/Lo"* warning light if the voltage drops below 24 V dc. Refer to heading *"Diagnosis of charging system problems"* later in this section, to determine which of the alternator or the voltage regulator is defective. Should the *"Battery"* warning light illuminate while the 24 volt voltmeter keeps on giving a normal reading and the *"Battery Hi/Lo"* warning light does not illuminate, the relay R-33 or its wiring is probably defective.

CAUTION: The relay R-33 should never be replaced with a relay provided with a suppressor diode on its coil as the output current (between 12 and 14 volts) at the alternator "R" terminal is not rectified, thus rendering relay inoperative.

NOTE: When the *"Battery"* warning light illuminates, the *"A/C & Heating"* system shuts off in order to prevent battery discharge.

GEAR DRIVEN OIL-COOLED ALTERNATOR

The 24 volt charging system consists of a gear driven, oil-cooled, brushless alternator, a 24 volt voltage regulator, an alternator relay and a 12 volt system that includes two 12 volt, 50 amp equalizers. The components used in this system are described under the applicable headings hereafter.

This oil-cooled alternator is of the self-rectifying type in which all current carrying members, windings, built-in diodes, and field coils are stationary. The only moving component is the rotor. The alternator is a totally-enclosed unit, cooled and lubricated by engine oil. The oil inlet is on the diode end cover. The oil drains back into the engine crankcase through the drive end frame and drive adapter housing. The alternator should never be operated with the oil supply line disconnected. A continuous flow of engine oil flows through the alternator to lubricate the bearings and cool the assembly.

Four terminals are used on this alternator: the DC output terminal, two field terminals, and a 12 volt relay terminal. The alternator output voltage is regulated by a separate 24 volt regulator that controls the alternator field current.

NOTE: The relay coils connected to the alternator *"relay terminal"* SHOULD NEVER BE PROVIDED WITH A SUPPRESSOR DIODE as the output current at this terminal is not rectified, thus rendering relay inoperative.

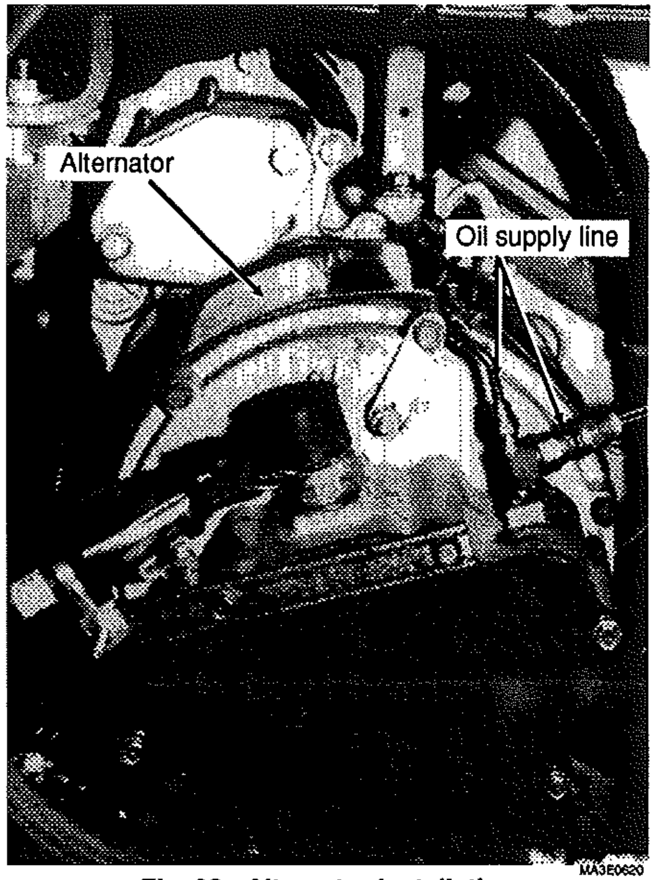


Fig. 20 - Alternator installation

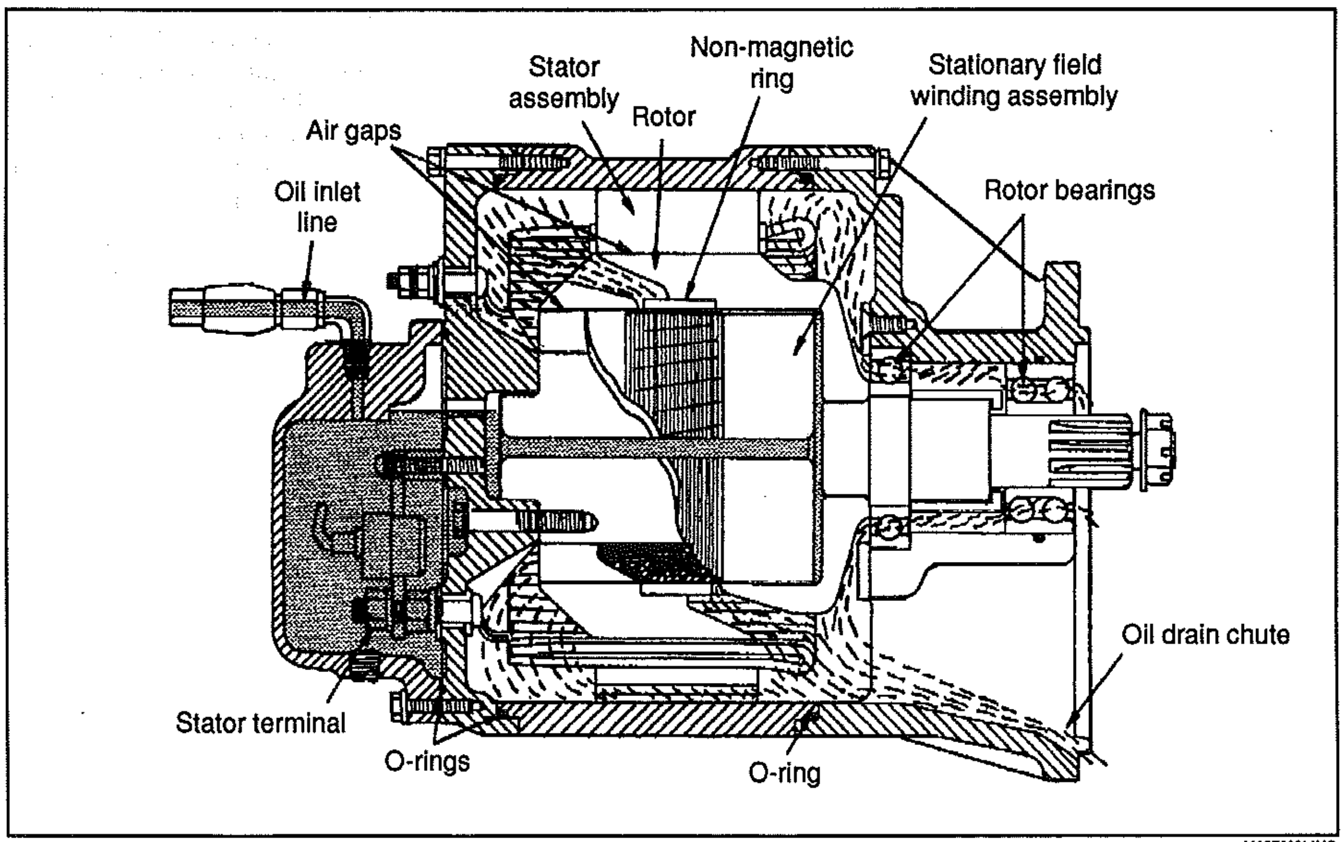


Fig. 21 - Oil circulation through alternator

CAUTION: The electrical system is NEGATIVE GROUND. Connecting the batteries or a battery charger with the positive terminal grounded will endanger the alternator diodes and vehicle wiring by a high current flow. Burned wiring harness and burned *"open"* diodes will result. Always ensure that the alternator and battery polarities are matched prior to installation. THE ALTERNATOR WILL NOT REVERSE TO ACCEPT INVERSE POLARITY. Also, do énot ground or short across any of the alternator or regulator terminals.

Since there are no brushes, slip rings, or rubbing seals, the alternator requires no periodic maintenance other than the following:

1. Check alternator-to-engine mounting bolts for looseness and tighten to the proper torque.

2. Check all electrical connections for tightness and corrosion. Clean and tighten connections as necessary. Be sure wiring insulation is in good condition and that all wiring is securely clipped to prevent chafing the insulation.

3. With the engine running, listen for noise and check the alternator for vibration. If the alternator is noisy or vibrates excessively, it should be removed for inspection and repair.

4. Ensure that battery terminals are clean and tight.

Diagnosis of charging system problems

The troubleshooting of the charging system is made easier by the use of a 12 and a 24 volt voltmeters, *"Battery"*, *"Battery balance"* and *"Battery Hi/Lo"* warning lights mounted in dashboard (for location refer to the *"Operator's Manual"*). The definition of each warning light is explained under the previous heading *"Electrical system monitor"*.

Alternator or voltage regulator

To determine which unit is faulty, proceed as follows:

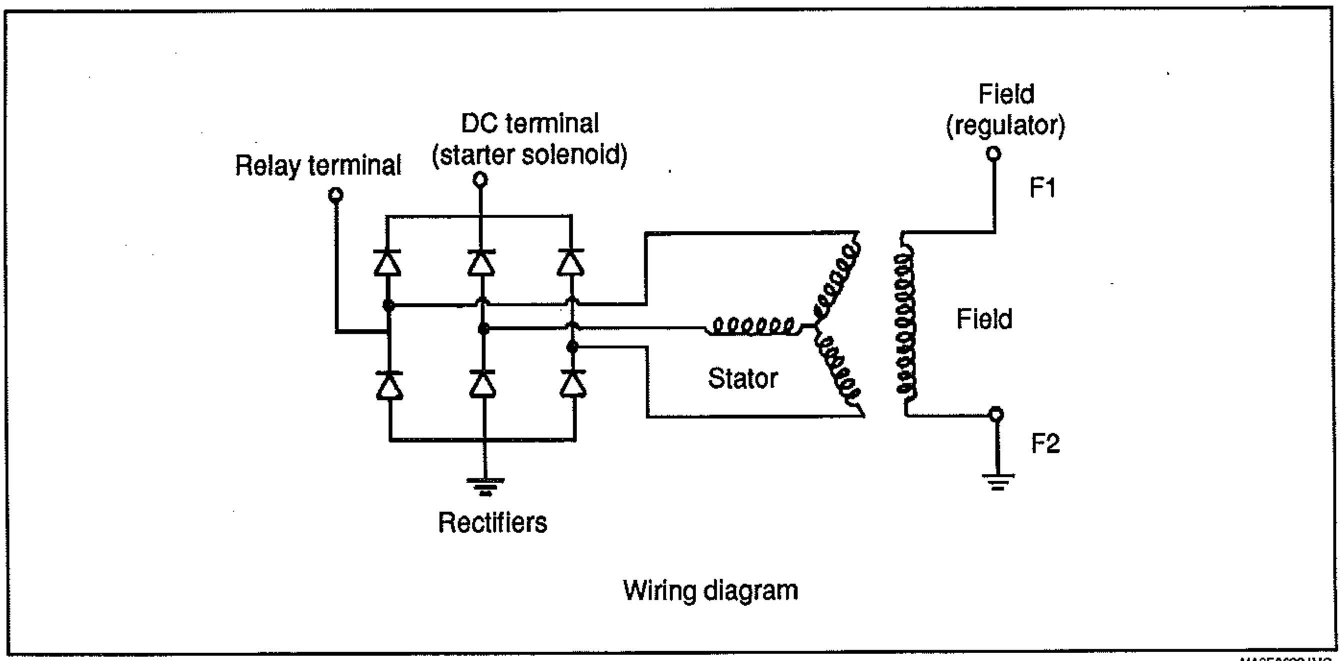
1. Start the engine and momentarily connect a jumper from the "F1" fie[illegible] terminal to "DC [illegible] (+)" terminal. For connections, r[illegible] figure 23.

CAUTION: [illegible] the [illegible] field "F1" terminal for more [illegible] gh voltage could burn out the wi[illegible] nents of charging system, and seriou[illegible] the alternator.

Do not jump the [illegible] with the "DC (+)" terminal on th[illegible] result in a direct short circu[illegible]

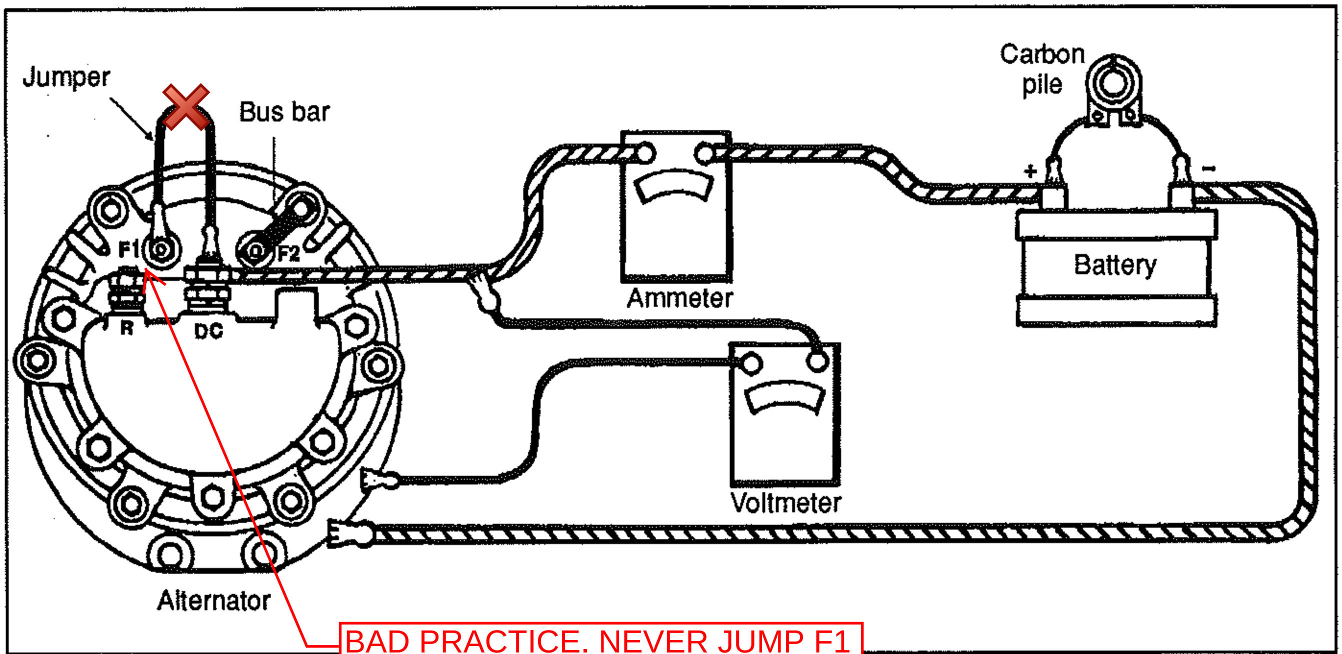
a) If the voltm[illegible] eadings incre[illegible] rouble is located in the 24 volt regulator or wiring. Check the regulator as explained under "Voltage regulator" later in this section.

b) If the voltmeter readings do not increase, the problem may be in the alternator.



MA3E0622.IMG

Fig. 22 - Alternator schematic diagram



ator output

Alternator diagnosis

CAUTION: Before checking the alternator, TURN OFF the battery main disconnect switches.

It is not necessary to disassemble completely the alternator to make electrical checks. All electrical checks are made at the diode end of the assembly without having to remove the rotor, drive end frame, or bearing. If the electrical components are not defective, but bearing replacement is necessary, this can be done at the drive end without having to disassemble the diode end of the unit.

The components in the alternator which require electrical checks are the field winding, the six diodes, and the stator winding.

Diode checks

Each diode may be checked for shorts and opens as follows:

1. Ensure the battery main disconnect switches are disconnected.

2. Remove the pipe plug from underneath the end housing to drain the oil in the rectifier engine oil supply.

3. Remove the cap screws (7) and lock washers which attach the diode end cover to the end housing. Remove the end cover from the end housing.

NOTE: Do not operate the alternator unless this unit is completely reassembled.

4. Remove seal from the end housing, detach and remove "DC" and relay terminals, stud, insulating sleeves and O-rings.

5. Disconnect all diode flexible leads, i.e. three from the output terminal stud and three from the diode supports. See figure 24 for more details.

Each diode may be checked for shorts and opens with an ohmmeter.

NOTE: The ohmmeter polarity may be determined by connecting its leads to the voltmeter leads. The voltmeter will read up-scale when the negative leads are connected together and the positive leads are connected together. The polarity of the voltmeter leads may be determined by connecting the leads to the identified terminals on a battery.

NOTE: Use an ohmmeter with a single 1.5 volt cell. Most accurate reading will be determined when the 300 ohm value is calibrated to the center one-third of the scale. DO NOT USE high voltage, such as a 110 volt test lamp to check diodes.

To check diodes mounted in the supports for shorts, connect the positive ohmmeter lead to each diode lead and the ohmmeter negative lead to each support as shown in "A", "B", and "C" of figure 25. To check diodes mounted in the end frame for shorts, connect the ohmmeter positive lead to each diode lead and the ohmmeter negative lead to the end frame as shown in parts "D", "E", "F". The ohmmeter readings may vary considerably when checking diodes for shorts, but if the reading is 300 ohms or less, the diode is likely defective and should be replaced. If the diode reads 300 ohms or less, it will allow excessive reverse current from the battery. Replace defective diodes as explained later in this section.

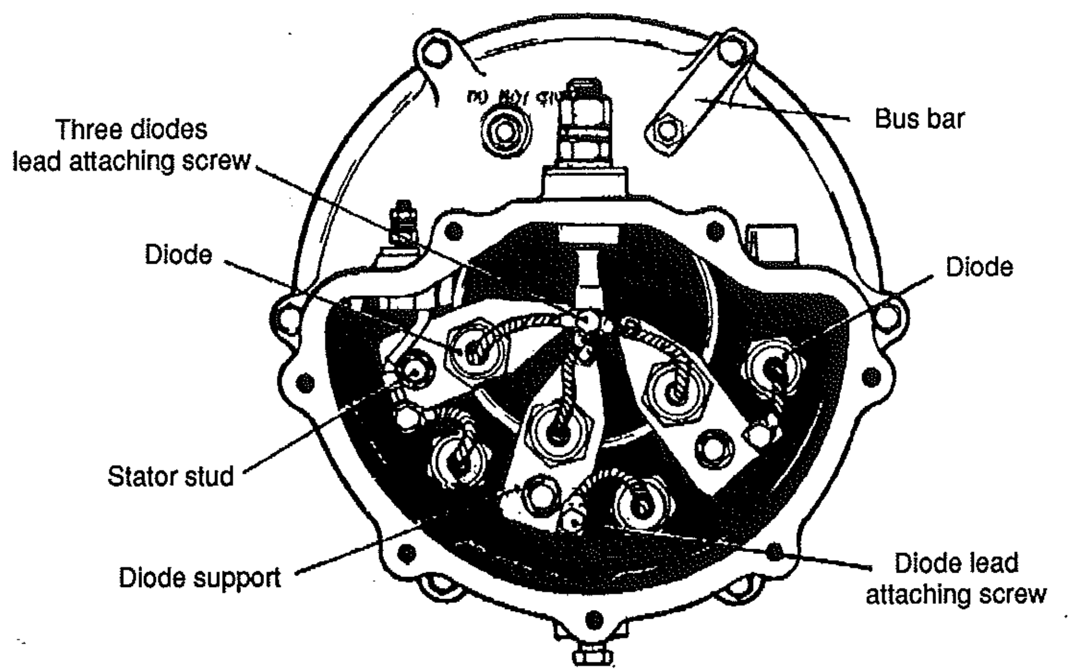


Fig. 24 - View of rectifier end frame with cover removed

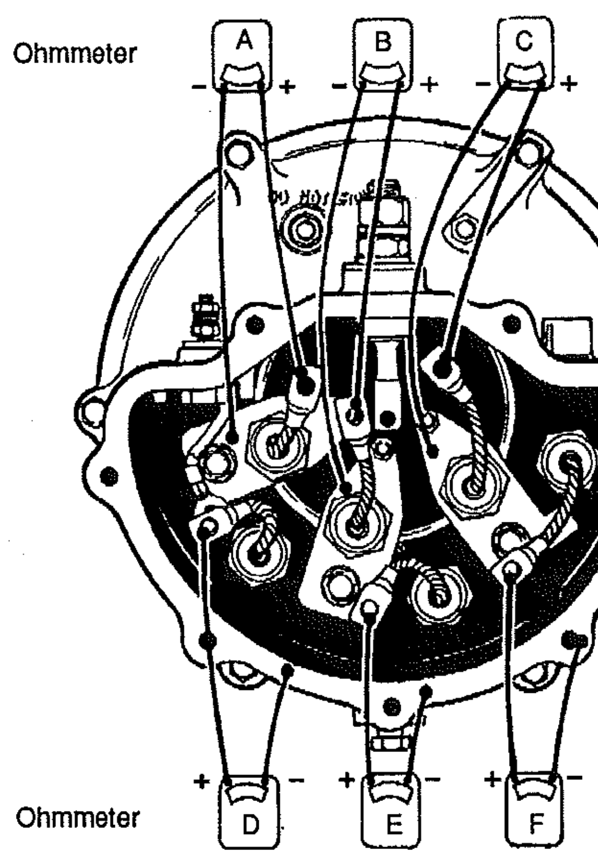


FIG. 25 - Checking diodes with ohmmeter on a typical oil-cooled alternator (end cover removed)

To check the diodes mounted in the diode supports for opens, connect the ohmmeter negative lead to each diode lead and the ohmmeter positive lead to each support as shown in parts "A", "B", and "C" of figure 26. To check the diodes mounted in end frame for shorts, connect the ohmmeter negative lead to each diode lead and the ohmmeter positive lead to the end frame as shown in parts "D", "E" and "F". An infinite resistance reading indicates an open diode. Diodes can be replaced by following the procedure outlined under the headings *"Disassembly"* and *"Reassembly"*.

When reinstalling diodes, torque to 9-11 ft•lbs (12-15 N•m). Re-stake next to the threads in an arbor press with an 1/8 inch (3,2 mm) round punch. Press the punch with gradual pressure; do not strike as the shock may damage the diodes.

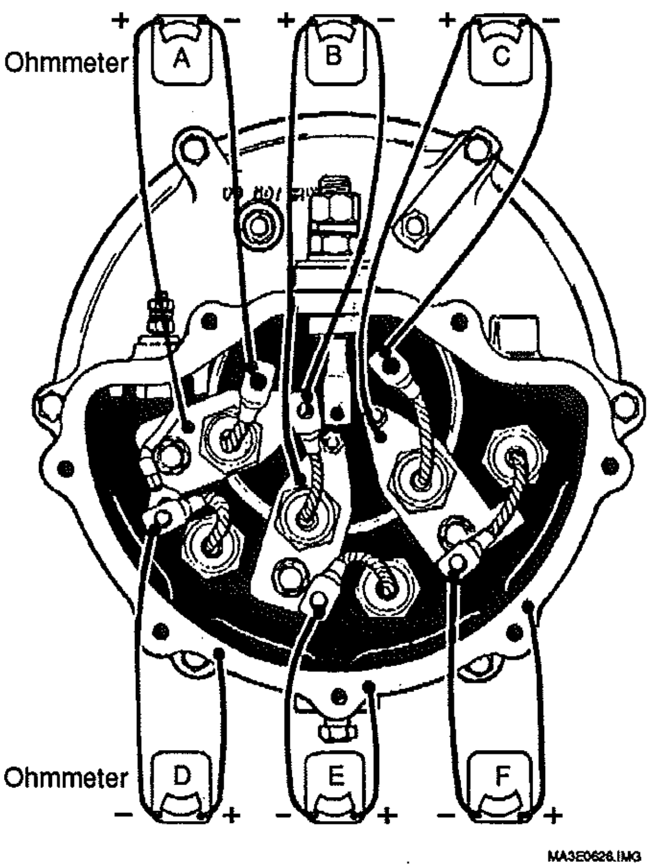


FIG. 26 - Checking diodes with ohmmeter on a typical oil-cooled alternator (end cover removed)

Field winding

The field winding may be checked for shorts and opens with an ohmmeter. To check the field winding, connect the ohmmeter to field terminal and to ground. A resistance reading above normal indicates an open, and a reading less than normal indicates a short. The normal resistance value is 3.0 to 3.3 ohms at 80 °F (27 °C). An alternate method of checking is to place a battery of specified voltage, and an ammeter in series with the field winding. The current should register 7.2 to 8.3 amperes at 24 volts. Coil resistance is approximately 3.1 ohms. Amperage readings, other than the above, indicate an open, grounded, or shorted field. A defective field coil can be replaced by removing the end frame on which the field terminal is located and then removing the four field coil mounting screws. See the headings "Disassembly" and "Reassembly" for a detailed procedure.

Stator winding

The stator winding may be checked for opens and shorts with an ohmmeter as follows:

Opens

Connect the ohmmeter leads to two pairs of diode supports as shown in parts "A", "B", and "C" of figure 27. Polarity of the leads must be observed. The ohmmeter should indicate a low resistance. If an infinite or a high resistance is measured in either one or both checks, the stator windings are open.

Grounds

To check the stator windings for grounds, connect an ohmmeter to the diode support and diode end frame as shown in part "C" of figure 27. The ohmmeter should indicate a very high or infinite resistance. If zero, or a very low resistance is measured, the windings are grounded.

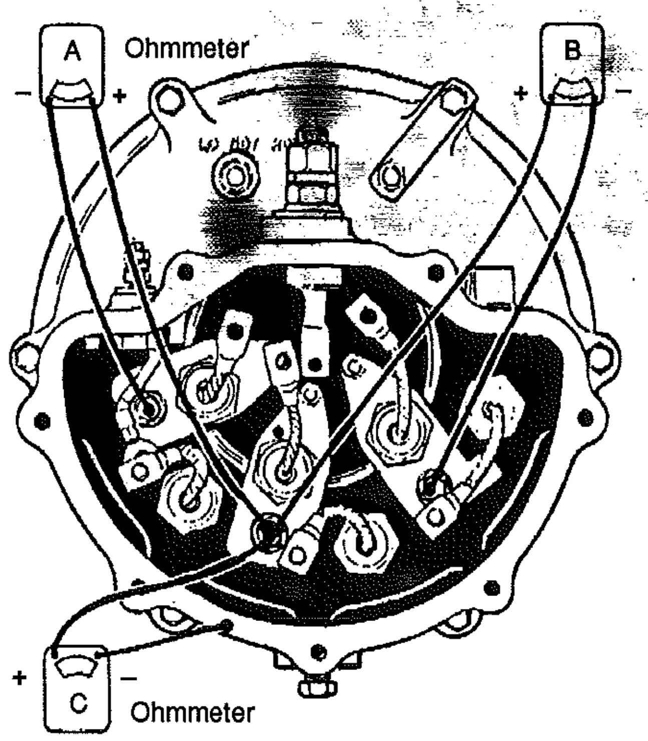


FIG. 27 - Checking stator windings for "Opens" and "Ground"

Shorts

The stator windings are difficult to check for shorts without finely calibrated laboratory test equipment due to the very low resistance values of the windings. However, if all other alternator checks are satisfactory, yet the unit fails to perform to specifications, shorted stator windings are likely.

Diode replacement

The following replacement procedures are based on the assumption that the diode end cover is still removed and diode leads were disconnected as explained earlier in this section.

NOTE: When replacing a diode, make sure it is designed for a negative ground system. The diode can be identified by the symbol stamped on the diode case. The arrow must point toward the diode flexible lead.

To replace the three diodes which are mounted in the supports attached to the stator lead studs, it is necessary to remove the diode and support assembly. The two outer diode and support assemblies are identical and can be installed on either side. The center unit has a different support, with 2 inches (50,8 mm) between the mounting hole centers.

NOTE: The outer supports are provided with 2 1/4" (57,15 mm) center holes.

Diode (in support) replacement

1. Remove nut with lock washer attaching the diode support to the stator lead stud.

2. Remove nut, lock washer, and flat washer attaching support to the small stud in the end frame.

3. Remove the diode and support assembly, then remove insert from small hole in support or from small stud in the end frame.

4. Remove nut and flat washer from diode mounting stud, then remove diode from the support.

5. Place a new diode in the support and install a flat washer and nut on the diode mounting stud. Hold the diode with a wrench placed over flats on the diode, while tightening nut on the mounting stud to a torque of 160-180 in•lbs (18-20 N•m).

6. Place diode and support assembly over the stator lead stud and the small mounting stud. Place insert over small stud inside the hole in the support. Install flat washer, lock washer, and nut on the small stud, and tighten to a torque of 22-25 in•lbs (2-3 N•m). Install nut with lock washer on stator lead stud and tighten firmly.

Diode (in end frame) replacement

To remove diode, use a thin 1 inch open end wrench on flats of the diode case to unscrew diode from the end frame. Thread the new diode into the end frame and tighten to a torque of 160-180 in•lbs (18-20 N•m). If no other parts are to be replaced, refer to *"Diode end cover installation"* later in this section.

Field replacement

Removal

1. Remove three diode and support assemblies from the end frame to provide access to the two lower field to end frame bolts.

2. Remove nut with lock washer and flat washer from three stator lead studs.

3. Remove the six bolts and lock washers attaching the diode end frame to the stator frame.

4. Separate the end frame from the stator frame, and remove the end frame and field assembly from the rotor while pushing the stator lead studs out of the end frame.

5. Remove nut, lock washer, flat washer, and insulating washer which secure the field lead terminal stud in the end frame. Push the stud out of the end frame.

6. Remove field terminal stud insulating bushing and seal from the end frame. Remove insulating sleeve from the field terminal stud.

7. Remove the four bolts and lock washers attaching the field to the end frame.

8. To separate the field from the end frame, install four 3/8-24 x 3 inch bolts in place of the 3/8-24 x 2 inch bolts removed in step 7. Thread bolts in to equal heights. Support the end frame in an arbor press, then using a suitable press plate to exert pressure on all four bolt heads, press the field out of the end frame.

Installation

1. Position the field assembly on the end frame, insert four 3/8-24 x 3 inch bolts through the end frame and thread into the field to keep holes aligned.

2. Support the end frame on an arbor press bed in such a manner that the diodes will not be damaged, and press the field into the end frame. Press in until shoulder on field coil bottoms against the end frame.

3. Remove the four guide bolts. Install four 3/8-24 x 2 inch bolts, using new lock washers to attach the field to the end frame. Tighten bolts securely.

4. Place insulating sleeve in inner side of the field terminal stud hole in the end frame, and insert the terminal stud through the sleeve. Place two O-rings and insulating bushing over the terminal stud and push into hole in the end frame. Install insulating washer, flat washer, toothed lock washer, and nut on terminal stud and tighten firmly.

5. Install each stator lead stud in the end frame as follows: Place insulating washer over the stud and insert the stud through the end frame. Place the insulating bushing over the stud and position in end frame hole. Install flat washer, lock washer, and nut on the stud, and tighten firmly.

6. Install three diode and support assemblies on the end frame as previously directed under *"Diode replacement"*.

7. Install a new seal in notch around end of the stator frame. Insert field into the rotor and position the end frame against the stator frame. Attach end frame to the stator frame with six bolts and lock washers. Tighten bolts firmly.

8. If no other parts require replacement, refer to *"Diode end cover installation"* later in this section to complete the assembly.

Stator replacement

If tests performed under "Stator winding checks" earlier in this section indicated an open circuit or short in the stator, the stator and frame assembly must be replaced.

Removal

1. Remove diode end frame and field assembly as previously directed in steps 1 through 4 under *"Removal"* in *"Field replacement"* procedure.

2. Remove the six bolts and lock washers attaching the stator frame to the drive end frame.

3. Separate the stator frame from the drive end frame and remove the stator frame from the end frame and rotor.

Soldering stator terminal leads

1. Using a wire brush, thoroughly clean the wire and terminal.

2. Silver solder the stator lead to the terminal using a torch.

3. Thoroughly clean the silver solder connection with a wire brush.

4. Using a high grade energized rosin flux, coat the silver soldered connection with a 80-20 tin-lead solder or pure tin solder to prevent deterioration of the silver solder by engine oil.

NOTE: The silver solder will provide the required mechanical strength which will not be affected by temperature. The tin-lead solder will protect the silver solder connection from deterioration by engine oil.

Installation

1. Position new seal in notch around the drive end of the stator frame.

2. Position the stator and frame assembly over the rotor against the drive end frame. Attach the stator frame to the drive end frame with six bolts and lock washers. Tighten bolts firmly.

3. Install diode end frame and field assembly as directed in steps 5, 6 and 7 under *"Installation"* in *"Field replacement"* procedure.

4. Install rectifier end cover as directed later.

DIODE END COVER INSTALLATION

1. Make sure all diodes are properly installed and securely tightened. Leads from diodes threaded into the end frame must be securely attached to the diode supports. The relay terminal lead must also be attached to the left diode support.

2. Connect leads from the three diodes mounted in supports to the output terminal stud. Tighten the attachment screw firmly. Place insulating bushing over relay terminal stud.

3. Place a new seal in the diode end frame.

4. With the end cover in place against the end frame, install the cap screws (7) and lock washers. Tighten the cap screws evenly and firmly.

5. Make sure the drain plug was installed in bottom of the end cover and was securely tightened.

ALTERNATOR REPLACEMENT

Removal

1. Place *"Starter selector switch"* in engine compartment to the *"Off"* position.

2. Place the 12 and 24 volt battery main disconnect switches to the *"Off"* position.

3. Remove the half section of engine splash guard near the alternator.

4. Remove drain plug from bottom of the diode end cover and drain oil into a suitable container. Install drain plug after draining.

5. Disconnect wires #25 from the relay "R" terminal, #107 from the field "F1" terminal regulator and disconnect battery cable from the "DC" terminal on the diode end cover. Tag wires removed from other terminals to aid in identification at time of installation.

6. Remove clip retaining the battery cable to the diode end cover.

7. Disconnect oil supply line from elbow on diode end cover and tape elbow and line to prevent entry of foreign matter. Remove clip securing flexible oil line to bracket on alternator drive end frame.

8. Fix a single sheave to the existing support over the alternator, and another one to the permanent clamp around the alternator (see fig. 28).

9. Open rear L.H. electric compartment, locate the engine compartment access panel at right of the junction box, remove the Phillips-head screws retaining access panel, then remove panel.

10. Using an approximately 15 foot (5 m) long cable (recommended minimum: 3/8" (9,5 mm) O.D.) nylon cable, insert one end of the cable through the access panel opening, then route it to the alternator.

11. Route cable through upper sheave, then through lower sheave, and fix cable to the support over the alternator as shown in figure 28.

NOTE: Another person is required to complete alternator removal procedure.

12. Take cable end in rear electric compartment, ensure a good grip on cable, move as far as possible from vehicle (approximately 10 ft (3 m)), then pull on cable to support alternator weight.

WARNING: Alternator weight is approximately 150 lbs (70 kg). This weight is reduced by 50% with the use of sheaves. Consequently, the person pulling on the cable should be aware and able to support a weight of 75 lbs (35 kg).

13. Remove nuts and lock washers from the six mounting studs. Pull the alternator straight back off mounting studs, then remove the alternator from under vehicle.

CAUTION: One person is required to guide alternator while the other lowers it very slowly.

14. If a new or rebuilt alternator is to be installed, remove driven gear from the alternator for installation on the replacement unit.

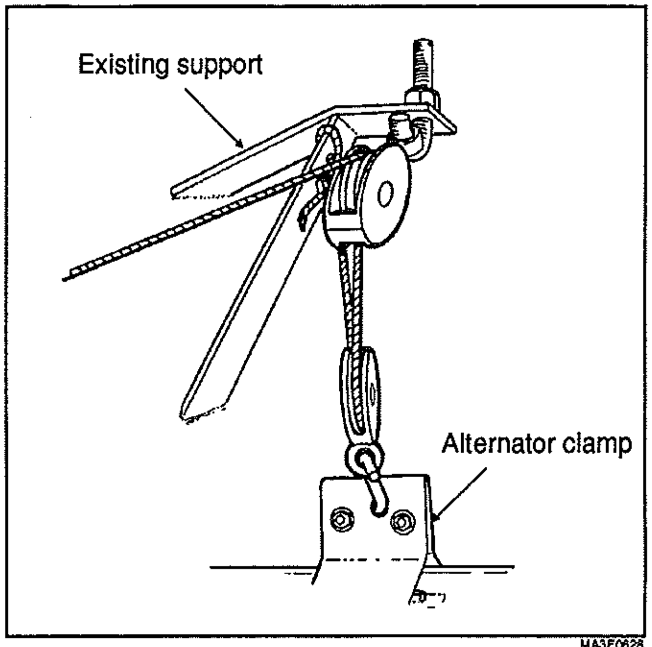


FIG. 28 - Recommended alternator supporting device installation

Disassembly of alternator

After diode, field or stator winding checks, the alternator can be disassembled to repair a faulty component, such as field, stator, or to proceed with bearing or rotor replacement. The alternator may be disassembled by following the steps hereafter:

1. Remove nuts and washers from "DC" terminal on diode end frame.

2. Separate the diode cover plate from the diode end frame by removing the mounting screws.

3. Remove the washer, nut and lock washer attaching the diode supports to the end frame, the three screws connecting the diode leads to the diode supports, and the three nuts which attach the stator studs to the diode supports.

4. Separate the diode support assemblies from the diode end frame, and the three nuts which connect the studs to the diode end frame.

5. Mark the position of the drive end frame and diode frame with respect to the stator assembly so that the parts can be reassembled in the same position.

6. Detach the diode end frame and field assembly from the stator assembly by removing the attachment screws.

7. Separate the field assembly from the diode end frame by removing the four attachment screws.

8. Separate the rotor assembly and drive end frame from the stator assembly by removing the attachment screws.

9. Remove the shaft nut and washer, and the pinion gear. Press the rotor shaft out of the drive end frame.

10. Remove the retainer plate and pull the bearings from the drive end frame.

Alternator cleaning and inspection

Whenever the alternator is disassembled, it should be cleaned and inspected as follows:

Cleaning

If sludge has accumulated on the stator, a light mineral oil should be used to clean the stator.

Inspection

When the alternator has been disassembled to a point that the stator is exposed, the stator should be checked for the following:

a) Adequate varnish.

b) Proper spacing of conductors so that "near shorts" do not exist.

c) Proper phase lead placement.

d) Strong conductor and cross-over welds.

Bearing or rotor replacement

Whenever the rotor and drive end frame are disassembled for any reason, the single-row ball bearing must be replaced with a new one due to the probability of its being damaged during disassembly.

Removal and disassembly

1. If the driven gear was not removed from the rotor shaft at time of alternator removal, remove the nut and flat washer from the shaft and pull the gear off the shaft.

2. Remove the six bolts and lock washers attaching the drive end frame to the stator frame. Separate the drive end frame from the stator frame, then remove the drive end frame and support assembly.

3. Support the drive end frame in an arbor press in such a manner that the rotor can be pressed down out of the end frame. Using a suitable adapter against the end of the rotor shaft which will pass through the inner race of the double-row ball bearing, press the rotor down out of the end frame and bearings. Since the single-row bearing outer race is held in the end frame by the retainer plate, and the inner race is a press fit on the rotor shaft, the bearing is likely to be damaged when the shaft is pressed out and must be replaced with a new part.

4. Remove the six screws attaching the bearing retainer plate to the drive end frame. Remove the retainer plate, the single-row bearing and the bearing spacer from the end frame.

5. Support the drive end frame in an arbor press with the double-row bearing down, in such a manner that the bearing can be pressed down out of the end frame. Using a suitable driver which will exert a force on the bearing outer race, press the bearing out of the end frame.

6. Remove the rubber bearing clamp from groove in the end frame.

Assembly and Installation

1. Install a new single-row ball bearing into inner side of the drive end frame. Install the bearing retainer plate and attach with six screws. Stake screws in place after tightening.

2. Position the rubber bearing clamp in groove in bearing bore of the drive end frame. Lubricate the clamp to permit the bearing to be pressed in without dislodging or damaging the clamp.

3. Position the rotor in an arbor press with the shaft end up. Install the drive end frame and single-row bearing assembly over the rotor shaft. Using a driver over the rotor shaft which will exert a force on the bearing inner race, press the bearing onto the shaft until it bottoms against the rotor.

4. Install bearing spacer over the rotor shaft. Position the double-row bearing over the rotor shaft at end frame bore. Using an adapter which will exert a force on both the inner and outer races of the bearing, press the bearing onto the shaft and into the end frame until the inner race bottoms against the bearing spacer.

5. Place a new seal around the drive end of the stator frame.

6. Insert the rotor between the stator and field, and position the drive end frame against the stator frame. Attach the end frame to the stator frame with six bolts and lock washers. Tighten the bolts to a torque of 5 to 5.4 ft•lbs (6-7 N•m).

CAUTION: When replacing the alternator on vehicle, ensure that an alternator with the proper drive ratio is used. Installation of an alternator with any other drive ratio will result in severe and costly damage to the alternator and engine.

Reassembly

Reassembly is the reverse of disassembly. When installing the single-row bearing into the drive end frame, press against the outer race ONLY to avoid loading the bearings. Attach the bearing retainer plate, and press against the bearing inner race to force the assembly over the shaft. To avoid pressure on the bronze ring in the rotor, support the inside of the rotor against the shaft, and place the shaft in an upright position to facilitate the assembly procedure. Press against the inner race to force the double-row bearing over the shaft. When attaching the field to the diode end frame, make sure the mating surfaces are perfectly clean and tighten the mounting screw securely.

NOTE: When tightening the outside nut on the "DC" output terminal, torque the nut to 30-35 ft•lbs (41-47 N•m). The lower nut should be supported while tightening the top nut.

When reinstalling diodes, tighten to a torque of 9-11 ft•lbs (12-15 N•m).

Output check

When removed from the engine, the alternator may be checked on a test bench without circulating oil, providing the output is limited to 100 amperes or less. The alternator may be bench tested without circulating oil at outputs exceeding 100 amperes, as long as the period of operation is limited to less than 15 seconds.

CAUTION: Operating the alternator at outputs greater than 100 amperes for periods exceeding 15 seconds without adequate oil circulation, will cause the alternator to overheat, resulting in damage to the winding and diodes.

If the alternator is to be operated at an output greater than 100 amperes for longer than 15 seconds, circulating oil must be provided. SAE 30 engine oil must be supplied to the connection on the diode end cover at a pressure of 35 psi and at a temperature of 60 °F to 220 °F (16 °C to 104 °C). This will provide an oil flow of about one gallon per minute.

To check the alternator on a test bench, make electrical connections as shown in figure 23. Be sure to connect the negative battery terminal to the alternator frame.

ALIGNMENT OF ALTERNATOR ADAPTER ("8-SHAPED" ADAPTER)

NOTE: This procedure applies only to models with alternator mounted on engine without geared adapter housing.

1. Position gasket, ring and *"8-shaped"* adapter on flywheel housing.

NOTE: Gasket must have a notch on inside edge of large circle for proper internal oil drainage. Refer to figure 29 for details.

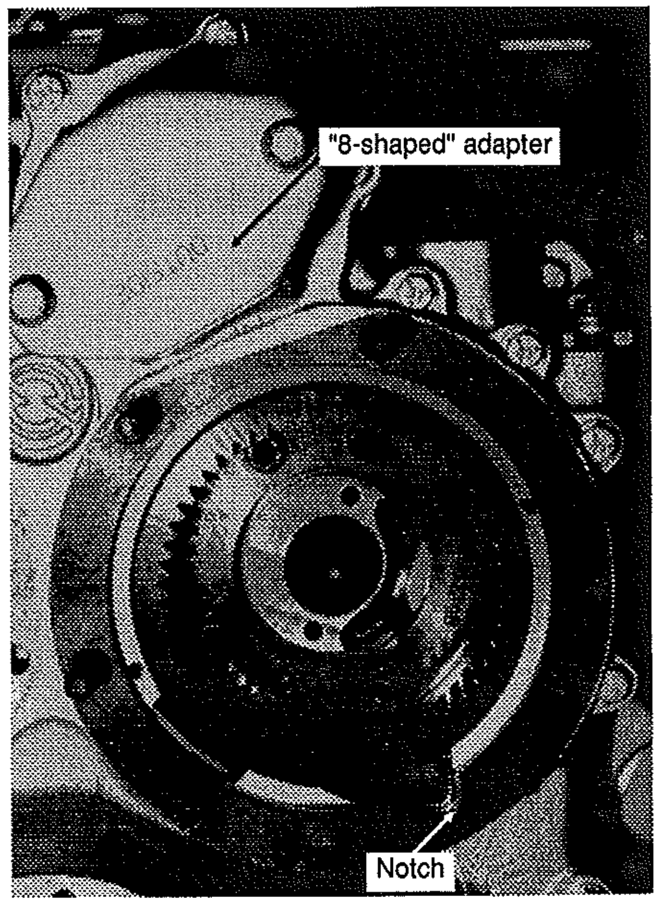


Fig. 29 - Alternator adaptor

2. Center the *"8-shaped"* adapter over cam gear using feeler gauge or other means. Install and tighten the four upper adapter bolts to a torque of 40-45 ft•lbs (54-61 N•m). Adjust the two setscrews to contact flywheel housing.

3. Place magnetic base (for dial indicator) on the hex-head capscrew mounting cam gear to camshaft. Install dial indicator on base and set stylus to contact inside edge of *"8-shaped"* adapter bore. Set dial indicator to zero.

NOTE: A tool, which quickly mounts a dial indicator on the 53-tooth alternator drive gear for alignment of *"8-shaped"* adapter, is available from Kent-Moore Corporation Service Tool Division (part no J29893) or through a Detroit Diesel Corporation distributor.

CAUTION: Engine must always be rotated in a clockwise direction when viewed from engine front. Barring the engine in the wrong direction will loosen the crankshaft end bolt. Engine damage will result when engine is started. An assistant is necessary to bar engine over while dial indicator is read.

4. Bar engine over. Dial indicator must rotate clockwise at least 180° of one revolution. The *"8-shaped"* adapter is centered if dial indicator reads within ± .002 TIR. If satisfactory, proceed with step 6.

5. If runout is more than ± .002 TIR, loosen the four upper adapter bolts. Back off the two setscrews (*"Allen screws"*) and readjust them until dial indicator reads within tolerance when engine is barred over. Repeat the procedure until the required reading is attained, or until it is determined that the *"8-shaped"* housing is out-of-round or otherwise defective. Replace as necessary.

6. Remove dial indicator and magnetic base. Tighten the four upper mounting bolts to a torque of 40-45 ft•lbs (54-61 N•m).

VOLTAGE REGULATOR

Location

The 24 volt regulator is located on the right wall of the L.H. ski compartment.

Description

The transistor regulator illustrated in figure 30 is an assembly consisting mainly of diodes, capacitors, resistors and transistors. These components are mounted on a printed circuit panel board to form a completely static unit containing no moving parts. Regulators of this type have only **three** terminals which are identified "NEG" (ground), "FLD" (field) and "POS" (battery).

The regulator components work together to limit the alternator voltage to the preset value by controlling the alternator field current. This is the only function that the regulator performs in the charging system.

The voltage at which the alternator operates is determined by the regulator adjustment. Once adjusted, the alternator voltage remains constant, since the regulator is unaffected by length of service, changes in temperature, or changes in alternator output and speed.

A typical wiring diagram of a negative ground system is illustrated in figure 31. This diagram shows only the basic charging system components, and does not show any components such as the control relays. Refer to *"Charging system"* wiring diagram, page 1 of 24 in *"Master wiring diagrams"* for the electric circuits and connections.

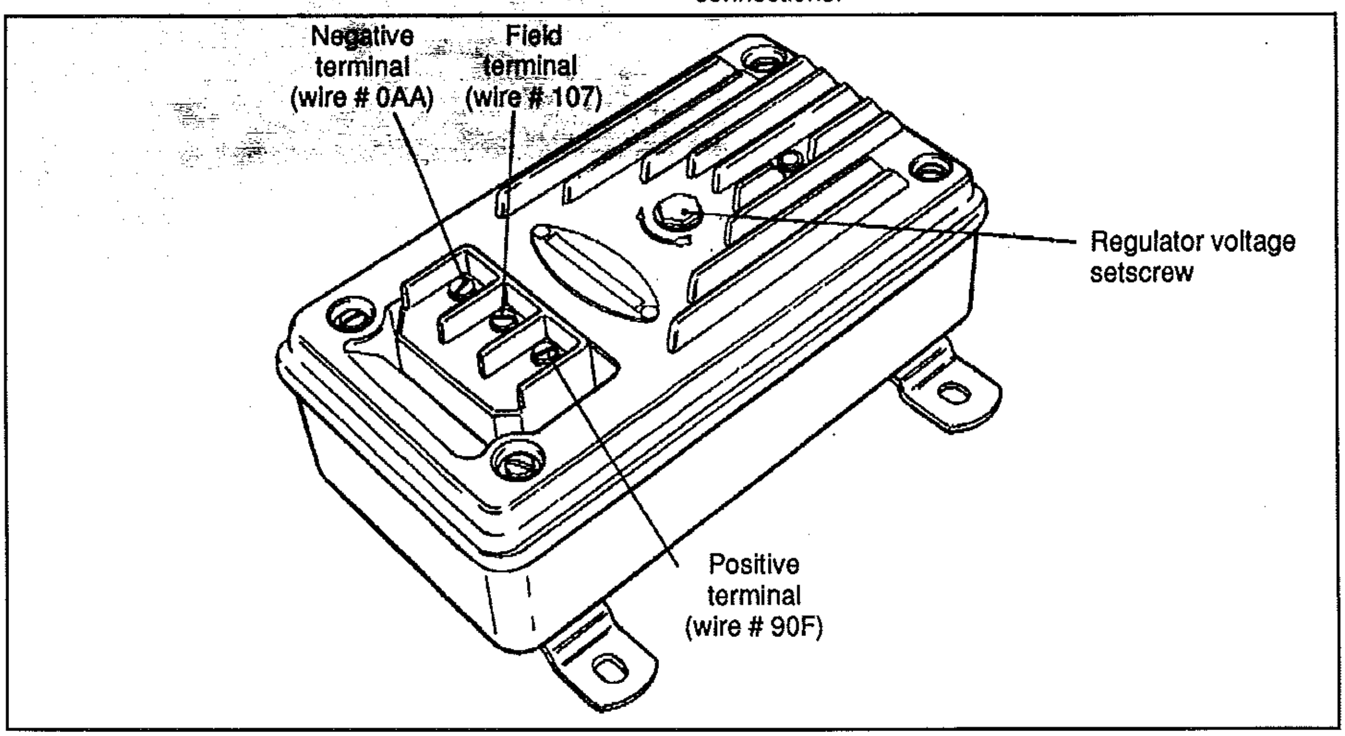


Fig. 30 - 24 volt regulator

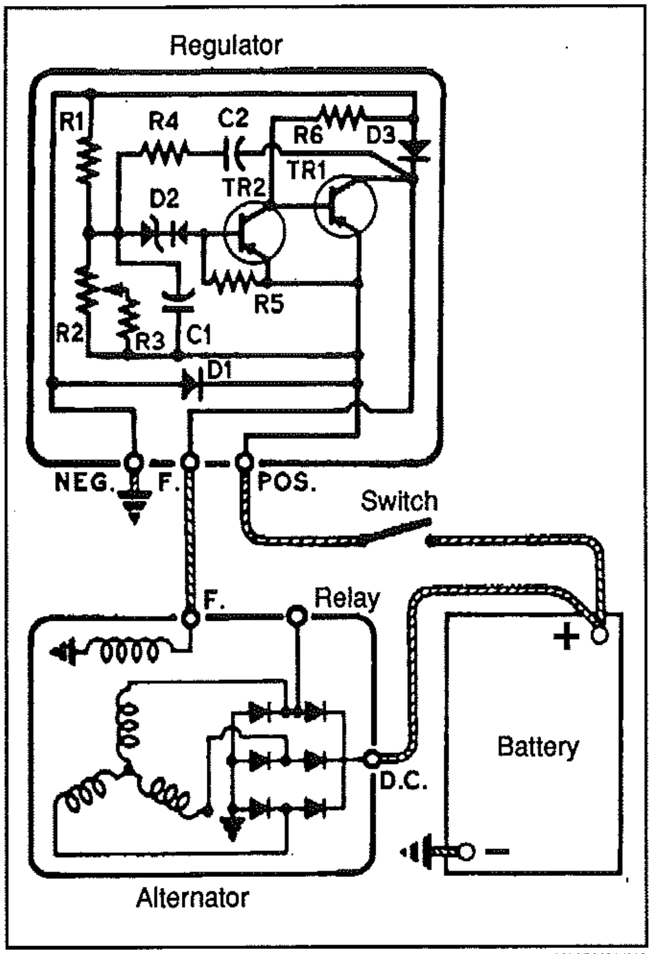


Fig. 31

Troubleshooting procedures

Trouble in the electrical system will usually be indicated by one of these two conditions: an undercharged or an overcharged battery. Either condition can result from an improper voltage regulator setting.

The absence of gassing at the continuous appearance of the green dot in the battery built-in hydrometer indicates that the voltage setting is satisfactory.

Checking regulator voltage setting

1. To check the voltage setting, connect a voltmeter across the "POS" and "NEG" terminals on the regulator, and an ammeter to the "DC" terminal on the alternator. Refer to figure 32.

2. Operate the engine at approximately 1000 rpm (about 2300 alternator rpm) with accessories turned on to obtain an alternator output of 20-200 amperes.

3. Note the voltage setting; it should be steady at 27.5 volts.

4. If not, the desired setting can be obtained by removing the plug from the voltage regulator cover and turning lightly the adjusting screw inside the regulator; clockwise to increase or counterclockwise to decrease the voltage setting. See figure 33 for details.

NOTE: If regulator voltage cannot be adjusted to the specified setting, remove the regulator, repair and/or replace it.

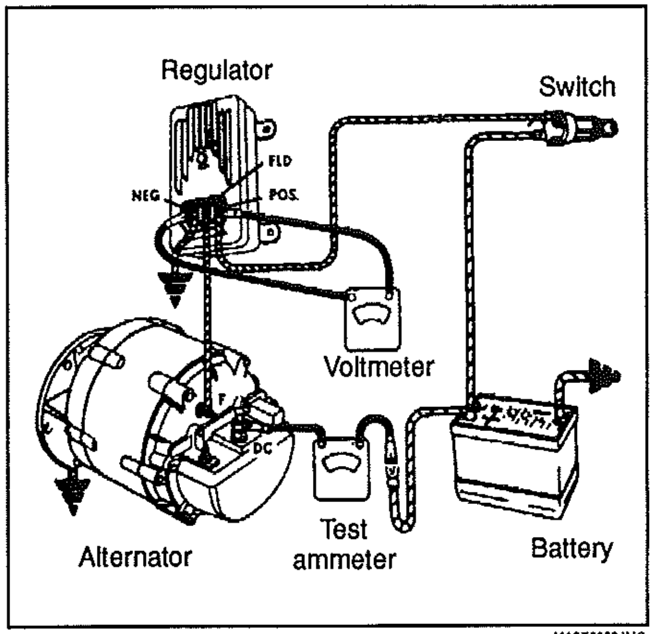


Fig. 32

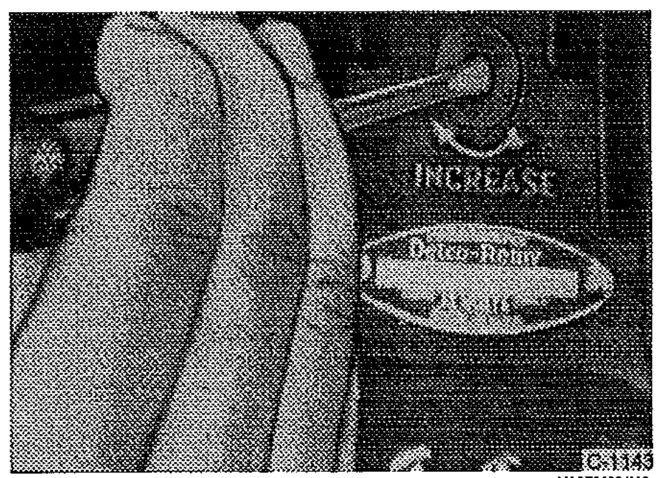


Fig. 33 - Adjusting regulator voltage setting

Undercharged battery

If the voltage setting as checked above is steady and reasonably close to the specified value and the battery is undercharged, raise the setting by 0.3 volt, then check for an improved battery condition over a minimum service period of 48 hours. If the voltage cannot be adjusted to the desired value, the alternator should be checked as follows:

1. Stop alternator, turn off all accessories and disconnect battery ground cable.
2. Disconnect all leads from the regulator and from the alternator field. **Do not allow leads to touch ground.**
3. Connect a voltmeter and an ammeter in the circuit at the alternator "DC" terminal.
4. Connect a jumper lead from the alternator "DC" terminal to the alternator field terminal.
5. Connect a carbon pile resistor load across the battery. Turn to the *"Off"* position.
6. See figure 34 for wiring connections.

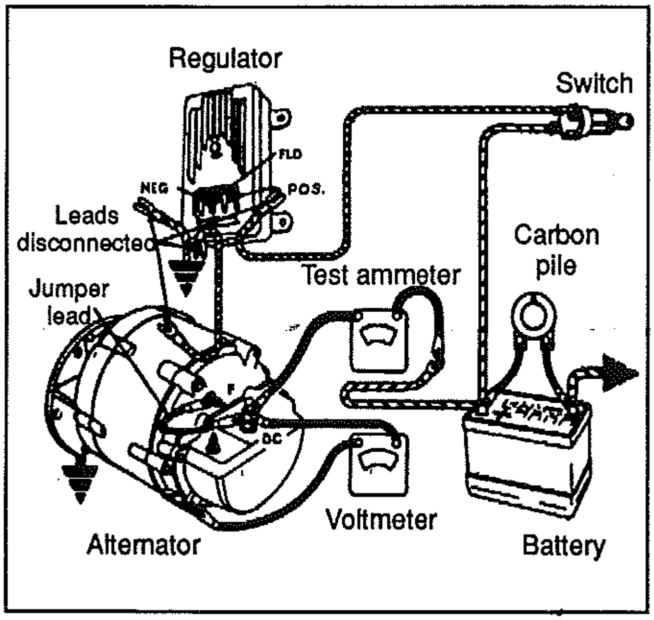


Fig. 34

7. Reconnect battery ground cable.
8. Turn on all vehicle accessories.
9. Operate alternator and adjust carbon pile resistor load as required to check for rated output as given in Delco-Remy Service Bulletin 1G-187 or 1G-188.
10. Check the alternator field winding as follows:

Disconnect the lead from the field terminal and connect an ohmmeter from the field terminal to ground. A resistance reading above normal indicates an open, and a resistance reading less than normal indicates a short or ground. The normal resistance can be calculated by dividing the voltage by the field current published in Delco-Remy Service Bulletin 1G-186, 1G-187, or 1G-188. The normal resistance value should be at or near midscale on the ohmmeter for accuracy. An alternate method of checking is to connect a battery of specified voltage and an ammeter in series with the field winding, and compare readings with published specifications in Delco-Remy Service Bulletin 1G-186, 1G-187, or 1G-188. An alternator is defective if it does not produce rated output or if field windings are faulty. If the alternator provides rated output, and field windings check satisfactorily, the regulator should be checked as covered under heading *"Regulator checks"*.

Overcharged battery

If the voltage setting as checked above is steady and reasonably close to the specified value, lower the setting by 0.3 volt and check for an improved battery condition over a minimum service period of 48 hours. If the voltage cannot be adjusted to the desired value, proceed as follows: where the alternator field is grounded internally in the alternator as shown in figure 31, a shorted or grounded field or a defective regulator can cause an overcharged battery. The field winding can be checked as covered in *"Undercharged battery"* section. If the field winding is found not to be defective, the alternator is not defective, and the regulator should be checked as covered under heading *"Regulator checks"*.

Regulator checks

Separate the cover from the base, and then remove the panel assembly from the cover. Carefully note the location of all washers and lock washers.

The component parts are keyed to figure 31. Before making electrical checks, visually inspect the components and make sure all soldered connections are secure. Various electrical checks with an ohmmeter can be made to determine which components are defective.

The ohmmeter **must** be accurate, and should be a scale-type meter with a 1.5 or 3 volt cell. Most digital ohmmeters can not be used to check semiconductors; however, some digital ohmmeters are specially designed to test semiconductors and can be used to test components in the regulator. Consult the ohmmeter manufacturer concerning the capabilities of his meter.

It is important that all of the following checks be made. If a defective part is found, replace it before proceeding with the remaining checks. Be sure to make all the checks as more than one component may be defective.

A defective regulator can be repaired according to the following methods:

A) By changing the printed circuit board into the regulator. Unscrew the retaining screws on printed circuit and remove it. Then, install a new printed circuit board. This method is the most commonly used.

B) By removing any retaining screws involved and unsoldering the connections. When resoldering, limit solder time to a minimum as excessive heat may damage the printed circuit and component parts. However, good soldered connections are essential for satisfactory operation. A resin core 63% tin 37% lead solder with a 360 °F (182 °C) melting point is recommended along with a soldering iron rated at 50 watts or less. Use extreme care to avoid overheating. Before checking the printed circuit board, remove transistor TR1, which must be checked separately. Connect the ohmmeter as shown in figure 35, and then reverse the ohmmeter leads to obtain two readings on the same component. Use the middle scale on scale-type meters where the 300 ohm value should be within, or nearly within, the middle third of scale.

Capacitors C1 and C2 = The ohmmeter should read high and low on each capacitor. If not, replace capacitor.

Diodes D1, D2, and D3 = Each diode should give one high and one low reading. If not, replace diode.

Resistor R2 = Turn voltage adjustment screw (identified in figure 33) with ohmmeter connecting each way. Reading should change as slotted screw is turned. If not, replace R2.

Transistor TR1 = See figure 35. Use the low scale. Each of the three checks should read low and high. If not replace TR1.

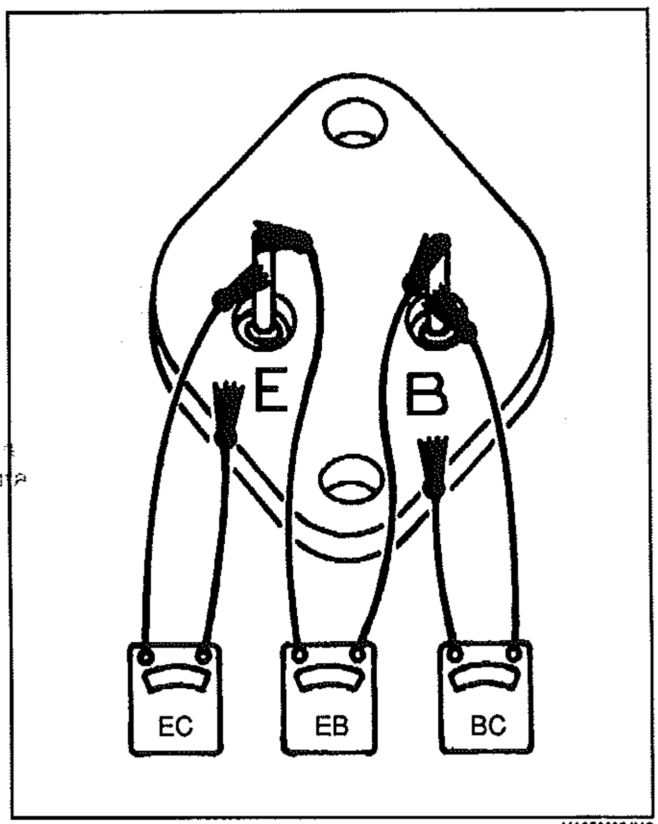


Fig. 35 - Checking transistors TR1

Transistor TR2 = Change the ohmmeter to use the low scale. Check EB should read low and high. Check BC should read low and high. Check EC should both read high. If not replace TR2. See figure 36.

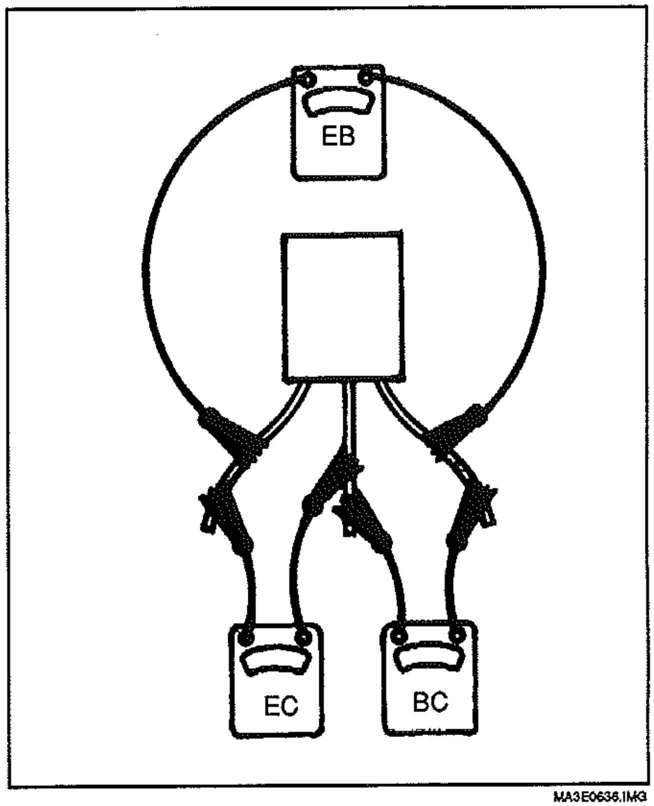


Fig. 36 - Checking transistors TR2

Adjusting voltage

After repair, the regulator must be adjusted to the desired voltage setting. Follow the procedure under previous heading *"Checking voltage setting"*. Turn **slowly** the adjusting screw full range and observe the voltmeter to insure that the voltage is being controlled, then adjust, **always slowly,** to the desired setting.

BATTERY EQUALIZERS

Description

The battery equalizer is an energy transfer device. It allows 12 and 24 volt powers to be taken simultaneously from a 24 volt battery system. The equalizer is designed to be connected to the batteries continuously much like an alternator. The amount of continuous duty 12 volt current is limited to the capacity (number of amps) of the equalizer. The equalizer causes the 12 volt current draw to be taken from both banks of batteries. For example, if a 10 amp, 12 volt load is presented to the system, 5 amps would be supplied by each bank of batteries. Any imbalance between the batteries is automatically equalized.

Operation

Situation 1

24 and 12 volt loads present - alternator on:
The alternator provides 24 volt service, the equalizers provides 12 volt service from both banks of batteries.

Situation 2

24 and 12 volt loads present - alternator off:
Both banks of batteries discharge at an equal rate even though there is an unequal load.

Situation 3

24 volt only - alternator on or off:
The equalizers are in the standby mode.

Situation 4

12 volt load only - alternator off:
The equalizers provide 12 volt current from both banks of batteries.

Advantages

1. Eliminates overcharging

The battery equalizer is designed to eliminate the overcharging of one bank of batteries in a split 24/12 volt system. This device electronically monitors voltages of both battery banks, and transfers current whenever one bank of batteries discharges at a different rate than the other.

2. Extends normal battery life

By maintaining equalization down to 0.1 volt, the equalizer will extend normal battery life by preventing both over and under charging.

Battery equalizer troubleshooting

Before proceeding with the next troubleshooting, open the *"main power junction sliding support"* located beside battery compartment and the engine compartment R.H. side door (only on V.I.P. model equipped with additional battery equalizers), then reset the circuit breaker located at the extremity of each battery equalizer by pushing on its button (see fig. 37). Check also that the equalizer junction terminals are tight, clean and corrosion free. If all previous are good, troubleshoot each battery equalizer following the method described after the notes.

NOTE: Allow at least 15 minutes to balance batteries after corrective measure has been taken.

NOTE: An open circuit breaker is usually caused by a reverse current applied between the + 12 V and ground terminals in excess of the nominal rating of the unit. It is important to note that this reverse current is a fault condition and can be avoided as follows:

1. When disconnecting batteries or welding on vehicle, always disconnect the equalizer ground terminal first. After work is completed, reattach ground terminal last.

2. When jump starting a vehicle, always connect ground cable last, then, when vehicle is running, disconnect this cable first.

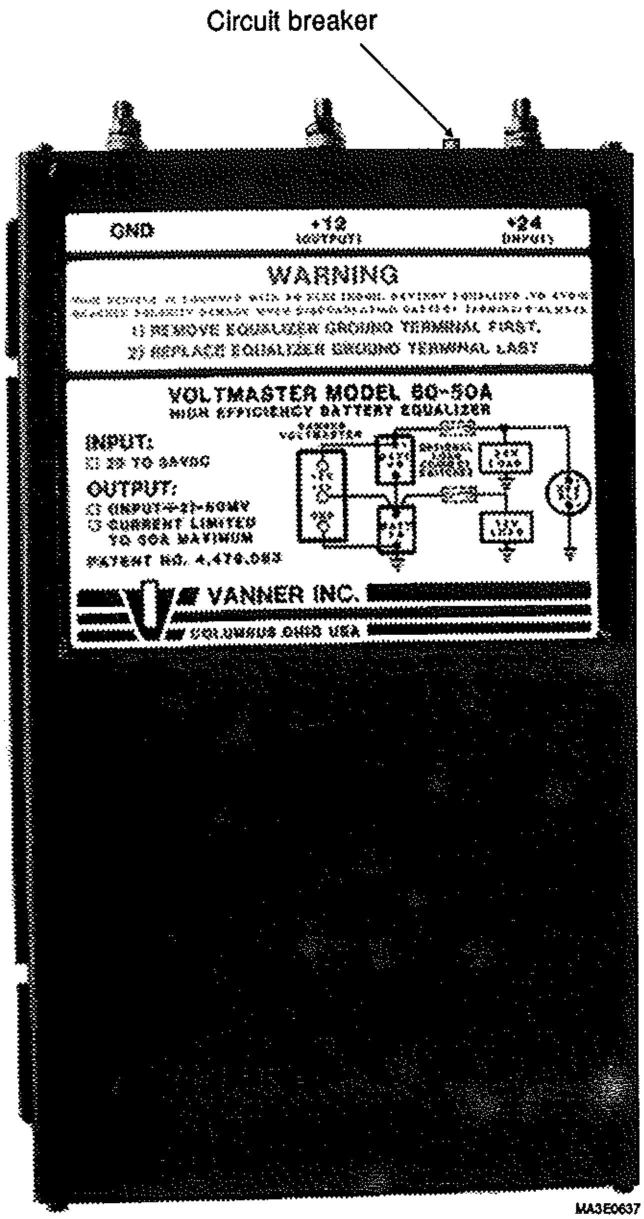


Fig. 37 - Battery equalizer

Battery equalizer troubleshooting (cont'd)

Analyse condition of each battery equalizer as follows:

1. Carefully remove the ground (GND) cable from the equalizer.

CAUTION: Do not allow this cable to touch any other connection on the equalizer as the other terminals are connected to the batteries.

2. Make sure there is approximately 12 volts between the +24 and +12 terminals of the equalizer.

3. Connect a 12 volt load (e.g. stoplights) between the +12 volt and GND terminals of the equalizers. The lamps should light and stay lit. If the lamps do not light, or light then go out, the equalizer requires repair.

4. Further verification may be made by measuring the voltages on the equalizer terminals. The lamps used earlier need to remain connected between the +12 and GND terminals.

5. Measure the voltage between the +24 and +12 terminals. Note this reading.

6. Measure the voltage from the +12 terminal to GND. Note this reading.

7. Compare the two readings by subtracting the +12 to GND reading from the +24 to +12 reading. A properly functioning equalizer is one where the difference is between - 0.5 and + 0.13 volt. For example, the +24 to +12 reading might be 12.85 volts. The +12 to GND voltage might read 12.75 volts. This equalizer would be functioning properly with a 0.10 difference (12.85 minus 12.75 volts) which is within specs.

STARTING MOTOR

Description

The starting motor has the shift lever and solenoid plunger that are totally enclosed to protect them from exposure to dirt, icing conditions and splash.

Positive lubrication is provided to the bronze bushing located in the commutator end frame, in the lever housing and in the nose housing, by an oil-saturated wick that projects through each bushing and contacts the armature shaft.

The clutch is a *"Positork"* drive type, moved into mesh with the ring gear by the action of the solenoid. Once engaged, the clutch will not disengage during intermittent engine firing, which prevents damage to pinion and ring gear teeth. The pinion remains engaged until starting is assured and the solenoid circuit is interrupted. Refer to figure 38 for more details.

Maintenance

All wicks and oil reservoirs should be saturated with SAE 10 oil, and the splines underneath the clutch should be lubricated with a light coating of SAE 10 oil. Other than normal periodic lubrication and keeping cable connections clean and tight, the starting motor should require no periodic maintenance. However, under normal operating conditions, the starting motor should be disassembled, inspected, cleaned and tested at time of engine overhaul.

Starting motor tests

To obtain full performance data on a starting motor, or to determine the cause of abnormal operation, the starting motor should be subjected to the following tests. These tests are performed with the starting motor removed from the engine. Check the armature for freedom of rotation by prying on the pinion with a screwdriver. Tight bearings, a bent armature shaft, or a loose pole shoe screw will prevent the armature from turning freely. Failure of the starting motor to perform according to specifications will require disassembling the motor for further checks and adjustments. However, if the armature does rotate freely, the motor should be given a no-load test before disassembly.

CAUTION: Never operate the starting motor more than 30 seconds at a time without pausing to allow it to cool for at least 2 minutes. Overheating, caused by excessive starting, will seriously damage the starting motor.

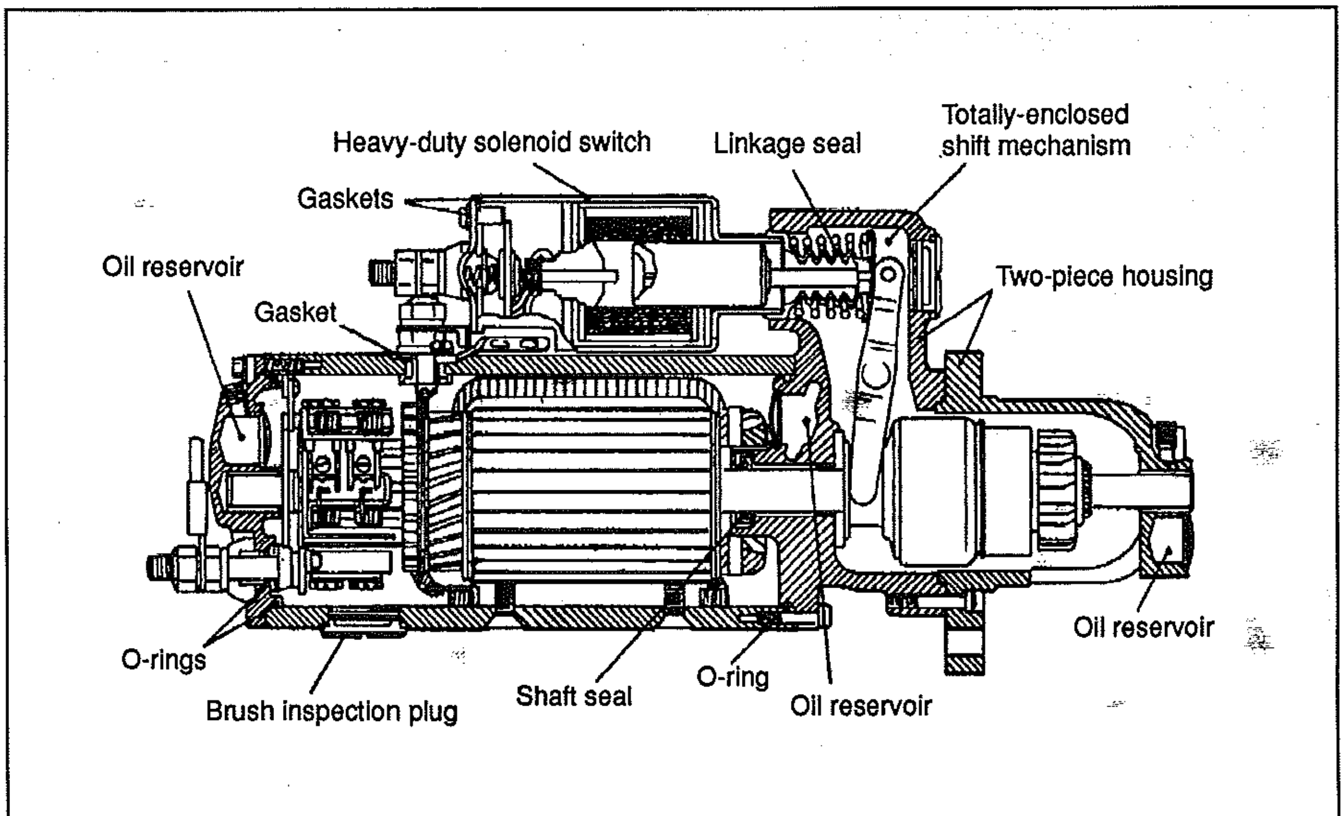


Fig. 38 - Starting motor construction

No-load test

Before disassembling the starting motor, the following check of starting motor operation should be made to determine condition which may require special attention during overhaul. Make test connections at the starting motor as follows:

Connect the starting motor in series with fully charged batteries to give 24 volts, an ammeter capable of reading several hundred amperes, and a variable resistance. Connect also a voltmeter as illustrated in figure 39 from the solenoid motor (M) terminal to the startor frame. A rpm indicator is necessary to measure armature speed. Proper voltage can be obtained by varying the resistance unit.

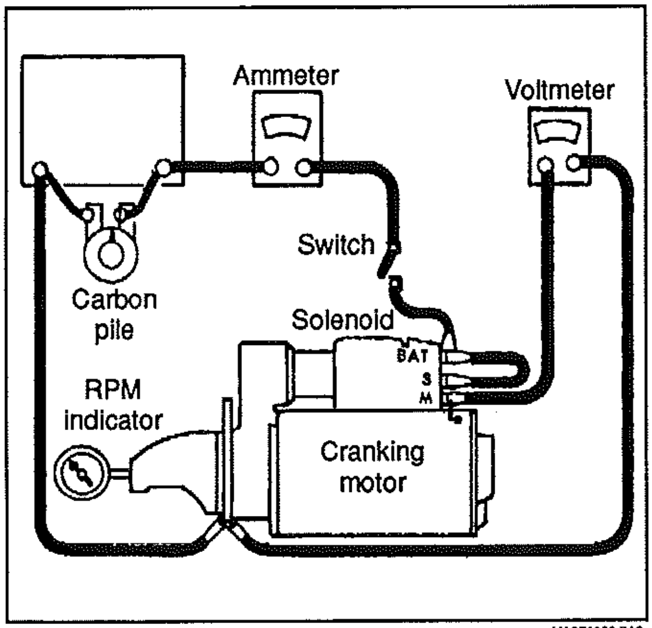


Fig. 39 - No-load test circuit MA3E0639.IMG

No-load test results

1. Rated current draw and no-load speed indicate normal condition of the starting motor.

2. Low free-speed and high current draw indicate the following:

a) Excessive friction; tight, dirty, or worn bearings, bent armature shaft, or loose pole shoes allowing the armature to drag.

b) Shorted armature. This can be further checked on a growler after disassembly of the starting motor.

c) Grounded armature or fields. Check further after disassembly.

3. Failure of the starting motor to operate with high current draw indicates the following:

a) A direct ground in the terminal or fields.

b) *"Frozen"* bearings. This should have been determined by turning the armature by hand.

4. Failure to operate with no current draw indicates:

a) Open field circuit. This can be checked after starting motor disassembly by inspecting internal connections and tracing circuit with a test lamp.

b) Open armature coils. Inspect the commutator for badly burned bars after disassembly.

c) Broken brush springs, worn brushes, high insulation between the commutator bars or other causes which would prevent good contact between the brushes and commutator.

5. Low no-load speed and low current draw indicate high internal resistance due to poor connections, defective leads, dirty commutator and causes listed previously in step 4.

6. High free-speed and high current draw indicate shorted fields. If shorted fields are suspected, replace the field coil assembly and check for improved performance.

Lock-torque test

A variable resistance with a high current capacity should be used. The starting motor should be **securely** mounted and a brake arm hooked to the drive pinion. When specified current is applied, the torque can be computed from the reading on the scale. A one foot brake arm will directly indicate foot-pounds.

WARNING: This test requires extreme caution. Follow instructions carefully.

Disassembly

Normally, the starting motor should be disassembled only so far as is necessary to make repair or replacement of the defective parts. As a precaution, it is suggested that safety glasses be worn when disassembling or assembling the cranking motor.

1. Note the relative position of the solenoid, lever housing, and nose housing so the motor can be reassembled in the same manner.

2. Disconnect field coil from solenoid motor terminal, and lead from solenoid ground terminal.

3. On motors with brush inspection plugs, remove the plugs and then remove the brush lead screws. This will disconnect the field leads from the brush holders.

4. Remove the attaching bolts and separate the commutator end frame from field frame.

5. Separate the nose housing and field frame from lever housing by removing attaching bolts.

6. Remove armature and clutch assembly from lever housing.

7. Separate solenoid from lever housing by pulling apart.

Cleaning

The driving mechanism armature and fields should not be cleaned in any degreasing tank, or with grease dissolving solvents, since these would dissolve the lubricants in the drive mechanism and damage the insulation in the armature and field coils. All parts, except the drive, should be cleaned with mineral spirits and a brush. The drive can be wiped with a clean cloth.

If the commutator is dirty, it may be cleaned with No. 00 sandpaper.

CAUTION: Never use emery cloth to clean commutator.

Armature servicing

If the armature commutator is worn, dirty, out of round, or has high insulation, the armature should be put in a lathe so the commutator can be turned down. The insulation should then be cut 1/32" (0,79 mm) wide and 1/32" (0,79 mm) deep, and the slots cleaned out to remove any trace of dirt or copper dust. As a final step in this procedure, the commutators should be sanded lightly with No. 00 sandpaper to remove any burrs left as a result of the undercutting procedures.

The armature should be checked for opens, short circuits and grounds as follows:

Opens circuit test

Opens are usually caused by excessively long starting periods. The most likely place for an open to occur is at the commutator riser bars. Inspect the points where the conductors are joined to the commutator bars for loose connections. The poor connections cause arcing and burning of the commutator bars as the starting motor is used. If the bars are not too badly burned, repair can often be performed by resoldering the leads in the riser bars (using rosin flux), and turning down the commutator in a lathe to remove the burned material. The insulation should then be undercut.

CAUTION: Do not undercut the insulation between the commutator segments after turning down the commutator.

Short circuit test

Short circuits in the armature are located by means of a growler. When the armature is revolved in the growler with a steel strip such as a hacksaw blade held above it, the blade will vibrate above the area of the armature core in which the short circuit is located. Shorts between bars are sometimes produced by brush dust or copper between the bars. These shorts can be eliminated by cleaning out the slots.

Ground test

Grounds in the armature can be detected by the use of a 110 volt test lamp and test points. If the lamp lights when one test point is placed on the commutator with the other point on the core or shaft, the armature is grounded. Grounds occur as a result of insulation failure, which is often brought about by overheating of the starting motor produced by excessively long starting periods, or by accumulation of brush dust between the commutator bars and the steel commutator ring.

Field coil checks

The field coils may be checked for grounds and opens by using a test lamp.

Grounds

If the motor has one or more coils normally connected to ground, the ground connections must be disconnected during this check. Connect one lead of the 110 volt test lamp to the field frame and the other lead to the field connector. If the lamp lights, at least one field coil is grounded, and it must be repaired or replaced.

Opens

Connect test lamp leads to ends of field coils. If lamp does not light, the field coils are open.

Field coil removal

Field coils can be removed from the field frame assembly by using a pole shoe screwdriver. A pole shoe spreader should also be used to prevent distortion of the field frame. Careful installation of the field coils is necessary to prevent shorting or grounding of the field coils as the pole shoe is tightened into place. Where the pole shoe has a long lip on one side and a short lip on the other, the long lip should be assembled in the direction of armature rotation so it becomes the trailing (not leading) edge of the pole shoe.

Reassembly

The reassembly is the reverse of disassembly.

To reassemble the end frame with brushes onto the field frame, pull the armature out of the field frame just far enough to permit the brushes to be placed over the commutator. Then push the commutator end frame and the armature back against the field frame.

The recommended torque for the cross-slotted pole shoe screws is 25-35 ft•lbs (34-47 N•m).

Lubrication

All wicks and oil reservoirs should be saturated with SAE 10 oil. The splines underneath the drive (on the shaft) should be wiped clean but not oiled. Oil in this area may cause failure to engage at very cold temperatures.

Pinion clearance

Pinion clearance should be checked after reassembly of motor to ensure the clearance is within specifications. To check pinion clearance (starting motor off engine), first disconnect the motor field connector from the solenoid motor terminal. Connect 24 volt battery with the positive battery lead to the solenoid switch terminal (5), and the negative battery lead to the grounded (G) solenoid terminal. Momentarily flash a jumper lead from the solenoid motor terminal to the grounded (G) solenoid terminal. The pinion gear will now shift into cranking position and remain so until the battery is disconnected. Push the pinion or drive back towards the commutator end to eliminate slack movement. Measure the distance between pinion and pinion stop. This should be 23/64" ± 1/32" (9,5 mm ± 0,79 mm). Pinion clearance is adjusted to these limits by turning the solenoid shaft nut after removing access plug in shift housing. See figure 40.

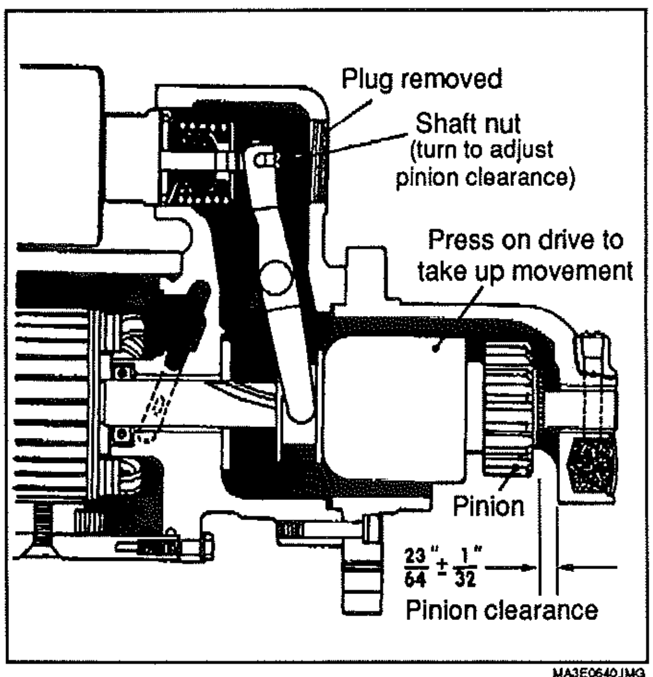


Fig. 40

Starter solenoid

Description

The starting motor solenoid shifts the starting motor pinion into mesh with the flywheel ring gear and also closes the electric circuit to energize the starting motor.

There are two windings in the solenoid: a pull-in winding and a hold-in winding. Both windings are energized when the external control switch is closed. They produce a magnetic field which pulls the plunger in so that the drive pinion is shifted into mesh, and the main contacts in the solenoid switch are closed to connect the battery directly to the starting motor. Closing of the main switch contacts shorts out the pull-in winding since this winding is connected accross the main contacts. The magnetism produced by the hold-in winding is sufficient to hold the plunger in, and shorting out the pull-in winding reduces drain on the battery. When the control switch is opened momentarily, the pull-in winding and the hold-in winding are connected in series between the battery and common ground.

The polarity of the pull-in winding is reversed and opposes the magnetic pull of the hold-in winding. All magnetic holding force on the solenoid plunger is thus cancelled. The return spring then quickly pulls the solenoid plunger back, opening the solenoid switch contacts and at the same time withdrawing the pinion gear from the meshing position. Proper operation of the switch depends on maintaining a definite balance between the magnetic strength of the pull-in and hold-in windings.

This balance is established in the design by the size of wire and the number of turns specified. An open circuit in the hold-in winding or attempts to start with a discharged battery may cause the switch to chatter.

Disassembly

To disassemble the solenoid, remove nuts, washers, and insulators from the switch terminal and battery terminal. Unscrew cover screws and remove cover. Take out the contact disk assembly.

Solenoid maintenance

The solenoid requires no periodic maintenance other than keeping the terminals clean and tight. Always check action of the solenoid if it has been removed. If the unit fails to function, first check wiring before condemning the solenoid. Solenoid windings can be checked for current draw, open circuit, or shorts.

Solenoid tests

Two tests must be made to determine the current draw of (1) both windings in parallel and (2) the hold-in winding alone. The solenoid windings can be tested with the solenoid either off or on the starting motor. However, when the solenoid is checked on the starting motor, it is necessary to disconnect both leads at the main solenoid terminals to prevent interference. The main solenoid terminal which is normally connected to the starting motor must then be grounded to the solenoid base by means of a jumper lead. For the first test, connect a source of variable voltage (battery and a variable resistance) in series with an ammeter between the solenoid base and the solenoid small switch terminal. Connect a voltmeter between the same two points. Slowly increase voltage and note the current draw. This should be 55-63 amps at 24 volts. Disconnect the jumper lead grounding the main solenoid terminal and readjust the variable resistance to obtain the specified voltage of 24 volts. This should not exceed 6.8 amperes.

When the solenoid has been removed from the starting motor for repair or replacement, the linkage must be adjusted to provide the correct pinion clearance when the solenoid is remounted on the starting motor. See *"Starting motor"* earlier in this section for correct pinion clearance adjustment.

Recommendations

1. Tag each lead to ensure correct connections when the starting motor is reinstalled.

2. Tighten the 5/8"-11 starter attachment bolts to a torque of 137-147 ft•lbs (186-200 N•m).

3. Keep all the electrical connections clean and tight.

4. When installing wiring terminal leads to the starting motor and the solenoid switch, torque the No. 10-32 connections to 16-30 in•lbs (2-3 N•m), and the 1/2"-13 connections to 20-25 ft•lbs (27-34 N•m).

ENGINE BLOCK HEATER

An engine *"immersion-type"* block heater is installed as standard equipment. It consists of a 115 volt, 1500 watt, single loop element type, fitted on front extremity of R.H. cylinder head (view facing the crankshaft pulley). It is plugged into a socket on the engine, but is operated by a switch located in front service compartment. Furthermore, this socket can be used as a 110 volt supply to connect an extension light when working in engine compartment.

Maintenance

This heater is non-serviceable except for the cord, and if faulty, must be replaced as a unit.

LIGHTING SYSTEM

Circuits for interior and exterior lights as well as their control switches, relays and circuit breakers are shown on the applicable wiring diagrams (pages 5 to 7 for exterior lighting and pages 9 to 12 for interior lighting) annexed at the end of this section.

EXTERIOR LIGHTING EQUIPMENT

Headlights

Each headlight assembly consists of two 12 volt halogen rectangular sealed-beam units. Outer lamps are double-filament units, having high and low beams. Inner lamps have single-filament and operate with high beam of outer units. For identification purposes, outer units are molded with "2A" and inner units are molded with "1A" in top of the lens.

Headlight dimmer switch

The multifunction lever located on the steering column is used to select proper lighting. High beams or low beams can be selected by respectively pushing the lever towards the dashboard or pulling it towards the driver. A high beam indicator on the central dashboard panel is illuminated when the high beam circuit is energized.

NOTE: High beams can be flashed momentarily by pulling the lever completely towards the driver and then releasing it.

Maintenance

Clean with soap and water and a good glass cleaner whenever dirty. For maximum illumination, headlight connections must be coated with a dielectric grease to prevent oxidation and proper voltage must be maintained. Low battery voltage, loose or dirty contacts in wiring system and poor ground contribute to a decrease in voltage. Check wiring and connections regularly and keep battery properly charged. When a headlight burns out, a new sealed-beam unit must be installed.

Headlights must be properly aimed to provide maximum allowable road illumination. When using mechanical aimers, follow manufacturer's instructions.

Headlight aim should be checked after installing a new sealed-beam unit. Aiming can be performed without removing headlight bezels. Horizontal and vertical aiming of each sealed-beam unit is provided by two adjusting screws which move the mounting ring in the body against the tension of the coil spring (see figure 41). There is no adjustment for focus since the sealed-beam unit is set for proper focus during manufacturing assembly.

Headlight adjustment

The following is a general procedure for headlight adjustment using a mechanical equipment, such as a *"Bear 47-132 headlight aligner"*. If your mechanical equipment is different, refer to the manufacturer's instruction manual.

Setting aligner according to slope

The floor level offset dial must match with slope to ensure a precise alignment.

1. Park vehicle on a level floor.
2. Fix one (1) calibration fixture to each aligner.
3. Install aligner in center of each wheel on one side of vehicle. Unit B must be installed besides the front axle wheel with its viewing port facing rearward, and unit A besides the drive axle wheel with its viewing port facing forward. See figure 42 for more details.

NOTE: Check that the three indicators on each module are set to the zero point.

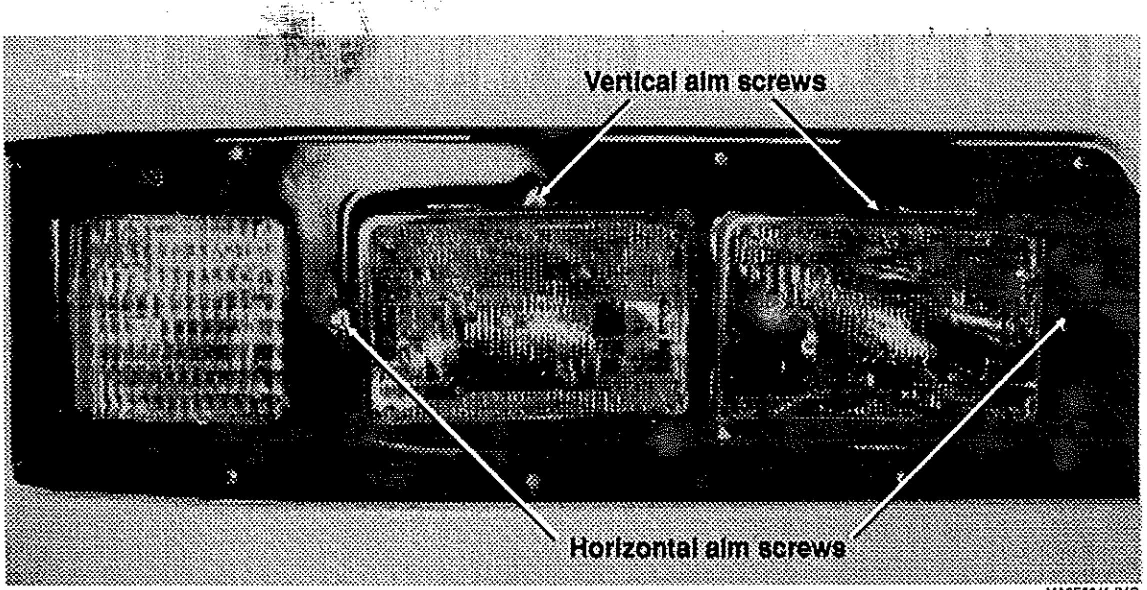


Fig. 41 - Headlight assemblies

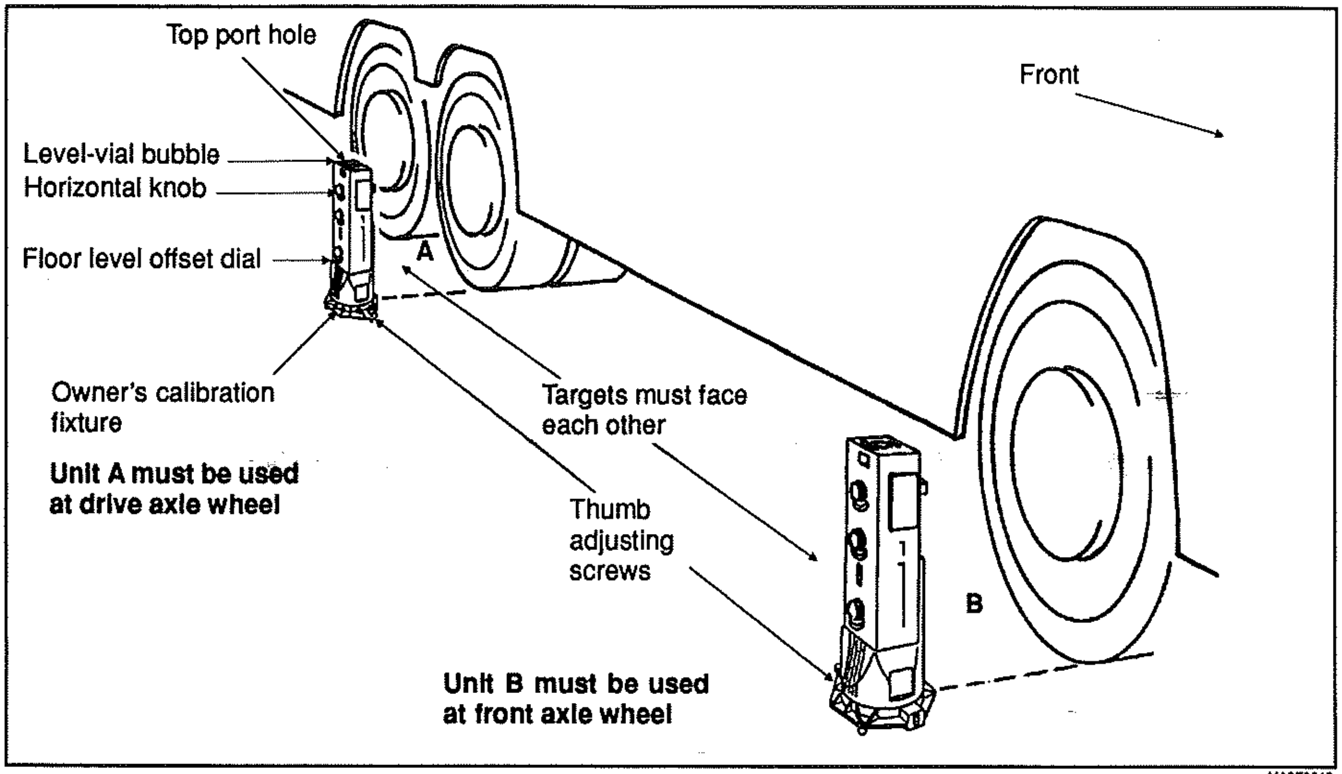


Fig. 42

4. Level each unit by means of the thumb adjusting screw on the fixture until level-vial bubble is centered.

5. Look through the top port hole of unit A, and turn horizontal knob until split images are aligned. See figure 43.

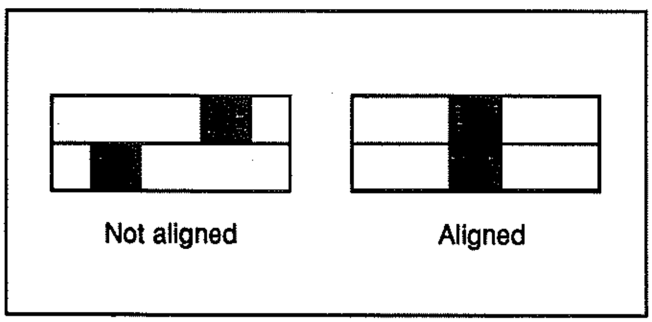


Fig. 43

6. Set according to floor slope. Transfer positive (+) or negative (-) reading of horizontal dial to the floor level offset dial to offset floor slope on each aligner (see fig. 44). Push on the floor level offset dial to register reading.

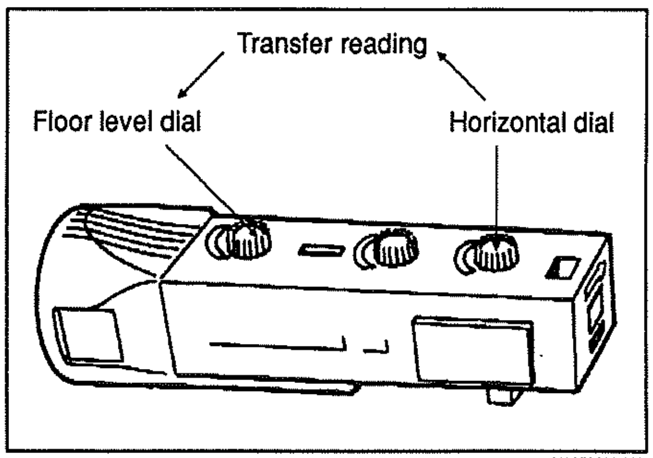


Fig. 44

7. Remove calibration fixture from each unit.

NOTE: If vehicle remains stationary during the headlight alignment procedure, avoid checking floor slope each time.

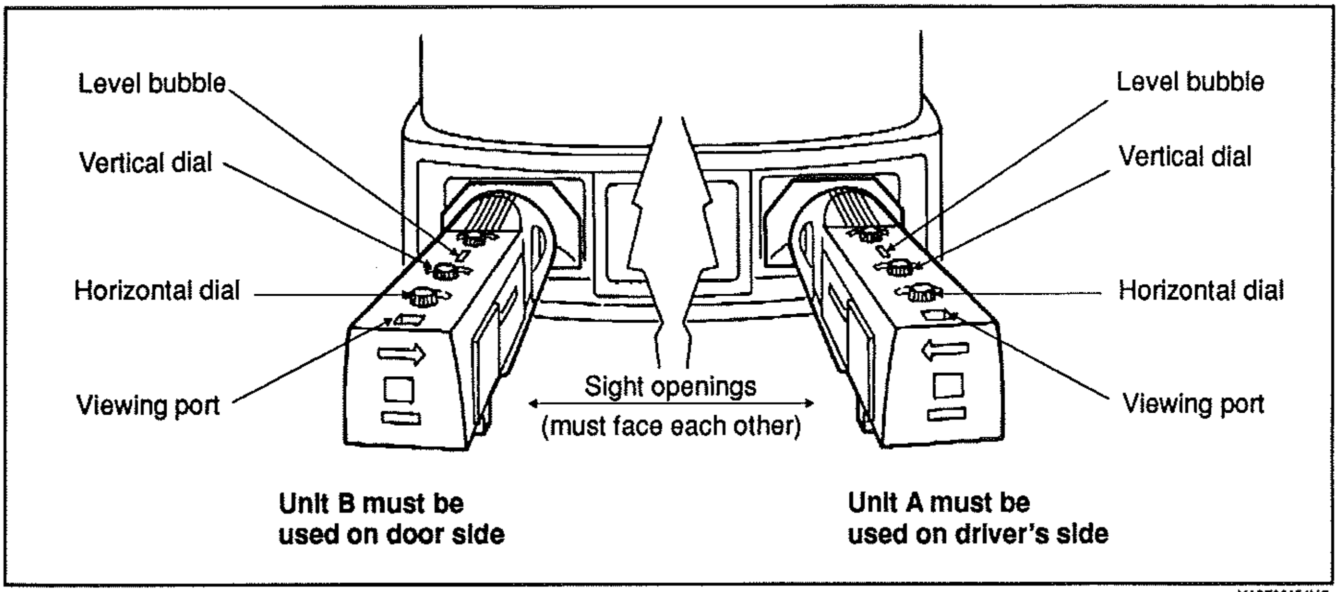


Fig. 45

Headlight alignment

The aligner is provided with adaptors for different sizes of headlights which are always aligned in pairs.

1. Fix the adequate adaptor on each headlight.

NOTE: The adaptors are equipped with steel inserts, thus providing a good seating for a precise headlight adjustment.

2. Install aligners on headlights (unit A on driver's side and unit B on other side with the sight openings facing each other), by pushing the handle forward to secure rubber suction disc, then pull handle until it locks. Refer to figure 45.

NOTE: Ensure that floor level offset dial is set adequately before aiming headlights.

Horizontal alignment

1. Reset horizontal dial to zero.

2. Check that split image is visible in the viewing port. If not, replace aligner by turning it.

3. Turn the horizontal aim adjusting screw of each headlight until split image is aligned (see fig. 46).

Vertical alignment

1. Reset vertical dial to zero.

2. Turn the adjusting screw of the headlight vertical aim until bubble is centered (see fig. 46). Repeat operation on other headlight.

3. Recheck the horizontal alignment.

Remove aligners by pressing on vacuum release button.

Repeat the same procedure for the high beams.

If mechanical equipment is not available, perform adjustments as described below:

1. Park vehicle on level floor so headlights are 25 feet (7,6 m) from a smooth surface preferably of light color. A door or wall is suitable. Center line of vehicle should be perpendicular to this vertical surface.

2. Draw a horizontal line on vertical surface at height of light center. Locate point on this horizontal line at which projected centerline of vehicle intersects. Measure distance between light centers and divide this distance equally on either side of center mark. Then draw two vertical lines directly ahead of each light center.

3. Switch on high beams and cover one headlight while adjusting other.

4. When aiming headlights, beam may appear distorted. A new sealed-beam unit must be installed to correct this condition.

5. After headlight is properly aligned, cover it and proceed in the same manner as above with opposite headlight.

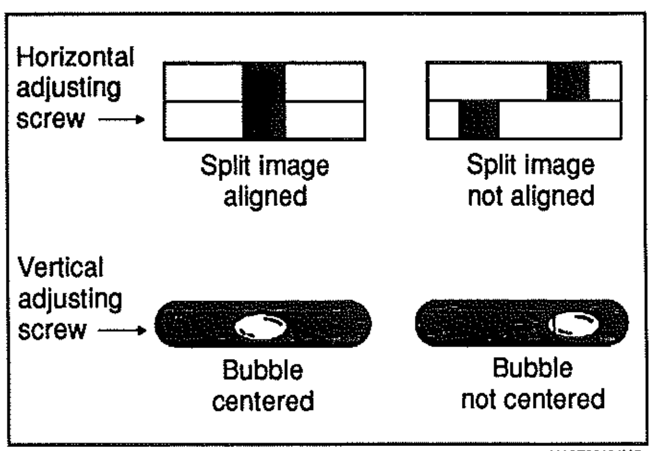


Fig. 46

Sealed-beam unit replacement

Removal

1. Remove screws attaching headlight bezel to front panel (12 *"Phillips"* screws) and remove bezel.
2. Remove four mounting screws attaching sealed-beam unit retaining ring to mounting ring.

NOTE: Do not disturb headlight adjusting screws.

3. Remove sealed-beam unit and pull wiring connector off back of unit.

Replacement

1. Install wiring connector on back of sealed-beam unit. Position unit in mounting ring with molded lens number at top.

NOTE: Sealed-beam units with number "1A" molded in top of the lens must be used at inside light positions. Units identified by number "2A" molded in top of the lens must be used at outside light positions.

2. Position the retaining ring over the lens and secure it to the mounting ring with four screws.

NOTE: The headlight aim must be checked and adjusted even if it was properly adjusted before the sealed-beam unit was replaced, and adjusting screws were not removed.

3. After installing and adjusting the headlight assembly, install the headlight bezel.

Front turn signal

The front turn signal is a part of the front headlight cluster. The turn signal lens is located on each front corner and shares a common bezel with the headlights. Turn signal is visible from both front and side.

Bulb removal and replacement

1. Remove the twelve *"Phillips"* screws attaching the headlight bezel, then remove it.
2. Remove socket from headlight bezel.
3. Remove the bulb by pushing and rotating it out of the socket.
4. Replace the new bulb by reversing sequence of the previous step.

Stop, tail, directional, back-up, and hazard warning lights

A combination stoplight, taillight, directional signal light and back-up light assembly is mounted on each side at rear of vehicle. Furthermore, when braking, a center stoplight will illuminate simultaneously with the stoplights for increased safety.

The stop, tail, directional signal and back-up lights consist of individual bulbs mounted in a common housing, and each light is serviced individually as a complete unit and need only to be plugged into or unplugged from socket after removing proper light lens.

The hazard warning flashing system uses simultaneously the front, side, and rear directional lights. This system is energized by a switch on the L.H. dashboard.

Bulb removal and replacement

1. Unscrew the retaining lens screws (2), then remove the lens.
2. Remove the bulb by pushing and then rotating it counterclockwise out of the socket.
3. Place the new bulb by pushing and rotating it clockwise, then replace the lens; the *"Hella"* inscription molded on the lens must be located upwards.

NOTE: Taillights are provided with a different candle power bulb. Be sure to replace defective bulb by the appropriate one.

License plate light

Two sealed units are mounted above the rear license plate(s) of vehicle. In case of burn out, the sealed unit must be changed according to the following procedure.

1. Pry out the rubber seal with a little screwdriver, then pull on the sealed unit and disconnect it.
2. Reconnect new sealed unit, place rubber seal, and press on it until it is seated in its former position.

Clearance, identification and marker lights

This vehicle is equipped with marker, identification and clearance lights. The clearance lights are mounted at each corner of the coach near the top and the identification lights in upper center of rear and front sections. They are red at the rear and yellow at the front.

The yellow marker lights are mounted along the sides of vehicle.

Marker light bulb removal and replacement

The marker light bulbs can be replaced as per the following procedure:

1. Unscrew both *"Phillips"* lens screws, then remove the lens.
2. Push and rotate the bulb counterclockwise in order to remove it from its socket.
3. Push new bulb into the socket, then rotate clockwise.
4. Position lens on housing, then place and screw the *"Phillips"* screws.

Clearance and identification light bulb removal and replacement

The clearance and identification light bulb can be replaced as per the following procedure:

1. Unscrew both *"Phillips"* lens screws, then remove the lens.
2. Pull the bulb straight out to remove it from its socket. Do not try to turn the bulb to remove it.
3. Place the new bulb by pushing it in socket.
4. Position lens on housing, then place and screw the *"Phillips"* screws.

Cornering lights

This vehicle is provided with two halogen headlights that serve as cornering lights. They are mounted on the vehicle as follows: One is mounted on the front L.H. side service compartment door, while the other is located between the front wheel and the entrance door on the R.H. side. The main function of these lights is to increase lateral visibility when turning a corner. These lights are energized simultaneously with the directional lights. On the V.I.P. model, a dashboard-mounted rocker switch may be actuated to cancel this system in special situations.

Docking lights

Two additional halogen headlights may have been installed over the rear wheelhouses. These lights are used as docking lights and both will illuminate automatically when reverse range is selected to facilitate back-up or docking procedure.

On the V.I.P. model, these lights are not operated automatically when the reverse range is selected, but by means of a dashboard-mounted rocker switch. When actuated, the docking as well as the cornering lights illuminate. Furthermore, a *"Low docking"* switch, also located on dashboard, allows the use of the docking and cornering lights at a lesser intensity when the docking switch is actuated.

Bulb removal and replacement

Both docking and cornering headlights can be changed according to the following procedure:

1. Unscrew the two *"Phillips"* screws of the retaining ring.
2. Disconnect the light unit connection.
3. Press on each tab of retaining clip, bring both tabs together, then lift the retaining clip.
4. Remove the bulb.
5. Position new bulb, place the retaining clip, then bring both tabs together; when the retaining clip is in position, release the tabs.

CAUTION: During this step, avoid contacting the bulb with your fingers, otherwise this could alter the bulb life.

6. Connect and then position the light unit.
7. Finally, place and screw the retaining ring.

Fog lights

Optional halogen fog lights can be mounted on this vehicle to allow the driver a better visibility in foggy weather, or to improve the range of vision just ahead of the coach.

Bulb removal and replacement

1. Remove the protector cap on light unit (if so equipped), then unscrew the light unit retainer screw and slide upward the retainer.
2. Remove the light unit, then disconnect the light unit connection.
3. Move the tabs of retaining clip out of its notches, then lift the retaining clip and remove the bulb.
4. Place the new bulb, then replace the retaining tab of clip to its position into the notches.
5. Reconnect the light unit connection, then place the light unit to its proper position.
6. Replace the retainer and screw it.
7. Replace the light unit cover (if so equipped).

INTERIOR LIGHTING EQUIPMENT

The instrument gauges and switches mounted on all control panels are energized whenever the exterior light switch is pushed to the first position. A control dimmer at the extremity of the L.H. side control panel is used to vary the brigthness of the panel gauges, switches and indicator lights.

The gauge lights, panel lights, switch lights and indicator lights have a different bulb arrangement. Thus, the procedure to change a defective bulb can vary according to the application.

Switch bulb replacement

1. Pull slightly the switch with a defective bulb away from the control panel.
2. Using a little screwdriver, press the tab on top of the switch housing, then pull the switch away from the control panel.
3. Use the same screwdriver and press on the light bulb housing tab in order to remove it from the switch.
4. The light bulb may be removed by pulling it away.
5. Push the new bulb into the socket to install it.
6. Place the light socket and push to its former position.
7. Replace the switch on control panel.

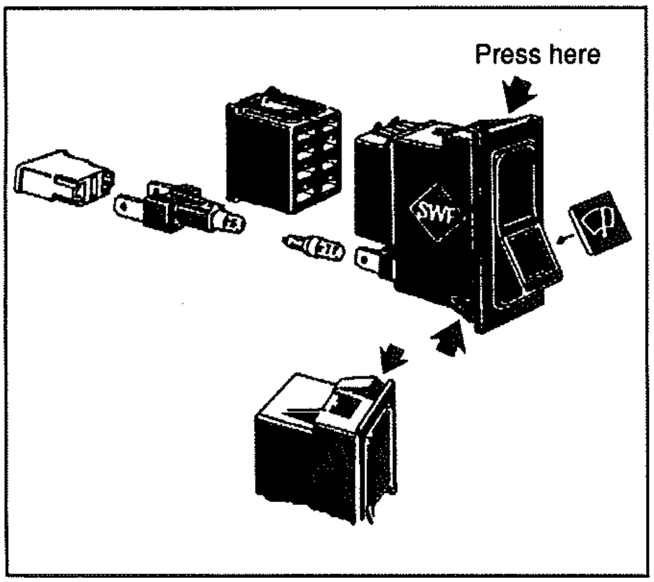


Fig. 47 - Panel switch MA3E0647.IMG

Indicator light bulb replacement

1. Remove the indicator light symbol cover.
2. Depending on the kind of socket, either of the following methods in this step should be used. With a ballpoint pen cap or manually, push the bulb into the socket, then twist off the bulb as it pulls out of the housing or pull lightly on the miniature bulb.
3. Place a new bulb, only push on for miniature bulb, or push on and twist it counterclockwise with a ballpoint pen cap or manually according to the socket design.
4. Replace the symbol cover, then push on until it snaps.

NOTE: The bulbs of the *"Check engine"* and *"Stop engine"* warning lights as well as those for the flasher indicator lights are 12 volts instead of 24 volts as in the case of all other indicator/warning lights.

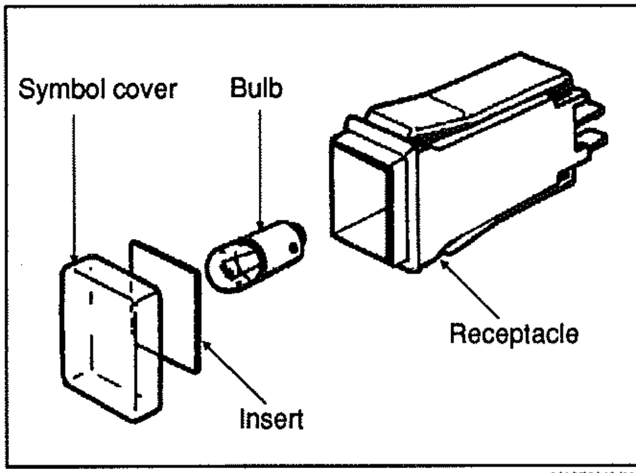
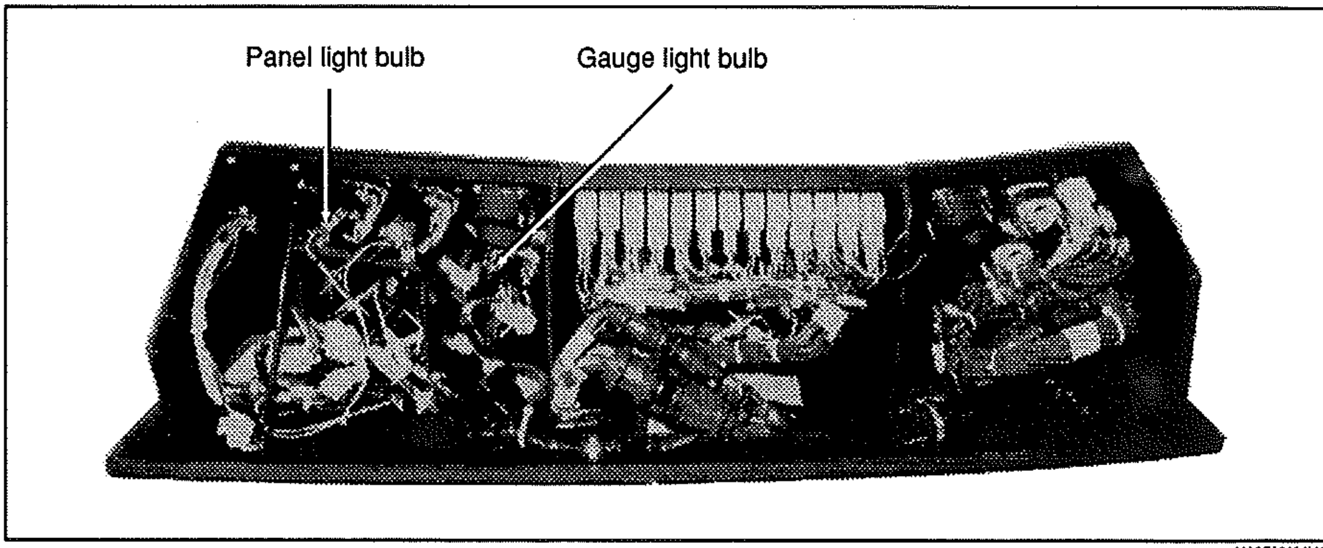


Fig. 48 - Indicator light MA3E0648.IMG

Gauge light bulb replacement

1. For any gauge light bulb replacement, the rear dashboard housing must be removed in order to have access to the rear of gauges.
2. Remove bulb socket from the gauge, turn the defective bulb counterclockwise and pull it out of the socket.
3. Push a new bulb into the socket and turn it clockwise to lock the bulb in place.
4. Replace bulb socket in gauge and replace the rear dashboard housing.



MA3E0649.IMG

Fig. 49 - Back of dashboard with rear housing removed

Panel light bulb replacement

Panel light bulbs are mounted under the dashboard panel in sockets and serve to illuminate control switches such as the heating and A/C switches.

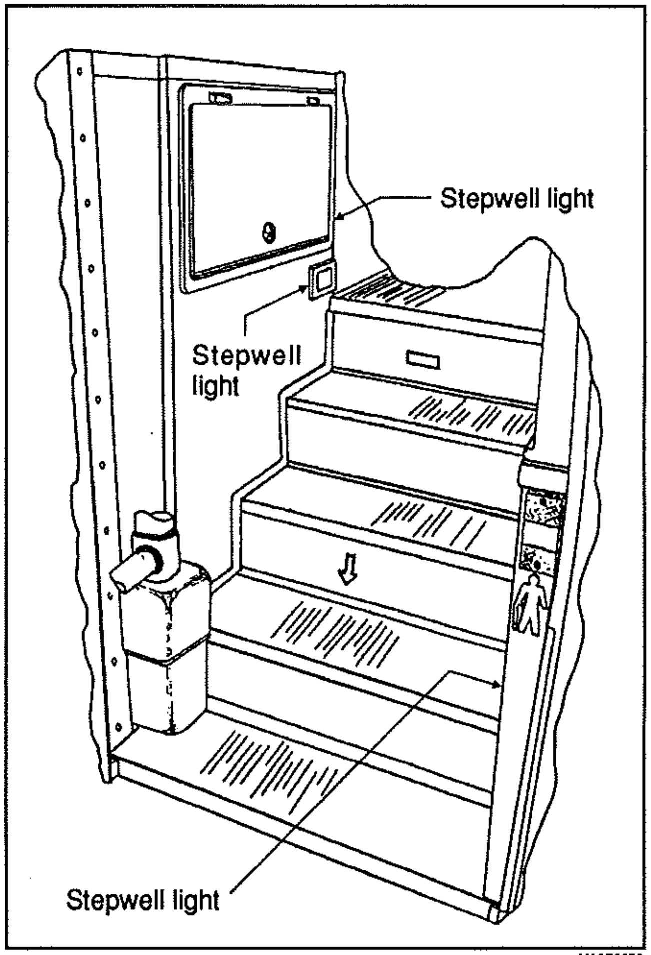
1. To replace a panel light bulb, the rear dashboard housing must be removed.
2. Push and turn the bulb counterclockwise, then pull it out of the socket.
3. Place the new bulb into the socket, then push and turn clockwise to lock in position.
4. Replace the rear dashboard housing.

Stepwell lights

Stepwell lights are illuminated when the door opening system is activated. The light bulbs are accessible after removal of the light lens which is held to the housing with two screws.

Bulb removal and replacement

1. With the light lens removed, push and turn the bulb counterclockwise, then pull it out of the socket.
2. Place the new bulb into the socket, then push and turn clockwise to lock in position.
3. Place the light lens and screw it in place.



MA3E0650

Fig. 50

Engine compartment lights

Six engine compartment lights controlled by a microswitch upon opening of the engine door, are provided in the engine compartment; two are of the circular type while the others are the same sealed unit type as used to illuminate the license plate.

Circular type

Each light is provided with two bulbs which can be replaced as follows:

1. Remove the retaining ring of lens by unscrewing the two screws.
2. Push and turn the defective bulb counterclockwise, then pull it out of the socket.
3. Place the new bulb into the socket, then push and turn clockwise to lock bulb in position.
4. Place the lens, then the retaining ring and screw it in place.

Sealed type

In case of burn out, the sealed unit must be changed according to the following procedure.

1. Pry out the sealed unit from its receptacle fixture by inserting a flat little screwdriver at one extremity, then pull on the sealed unit and disconnect it.
2. Reconnect new sealed unit, and press on it until it is seated in its former position.

Fluorescent lighting system

The interior of vehicle is lighted by two types of fluorescent tube lamps installed on parcel racks.

The aisle bulb lights are located on front of parcel racks, while fluorescent lights for general and in-station lighting are located under the parcel racks. A dual power system is available for this lighting either from the 24 volt vehicle power supply or from a 110 volt outlet supply. In order to save batteries during extended periods of in-station lighting, no current is drawn from the batteries as soon as the 110 volt circuit is connected.

Moreover, adjustable reading lamps are installed under parcel racks for passenger accomodation.

Removal and replacement of aisle fluorescent light

1. Remove the front lens by unscrewing the four *"Phillips"* side screws (two each side), then the lens.
2. Pull out the fluorescent from its base.
3. Place a new fluorescent and push on until the proper position is reached.
4. Replace front lens and screw it.

Removal and replacement of fluorescent light

1. Push on the screen lens of fluorescent in order to unsnap it.
2. Rotate and pull out the fluorescent tube from its socket.
3. Place the new fluorescent tube and rotate the tube to secure it in its socket.

Removal and replacement of reading lamp bulb

1. Slide lightly the reading lamp and pull in order to unsnap it.
2. Turn over the reading lamp and unscrew both screws of the retaining socket support.
3. Push and turn bulb counterclockwise, then pull it out of the socket.
4. Place new bulb into the socket, then push and turn clockwise to lock bulb in position.
5. Place retaining socket support and screw in place.
6. Position the reading lamp and press until it snaps.

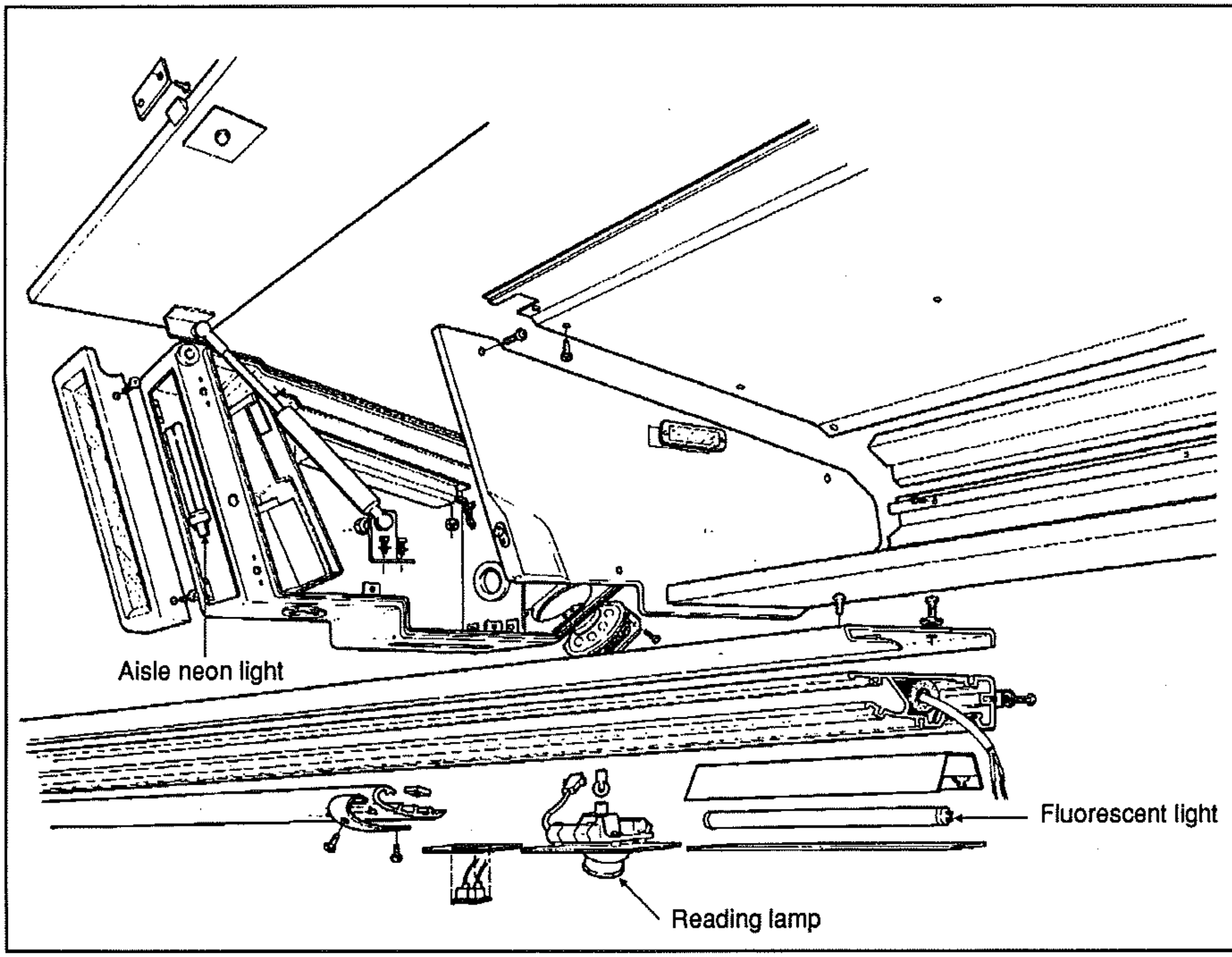


Fig. 51

Dome lights

Two dome lights (each provided with two bulbs) are installed over the stepwell and the driver in driver's compartment. These lights are frequently used for nighttime operation when passengers board or leave coach.

Bulb removal and replacement

1. Unsnap the lens and remove it.
2. Push and turn the defective bulb counterclockwise, then pull it out of the socket.
3. Place the new bulb, push and turn clockwise until it locks in position.
4. Replace the lens and snap it back in place.

Light bulb data

When replacing a light bulb, special attention must be paid to the voltage rating (refer to light bulb data hereafter).

NOTE: Note that all exterior lights are 12 volts and that all interior lighting are 24 volts, except for the *"Check engine"* and *"Stop engine"* warning lights and flasher indicator lights which are also on 12 volt system.

LIGHT BULB DATA

APPLICATION	PREVOST PART NO.	TRADE OR SAE NUMBER	WATTS OR CANDLE POWER	VOLTS	QTY
EXTERIOR LIGHTING					
Hi-beam	56-1198	H4651	50 W	12	2
Lo-beam	56-1199	H4656	35 W	12	2
Docking & cornering	56-1882	H3 (Osram)	55 W	12	4
Fog	56-1882	H3 (Osram)	55 W	12	2
License plate (sealed)	93-0266	---	---	12	2
Side directional	56-1917	1893	2 cp	12	12
Side marker	56-1917	1893	2 cp	12	12
Identification	56-2059	194	2 cp	12	6
Clearance	56-2059	194	2 cp	12	8
Front directional (hazard & marker)	56-1899	1157 NA	32/6 cp	12	2
Rear directional	56-1880	Hella	21 W	12	4
Stop	56-1880	Hella	21 W	12	4
Back-up	56-1880	Hella	21 W	12	4
Center stop	56-1880	Hella	21 W	12	1
Tail	56-1881	Hella	10 W	12	4
Kneeling indicator	56-1166	464	3 cp	24	1
Exterior compartment (except engine)	56-0135	623	6 cp	24	34
Engine compartment	56-0135 93-0266	623 ---	6 cp ---	24 12	4 4
INTERIOR LIGHTING					
Check engine	56-2048	E-9 (Norma)	2 W	12	1
Stop engine	56-2048	E-9 (Norma)	2 W	12	1
Flasher indicator	56-2048	E-9 (Norma)	2 W	12	2
Other indicator - 1/unit	56-2049	(Osram)	2 W	24	AR
Speedometer	56-0145	1829	1 cp	24	2
Tachometer	56-0145	1829	1 cp	24	2
Turbo boost	56-1167	3899 (Osram)	3 W	24	1
Tachographe	56-1006	1-405-804	1.2 cp	24	3
Other instrument - 1/unit	56-0144	1820	1.6 cp	24	AR
Step	56-0135	623	6 cp	24	3
Lavatory	56-0135	623	6 cp	24	1
Parcel rack	56-0144	1820	1.6 cp	24	15
Driver's area	56-1553	Hella	10 W	24	4
"Emergency exit" decal	56-0601	456	2 cp	24	20
"Lavatory occupied"	56-0144	1820	1.6 cp	24	2
"Watch your step"	56-0144	1820	1.6 cp	24	2
Aisle	56-0141	1251	3 cp	24	6
Switch - 1/unit	56-1123	2741 (Osram)	1 W	24	AR
Reading	56-2033	961-4940	8 W	24	48
Fluorescent	83-0102	F15T8 CW	15 W	---	22
Lavatory fluorescent	83-0102	F15T8 CW	15 W	---	2
Destination sign fluorescent	83-0080	F30T8 CW4	20 W	---	1
Parcel rack front neon	83-0108	PL7	7 W	---	16
R.H. lateral console	56-0623	313	3.5 cp	24	2
Shift selector (ATEC)	56-1930	16005999	---	12	8
Shift selector (NON ATEC)	56-0134	356	3.5 cp	24	1

SPECIFICATIONS

BATTERY

Make . . . . Delco-Remy
Model 1150
Type . . . . Maintenance-free
Terminal type . . . . Top Stud
Group size 31
Volts 12
Load test amperage* 290
Reserve capacity (minutes) 180
Cold cranking (in amps)
- At 0 °F (-18 °C) . . . . 625 (each battery)
- At -20 °F (-29 °C) . . . . 490 (each battery)
Maximum dimensions (inches/mm)
- Length (including flange) 13.0/330,2
- Width 6.8/172,7
- Height (including top posts) 9.4/238,8
- Approximate weight (lbs/kg) 60/27,2

* *Battery tester cable clamps should be between terminal nuts and lead pads of terminals. If not possible, load value should be 210 amperes.*

TORQUE SPECIFICATIONS

Battery cable to post . . . . 10-15 ft•lbs (13-20 N•m)
Battery cover . . . . 45-50 in•lbs (5-6 N•m)

ELECTRICAL SYSTEM MONITOR

Make . . . . Vanner
Model EM-70
Input . . . . 24 V dc
System high . . . . greater than 30 V dc
System low . . . . less than 24 V dc
Trip level . . . . ± 0.75 V dc
Prevost number 56-2058

ALTERNATOR

Make . . . . Delco-Remy
Model Number 1117702
Series . . . . 50 DN
Type 600
Field current at 80 °F (27 °C)
- Amperes . . . . 7.2 - 8.0
- Volts 24
Hot output
- Amperes . . . . 270 at 80 °F (27 °C) ambient
- Volts 28
- Approximate rpm 3000
Ground . . . . Negative
Prevost Number 56-1723

REGULATOR

Make . . . . Delco-Remy
Model Number 1118447
Type . . . . Transistor
Voltage adjustment . . . . External screw
Prevost Number 56-0030

BATTERY EQUALIZER

Make . . . . Vanner
Model 60-50A
Amperes . . . . 50 amps
Prevost Number 56-1016

STARTING MOTOR

Make . . . . Delco-Remy
Model Number 1990269
Series . . . . 50 MT
Type 400
Rotation (viewing drive end) . . . . .CW
Brush tension . . . . 5 lbs (2,2 kg) Min.
Voltage 24
No-load test
- Volts 23
- Min. current draw . . . . 60 amperes
- Max. current draw . . . . 90 amperes
- Min. rpm . . . . .7000 rpm

STARTING MOTOR SOLENOID

Make . . . . Delco-Remy

Model Number 1115557

Current Draw 80 °F (27 °C)

- Hold-in winding . . . . .7.35 - 8.2 amps

- Pull-in winding . . . . 48 - 54.5 amps

Volts 24

SERVICE BULLETINS AND SERVICE INFORMATION LETTERS

Service Bulletins and Service Information Letters will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of publications pertaining to this section should be noted below as soon as received. These should then be filed for future reference.

NUMBER	DATE	SUBJECT

07

TRANSMISSION

CONTENTS OF THIS SECTION

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DESCRIPTION

The H3-40 may be provided with either a manual or automatic transmission.

Manual Transmission

The Spicer 1362-B six-speed, twin-countershaft transmission has six forward speeds and one reverse speed. The twin-countershaft design splits the torque equally between the two shafts, thus providing a high torque capacity-to-weight ratio.

Automatic Transmission

The Allison HT-740 and HT-748 transmissions have four forward speeds and one reverse speed, whereas HT-754, HT-755 and HTB-755 transmissions have five forward speeds and one reverse speed, all capable of providing automatic upshifts and downshifts through their forward gear ratios.

An automatic lockup clutch provides maximum efficiency by a direct mechanical link through the transmission. This feature improves fuel economy by eliminating *"slippage"* or power loss in the torque converter.

The HT-748, HT-755 and HTB-755 models are provided with the Allison Transmission Electronic Control system (ATEC). The *"ATEC"* system consists mainly of the electronic control unit (ECU), throttle sensor, speed sensor, and shift selector. The throttle sensor, speed sensor, and shift selector transmit information to the *"ECU"*. The *"ECU"* processes this information and then send signals to actuate specific solenoids located on the control valve body in the transmission. The action of the solenoids affects hydraulic circuits which in turn control the upshifts, downshifts, and lockup functions. In addition to controlling the operation of the transmission, the *"ATEC"* monitors the system for abnormal conditions (refer to heading "Troubleshooting").

Output Retarder (if applicable)

The Allison HTB-755 transmission is equipped with an output retarder, which is a proven combination of hydrodynamic multidisk braking, providing effective braking force all the way down the speed range.

The retarder is mounted on the rear of the transmission, and transmits its braking force directly to the propeller shaft.

MAINTENANCE

Transmission Oil Level

The transmission oil level must be checked with the vehicle on a flat and level surface and with parking brake applied.

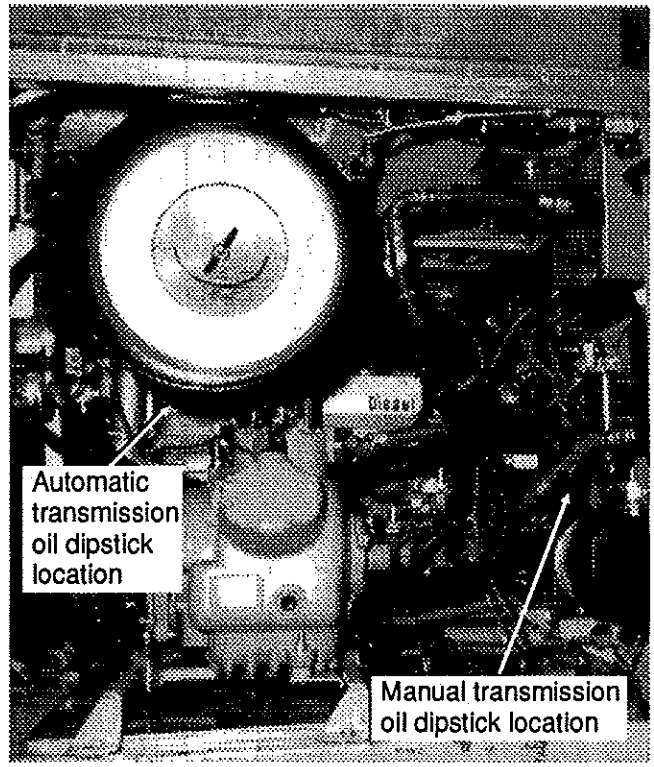


Fig. 1

Manual Transmission

Always check the transmission oil level when the engine is stopped and cold. To gain access to the dipstick, open the engine compartment R.H. side door. The dipstick is located beside the engine and transmission assembly, at the rear of engine (refer to fig. 1). Maintain level to the *"FULL"* mark on the dipstick with engine oil (refer to section 24 "Lubrication").

CAUTION: Clean end of tube before removing the dipstick to prevent oil contamination.

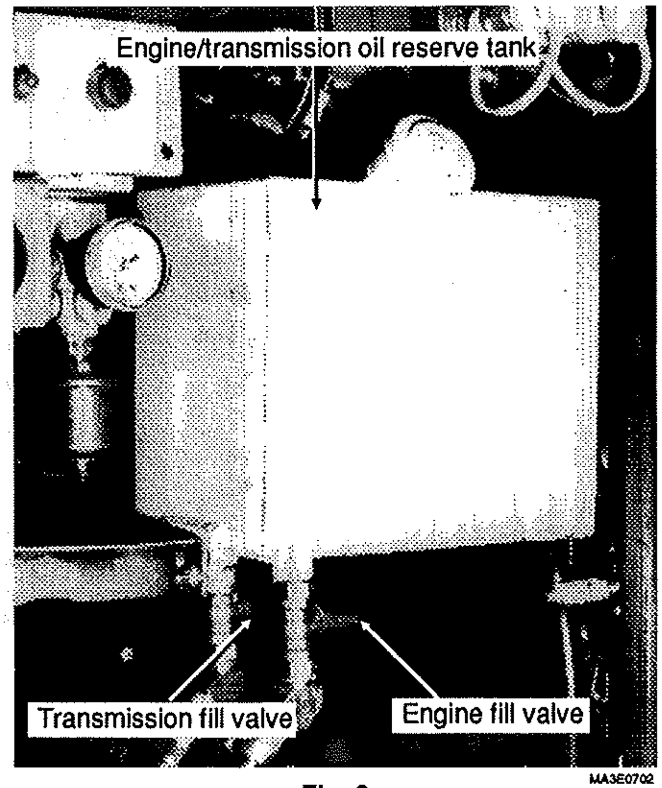


Fig. 2

The vehicle is provided with an oil reserve tank in engine compartment, which is used for both the engine and manual transmission. To adjust level, open the appropriate valve and allow oil to discharge into transmission until reaching the *"FULL"* mark on the dipstick, then close the valve. Check oil reserve tank level through the level sight tube on the side of tank.

CAUTION: Do not overfill transmission. Oil breakdown due to excessive heat and/or sludge deposits impairing proper operation of transmission may result.

Automatic Transmission

Operate engine at 1000 - 1200 rpm for approximately one minute to purge air from the hydraulic circuits. Allow engine to idle, then shift transmission lever to *"DRIVE"* and then *"REVERSE"* to fill clutch cavities and circuits. Shift to *"NEUTRAL"*, then check oil level.

To gain access to the dipstick, open the R.H. engine compartment rear door. The dipstick is located beside the engine (refer to fig. 1).

Two checks must be performed to ensure proper oil level in the transmission:

Cold Oil Check

A *"cold oil check"* is required to ensure that sufficient oil is present to operate transmission safely until the *"hot oil check"* can be made.

With transmission oil at 60 - 140 °F (16 - 60 °C), wipe the dipstick clean, then check oil level. The level should always be within the cold safe range on the dipstick. Correct level as required with *"Dexron II"* or *"Mercon"* automatic transmission fluid.

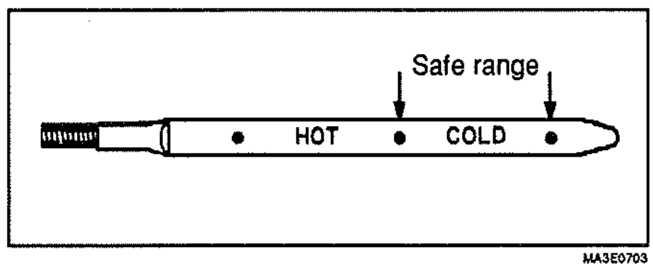


Fig. 3 - Cold oil check

CAUTION: The oil level rises as oil temperature increases. Do not fill above the cold safe range before the transmission reaches its normal operating temperature.

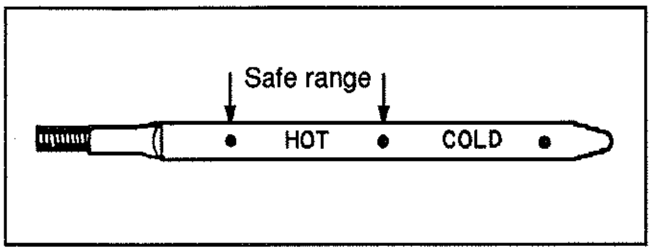
Hot Oil Check

A *"hot oil check"* is required to ensure proper operating level of transmission oil.

With transmission oil at 160 - 250 °F (70 - 120 °C), wipe the dipstick clean, then check oil level. The level should always be within the hot safe range on the dipstick. If necessary, add oil up to the middle of the safe range. Reinstall dipstick, then turn the handle several turns clockwise to tighten rubber seal properly.

CAUTION: Do not overfill the transmission. Overfilling can cause oil aeration (milky appearance) and overheating. If overfilling occurs, drain oil as required to bring it to the proper level.

NOTE: Approximately 1 US qt (1 l) of oil is required to bring level from the bottom mark to the middle of the safe range on the dipstick.



MA3E0704

Fig. 4 - Hot oil check

Transmission Oil Change

Transmission oil change must be performed with the vehicle on a flat and level surface and with parking brake applied.

Oil change intervals are determined by the severity of transmission service. The intervals given in section 24 *"Lubrication"* act as a general guide. More frequent changes may be required when components are subject to high levels of contamination and/or overheating.

Manual Transmission

It is better to drain oil when it is still warm.

1. From under the vehicle, remove the transmission drain plug and allow oil to drain.

WARNING: Avoid contacting the transmission oil as it can be very hot and cause personal injuries.

2. Reinstall the drain plug.

3. To refill transmission, open the appropriate valve under the engine/transmission oil tank and pour oil into transmission until reaching the *"FULL"* mark on the dipstick, then close the valve (refer to fig. 2). Check oil reserve tank level through the level sight tube on side of tank. Refer to section 24 *"Lubrication"* for recommended oil type.

Automatic Transmission

1. Warm up the transmission at its normal operating temperature (160 - 250 °F (70 - 120 °C)) to ensure quicker and better oil drainage. Stop engine.

2. From under the vehicle, remove the transmission drain plug and allow oil to drain.

WARNING: Avoid contacting the transmission oil as it can be very hot and cause personal injuries.

3. Inspect the drain plug washer and replace if necessary. Reinstall the drain plug and tighten to 15 - 20 lbf•ft (20 - 25 N•m).

4. Remove the transmission dipstick and pour approximately 30 US qt (28 l) of *"Dexron II"* or *"Mercon"* automatic transmission fluid through the filler tube. Check and adjust oil level as directed under heading *"Transmission Oil Level"*.

CAUTION: Do not overfill the transmission. Overfilling can cause oil aeration (milky appearance) and overheating. If overfilling occurs, drain oil as required to bring it to the proper level.

Oil Filter Change (automatic transmission)

The transmission oil filter change intervals are determined by the severity of transmission service. The intervals given in section 24 *"Lubrication"* act as a general guide. More frequent changes may be required when components are subject to high levels of contamination and/or overheating.

1. Remove the oil filter by turning it counterclockwise, then discard filter.

2. Thoroughly clean dirt and oil from filter cover with a clean cloth.

3. Coat the new filter gasket with clean transmission oil.

4. Install the new filter and tighten 2/3 of a turn after gasket contact with filter cover.

MANUAL TRANSMISSION REMOVAL

The following procedure deals with the removal of the transmission without removing the power plant cradle from vehicle. The method used to support the transmission depends upon conditions and available equipment.

1. Set transmission shift lever to neutral position, apply parking brake, then turn main battery disconnect switches to the *"OFF"* position.

2. Jack-up vehicle, then place safety supports underneath body.

CAUTION: Only the recommended jacking points must be used as outlined in section 18 *"Body"*.

NOTE: For more clearance between the tag axle and transmission, the tag axle may be unloaded and jacked-up, or retracted (if applicable).

3. Remove wheels from tag axle.

4. Remove engine splash guards surrounding transmission.

5. Remove cross member from under transmission.

6. Remove the transmission drain plug and allow oil to drain. Reinstall drain plug.

WARNING: It is better to drain oil when it is still warm. Avoid contacting oil since it can be very hot and cause personal injuries.

7. Disconnect oil filling hose from transmission. Cover hose end and fitting to prevent fluid contamination.

8. Remove transmission dipstick and its tube.

9. Disconnect propeller shaft from transmission, and remove its safety guard. Refer to section 09 *"Propeller Shaft"*.

10. Disconnect gear shift linkage as follows:

a) Disconnect universal joint from shift rod.

b) Remove the three bolts that secure the coupling lever to the shift rod.

c) Push the shift rod all the way into bushing.

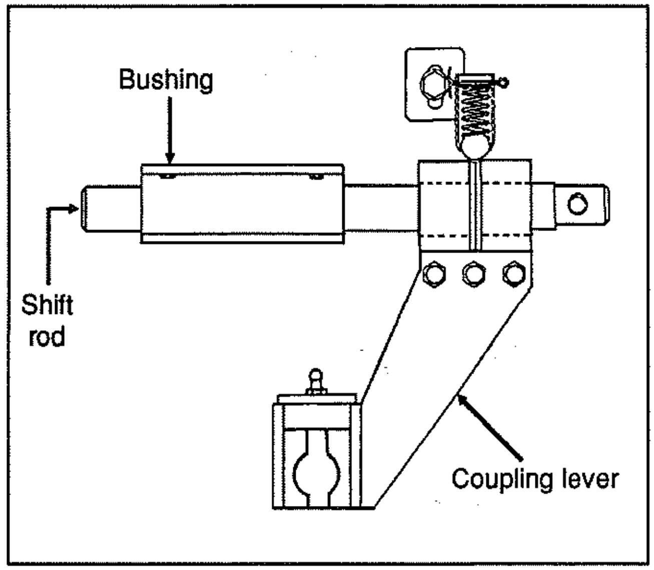


Fig. 5

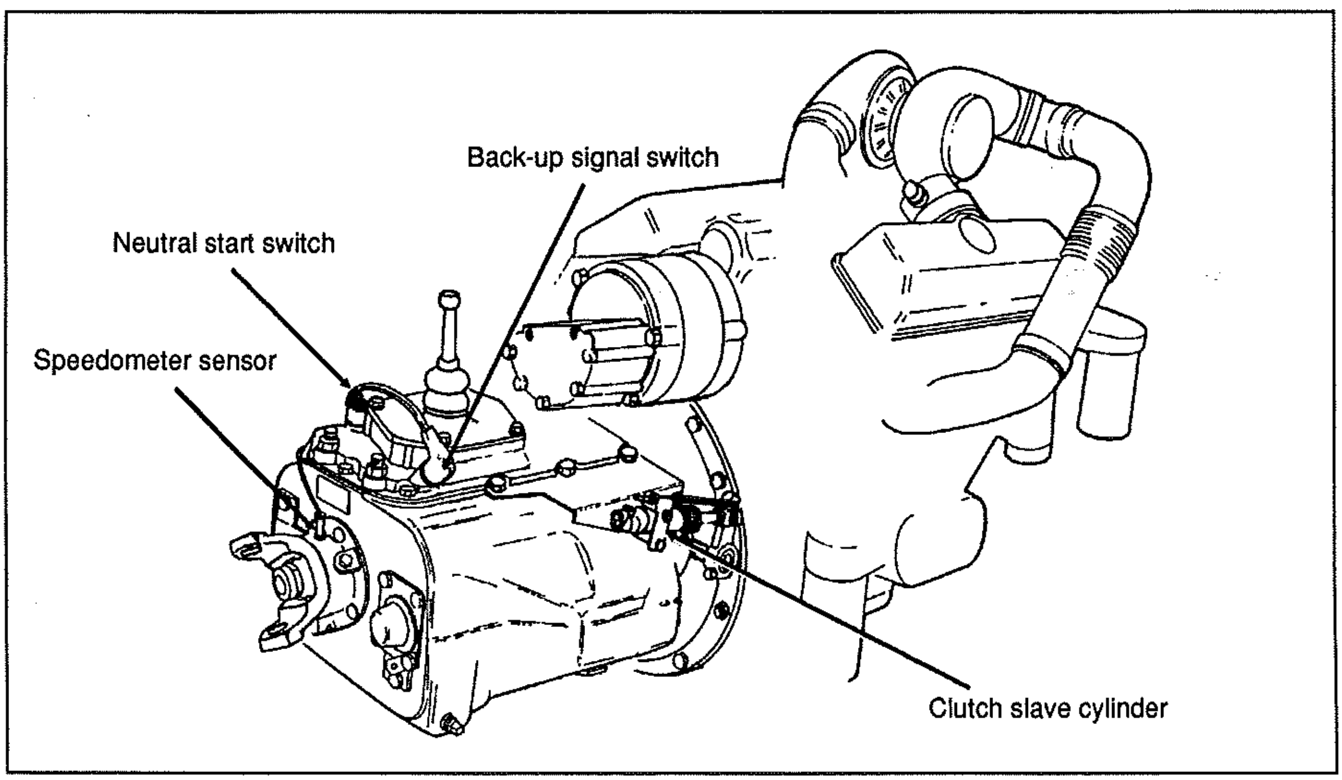


Fig. 6 - Manual transmission

11. Remove return spring, disconnect yoke, then remove clutch slave cylinder from transmission without disconnecting the hydraulic hose.

NOTE: Removing clutch slave cylinder will enable the release yoke to turn up and pull free from the release bearing thrust pads.

12. Disconnect speedometer sensor, back-up signal switch and neutral start switch.

13. Remove any locking tie, clamp and bracket that will interfere with the removal of transmission.

14. Support transmission using a suitable transmission jack, then remove the eleven mounting screws.

CAUTION: Make sure to maintain transmission-to-engine alignment when removing transmission. Do not let the rear end of transmission drop down and hang unsupported in the spline hubs of the clutch discs to avoid bending or distorting the friction discs.

15. Slowly pull straight transmission to clear the input shaft. Remove transmission.

MANUAL TRANSMISSION INSTALLATION

NOTE: For more clearance between the tag axle and transmission, the tag axle may be unloaded and jacked-up, or retracted (if applicable).

1. Place the transmission on a transmission jack.

2. Ensure clutch brake is in position on transmission input shaft.

3. Position the clutch release bearing with the flat section on top.

4. Shift transmission into 5th gear, then raise it and position the input shaft into clutch discs. Align input shaft splines with those on clutch discs by rotating the output shaft.

As the input shaft enters the clutch discs, rotate the clutch release yoke backward until the release yoke fingers clear the pads on release bearing housing. Rotate the clutch release yoke into proper position as transmission is pushed into place.

CAUTION: Avoid hanging the weight of the transmission on the clutch or forcing the transmission into the clutch or flywheel housing. Either of these abuses can cause bent or *"sprung"* clutch discs and prevent the clutch from releasing.

CAUTION: The clutch housing must be seated against the flywheel housing prior to tightening any screw. DO NOT USE SCREWS TO SEAT THE HOUSING.

5. Start all clutch housing screws, then tighten four of them gradually and in a criss-cross manner around the housing. Tighten the remaining screws. Recommended torque is 45 lbf•ft (60 N•m).

6. Remove jack from under transmission.

7. Install clutch slave cylinder and its return spring.

NOTE: Refer to section 02 *"Clutch"* for adjustment.

8. Connect speedometer sensor, back-up signal switch and neutral start switch (refer to fig. 6).

9. Reinstall clamps, brackets, and replace locking ties that have been removed during removal procedure.

10. Shift transmission to neutral, then secure both the coupling lever and universal joint to shift rod with applicable fasteners.

NOTE: Refer to heading *"Gear Shift Linkage"* for proper adjustment.

11. Install propeller shaft and its safety guard. Refer to section 09 *"Propeller Shaft"*.

12. Install transmission dipstick and its tube, then connect oil filling hose to transmission.

13. Install cross member under transmission.

14. Install engine splash guards.

15. Install tag axle wheels.

16. Make sure that the drain plug is in place, then refill transmission through the engine/transmission oil tank. Open the appropriate valve under the oil tank and pour oil into transmission until reaching the *"FULL"* mark on the dipstick, then close the valve (refer to fig. 2). Check oil reserve tank level through the level sight tube on the side of tank. Refer to section 24 *"Lubrication"* for recommended oil type.

MANUAL TRANSMISSION OVERHAUL

Gear Shift Housing Disassembly

1. Place the gear shift housing on a bench with forks in neutral position.

2. Remove the LO/reverse fork and bracket set screws. As parts are being removed, use care so that the poppet ball and spring are not lost.

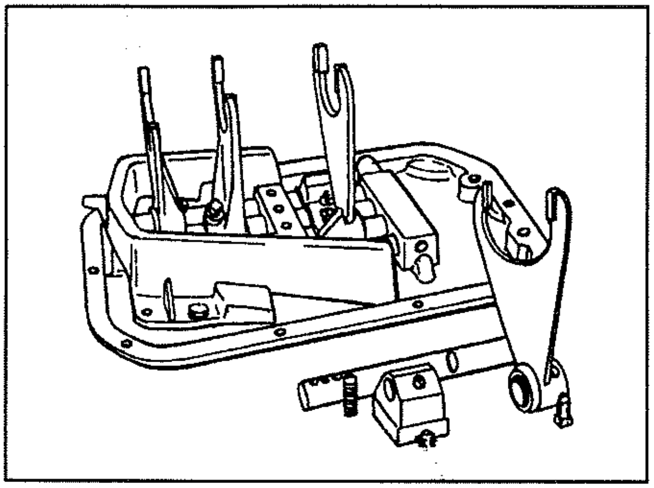


Fig. 7 MA3E0707

3. Remove the set screw from the 1st/2nd fork. Tap the rod rearward and remove the poppet ball and spring. As the shift rod is pulled from the rear of the housing, be sure not to lose the interlock pin located in the rod.

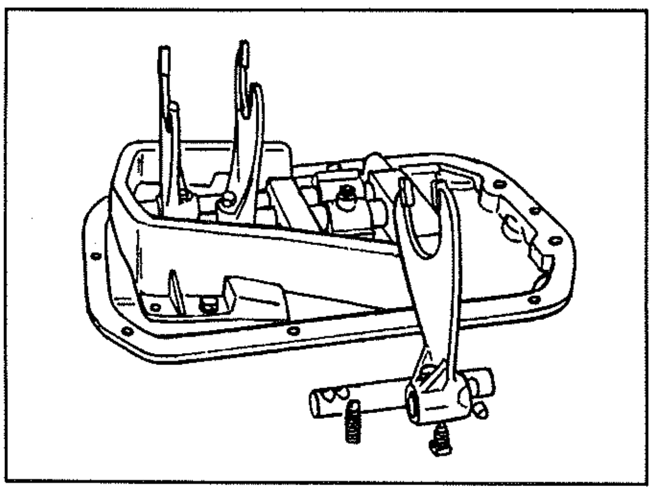


Fig. 8 MA3E0708

4. In the same manner, remove the 3rd speed fork and bracket. Recover the poppet ball and spring and also the interlock pin and ball.

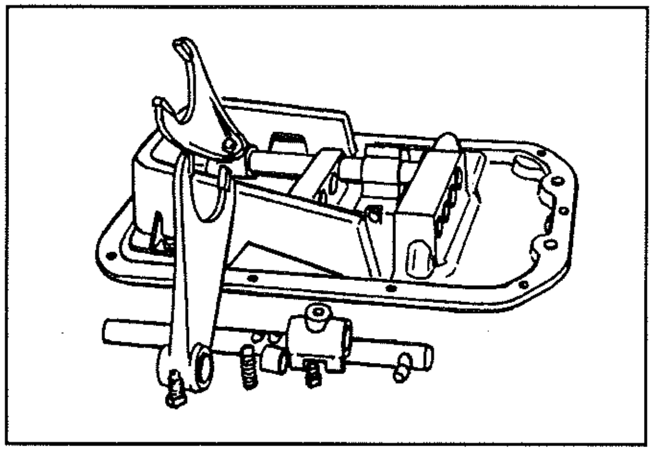


Fig. 9 MA3E0709

5. Remove the 4th/5th fork and bracket to complete the disassembly.

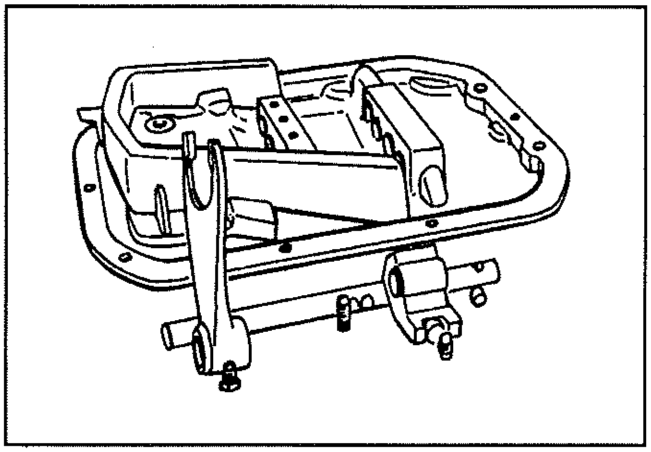


Fig. 10 MA3E0710

6. Check the poppet holes for chipping or other signs of wear. Since sharp corners are required to insure the proper functioning of the shift rods, any worn holes will result in the unit sticking in gear.

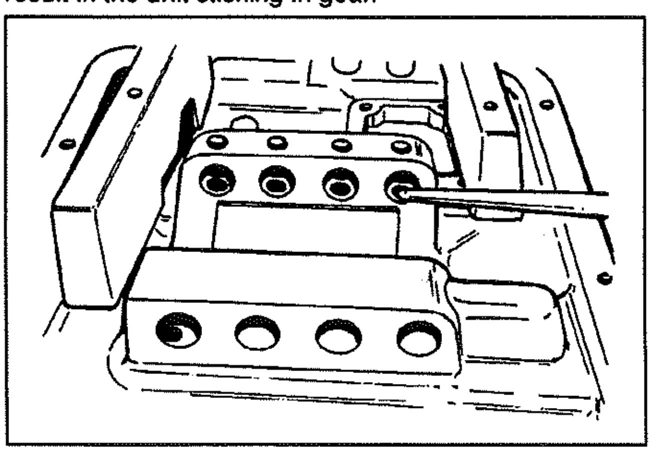


Fig. 11 MA3E0711

Gear Shift Housing Assembly

1. After inspection, install the 4th/5th shift bracket and fork.

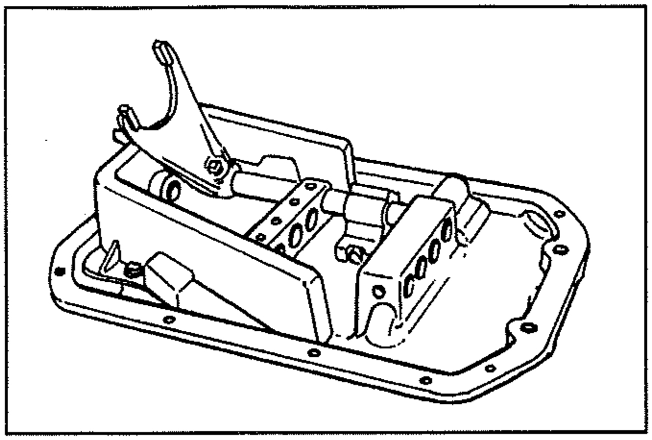


Fig. 12 MA3E0712

2. Tighten shift fork set screws to 35 - 40 lbf•ft (45 - 55 N•m). Be sure to check each shift rod for free movements as the reassembly progresses.

3. Install the 3rd speed fork and bracket.

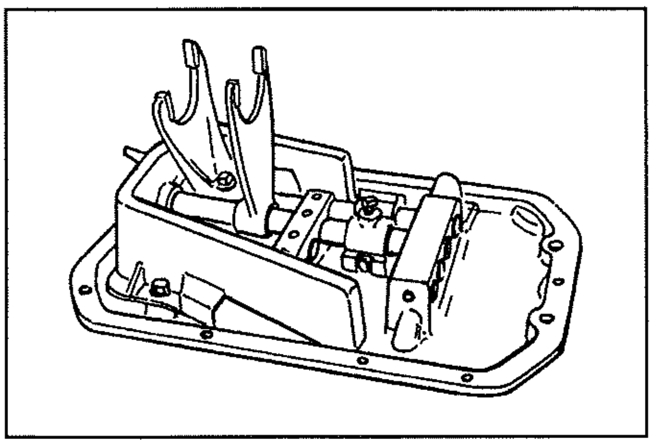


Fig. 13 MA3E0713

4. Install the 1st/2nd shift fork.

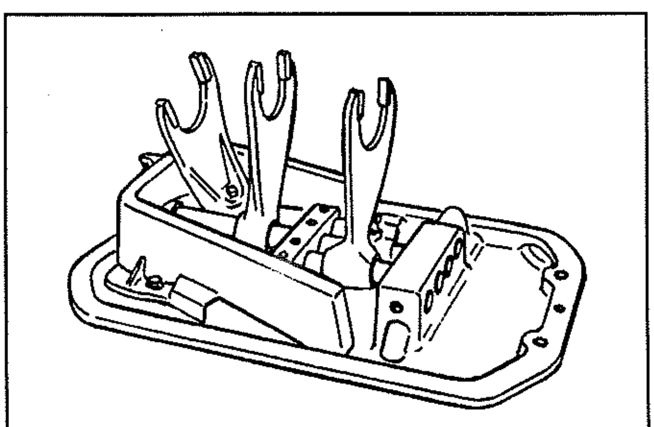


Fig. 14 MA3E0714

5. During the installation of each shift rod, careful attention is needed to insure the proper installation of all interlock balls. These interlocks prevent the transmission from being shifted into two gears at the same time.

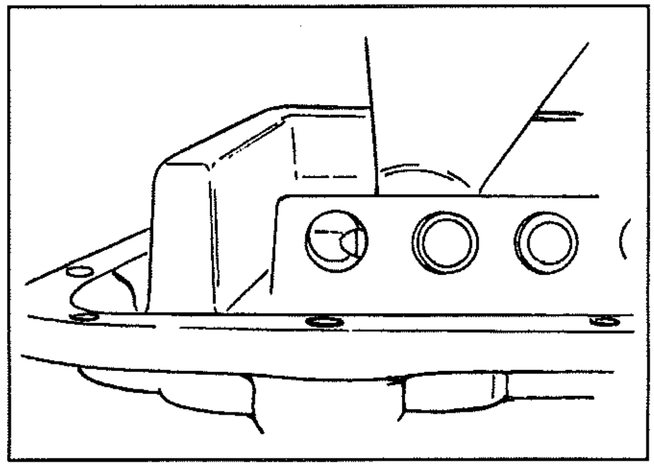


Fig. 15 MA3E0715

6. Install LO/reverse fork.

With the gear shift housing reassembly completed, it is advisable to check for the proper functioning of these interlocks. Shift one fork into gear; if all interlocks are installed correctly, none of the other forks will shift into gear.

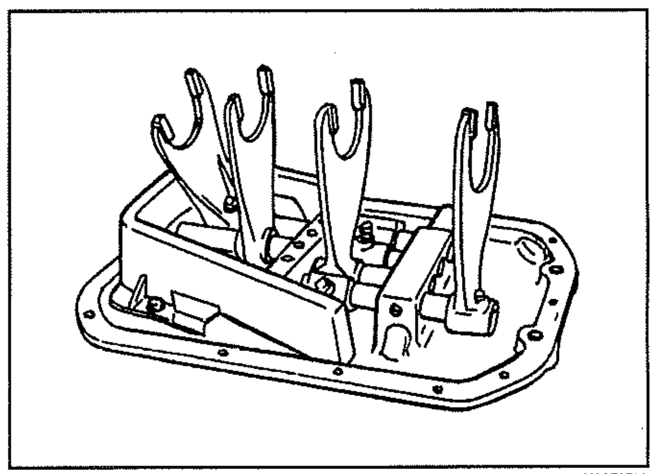


Fig. 16 MA3E0716

Transmission Disassembly

1. Remove the output bearing cap and gasket, and then the countershaft bearing retainers.

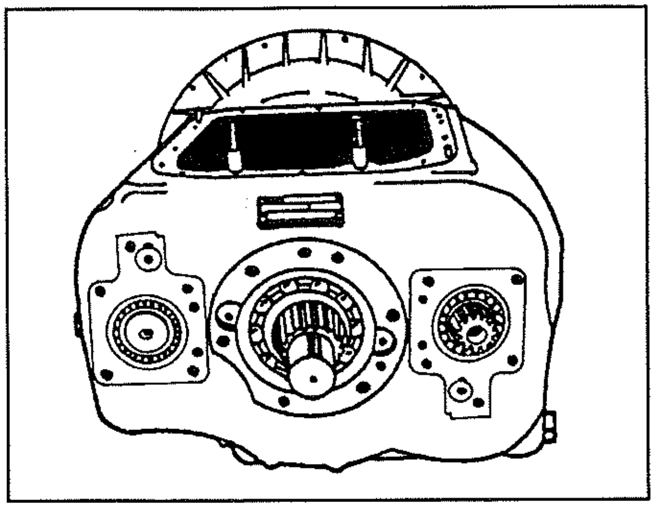


Fig. 17 MA3E0717

2. Insert a cap screw into the upper reverse idler shaft and remove the shaft. Do not lose the lock ball in the shaft.

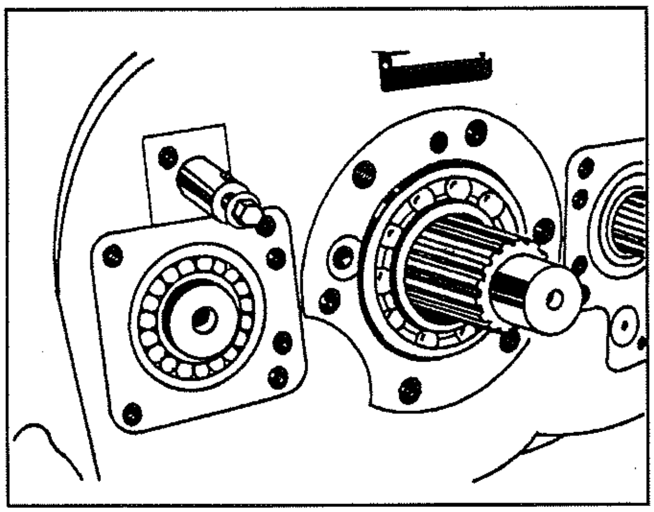


Fig. 18 MA3E0718

3. Roll the upper reverse idler gear toward the side of the case.

Fig. 19 MA3E0719

4. Engage the LO/reverse collar into reverse gear.

Fig. 20 MA3E0720

5. Two milled slots facilitate the removal of the output bearing.

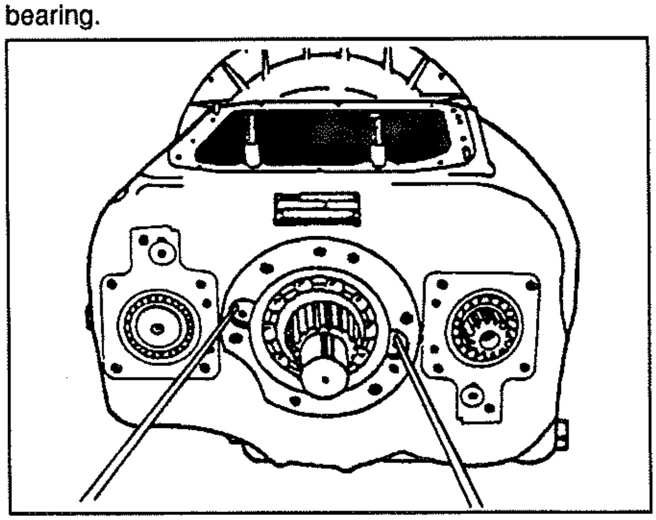


Fig. 21 MA3E0721

6. Remove the main shaft snap ring and the internal spline thrust washer.

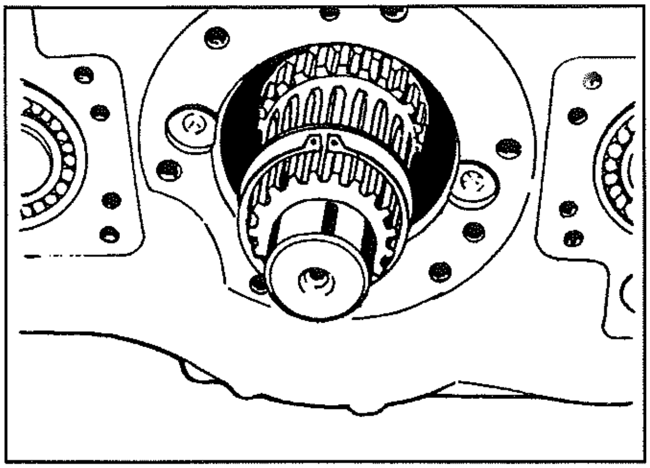


Fig. 22 MA3E0722

7. Next, remove the gear bore snap ring and both the external and internal spline thrust washers.

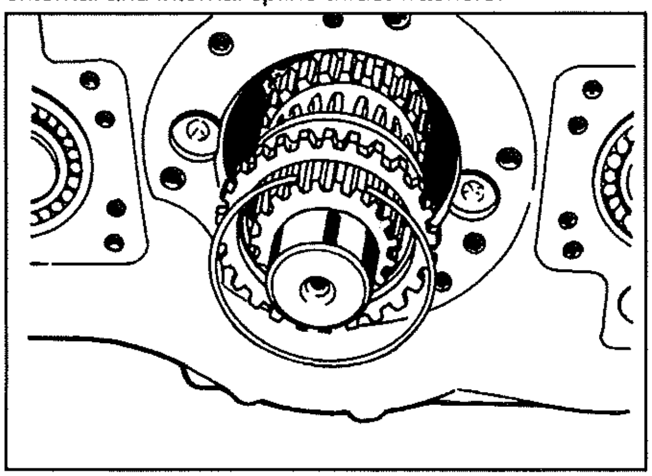


Fig. 23 MA3E0723

8. Finally, remove the remaining gear bore snap ring.

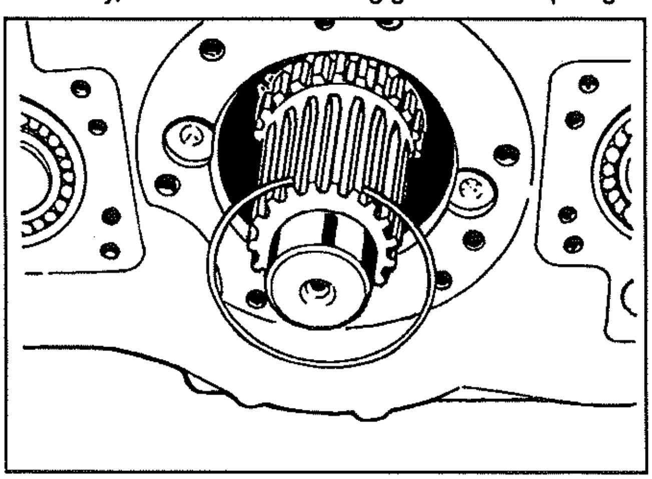


Fig. 24 MA3E0724

9. Now, butt the LO and reverse gears together. Secure both gears with lock wire to provide the necessary clearance for removal of the main shaft assembly.

Fig. 25 MA3E0725

10. Remove the clutch housing, and then the input bearing cap.

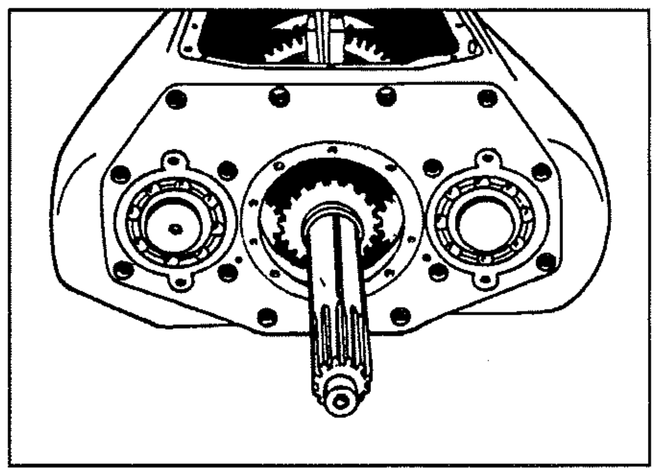


Fig. 26 MA3E0726

11. Remove the input gear.

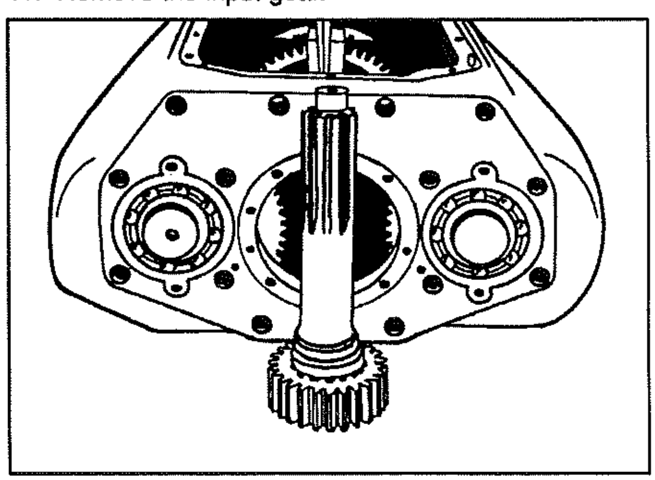


Fig. 27 MA3E0727

12. Using an appropriate puller (Snap-on - CJ80), remove the countershaft front bearings.

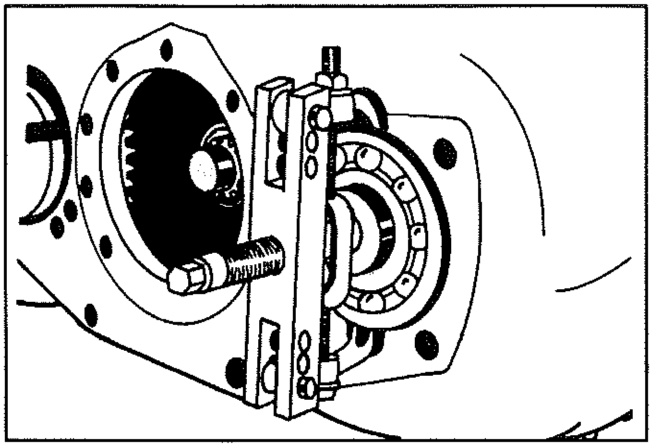


Fig. 28 MA3E0728

13. Now, move the countershafts to the rear as far as possible and install a puller (Snap-on - CJ950) for bearing removal.

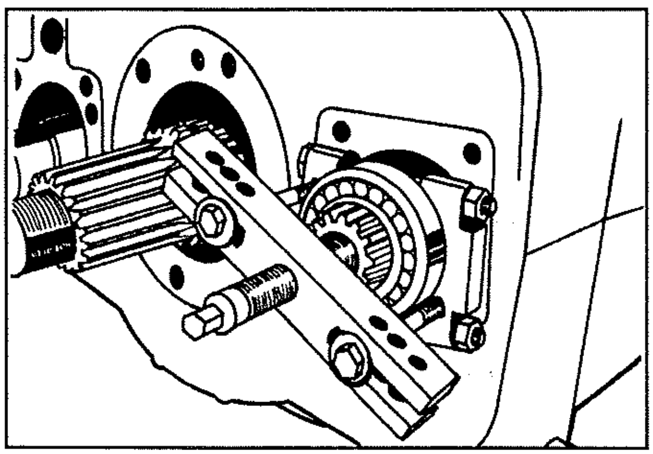


Fig. 29 MA3E0729

14. To provide adequate clearance for main shaft removal, move both countershafts forward and toward the side of the case, then lift the main shaft assembly out of the case.

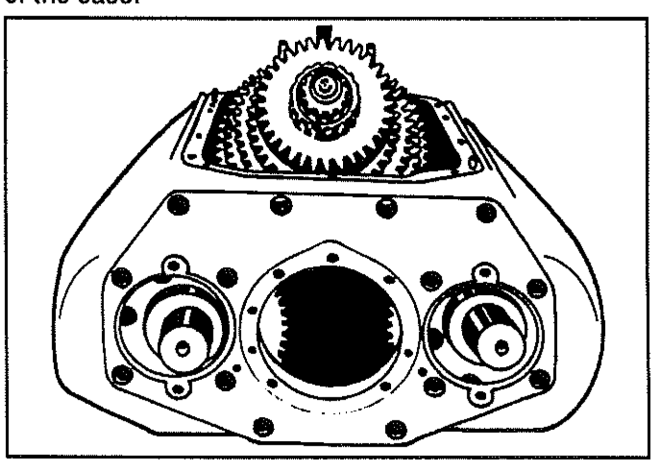


Fig. 30 MA3E0730

15. Remove the upper reverse idler gear.

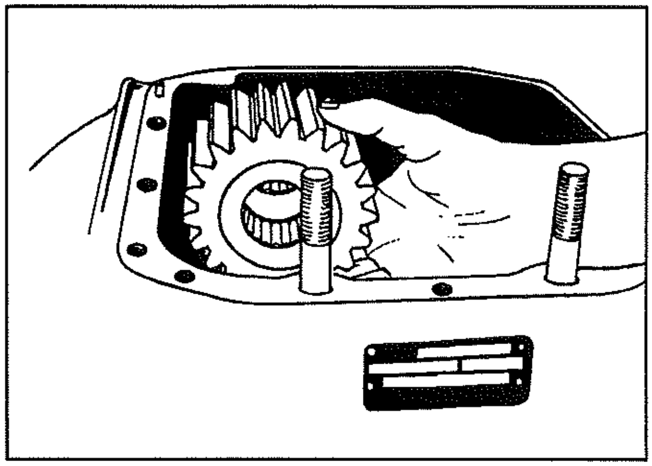


Fig. 31 MA3E0731

16. Because of the upper idler boss interference, remove the R.H. countershaft first, then the left.

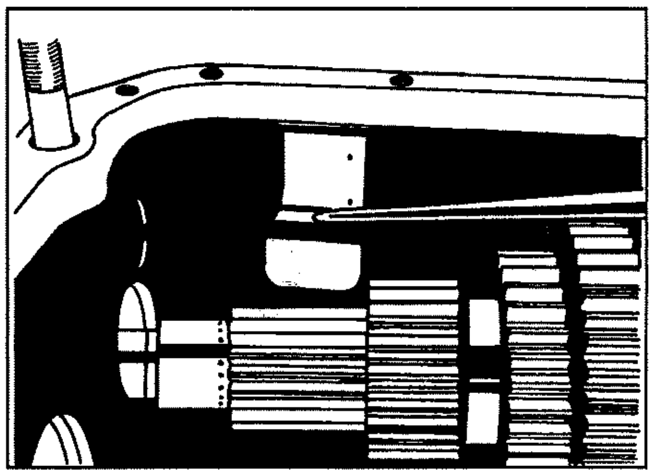


Fig. 32 MA3E0732

17. Remove both the lower reverse idler shaft and gear.

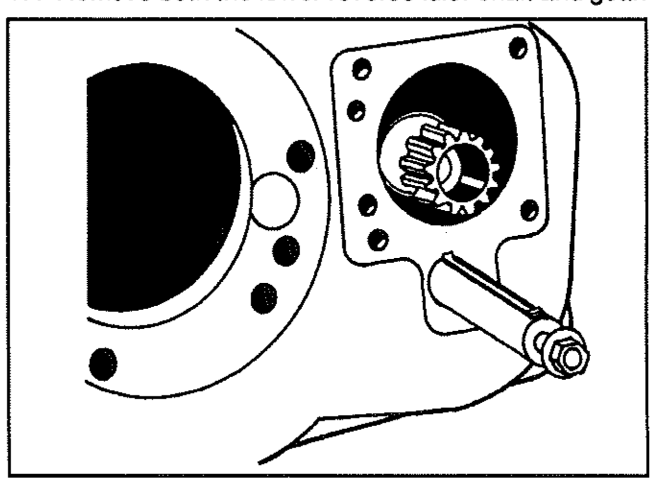


Fig. 33 MA3E0733

18. Check both the idler gear and bearings for wear.

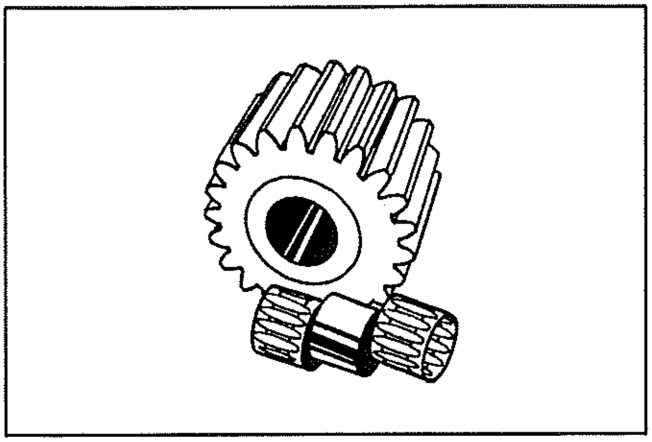


Fig. 34 MA3E0734

Main Shaft Disassembly and Reassembly

1. Begin the main shaft disassembly by removing the clutch collar.

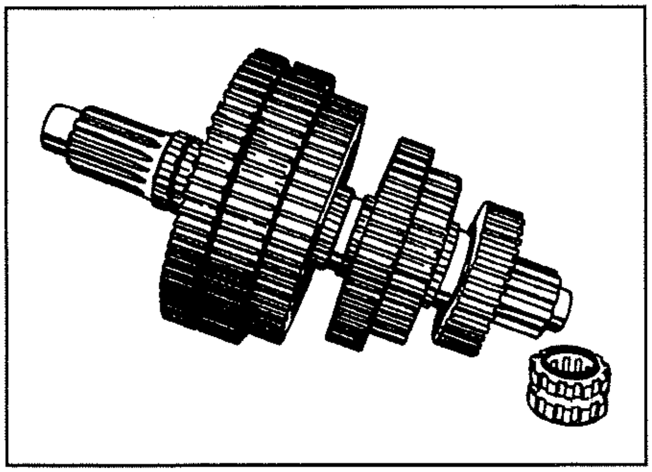


Fig. 35 MA3E0735

2. Cut the lock wire and remove reverse gear.

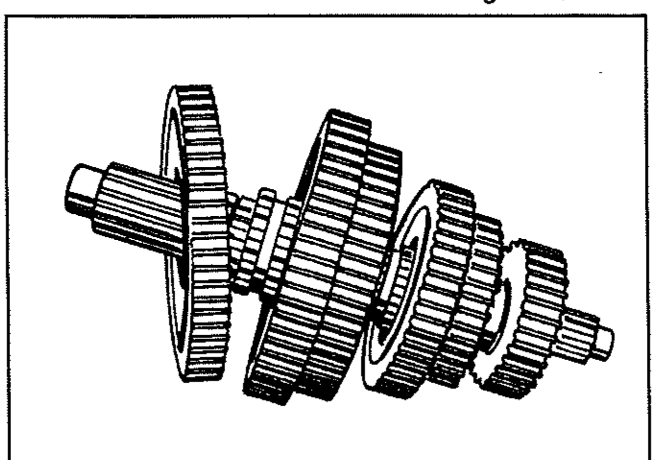


Fig. 36 MA3E0736

3. Remove the snap ring and 4th speed gear.

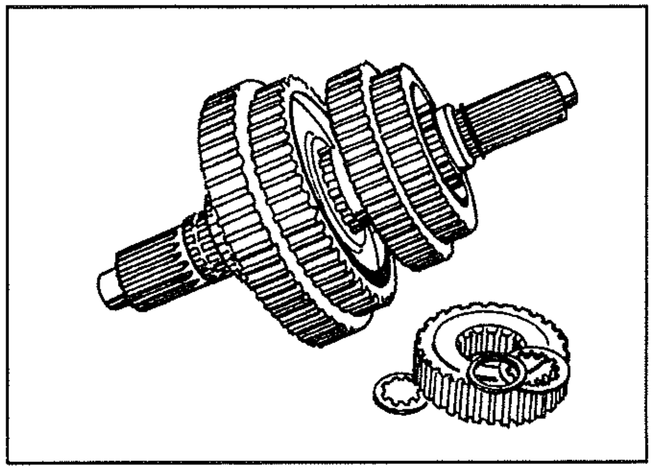


Fig. 37 MA3E0737

4. Remove another snap ring and the 3rd speed clutch collar.

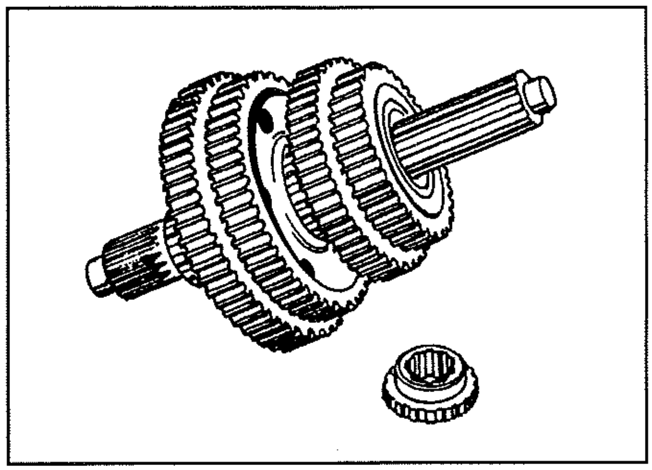


Fig. 38 MA3E0738

5. After removing the next snap ring, lift both the 3rd and 2nd speed gears from the main shaft.

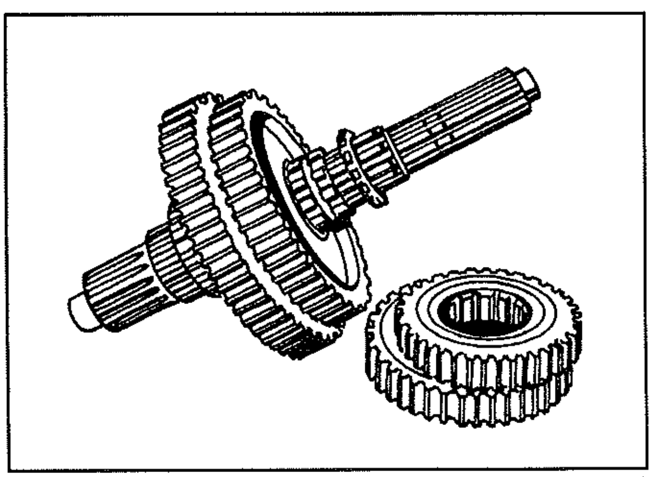


Fig. 39 MA3E0739

6. The 1st/2nd speed clutch collar may be removed.

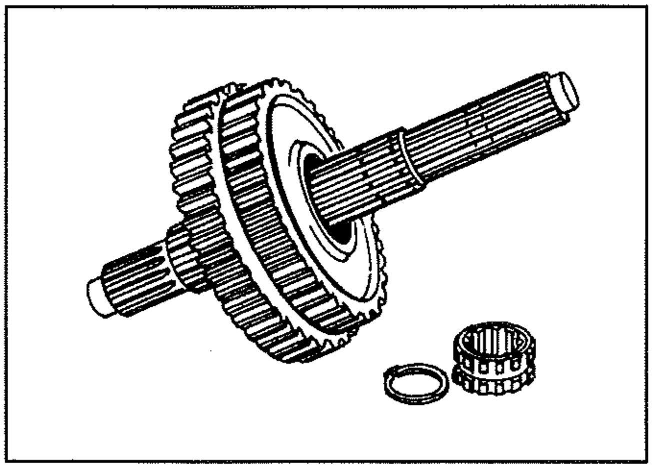


Fig. 40 MA3E0740

7. Another snap ring secures both the 1st and the LO speed gears to the main shaft.

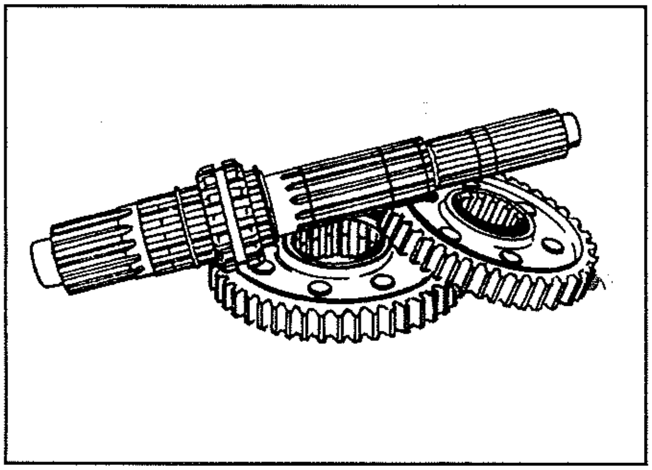


Fig. 41 MA3E0741

8. All that remains on the main shaft are two snap rings and the LO/reverse clutch collar.

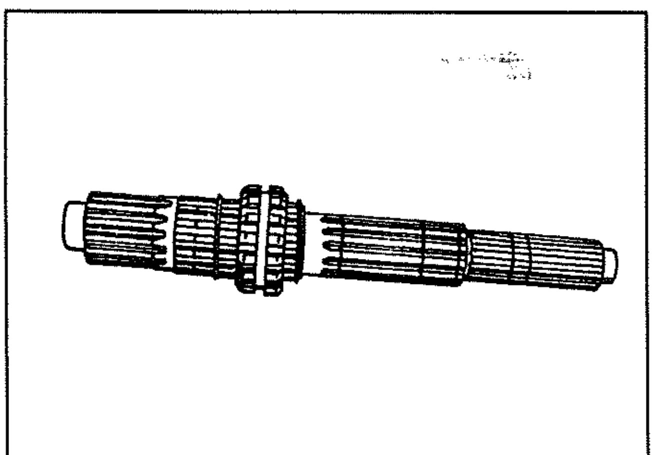


Fig. 42 MA3E0742

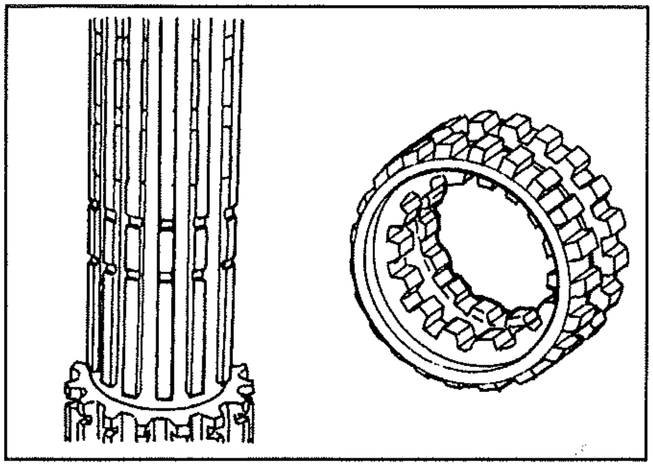


Fig. 43 MA3E0743

NOTE: Spicer uses *"gear locks"* to maintain clutch collar engagement. The main shaft splines have machined grooves. While the clutch collar has a relieved area on the internal diameter that provides sharp corners when *"in gear"*, these edges lock together to keep the transmission in the selected gear.

9. Reassembly of the main shaft may now begin. Apply a light coat of oil on all thrust washer faces. All main shaft gears contain a set of these thrust washers. The external spline washer is positioned against the gear bore snap ring and the internal spline washer against the snap ring on the main shaft.

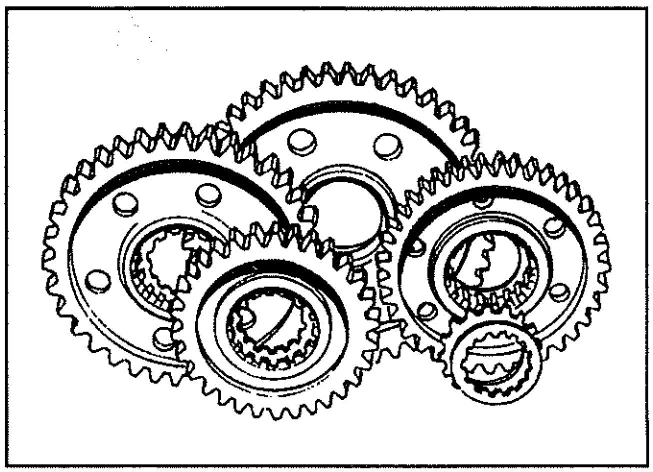
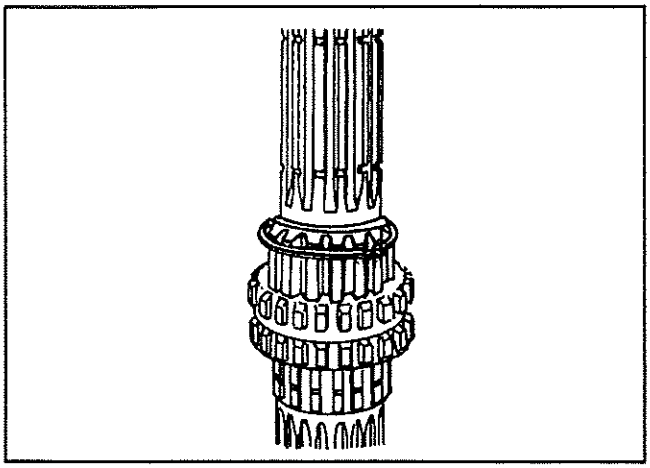


Fig. 44 MA3E0744

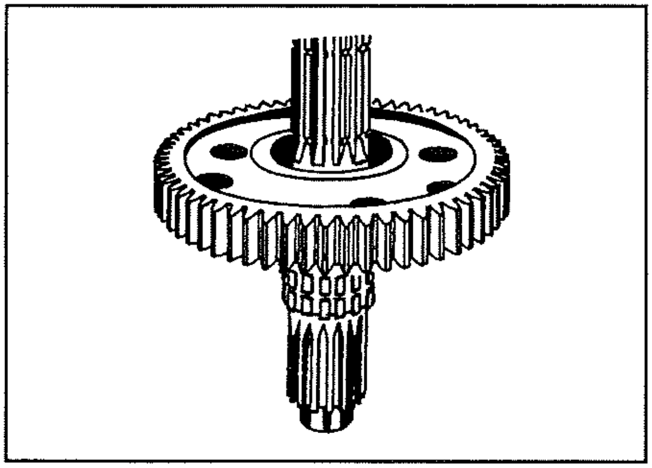
10. Install the LO/reverse clutch collar between the main shaft snap rings.



MA3E0745

Fig. 45

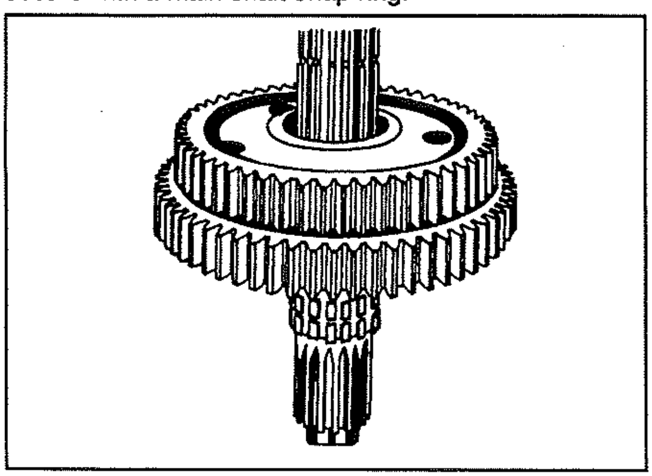
11. Next, the LO speed gear, complete with thrust washers, is placed on the main shaft.



MA3E0746

Fig. 46

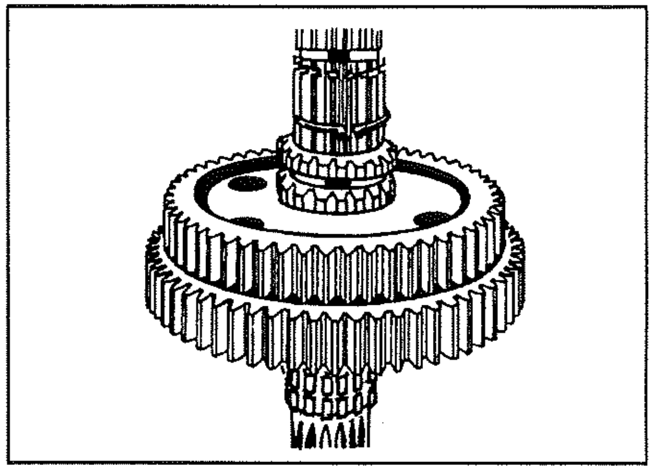
12. Place the 1st speed gear on the main shaft and secure with a main shaft snap ring.



MA3E0747

Fig. 47

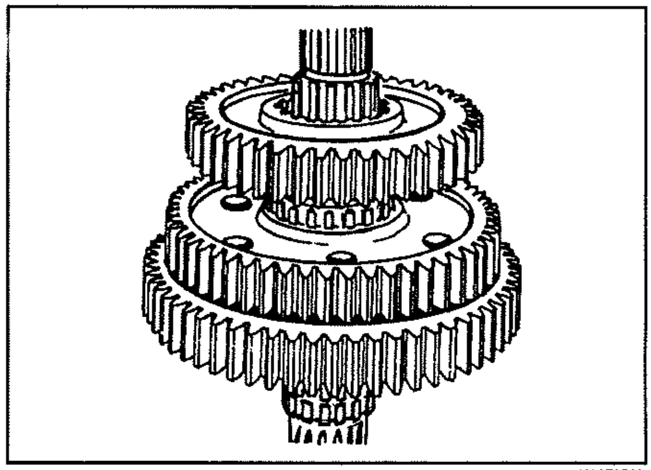
13. Slide the 1st/2nd clutch collar onto the main shaft.



MA3E0748

Fig. 48

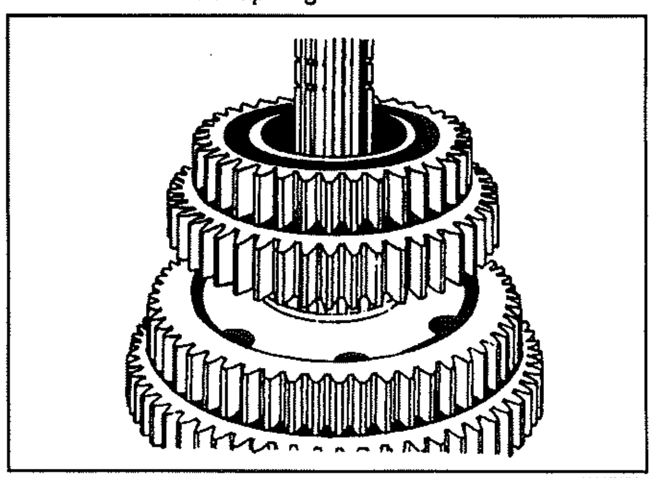
14. Place the 2nd speed gear on the main shaft with the clutch teeth down.



MA3E0749

Fig. 49

15. The 3rd speed gear is installed next and secured with a main shaft snap ring.



MA3E0750

Fig. 50

16. Slide the 3rd gear clutch collar onto the main shaft.

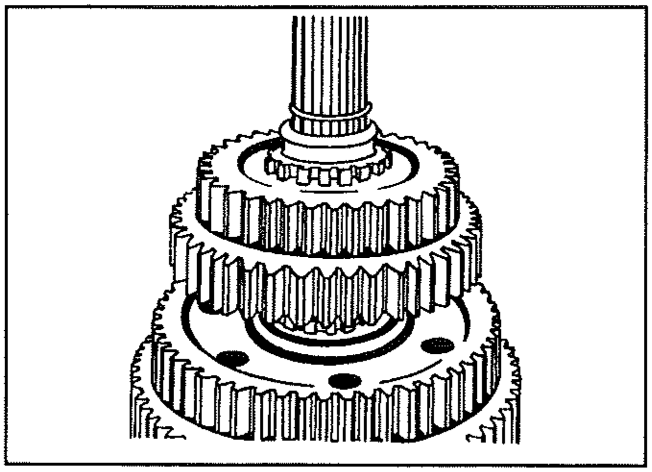


Fig. 51 MA3E0751

17. Then place the 4th speed gear on the main shaft and secure with a snap ring.

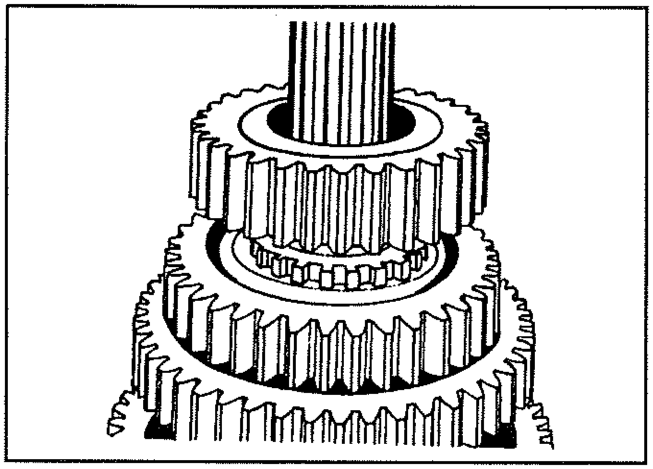


Fig. 52 MA3E0752

18. Install the reverse gear and butt it against the LO speed gear. Secure with lock wire.

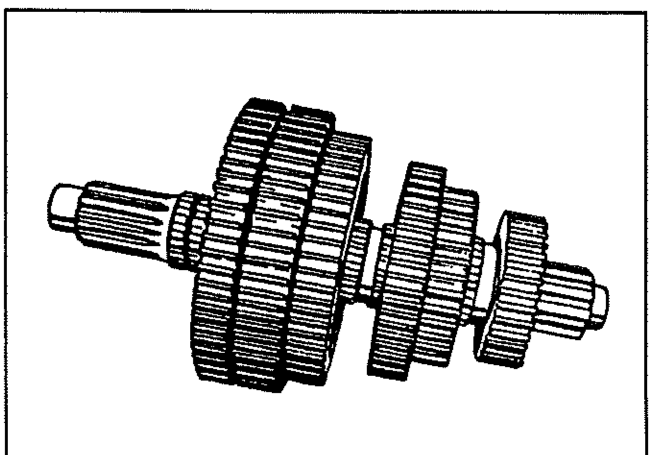


Fig. 53 MA3E0753

Countershaft Disassembly and Reassembly

1. The LO/reverse gear is an integral part of the shaft, while the remaining gears are secured with individual Woodruff keys under each gear.

2. Every gear on the countershaft will be in line when placing a straight edge between these painted teeth. When setting countershafts in time, these marks will be directly across from each other.

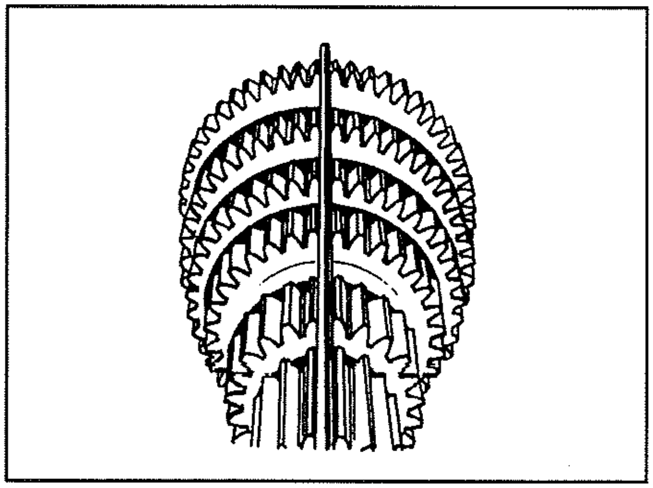


Fig. 54 MA3E0754

3. The countershaft rear bearing requires a spacer ring for proper location.

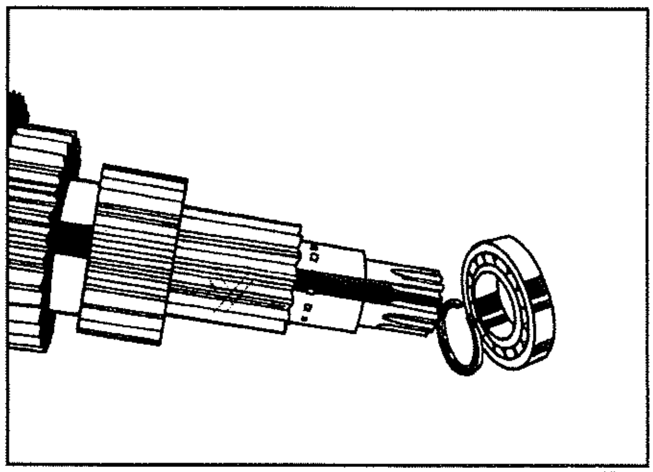


Fig. 55 MA3E0755

Input Gear Disassembly and Reassembly

1. The input gear and shaft are separate components secured with a snap ring. The figure shows the input sub-assembly when disassembled.

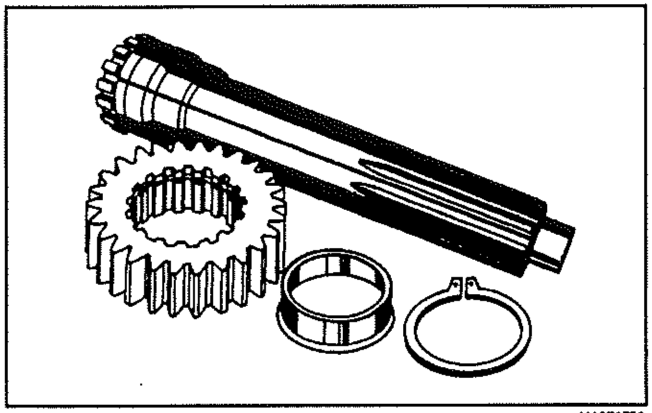


Fig. 56

2. The input bearing is a press fit into the input bearing cap.

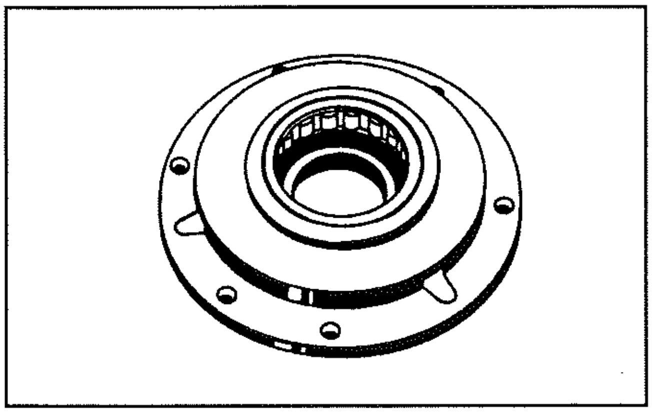


Fig. 57

3. Remove the pocket bearing (Kent-Moore puller J-29128 is recommended).

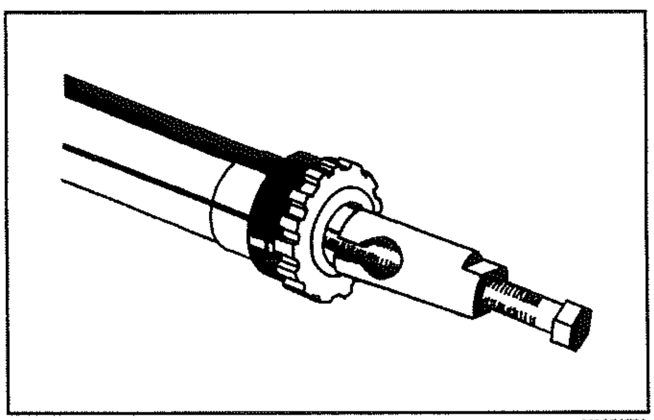


Fig. 58

NOTE: The pocket bearing is reversible.

4. The snap ring in the input shaft secures the gear in its proper location.

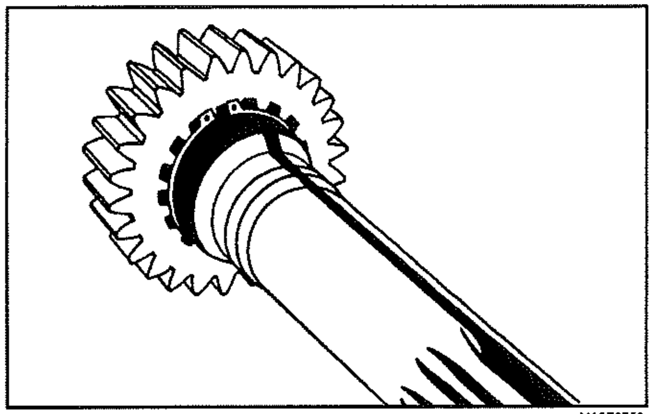


Fig. 59

Transmission Assembly

1. Reassembly of the transmission begins by placing the lower reverse idler gear and the shaft into the case.

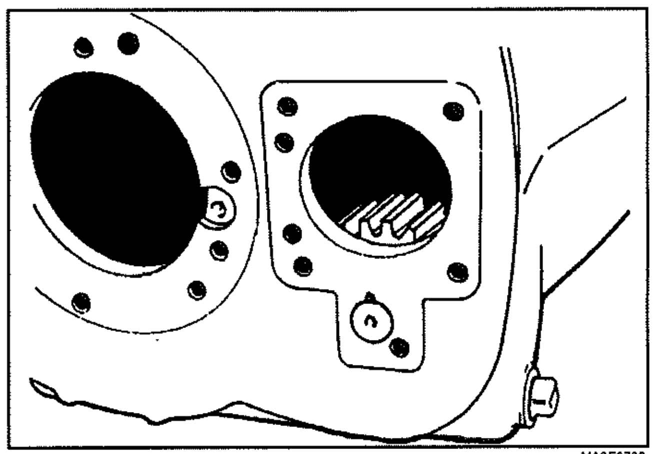


Fig. 60

2. Install the left side countershaft first, then the right side (Kent-Moore alignment blocks J-28720 are recommended).

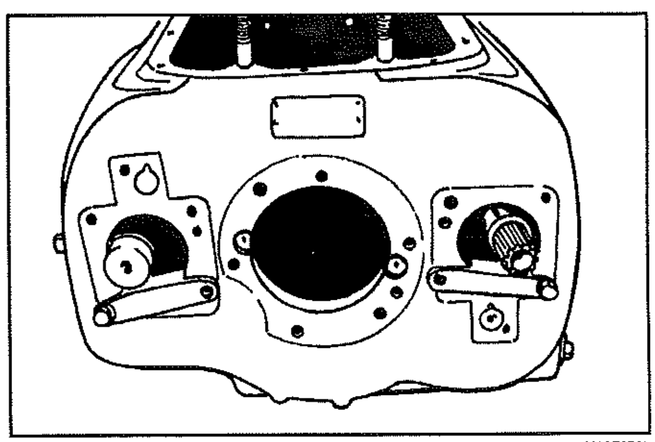


Fig. 61

3. Set the upper reverse idler gear into the case. However, do not install the shaft at this time.

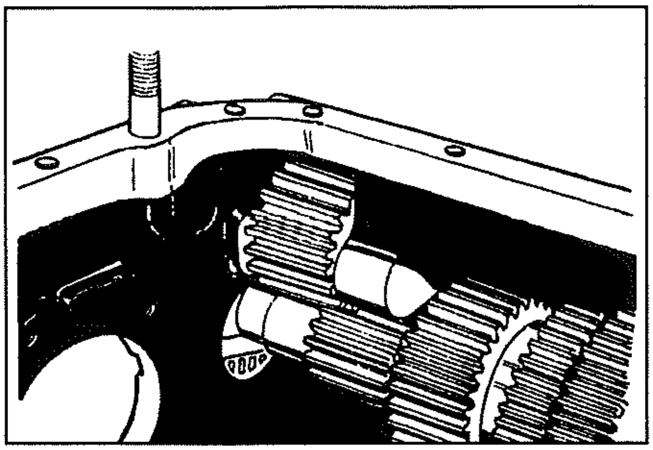


Fig. 62

4. Lower the main shaft assembly into the case.

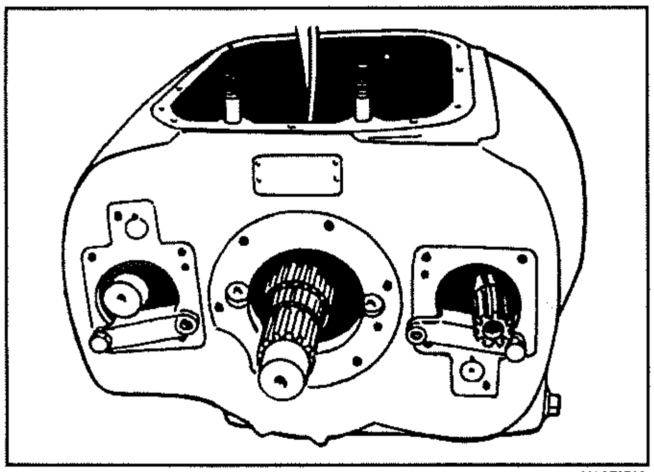


Fig. 63

5. Cut and remove the lock wire. Slide the reverse gear rearward and install the LO gear bore snap ring.

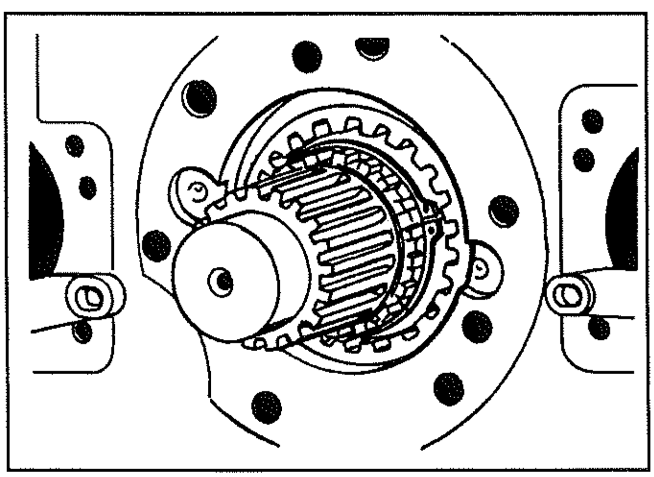


Fig. 64

6. Next, place both the internal and external spline thrust washers into the bore and secure these washers with the remaining gear bore snap ring.

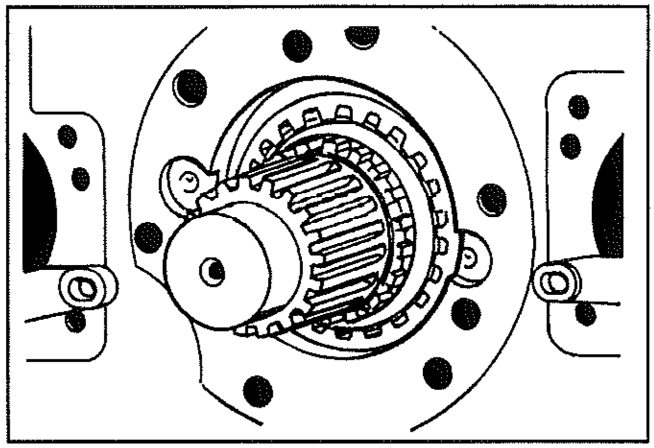


Fig. 65

7. Finally, install the internal spline thrust washer and secure it with the main shaft snap ring.

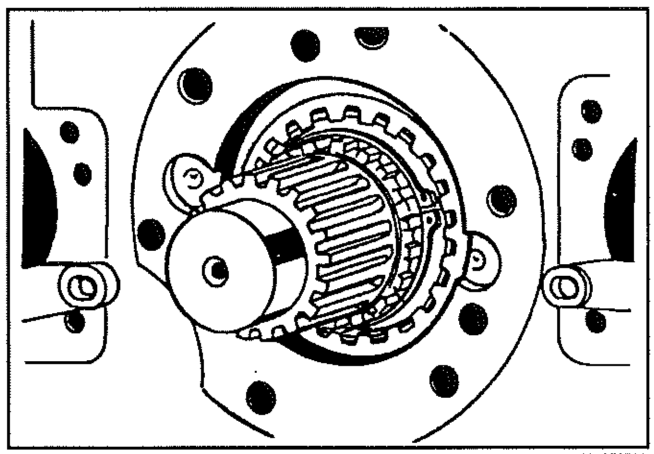


Fig. 66

8. Slide the output bearing onto the shaft and using a suitable driver, install the bearing.

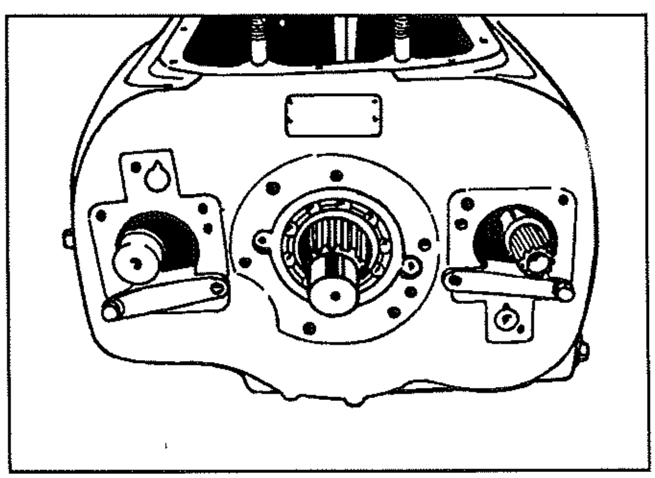


Fig. 67

9. Align the countershaft timing marks toward the center of the case.

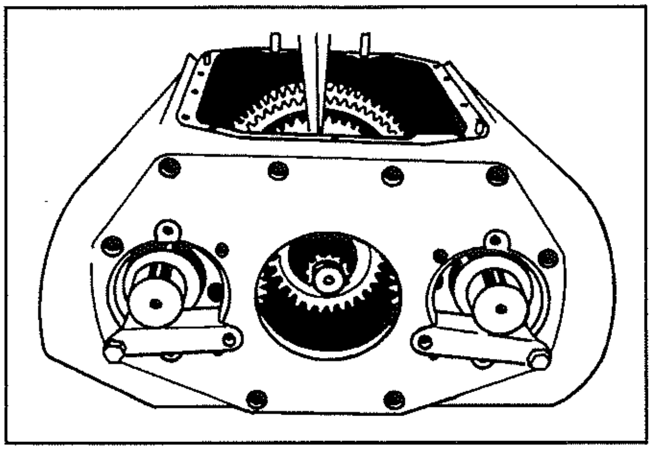


Fig. 68 MA3E0768

10. Install the 4th/5th clutch collar.

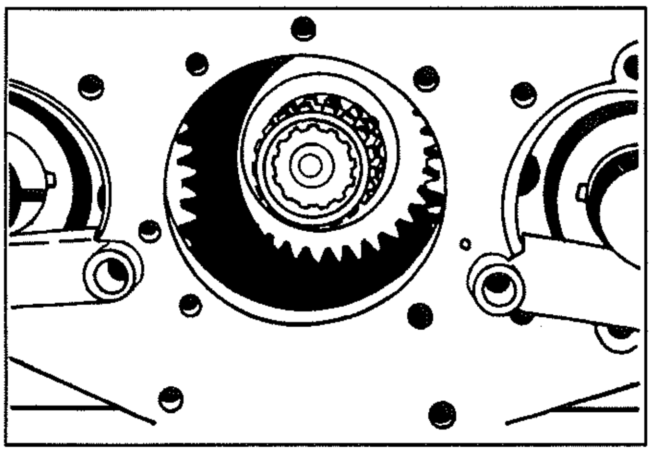


Fig. 69 MA3E0769

11. Place the input subassembly into the case, then install the input bearing cap and secure with cap screws.

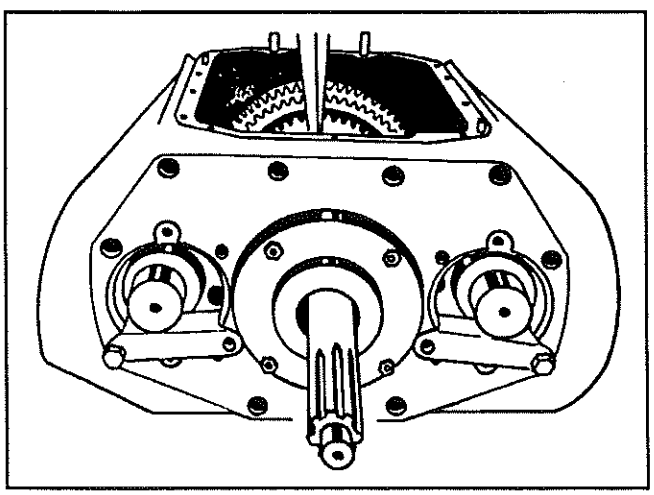


Fig. 70 MA3E0770

12. Using the countershaft lift hook (Kent-Moore J-23667), set countershaft in time.

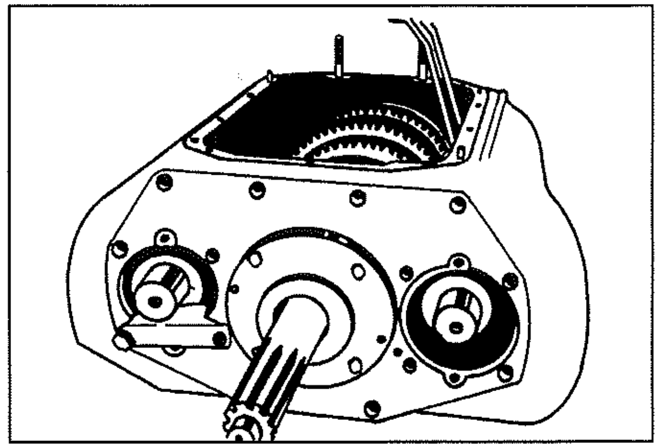


Fig. 71 MA3E0771

This is accomplished by matching paint marks.

13. Install both the front and the rear bearings.

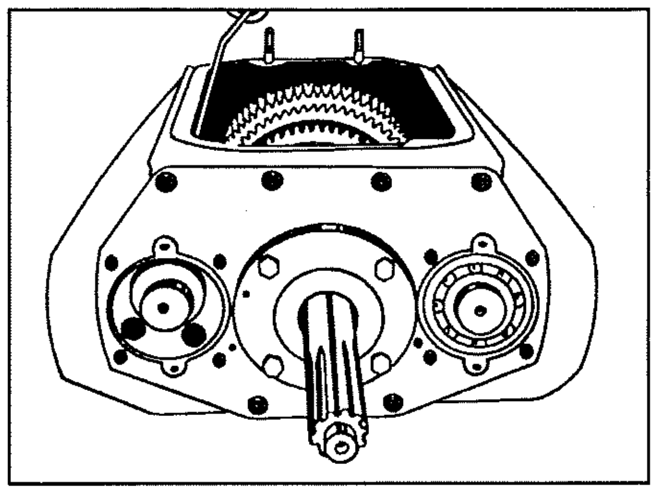


Fig. 72 MA3E0772

14. Repeat the procedure for the remaining countershaft.

15. The input shaft may now be rotated to check for correct timing. If the shaft turns freely, the unit is in time. If it locks up, check the timing marks for proper alignment.

16. Install the upper reverse idler shaft with lock ball. It is necessary to lift up on the main shaft reverse gear to obtain proper alignment.

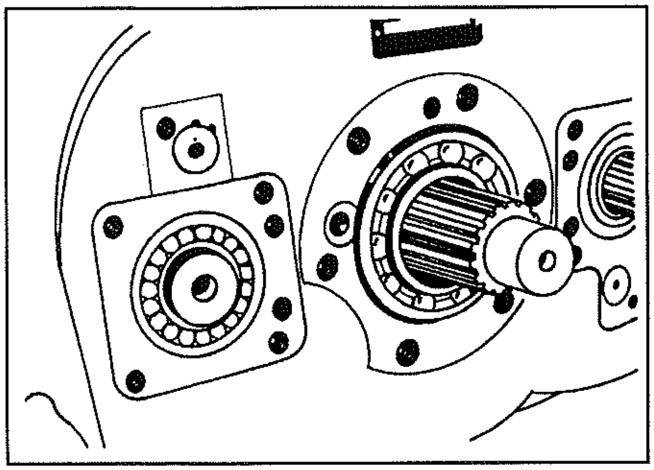


Fig. 73 MA3E0773

17. Secure the countershaft rear bearing retainers with cap screws (see fig. 74). Tighten to 35 - 40 lbf•ft (45 - 55 N•m).

18. Place the output bearing cap on the case and secure with cap screws.

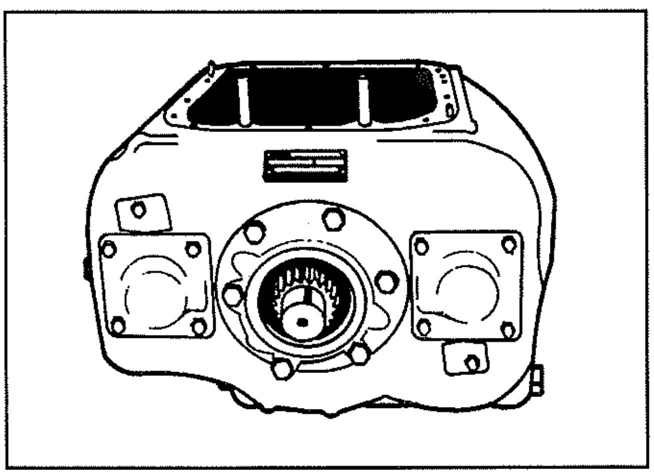


Fig. 74 MA3E0774

19. Assemble the clutch housing to the case.

20. Shift all the clutch collars into *"NEUTRAL"* position.

21. Place the gear shift housing in its proper position and secure with cap screws.

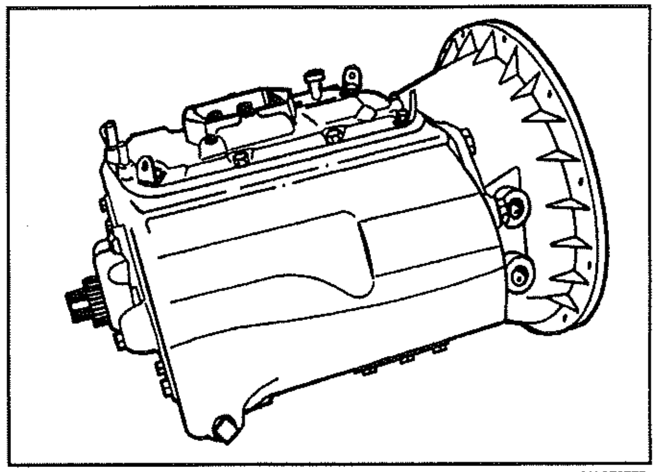


Fig. 75 MA3E0775

AUTOMATIC TRANSMISSION REMOVAL

The following procedure deals with the removal of the transmission without removing the power plant cradle from vehicle. The methods used to support the transmission and engine depend upon conditions and available equipment.

1. Select transmission *"NEUTRAL"* position, apply parking brake, then turn main battery disconnect switches to the *"OFF"* position.

2. Jack-up vehicle, then place safety supports underneath body.

CAUTION: Only the recommended jacking points must be used as outlined in section 18 *"Body"*.

NOTE: For more clearance between the tag axle and transmission, the tag axle may be unloaded and jacked-up, or retracted (if applicable).

3. Remove wheels from tag axle.

4. Remove engine splash guards surrounding transmission.

5. Remove cross member from under transmission.

6. Remove the transmission drain plug and allow oil to drain. Inspect the drain plug washer and replace if necessary. Reinstall the drain plug and tighten to 15 - 20 lbf•ft (20 - 25 N•m).

WARNING: It is better to drain oil when it is still warm. Avoid contacting oil since it can be very hot and cause personal injuries.

7. Remove transmission dipstick and filler tube.

8. Disconnect propeller shaft from transmission, and remove its safety guard. Refer to section 09 *"Propeller Shaft"*.

9. Remove the engine oil filter assembly from transmission without disconnecting hoses (W/6V92).

10. Identify, then disconnect the two oil cooler hoses from transmission. Cover hose ends and fittings to prevent fluid contamination.

WARNING: A significant amount of oil may drain from oil lines when they are disconnected.

11. Disconnect the oil temperature sensor.

12. *"NON-ATEC"* TRANSMISSION:

a) Remove gear shift cable from transmission.

b) Disconnect speedometer sensor, back-up signal switch and neutral start switch.

c) Disconnect modulator line (steel-braided hose) from transmission.

13. *"ATEC"* TRANSMISSION:

a) Disconnect speed sensor.

b) Disconnect main wiring harness.

c) Disconnect the air supply line (steel-braided hose) from the retarder control valve (if applicable).

14. Remove any locking tie, clamp and bracket that will interfere with removal of transmission.

15. Remove the access plug from the flywheel housing, right over the starter, and then the 12 converter-to-flexible plate attaching screws. Place a wrench on crankshaft pulley attaching screw to turn the converter to gain access to the attaching screws.

CAUTION: Do not rotate crankshaft counterclockwise to avoid loosening the crankshaft pulley retaining screw.

16. Support adequately the rear end of engine using a suitable jack.

17. Support transmission using a suitable transmission jack, then remove both rear supports of engine and transmission assembly.

18. Remove the 23 screws retaining the torque converter housing to the flywheel housing.

CAUTION: Make sure to maintain transmission-to-engine alignment when removing screws. Do not let the rear end of engine and/or transmission drop down to avoid damaging torque converter housing.

WARNING: Severe damages and/or personal injuries can result if transmission and/or rear end of engine are not supported adequately.

19. Slowly pull straight transmission to clear engine. Remove transmission.

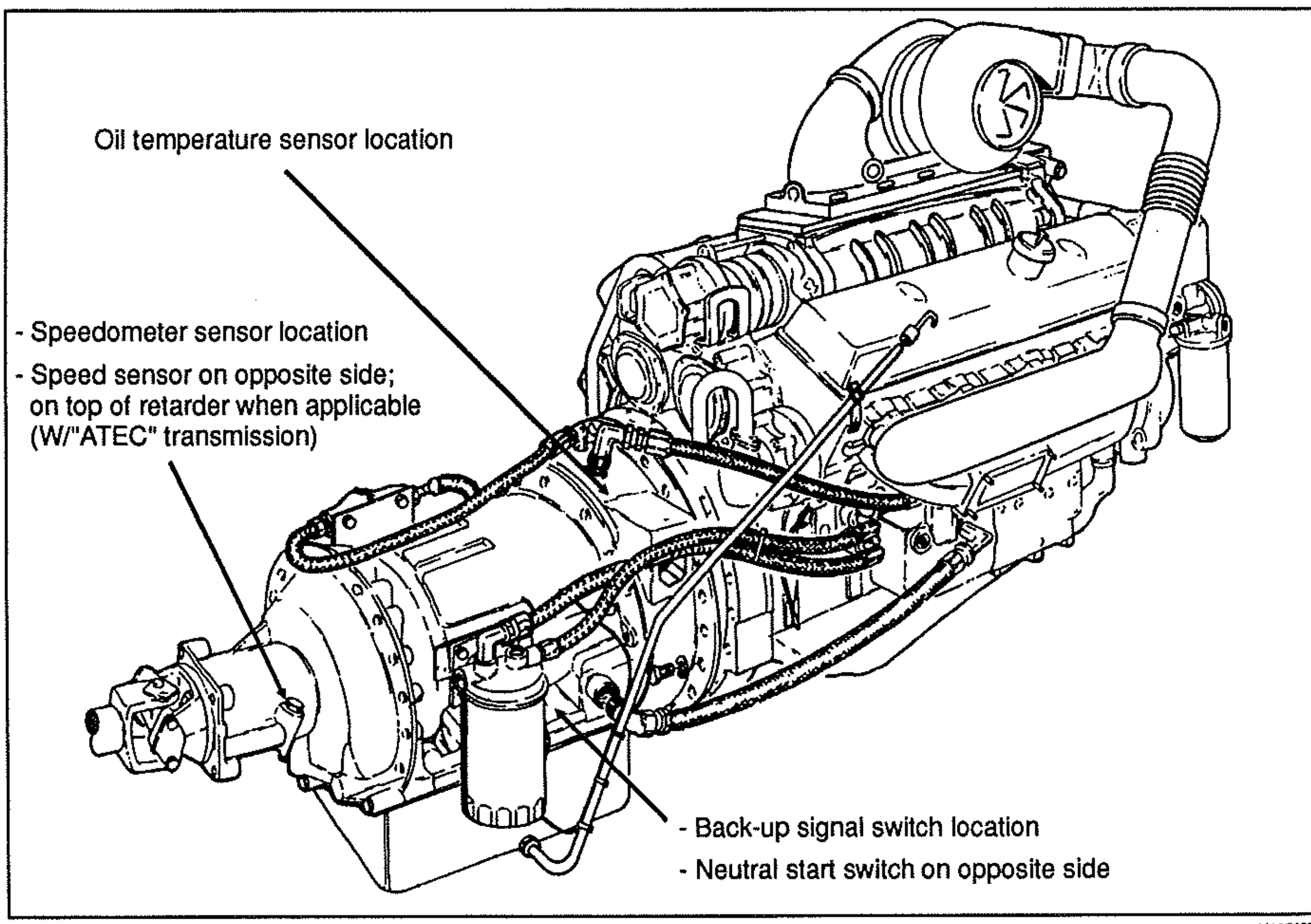


Fig. 76 - Automatic transmission

AUTOMATIC TRANSMISSION INSTALLATION

NOTE: For more clearance between the tag axle and transmission, the tag axle may be unloaded and jacked-up, or retracted (if applicable).

1. With the access plug removed, align one of the 12 attaching screw holes in the flexible plate with the access opening, right over the starter.

2. Place the transmission on a transmission jack.

3. Install a headless guide bolt 1/2"-20 into one of the 12 threaded holes for flexible plate attaching screws in the flywheel.

4. Lubricate the flywheel center pilot boss with molybdenum disulfide grease (Molycote G, or equivalent).

5. Raise transmission and position the flywheel pilot boss into the flexible plate adapter. Align the guide bolt previously installed in the flywheel with the flexible plate hole facing the access opening in the flywheel housing.

WARNING: Severe damages and/or personal injuries can occur if transmission and/or rear end of engine are not supported adequately.

6. Seat the transmission squarely against the engine flywheel housing. NO FORCE IS REQUIRED; if interference is encountered, move the transmission away from engine, then investigate the cause.

CAUTION: The torque converter housing must be seated against the flywheel housing prior to tightening any screw. DO NOT USE SCREWS TO SEAT THE HOUSING.

7. Start all torque converter housing screws, then tighten four of them gradually and in a criss-cross sequence around the housing. Tighten the remaining screws. Recommended torque is 45 lbf•ft (60 N•m).

8. Remove the guide bolt through the access opening in the flywheel housing. Replace it with a 1/2"-20 x 1" self-locking screw, finger tight. Start the remaining screws, then tighten to 95 - 115 lbf•ft (130 - 155 N•m). Place a wrench on crankshaft pulley attaching screw to turn the converter to gain access to the threaded holes.

CAUTION: Do not rotate crankshaft counterclockwise to avoid loosening the crankshaft pulley retaining screw.

9. Reinstall the access plug.

10. Install both rear supports of engine and transmission assembly to the transmission with the 12 screws (6 on each side), then tighten to 160 - 190 lbf•ft (220 - 255 N•m). This recommended torque applies to grade 8 screws.

11. Secure supports to cradle with applicable bolts, then tighten to 135 - 170 lbf•ft (180 - 230 N•m).

12. Remove jacks from under transmission and engine.

13. *"NON-ATEC"* TRANSMISSION:

a) Connect modulator line (steel-braided hose) to transmission.

b) Connect speedometer sensor, back-up signal switch and neutral start switch (refer to fig. 76).

c) Install shift cable.

NOTE: Refer to heading *"Gear Shift Linkage"* for proper adjustment.

14. *"ATEC"* TRANSMISISON:

a) Connect the main wiring harness.

b) Connect speed sensor (refer to fig. 76).

c) Connect the air supply line (steel-braided hose) to the retarder control valve (if applicable).

15. Connect oil temperature sensor (refer to fig. 76).

16. Connect the two transmission oil cooler hoses as previously identified during removal procedure.

17. Install the engine oil filter assembly to its bracket on the transmission (W/6V92).

18. Reinstall clamps, brackets, and replace locking ties that have been removed during removal procedure.

19. Install propeller shaft and its safety guard. Refer to section 09 *"Propeller Shaft"*.

20. Install transmission dipstick and filler tube.

21. Install cross member under transmission.

22. Install engine splash guards.

23. Install tag axle wheels.

24. Make sure that the drain plug is in place, then remove the transmission dipstick and pour approximately 30 US qt (28 l) of *"Dexron II"* or *"Mercon"* automatic transmission fluid through the filler tube. Check and adjust oil level as directed under heading *"Transmission Oil Level"*.

CAUTION: Do not overfill the transmission. Overfilling can cause oil aeration (milky appearance) and overheating. If overfilling occurs, drain oil as required to bring it to the proper level.

AUTOMATIC TRANSMISSION OVERHAUL

HT-740 and HT-754 Allison Transmissions

Refer to *"Allison Transmission HT-700D Series Service Manual SA 1270K".*

HT-748, HT-755 and HTB-755 Allison Transmissions

Refer to *"Allison Transmission HT-700D Series Service Manual SA 2004".*

GEAR SHIFT LINKAGE

Gear Shift Linkage Adjustment

Manual Transmission

With both the gear shift lever and transmission in the *"NEUTRAL"* position, adjust shim pack thickness on the gear shift linkage in order to obtain a distance of 1 7/32" - 1 3/8" (31 - 35 mm) between the shift rod bushing and coupling lever (refer to fig. 77).

NOTE: The gear shift lever is in *"NEUTRAL"* position when the center of universal joint is 9 1/2" (241 mm) from the center of shift lever housing front fixing hole.

Automatic Transmission (NON-ATEC)

With both the shift selector and transmission in *"NEUTRAL"* position, adjust swivel on cable end so it will enter the selector lever hole freely.

NOTE: The selector lever, on the transmission, is in *"NEUTRAL"* position at the second detent notch from its lowest position.

NOTE: The linkage should be adjusted so that the stops in the shift selector are positioned by the detents in the transmission.

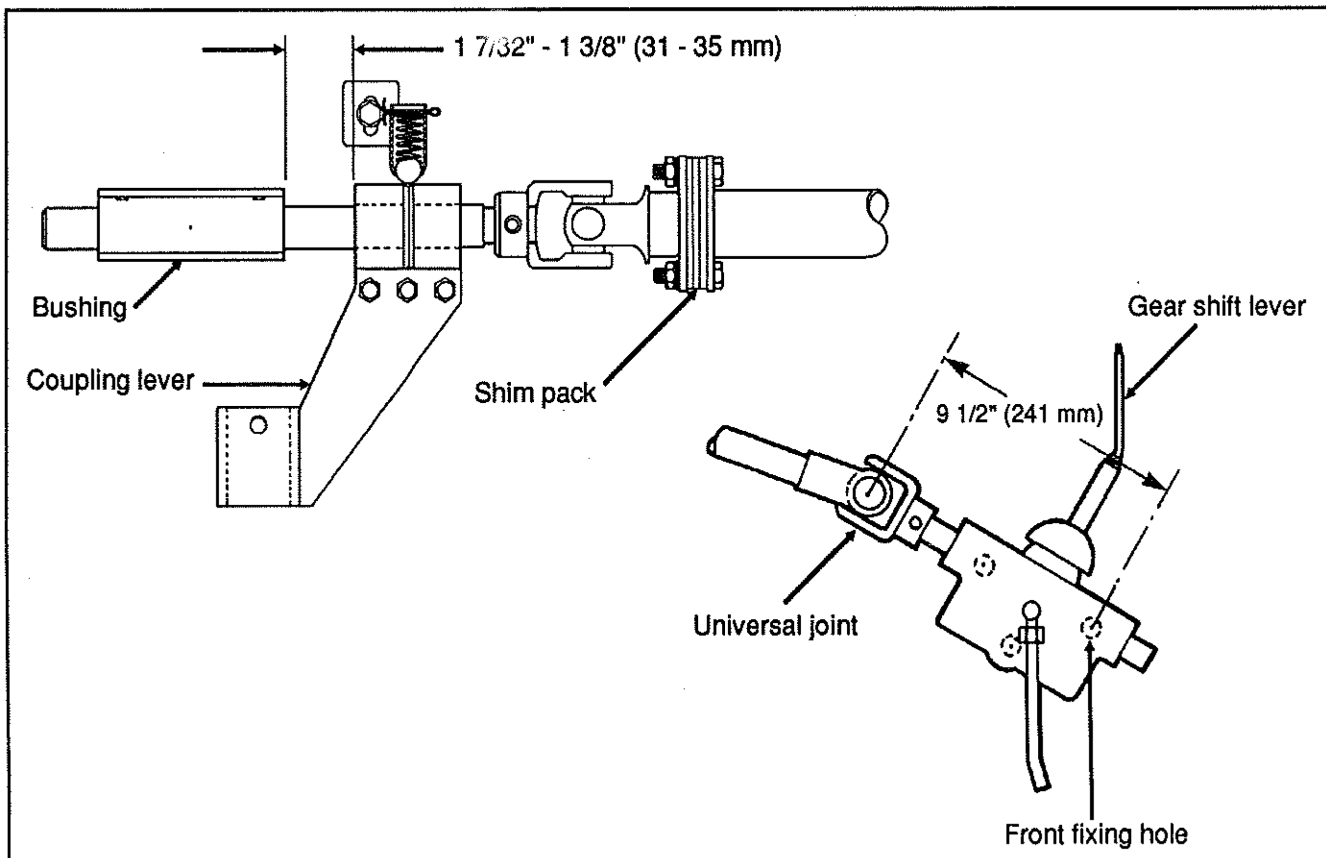


Fig. 77 - Gear shift lever in "NEUTRAL" position (manual transmission)

Gear Shift Linkage Maintenance

Manual Transmission

The shift lever housing, shift rod bushing and coupling lever pivot are provided with grease fittings. Under normal conditions, these should be serviced every 5000 miles (8000 km), and every 2500 miles (4000 km) under adverse conditions.

The four shift control rod universal joints are also provided with grease fittings, which should be serviced every 25000 miles (40000 km) under normal conditions, and every 12500 miles (20000 km) under adverse conditions.

A molybdenum disulphide grease is recommended (refer to section 24 "Lubrication").

TROUBLESHOOTING

Road Test

When locating and correcting troubles, a systematic procedure should be followed.

Road test whenever possible. Mechanics usually get second or third hand reports of trouble experienced with the unit, and these reports do not always accurately describe the actual conditions. Sometimes, symptoms seem to indicate trouble in the transmission, while actually the trouble may be caused by the axle, propeller shaft, universal joint, engine, etc.. This is especially true of complaints on noise. Therefore, before removing transmission or related components to locate trouble, always road test to check possibility that trouble may exist in other closely associated units. If the mechanic can drive, road testing will be more effective; however, just riding with the driver can be very informative.

Check Functioning Prior to Disassembly

A careful check of the shift lever and linkage must be made. They must be in good working condition if the transmission is expected to shift satisfactorily.

Many times the answer to the trouble is apparent when transmission is inspected prior to disassembly, but this evidence is often lost when the parts are separated. If possible, check the transmission prior to disassembly. Bear in mind that a careful inspection should be made as each disassembly step is performed.

Inspect Thoroughly During Disassembly

It is poor practice to disassemble a transmission as quickly as possible without bothering to examine the parts as they come down. It happens many times that a mechanic has completely disassembled a transmission and failed to find the cause of the trouble, because he did not bother to examine the parts as they came apart. After the transmission is disassembled, check the lubricant for foreign particles which often reveal sources of trouble that are overlooked during the disassembly.

Repair or Replace Worn Parts

Many times the parts or critical adjustments that have caused the trouble are not replaced or corrected, because the mechanic will only inspect and replace parts that have failed completely. All pieces should be carefully examined, because the broken parts are often the result and not the cause of the trouble. All parts that are broken or worn and no longer meet specifications should be replaced. It is suggested that a mechanic replaces parts that are worn to the extent that they do not have a long service life remaining. This avoids another teardown of the unit in the near future. It is also good practice, at this time, to make the changes or modifications recommended to bring the transmission up to date and increase the service life of the unit.

Troubleshooting (Manual Transmission)

Oil Leak

Possible Causes:

a) Oil level too high.

b) Wrong lubricant in unit.

c) Drain plug loose.

d) Speedometer sensor, back-up signal and neutral switches.

e) Transmission breather omitted, plugged internally, etc..

f) Cap screws loose, omitted or missing from gear shift housing, bearing caps, etc..

g) Seals defective, or wrong type of seals used.

h) Broken gaskets, gaskets shifted or squeezed out of position, pieces still under bearing caps, clutch housing, etc..

i) Cracks or holes in casting.

j) Also possibility that oil leakage could be from engine.

Noisy Operation

Noise is usually very elusive and generally not the fault of the transmission; therefore, mechanics should road test to determine if the driver's complaint of noise is actually in the transmission.

In numerous instances, drivers have insisted that the noise was in the transmission; however, investigations revealed the noise to be caused by one of the following conditions:

a) Engine rough at idle producing rattle in gear train.

b) Air leaks on suction side of induction system, especially with turbochargers.

c) Fan out of balance or blades were bent.

d) Defective vibration dampers.

e) Flywheel mounting screws loose.

f) Flywheel out of balance.

g) Crankshaft out of balance.

h) Engine mounts loose or broken.

i) Clutch assembly out of balance.

j) Universal joint angles out of plan or at excessive angle.

k) Universal joints worn out.

l) Propeller shaft out of balance.

m) Wheels out of balance.

n) Tire treads humming or vibrating at certain speeds.

Mechanics should try to locate and eliminate noise by other means than transmission removal or overhaul. However, if the noise appears to be in the transmission, try to break it down into the following classifications. If possible, determine what position the gear shift lever is in when the noise occurs. If the noise is evident in only one gear position, the cause of the noise is generally traceable to the gears in position.

Growl and Humming, or Grinding Noise

These noises are caused by worn, chipped, rough or cracked gears. As gears continue to wear, the grinding noise will be noticeable, particularly in the gear position that throws the greatest load on the worn gear.

Hissing, Thumping or Bumping-Type Noise

Hissing noises can be caused by bad bearings. As bearings wear and retainers start to break up, etc., the noise could change to a thumping or bumping.

Metallic Rattles

Engine torsional vibrations are transmitted to the transmisison through the clutch. In heavy-duty equipment, clutch discs with vibration dampers are not used, so a rattle, particularly in *"NEUTRAL"*, is common with diesel equipment. A defective or faulty injector can cause a rough or low idle speed and a rattle in the transmission.

Gear Whine

Gear whine is usually caused by lack of backlash between mating gears.

Improper lubricants or lack of lubricant can produce noises. Transmission with low oil level sometimes run hotter than normal, as there is insufficient lubricant to cool and cover the gears.

Noise in *"NEUTRAL"* Position

Possible Causes:

a) Insufficient lubrication.

b) Use of incorrect grade of lubricant.

c) Worn flywheel pilot bearing.

d) Misalignment of transmission.

e) Worn main shaft pocket bearing.

f) Worn or scored countershaft bearings.

g) Sprung or worn countershaft.

h) Excessive backlash in gears.

i) Scuffed gear tooth contact surface.

j) Worn or rough reverse idler gear.

Noise in Gear

Possible Causes:

a) Noisy speedometer gears.

b) Worn or rough main shaft rear bearing.

c) Excessive end play of main shaft gears.

d) Rough, chipped, or tapered gear teeth.

e) Refer to conditions listed under *"Noise in "NEUTRAL" position"*.

Walking or Jumping Out of Gear

Possible Causes

Interference or resistance in the shift mechanism may prevent full engagement of the clutch collar.

The mechanic must satisfy himself that the shift mechanism is satisfactory and that transmission is actually at fault. Also, does the gear hop occur on smooth or only on rough roads. A number of items that would prevent full engagement of gears are:

a) Improper linkage adjustment (shim pack thickness) that limits shift lever travel from the *"NEUTRAL"* position.

b) Gear shift housing and/or shift lever housing flimsy.

c) Shift linkage not secured properly at both ends.

d) Set screws loose at linkage universal joints or on shift forks inside transmission.

e) Worn or loose supports of engine and transmission assembly.

f) Transmission and engine out of alignment either vertically or horizontally.

g) Shift fork pads or groove in clutch collar worn excessively.

h) Worn splines on main shaft and/or clutch collar.

A few items which could move the gear or shaft out of proper position, particularly on rough roads are:

a) Shift rod poppet springs broken.

b) Shift rod poppet notches worn.

c) Shift rod bent or sprung out of line.

d) Shift fork pads not square with shift rod bore.

e) Excessive end play in drive gear, main shaft or countershaft, caused by worn bearings, retainers, etc..

f) Thrust washers worn excessively or missing.

Hard Shifting

An improperly operating clutch will interfere with the proper shifting of gears. It is important that the release mechanism also be used in proper working order. If the mechanic is sure that a full and complete clutch release is being made, the following could be a few of the possible causes for hard shifting complaints:

a) Driver not familiar with proper shifting procedure for this transmission.

b) Clutch or drive gear pilot bearing seized, rough, or dragging.

c) Clutch brake engaging too soon when clutch pedal is depressed.

d) Lack of grease in gear shift linkage.

e) Wrong lubricant used, causing buildup of sticky varnish and sludge deposits.

f) Improper linkage adjustment (shim pack thickness).

g) Badly worn or bent shift rods.

h) Clutch collar teeth burred over, chipped or badly mutilated due to improper shifting.

Sticking in Gear

Possible Causes:

a) Improper adjustment, excessive wear, or lost motion in gear shift linkage.

b) Clutch not releasing.

c) Clutch brake set too high on clutch pedal, thus locking gears.

d) Clutch collars tight on splines.

e) Chips wedged between or under splines of shaft and gear.

Bearing Failures

The service life of the transmission is governed by the life of the bearings. Majority of bearing failures can be attributed to vibration and dirt. Some of the more prominent reasons for unit removal with bearing failures are:

a) Wrong type or grade of lubricant.

b) Lack of lubricant.

c) Acid etch of bearings due to water in lube.

d) Worn out due to dirt.

e) Fatigue of raceways or balls.

f) Vibrations - breakup of retainer and brinelling of races - fretting corrosion.

g) Bearings tied-up due to chips in bearings.

h) Bearings setup too tight or too loose.

i) Improper assembly - brinelling bearing.

j) Improper fit of shafts or bore.

Troubleshooting (Automatic Transmission)

HT-740 and HT-754 Allison Transmissions

Refer to *"Allison Transmission HT-700D Series Service Manual SA 1270K".*

HT-748, HT-755 and HTB-755 Allison Transmissions

Refer to *"Allison Transmission HT-700 Series Troubleshooting Manual SA 1960".*

"ATEC" DIAGNOSTIC CODES

To read codes:

If a Diagnostic Data Reader (Kent-Moore "DDR" J-36500) is not available, set the *"ATEC Test"* switch, in the upper section of left front service compartment, to the *"ON"* position and observe the *"CHECK"* transmission light on dashboard. The *"CHECK"* transmission light will illuminate in a series of flashes separated by a pause, thus corresponding to a given code.

e.g. A code "12" consists of one flash, followed by a short pause, then two flashes in quick succession.

DIAGNOSTIC CODES AND SYSTEM RESPONSE FOR HT-700 SERIES ALLISON TRANSMISSION ELECTRONIC CONTROL

Code	Description	"DO NOT SHIFT" Light	Transmission Response	Clearing the "CHECK" Transmission Light
12	Low fluid pressure/level	OFF	Inhibits high gear	Next valid lube pressure/level
13	Low input voltage: in neutral	ON	Hold in neutral	Acceptable volts
	in range	OFF	May not shift	Not turned on
14	Forward pressure switch	OFF	Normal operation	Next valid signal
15	Reverse pressure switch	OFF	Normal operation	Next valid signal
21	Throttle sensor, in error zone	OFF	Full throttle assumed	ECU power OFF/ON
22	Speed sensor	ON	Drop LU & hold in gear	ECU power OFF/ON
23	Shift selector (primary)	OFF	Hold in last range	Next valid range
24	Fluid temperature:			
	cold below -25 °F (-32 °C) No Code	ON	Hold in neutral	Temp above -25 °F (-32 °C)
	cool -25 to 20 °F (-32 to -7 °C) No Code	OFF	Inhibits upshifts	Not turned on
	hot above 270 °F (132 °C)	OFF	Inhibits high gear	Temp below 270 °F (132 °C)
31	Shift selector (secondary)	OFF	Hold in last range	Next valid range
32	Wrong direction signal	OFF	Shift to neutral	Select neutral
33	Temp. sensor, in error zone	OFF	Normal operation	Next valid temp
34	PROM check	ON	Drop LU & hold in gear	ECU power OFF/ON
41	J solenoid (neutral) on test			
	Below specified output rpm*	OFF	May not shift	ECU power OFF/ON
	Above specified ouput rpm*	ON	Drop LU & hold in gear	ECU power OFF/ON
42	F solenoid (fwd/rev) on test			
	Below specified ouput rpm*	OFF	May not shift	ECU power OFF/ON
	Above specified output rpm*	ON	Drop LU & hold in gear	ECU power OFF/ON
43	D solenoid on test			
	Below specified output rpm*	OFF	May not shift	ECU power OFF/ON
	Above specified output rpm*	ON	Drop LU & hold in gear	ECU power OFF/ON
44	C solenoid on test			
	Below specified output rpm*	OFF	May not shift	ECU power OFF/ON
	Above specified output rpm*	ON	Drop LU & hold in gear	ECU power OFF/ON

Code	Description	"DO NOT SHIFT" Light	Transmission Response	Clearing the "CHECK" Transmission Light
45	B solenoid on test			
	Below specified output rpm*	OFF	May not shift	ECU power OFF/ON
	Above specified output rpm*	ON	Drop LU & hold in gear	ECU power OFF/ON
46	A solenoid on test			
	Below specified output rpm*	OFF	May not shift	ECU power OFF/ON
	Above specified output rpm*	ON	Drop LU & hold in gear	ECU power OFF/ON
51	G solenoid (lockup)	OFF	Possible loss of lockup	Valid signal
52	E solenoid (trim boost)	OFF	Possible full trim boost	Valid signal
53	H solenoid (neutral)			
	On test	OFF	May not shift	ECU power OFF/ON
	Off test	ON	Drop LU & hold in gear	ECU power OFF/ON
54	A,B,C,D,F & J solenoids off test	ON	Drop LU & hold in gear	ECU power OFF/ON
66	Bi-directional comm. link	ON	No modulation of shifts	Valid BDCL signal
69	Electronic control unit test	ON	Drop LU & hold in gear	ECU power OFF/ON

*** Speed specified by transmission.**

NOTE: For all errors, the *"CHECK"* transmission light will illuminate immediately.

Except for codes "22" and "69", lockup clutch will not be dropped until the retarder or compression brake (if applicable) shuts off.

Engine restart will usually turn *"ECU"* power off/on.

SPECIFICATIONS

Manual Transmission

Make . . . . Spicer

Model . . . . 1362-B Six-Speed

Ratio:

LO 8.53:1

1st 4.87:1

2nd 3.00:1

3rd 1.90:1

4th 1.33:1

5th 1.00:1

Rev 8.53:1

Fluid:

Type . . . . .Same as engine oil

Capacity . . . . 20.5 US qts (19 l)

Automatic Transmissions

Make	Allison Transmission
Model	HT-740 & HT-748 Four-Speed
	HT-754, HT-755 & HTB-755 Five-Speed
"ATEC" system	W/HT-748, HT-755 & HTB-755
Lockup clutch	W/all models
Output retarder	W/HTB-755

Rating:

Maximum input torque (net installed)	1300 lbf•ft (1762 N•m)
Input speed (full load gov.)	1900 rpm (min.)
	2400 rpm (max.)
Idle speed in range	500 rpm (min)

Ratio (HT-740 & HT-748):

1st	3.69:1
2nd	2.02:1
3rd	1.38:1
4th	1.00:1
Rev	6.04:1

Ratio (HT-754, HT-755 & HTB-755):

1st	3.69:1
2nd	2.00:1
3rd	1.58:1
4th	1.25:1
5th	1.00:1
Rev	9.65:1

Stall test:

W/6V92; 300 hp	1750 ± 150 rpm
330 hp	1890 ± 150 rpm
350 hp	1880 ± 150 rpm
W/8V92; 400 hp	1550 ± 150 rpm
450 hp	1700 ± 150 rpm
475 hp	1670 ± 150 rpm

Fluid:

Type	Dexron II or Mercon
Capacity	30 US qts (28,4 l)
Lubrication pressure; HT-740, HT-748, HT-754 & HT-755	25 psi (172 kPa) @ 1900 rpm
HTB-755	30 psi (205 kPa) @ 1900 rpm

Main oil pressure:

Idle 600 rpm in forward or reverse . . . . .90 psi (620 kpa) (min.)
Stall 1200 rpm in forward . . . . .140 - 175 psi (965 - 1205 kPa)
Stall 1200 rpm in reverse . . . . 235 - 270 psi (1620 - 1860 kPa)
1500 - 2000 rpm in all forward ranges . . . . .140 - 175 psi (965 - 1205 kPa)

OIL FILTER

Make . . . . A.C. Spark Plug Div. GMC
Type . . . . Disposable cartridge
Supplier number 25010643
Prevost number 57-1457

TORQUE CONVERTER

Type . . . . .Single-stage, poly-phase, 3-element
Model; HT-748, HT-754 & HT-755; W/6V92 . . . . TC 495
HT-740, HT-754, HT-755 & HTB-755; W/8V92 . . . . TC 496
Torque multiplication ratio (at stall); TC 495; W/HT-748, HT-754 & HT-755 . . . . 2.21:1
TC 496; W/HT-740 & HT-754 . . . . 1.83:1
TC 496; W/HT-755 & HTB-755 . . . . 1.81:1
Lockup clutch . . . . Automatic in selected ranges

OUTPUT RETARDER (if applicable)

Make . . . . Allison Transmission
Absorption capacity . . . . 550 bhp (410 kW) @ 2100 rpm

SERVICE BULLETINS AND SERVICE INFORMATION LETTERS

Service Bulletins and Service Information Letters will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of publications pertaining to this section should be noted below as soon as received. These should then be filed for future reference.

NUMBER	DATE	SUBJECT

09

PROPELLER SHAFT

CONTENTS OF THIS SECTION

DESCRIPTION . . . . 9 - 1
MAINTENANCE . . . . 9 - 2
DISASSEMBLY OF UNIVERSAL JOINT . . . . 9 - 6
CLEANING AND INSPECTION . . . . 9 - 6
REASSEMBLY . . . . 9 - 6
LUBRICATION . . . . 9 - 6
TROUBLESHOOTING . . . . 9 - 7
SPECIFICATIONS . . . . 9 - 8

DESCRIPTION

The propeller shaft transmits power from the transmission to the differential (refer to fig. 1). According to the engine size, two types of propeller shaft are available. The 6V92 engine is fitted with a *"Dana 1710"*, while the 8V92 is provided with a *"Dana 1810"*. Refer to heading *"Specifications"* at the end of this section for details. Both are tubular-type shafts provided each with two heavy-duty needle bearing universal joints.

Furthermore, a slip joint on the propeller shaft compensates variations in distance between transmission and differential, or between output retarder and differential. These variations are brought about by the rise and fall of the drive axle as the vehicle passes over uneven surfaces. The slip joint also eases removal of the transmission or the drive axle. Refer to figure 2.

The propeller shaft has a splined yoke at each end when transmission is connected directly to differential. When vehicle is equipped with a retarder, the propeller shaft extremity coupling with the retarder companion flange is fitted with a flanged yoke.

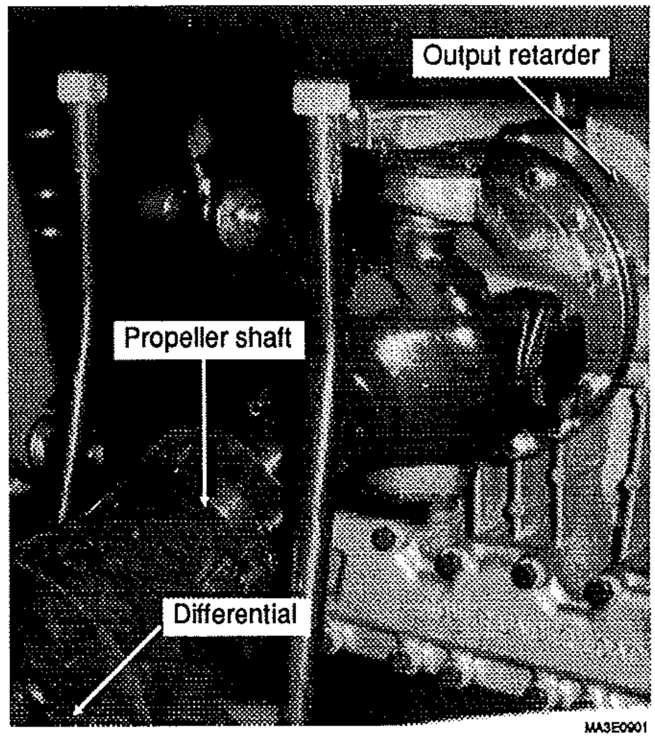


FIG. 1 - Propeller shaft installation between output retarder and differential

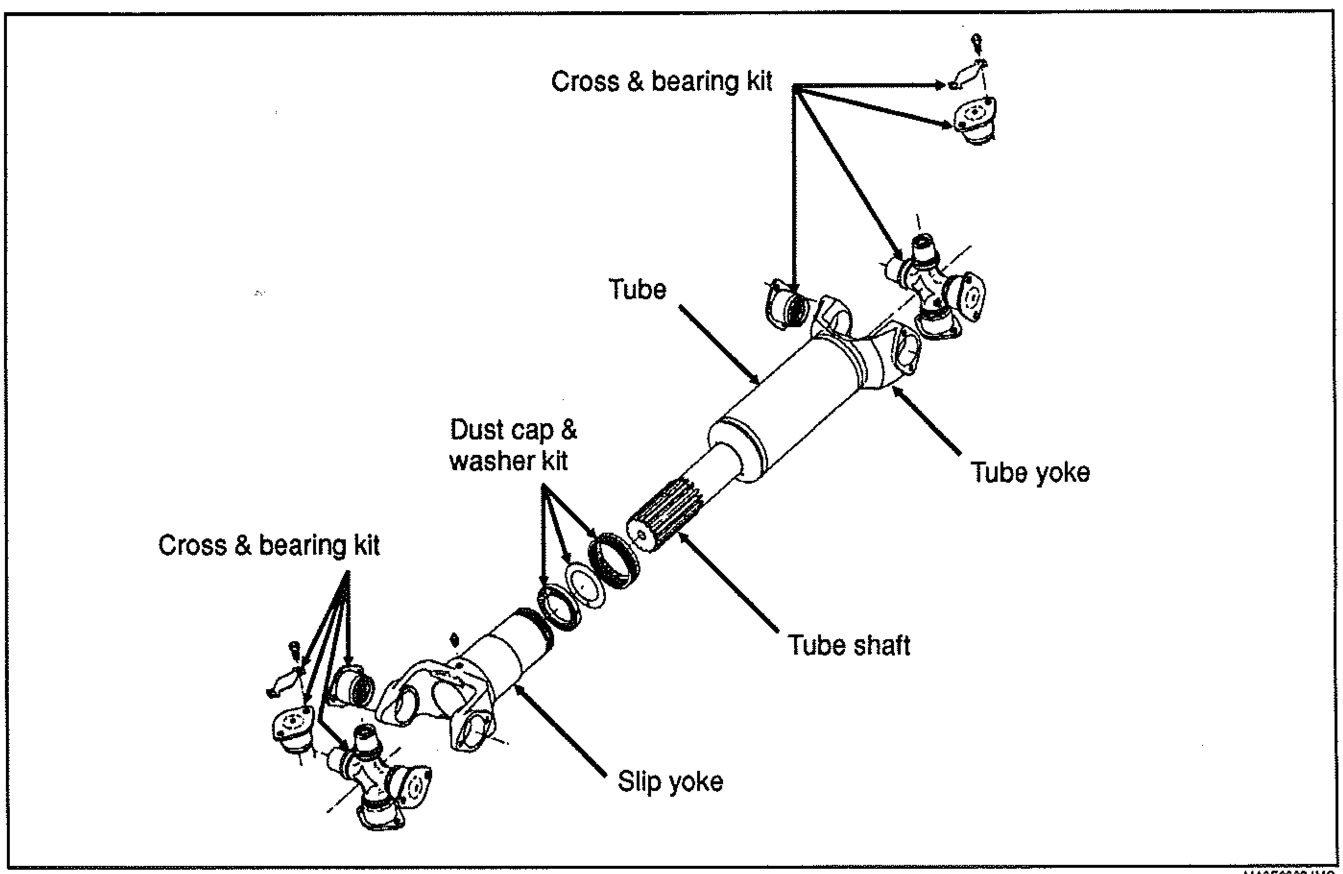


Fig. 2

MAINTENANCE

Lubrication

The universal joints and slip joint on both propeller shaft models are provided with lubrication fittings which should be serviced according to the *"Lubrication Chart and Service Check Points"* in section 24 (Lubrication) of this manual.

Inspection

Propeller shaft inspection should be performed during routine servicing, and when detecting a propeller shaft vibration or suspecting a problem. Check the following items when suspecting a propeller shaft problem.

1. Check output/input end yoke looseness.

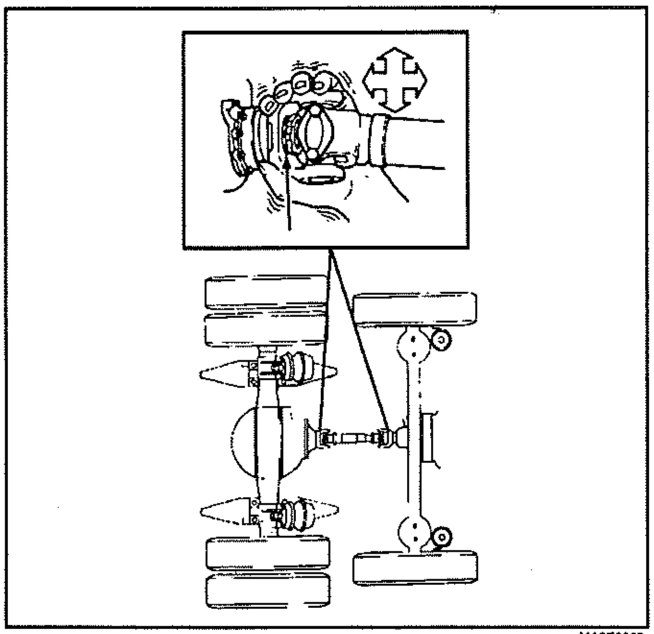


Fig. 3

a) Check the output and input end yokes on both the transmission and axle.

b) If loose, determine and correct cause.

c) If necessary, replace yoke.

2. Check output/input shafts for radial looseness.

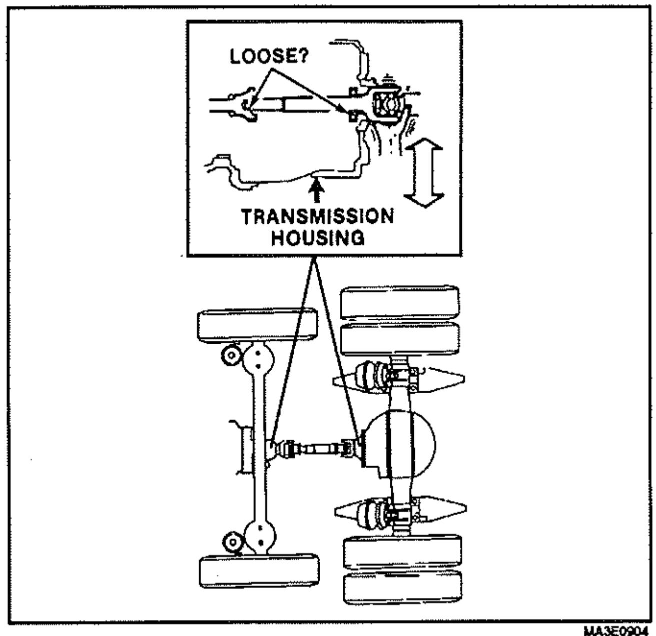


Fig. 4

a) If yoke ends are tight, check transmission output, axle input and output shafts for radial (up and down, side to side) looseness.

b) Check manufacturer's specifications for looseness limits, checking methods, and if necessary, replacement procedures.

3. Check for looseness at ends of U-joints.

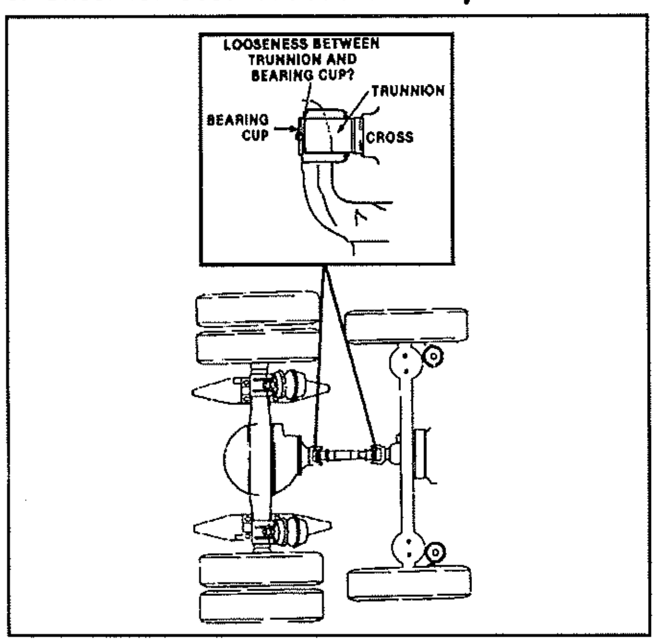


Fig. 5

a) Check for excessive looseness between bearing cups and trunnion ends of all U-joints.

b) Refer to manufacturer's specifications for limits.

c) Retorque or replace if necessary.

4. Check slip splines for excessive radial looseness.

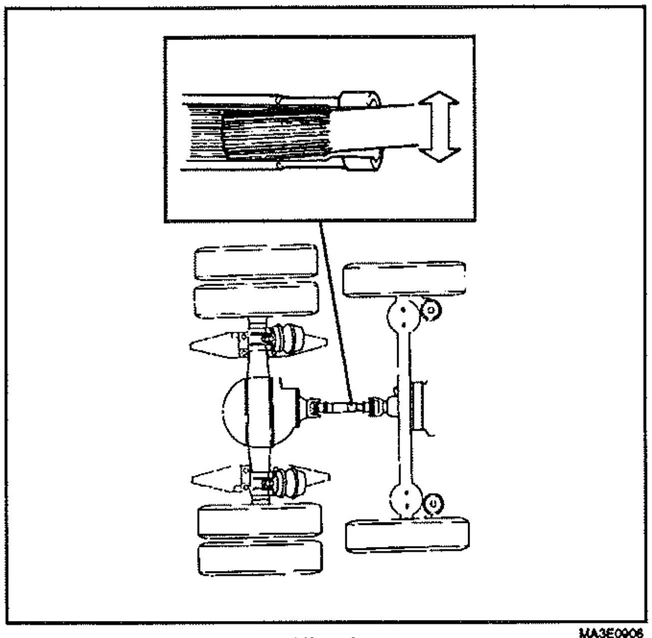


Fig. 6

a) Check slip splines for any radial looseness.

b) If there is any looseness, replace the worn spline members.

5. Check shafts for damage, or foreign material.

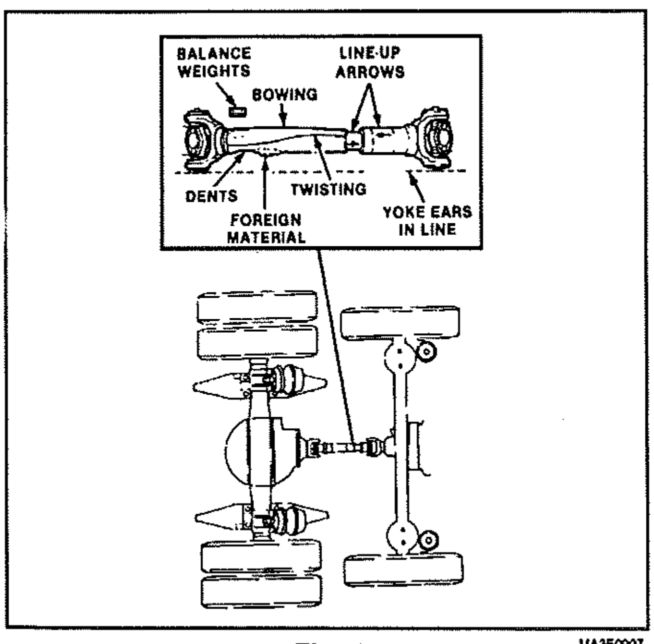


Fig. 7

a) Check shaft for dents or damage.

b) Check to be sure yoke lugs and line-up arrows are properly aligned, and that shaft is not bent or twisted.

c) Check to be sure there is no buildup of foreign material such as concrete, asphalt, or undercoating. If there is, remove any material buildup.

CAUTION: If shaft is warped or broken, it should be replaced. Welding of broken shafts is not recommended.

6. Check for loose or missing welch plug.

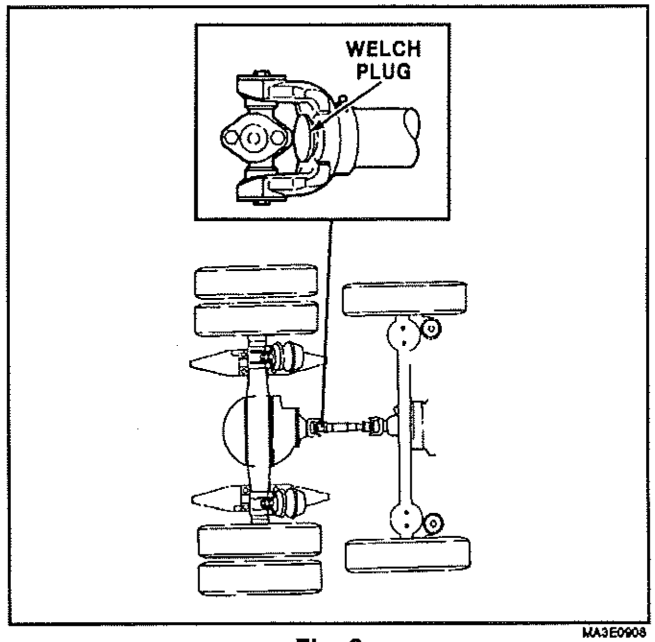


Fig. 8

a) Check to be sure that welch plug is not loose or missing. If it is, repair or replace it.

b) If welch plug is loose or missing, check propeller shaft length to be sure spline plug is not hitting welch plug and knocking it out.

Explanation of common damages

1. **Cracks:** Stress lines due to metal fatigue. Severe and numerous cracks will weaken the metal until it breaks.

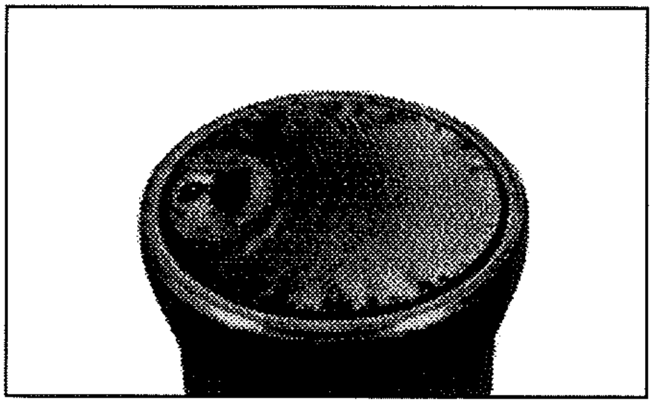


Fig. 9 - Cracks MA3E0909.IMG

2. **Galling:** Scraping off of metal or metal displacement due to friction between surfaces. Commonly found on trunnion ends.

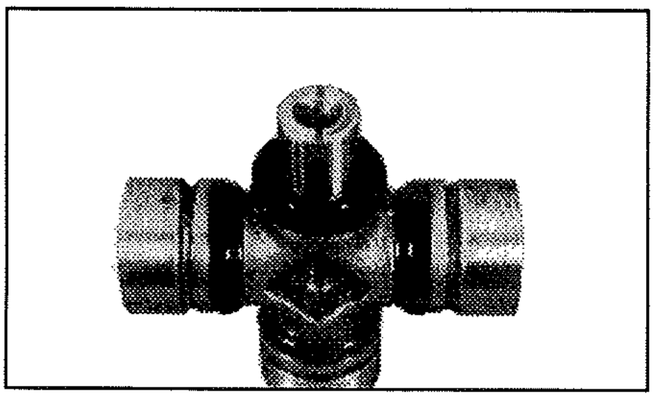


Fig. 10 - Galling MA3E0910.IMG

3. **Spalling (surface fatigue):** Breaking off of chips, scales, or flakes of metal due to fatigue rather than wear. It is usually found on splines and U-joint bearings.

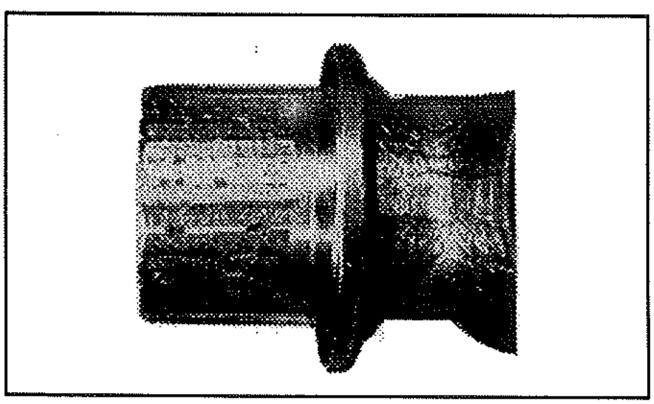


Fig. 11 - Spalling MA3E0911.IMG

4. **Pitting:** Small pits or craters in metal surfaces due to corrosion. If excessive, pitting can lead to surface wear and eventual failure.

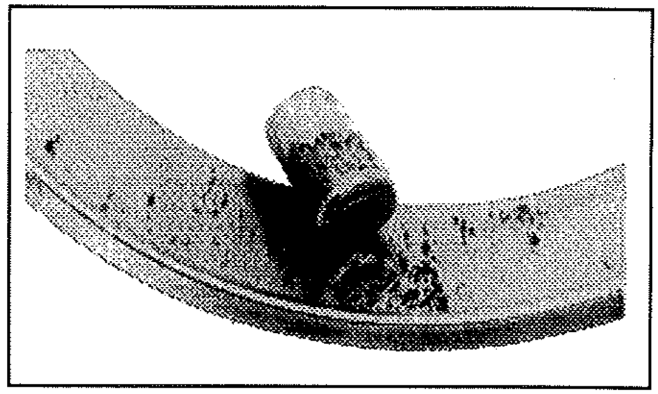


Fig. 12 - Pitting MA3E0912.IMG

5. **Brinelling:** Surface wear failure due to the wearing of grooves in metal. It is often caused by improper installation procedures. Do not confuse the polishing of a surface (false brinelling) where no structural damage occurs with actual brinelling.

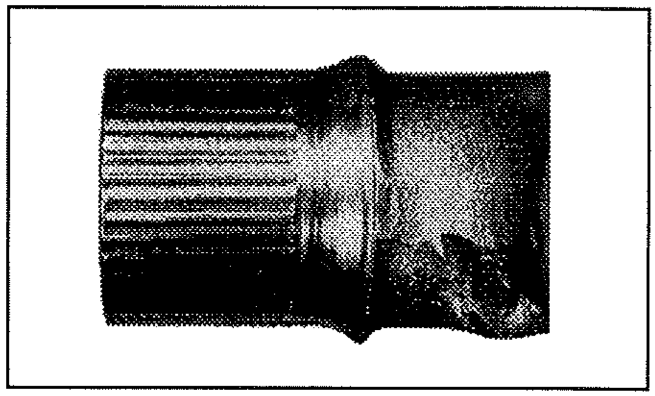


Fig. 13 - Brinelling MA3E0913.IMG

6. **Structural overloading:** Structural overloading is a failure caused by a load greater than the component can stand. A structural overload may cause propeller shaft tubing to twist under strain or it may cause cracks or breaks in U-joints and spline plugs.

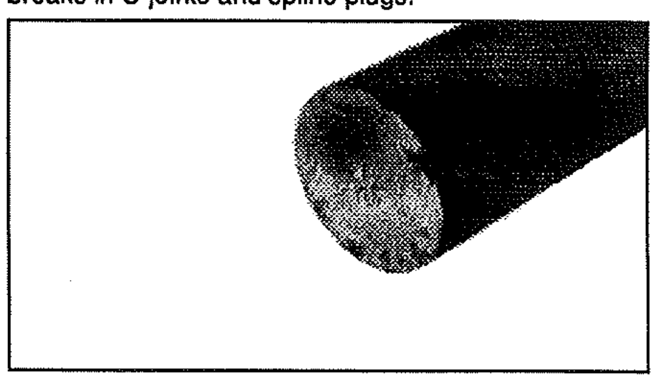


Fig. 14 - Structural overloading MA3E0914.IMG

Removal and replacement

NOTE: Before attempting to remove propeller shaft, note that slip yoke and shaft are marked with arrows to insure correct alignment of trunnions. If these arrows are not clearly identified, mark yoke and shaft before disconnecting slip joint.

Proceed as follows to remove propeller shaft from vehicle:

1. Unbolt and remove propeller shaft safety guard.

2. On vehicles equipped with retarder, remove bolts and nuts which attach propeller shaft flange yoke to retarder.

3. On vehicles without retarder, disconnect tube yoke from splined yoke by removing the two bearings from splined yoke. To proceed, remove the two cap screws retaining the bearing at each end of the splined yoke, as outlined under heading *"Disassembly of universal joint"*, later in this section. Refer to figure 15 for details.

CAUTION: Remove bearings slowly in order to retain loose bearing needles in the housing. If one or more needles is lost, replace complete bearing assembly. Never mix needles of a bearing with needles of another bearing.

4. To separate tube shaft from slip yoke, unscrew dust cap from slip yoke, telescope the propeller together at the slip joint, then the shaft can be removed.

CAUTION: In order to prevent entry of foreign material and loss of bearing needles, replace cross bearings to their proper positions and tape them together with the extremity.

5. Disconnect slip yoke from splined yoke by removing the two bearings from splined yoke.

6. Reverse removal procedure to replace propeller shaft.

NOTE: When replacing needle bearings, be sure to coat them with grease to retain them in their housing.

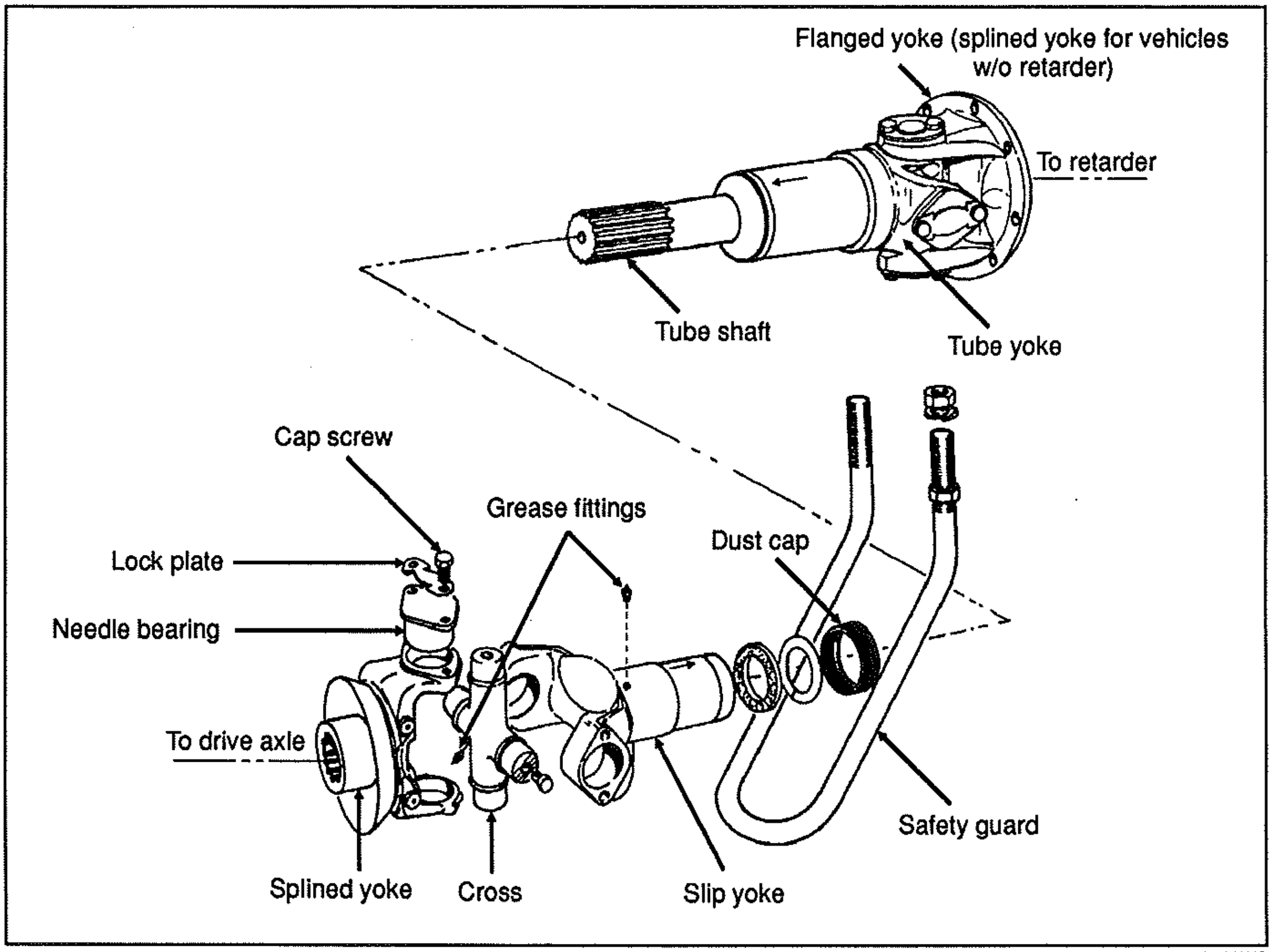


Fig. 15

DISASSEMBLY OF UNIVERSAL JOINT

1. Use a chisel or a screwdriver and bend tabs of lock plate away from cap screws.

2. Unscrew cap screws and remove lock plate.

3. Remove the needle bearings and retaining cap subassembly. Use a large pair of channel lock pliers on retaining cap edges, turn retaining cap and bearing subassembly. In the same time, lift upward to remove the subassembly from the journal trunnion diameter and out of the yoke hole.

4. Turn the joint over and tap with a plastic or rawhide hammer, the exposed end of the journal until the opposite needle bearing is freed. Use a soft round flat face drift approximately 1/32" (.79 mm) smaller in diameter than the hole in the yoke.

CAUTION: Never use a steel hammer when removing the bearings, and avoid dropping the bearings on the floor, as it may seriously damage the bearings.

5. Remove the journal cross by sliding it to one side of the yoke and tilting it over the top of the yoke lug.

CLEANING AND INSPECTION

Thoroughly clean grease from bearings, journals, and other parts. Clean all lubricant passages in the journal, and the lubrication fittings. Needle bearing assemblies may be soaked in a cleaning solution to soften hard grease particles. It is extremely important that bearing assemblies be absolutely clean and blown out with compressed air, since small particles of dirt or grit can cause rapid bearing wear. Do not attempt to disassemble needle bearings.

Bearing journal areas should be inspected for roughness or grooving. If light honing does not remove roughness, the entire bearing assembly should be replaced. Excessive wear of the needle bearing is indicated if the needles drop out of the retainer, or if marks are present on the journal bearing surface. In such case, replace bearing assembly.

NOTE: Universal joint repair kits are available for overhaul of these assemblies. Refer to parts manual.

Finally, inspect yokes for cracks, wear or distortion.

REASSEMBLY

Pack needle bearing assemblies with clean grease. Insert one trunnion of the journal into the yoke as far as possible from the inside, and tilt until opposite trunnion clears the yoke and drops into position. Install lubrication fittings and lubricate bearing approximately 1/3 full with the lubricant specified in the *"Lubrication Chart and Service Check Points"* annexed to section 24 *"Lubrication"*.

Insert bearing assemblies from outside of yoke and tap into place with a plastic hammer.

CAUTION: Do not use a steel hammer for this purpose.

The joints should move freely in the bearings and not bind. If new needle bearing assemblies are not being installed, care should be taken to replace bearing assemblies in the same locations from which they were removed. Install bearing caps, new lock plates, and cap screws. Tighten cap screws to a torque of 33-38 ft•lbs (45-52 N•m), then lock screws by bending lock plate tabs against cap screw heads.

LUBRICATION

Universal joints

To insure proper lubrication of all four bearing assemblies on universal joints, it is essential to add lubricant until it appears at all journal cross bearing seals. Refer to figure 16. This ensures removal of dirt particles and other contaminants that may find their way into the bearings and indicates that the bearings are fully lubricated.

Do not assume that bearing cavities have been filled with new lubricant unless flow is noticed around all four bearing seals.

Journal cross seals are designed to relieve. However, if all the seals do not *"pop"* when being lubricated, move the propeller shaft laterally in all four directions, and pull or push on the propeller shaft in the direction opposite to the journal cross seal not relieving, while lube gun pressure is being applied to the alemite fitting. An increase in line pressure may also be necessary.

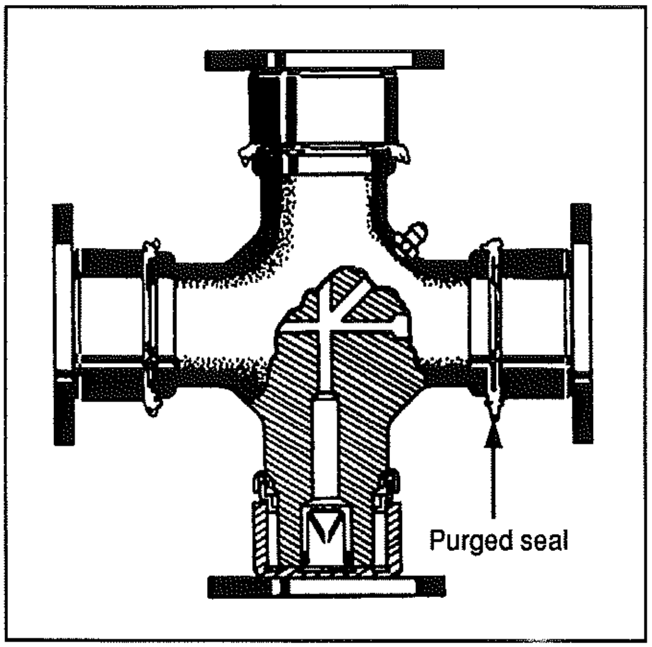


Fig. 16

Propeller shaft assembly

Factory assembled propeller shafts are lubricated prior to shipment. When installing spare part replacement assemblies, it is recommended that all universal joints be lubricated after installation of the propeller shaft prior introducing vehicle in service. High-quality extreme pressure (EP) grease is recommended for universal joints. Lithium-soap base greases meeting NLGI Grade 1 and 2 specifications are preferred. The use of greases that tend to separate and cake should be avoided. Refer to the *"Lubrication Chart and Service Check Points"* annexed to section 24 *"Lubrication"* for lubrication intervals and recommended grease.

Periodic lubrication

Relubrication cycles for propeller shaft universal joints and slip joint vary with operating conditions, such as high ambient temperatures or extremely rough road conditions. In such case, lubrication intervals must be increased (i.e. a 5,000 mile interval (8 000 km) must be divided by 2, thus resulting in a 2,500 mile interval (4 000 km)).

TROUBLESHOOTING

Noise and vibration in the drive line often originate from the propeller shaft. Noise and vibration originating in the universal joint and propeller shaft assembly appear only at certain speeds, and usually come and go as the vehicle speed is increased or decreased. Noises produced by the rear axle, on the other hand, are generally present throughout the vehicle's speed range.

When propeller shaft assembly noise and vibration become excessive, the cause should be determined and corrected immediately, since rear axle pinion failure is often a direct result. Propeller shaft noise and vibration often appears to originate in the rear axle.

Common causes of propeller shaft and universal joint vibration are:

a) Propeller shaft assembly out of balance

b) Excessive flange runout or distorted yokes

c) Loose yoke nut

d) Universal joint yoke misalignment.

If an out-of-balance condition is suspected, the assembly may be tested using a balancing machine. If a balancing machine is not available, a check of each component of the assembly may be made on the vehicle. Substitute one component at a time, road testing as each new part is installed. Continue this procedure until the entire assembly meets the required standard of performance.

SPECIFICATIONS

PROPELLER SHAFTS

For vehicles equipped with 6V92 engine

Make . . . . Spicer Clutch Div. (DANA)
Serie 1710
Splines 16
U-joint kit, Supplier number 5-280X
U-joint kit, Prevost number 58-0031
Dust cap & washer kit, Supplier number 6.3-86-18
Dust cap & washer kit, Prevost number 58-0046

Propeller shafts for vehicles equipped with manual transmission:
Supplier number 90775-2124
Prevost number 58-0032

For vehicles equipped with HT-754 or HT-755 automatic transmission:
Supplier number 905569-1016
Prevost number 58-0033

For vehicles equipped with HT-740 or HT-748 automatic transmission:
Supplier number 905569-1324
Prevost number 58-0034

For vehicles equipped with 8V92 engine

Make . . . . Spicer Clutch Div. (DANA)
Serie 1810
Splines 16
U-joint kit, Supplier number 5-281X
U-joint kit, Prevost number 58-0043
Dust cap & washer kit, Supplier number 6.3-86-18
Dust cap & washer kit, Prevost number 58-0046

Propeller shafts for vehicles equipped with manual transmission:
Supplier number 905116-1000
Prevost number 58-0041

For vehicles equipped with HT-754 or HT-755 automatic transmission:
Supplier number 908024-1
Prevost number 58-0035

For vehicles equipped with HT-755 automatic transmission and retarder:
Supplier number 907877-5
Prevost number 58-0059

SERVICE BULLETINS AND SERVICE INFORMATION LETTERS

Service Bulletins and Service Information Letters will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of publications pertaining to this section should be noted below as soon as received. These should then be filed for future reference.

NUMBER	DATE	SUBJECT

10

FRONT AXLE

CONTENTS OF THIS SECTION

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DESCRIPTION

The H3-40 vehicle front axle assembly is a tubular-type design manufactured by Rockwell and consists of a rectangular-beam construction using tempered seamless steel tube for its center section, with heat-treated, forged steel knuckle pin ends. Knuckle pin ends are integral parts of the axle center.

Steering knuckles are bushed in the upper and lower pin bosses, so they may turn freely about the pins. Delrin *"Easy steer"* bushings with diagonal grooves give complete flushing action during lubrication. Grease fittings are installed at both upper and lower knuckle pin bosses. Covers and plugs prevent dust and moisture from entering bushings and serve as seals.

On this axle, the steering knuckle assemblies are connected to each other by a tie rod, which is threaded at each end and held securely in position by clamps. Right-hand and left-hand threads are provided to simplify toe-in adjustment. Stop screws installed at each end of axle center limit turning angle of front wheels.

Wheel bearings, air suspension, steering, and brake parts which are mounted on the front axles are described in the applicable sections of this manual.

LUBRICATION

Perform periodic lubrication according to the recommendations given in *"Rockwell Maintenance Manual No. 2 - Front Non-Drive Steering Axles"* annexed to the end of this section Points which require lubrication on the front axles, are shown on the lubrication and servicing chart annexed to section 24. These points, such as steering knuckle pins, tie rod ends and drag link ends are provided with grease fittings for pressure lubrication.

MAINTENANCE

A periodic inspection of the front axle assembly should be made to check that all bolts are tight, and that no damage and distortion have taken place. Suspension support stud nuts, U-bolt nuts, tie rod arms, steering arm nuts, and stop screws should be checked and tightened if necessary to the torque specifications given at the end of this section. Check also the condition of the steering knuckle pins and bushings. In case of excessive looseness, the bushings and pins should be replaced.

Any looseness in the steering linkage under normal steering loads is a sufficient cause to check immediately all pivot pins for wear, regardless of accumulated mileage. Steering linkage pivot points should be checked each time the axle assemblies are lubricated. Looseness at the steering linkage pivot points can be visually detected during rotation of the steering wheel.

Steering knuckles, knuckle pins, and bushings may be replaced without removing the axle from the vehicle. However, if extensive overall work of the front axle is necessary, the axle should be removed.

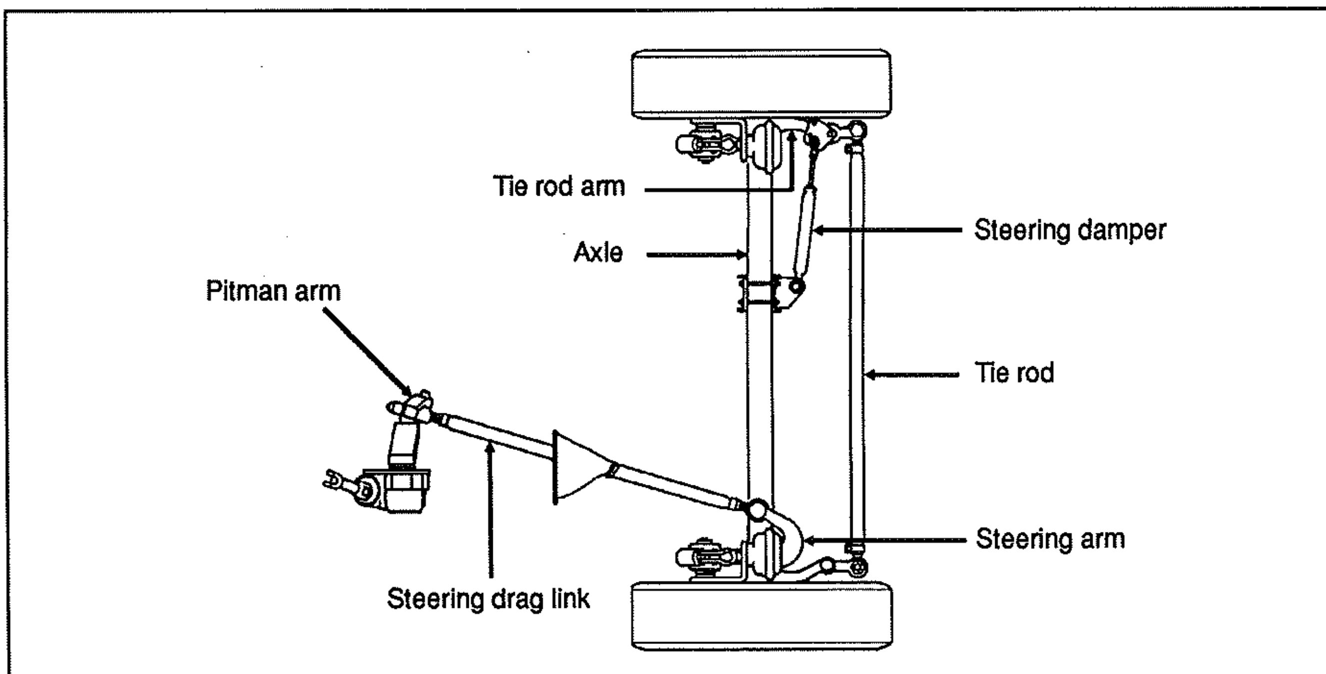


Fig. 1

REMOVAL AND REPLACEMENT

The following procedure deals with the removal of the front axle assembly. The method used to support the axle and suspension components during removal and disassembly, depends upon local conditions and available equipment.

Removal

1. Raise the vehicle by its jacking points on the body (see Section 18 (Body) under heading *"Vehicle jacking points"*) until vehicle body is approximately 20" (508 mm) from the floor. Place jack stands under frame. Remove the wheels and tires (if required, refer to section 13 Wheels, Hubs and Tires).

2. Exhaust compressed air from the air supply system by opening the drain valve of each air reservoir.

3. Install jacks under axle jacking points to support the axle weight.

WARNING: To help prevent personal injury caused by the axle rolling off the jacks, jack lifts should be equipped with U-adapters, or similar precautions should be taken.

4. Disconnect the steering drag link from the steering arm.

5. Remove ABS sensors (if vehicle is so equipped) from their location into the hubs.

6. Disconnect the height control valve link from its support on axle.

7. Disconnect the hoses from brake chambers.

NOTE: Position the air lines so they will not be damaged when removing the axle.

8. Remove sway bar links from suspension supports as outlined in section 16 (Suspension) under *"Sway bar removal"*.

9. Remove the two shock absorbers as outlined in section 16 (Suspension) under *"Shock absorber removal"*.

10. Remove the lower, upper, and transversal radius rod supports from subframe as outlined in section 16 (Suspension) under *"Radius rod removal"*.

11. Remove the two retaining nuts from each air spring lower mounting plate.

12. Use the jacks to lower axle. Carefully pull away the jacks and axle assembly from under the vehicle.

Replacement

Reverse removal procedure to reinstall the axle. Be certain the air spring mounting plates are clean.

NOTE: Refer to section 16 *"Suspension"* for proper tightening torques of suspension components.

CAUTION: Be sure to reinstall the drag link clamp in the same angular position in order to avoid interference with axle components.

DISASSEMBLY OF FRONT AXLE

Disassembly of front axle is explained under applicable heading in *"Rockwell Maintenance Manual No. 2 - Front Non-Drive Steering Axles"* annexed to this section.

PREPARATION FOR ASSEMBLY

Preparation for assembly of front axle is explained under applicable heading in *"Rockwell Maintenance Manual No. 2 - Front Non-Drive Steering Axles"* annexed to this section.

ASSEMBLY OF FRONT AXLE

Assembly of front axle is explained under applicable heading in *"Rockwell Maintenance Manual No. 2 - Front Non-Drive Steering Axles"* annexed to this section.

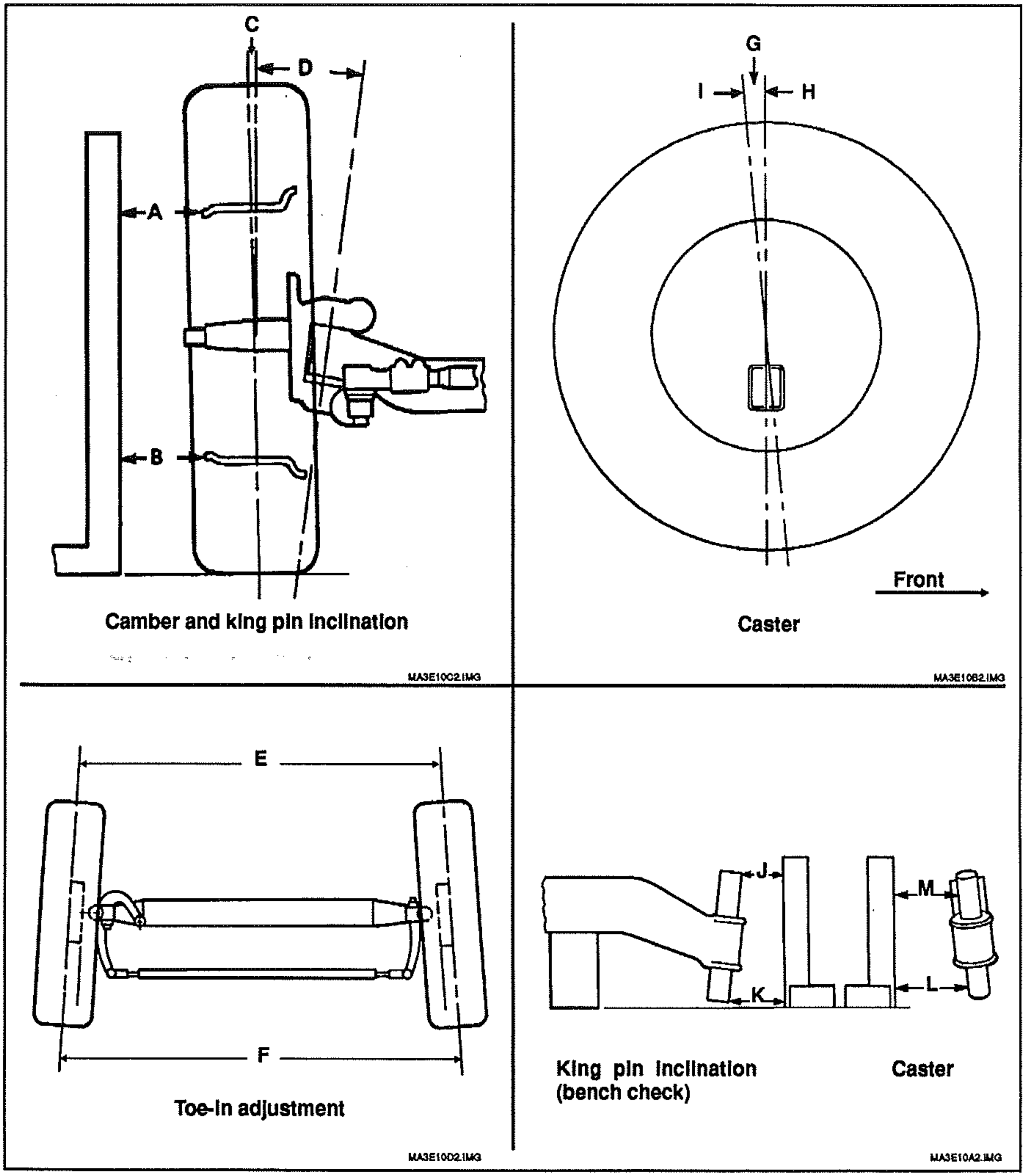
TROUBLESHOOTING GUIDE

A troubleshooting guide of front axle is given in *"Rockwell Maintenance Manual No. 2 - Front Non-Drive Steering Axles"* annexed to this section.

FRONT END ALIGNMENT

Correct front end alignment must be maintained for ease of steering and satisfactory tire life. Road shocks, vibrations, normal stresses and strains on the front end system under average operation can result in loss of front end alignment.

If incorrect front end alignment is suspected, front wheel balance should first be checked to ensure that the difficulties are not originating from out-of-balance front wheels. A check of tire inflation, wheel installation and run-out, wheel bearing adjustment, tie rods and drag link end wear should also be made. Correct front end alignment can only be maintained when parts in the steering knuckle are in satisfactory condition.



B minus A . . . . Camber (Inches)
C . . . . Camber (Degrees)
D . . . . King Pin Inclination (Degrees)
F minus E . . . . .Front End Toe-In (Inches)
G . . . . Caster angle (Degrees)
H . . . . Vertical
I . . . . Centerline of King Pin (Knuckle)
K minus J . . . . .King Pin Inclination (Inches)
L minus M . . Caster (Inches) (measured at front of axle)

Refer to heading *"Specifications"* later in this section for numerical values.

Fig. 2 - Front wheel alignment chart

FRONT END INSPECTION

Before checking front end alignment, inspect the following points:

1. Check that vehicle is at normal ride height. Refer to section 16 (Suspension) under heading *"Suspension height adjustment"*.
2. Check tires for proper inflation.
3. Check wheel installation and run-out.
4. Check wheel bearing adjustment.
5. Check tie rod and drag link ends for looseness.
6. Check knuckle pins for looseness.

FRONT WHEEL CAMBER

Description

Camber is the amount of degrees that front wheels are tilted outward at top from the vertical plane (see "C" fig. 2).

A reverse or *"negative"* camber is an inward inclination of wheels at the top. Camber variations may be caused by wear at the wheel bearings wheel knuckle bushings, or bent suspension parts. If camber is extreme, improper steering (steering ease is affected by any deviation from proper camber) and uneven tire wear will result. Excessive positive camber results in irregular wear of the tires at the outer shoulders, and negative camber causes wear at the inner shoulders.

Camber check

Before checking camber, check wear at knuckle pins according to step 1.

1. Jack slightly front of vehicle, pull bottom of wheel outward and take a camber reading. If reading varies more than 1/4 of 1 degree, perform adjustments given in step 2.
2. Adjust the wheel bearings and repeat the check. If reading still varies over 1/4 of 1 degree, replace steering knuckle bushings and knuckle pins as instructed in front axle *"Rockwell Maintenance Manual No 2 - Front Non-Drive Steering Axles"*, annexed to the end of this section.
3. Check the wheel run-out as instructed in section 13 *"Wheels, Hubs and Tires"*. If run-out is excessive, straighten or replace wheel(s).
4. With normal weight of vehicle on a level surface, place front wheels on turning plates in a straight ahead position. Attach alignment gauge to each wheel spindle. Record the camber readings for each wheel and compare with specifications. If camber gauge is not available, readings can be taken as shown on the *"Front wheel alignment chart"* in figure 2. Place square as illustrated and measure distances "A" and "B". Distance "B" should exceed distance "A" by the specified amount. Camber readings of R.H. wheel should not vary over 3/32" (2,38 mm) from camber readings of L.H wheel. If final camber reading is incorrect, either steering knuckle or axle center is bent.
5. To determine which part is bent, check knuckle pin inclination (K minus J) as shown on the *"Front wheel alignment chart"* in figure 2 or "D". If knuckle pin inclination is correct, the trouble is a bent steering knuckle which should be replaced.

FRONT WHEEL TOE-IN

Description

Wheel toe-in is the degree (usually expressed in fractions of an inch) to which the forward part of the vehicle front wheels are closer together than the rear part, measured at hub height with the wheels in the normal *"straight ahead"* position of the steering gear. Incorrect toe-in results in excessive tire wear caused by side slippage and also steering instability with a tendency to wander. Toe-in may be measured from center of tire treads or from inside of tires. Take measures at both front and rear of axle (see "E" and "F" on the *"Front wheel alignment chart"* in fig. 2).

When setting *"toe-in"* adjustment, the front suspension must be neutralized; that is, all component parts must be in the same relative position when making the adjustment as they will be when in operation. To neutralize the suspension, the vehicle must be rolled forward approximately ten feet. By rolling the vehicle forward, all tolerances in the front suspension are taken up and the suspension is then in its normal operating position. Neutralizing the front suspension is extremely important, especially if the vehicle has been jacked up in order to mark the tires, otherwise the front wheels will not return to their normal operating position due to the tires gripping the floor surface when the vehicle jack is lowered.

NOTE: *"Toe-In"* measurements must be taken at the horizontal axis of the wheel.

Checking and correcting front wheel toe-in

1. Check the camber adjustment and change worn parts is required.

2. Jack up the front axle.

3. Use paint or chalk and whiten the center area of front tires around the entire circumference.

4. Position a scriber or pointed instrument against the whitened part of each tire and rotate the tires. The scriber must be held firmly in place so that a single straight line is scribed all the way around the tire.

5. Lower vehicle on floor and then move the vehicle backward and then forward approximately ten feet, in order to neutralize front suspension.

6. Position wheels perpendicular to axles by placing pins on axle (see fig. 3); measure the distance between pin and rims on each side. The distance should be the same on each side. If not, adjust distance by pushing inside or outside of tires as required. For example, if the distance on one side is 7 1/4" and is equal to 7" on the other side, the final reading should be 7 1/8" on each side.

7. Position trammel bar at rear of tires, adjust pointers to line up with scriber lines and lock in place (scale should be set to zero). Pointers must be raised to spindle height on the tire.

8. Position the trammel bar at front of tires. Adjust scale end so that pointers line up with scriber marks.

9. Read toe-in (or toe-out) from scale (see fig. 4).

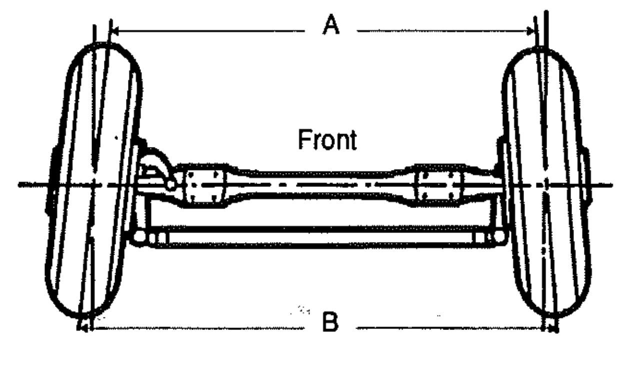


Fig. 4

MA3E1004.IMG

10. These two measurements must be taken at the same height above the floor. Toe-in (or toe-out) is the difference between the measurements taken at the front and rear of the tires (see fig. 4). The toe-in measurement should be 3/32" ± 1/32" (2,4 mm ± 0,8 mm).

NOTE: The same measurements can be taken with a steel tape at spindle height.

11. If an adjustment is necessary, loosen cross tube clamps, rotate cross tube as required and tighten clamp bolts securely. Refer to heading *"Specifications"* at the end of this section for correct clamp bolt torque. Move vehicle backward and then forward about ten feet. This is particularly important when setting the toe-in on vehicles equipped with radial tires.

12. Recheck toe-in setting to make sure it is correct.

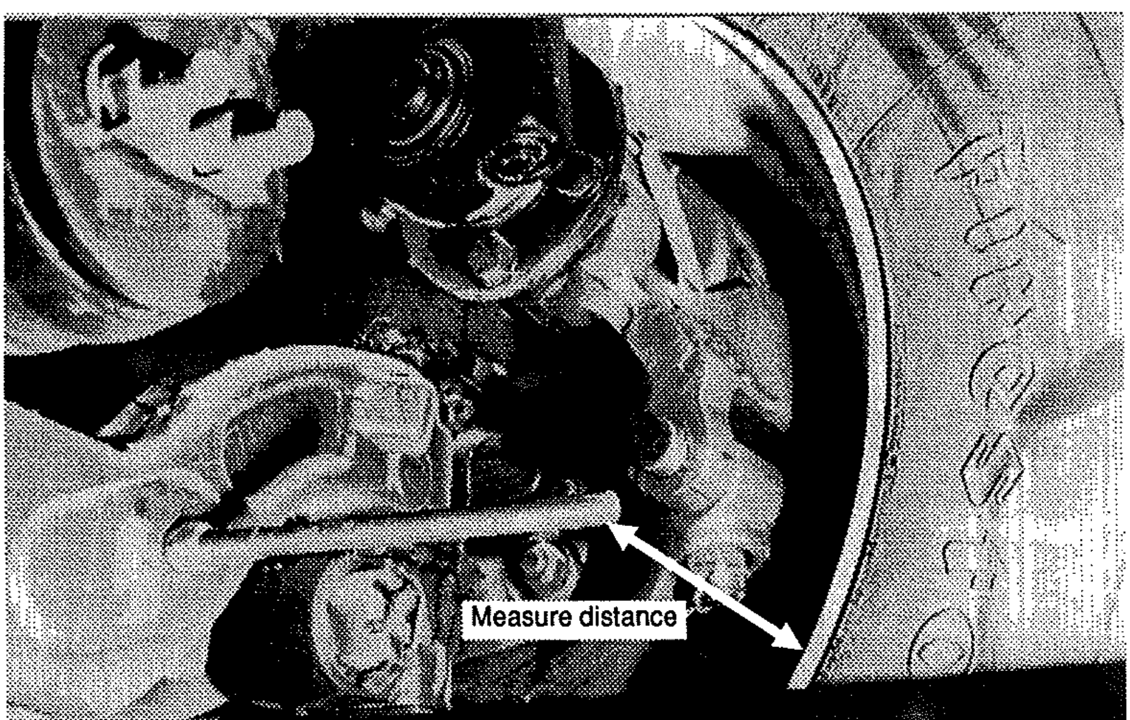


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Fig. 3 - Pin installation on axle

FRONT WHEEL CASTER

Description

Positive caster is the rearward tilt from the vertical of the knuckle pin. Negative caster is the forward tilt from the vertical of the knuckle pin. This vehicle is designed with positive caster. The purpose of caster angle is to give a trailing effect. This results in a stabilized steering and a tendency of the wheels to return to the straight ahead position after taking a turn.

Excessive caster results in hard steering around corners. A shimmy may also develop when returning to the straight ahead position (pulling out of curves).

Insufficient caster will cause wandering and steering instability. Caster variations may be caused by a bent axle, tilting or distortion of the side suspension supports, damaged radius rod bushings, or unequal tightening of the front and rear suspension support bolts. Incorrect caster must be corrected by replacing the damaged suspension parts. A precision instrument should be used to measure caster.

NOTE: The caster of this vehicle is factory set and is nonadjustable. However, if after replacing damaged parts on vehicle or in case of improper caster due to an irregular setting, the caster of front axle can be adjusted by means of shims on the upper radius rod attachments (axle side) in order to obtain minor adjustment.

PITMAN ARM

Removal (clamp bolt type)

1. Remove cotter pin, nut and washers (2) from drag link ball stud at pitman arm.

2. Disconnect drag link from pitman arm, using jaw style pullers (pressure screw type).

WARNING: Always wear an approved eye protection equipment when operating pullers.

CAUTION: Do not drive pitman arm on or off pitman shaft as this can damage the steering gear.

Heating of components to aid in disassembly is not allowed because it has detrimental effect on axle components and steering linkages.

3. Remove pitman arm clamp bolt nut, washer, and bolt.

4. Check the radial position of the pitman arm in relation to the sector shaft prior removal of pitman arm.

5. Add reference marks to the arm and shaft if necessary to insure correct alignment at reassembly.

6. Remove pitman arm. A chisel will help you loosen the pitman arm. Use only a puller if you cannot remove manually the pitman arm.

Installation

1. Position pitman arm on sector gear shaft with reference marks aligned, while ensuring the clamp bolt groove is matching.

2. Install bolt, washer and nut, then tighten nut to 280-300 ft•lbs (380-408 N•m).

3. Connect drag link to pitman arm. Install washers (2), nut and tighten to 200-220 ft•lbs (272-300 N•m). Afterwards, install a new cotter pin.

Adjustment

1. Disconnect the drag link from pitman arm, then center steering wheel by dividing in two the total number of steering wheel turns. Scribe a reference mark on steering gearbox at the center previously determined.

2. Using a protractor, check the angle of the pitman arm (refer to fig. 5 for details).

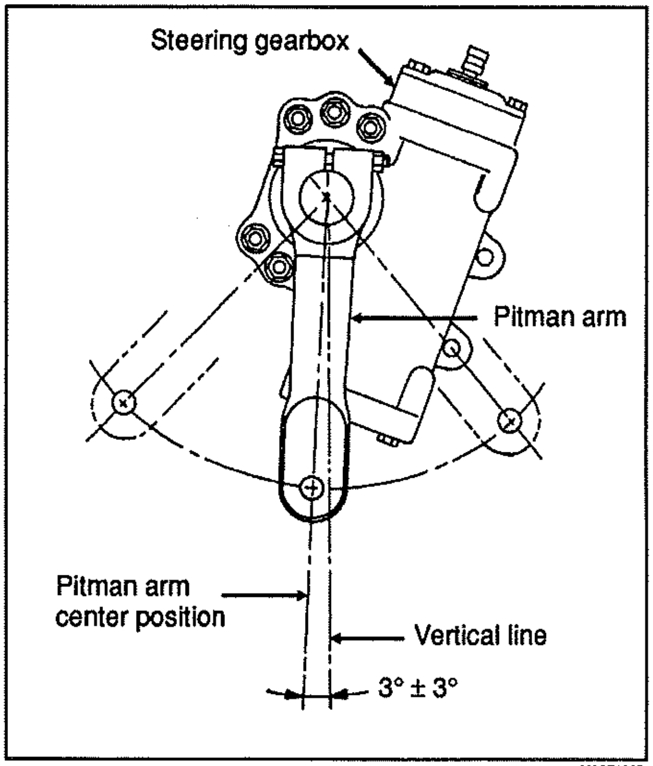


Fig. 5 - Pitman arm adjustment

3. The pitman arm should be adjusted to an angle of 3° ± 3° in relation with the vertical axis (toward rear of vehicle). If not, unscrew and remove bolt, nut and washer. Remove the pitman arm according to the procedure outlined under previous heading *"Pitman arm removal"*, then adjust to the proper angle.

NOTE: As a reference, each spline on the sector gear shaft affects the angle by 6°.

4. When adjustment is achieved, replace bolt, nut and washer, and torque to 280-300 ft•lbs (380-408 N•m).

STEERING STOP SCREW ADJUSTMENTS

This vehicle is provided with steering stop screws. The steering stop screws are factory adjusted to accomodate chassis design. Steering stop screw adjustments on new vehicles are therefore not required.

The adjustments of both axle steering stops should be checked and corrected any time any part of the steering system is disassembled, replaced, added or adjusted. Adjust the left and right knuckle steering stops to contact when the maximum turning angle of the specific axle is reached, and tighten the locknut afterwards.

Proceed with the following method to check steering stop screw adjustments.

A) When the wheels are turned to the R.H. side

1. Turn the steering wheel to its maximum turning angle.
2. Verify the nearest point of contact of the drag link with the tire. At this point, measure the distance between tire and drag link.
3. This distance should be approximately 1/4" (6 mm). If not, the steering stop screws must be readjusted. Unscrew the locknut, then loosen or tighten the set screw according to the proper measure. Tighten the locknut afterwards.
4. This must be done for full right turn.

B) When the wheels are turned to the L.H. side

1. Turn the steering wheel to its maximum turning angle.
2. Verify the nearest point of contact of the steering damper with the axle beam. At this point, measure the distance between axle beam and steering damper.
3. This distance should be approximately 1/16" (1,6 mm). If not, the steering stop screws must be readjusted. Unscrew the locknut, then loosen or tighten the set screw according to the proper measure. Tighten the locknut afterwards.
4. This must be done for full left turn.

STEERING GEOMETRY

Steering geometry depends on the design of the front end components. Field adjustments are not possible, but a check should be made to see that steering arms, linkage and other parts are properly installed, and are not bent and distorted. Bent or damaged parts should be replaced. The alignment chart includes measurements which can be taken to determine satisfactory condition of the front end parts.

FRONT WHEEL ALIGNMENT SPECIFICATIONS

Camber (C), degrees	Right - 1/8° ± 7/16°
	Left + 3/8° ± 7/16°
Caster (G) degrees	+ 2 1/2° to 4 3/4° (+ 3° desired)
Toe-in (F minus E)	3/32" ± 1/32" (2,4 mm ± 0,8 mm)
Knuckle pin inclination (K minus J), degrees	Right 6°15'
	Left 5°45'
Track	85.67" (2 176 mm)
Pitman arm adjustment angle	3° ± 3° (toward rear of vehicle)

SPECIFICATIONS

FRONT AXLE

Make	Rockwell International
Model	FG-952
Wheel track	85.67" / 2 176 mm
Capacity (each)	13,000 lbs / 5 900 kg

TORQUE SPECIFICATIONS

Tie rod end stud nuts	160-215 ft•lbs / 218-292 N•m
Tie rod end clamp bolt nuts	50-65 ft•lbs / 68-88 N•m
Steering arm end stud nuts	160-215 ft•lbs / 218-292 N•m
Tie rod arm nut	550-740 ft•lbs / 748-1006 N•m
Drag link end stud nut (on steering arm)	160-215 ft•lbs / 218-292 N•m
Drag link end stud nut (on pitman arm)	200-220 ft•lbs / 272-300 N•m
Drag link end clamp bolt nuts	50-65 ft•lbs / 68-88 N•m
Pitman arm nut	280-300 ft•lbs / 380-408 N•m

SERVICE BULLETINS AND SERVICE INFORMATION LETTERS

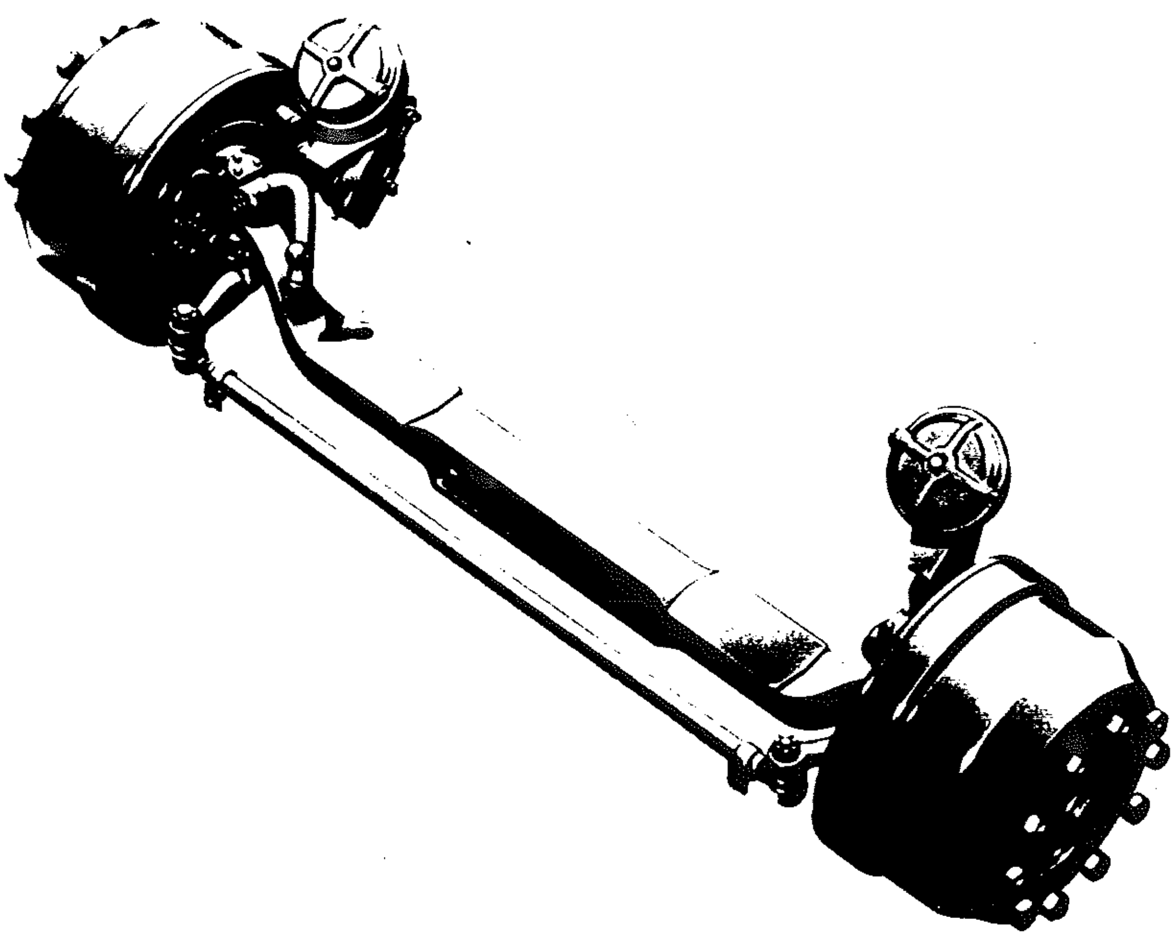
Service Bulletins and Service Information Letters will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of publications pertaining to this section should be noted below as soon as received. These should then be filed for future reference.

NUMBER	DATE	SUBJECT

MAINTENANCE MANUAL NO. 2
REVISED 5-91

Front Non-Drive Steering Axles

Rockwell



Service Notes

This Field Maintenance Manual describes the correct service and repair procedures for Rockwell Front Non-Driving Steering Axles.

The information contained in this manual was current at the time of printing and is subject to change without notice or liability.

You must follow your company safety procedures when you service or repair equipment. Be sure you understand all the procedures and instructions before you begin work on the unit.

Rockwell uses the following types of notes to give warning of possible safety problems and to give information that will prevent damage to equipment:

WARNING

A warning indicates procedures that must be followed exactly. Personal injury can occur if the procedure is not followed.

CAUTION

A caution indicates procedures that must be followed exactly. If the procedure is not followed, damage to equipment or components can occur. Personal injury can also occur in addition to damaged or malfunctioning equipment or components.

TORQUE

This symbol is used to indicate fasteners that must be tightened to a specific torque value.

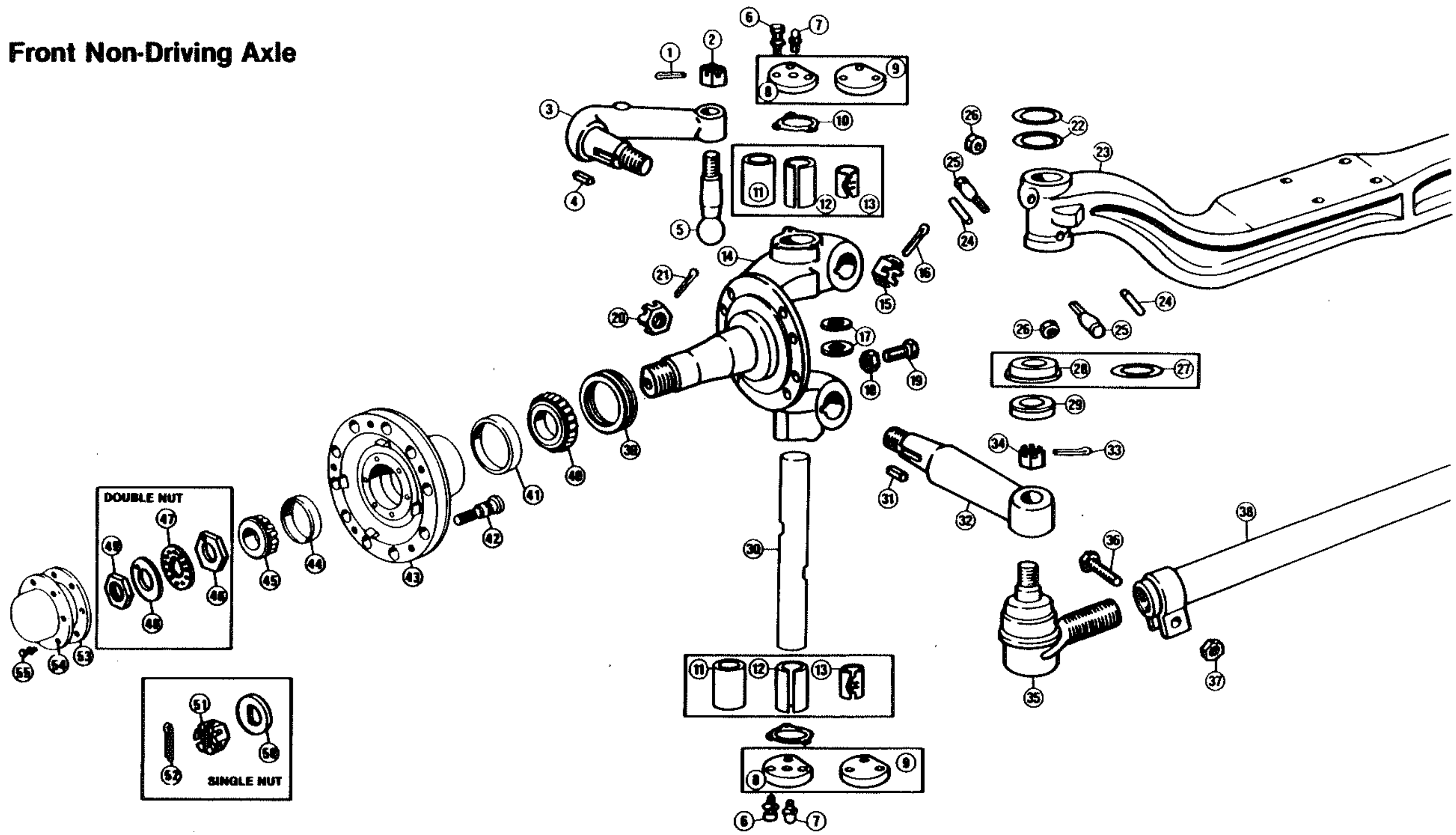
NOTE

A note indicates an operation, procedure or instruction that is important for correct service.

Some procedures require the use of special tools for safe and correct service. Failure to use these special tools when required, can cause injury to service personnel or damage to vehicle components.

This manual is written in Rockwell Universal Language System (RULS).

Front Non-Driving Axle



Number	Description	Number	Description	Number	Description	Number	Description
1	Cotter Pin	15	Castle Nut. Steering Arm to Knuckle	29	Thrust Bearing	43	Hub
2	Castle Nut - Drag Link to Steering Arm	16	Cotter Pin	30	King Pin	44	Outer Wheel Bearing Cup
3	Steering Arm	17	Seal - Knuckle Bushing	31	Key	45	Outer Wheel Bearing Cone
4	Key	18	Jam Nut, Steering Stop Screw	32	Tie Rod Arm	46	Adjusting Nut
5	Ball Stud	19	Steering Stop Screw	33	Cotter Pin	47	Pierced Lock Ring
6	Bolt	20	Castle Nut, Tie Rod Arm to Knuckle	34	Castle Nut, Tie Rod Arm to Tie Rod End	48	Lock Washer
7	Grease Fitting	21	Cotter Pin	35	Tie Rod End	49	Jam Nut
8	Knuckle Cap-Greaseable	22	Shims	36	Bolt, Clamp	50	'D' Washer
9	Knuckle Cap-Sealed	23	Axle Beam	37	Locknut, Clamp	51	Adjusting Nut
10	Gasket	24	Tapered Draw Key	38	Crosstube	52	Cotter Pin
11	Knuckle Bushing - Easy Steer™	25	Threaded Draw Key	39	Hub Grease Seal	53	Gasket
12	Knuckle Bushing - Bronze	26	Nut, Threaded Draw Key	40	Inner Wheel Bearing Cone	54	Hub Cap
13	Knuckle Bushing - Nylon	27	'Flat'-Type Thrust Bearing Seal	41	Inner Wheel Bearing Cup	55	Capscrew and Washer
14	Knuckle	28	'Cover' Type Thrust Bearing Seal	42	Stud		

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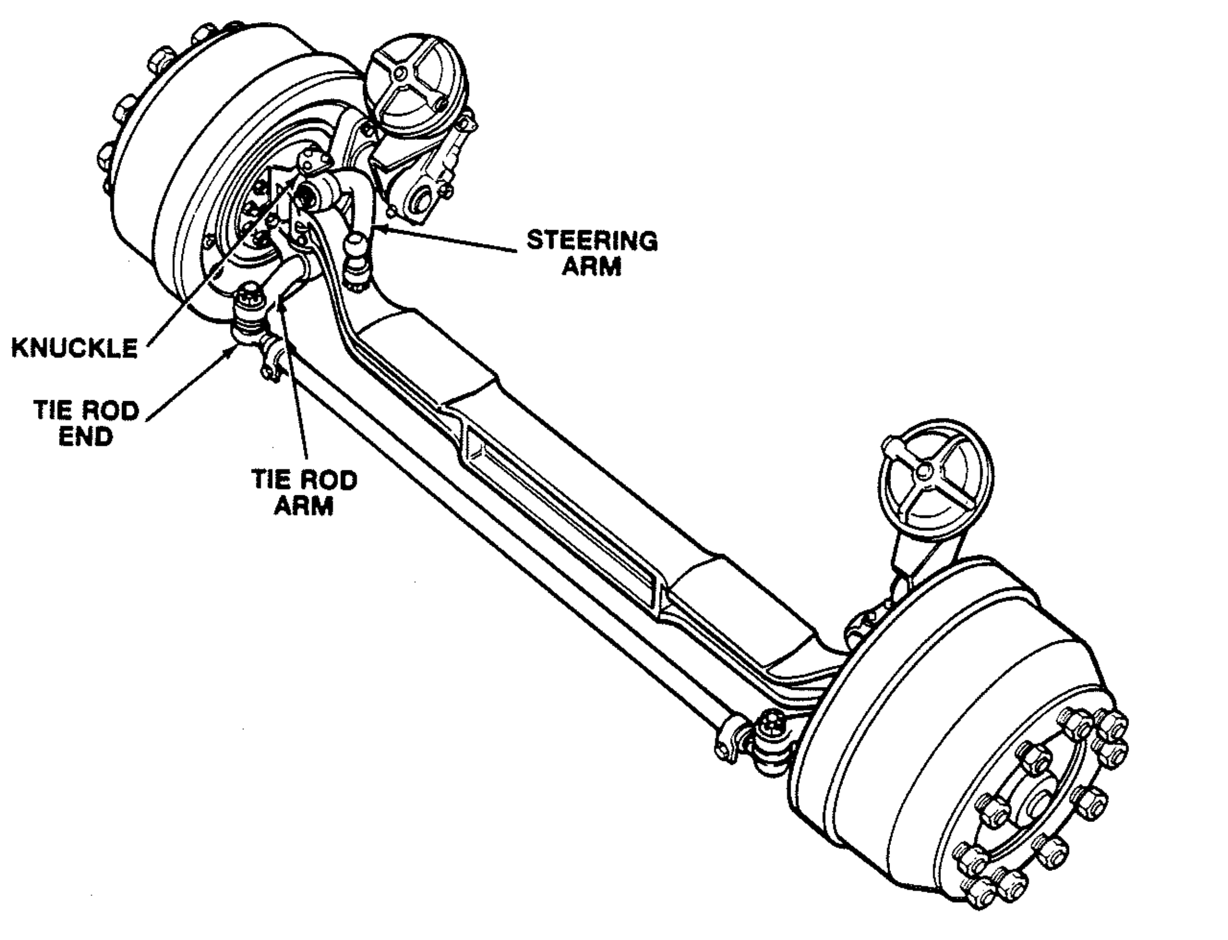
Description

Rockwell non-driving front axles have the following components. **Figure 1.**

- **Tie Rod Arm, Knuckle and King Pin.** The right tie rod is a mirror image of the left and converts the force from the tie rod into a movement to turn the right knuckle, wheel and tire around the king pin. The right knuckle and king pin assembly is similiar to the left except that it does not have a steering arm attached to it in a manual steering system. A power steering system uses an auxiliary assist cylinder attached to the right knuckle that requires a steering arm in various applications.
- **Steering Knuckle.** Steering knuckles are rated according to the capacity of the front axle. All models use straight knuckle pins. Three types of knuckle bushings are used: nylon, bronze and Easy Steer™.
- **Steering Arms.** The steering arm (usually a forged component) converts the drag link force into a turning movement through the left king pin through the knuckle.
- **Pitman Arm.** The Pitman arm converts the output torque from the steering gear into a force to the drag link.

Figure 1



Section 1
Introduction

Identification

To identify the model number, see the identification plate on the front of the beam. See the plate to determine the model number of the axle. Use the complete model number to order parts. **Figure 2.**

See **Figure 3** for an explanation of the model number.

For a description of all models, see the chart in **Figure 4.**

Figure 2

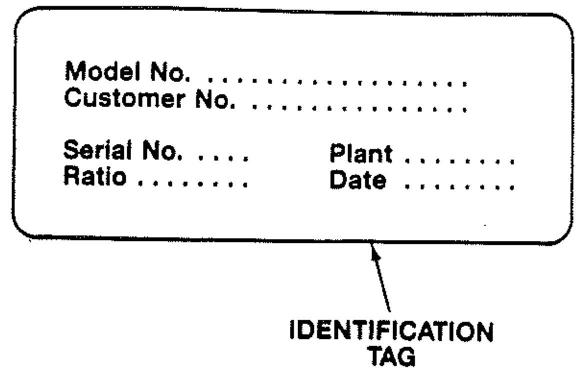


Figure 3

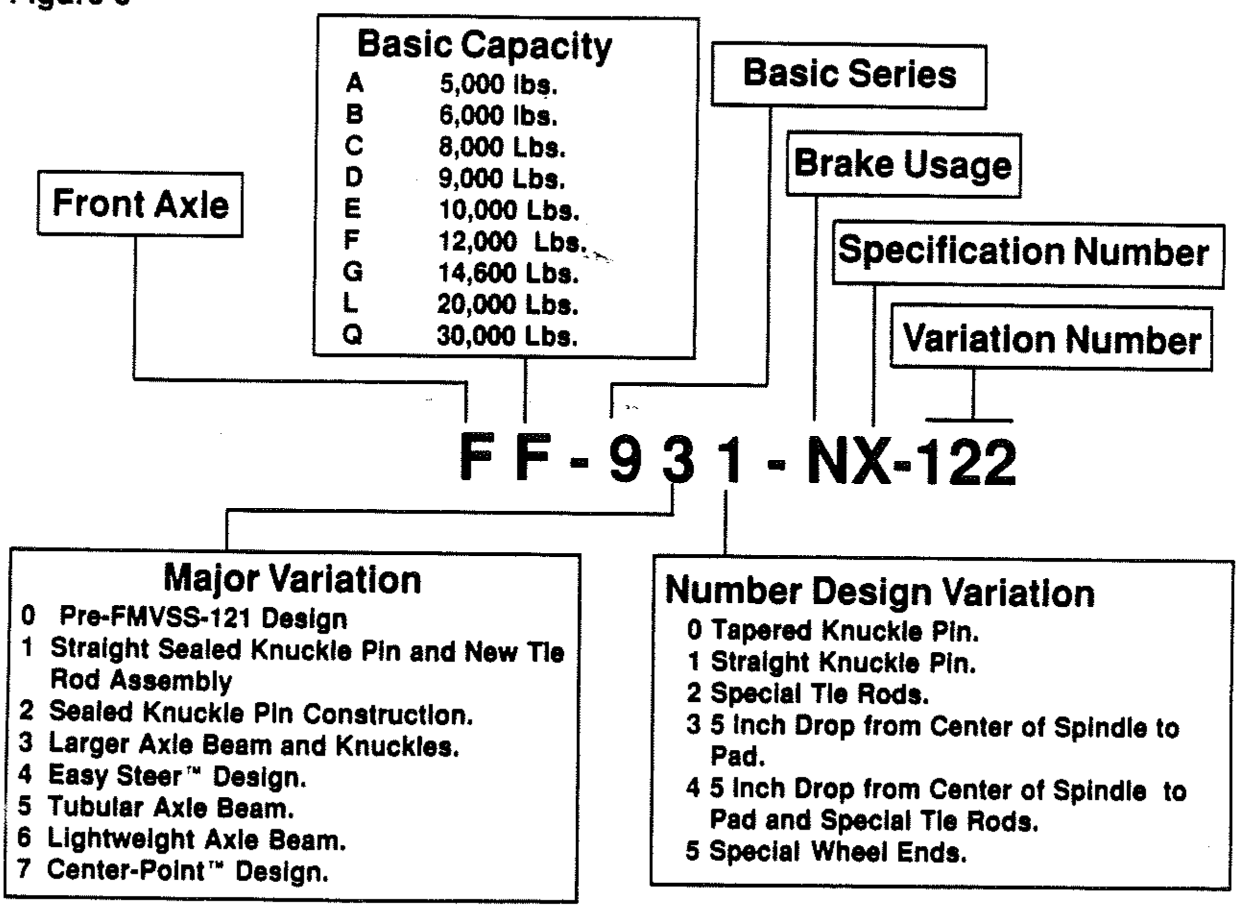


Figure 4 FRONT NON-DRIVING AXLE MODEL NUMBER INFORMATION

Model Number	Capacity	Major Variation	Number Design Variation
FC-901	7000 lbs.	Pre-FMVSS-121 Design	Straight Knuckle Pin
FC-903	7000 lbs.	Pre-FMVSS-121 Design	5 Inch Drop from Center of Spindle to Pad
FD-901	9000 lbs.	Pre-FMVSS-121 Design	Straight Knuckle Pin
FD-931	9000 lbs.	Larger Axle Beam and Knuckles	Straight Knuckle Pin
FD-933	9000 lbs.	Larger Axle Beam and Knuckles	5 inch drop from Center of Spindle to Pad
FD-961	9000 lbs.	Lightweight Axle Beam	Straight Knuckle Pin
FE-970	10,000 lbs.	Center-Point™ Design	Tapered Knuckle Pin
FF-921	12,000 lbs.	Sealed Knuckle Pin Construction	Straight Knuckle Pin - Off-Highway
FF-931	12,000 lbs.	Larger Axle Beam and Knuckles	Straight Knuckle Pin
FF-932	12,000 lbs.	Larger Axle Beam and Knuckles	Special Tie Rods
FF-933	12,000 lbs.	Larger Axle Beam and Knuckles	5 Inch Drop from Center of Spindle to Pad
FF-934	12,000 lbs.	Larger Axle Beam and Knuckles	5 Inch drop from Center of Spindle to Pad and Special Tie Rods
FF-941	12,000 lbs.	Easy Steer™ Design	Straight Knuckle Pin
FF-942	12,000 lbs.	Easy Steer™ Design	Special Tie Rods
FF-943	12,000 lbs.	Easy Steer™ Design	5 inch drop from Center of Spindle to Pad
FF-944	12,000 lbs.	Easy Steer™ Design	5 Inch Drop from Center of Spindle to Pad and Special Tie Rods
FF-961	12,000 lbs.	Lightweight Axle Beam	Straight Knuckle Pin
FF-971	12,000 lbs.	Center-Point™ Design	Straight Knuckle Pin
FG-931	14,600 lbs.	Larger Axle Beam and Knuckles	Straight Knuckle Pin
FG-933	14,600 lbs.	Larger Axle Beam and Knuckles	5 Inch Drop from Center of Spindle to Pad
FG-941	14,600 lbs.	Easy Steer™ Design	Straight Knuckle Pin
FG-943	14,600 lbs.	Easy Steer™ Design	5 Inch Drop from Center of Spindle to Pad
FL-931	20,000 lbs.	Larger Beam and Knuckles	Straight Knuckle Pin
FL-933	20,000 lbs.	Larger Beam and Knuckles	5 Inch Drop from Center of Spindle to Pad
FL-941	20,000 lbs.	Easy Steer™ Design	Straight Knuckle Pin
FL-943	20,000 lbs.	Easy Steer™ Design	5 Inch Drop from Center of Splindle to Pad
FL-951	20,000 lbs	Tubular Axle Beam	Straight Knuckle Pin
FU-910	30,000 lbs.	Sealed Knuckle Pin and Tie Rod Assembly - Export	Tapered Knuckle Pin
FU-935	30,000 lbs.	Larger Beam and Knuckles	Special Wheel Ends

Section 2
Troubleshooting

Troubleshooting

See the following charts to troubleshoot the axle.

CONDITION	CAUSE	CORRECTION
Tires wear out quickly or have uneven tire tread wear.	1. Tires have incorrect air pressure. 2. Tires out-of-balance. 3. Incorrect tandem axle alignment. 4. Incorrect toe-in setting. 5. Incorrect steering arm geometry.	1. Put specified air pressure in tires. 2. Balance or replace tires. 3. Align tandem axles. 4. Adjust toe-in specified setting. 5. Service steering system as necessary.
Vehicle is hard to steer.	1. Low pressure in the power steering system. 2. Steering gear not assembled correctly. 3. Steering linkage needs lubrication. 4. King pins binding. 5. Incorrect steering arm geometry. 6. Caster out-of-adjustment. 7. Tie rod ends hard to move. 8. Worn thrust bearing.	1. Repair power steering system. 2. Assemble steering gear correctly. 3. Lubricate steering linkage. 4. Replace king pins. 5. Service steering system as necessary. 6. Adjust caster as necessary. 7. Replace tie rod ends. 8. Replace thrust bearing.
Ends of the cross tube are worn.	1. Ends of the cross tube need lubrication. 2. Severe operating conditions. 3. Damaged boot on end of cross tube. 4. Add-on type of power steering cylinders not installed correctly.	1. Lubricate ends of cross tube. Make sure lubrication schedule is followed. 2. Operate vehicle correctly. 3. Replace boot. 4. Install power steering cylinders correctly.
Bent or broken cross tube, ball stud, steering arm or cross tube arm.	1. Too much pressure in the power steering system. 2. Cut-off pressure of the power steering system out-of-adjustment. 3. Vehicle not operated correctly. 4. Add-on type of power steering system not installed correctly.	1. Adjust power steering system to specified pressure. 2. Adjust power steering system to specified pressure. 3. Make sure vehicle is operated correctly. 4. Correctly install add-on power steering system.
Worn or broken steering ball stud.	1. Drag link fasteners tightened past specified torque. 2. Lack of lubrication or incorrect lubricant. 3. Power steering stops out-of-adjustment.	1. Tighten drag link fasteners to specified torque. 2. Lubricate linkage with specified lubricant. 3. Adjust stops to specified dimension.

Section 2
Troubleshooting

CONDITION	CAUSE	CORRECTION
Worn king pins and knuckle bushings.	1. Worn or missing seals and gaskets. 2. Incorrect lubricant. 3. Axle not lubricated at scheduled frequency. 4. Incorrect lubrication procedures. 5. Lubrication schedule does not match operating conditions.	1. Replace seals and gaskets. 2. Lubricate axle with specified lubricant. 3. Lubricate axle at scheduled frequency. 4. Use correct lubrication procedures. 5. Change lubrication schedule to match operating conditions.
Vibration or shimmy of front axle during operation.	1. Caster out-of-adjustment. 2. Wheels and/or tires out-of-balance. 3. Worn shock absorbers.	1. Adjust caster. 2. Balance or replace wheels and/or tires. 3. Replace shock absorbers.

Section 3
Inspection

Inspection

Do the following during an inspection.

- **Fasteners.** Make sure all fasteners are tightened to the specified torque. Use a torque wrench to check the torque in a tightening direction. As soon as the fastener starts to move, record the torque. Correct if necessary. Replace any worn or damaged fasteners.

CAUTION

The repair or reconditioning of front axle components is not allowed. Rockwell recommends replacing damaged or out-of-specification components. All major components are heat treated and tempered. The components cannot be bent, welded, heated or repaired in any way without reducing the strength or life of the component and voiding the warranty and may cause a vehicle accident which can result in personal injury.

- **Wear and Damage.** Inspect the parts of the axle for wear and damage. Look for bent or cracked parts. Replace all worn or damaged parts.
- **Pivot Points.** Make sure looseness does not exist at the pivot points. Make sure the pivot points are lubricated.
- **Operation.** Make sure all the parts move freely through the complete turning radius.
- **Tire Wear.** Inspect the tires for wear patterns that indicate suspension damage or misalignment.

Checking the Vertical End Play of the Steering Knuckle

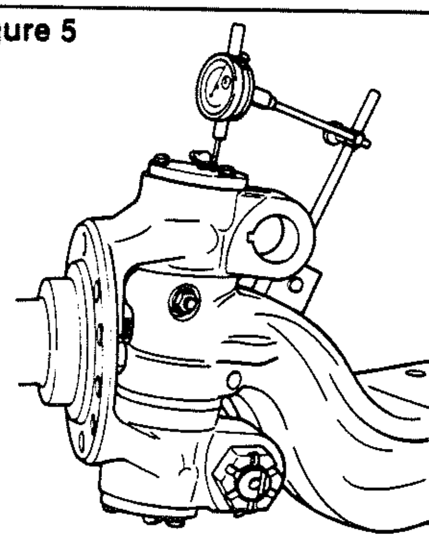
1. Put blocks in front and behind the rear wheels to prevent the vehicle from moving.

WARNING

Do not work under a vehicle only supported by jacks. Jacks can slip or fall over and cause injury.

2. Use a jack to raise the vehicle until the front wheets are off the ground. Support the front axle with safety stands.
3. Install a dial indicator so that the base is on the I-beam and that the tip is on the top knuckle cap. **Figure 5.**
4. Put a pry bar between the boss for the tie rod arm and the I-beam. Push the knuckle to the bottom of vertical travel. **Figure 6.**
5. Set the dial indicator on 'zero' (0).
6. Use the pry bar to push the knuckle upward. Record the reading on the dial indicator.

Figure 5

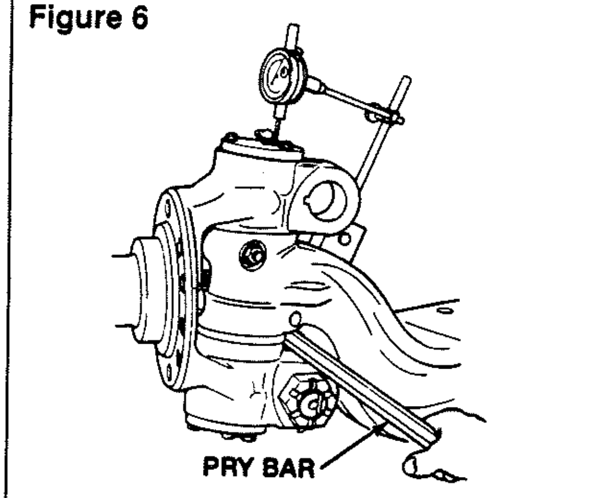


The reading must be 0.001-0.025 inch (0.025-0.635 mm) for new or rebuilt axles and 0.001-0.065 inch (0.025-1.650 mm) for axles in service. **Figure 6.**

If the reading is 'zero' (0), remove the knuckle and remove shims from the shim pack. See Sections 6-8 of this manual.

If the reading is more than the maximim specification, remove the knuckle and add shims to the shim pack. See Sections 6-8 of this manual.

Figure 6



Checking the Knuckle Bushings for Wear

1. Put blocks in front and behind the rear wheels to prevent the vehicle from moving.

WARNING

Do not work under a vehicle only supported by jacks. Jacks can slip or fall over and cause injury.

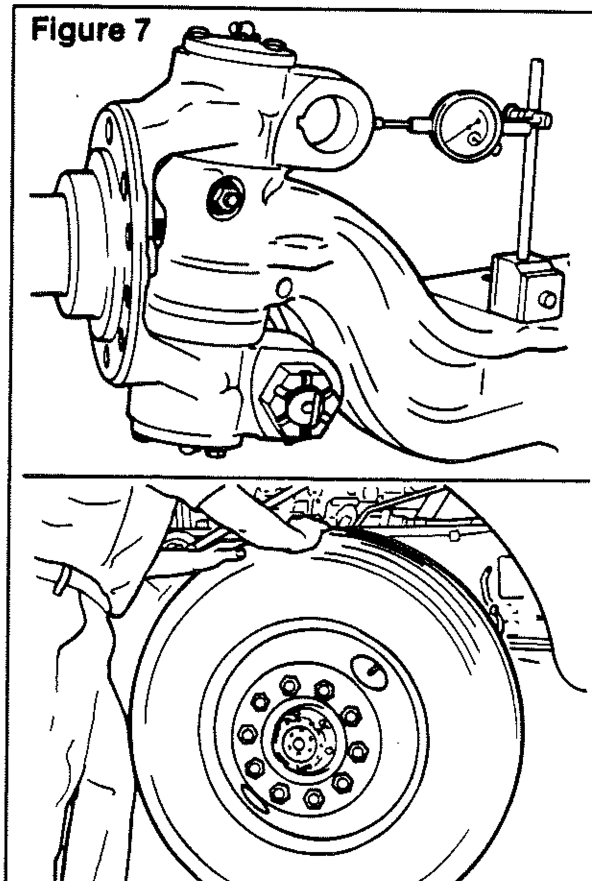
2. Use a jack to raise the vehicle until the wheels are off the ground. Support the vehicle with safety stands.
3. Check the upper knuckle bushing for wear. Install a dial indicator so that the base is on the I-beam and that the tip is against the side of the top of the knuckle. **Figure 7.**
4. Set the dial indicator on 'zero' (0).

NOTE

If one bushing must be replaced, replace both bushings in the knuckle.

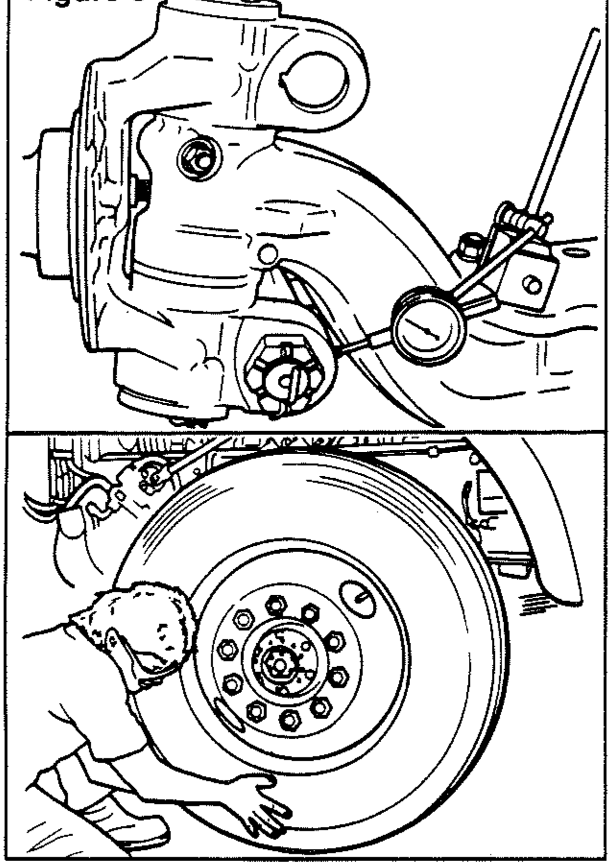
5. Move the top of the tire side-to-side towards and away from the vehicle. If the dial indicator moves a total of 0.010 inch (0.254 mm), the upper bushing is worn or damaged. Replace both bushings. See Sections 6-8 of this manual. **Figure 7.**
6. Check the lower knuckle bushing. Install a dial indicator so that the base is on the I-beam and that the tip is against the side of the bottom of the knuckle. **Figure 8.**

Figure 7



7. Set the dial indicator on 'zero' (0).
8. Move the bottom of the tire side-to-side towards and away from the vehicle. If the dial indicator moves a total of 0.010 inch (0.254 mm), the lower bushing is worn or damaged. Replace both bushings. See Sections 6-8 of this manual. **Figure 8.**

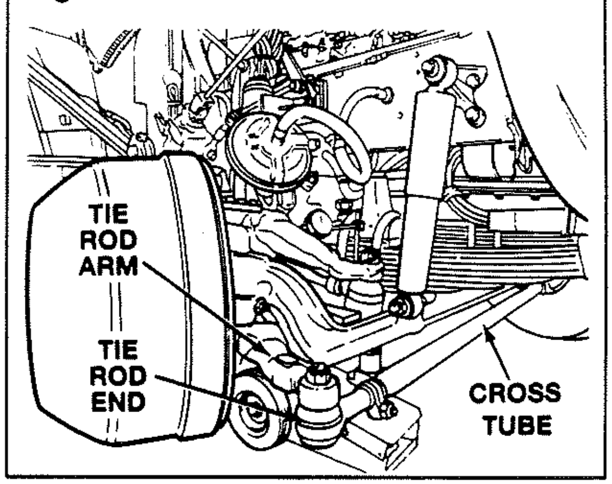
Figure 8



Checking the Tie Rod Ends

1. Grab and try to move the cross tube in any direction. If any movement or looseness is felt between the tie rod ends and the tie rod arms, remove and replace the tie rod ends. See Sections 6-8 of this manual. **Figure 9.**

Figure 9



Lubricant Specifications

Lubricate the king pins, the ball studs on the tie rod arm ends, the ball stud on the steering arm and the grease lubricated wheel bearings with the following lubricant.

- **Chassis Grease**, 6% 12-hydroxy lithium stearate grease, NLGI Grade No.1, Rockwell specification 0-617-A or equivalent.
- **Chassis Grease,** 8% 12-hydroxy lithium stearate grease, NLGI Grade No.2, Rockwell specification 0-617-B or equivalent.

Lubricate the oil lubricated wheel bearings with the oil specified in **Figure 10.**

When to Lubricate the Assemblies

See the Chart in **Figure 17** at the end of this section.

Lubricating the King Pins - Conventional Front Axles

NOTE

This procedure applies to 901, 903, 910, 935, 952 and 970 front conventional axles. See the identification tag on the front of the axle beam.

On conventional front axles, the grease fittings are on the side of the knuckle.

WARNING

Do not work under a vehicle supported only by jacks. Jacks can slip or fall over and cause injury.

1. Lift the vehicle so that the tires are off the ground. The tires should be off the ground when the king pins are lubricated. Support the vehicle with safety stands. Put blocks in front and in back of the rear wheels to keep the vehicle from moving.

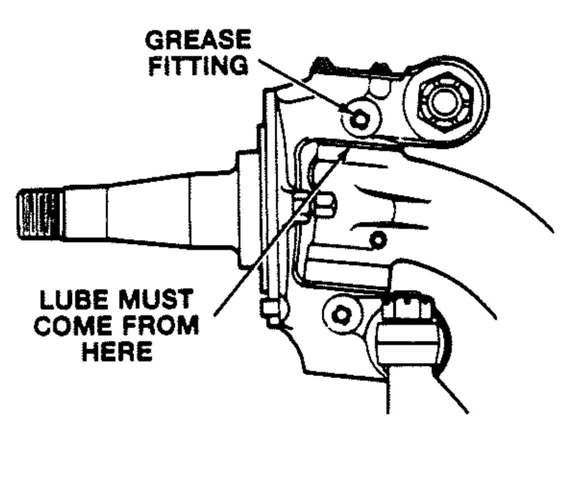
Figure 10

Oil-Lubricated Wheel Bearing Lubricant Specifications

Rockwell Lubricant Specification Number	Description	Cross Reference	Minimum Outside Temperature	Maximum Outside Temperature
0-76-D	Hypoid Gear Oil	GL-5, S.A.E. 80W/90	-15° F (-26° C)	None
0-76-E	Hypoid Gear Oil	GL-5, S.A.E. 75W/90	-40° F (-40° C)	None
0-76-J	Hypoid Gear Oil	GL-5, S.A.E. 75W	-40° F (-40° C)	+35° F (+2° C)
0-76-L	Hypoid Gear Oil	GL-5, S.A.E. 75W/140	-40° F (-40° C)	None

2. Lubricate the king pins through the top and the bottom grease fittings on the side of the knuckle. **Figure 11.**
3. Apply lubricant until new lubricant comes from between the upper shim pack and thrust bearing seal.
4. Lower the vehicle so that the wheels touch the ground.
5. Apply lubricant to the bottom fitting until new lubricant purges and fills the thrust bearing.

Figure 11



Lubricating the King Pins - Sealed Front Axles

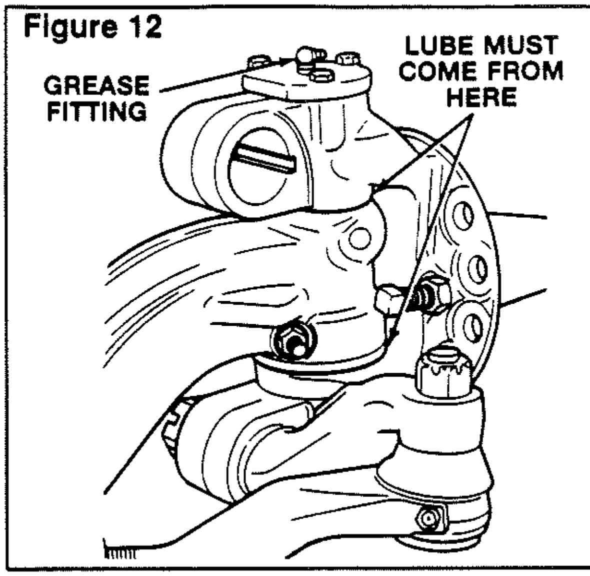
NOTE

This procedure applies to 911, 921, 931, 932, 933, 934, 951, 961, 963, 971 and 975 Series sealed front axles. See the identification tag on the front of the axle beam.

On sealed front axles, the grease fittings are on the top and bottom king pin caps of the knuckle.

1. Make sure the tires touch the ground. DO NOT RAISE THE VEHICLE.
2. Lubricate the king pins through the grease fittings on the top and bottom of the knuckle. **Figure 12.**
3. Apply lubricant until new lubricant comes from the thrust bearing seal and the upper shim pack.

Figure 12



Lubricating the King Pins - Easy Steer™ Front Axles

NOTE

This procedure applies to 941, 942, 943 and 944 Series Easy Steer™ front axles. See the identification tag on the front of the axle beam.

On Easy Steer™ front axles, the grease fittings are on the top and bottom king pin caps of the knuckle.

NOTE

On 941, 942, 943 and 944 series axles, lubricate the axle before the axle is put into service and after the first 4,000 miles (6,500 km) of operation.

⚠ *WARNING*

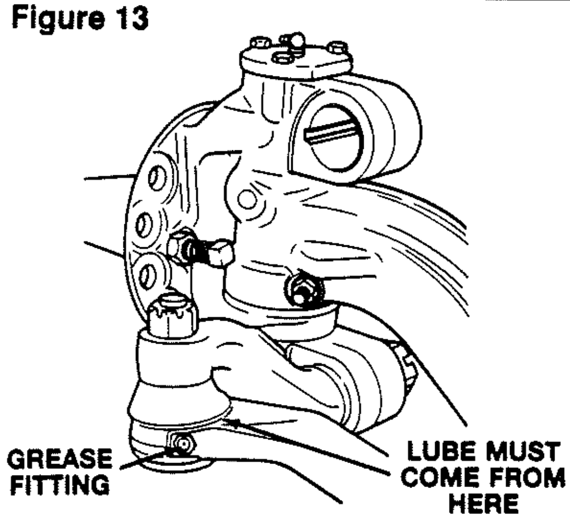
Do not work under a vehicle supported only by jacks. Jacks can slip or fall over and cause injury.

1. Lift the vehicle so that the tires are off the ground. The tires should be off the ground when the king pins are lubricated. Support the vehicle with safety stands. Put blocks in front and in back of the rear wheels to keep the vehicle from moving.
2. Lubricate the king pins through the grease fittings on the top and bottom of the knuckle. **Figure 12.**
3. Apply lubricant until new lubricant comes from the thrust bearing seal and the rear of the upper shim pack.
4. Lower the tires to the ground and repeat steps 2 and 3.

Lubricating the Ball Studs on the Steering Arm, the Tie Rod Arm Ends and the Drag Link

1. Make sure the tires touch the ground.
2. Apply lubricant until new lubricant comes from the boot. **Figure 13.**

Figure 13

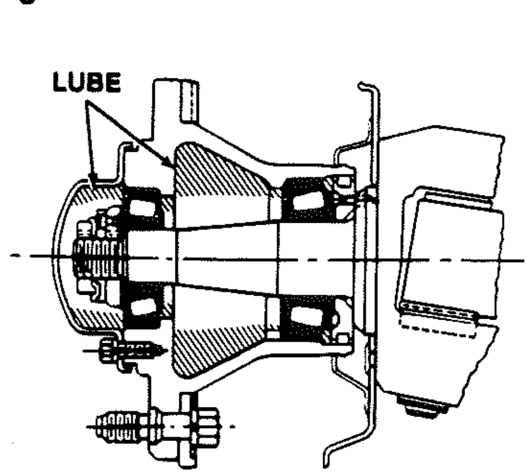


Lubricating the Grease Lubricated Wheel Bearings

See Figure 14.

1. Remove the tire and wheel assembly. Remove and disassemble the hub. See 'Removing the Wheel Ends' in Section 6.
2. Remove the old lubricant from all parts. Discard the seals. Inspect the wheel bearings for wear or damage. Replace worn or damaged bearings. See Section 7, 'Preparing the Parts for Assembly'.
3. Force the specified lubricant from the large end of the cones into the cavities between the rollers and cage. Pack the hub between the bearing cups with lubricant to the level of the smallest diameter of the cups.
4. Install the inner and outer bearing cones into the cups in the hubs. The bearing cups must be pressed tight against the shoulder in the hubs
5. Install new wheel seals in the hubs.

Figure 14



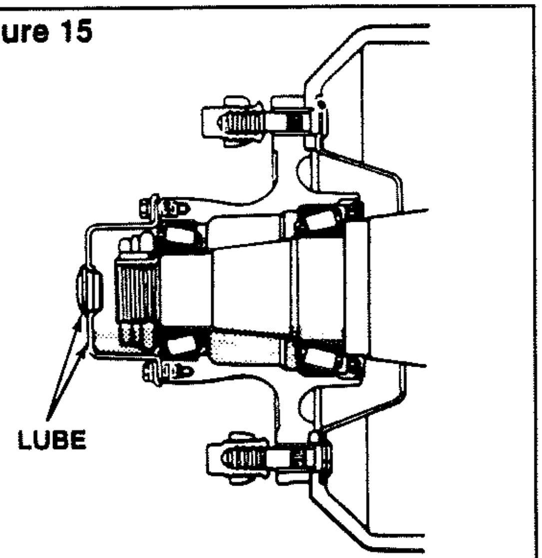
6. Install the hub and the wheel and tire assembly. Install the outer wheel bearing cone in the hub. Install the adjusting nut.
7. Adjust the wheel bearings. See 'Adjusting the Wheel Bearings' in Section 5.

Lubricating Oil Lubricated Wheel Bearings

See Figure 15.

1. Check the level on the cap. If the oil level is not at the specified level on the cap, remove the fill plug. Add the specified oil until the oil is at the specified level.

Figure 15



Tightening Draw Key Nuts

NOTE

This procedure applies to all except 901, 903 and 970 Series axles. See the identification tag on the front of the axle beam.

Tighten the nuts that hold the draw keys on the side of the knuckle to 30-45 lb-ft (41-61 N.m) at the following times. **Figure 16.**

- After the first 6,000 miles (10,000 km) of new vehicle operation.
- Every 36,000 miles (58,000 km) of operation.

Figure 16

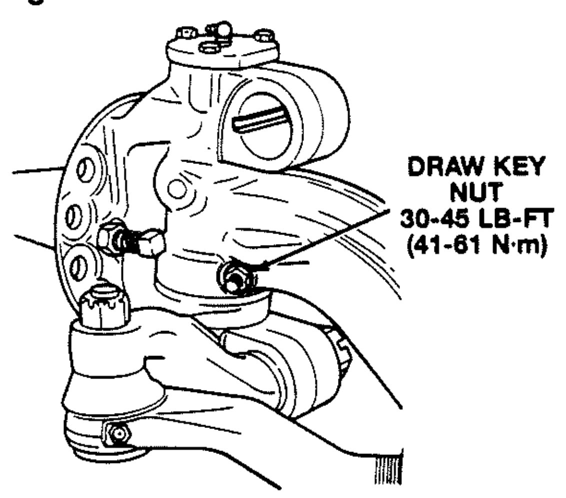


Figure 17

Lubrication Intervals

Model Number	King Pins and Bushings Lubrication Interval	Wheel Position	Ball Stud and Grease Lubricated Wheel Bearing Interval	Oil Lubricated Wheel Bearing Interval
FC-901	3,000 miles(4,800 km)	Off Ground	**Ball Studs on Conventional and Easy Steer Axles:** Lubricate every 50,000 miles (80,000 km) or 12 months, whichever comes first. **Ball Studs on Sealed Axles:** Inspect the boot on the ball studs every 96,000 miles (154,000 km) for wear and damage. Service as necessary. **Grease Lubricated Wheel Bearings:** Change the grease when seals are replaced, the brakes are relined or for On-Highway Operation every 30,000 miles (48,000 km) or twice a year and for On/Off Highway and Off Road Operation twice a year.	**Oil Lubricated Wheel Bearings:** Check the oil level every 1,000 miles (1,600 km). Change the oil when seals are replaced, the brakes are relined or for On-Highway Operation every 100,000 miles (161,000 km) or once a year and for On/Off Highway and Off Road Operation once a year.
FC-903	3,000 miles(4,800 km)	Off Ground		
FD-901	3,000 miles(4,800 km)	Off Ground		
FD-931	50,000 miles(80,500 km) or 12 months	On Ground		
FD-933	50,000 miles(80,500 km) or 12 months	On Ground		
FD-961	50,000 miles(80,500 km) or 12 months	On Ground		
FE-970	3,000 miles(4,800 km)	Off Ground		
FF-921	50,000 miles(80,500 km) or 12 months	On Ground		
FF-931	50,000 miles(80,500 km) or 12 months	On Ground		
FF-932	50,000 miles(80,500 km) or 12 months	On Ground		
FF-933	50,000 miles(80,500 km) or 12 months	On Ground		
FF-934	50,000 miles(80,500 km)or 12 months	On Ground		
FF-941	①	Off Ground		
FF-942	①	Off Ground		
FF-943	①	Off Ground		
FF-944	①	Off Ground		
FF-961	50,000 miles(80,500 km) or 12 months	On Ground		
FF-971	50,000 miles(80,500 km) or 12 months	On Ground		
FG-931	50,000 miles(80,500 km) or 12 months	On Ground		
FG-933	50,000 miles(80,500 km) or 12 months	On Ground		
FG-941	①	Off Ground		
FG-943	①	Off Ground		
FL-931	50,000 miles(80,500 km) or 12 months	On Ground		
FL-933	50,000 miles(80,500 km) or 12 months	On Ground		
FL-941	①	Off Ground		
FL-943	①	Off Ground		
FL-951	50,000 miles(80,500 km) or 12 months	On Ground		
FU-910	3,000 miles(4,800 km)	Off Ground		
FU-935	3,000 miles(4,800 km)	Off Ground		

NOTES:

① **Lubricate when the axle is new and after the first 4,000 miles (6,500 km) of operation.**

Section 5
Adjustments

Inspection Before Alignment

Check the following before doing a front wheel alignment.

Inspection

See 'Inspection' in Section 3, Inspection.

Wheels and Tires

- Make sure the tires are inflated to the specified pressure.
- Make sure the front tires are the same size and type.
- Make sure the lug nuts are tightened to the specified torque.
- Make sure the wheels are balanced.

Front Suspension

- Make sure all fasteners are tightened to the specified torque.
- Inspect the leaf springs for wear and damage.
- Inspect the shock absorbers for wear and damage.

Rear Axle and Rear Suspension

Front tire wear can be caused by the rear axle. If the outer edge of one front tire is worn and the inner edge of the other front tire is worn, check the following.

- Make sure all fasteners are tightened to the specified torque.
- Make sure the leaf springs are not worn or damaged.
- Make sure the bushings in the leaf springs are not worn or damaged.
- Make sure the torque rods (if used) are correctly adjusted.
- Make sure the frame is not bent.
- Make sure the rear axle (especially a tandem axle) is correctly aligned. See the procedure of the manufacturer of the vehicle or the suspension.
- Refer to any additional recommendations and specifications from the manufacturer of the vehicle on rear axles and suspensions.

Front Wheel Alignment

Check the front wheel alignment when the following occur:

- Every 200,000 miles (320,000 km) or 24 months (normal maintenance).
- When the vehicle does not steer correctly.
- To correct a tire wear condition.

There are two types of front wheel alignment: a minor alignment and a major alignment.

Minor Front Wheel Alignment

Do a minor front wheel alignment for all normal maintenance conditions.

Do the minor front wheel alignment in the following sequence:

1. Inspect all the systems that affect the wheel alignment. See 'Inspection Before Alignment' in this section.
2. Check and adjust the wheel bearings.
3. Check and adjust the toe-in.

Major Front Wheel Alignment

Do a major front wheel alignment to correct steering and tire wear conditions.

Do the major front wheel alignment in the following sequence:

1. Inspect all the systems that affect the wheel alignment. See 'Inspection Before Alignment' in this section.
2. Check and adjust the wheel bearings.
3. Check and adjust the maximum turn angle.
4. If the vehicle has power steering, check and adjust the pressure relief in the power steering system. See the procedure on page 20.
5. Check and adjust the turning radius angle (toe-out on turns or Ackerman angle).
6. Check the king pin (or steering axis) inclination.
7. Check the camber angle.
8. Check and adjust the caster angle.
9. Check and adjust the toe-in.

Checking and Adjusting the Wheel Bearings

WARNING

Do not work under a vehicle supported only by jacks. Jacks can slip or fall over and cause injury.

1. Raise the vehicle so that the wheels are off the floor. Support the vehicle with safety stands.
2. Remove the capscrews and remove the gasket and the cap from the hub.
3. Make sure that the brake drum and the hub fasteners are tightened to the manufacturer's specifications.
4. Attach a dial indicator with the magnetic base at the bottom of the hub or the brake drum.

   Adjust the dial indicator so that the pointer is against the center of the knuckle. Set the dial indicator on zero. **Figure 18.**

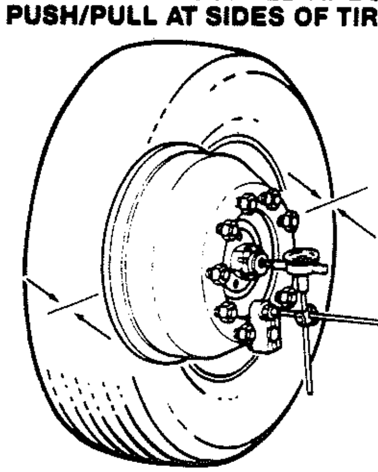
NOTE

Do not push/pull at the top and the bottom of the hub or drum. Pushing or pulling at the top and the bottom will not give a true reading of the end play.

5. Measure the end play by pushing/pulling on the each side of the hub or drum while looking at the dial indicator. The end play is the total travel observed. If the end play is not within 0.001-0.005 inch (0.025-0.127 mm), adjust the wheel bearings. **Figure 18.**
6. If necessary, adjust the wheel bearings. See steps 7-17.

Figure 18

WITH INDICATOR MOUNTED AT BOTTOM, PUSH/PULL AT SIDES OF TIRE



7. **On Double Nut and Lock Fasteners,** bend the lockwasher off the jam nut. Remove the jam nut, the lockwasher and the pierced lock ring. **Figure 19.**

   On Single Nut Fasteners, remove the cotter pin from the adjusting nut. **Figure 20.**

Figure 19

DOUBLE NUT AND LOCK ADJUSTMENT

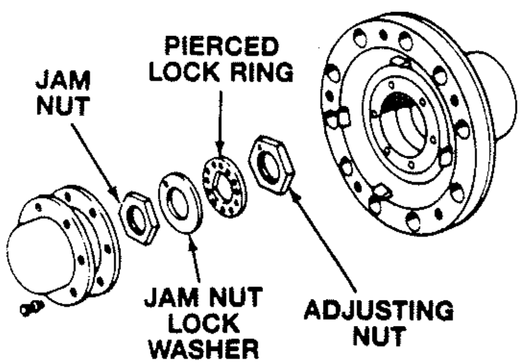
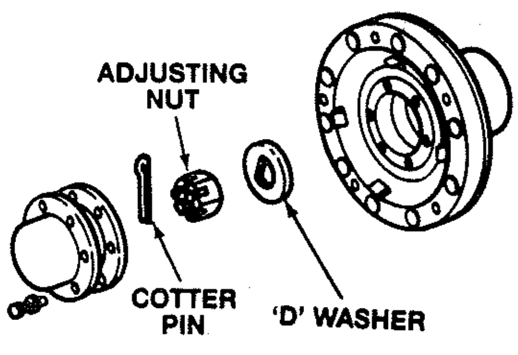


Figure 20

SINGLE NUT ADJUSTMENT



NOTE

When removing or installing the adjusting nuts, use the correct wrench socket to avoid damaging the adjusting nuts.

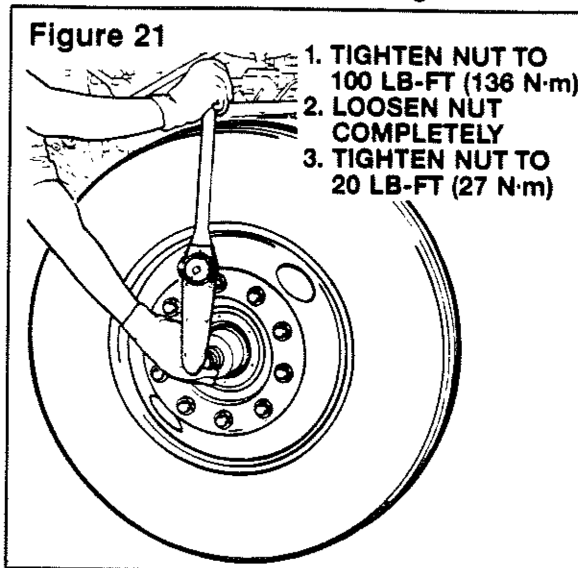
CAUTION

Do not strike the adjusting nut with a metal hammer. Do not use a hammer and chisel or drift to loosen the adjusting nut. This will damage the nut.

8. Use a torque wrench to tighten the adjusting nut to 100 lb-ft (136 N.m) while rotating the tire in both directions. **Figure 21.**

9. Loosen the nut completely and then tighten the nut to 20 lb-ft (27 N.m) while rotating the tire. **Figure 21.**

Figure 21



10. **On Single Nut Fasteners,** back off the adjusting nut 1/8 turn. **Figure 22.**

    On Double Nut and Lock Fasteners, back off the adjusting nut 1/3 turn. **Figure 22.**

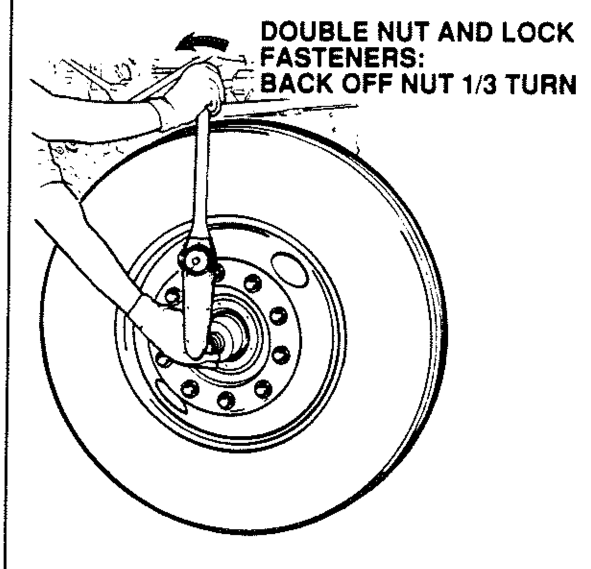
11. **On Single Nut Fasteners,** install a new cotter pin in the adjusting nut.

12. **On Double Nut and Lock Fasteners,** install the pierced lock ring, the lock washer and the jam nut.

13. **On Double Nut and Lock Fasteners,** tighten jam nuts over 1-1/8 and 2-5/8 inch thread size to 200-300 lb-ft (271-407 N.m). Tighten jam nuts over 2-5/8 inch thread size to 250-400 lb-ft (339-542 N.m).

14. Measure the end play. The end play must be 0.001-0.005 inch (0.025-0.127 mm). See steps 4-5.
15. **On Double Nut and Lock Fasteners,** bend the edge of the lockwasher over the jam nut.
16. Install the gasket and the cap on the hub. Install the capscrews and tighten to 20-30 lb-ft (27-41 N.m). T
17. Lower the vehicle to the ground. Check the correct vehicle operation.

Figure 22



Adjusting the Maximum Turn Angle

CAUTION

Adjust the maximum turn angle only if the manufacturer of the vehicle specifies the adjustment. Do not <u>increase</u> the maximum turn angle. If the angle is increased, the steering arms, the cross tube and the tie rod ends will be damaged.

Check the angle if the front tires rub against the frame or if the steering gear has been serviced. Use an alignment machine to check the angle. See the procedure of the manufacturer of the equipment.

The stop bolt on the back of the knuckle controls the maximum turn angle.

For power steering systems, the stop bolt should **NOT** touch the knuckle or beam (depending where installed). The stop bolt should always have a minimum clearance of 1/8 inch (3 mm) as shown in **Figure 23**.

For manual steering systems, Rockwell recommends a stop bolt clearance of 1/8 inch (3 mm). Stop bolt contact is acceptable if no other stops are used in the steering system.

CAUTION

If the stop bolt is missing, bent or broken, the system requires adjustment. See 'Mechanical Stop' in this section.

NOTE

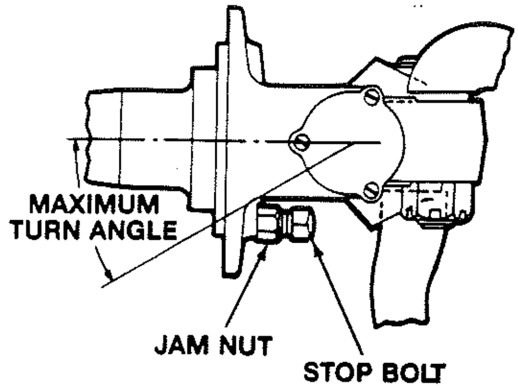
If the steering system is out-of-adjustment, inspect the steering arm for damage. Use a magnetic particle or liquid penetrant inspection procedure to inspect the steering arm. Pay particular attention to the bend, the taper and the area near the ball stud. See the procedure of the manufacturer of the vehicle for additional procedures.

CAUTION

In power steering systems, the hydraulic pressure should relieve or 'drop off' at the end of the steering stroke (with 1/8 inch or 3 mm minimum clearance at the stop bolt). If the pressure does not relieve, the components of the front axle will be damaged.

Figure 23

KNUCKLE POSITIONS FOR STOP BOLT ADJUSTMENT



1. Put a 1/8 inch (3 mm) spacer between the the stop bolt and the boss on the axle beam.
3. Turn the steering wheel until the boss on the axle beam touches the spacer in front of the stop bolt. Measure the turn angle.
4. If the maximum turn angle is not to the specifications of the manufacturer of the vehicle, see the following.
   A. Loosen the jam nut on the stop bolt.
   B. Turn the stop bolt until the specified angle is obtained. **Figure 23.**
   C. Tighten the jam nut to 50-65 lb-ft (68-88 N.m). T

Adjusting the Pressure Relief in the Power Steering System

The pressure relief in the power steering system stops or reduces pressure applied to the axle in the full turn positions.

Check the pressure relief if the steering arm is damaged or the power steering gear is serviced.

Two types of systems are used to adjust the pressure relief.

- Mechanical Stop on the Pitman Arm or in the Assist Cylinder.
- Hydraulic Pressure Relief in the Power Steering Gear.

CAUTION

Rockwell does not recommend a power steering system that does not have mechanical stops or pressure relief before the maximum turn angle is obtained. The stops or the pressure relief are used to prevent damage to the axle.

Mechanical Stop

Use the mechanical stop in the steering system to adjust the pressure relief. Do not use the stop bolt on the knuckle to adjust the pressure relief.

NOTE

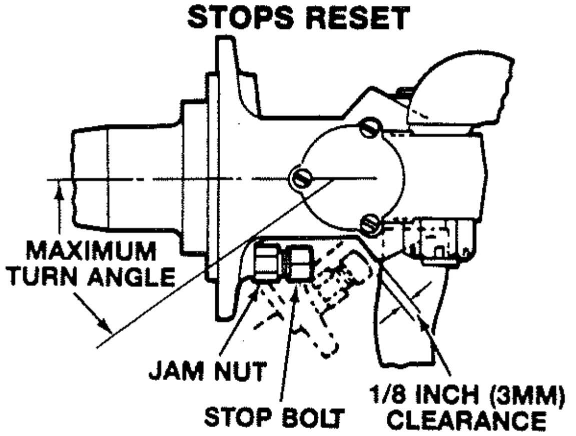
See the specified procedure of the manufacturer of the vehicle.

CAUTION

Use a pressure gauge to make sure that the pressure drops from the maximum system delivery pressure to a maximum of 700-1000 psi (4825-6890 kPa) BEFORE the full turning angle is achieved.

Systems with mechanical stops are adjusted to stop travel 1/8 inch (3 mm) before the stop bolt touches the boss on the axle beam. The adjustment is done on full right and full left turn positions. **Figure 24.**

Figure 24
KNUCKLE POSITION AFTER PITMAN ARM/CYLINDER STOPS RESET



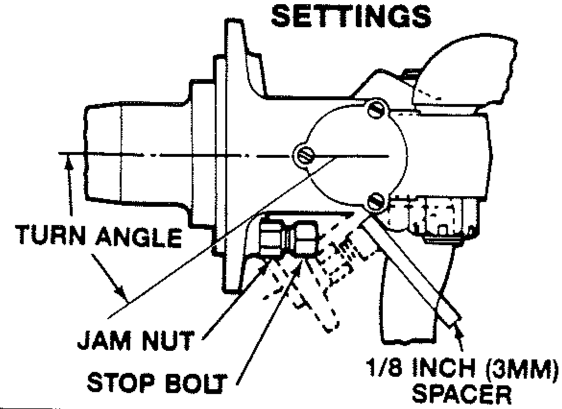
Hydraulic Pressure Relief in the Steering Gear

NOTE
See the specified procedure of the manufacturer of the vehicle.

NOTE
The stop bolt should always have a minimum clearance of 1/8 inch (3 mm).

Hydraulic steering gears with poppet valves are adjusted with a spacer between the stop bolt in the knuckle and the boss on the axle beam. The poppet valves are adjusted to stop or reduce pressure at the distance of the spacer. **Figure 25.**

Figure 25 **KNUCKLE POSITIONS FOR POPPET VALVE SETTINGS**



Turning Radius Angle

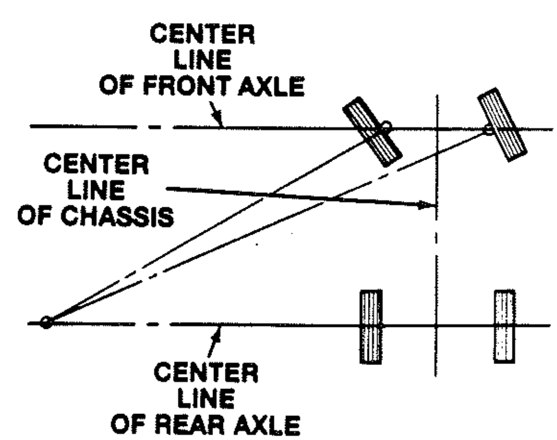
See Figure 26.

When turning, the inner wheel must turn in a greater angle than the outer wheel. This angle is the turning radius angle (often called the Ackermann angle). The angle is built into the design of the tie rod arms, the tie rod ends and the cross tube assembly to give the best possible road contact and to minimize tire wear during turns.

Check the turning radius angle with the radius plates on the alignment equipment. See the procedure of the manufacturer of the equipment.

Figure 26

TURNING RADIUS ANGLE



If the angle is not within specifications, tire wear will occur. Inspect the knuckle, tie rod arms, tie rod ends and cross tube for wear or damage. Service as necessary.

King Pin Inclination

See Figure 27.

NOTE

See the specifications of the manufacturer of the vehicle for the king pin inclination specifications.

King pin (or steering axis) inclination is the angle measured between the centerline of the king pin and the vertical position (as viewed from the front of the vehicle). The king pin inclination and the camber angle put the approximate center of the tire tread in contact with the road. This reduces steering effort and improves directional stability.

Use an alignment machine to check the king pin inclination angle. See the procedure of the manufacturer of the equipment.

The king pin inclination is not adjustable. If the inclination is not at the specified angle, check the axle beam and knuckle for damage. Service as necessary.

Figure 27
KING PIN INCLINATION

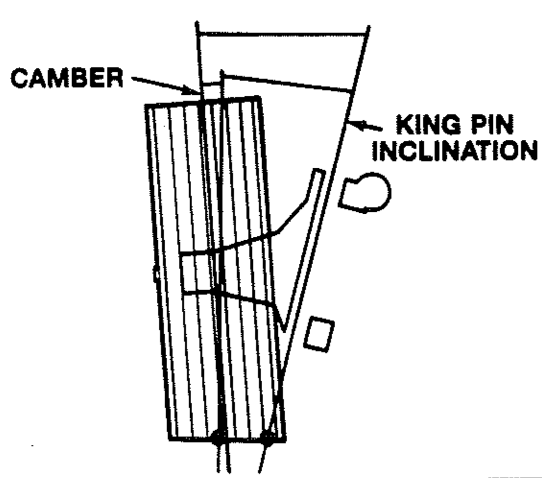
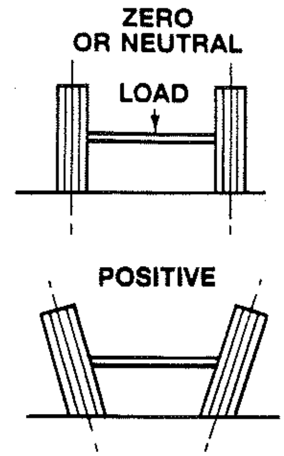


Figure 28
CAMBER



Camber Angle

See Figure 28.

CAUTION

The camber angle is not adjustable. Rockwell does not recommend changing the camber angle or bending the axle beam. If the axle beam is bent to change the camber angle, the strength of the axle is reduced and the warranty is voided. The axle may be damaged if bent. An axle damaged by bending may cause a vehicle accident and personal injury.

Camber is the angle of the tire with respect to the ground. Camber is positive when the distance between the top of the wheels is greater than the distance at the ground. A small amount of positive camber is built into the knuckle because camber changes with load. This results in a zero camber angle when the vehicle is operated at the normal load.

If camber is out-of-specification by more than 1-1/2°, tire wear will occur. Bias ply tires will show tire wear because of too much camber more than radial tires.

The camber angle is not adjustable. The camber angle is machined into the axle beam. If the camber angle is not at the specified angle, check the axle beam and the steering knuckle for damage. Service as necessary.

Use an alignment machine to check the camber angle. See the procedure of the manufacturer of the equipment.

See the specifications of the manufacturer of the vehicle for the correct camber setting. The chart in **Figure 29** gives the specification Rockwell builds into the axle but always use the specification of the manufacturer of the vehicle.

Figure 29

CAMBER RECOMMENDATIONS

CONDITIONS	LEFT (DRIVER'S) SIDE	RIGHT SIDE
Camber angles machined into axles. • **Hubs not installed.** • **Axle not installed in vehicle.** • **Load not applied on axle.**	**+3/4° Nominal**	**+1/4° Nominal**
Camber angles of axles equipped with hubs. • **Axle not installed in vehicle.** • **Load not applied on axle.**	**+3/4° (±7/16°)** **or** **+1-3/16° to +5/16°** **(final reading)**	**+1/4° (±7/16°)** **or** **+11/16° to -3/16°** **(final reading)**
Camber angles under load • **Axle installed in vehicle**	**+11/16° to -3/16°** **(final reading)**	**+3/16° to -11/16°** **(final reading)**

Caster Angle

See Figure 30.

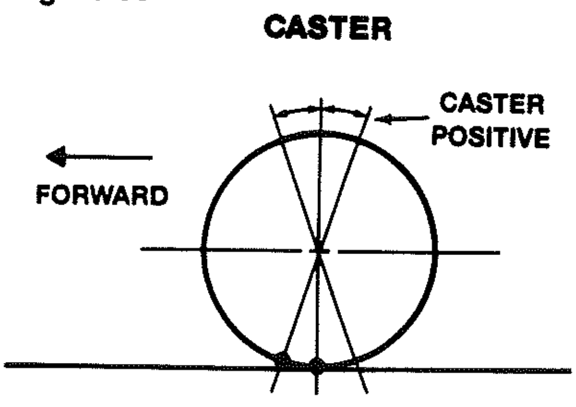
The caster angle is the angle from the vertical position to the centerline of the king pin when seen from the side of the vehicle. If the top of the king pin axis is toward the rear of the vehicle, the caster is positive. Positive caster creates a self-aligning moment to stabilize the vehicle when driving straight ahead. If caster is too much, steering effort will increase or may amplify a shimmy condition.

The caster angle is controlled by tapered shims installed under the leaf springs. Adjust caster according to the procedure of the manufacturer of the vehicle.

Use an alignment machine to check the caster angle. See the procedure of the manufacturer of the equipment.

Caster specifications are supplied by the vehicle manufacturer. **See the specifications of the vehicle manufacturer for the caster setting.** If caster specifications are not available from the vehicle manufacturer, Rockwell recommends a caster setting of +1° to +2-1/2° for vehicles with manual steering and +2° to +4-1/2° for vehicles with power steering. FE-970 and FE-971 axles have a recommended caster setting of -1/2° to -2°.

Figure 30



Adjusting the Toe-In

Specification:

- **Unloaded Vehicles:** 1/16 inch (1.587 mm) ± 1/32 inch (0.794 mm).
- **Loaded Vehicles:** 1/32 inch (0.794 mm) ± 1/32 inch (0.794 mm).

Toe is the relationship of the distance between the front of the front tires and the rear of the front tires. When the front distance is less than the rear distance, the wheels are "toed-in". Toe-in is designed into the vehicle to counteract the tendency of the tires to toe-out when the vehicle is driven. Incorrect toe-in will result in rapid tire wear.

CAUTION

Most tire wear is caused by incorrect toe settings. Do not change camber or caster settings to correct tire wear problems. If the axle assembly is bent to change caster or camber, the strength of the axle is reduced and the warranty is voided. An axle damaged by bending may cause a vehicle accident and personal injury.

1. Make sure the vehicle is on a level surface. Put blocks behind the rear wheels to prevent the vehicle from moving. Raise the vehicle so that the front tires are off the floor.
2. Use paint or chalk to mark the center area of both front tires around the complete outer surface of the tire.
3. Put the pointers of a trammel bar on the marks of each tire. Rotate the tires. Make sure a straight line is marked on the outer surface of the tire.

NOTE

Do not measure toe-in with the front axle in the raised position. The weight of the vehicle must be on the front axle when toe-in is measured.

4. Lower the vehicle to the floor. Move the vehicle forward and backward 10 feet (3 meters).
5. Put the trammel bar at the back of the tires. Raise the pointers so that the pointers are level with the spindles. Align the pointers with the marks on the tires. Measure and record the distance between the pointers.
6. Put the trammel bar at the front of the tires. Raise the pointers so that the pointers are level with the spindles. Align the pointers with the marks on the tires. Measure and record the distance between the pointers. **Figure 31.**
7. To get the toe measurement, subtract the reading of the front of the tires from the reading at the back of the tires. **Figure 32.**
8. If the toe measurement is not at the specified distance, see the following procedure.
   a. Loosen the tube clamp nut and bolt on each end of the cross tube.
   b. Turn the cross tube until the specified toe-in distance is obtained.
   c. Tighten the nut and bolt on each end of the cross tube to the specified torque. See the Torque Chart in Section 9. T
9. Repeat steps 1-7 to check the toe-in dimension.

Figure 31

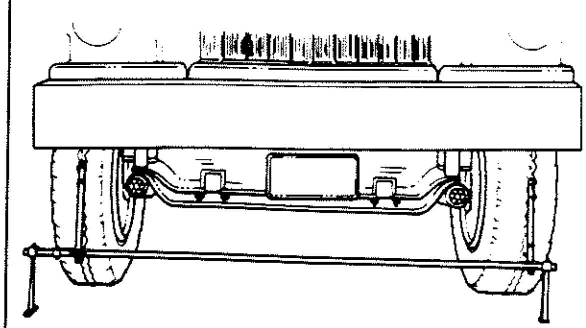
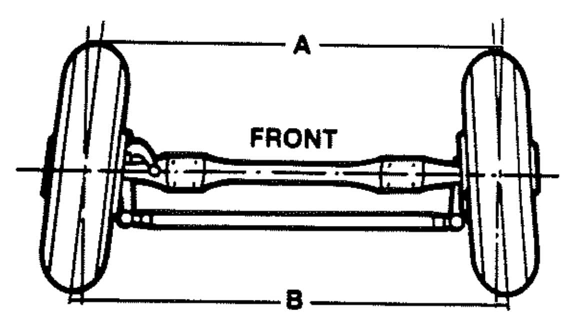


Figure 32



B MINUS A EQUALS TOE-IN

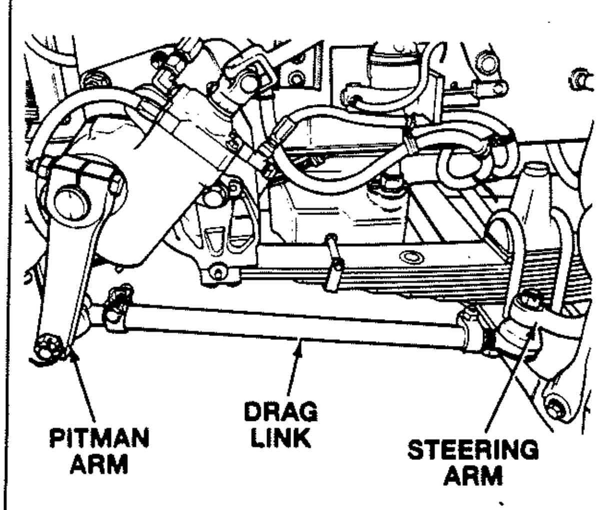
Section 6
Removal

Removing the Drag Link

See Figure 33.

1. Remove the cotter pins from the ball studs.
2. Remove the nuts from the ball studs.
3. Disconnect the drag link from the Pitman arm and the steering arm.
4. Inspect the drag link. See Section 7, 'Preparing the Parts for Assembly.'

Figure 33

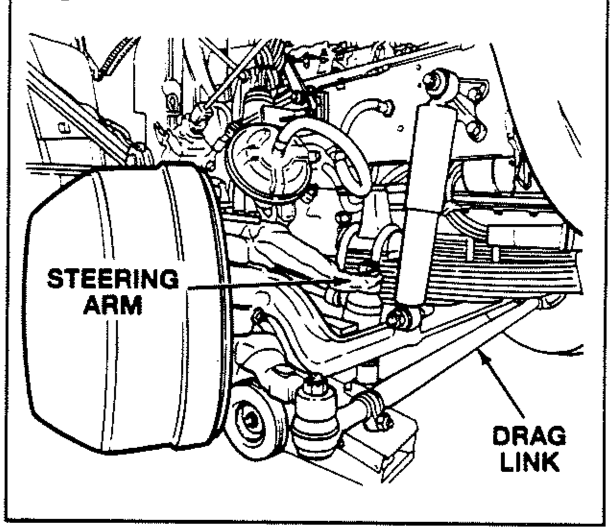


Removing the Steering Arm

See Figure 34.

1. Remove the cotter pin and the nut that fasten the steering arm to the drag link. Disconnect the steering arm.
2. Remove the cotter pin and the nut that fastens the steering arm to the knuckle.
3. Remove the steering arm from the knuckle. If necessary, tap on the end of the arm with a leather or plastic mallet to separate the arm from the knuckle.
4. Remove the key from the steering arm.
5. Inspect the steering arm. See Section 7, 'Preparing the Parts for Assembly.'

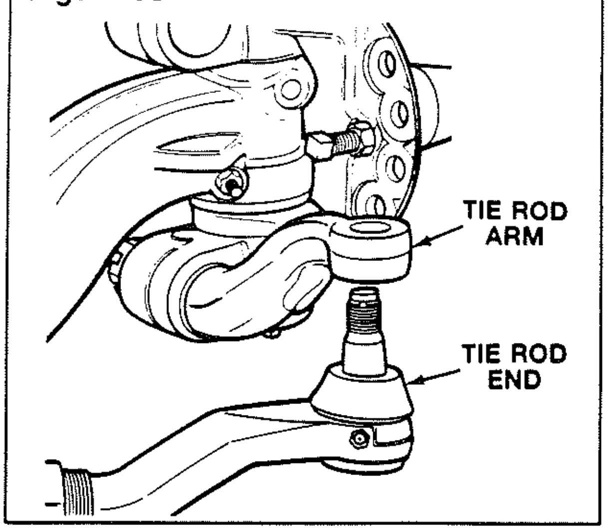
Figure 34



Removing the Tie Rod Arms, the Tie Rod Ends and the Cross Tube

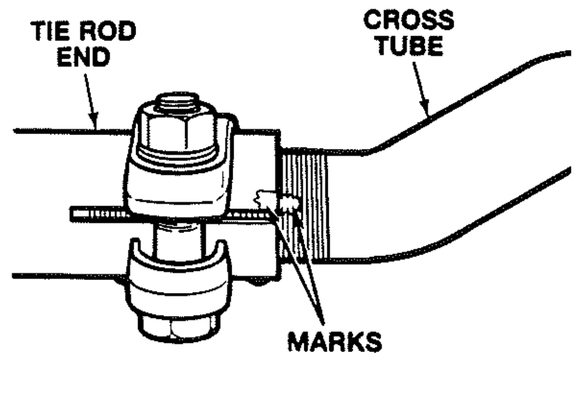
1. Remove the cotter pins and the nuts that fasten each tie rod end to the tie rod arms. **Figure 35.**
2. Disconnect the cross tube assembly from the tie rod arms. If necessary, use a removal tool to separate the tie rod end from the tie rod arm. **Figure 35.**
3. Remove the cotter pin and the nut that fasten the tie rod arms in the knuckle. **Figure 35.**

Figure 35



4. Remove the tie rod arms from the knuckle. If necessary, tap on the end of the rod with a leather or plastic mallet. Remove the key.
5. If necessary, remove the tie rod ends. See the following procedure. **Figure 36.**
   a. Mark the position each tie rod is installed in the cross tube.
   b. Remove the bolts and the nuts from the clamp on the cross tube.
   c. Remove the tie rod ends from the cross tube.
6. Inspect the parts. See Section 7, 'Preparing the Parts for Assembly.'

Figure 36



Removing the Wheel Ends

⚠ *WARNING*

Do not work under a vehicle supported only by jacks. Jacks can slip or fall over and cause injury.

1. Raise the vehicle until the wheels are off the floor. Support the vehicle with safety stands.
2. Remove the capscrews that fasten the cap to the hub. Remove the cap and the gasket.

NOTE

When the adjusting nuts are tightened or loosened, always use the correct size socket to avoid damaging the nut.

3. Remove the fasteners for the wheel bearings. See the following procedure.

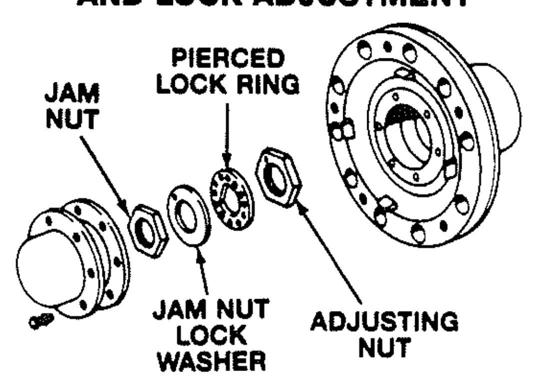
Double Nut and Lock Fasteners

a. Bend the tabs of the lock washer off the jam nut and the adjusting nut. **Figure 37.**

b. Remove the jam nut, the lock washer, the pierced lock ring and the adjusting nut from the knuckle. **Figure 37.**

Figure 37

DOUBLE NUT AND LOCK ADJUSTMENT



Single Nut Fasteners

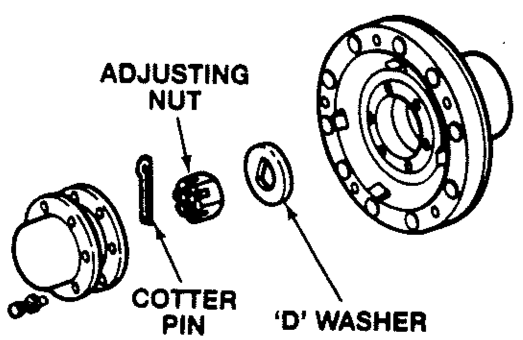
a. Remove the cotter pin from the adjusting nut. **Figure 38.**

b. Remove the adjusting nut and the 'D' washer from the spindle. **Figure 38.**

4. Remove the outer wheel bearing cone from the hub.
5. Remove the wheel and tire, the hub and the drum as assembly.

Figure 38

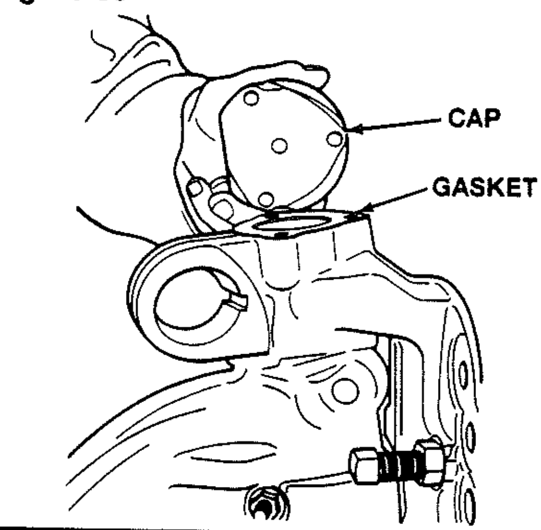
SINGLE NUT ADJUSTMENT



Removing the King Pins and the Steering Knuckle

1. Remove the wheels ends as described in this section.
2. Remove the air from the brake system. Disconnect the air lines from the brakes.
3. Remove the brake assembly from the spindle. See the procedure of the manufacturer of the brake.
4. Remove the tie rod arms and the steering arms from the knuckle. See the procedure in this section.
5. Remove the capscrews that fasten the caps to the top and the bottom of the spindle. Remove the caps and the gaskets. **Figure 39.**

Figure 39



NOTE

All models except FE-970, FF-971 and FL-901 use threaded draw keys. Models FE-970, FF-971 and FL-901 use plain draw keys.

6. Remove the plain or the threaded draw keys. See the following procedure.

Removing Plain Draw Keys

⚠ *WARNING*

Wear safe eye protection. Do not hit steel parts or tools with a steel hammer. Parts or tools can break and cause injury.

a. Use a brass hammer and a steel drift to remove the draw key. Put the drift on the small ('D'-shaped) end of the key. **Figure 40.**

Figure 40

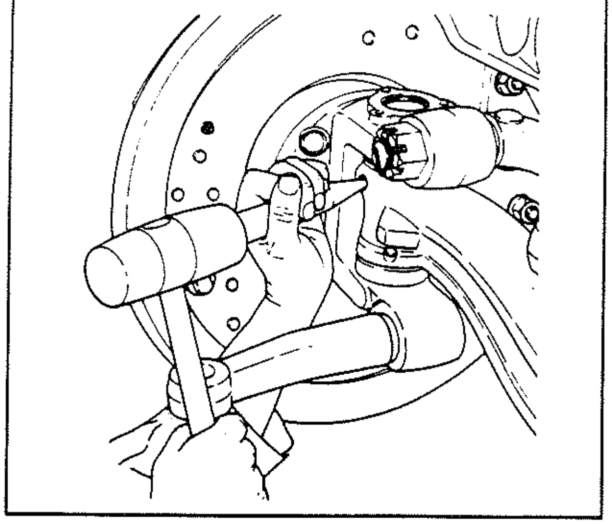
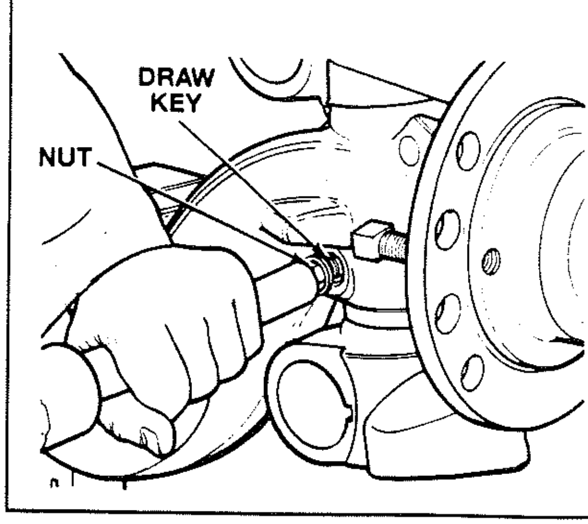


Figure 41



Removing Threaded Draw Keys

a. Loosen the lock nut until the top of the lock nut is even with the end of the draw key.

WARNING

Wear safe eye protection. Do not hit steel parts or tools with a steel hammer. Parts or tools can break and cause injury.

CAUTION

Force must be directly applied to the bottom of the nut and the end of the key. If force is not directly applied, the draw key will be damaged.

b. Use a brass drift and a hammer to hit the end of the nut to loosen the draw key. **Figure 41.**

c. Remove the nut from the draw key. Remove the draw key from the knuckle.

NOTE

If the bushings are not being replaced, do the following to prevent damaging the bushings during king pin removal.

1. Remove any flaring on the drift that may touch the knuckle pin.

2. Wrap tape to a thickness of 1/16 inch (1.5 mm) on the end of the drift.

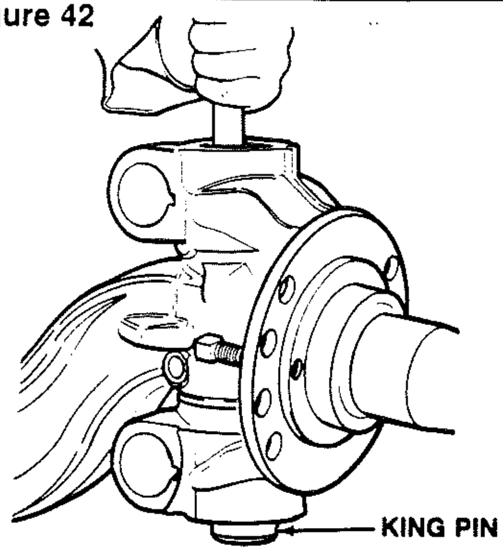
NOTE

For optimal tire wear on crowned road surfaces, the right and the left king pin bores in the beam are machined to slightly different king pin angles. The front of the beam must be installed toward the front of the vehicle. The front of the the beam is marked by the identification tag on the front of the beam and/or a white paint stripe on the left (driver's side) of the beam. If the paint stripe or identefication tag are missing, mark the front of the beam for correct installation.

7. Use a brass drift and a hammer to remove the king pins from the knuckle. **Figure 42.**

If the king pin is hard to remove, use a hydraulic king pin remover. See the Special Tool Chart in Section 9.

Figure 42

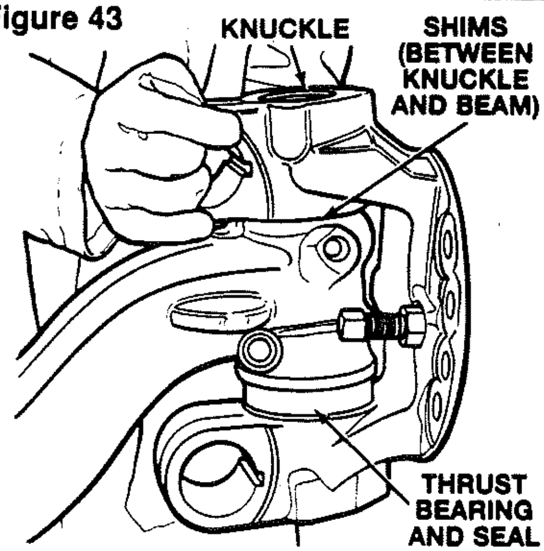


⚠ *WARNING*

Wear gloves when removing shims. The shims have sharp edges.

8. Remove the knuckle from the axle beam. Remove the shims, the thrust bearing and the seal from between the beam and the knuckle. **Figure 43.**
9. Inspect the parts. See Section 7, 'Preparing the Parts for Assembly.'

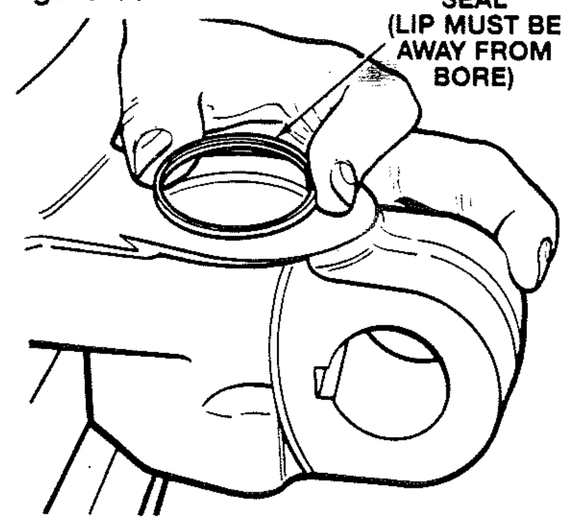
Figure 43



Removing the Bushings from the Knuckle

1. Remove and discard the seal in front of the bushing. **Figure 44.**

Figure 44

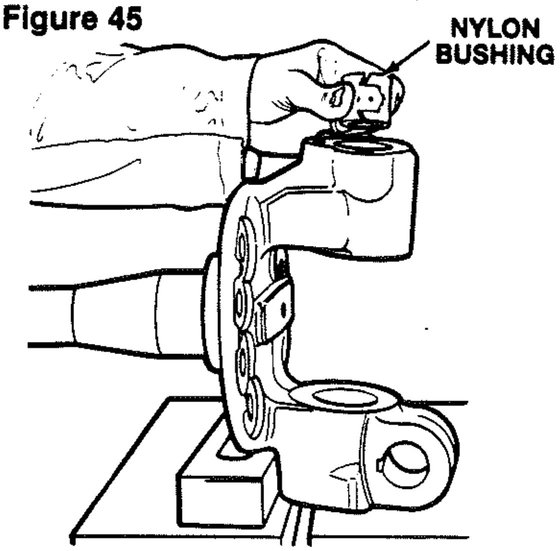


2. Remove the bushing according to the following procedure.

Nylon Bushings

a. Remove the top and the bottom bushing from the knuckle bore. **Figure 45.**

Figure 45



Bronze and Easy Steer™ Bushings

NOTE
On FF-, FG- and FL-Series axles the bushings can be removed with Bushing Service Kit from Kent-Moore Tools. See the 'Special Tools Chart' in Section 9.

a. Make a tool to remove the bushings. See **Figure 47** for the dimensions of the tool.

b. Put the knuckle on a press. Use a press with a 5 ton capacity. Make sure the knuckle does not move when the bushings are removed.

c. Install the tool in the top bushing. Press the top bushing from the knuckle bore. **Figure 46.**

d. Install the tool in the bottom bushing. Press the bottom bushing from the knuckle bore. **Figure 46.**

Figure 46

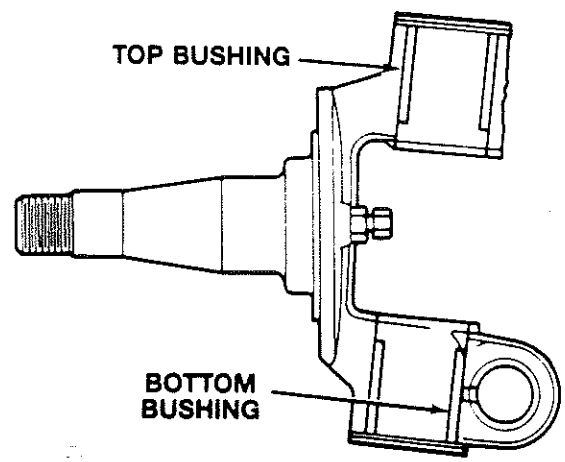
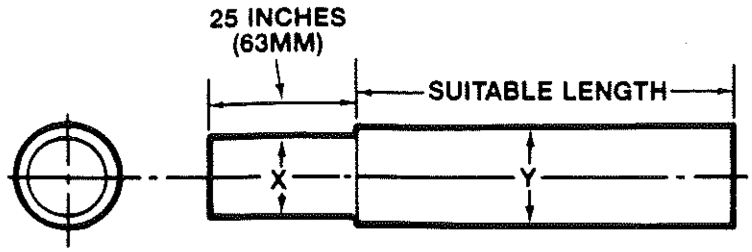


Figure 47

Dimensions for Bushing Removal and Installation Tool



Axle Model Number	Dimension'X'		Dimension'Y'	
	(±0.001 inch)	(±0.025 mm)	(± 0.001 inch)	(±0.025mm)
FC-901	1.228	31.191	1.350	34.290
FC-903	1.228	31.191	1.350	34.290
FD-901	1.427	36.245	1.552	39.420
FD-931	1.600	40.640	1.725	43.815
FD-933	1.600	40.640	1.725	43.815
FD-961	1.786	45.364	1.911	48.539
FE-970	1.600	40.640	1.725	43.815
FF-921	1.787	45.389	1.911	48.539
FF-931	1.787	45.389	1.911	48.539
FF-932	1.787	45.389	1.911	48.539
FF-933	1.787	45.389	1.911	48.539
FF-934	1.787	45.389	1.911	48.539
FF-941	1.786	45.364	1.911	48.539
FF-942	1.786	45.364	1.911	48.539
FF-943	1.786	45.364	1.911	48.539
FF-944	1.786	45.364	1.911	48.539
FF-961	1.786	45.364	1.911	48.539
FF-971	1.600	40.640	1.725	43.815
FG-931	1.787	45.389	1.911	48.539
FG-933	1.787	45.389	1.911	48.539
FG-941	1.786	45.364	1.911	48.539
FG-943	1.786	45.364	1.911	48.539
FL-931	1.992	50.596	2.116	53.746
FL-933	1.992	50.596	2.116	53.746
FL-941	1.990	50.546	2.116	53.746
FL-943	1.990	50.546	2.116	53.746
FL-951	1.992	50.596	2.116	53.746
FU-910	2.054	52.171	2.179	55.346
FU-935	2.054	52.171	2.179	55.346

Preparing the Parts for Assembly

Repairing of Parts

The repair or reconditioning of front axle components is not allowed. Rockwell recommends replacing damaged or out-of-specification components. All major components are heat treated and tempered. **The components cannot be bent, welded, heated or repaired in any way without reducing the strength or life of the component and voiding the warranty.**

The following operations are prohibited on front axle components.

1. Welding of or to the steering arms, tie rod arms, the knuckles, the king pins, the axle beams, the tie rod assemblies, the hubs, the drums or the brakes.
2. Hot or cold bending of the knuckles, the steering arms, the tie rod arms, the ball studs, the axle beams or the tie rod assemblies.
3. Drilling out of the holes in the axle beam for the king pins.
4. Drilling out of the draw key holes in the knuckle.
5. Spray welding of bearing diameters on the knuckles or in the machined bores.
6. Milling or machining of any component.

WARNING

If you use cleaning solvents, hot solution tanks or alkaline solutions incorrectly, injury can occur. To prevent injury, follow the instructions supplied by the manufacturer. Do NOT use gasoline to clean parts. Gasoline can explode.

Cleaning the Ground or Polished Parts

Use a cleaning solvent to clean ground or polished parts and surfaces. Kerosene or diesel fuel can be used for this purpose. DO NOT USE GASOLINE.

Do NOT clean ground or polished parts in a hot solution tank or with water, steam or alkaline solutions. These solutions will cause corrosion of the parts

Cleaning the Rough Parts

Rough parts can be cleaned with the ground or polished parts. Rough parts also can be cleaned in hot solution tanks with a weak alkaline solution. Parts must remain in the hot solution tanks until they are completely cleaned and heated.

Drying the Cleaned Parts

Parts must be dried immediately after cleaning. Dry parts with clean paper or rags, or compressed air. Do not dry bearings by spinning with compressed air.

Preventing Corrosion and Rust on Cleaned Parts

Apply a light oil to cleaned and dried parts that are not damaged and are to be immediately assembled. Do NOT apply oil to the brake linings or the brake drums.

If parts are to be stored, apply a good rust preventative to all surfaces. Do NOT apply the material to the brake linings or the brake drums. Store the parts inside special paper or other material that prevents corrosion rust.

Section 7
Preparing the Parts for Assembly

Inspecting the Parts

Carefully inspect all parts before assembly. See the following.

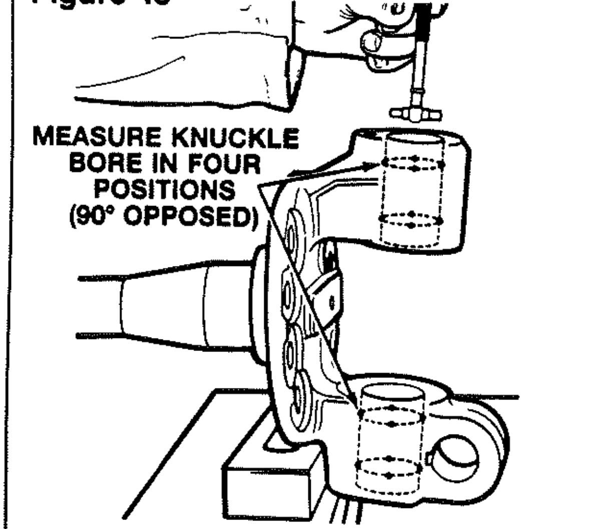
A. Inspect and replace any parts that are worn, cracked or damaged. Check for cracks with a die check or a magnetic or florescent particle inspection.

B. Use a micrometer and a telescoping gauge to measure the bore in the knuckle. Rounding at the top and bottom edges of the bore is acceptable. Make sure the bushing is removed from the knuckle.

Measure the bore in two positions at the center line of the side of the knuckle. If the average measurement is more than the Knuckle Bore Maximum Diameter specification in **Figure 56**, replace the knuckle. **Figure 48.**

Repeat the measurement in two more positions at the centerline of the front of the knuckle. If the average measurement is more than the Knuckle Bore Maximum Diameter specification in **Figure 56**, replace the knuckle. **Figure 48.**

Figure 48

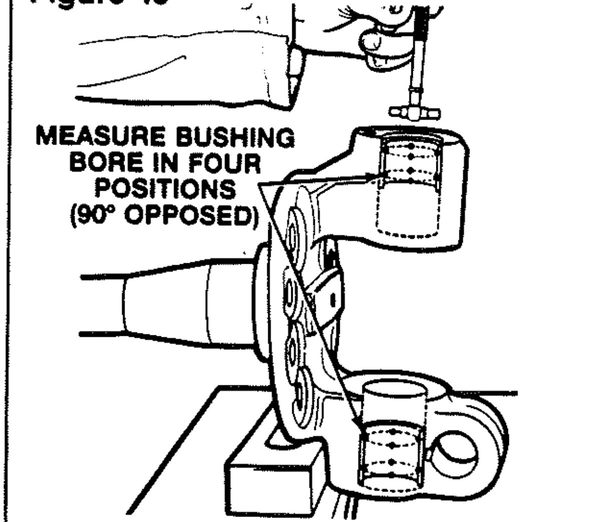


C. Use a micrometer and a telescoping gauge to measure the inner diameter of the bushing in the knuckle.

Measure the inner diameter of the bushing in two positions at the centerline of the side of the knuckle. If the average measurement is more than the Knuckle Bushing Maximum Inner Diameter specification in **Figure 56**, replace the bushing. **Figure 49.**

Repeat the measurement in two more positions at the centerline of the front of the knuckle. If the average measurement is more than the Knuckle Bushing Maximum Inner Diameter specification in **Figure 56**, replace the bushing. **Figure 49.**

Figure 49

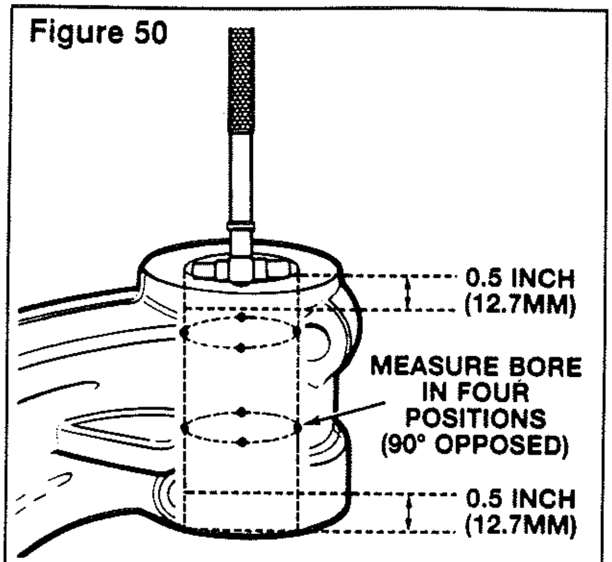


D. Use a micrometer and a telescoping gauge to measure the bore in the beam. Rounding at the top and bottom edges of the bore is acceptable.

Measure the bore in two positions at the centerline of the side of the beam between 1/2 inch (25mm) from the top of the bore and 1/2 inch (25mm) from the bottom of the bore. If the average measurement is more than the Beam Bore Maximum Diameter specification in **Figure 56**, replace the beam. **Figure 50.**

Repeat the measurement in two more positions at the centerline of the front of the beam between 1/2 inch (25mm) from the top of the bore and 1/2 inch (25mm) from the bottom of the bore. If the average measurement is more than the Beam Bore Maximum Diameter specification in **Figure 56**, replace the beam. **Figure 50.**

Figure 50



Inspecting the Wheel Bearings

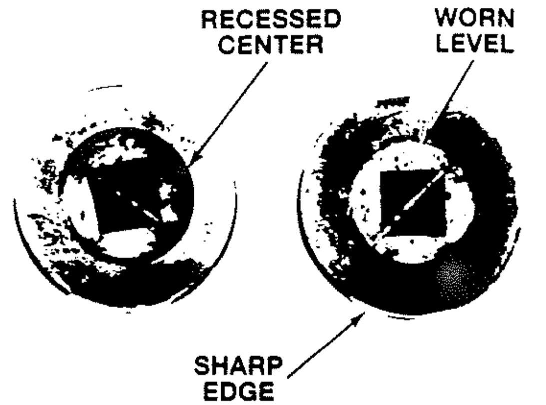
Inspect the wheel bearings when the knuckle is inspected or repaired.

Remove all lubricant from the bearings, knuckle, hub and hub cap.

Inspect the cup, the cone and the rollers and cage of all bearings. If any of the following conditions exist, the bearing **MUST** be replaced.

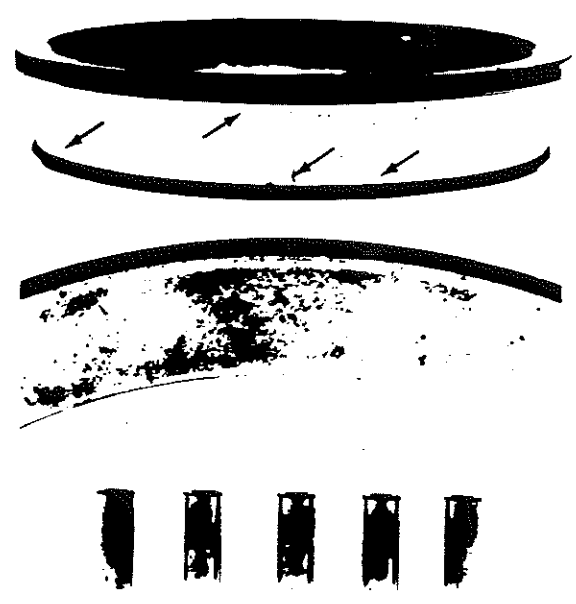
1. The center of the large diameter end of the rollers is worn level or below the outer surface. **Figure 51.**
2. The radius at the large diameter end of the rollers is worn to a sharp edge. **Figure 51.**

Figure 51



3. A visible roller groove in the cup or the cone inner race surfaces. The groove can be seen at the small or large diameter end of both parts. **Figure 52.**

Figure 52



4. Deep cracks or breaks in the cup, the cone inner race or the roller surfaces. **Figure 53.**

Figure 53

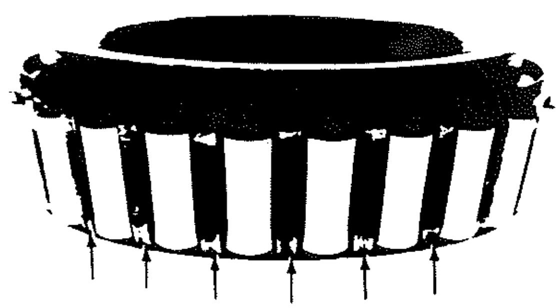


Figure 54

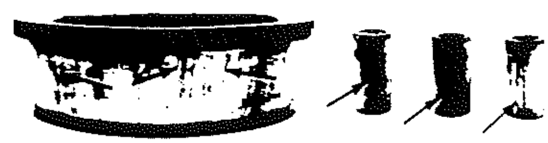
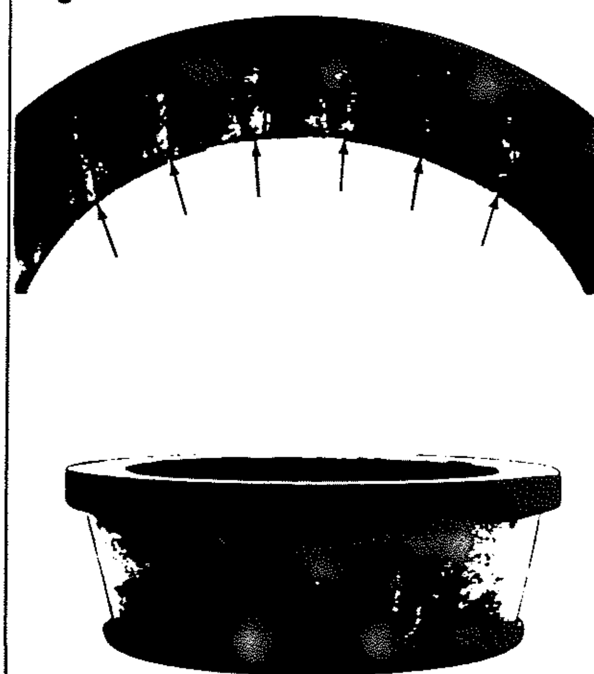


Figure 55



5. Bright wear marks on the outer surface of the roller cage. **Figure 54.**
6. Damage on the rollers and on the surfaces of the cup and the cone inner race that touch the rollers. **Figure 54.**
7. Damage on the cup and the cone inner surfaces that touch the rollers. **Figure 55.**

Figure 56

Axle Wear Limits Specifications

Model Number	Knuckle Bore Maximum Diameter	Beam Bore Maximum Diameter	Knuckle Bushing Maximum Inner Diamater
FC-901 ①	1.361 in.(34.569mm)	1.238 in.(31.445mm)	1.240 in.(31.496mm)
FC-901 ②	1.361 in.(34.569mm)	1.238 in.(34.445mm)	1.238 in.(31.442mm)
FC-903 ①	1.361 in.(34.569mm)	1.238 in.(31.445mm)	1.240 in.(31.496mm)
FC-903 ②	1.361 in.(34.569mm)	1.238 in.(34.445mm)	1.238 in.(31.442mm)
FD-901	1.563 in.(39.700mm)	1.4375 in.(36.5125mm)	1.438 in.(36.525mm)
FD-931	1.736 in.(44.094mm)	1.6110 in.(40.9194mm)	1.6105 in.(40.9067mm)
FD-933	1.736 in(44.094mm)	1.6110 in.(40.9194mm)	1.6105 in.(40.9067mm)
FD-961	1.922 in(48.818mm)	1.7980 in.(45.6692mm)	1.796 in.(45.618mm)
FE-970	1.736 in.(44.094mm)	1.6110 in.(40.9194mm)	1.6105 in.(40.9067mm)
FF-921	1.922 in.(48.818mm)	1.7980 in.(45.6692mm)	1.7975 in.(45.6565mm)
FF-931	1.922 in.(48.818mm)	1.7980 in.(45.6692mm)	1.7975 in.(45.6565mm)
FF-932	1.922 in.(48.818mm)	1.7980 in.(45.6692mm)	1.7975 in.(45.6565mm)
FF-933	1.922 in.(48.818mm)	1.7980 in.(45.6692mm)	1.7975 in.(45.6565mm)
FF-934	1.922 in.(48.818mm)	1.7980 in.(45.6692mm)	1.7975 in.(45.6565mm)
FF-941	1.922 in.(48.818mm)	1.7980 in.(45.6692mm)	1.796 in.(45.618mm)
FF-942	1.922 in.(48.818mm)	1.7980 in.(45.6692mm)	1.796 in.(45.618mm)
FF-943	1.922 in.(48.818mm)	1.7980 in.(45.6692mm)	1.796 in.(45.618mm)
FF-944	1.922 in.(48.818mm)	1.7980 in.(45.6692mm)	1.796 in.(45.618mm)
FF-961	1.922 in.(48.818mm)	1.7980 in.(45.6692mm)	1.796 in.(45.618mm)
FF-971	1.736 in.(44.094mm)	1.6105 in.(40.9067mm)	1.6105 in.(40.9067mm)
FG-931	1.922 in.(48.818mm)	1.7980 in.(45.6692mm)	1.7975 in.(45.6565mm)
FG-933	1.922 in.(48.818mm)	1.7980 in.(45.6692mm)	1.7975 in.(45.6565mm)
FG-941	1.922 in.(48.818mm)	1.7980 in.(45.6692mm)	1.796 in.(45.618mm)
FG-943	1.922 in.(48.818mm)	1.7980 in.(45.6692mm)	1.796 in.(45.618mm)
FL-931	2.127 in.(54.025mm)	2.0030 in.(50.8762mm)	2.0030 in.(50,8767mm)
FL-933	2.127 in.(54.025mm)	2.0030 in.(50.8762mm)	2.0030 in.(50.8767mm)
FL-941	2.127 in.(54.025mm)	2.0030 in.(50.8762mm)	2.001 in.(50.825mm)
FL-943	2.127 in.(54.025mm)	2.0030 in.(50.8767mm)	2.001 in.(50.825mm)
FL-951	2.127 in.(54.025mm)	2.0030 in.(50.8767mm)	2.0030 in.(50.8767mm)
FU-910	2.190 in.(55.626mm)	2.0655 in.(52.4637mm)	2.0645 in.(52.4383mm)
FU-935	2.190 in.(55.626mm)	2.0655 in.(52.4637mm)	2.0645 in.(52.4383mm)

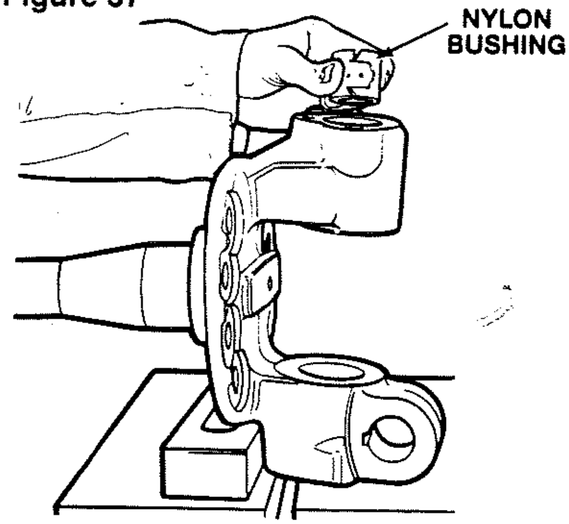
NOTES:

① Knuckles with nylon bushings.
② Knuckles with bronze bushings.

Installing Nylon Bushings in the Knuckle

1. Put the bushings in the knuckle bores. Make sure the bushing is against the bore in the knuckle. Install the king pin to make sure the bushing is installed correctly. **Figure 57.**

Figure 57



Installing Bronze and Easy Steer™ Bushings in the Knuckle

NOTE

On FF-, FG- and FL-Series axles, the bushings can be installed without a press. Use the Bushing Service Kit from Kent-Moore tools to install and ream the bushings. See the 'Special Tools Chart' in Section 9.

Use the tool shown in **Figure 47** to install the bushings.

Use a press with a minimum capacity of 5 tons.

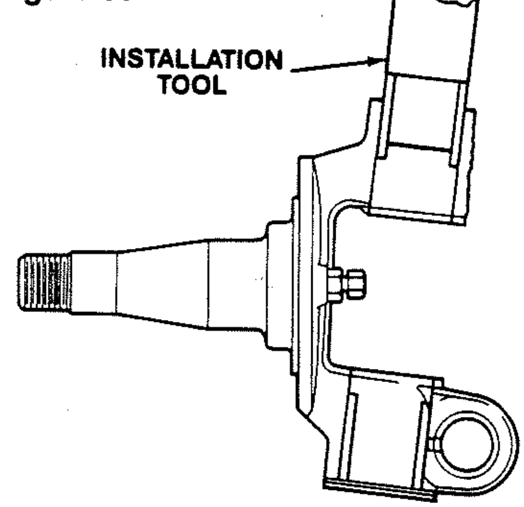
Make sure the knuckle does not move when installing the bushings.

Ream the bronze and Easy Steer bushings after installation.

Installing the Bronze Knuckle Bushings

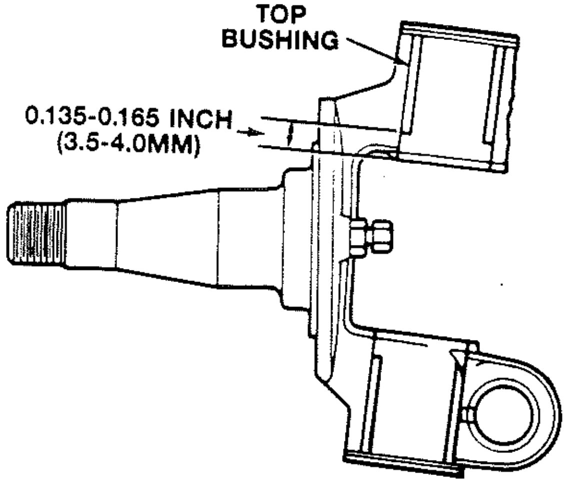
1. Install the top bushing first.
2. Put the knuckle in a press so that the top of the knuckle is toward the top of the press. Make sure the top of the bores are parallell to the top of the press.
3. Put the bushing in the bore. Make sure the hole in the bushing is aligned with the hole in the bore. **Figure 58.**

Figure 58



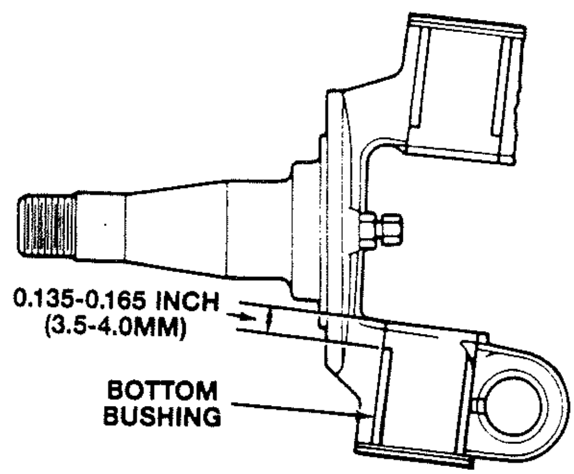
4. Use the installation tool and press the bushing 1/8 inch (3 mm) into the bore. Release the pressure. Make sure the bushing is straight.
5. Press the bushing until there is 0.135-0.165 inch (3.5-4.0 mm) between the bottom of the bushing and the bottom of the top bore. **Figure 59.**

Figure 59



6. Turn the knuckle over so that the bottom of the knuckle is toward the top of the press. Make sure the bore for the bushing is parallel to the top of the press.
7. Put the bottom bushing in the bore. Make sure the hole in the bushing is aligned with the hole in the bore.
8. Use the installation tool and press the bushing 1/8 inch (3 mm) into the bore. Release the pressure. Make sure the bushing is pressed straight.
9. Press the bushing until there is 0.135-0.165 inch (3.5-4.0 mm) between the bottom of the bushing and the top of the bottom bore. **Figure 60.**
10. Ream the bushings. See the procedure in this section.

Figure 60

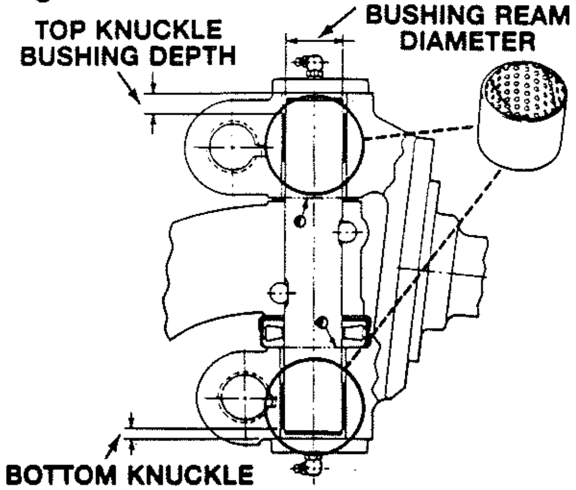


Installing the Easy Steer™ Bushings

1. Install the top knuckle bushing first.
2. Put the knuckle in a press so that the top of the knuckle is toward the top of the press. Make sure the top of the bores are parallel to the top of the press.
3. Put the bushing in the bore.
4. Use the installation tool and press the bushing 1/8 inch (3 mm) into the bore. Release the pressure. Make sure the bushing is pressed straight.
5. Press the bushing until the top of the bushing is 0.352-0.382 inch (8.94-9.70 mm) below the top of the knuckle. **Figure 61.**
6. Turn the knuckle over so that the bottom of the knuckle is toward the top of the press. Make sure the bore is parallel to the top of the press.
7. Put the bottom bushing in the bore.
8. Use the installation tool and press the bushing 1/8 inch (3 mm) into the bore. Release the pressure. Make sure the bushing is straight.

9. Press the bushing until the top of the bushing is 0.352-0.382 inch (8.94-9.70 mm) below with the top of the knuckle. **Figure 61.**
10. Ream the bushings. See the procedure in this section.

Figure 61



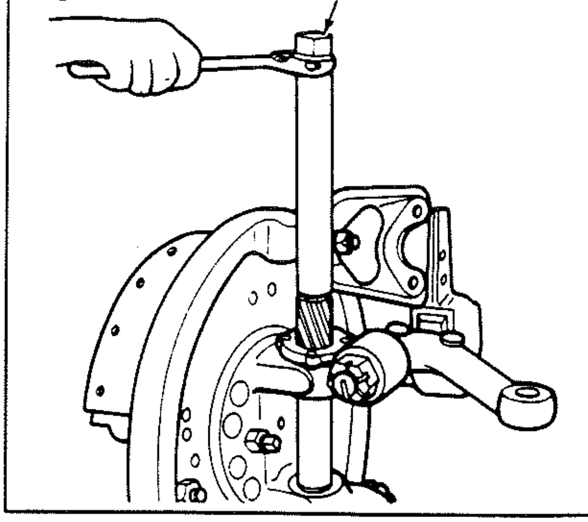
Reaming the Bronze and Easy Steer™ Bushings

CAUTION

Reaming with a fixed reamer is the only recommended procedure. Do not hone or burnish the bushings. The bushings will be damaged by honing or burnishing.

1. Put the knuckle in a vise with brass jaws.
2. See **Figure 64** for the dimensions of the reamer tool.
3. Slide the pilot of the reamer through the top bushing until the reamer blades touch the bushing. **Figure 62.**
4. Rotate the reamer with a light downward pressure. Do not apply too much force. Rotate the reamer smoothly.

Figure 62



5. After the reamer cuts most of the top bushing, make sure the tool does not drop to the bottom bushing.
6. After cutting the top bushing, guide the reamer into the bottom bushing. Repeat steps 3-5. **Figure 63.**
7. Slide the reamer out of the bottom bushing. If the reamer must be removed through the top bushing, rotate the tool in the opposite cutting direction.
8. Clean all material from the bushings.

Figure 63

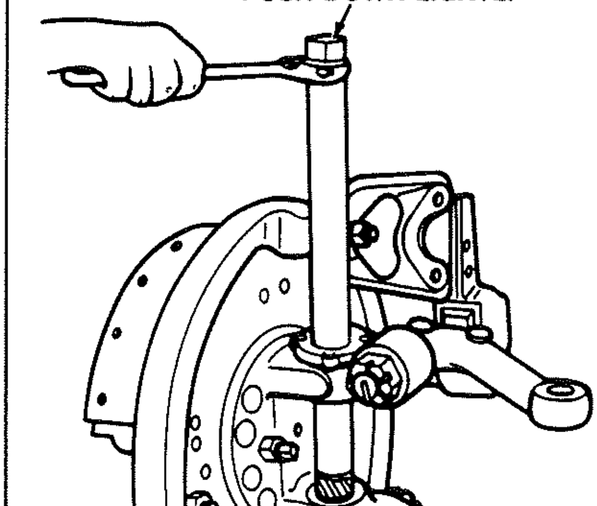
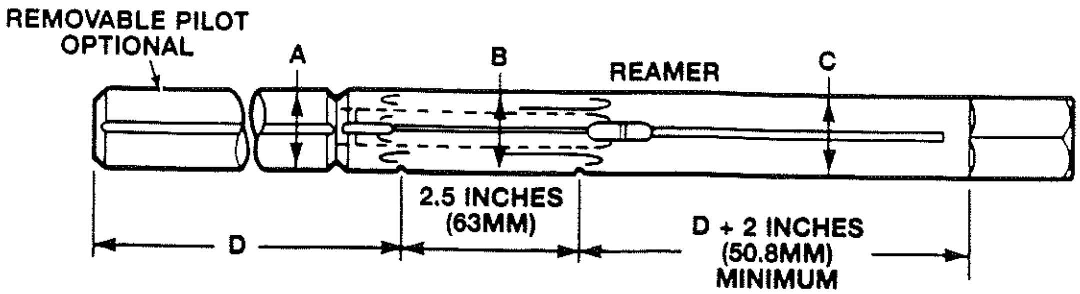


Figure 64

BUSHING REAMER DIMENSIONS



GENERAL REAMER SPECIFICATIONS

MATERIAL: HIGH SPEED STEEL

NUMBER OF BLADES: IF DIMENSION 'A' IS 1.2205 INCH (31.0007 MM), USE 8-12 BLADES. IF DIMENSION 'A' IS MORE THAN 1.2205 INCH (31.0007 MM) , USE 10-14 BLADES.

CUT OF BLADES: RIGHT HAND CUT, LEFT HAND FLUTE

LENGTH OF BLADES: 2.50 INCHES (63.5 MM)

Axle Model	Lower Pilot Diameter Dimension 'A' (+0.001 inch or +0.0245 mm)		Blade Diameter Dimension 'B' (+0.0005 inch or +0.0127 mm)		Upper Pilot Diameter Dimension 'C' (+0.001 inch or +0.0245 mm)		Lower Pilot Length Dimension 'D'		Upper Pilot Length Minimum Dimension 'E'	
	Inch	MM.	Inch	MM	Inch	MM	Inch	MM.	Inch	MM.
FC-901	1.2225	31.0515	1.2375	31.4325	1.2320	31.2928	6.75	171.45	8.75	222.25
FC-901 *	1.2225	31.0515	1.2375	31.4325	1.2320	31.2928	6.75	171.45	8.75	222.25
FC-903	1.2225	31.0515	1.2375	31.4325	1.2320	31.2928	6.75	1.7145	8.75	222.25
FD-901	1.4220	36.1188	1.4370	36.4998	1.4315	36.3601	8.50	215.90	10.50	266.70
FD-901*	1.4220	36.1188	1.4370	36.4498	1.4315	36.3601	8.50	215.90	10.50	266.70
FD-931	1.5950	40.5130	1.6100	40.8940	1.6405	41.6687	8.50	215.90	10.50	266.70
FD-933	1.5950	40.5130	1.6100	40.8940	1.6405	41.6687	8.50	215.90	10.50	266.70
FD-961	1.7800	45.2120	1.7955	45.6057	1.7900	45.4660	10.25	260.35	12.25	311.15
FE-970	1.5950	40.5130	1.6100	40.8940	1.6405	41.6687	8.50	215.90	10.50	266.70
FF-921	1.7820	45.2628	1.7970	45.6438	1.7915	45.5041	9.30	236.22	11.30	287.02
FF-931	1.7820	45.2628	1.7970	45.6438	1.7915	45.5041	9.30	236.22	11.30	287.02
FF-932	1.7820	45.2628	1.7970	45.6438	1.7915	45.5041	9.30	236.22	11.30	287.02
FF-933	1.7820	45.2628	1.7970	45.6438	1.7915	45.5041	9.30	236.22	11.30	287.02
FF-934	1.7820	45.2628	1.7970	45.6438	1.7915	45.5041	9.30	236.22	11.30	287.02
FF-941	1.7800	45.2120	1.7955	45.6057	1.7900	45.4660	10.25	260.35	12.25	311.15
FF-942	1.7800	45.2120	1.7955	45.6057	1.7900	45.4660	10.25	260.35	12.25	311.15

* **Use these specifications when replacing the existing bushing with an Easy Steer™ bushing.**

Figure 64 (Continued)

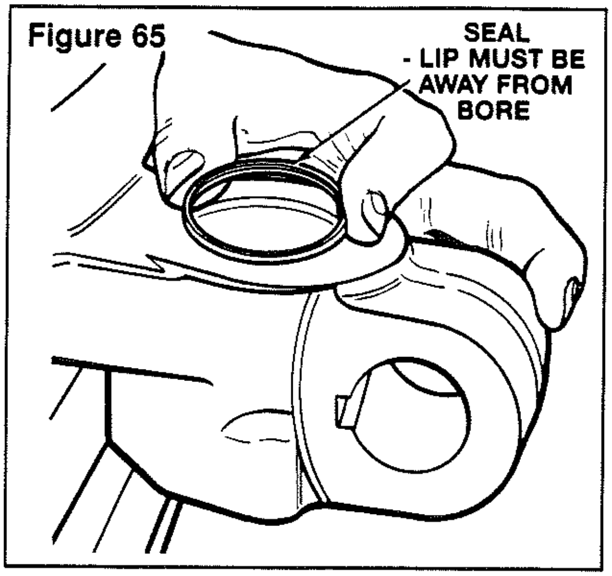
BUSHING REAMER DIMENSIONS
(Continued)

Axle Model	Lower Pilot Diameter Dimension 'A' (+0.001 inch or +0.0245 mm)		Blade Diameter Dimension 'B' (+0.0005 inch or +0.0127 mm)		Upper Pilot Diameter Dimension 'C' (+0.001 inch or +0.0245 mm)		Lower Pilot Length Dimension 'D'		Upper Pilot Length Minimum Dimension 'E'	
	Inch	MM.	Inch	MM	Inch	MM	Inch	MM.	Inch	MM.
FF-943	1.7800	45.2120	1.7955	45.6057	1.7900	45.4660	10.25	260.35	12.25	311.15
FF-944	1.7800	45.2120	1.7955	45.6057	1.7900	45.4660	10.25	260.35	12.25	311.15
FF-961	1.7800	45.2120	1.7955	45.6057	1.7900	45.4660	10.25	260.35	12.25	311.15
FF-971	1.5950	40.5130	1.6100	40.8940	1.6405	41.6687	8.50	215.90	10.50	266.70
FG-931	1.7820	45.2628	1.7970	45.6438	1.7915	45.5041	9.30	236.22	11.30	287.02
FG-933	1.7820	45.2628	1.7970	45.6438	1.7915	45.5041	9.30	236.22	11.30	287.02
FG-941	1.7800	45.2120	1.7955	45.6057	1.7900	45.4660	10.25	260.35	12.25	311.15
FG-943	1.7800	45.2120	1.7955	45.6057	1.7900	45.4787	10.25	260.35	12.25	311.15
FL-931	1.9870	50.4698	2.0025	50.8635	1.9970	50.7238	10.10	256.54	12.10	307.34
FL-933	1.9870	50.4698	2.0025	50.8635	1.9970	50.7238	10.10	256.54	12.10	307.34
FL-941	1.9850	50.4190	2.0005	50.8127	1.9950	50.6730	10.10	256.54	12.10	307.34
FL-943	1.9850	50.4190	2.0005	50.8127	1.9950	50.6730	10.10	256.54	12.10	307.34
FL-951	1.9850	50.4190	2.0005	50.8127	1.9950	50.6730	10.10	256.54	12.10	307.34
FU-910	2.0490	52.0446	2.0640	52.4256	2.0585	52.2859	11.32	287.52	13.32	338.32
FU-935	2.0490	52.0446	2.0640	52.4256	2.0585	52.2859	11.32	287.52	13.32	338.32

Installing the Seals for the Knuckle Bushings

1. Put the top of the knuckle in a vise with brass jaws. The bottom of the knuckle must be toward you.
2. Put the seal in the bottom of the top knuckle bore. The lip of the seal must be away from the bore. **Figure 65.**

Figure 65

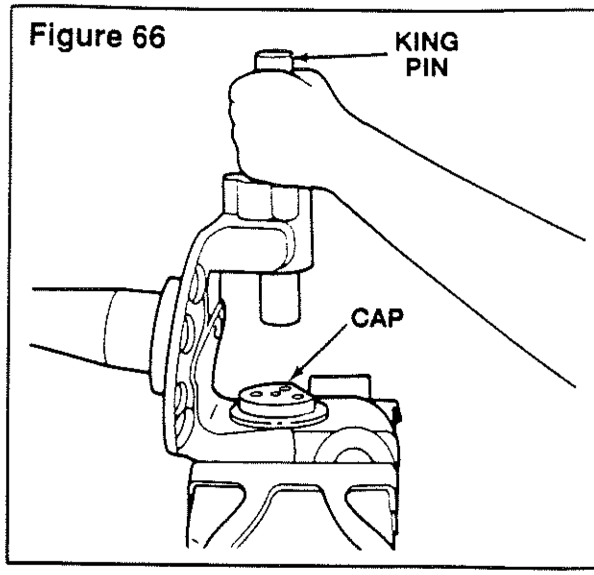


3. Put the end cap for the knuckle on top of the seal. Slide the king pin through the opposite knuckle bore. Use the king pin to install the seal. **Figure 66.**

   For bronze bushings, make sure the bottom of the seal touches the bushing.

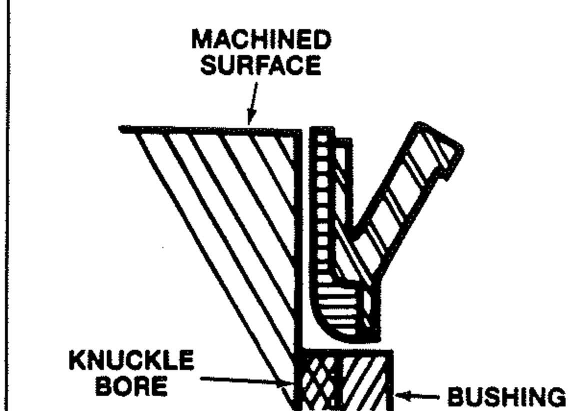
   For Easy-Steer™ and plastic bushings, make sure the top of the seal is even with the top of the knuckle. **Figure 67.**

Figure 66



4. Turn the knuckle over in the vise. The jaws of the vise must hold the bottom of the knuckle and the top of the knuckle must be toward you.
5. Put the seal in the top of the bottom knuckle bore. The lip of the seal must be away from the bore. **Figure 65.**
6. Repeat step 3 of this procedure.

Figure 67



Installing the Knuckle

NOTE

For optimal tire wear on crowned road surfaces, the right and the left king pin bores in the beam are machined to slightly different king pin angles. The front of the beam must be installed toward the front of the vehicle. The front of the the beam is marked by the identification tag on the front of the beam and/or a white paint stripe on the left (driver's side) of the beam. If the paint stripe or identification tag are missing, mark the front of the beam for correct installation.

1. Clean the bores of the knuckle and the axle beam.
2. Put the knuckle on the axle beam.
3. Install the seal on the thrust bearing.

   On 'cover' type seals, install the seal over the open end of the bearing. **Figure 68.**

   On 'flat'-type seals, put the seal over the closed part of the bearing. **Figure 68.**

Figure 68

SEAL TYPES

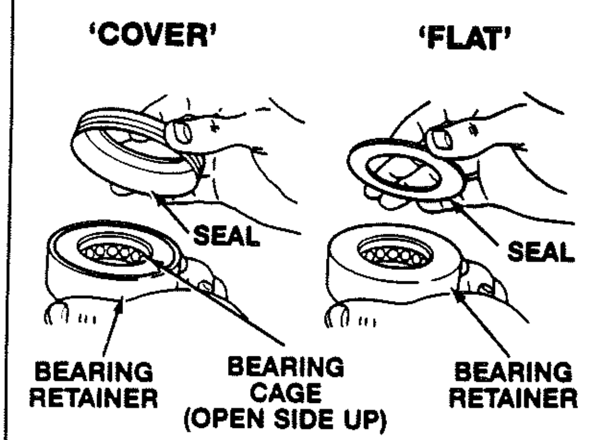
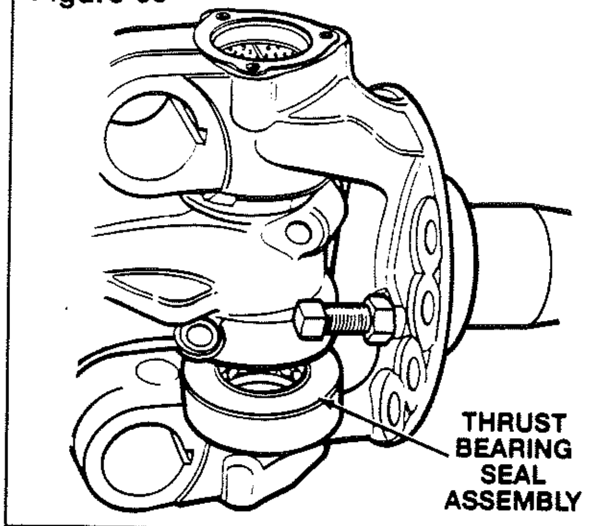


Figure 69



4. Slide the seal and thrust bearing assembly between the bottom of the axle beam and the knuckle. Make sure the seal is toward the beam. **Figure 69.**

WARNING

Wear gloves when installing shims. The shims have sharp edges.

5. Install the shims according to the following procedure.

   A. Inspect the shims. Replace damaged shims.

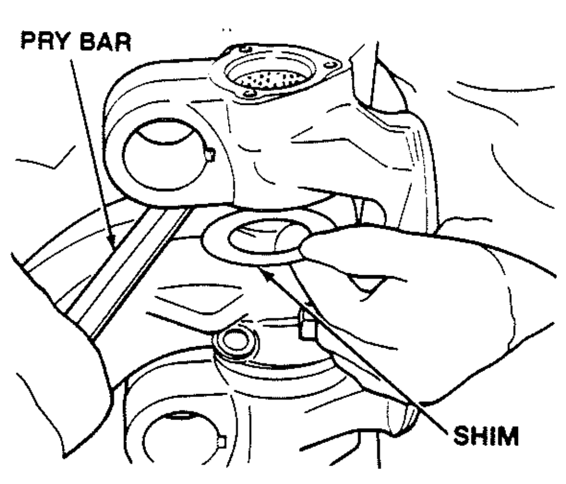
   B. If a new shim pack must be determined, select the amount of shims that will give the smallest end play.

   C. Put a pry bar between the steering arm boss and the axle beam. Lift the knuckle and slide the shim pack between the top of the beam and the knuckle. **Figure 70.**

   D. Make sure all the bores are aligned. If the bores are not aligned, the parts will be damaged when the king pin is installed.

   E. Remove the pry bar.

Figure 70



6. Install the king pin according to the following procedure. **Figure 71.**

   A. Apply the specified lubricant to the bottom half of the king pin.

   B. Install the pin in the top of the knuckle. Make sure the word '**TOP**' is toward you.

   C. Rotate the pin so that the slots are aligned with the holes in the knuckle.

CAUTION

Do not force the pin through the top bushing or the shims will be damaged.

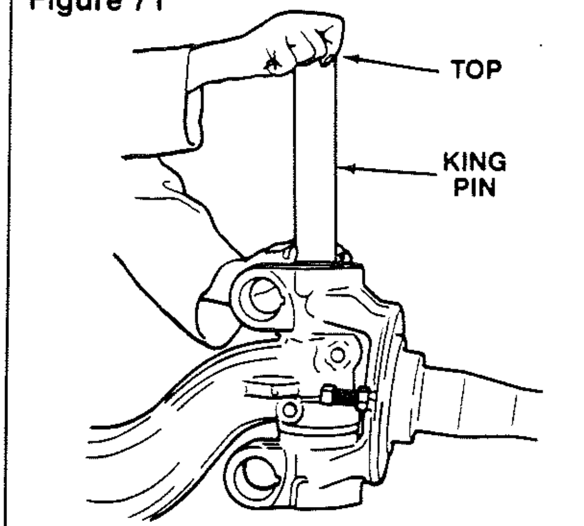
   D. Push the pin through the top bushing, the seal and the shim pack. If the pin is difficult to install, make sure the parts are aligned.

WARNING

Wear eye protection. Do not hit steel parts with a steel hammer. Parts can break and cause injury.

   E. Push the pin into the bottom bushing. If necessary, use a brass hammer to drive the pin into the bushing. Make sure all parts are aligned.

Figure 71



   F. Make sure the slots in the pin are aligned with the holes in the axle beam.

NOTE

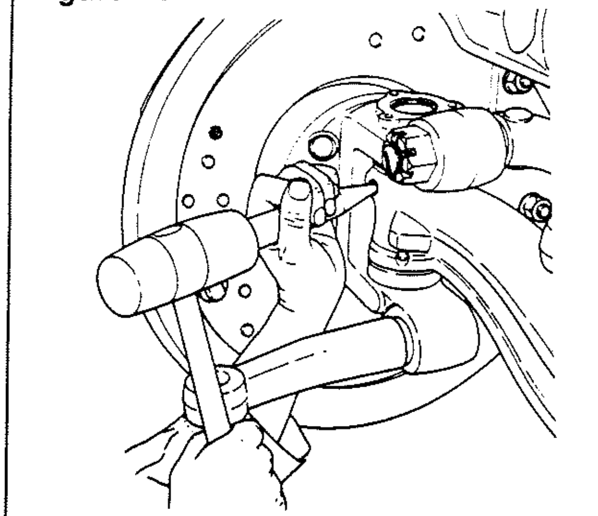
Do not drive or tighten the draw keys into the knuckle until the end play is checked and adjusted.

NOTE

All models except FE-970, FF-971 and FL-901 use threaded draw keys. Models FE-970, FF-971 and FL-901 use plain draw keys.

7. Install the top draw key in the front of the knuckle. Install the bottom draw key in the back of the knuckle. Make sure the key goes through the slot in the pin. **Figure 72.**

Figure 72



8. Check the end play of the knuckle according to the following procedure.

   A. Hit the boss of the knuckle with a rubber mallet to move the parts in position. **Figure 73.**

   B. Turn the knuckle to the straight (forward) position.

   C. Attach a dial indicator. Put the base on the knuckle. Put the tip on the center of the king pin. Set the dial indicator on 'zero' (0). **Figure 74.**

Figure 73

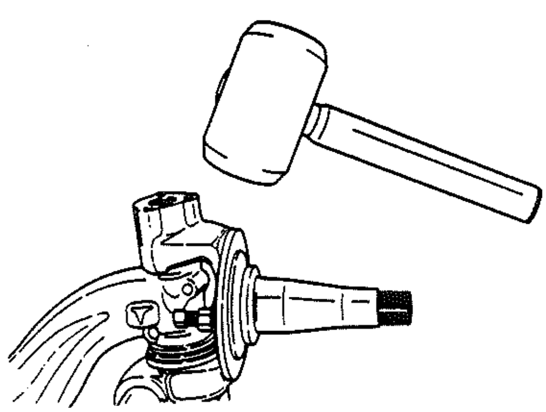
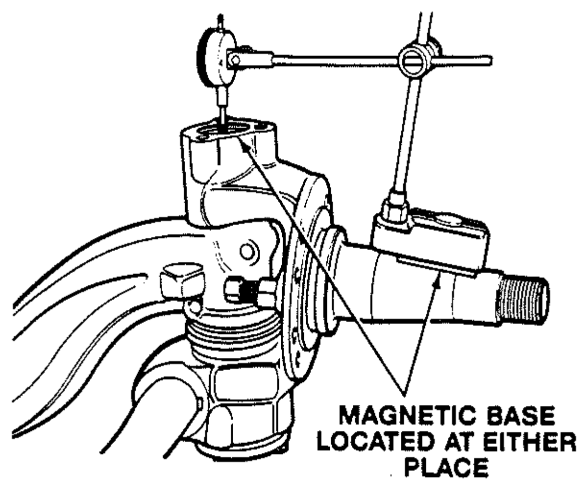


Figure 74



   D. Use one of the following procedures to measure the end play.

   - Put a pry bar between the knuckle and the top of the axle center. Push the knuckle up and measure the end play. **Figure 75.**

WARNING

If a hydraulic jack is used to measure end play, use two safety stands to support the axle. If safety stands are not used, the axle can fall and cause injury.

   - Put a block of wood and a hydraulic jack under the bottom of the knuckle. Raise the knuckle until the pointer on the dial indicator stops. **Figure 76.**

   E. Repeat steps C and D with the axle in the full right and full left turn positions.

Figure 75

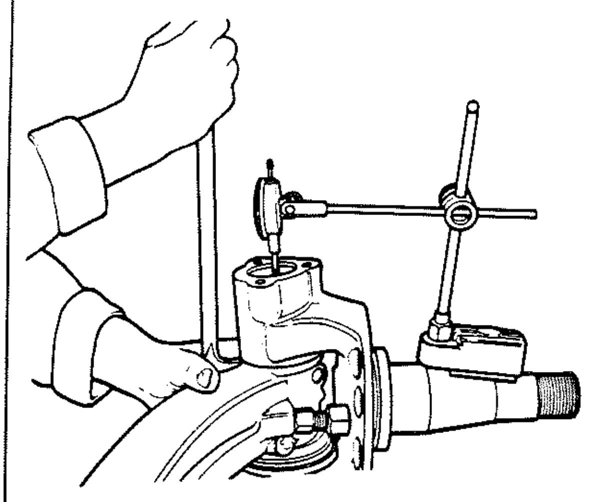
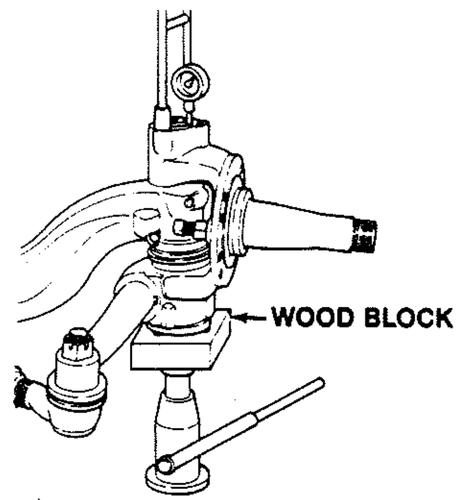


Figure 76



F. The end play must be 0.001-0.025 inch (0.025-0.635 mm) in all positions.
If the knuckle binds or 0 (zero) end play is measured, remove shims from the shim pack.

If more than 0.025 inch end play is measured, add shims to the shim pack.

WARNING

Wear eye protection. Do not hit steel parts with a steel hammer. Parts can break and cause injury.

CAUTION

Make sure the draw key is installed completely or the locknut is tightened to the specified torque. If not installed correctly, the knuckle pin and the axle beam will be damaged.

NOTE

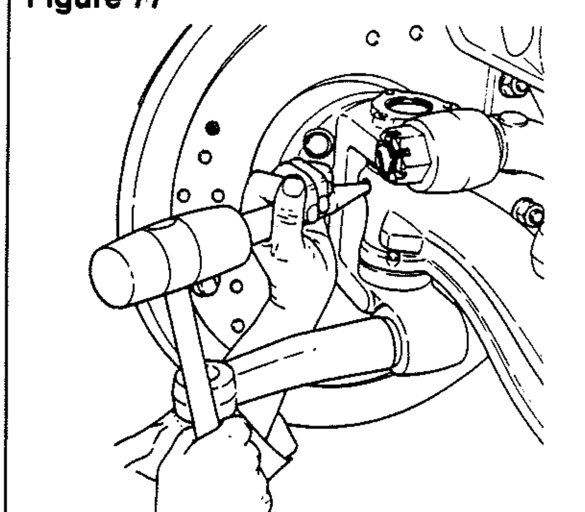
All models except FE-970, FF-971 and FL-901 use threaded draw keys. Models FE-970, FF-971 and FL-901 use plain draw keys.

9. Install the draw keys. See the following procedure.

Plain Draw Keys

Use a hammer and a brass drift to install the draw key in the axle beam and knuckle. Make sure the key is installed 1/32-1/8 inch (1-3mm) below the outer surface of the beam. **Figure 77.**

Figure 77

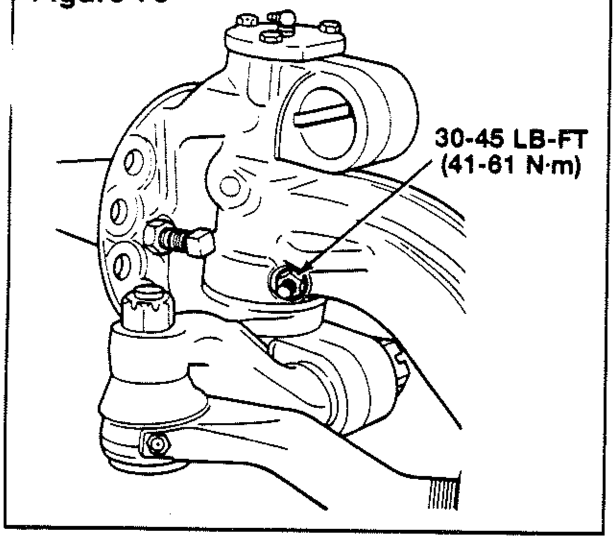


Section 8
Installation

Threaded Draw Keys

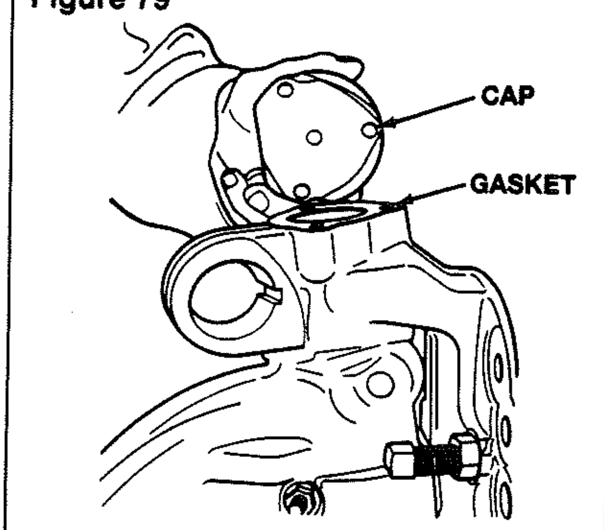
On threaded draw keys, install the lock nut and tighten to 30-45 lb-ft (41-54 N.m). **Figure 78.** T

Figure 78



10. Install new gaskets and the caps on the top and the bottom of the knuckle. Install the capscrews and the washers and tighten to 20-30 lb-ft (28-40 N.m). **Figure 79.** T

Figure 79



11. Connect the tie rod arm to the knuckle. See the procedure in this section.
12. Install the brake assembly on the knuckle. See the procedure of the manufacturer of the vehicle.
13. Lubricate the wheel bearings. See Section 4, Lubrication.
14. Install the drum and the wheel and tire assembly.
15. Lubricate the wheel bearings. See Section 4, Lubrication and Maintenance.
16. Install the outer wheel bearing cone in the hub. Install the adjusting nut.
17. Adjust the wheel bearings. See Section 5, Adjustments.
18. Install the cap and the gasket on the hub. Install the capscrews and tighten to 20-30 lb-ft (27-41 N.m). T
19. Lower the vehicle to the ground. Check for correct operation.
20. Check and adjust the toe-in. See Section 5, Adjustments.

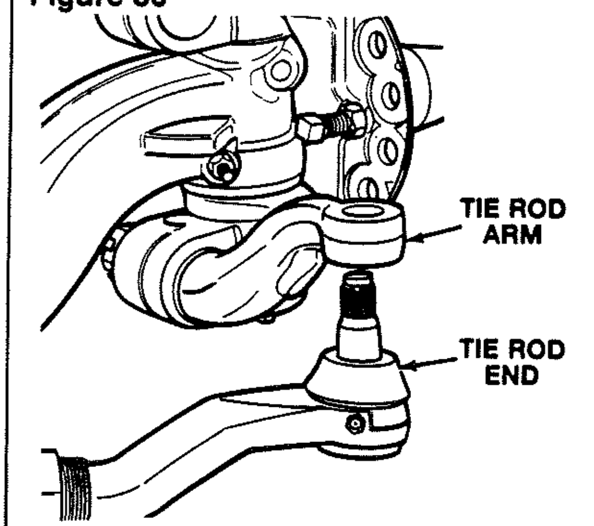
Installing the Tie Rod Arms, the Tie Rod Ends and the Cross Tube

NOTE

If a different tie rod arm is installed, (such as for increasing the maximum turn angle) the steering geometry is changed and may cause tire wear. See Rockwell Technical Service Aid, TSA-87121 to choose the correct tie rod arm. Contact your Rockwell service representative.

1. Press the key in the slot in the arm. **Figure 80.**
2. Install the tie rod arm in the knuckle. **Figure 80.**

Figure 80



CAUTION

Tighten the nuts to the specified torque. If the nuts are not tightened to the specified torque, the parts will be damaged.

3. Install the nut on the tie rod arm. Tighten to the specified torque. See the Torque Chart on page 52. T
4. Install the cotter pins. If the necessary, tighten the nut until the holes are aligned. Do not loosen the nut to install the cotter pin.

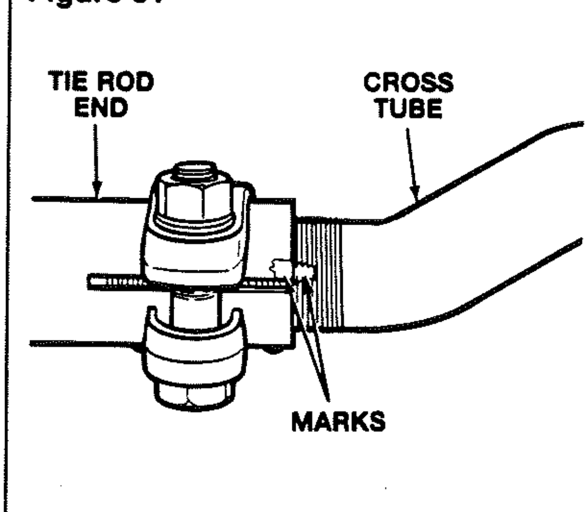
NOTE

The cross tube has right-hand threads on one end and left hand threads on the other end. Make sure the ends are installed on the tube.

5. If removed, install the tie rod ends on the cross tube to the position marked during removal. **Figure 81.**

   If new tie rod ends are installed, thread the ends equally on the cross tube to the required length.
6. Install the nuts and the bolts in the clamps. Tighten to the specified torque. See the Torque Chart on page 52. **Figure 81.** T
7. Connect the tie rod ends into the tie rod arms.
8. Install the nuts on the tie rod ends. Tighten to the specified torque. See the Torque Chart on page 52. T

Figure 81



9. Install the cotter pins. If necessary, tighten the nut until the holes are aligned. Do not loosen the nut to install the cotter pin.
10. Check and, if necessary, adjust the toe-in. See Section 5, Adjustments.

Installing the Steering Arm

See Figure 82.

1. Press the key in the slot in the arm.
2. Install the steering arm in the knuckle.
3. Connect the steering arm to the drag link.

CAUTION

Tighten the nuts to the specified torque. If the nuts are not tightened to the specified torque, the parts will be damaged.

4. Install the nuts. Tighten to the specified torque. See the Torque Chart on page 52.
5. Install the cotter pins. If the necessary, tighten the nut until the holes are aligned. Do not loosen the nut to install the cotter pin.
6. Lubricate the steering arm. See Section 4, Lubrication and Maintenance.
7. Check for correct operation.

Installing the Drag Link

See Figure 83.

1. Connect the drag link to the steering arm.
2. Connect the drag link to the Pitman arm.

CAUTION

Tighten the nuts to the specified torque. If the nuts are not tightened to the specified torque, the parts will be damaged.

3. Install the nuts. Tighten to the specified torque. See the Torque Chart on page 52.
4. Install the cotter pins. If the necessary, tighten the nut until the holes are aligned. Do not loosen the nut to install the cotter pin.
5. Lubricate the drag link. See Section 4, Lubrication and Maintenance.
6. Check for correct operation.

Figure 82

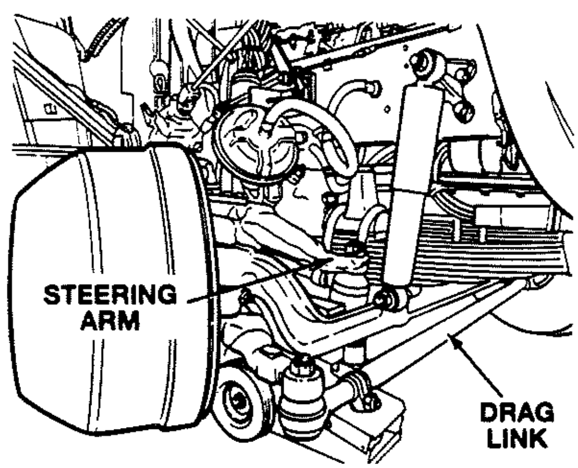
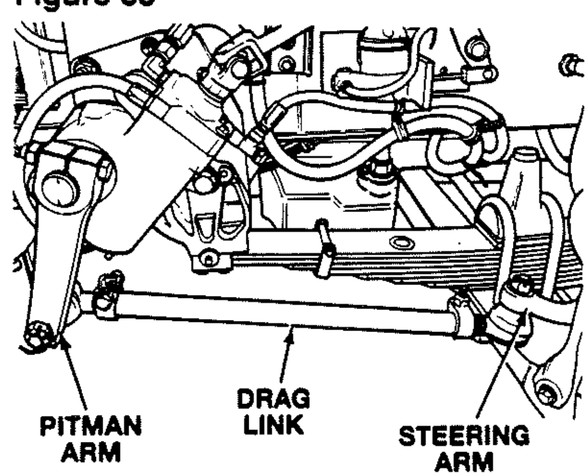


Figure 83



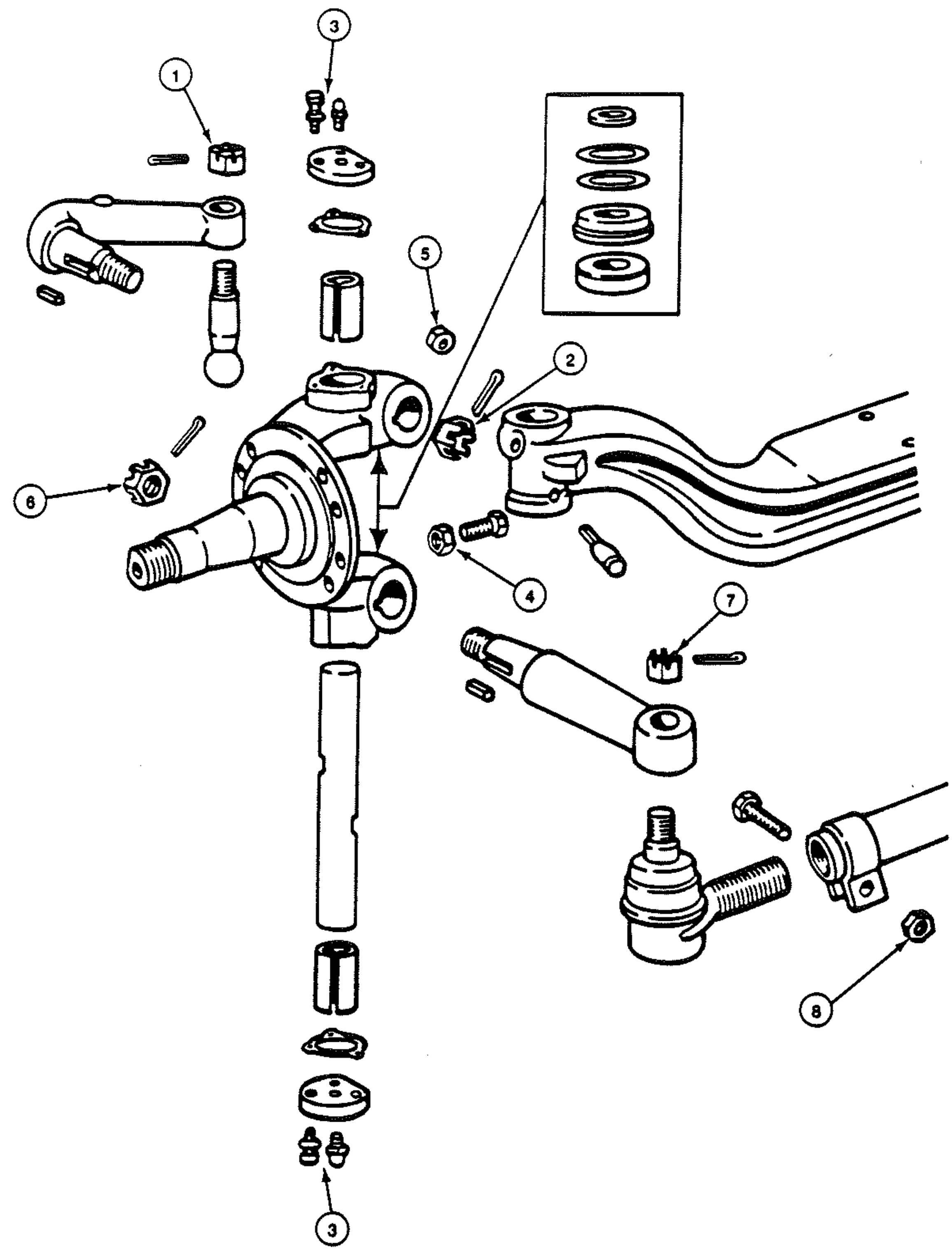
Lubricant Specifications - Front Axle

Description	Lubricant Specification
Drag Link, King Pins, Steering Arm, Tie Rod Ends and Grease Lubricated Wheel Bearings	• Multi-Purpose Chassis Grease, 6 % 12-hydroxy lithium stearate grease, NLGI Grade #1, Rockwell Specification, 0-617-A, or equivalent • Multi Purpose Chassis Grease 8% 12-hydroxy lithium stearate grease, NLGI Grade #2 Rockwell Specification 0-617-B, or equivalent.

Oil-Lubricated Wheel Bearing Lubricant Specifications

Rockwell Lubricant Specification Number	Description	Cross Reference	Minimum Outside Temperature	Maximum Outside Temperature
0-76-D	Hypoid Gear Oil	GL-5, S.A.E. 80W/90	-15° F (-26° C)	None
0-76-E	Hypoid Gear Oil	GL-5, S.A.E. 75W/90	-40° F (-40° C)	None
0-76-J	Hypoid Gear Oil	GL-5, S.A.E. 75W	-40° F (-40° C)	+35° F (+2° C)
0-76-L	Hypoid Gear Oil	GL-5, S.A.E. 75W/140	-40° F (-40° C)	None

Front Axle Torque Illustration



Front Axle Torque Specifications

Item	Description	Size	Torque Range	
			Lb-Ft	N.m
1	Steering Arm to Drag Link Nut	5/8"-16	60-115	82-155
		5/8"-18	60-115	82-155
		3/4"-16	90-170	123-230
		7/8"-14	160-300	217-407
2	Steering Arm to Knuckle Nut	7/8"-14	250-450	339-610
		1"-14	390-725	529-982
		1-1/8"-12	550-1025	746-1389
		1-1/4"-12	775-1450	1051-1965
		1-1/2"-12	1350-2525	1831-3423
3	Knuckle Cap Capscrew	5/16"-18	20-30	28-40
4	Stop Screw Locknut	1/2"-13	50-65	68-88
5	Draw Key Nut	7/16"-20	30-45	41-61
6	Tie Rod Arm to Knuckle Nut	7/8"-14	250-450	339-610
		1"-14	390-725	529-982
		1-1/8"-12	550-1025	746-1389
		1-1/4"-12	775-1450	1051-1965
		1-1/2"-12	1350-2525	1831-3423
7	Tie Rod Arm to Tie Rod End Nut	7/8"-14	160-300	217-406
		1"-14	250-450	339-610
		1-1/8"-12	350-650	475-881
		1-1/4"-12	500-675	678-915
8	Cross Tube Clamp Nut	5/8"-11	40-60	55-81
		3/4"-10	155-175	211-237

Section 9
Specifications

Special Tools

Description	Kent-Moore Tool Number ①	Owatonna Tool Number ②	Snap-On® ③ Tool Number
King Pin Remover	J 36136	4240	20 Ton: CG430HYB 35 Ton: CG730HY
King Pin Bushing Service Kit	④		
Basic Service Kit	PT 4375	—	—
FF- and FG-Series Kit	PT 4370-10	—	—
FL-Series Kit	PT 4370-20	—	—

NOTES:

① Order Kent-Moore tools from, Kent-Moore Heavy Duty Division, 29874 Little Mack, Roseville, MI 48066-2298.

② Order Owatonna tools from OTC Toll and Equipment Division, 655 Eisenhower Drive, Owatonna, MN 55060.

③ See your local Snap-On® dealer.

④ Use Basic Service Kit along with the correct axle series kit.

Notes

Notes

Rockwell International

Automotive Operations
Rockwell International Corporation
2135 West Maple Road
Troy, Michigan 48084 U.S.A.

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11

REAR AXLES

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DRIVE AXLE

Description

The Rockwell drive axle is equipped with a single reduction standard carrier mounted in front of axle housing. The carrier has a hypoid drive pinion, a ring gear set and bevel gears in the differential assembly.

A straight roller bearing (spigot) is mounted on the head of the drive pinion. All other bearings in the carrier are tapered roller bearings. When the carrier operates, there is a normal differential action between the wheels all the time.

The standard final drive ratio is 3.58 : 1. Other ratios are also available.

Lubrication

Lubrication recommendations are given in section 24 *"Lubrication"* of this manual under heading *"Differential"*. Additional lubrication information are covered in *"Field Maintenance Manual No. 5"* annexed to the end of this section.

During initial stages of normal operation, tiny metal particles are freed from mating surfaces of moving parts. These metal particles are carried by the lubricant through the assembly and act as lapping compound which accelerates wear of all parts. To ensure maximum life of the differential and prevent premature failure, the original *"factory fill"* lubricant should be drained. ***CHANGE BREAK-IN OIL AFTER 1,000 MILES (1 600 KM) BUT NO MORE THAN 3,000 MILES (4 800 KM) OF INITIAL OPERATION, THEN ACCORDING TO THE LUBRICATION AND SERVICING SCHEDULE. DRAIN THE UNIT WHILE IT IS STILL WARM FROM OPERATION.*** This prevents lubricant contamination caused by differences in the *"factory fill"* and the lubricant used by the operator when topping up.

Maintenance

A proper vehicle operation is the beginning of a preventive maintenance, such as good lubrication and good differential use. The most common types of drive axle carrier failures are spinout, shock, fatigue and lubrication. Avoid neglecting these points as it would be the first step to improper maintenance, expensive repairs, and excessive downtime.

Inspect the pinion oil seal, axle shaft flange and carrier to housing gaskets for evidence of lubricant leakage. Tighten the bolts and nuts, or replace the gaskets and seals to correct leaks. Maintenance of the axle mountings consists primarily in a regular and systematic inspection of the air suspension units and radius rods as directed in section 16 *"Suspension"*.

Removal and replacement

The following procedure deals with the removal of the drive axle assembly and its attachments as a unit. The method used to support the axle during removal and disassembly depends upon local conditions and available equipment.

Removal

1. Raise vehicle by its jacking points on the body (see Section 18 *"Body"* under heading *"Vehicle jacking points"*) until vehicle body is approximately 3' (1 m) from floor. Place jack stands under frame. Remove drive axle wheels (if required, refer to section 13 *"Wheels, hubs and tires"*).

2. Exhaust compressed air from the air supply system by opening the drain cock of each air reservoir.

3. Disconnect the propeller shaft as directed in section 9 *"Propeller shaft"* of this manual.

4. On both sides of vehicle, unscrew fasteners retaining front wheelhouse plastic guards then remove them from vehicle.

5. Disconnect both height control valve links from air spring mounting plate brackets.

6. Remove cable ties securing the ABS cables (if vehicle so equipped) to the service brake chamber hoses, then disconnect the ABS cable connectors located at the opposite extremity of the sensor ends.

NOTE: When you remove cable ties to ease operation, remember to replace them afterwards.

7. Disconnect the brake chamber hoses. Position the hoses so they will not be damaged when removing axle.

8. Install jacks under the axle jacking points to support the axle weight.

9. Remove the four shock absorbers as outlined in section 16 (Suspension) under *"Shock absorber removal"*.

10. Remove the lower and upper longitudinal radius rod supports from vehicle subframe as outlined in section 16 (Suspension) under *"Radius rod removal"*.

NOTE: The upper mounting bolt of each lower radius rod support is accessible from the last baggage compartment.

11. Remove the transversal radius rod support from vehicle subframe.

12. Remove the two air spring retaining nuts from each of the four air spring lower mounting plates.

13. Use the jacks to lower axle. Carefully pull away the jacks and axle assembly from under vehicle.

Replacement

Reverse previous removal procedure to reinstall drive axle.

NOTE: Refer to section 16 *"Suspension"* for proper tightening torques of suspension components.

Disassembly and reassembly

Disassembly and reassembly procedures are explained under applicable headings in *"Rockwell Field Maintenance Manual No. 5"* annexed to this section.

Gear set identification

Gear set identification is explained under applicable heading in *"Rockwell Field Maintenance Manual No. 5"* annexed to this section.

Adjustments

Adjustments are explained under applicable headings in *"Rockwell Field Maintenance Manual No. 5"* annexed to this section.

Fastener torque chart

A differential fastener torque chart is given in *"Rockwell Field Maintenance Manual No. 5"* annexed to this section.

Tire matching

Drive axle tire matching is explained under applicable heading in section 13 (Wheels, hubs, and tires) of this manual.

Drive axle alignment

Description

The axle alignment consists in aligning the axle according to the frame. The axle must be perpendicular to the frame. The alignment is achieved with the use of shims inserted between the lower longitudinal radius rod supports and the frame. Drive axle alignment is factory set and is not subject to any change, except if vehicle has been damaged by an accident or if there is requirements for part replacement.

CAUTION: If this setting is altered significantly, the vehicle will produce offset tracking (dog tracking).

If axle has been removed for repair or servicing and if all members are reinstalled exactly at the same place, the axle alignment is not necessary. However, if the suspension supports have been replaced or altered, proceed with the following instructions to verify or adjust the drive axle alignment.

Procedure

1. Park vehicle on level floor, then chock front vehicle wheels.

2. Using two jacking points (which are at least 30" (76 cm) apart) on drive axle, raise vehicle sufficiently so that wheels can turn freely at about 1/2" from ground, secure in this position with safety stands, then release parking brake.

3. Using an optical toe & tracking system installed on each side of drive axle, fix and position the projector in center of wheel. Measure the distance on each side of projector mounting rods; distance should be equal on both sides. If not, loosen wing nut, adjust projector to the proper distance, then tighten wing nut. Refer to figure 1.

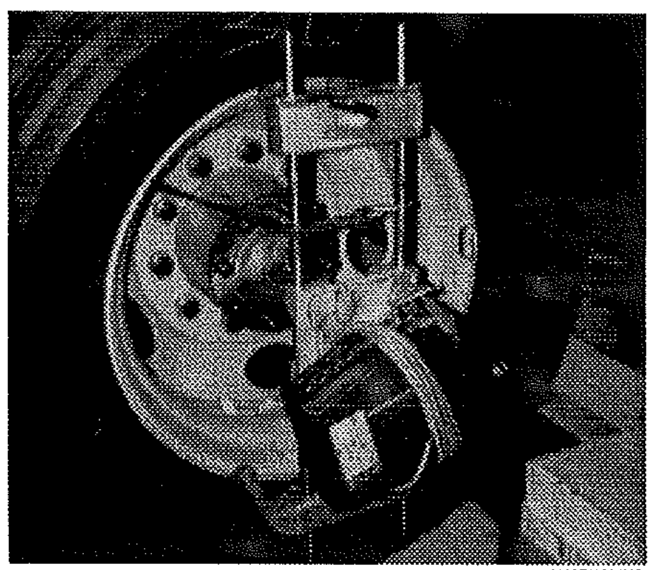

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FIG. 1 - Optical toe and tracking system installation

4. Install a target board on each side of vehicle, at level of the last baggage compartment front wall (see installation in fig. 2).

5. Connect the projectors and set to zero; rotate the wheel, and set projectors to zero at four opposite positions. It is important that mark remains to zero when rotating the wheel in order to eliminate wheel run-out.

6. Aim the projector on the target board, then measure distance between target center line (provided by the projector) and the frame post located right beside the target board. Note measure, then repeat on other side (refer to fig. 2). Dimensions obtained are identified RR on rear right hand side and RL on rear left hand side.

7. Move target boards toward front of vehicle, i.e. at level of the first baggage compartment front wall (see installation in fig. 2).

8. Aim the projector on the target board, then measure the distance between target center line (provided by the projector) and the frame post located right beside the target board. Note measure, then repeat on other side. Dimensions obtained are identified FR on front right hand side and FL on front left hand side.

9. Subtract measure taken at rear of vehicle from measure taken at front of vehicle on the same side. Note result. Repeat previous operation on other side of vehicle. Note result.

FR - RR = RESULT "A"

FL - RL = RESULT "B"

10. The results on either side must be equal or less than 3/4" (19 mm); if one or both results exceed 3/4" (19 mm), take a corrective measure as regards the axle position.

11. Correct axle position by inserting a shim between the lower longitudinal radius rod support and the frame, on right or left side of vehicle according to the previous results.

CAUTION: The proper tightening torque of the longitudinal radius rod support nuts is 130-140 lbf•ft (177-190 N•m)

12. Perform again steps 6 to 10 in order to ensure that axle is truly perpendicular to the frame.

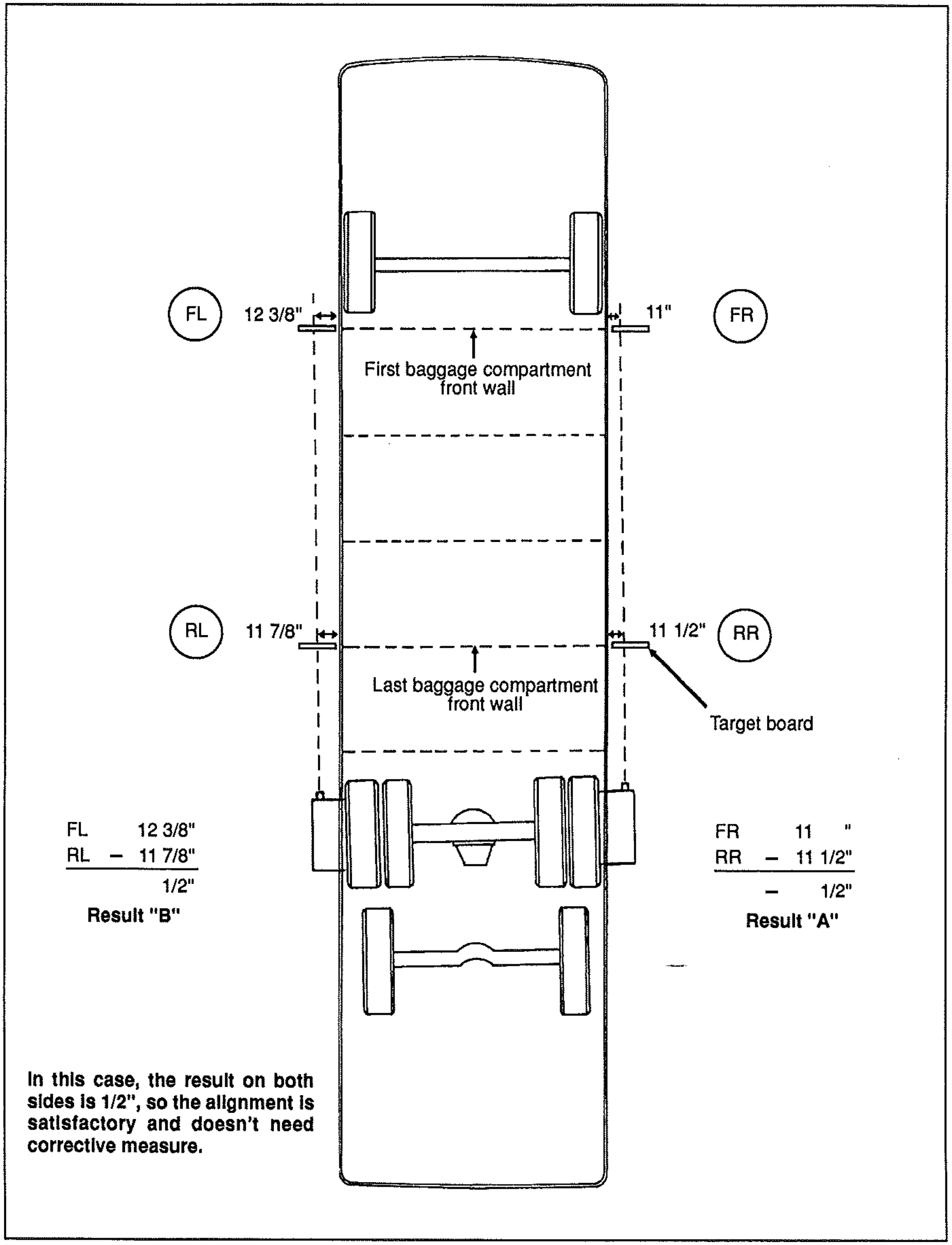

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FIG. 2 - Demonstration of drive axle alignment check (Intentional misalignment of rear axles for a better understanding)

TAG AXLE

Description

The tag axle is located behind the drive axle. It carries a single wheel and tire on each side. The standard system allows unloading of the tag axle air springs without raising axle, while the optional system enables unloading and raising of the tag axle (refer to Operator's Manual for details about control location). These both systems have been designed for the same purpose:

- shortening of the wheelbase, thus allowing tighter turning in tight maneuvering areas as in a parking lot or when turning a short corner.

- transferring extra weight and additional traction to the drive wheels on a slippery surface.

CAUTION: Never exceed 30 mph (50 km/h) with tag axle up or unloaded and resume normal driving as soon as possible.

The tag axle service brakes operate only when the axle is in the normal driving (loaded) position.

Removal and replacement

The following procedure deals with the removal of the tag axle assembly along with the suspension components. The method used to support the axle and suspension components during removal and disassembly depends upon local conditions and available equipment.

Removal

1. Raise the vehicle by its jacking points on the body (see Section 18 *"Body"* under heading *"Vehicle jacking points"*) until vehicle body is approximately 3' (1 m) from floor. Place jack stands under frame. Remove tag axle wheels (if required, refer to section 13 *"Wheels, hubs and tires"*).

2. Exhaust compressed air from the air supply system by opening the drain cock of each air reservoir.

3. Install jacks under tag axle jacking points to support the axle weight.

4. Disconnect tag axle lifting chain collars from lower longitudinal radius rods (only for vehicle equipped with the retractable tag axle).

5. Remove the propeller shaft as directed in section 9 *"Propeller shaft"* of this manual.

6. Disconnect the tag axle brake chamber hoses. Position the hoses so they will not be damaged when removing axle.

7. Remove the air spring retaining nuts from each of the two upper mounting plates.

8. Disconnect hose from the air spring upper mounting plate.

9. Remove the two shock absorbers as outlined in section 16 *"Suspension"* under *"Shock absorber removal"*.

10. Disconnect the lower longitudinal radius rods as outlined in section 16 *"Suspension"* under *"Radius rod removal"*.

11. Disconnect the transversal radius rod.

12. Disconnect the upper longitudinal radius rod.

13. Use the jacks to move the axle forward ahead of transmission, then lower it down.

CAUTION: On vehicles equipped with automatic transmission (with or witout the output retarder), move tag axle assembly very carefully paying a special attention to the U-shaped section as the transmission end components may be easily damaged with a false maneuver.

Replacement

Reverse previous removal procedure to reinstall tag axle.

NOTE: Refer to section 16 *"Suspension"* for proper tightening torques of suspension components.

Tag axle alignment

Description

The axle alignment consists in aligning it parallel to the drive axle position. Before aligning tag axle, proceed with the drive axle alignment (see previous heading) and keep results in mind. The tag axle alignment is achieved with the use of shims inserted between the lower longitudinal radius rod supports and axle. Tag axle alignment is factory set and is not subject to any change, except if vehicle has been damaged by an accident or if there is requirements for part replacement.

CAUTION: If this setting is altered significantly, it will cause excessive tire wear.

If axle has been removed for repair or servicing and if all members are reinstalled exactly at the same place, the axle alignment is not necessary. However, if the suspension supports have been replaced or changed in position, proceed with the following instructions to verify or adjust the tag axle alignment.

Procedure

1. Park vehicle on level floor, unload tag axle (or lift, if so equipped) using the appropriate control located on the right lateral console (refer to *"Operator's Manual"* for details), then chock front vehicle wheels.

2. Using two jacking points (which are at least 30" (76 cm) apart) on drive axle, raise vehicle sufficiently so that wheels are raised about 1/2" from ground, secure in this position with safety stands.

3. Using jacking points on tag axle, raise axle sufficiently (no more than 1/2" from ground) to turn tag axle wheels freely.

4. Using an optical toe & tracking system installed on each side of tag axle, fix and position the projector in center of wheel. Measure the distance on each side of projector mounting rods; distance should be equal on both sides. If not, loosen wing nut, adjust projector to the proper distance, then tighten wing nut. Refer to previous figure 1.

5. Install a target board on each side of vehicle, at level of the last baggage compartment front wall (see installation in fig. 3).

6. Connect the projectors and set to zero; rotate the wheel and set projectors to zero at four opposite positions. It is important that mark remains to zero when rotating the wheel in order to eliminate wheel run-out.

7. Aim the projector on the target board, then measure distance between target center line (provided by the projector) and the frame post located right beside the target board. Note measure, then repeat on the other side (refer to fig. 3). Dimensions obtained are identified RR on rear right hand side and RL on rear left hand side.

8. Move target boards toward front of vehicle, i.e. at level of the first baggage compartment rear wall (see installation in fig. 3).

9. Aim the projector on the target board, then measure the distance between target center line (provided by the projector) and the frame post located right beside the target board. Note measure, then repeat on the other side. Dimensions obtained are identified FR on front right hand side and FL on front left hand side.

10. Subtract measure taken at rear of vehicle from measure taken at front of vehicle on the same side. Note result. Repeat previous operation on other side of vehicle. Note result.

FR - RR = RESULT "C"

FL - RL = RESULT "D"

11. The results on either side must be equal or less than 3/4" (19 mm); if one or both results exceed 3/4" (19 mm), take a corrective measure as regards the axle position.

12. Moreover, to make sure that tag axle is parallel to the drive axle, subtract the result "C" from the result "A" (obtained previously in drive axle alignment); the result should be 1/4" (6 mm) or less, if not take a corrective measure as regards the tag axle position.

13. Repeat the same operation on other side, i.e. "B" - "D"; again the result should be 1/4" (6 mm) or less, if not take a corrective measure as regards the tag axle position.

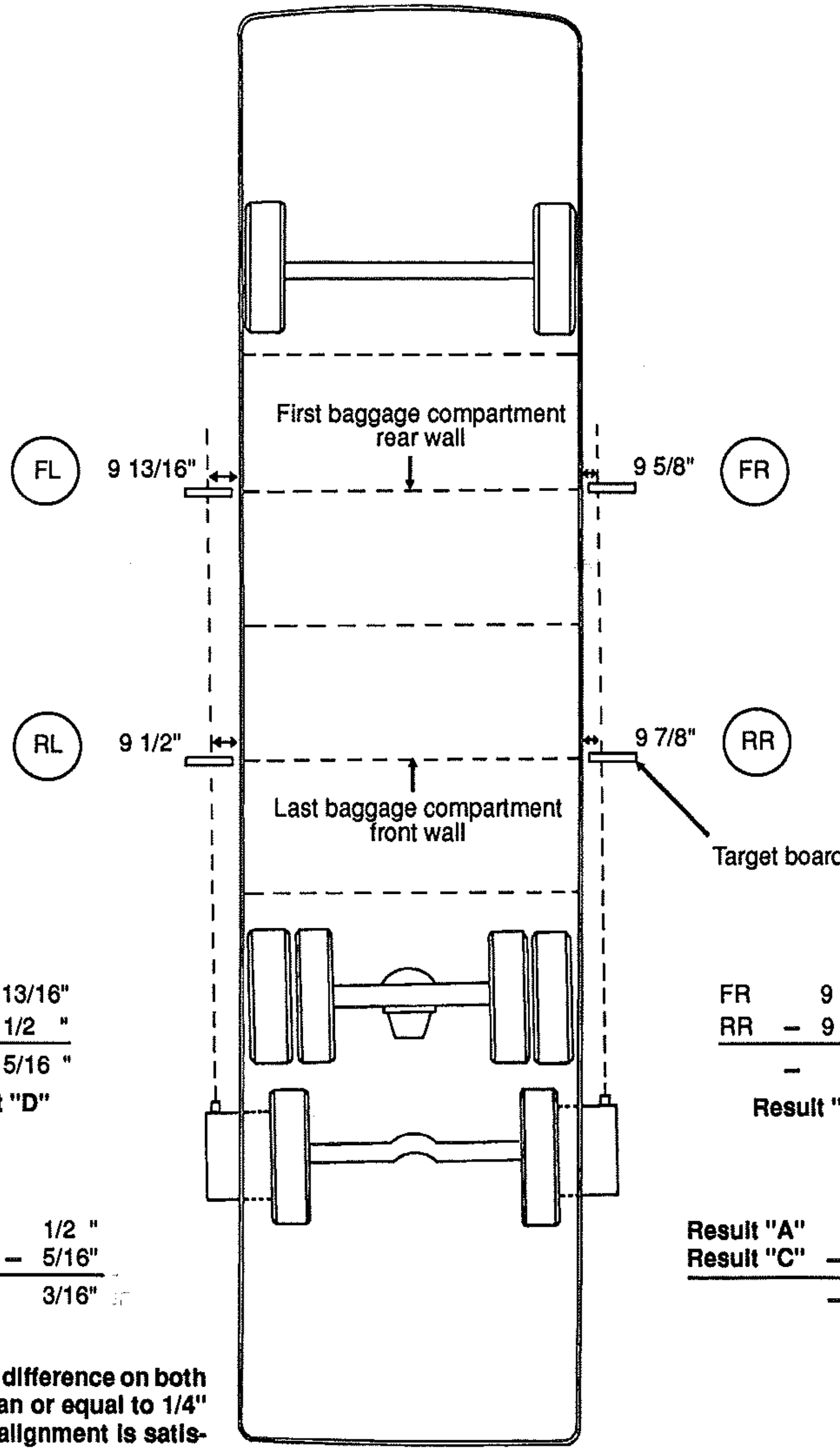
"A" - "C" = 1/4" (6 mm) OR LESS

"B" - "D" = 1/4" (6 mm) OR LESS

14. Correct axle position by inserting a shim between the lower longitudinal radius rod support and the axle, on right or left side of vehicle according to the previous results.

CAUTION: The proper tightening torque of the longitudinal radius rod support nuts is 130-140 lbf•ft (177-190 N•m).

15. Perform again steps 7 to 13 in order to ensure that axle is truly parallel to the drive axle.



FL 9 13/16"
RL − 9 1/2 "
5/16 "
Result "D"

FR 9 5/8"
RR − 9 7/8"
− 1/4"
Result "C"

Result "B" 1/2 "
Result "D" − 5/16"
3/16"

Result "A" 1/2"
Result "C" − 1/4"
− 1/4"

In this case, the difference on both sides is less than or equal to 1/4" (6 mm), so the alignment is satisfactory and doesn't need a corrective measure.

MA3E1103

FIG. 3 - Demonstration of tag axle alignment check (intentional misalignment of rear axles for a better understanding)

SPECIFICATIONS

DRIVE AXLE

Make	Rockwell International
Model	61143
Differential carrier model	RS-23-160
Wheel track	75.6" (1 920 mm)
Gear type	Hypoid
Axle type	full floating
Final end ratio (standard)	3.58 : 1
(Other ratios available)	
Lube capacity	22.6 US qts (21,4 liters)

TAG AXLE

Make	Prevost
Type	Replaceable spindles
Wheel track	81" (2 057 mm)
Toe alignment	0 ± 3/32" (0 ± 2,4 mm)

SERVICE BULLETINS AND SERVICE INFORMATION LETTERS

Service Bulletins and Service Information Letters will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of publications pertaining to this section should be noted below as soon as received. These should then be filed for future reference.

NUMBER	DATE	SUBJECT

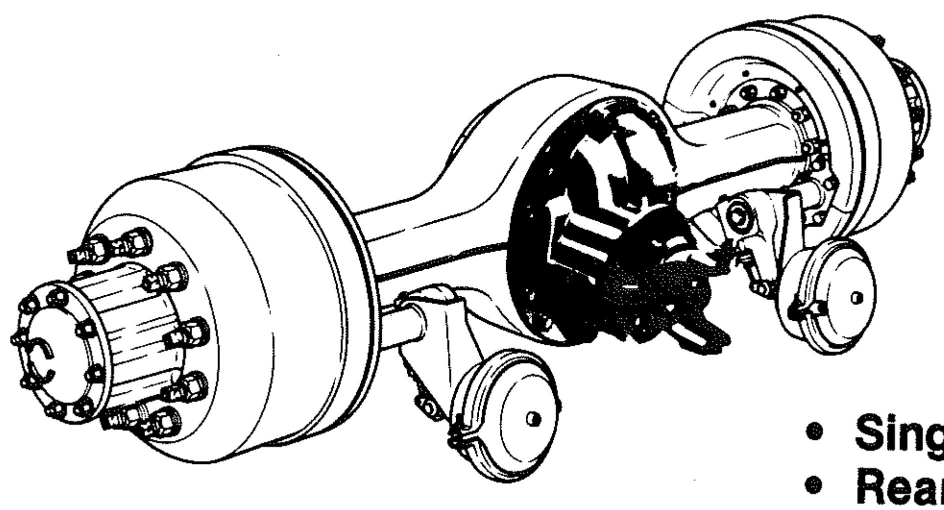
$2.00

MAINTENANCE MANUAL NO. 5
REVISED 3-91

Single Reduction Differential Carriers

Rockwell

Standard and Diff. Lock Carriers For:



- Single Axles
- Rear of Tandem Axles
- Front Drive Steering Axles

(See inside front cover for specific axle models)

Use only genuine Rockwell Parts

Axle Models Covered In This Manual

Single drive axles:

A-150	E-100	F-140	H-172	Q-100	R-163	RS-16-140	RS-23-180
B-100	E-105	G-161	L-100	Q-145	R-170	RS-17-140	RS-26-180
B-140	E-150	H-100	L-140	RL-170	S-170	RS-16-141	RS-36-180
B-150	F-100	H-140	L-155	R-100	U-140	RS-17-141	
C-100	F-106	H-150	L-172	R-140	W-170	RS-19-145	
D-100	F-120	H-162	M-172	R-155	RS-13-120	RS-21-145	
D-140	F-121	H-170	QT-140	R-160	RS-15-120	RS-23-160	

Rear axle of tandem axles:

SDHD	SL-100	SQHD	SSHD	SU-170	RT-34-140	RT-40-145	RT-48-180
SFHD	SLHD	SR-170	ST-170	SUHD	RT-40-140	RT-44-145	RT-52-180
SHHD	SQ-100	SRHD	STHD	SW-170	RT-34-145	RT-46-160	RT-58-180

Front drive steering axles:

FDS-75	FDS-85	FDS-93	FDS-1807	FDS-2100	FDS-2107	FDS-2111	FDS-2117
FDS-78	FDS-90	FDS-1600	FDS-1808	FDS-2101	FDS-2110		

Service Notes

This Field Maintenance Manual describes the correct service and repair procedures for Rockwell Single Reduction Carriers. The information contained in this manual was current at the time of printing and is subject to change without notice or liability.

You must follow your company safety procedures when you service or repair equipment. Be sure you understand all the procedures and instructions before you begin work on the unit.

Rockwell uses the following types of notes to give warning of possible safety problems and to give information that will prevent damage to equipment:

WARNING:

A warning indicates procedures that must be followed exactly. Injury can occur if the procedure is not followed.

CAUTION:

A caution indicates procedures must be followed exactly. If the procedure is not followed, damage to equipment or components can occur. Personal injury can also occur in addition to damaged or malfunctioning equipment or components.

TORQUE:

The torque symbol is used to indicate fasteners that must be tightened to a specific torque value.

NOTE:

A note indicates an operation, procedure or instruction that is important for correct service.

Some procedures require the use of special tools for safe and correct service. Failure to use these special tools when required, can cause injury to service personnel or damage to vehicle components.

This manual is written in Rockwell Universal Language System (RULS).

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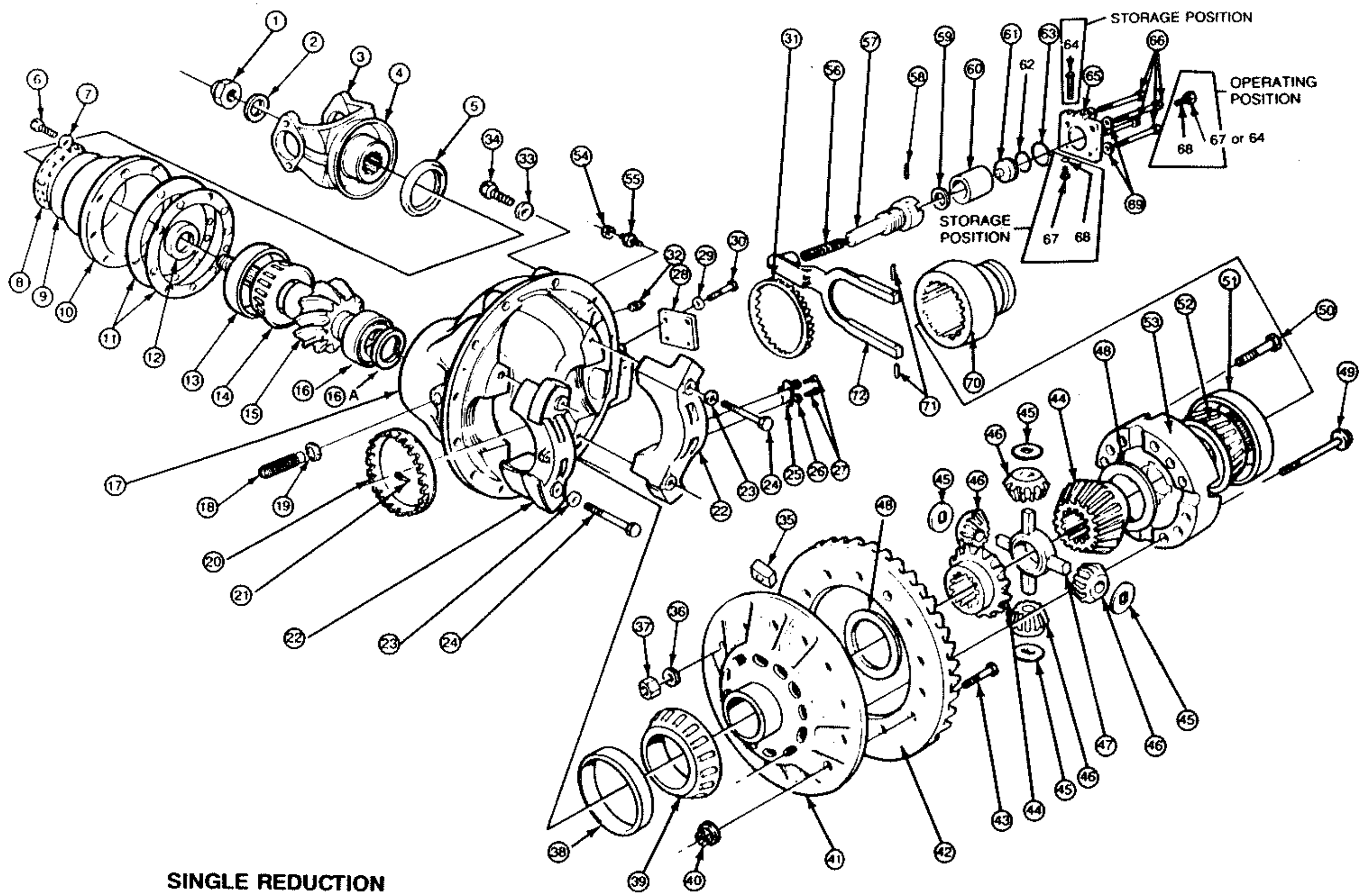

SINGLE REDUCTION DIFFERENTIAL CARRIER

NOTE DIFFERENTIAL CARRIERS WITHOUT DIFF. LOCK DO NOT HAVE PARTS 54 THROUGH 72. SOME OF THESE CARRIERS HAVE A COVER AND PLUG INSTALLED OVER THE AIR CYLINDER OPENING AND SENSOR SWITCH HOLE IN THE CARRIER

ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	Nut - Drive Pinion	11	Shims
2	Washer - Drive Pinion*	12	Spacer - Pinion Bearing
3	Input Yoke* or Flange*	13	Bearing Cup - Pinion Inner
4	Deflector	14	Bearing Cone - Pinion Inner
5	Oil Seal	15	Drive Pinion
6	Capscrew - Bearing Cage	16	Spigot Bearing
7	Washer	16A	Snap Ring
8	Bearing Cone - Pinion Outer	17	Carrier
9	Bearing Cup - Pinion Outer	18	Thrust Screw*
10	Bearing Cage - Drive Pinion	19	Jam Nut* - Thrust Screw*

*Some Rockwell Carriers do not have the parts described.

ITEM	DESCRIPTION
20	Adjusting Ring - L.H.
21	Cotter* or Pin*
22	Caps - Differential Bearing
23	Washers
24	Capscrews - Diff. Bearing Cap
25	Lock Plate* - Adjusting Ring
26	Washers* - Lock Plate*
27	Capscrews* - Lock Plate*
28	Cover* - Air Cylinder Opening
29	Washers* - Cover*
30	Capscrews* - Cover*
31	Adjusting Ring - R.H.
32	Plug* - Oil Fill Hole (carrier)
33	Washer* - Capscrew/Plug*
34	Capscrew/Plug* - Sensor Hole
35	Thrust Block*
36	Washers* - Differential Case
37	Nuts* - Differential Case
38	Bearing Cup - Differential L.H.
39	Bearing Cone - Differential L.H.
40	Nuts* - Ring Gear and Case Half
41	Case Half - Flange
42	Ring Gear
43	Bolts* or Rivets* - Ring Gear and Case Half
44	Side Gears - Differential
45	Thrust Washers - Differential Pinion
46	Pinions - Differential
47	Spider - Differential
48	Thrust Washers - Differential Side Gear
49	Capscrews - Differential Case
50	Bolts* - Differential Case
51	Bearing Cup - Differential R.H.
52	Bearing Cone - Differential R.H.
53	Case Half - Plain

THE FOLLOWING PARTS ARE FOR DIFF. LOCK CARRIERS ONLY

ITEM	DESCRIPTION
54	Lock Nut - Sensor Switch
55	Sensor Switch
56	Spring - Shift Shaft
57	Shift Shaft
58	Pin - Spring Retaining
59	Washer* or Silastic* - Air Cylinder
60	Tube - Air Cylinder
61	Piston
62	O-Ring - Piston
63	Copper Gasket - Cylinder Cover
64	Capscrew - Manual Actuation
65	Cylinder Cover
66	Capscrews - Cylinder Cover
67	Plug - Cylinder Cover
68	Gasket - Cover Plug
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section 1 Introduction

Standard Single Reduction Carriers Without Diff. Lock

Rockwell single reduction standard carriers, Figure 1, are used in most Rockwell single axles, rear of tandem axles and front drive steering axles.

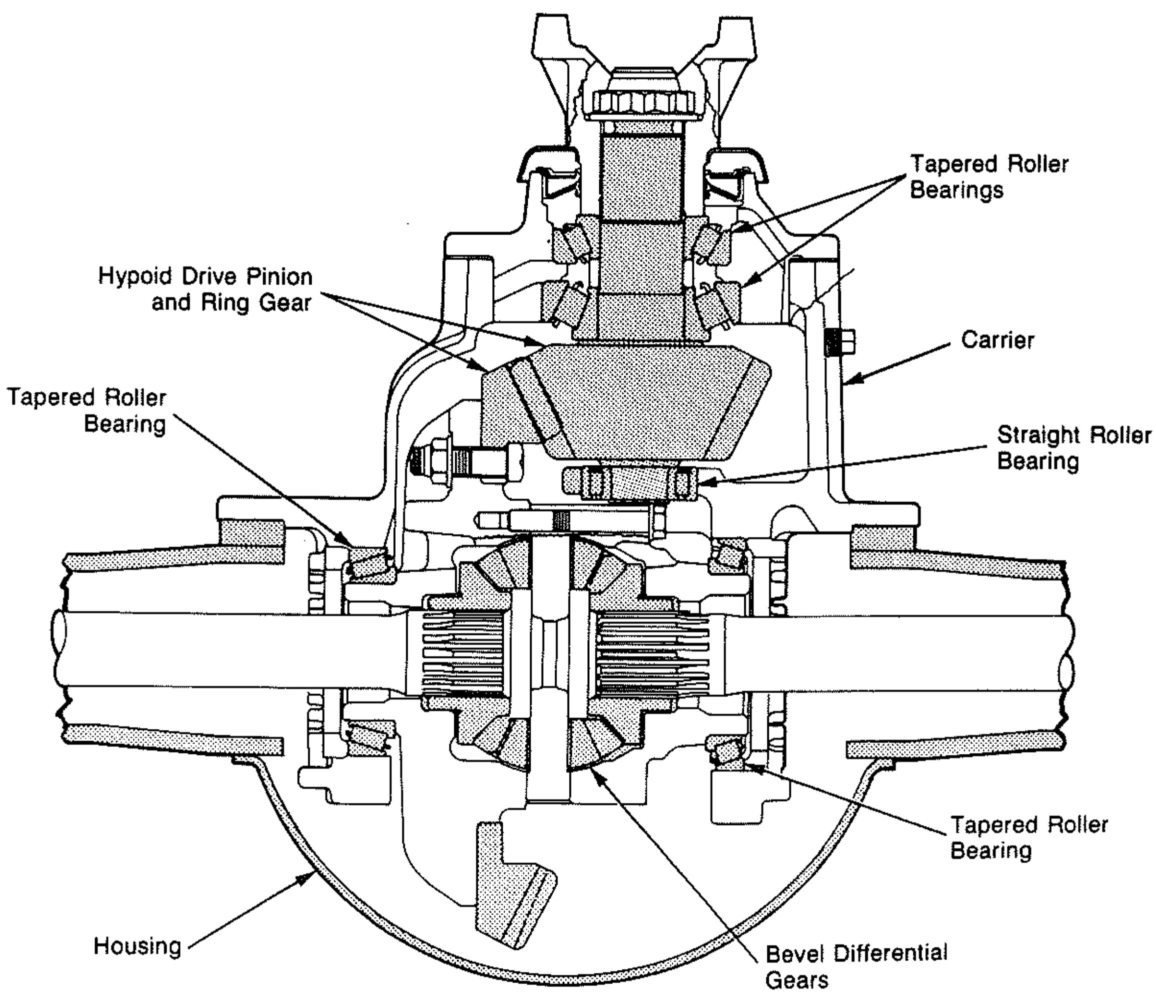
The single reduction carrier models are front mounted into the axle housing. These carriers have a hypoid drive pinion and ring gear set and bevel gears in the differential assembly.

A straight roller bearing (spigot) is mounted on the head of the drive pinion. All other bearings in the carrier are tapered roller bearings.

When the carrier operates, there is normal differential action between the wheels all the time.

Figure 1

Standard Carrier



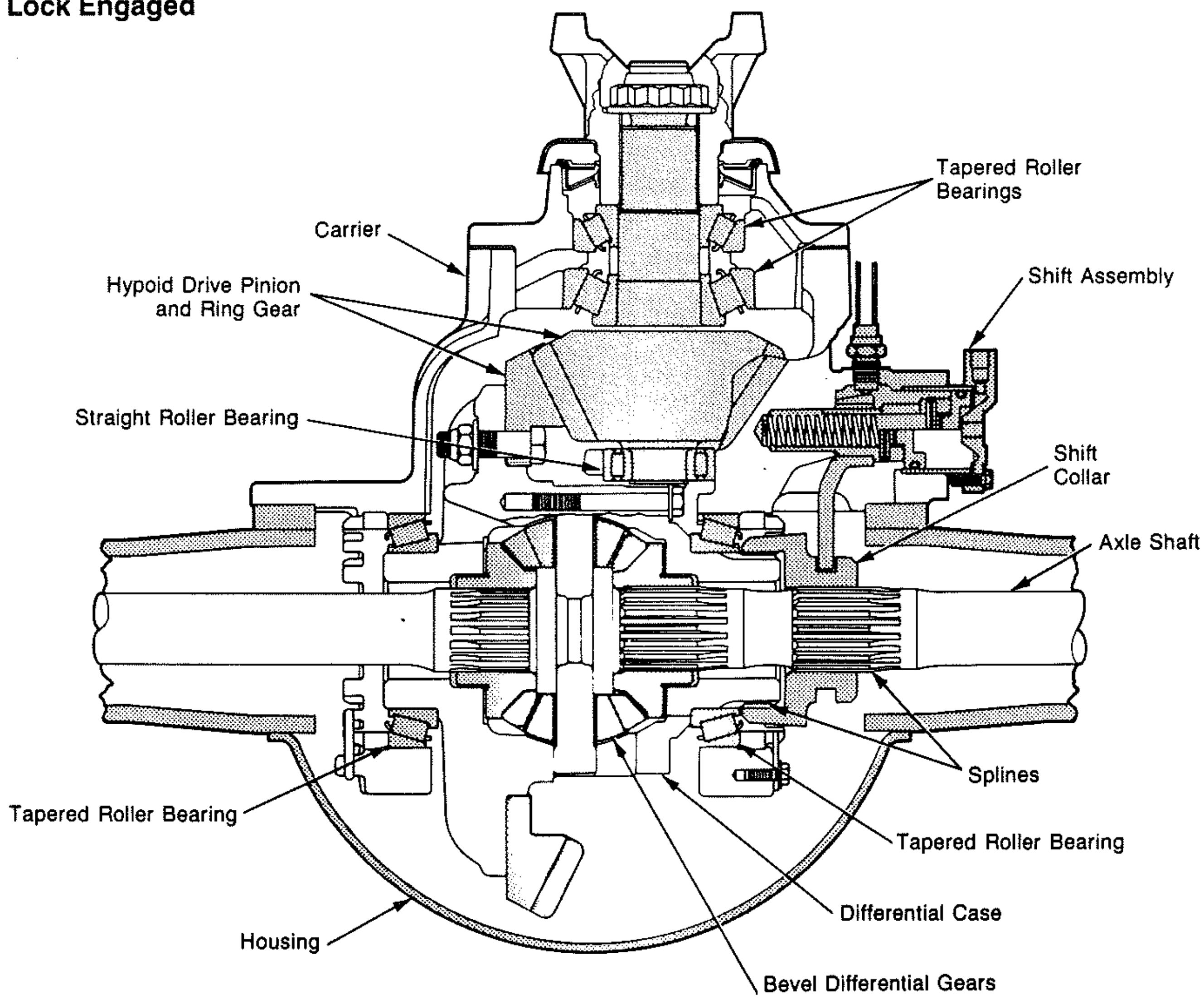
Single Reduction Carriers with Driver Controlled Main Differential Lock (Diff. Lock)

Rockwell single reduction carriers with Differential Lock, Figure 2, have the same type of gears and bearings as the standard type carriers.

The differential lock is operated by an air actuated shift assembly that is mounted on the carrier. When the differential lock is activated, the shift collar is moved along the splines of the axle shaft toward the differential case. When the splines on the collar are engaged with splines on the differential case the axle shafts and differential assembly are locked together. When the carrier operates in the locked position, there is no differential action between the wheels. When the carrier is operated in the unlocked position, there is normal differential action between the wheels all the time.

Shown With Differential Lock Engaged

Carrier With Diff. Lock



section 2 Disassembly

Remove Differential Carrier From Axle Housing

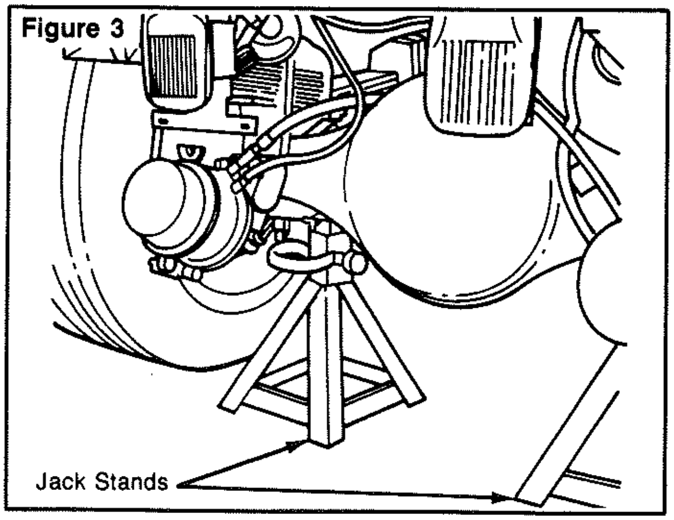
IMPORTANT: If the vehicle is equipped with a driver controlled main differential lock, see complete instructions beginning on page 53. To tow a vehicle see instructions on pages 25 and 26.

1. Raise the end of vehicle where the axle is mounted. Use a jack or other lifting tool. **Figure 3.**

WARNING:

Do not work under the vehicle if supported by jacks or lifting tools only. Jacks and lifting tools can slip and cause injury.

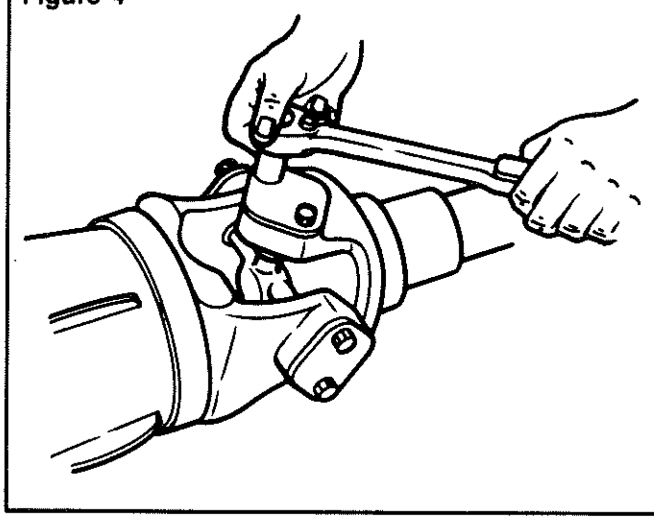
Figure 3



2. Put jack stands under each spring seat of the axle to hold vehicle in the raised position. **Figure 3.**
3. Remove the plug from bottom of axle housing and drain lubricant from the assembly.
4. Disconnect the driveline universal joint from the pinion input yoke or flange on the carrier. **Figure 4.**
5. Remove the capscrews* and washers or stud nuts* and washers from the flanges of both axle shafts.
6. Loosen the tapered dowels* in the flanges of both axle shafts as follows.

Some Rockwell carriers do not have the parts described.

Figure 4

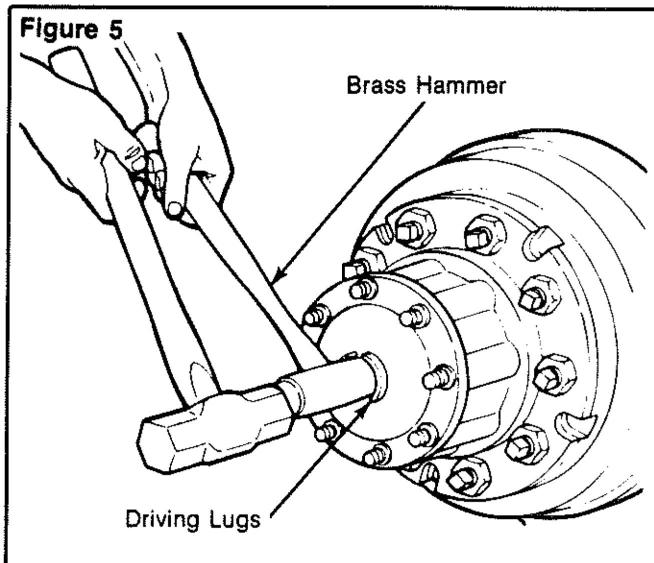


WARNING:

Wear safe eye protection. Do not hit the round driving lugs on the head of axle shafts. Lugs can break and cause injury.

A. Hold a 1-1/2 inch diameter brass drift against the center of the axle shaft, inside the round driving lugs. **Figure 5.**

Figure 5



NOTE:

A 1-1/2 inch diameter brass hammer can be used as a drift.

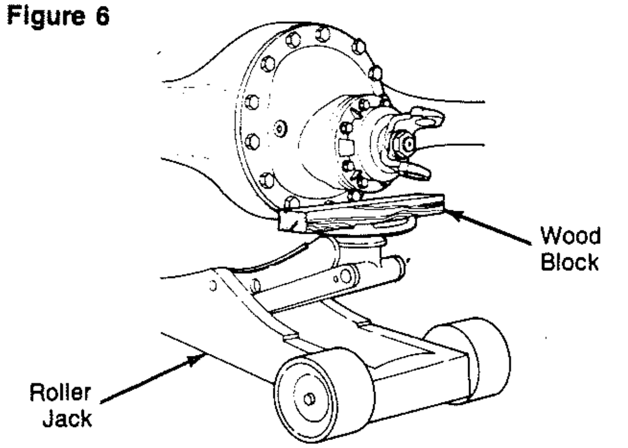
B Hit the end of the drift with a large hammer (five to six pounds) and the axle shaft and tapered dowels will loosen.

CAUTION:

Do not use a chisel or wedge to loosen the axle shafts and dowels. The chisel or wedge can damage the hub, axle shafts and, if used, oil seals.

7. Remove the tapered dowels and both axle shafts from the axle assembly.
8. Place a hydraulic roller jack under the differential carrier to support the assembly. **Figure 6.**

Figure 6



9. Remove all but the top two carrier to housing capscrews or stud nuts and washers.
10. Loosen the top two carrier to housing fasteners and leave attached to the assembly. The fasteners will hold the carrier in the housing.
11. Loosen the differential carrier in the axle housing. Use a leather mallet to hit the mounting flange of carrier at several points.

NOTE:

Some carrier models have threaded puller screw holes in the mounting flange. Puller screws can be used to loosen and pull the carrier from the axle housing. If puller screws are used, clean the threaded holes before the puller screws are installed.

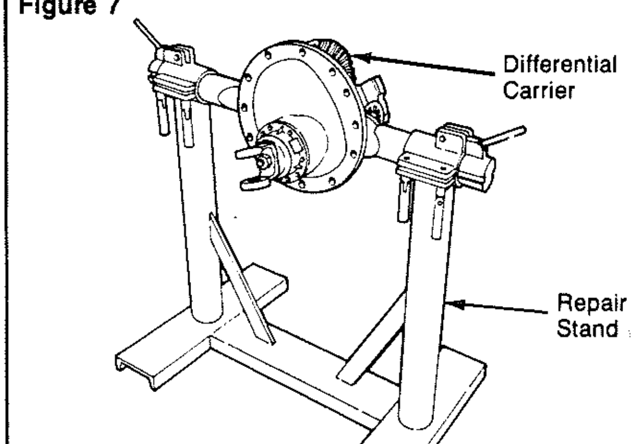
12. After the carrier is loosened, remove the top two fasteners.
13. Carefully remove the carrier from the axle housing using the hydraulic roller jack. Use a pry bar that has a round end to help remove the carrier from the housing.

CAUTION:

When using a pry bar be careful not to damage the carrier or housing flange. Damage to these surfaces will cause oil leaks.

14. Remove and discard the carrier to housing gasket.
15. Lift the differential carrier by the input yoke or flange and put the assembly in a repair stand. **Figure 7.** Use a lifting tool for this procedure. Do not lift by hand. A carrier stand can be made by using the drawing on page 6.

Figure 7



Remove The Differential And Ring Gear From The Carrier

NOTE:

Before you start work on the differential carrier inspect the hypoid gear set for damage. If the inspection shows no damage, the same gear set can be used again. Measure the backlash of the gear set and make a note of the dimension. **Figure 8.** ***(See procedure on page 46, Steps 1 to 5.) Adjust the backlash to the same dimension after the gear set is installed into the carrier.***

A carrier stand, part number J 3409-01 is available from Kent-Moore, Heavy-Duty Division, 29784 Little Mack, Roseville, Michigan 48066-2298.

Carrier Stand

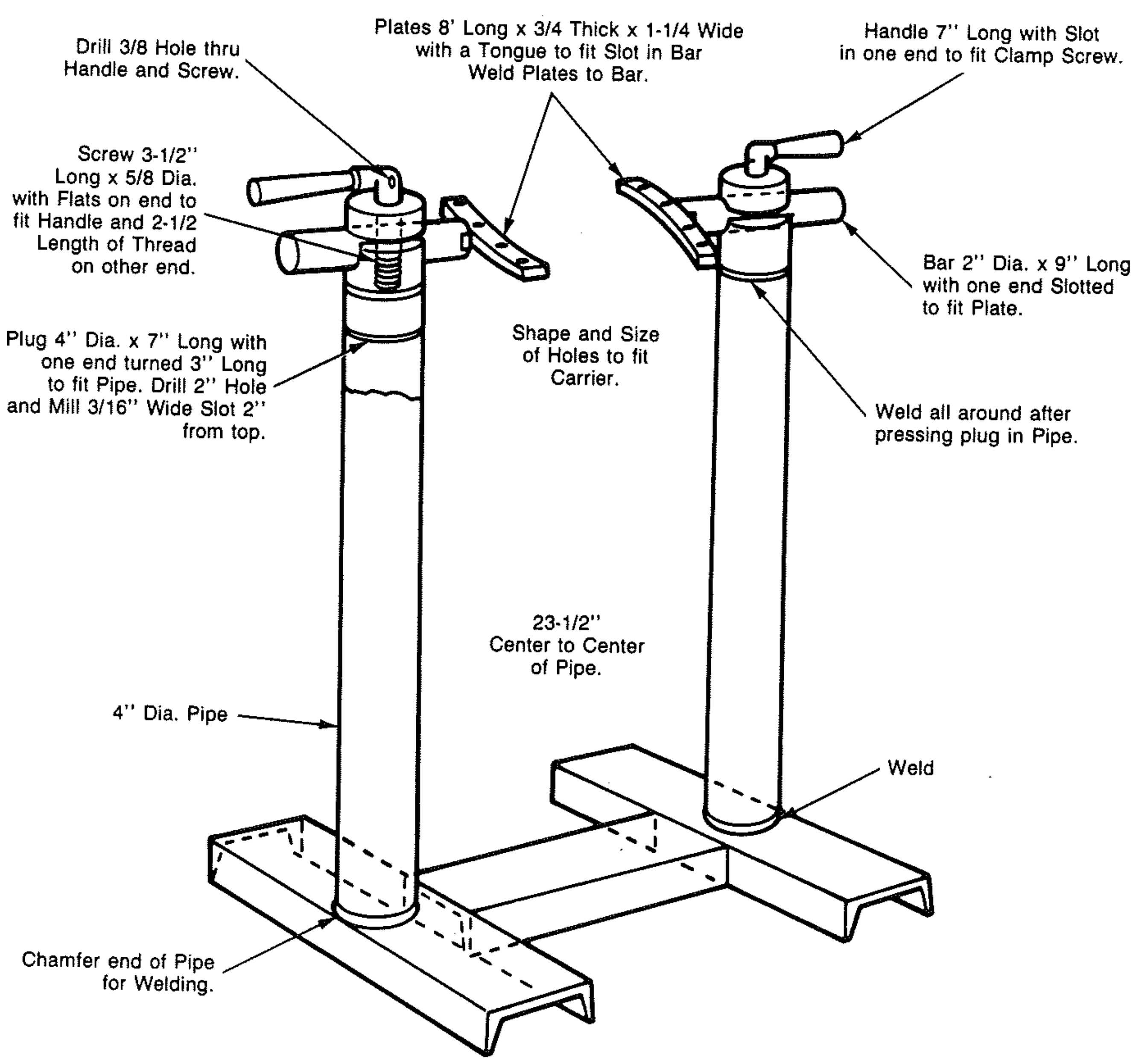
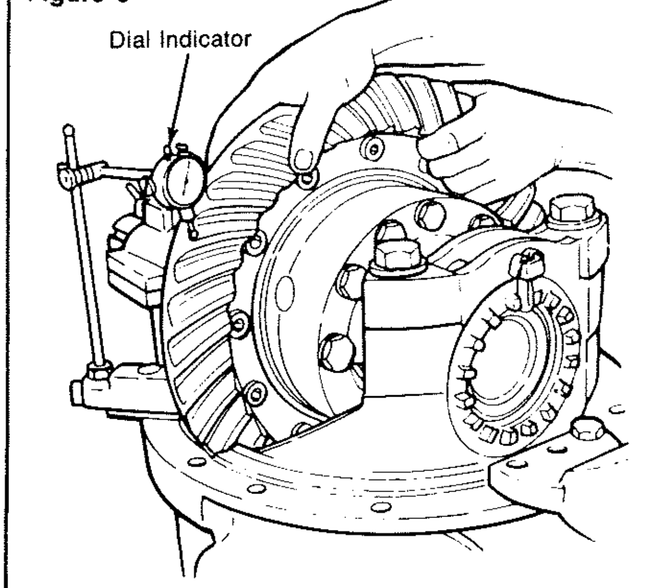


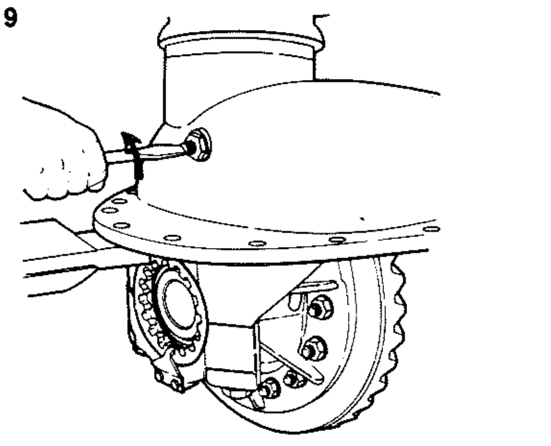
Figure 8



1. Loosen the jam nut* on the thrust screw*.

2. Remove the thrust screw* and jam nut* from the differential carrier. **Figure 9.**

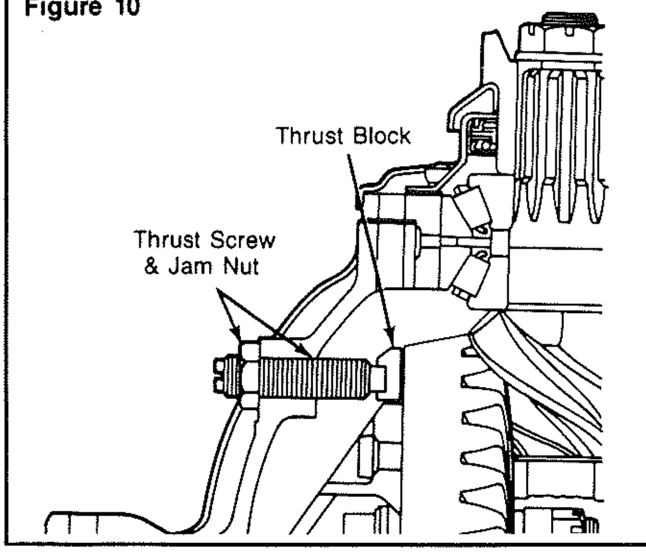
Figure 9



NOTE:

Some Rockwell carrier models have a thrust block*. The thrust block will fall away from the ring gear inside the carrier when you remove the thrust screw. Figure 10.

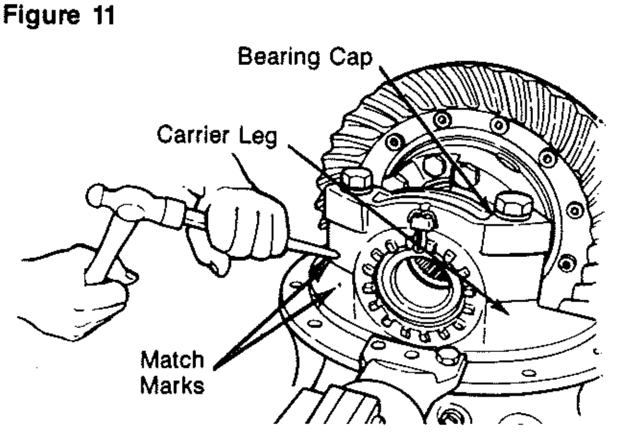
Figure 10



3. Rotate the differential carrier in the repair stand until the ring gear is at the top of the assembly.

4. Mark one carrier leg and bearing cap for the purpose of correctly matching the parts when you assemble the carrier. A center punch and hammer can be used to mark the parts. **Figure 11.**

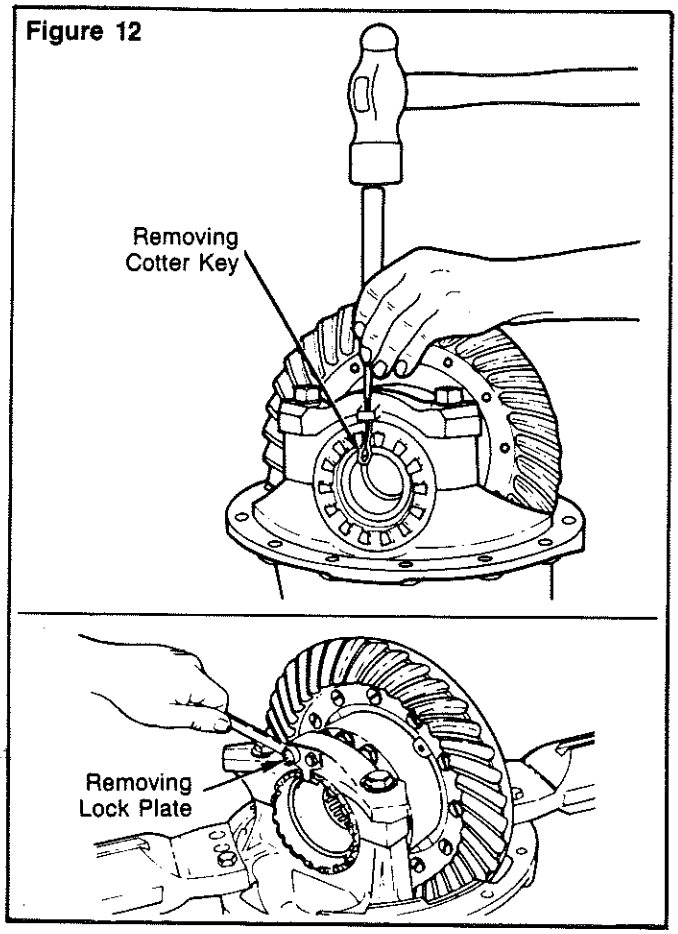
Figure 11



5. Remove the cotter keys*, pins* or lock plates* that hold the two bearing adjusting rings in position. Use a small drift and hammer to remove pins. Each lock plate is held in position by two capscrews. **Figure 12.**

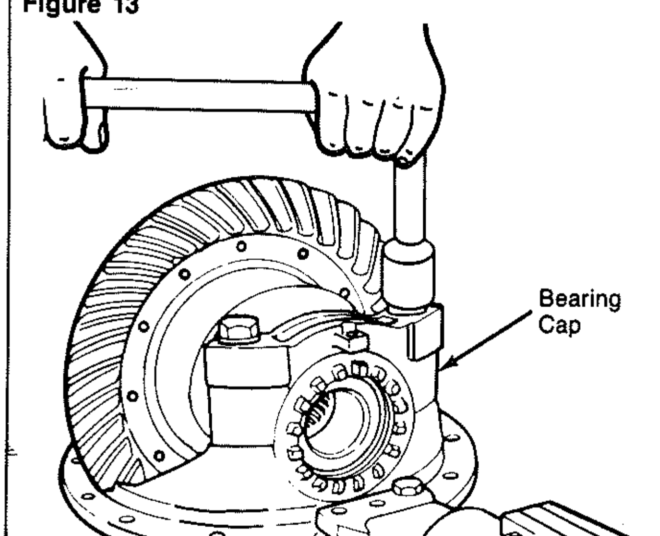
**Some Rockwell carriers do not have the parts described.*

Figure 12



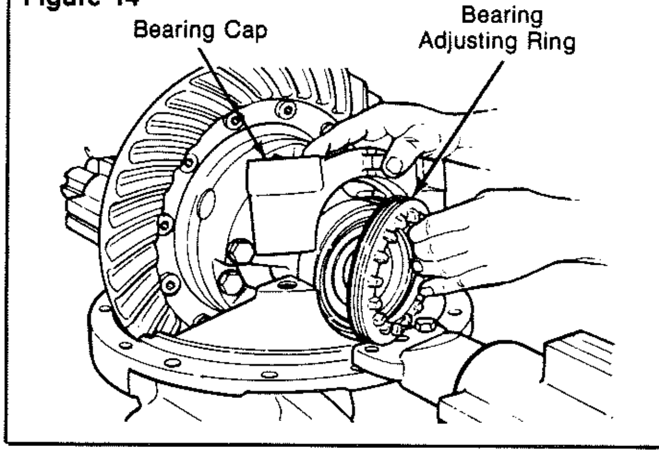
6. Remove the capscrews and washers that hold the two bearing caps on the carrier. Each cap is held in position by two capscrews and washers. **Figure 13.**

Figure 13



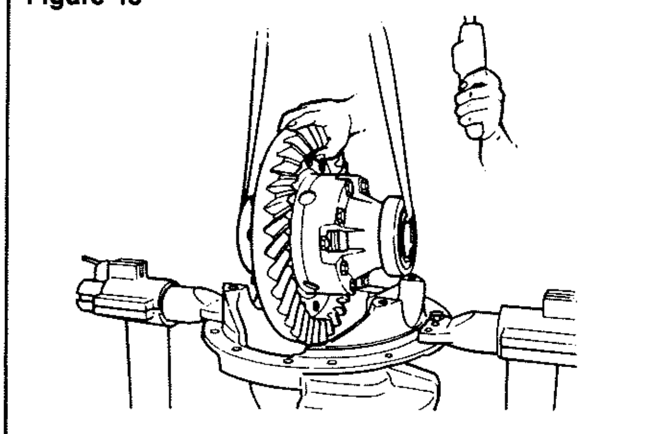
7. Remove the bearing caps and bearing adjusting rings from the carrier. **Figure 14.**

Figure 14



8. Safely lift the main differential and ring gear assembly from the carrier. Put the assembly on a work bench. **Figure 15.**

Figure 15



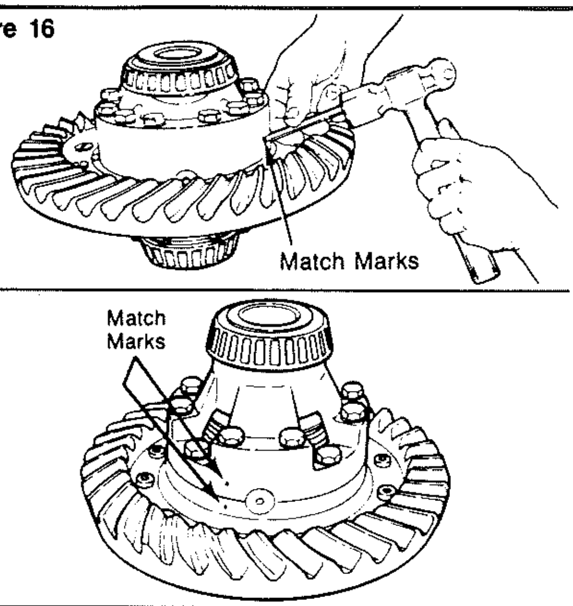
9. Remove the thrust block* from inside the carrier.

Disassemble the Differential and Ring Gear Assembly

1. If the matching marks on the case halves of the differential assembly are not visible, mark each case half with a center punch and hammer. The purpose of the marks is to match the plain half and flange half correctly when you assemble the carrier. **Figure 16.**

**Some Rockwell carriers do not have the parts described.*

Figure 16



2. Remove the lock wire* capscrews* and washers* or bolts*, nuts* and washers that hold the case halves together.

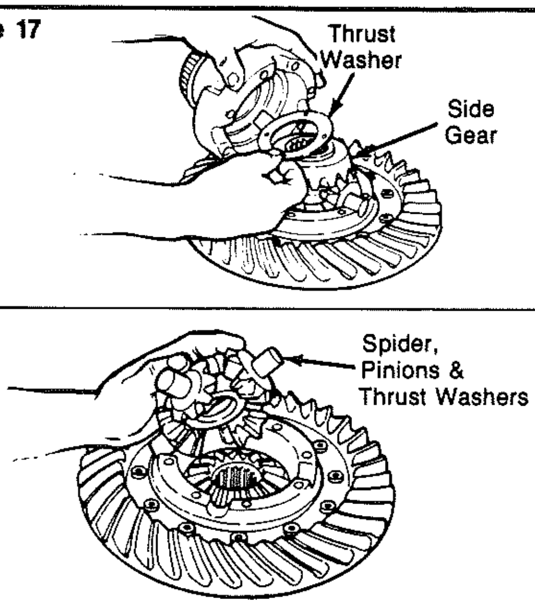
WARNING:

Wear safe eye protection. Do not hit steel parts with a steel hammer. Parts can break and cause injury.

3. Separate the case halves. If necessary, use a brass, plastic or leather mallet to loosen the parts.

4. Remove the differential spider (cross), four pinion gears, two side gears and six thrust washers from inside the case halves. **Figure 17.**

Figure 17



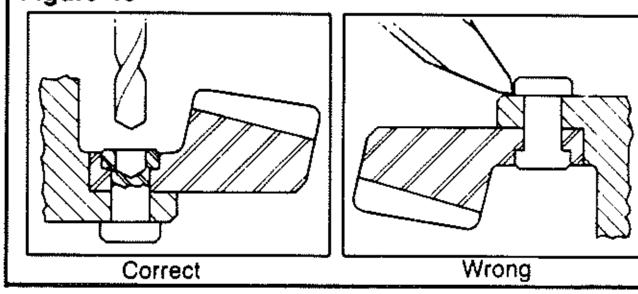
5. If the ring gear needs to be replaced, remove the bolts*, nuts*, and washers* that hold the gear to the flange case half.

6. If rivets* hold the ring gear to the flange case half, remove the rivets as follows:

   A. Carefully center punch each rivet head in the center, on the ring gear side of the assembly.

   B. Drill each rivet head on the ring gear side of the assembly to a depth equal to the thickness of one rivet head. Use a drill bit that is 1/32 of an inch smaller than the body diameter of the rivets. **Figure 18.**

Figure 18



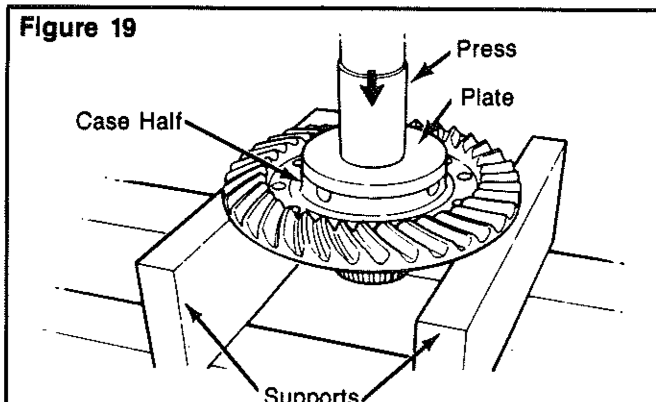
   C. Press the rivets through holes in the ring gear and flange case half. Press from the drilled rivet head.

CAUTION:

***Do not remove the rivets or rivet heads with a chisel and hammer. The chisel can damage the flange case half.* Figure 18.**

7. Separate the case half and ring gear using a press. Support the assembly under the ring gear with metal or wood blocks and press the case half through the gear. **Figure 19.**

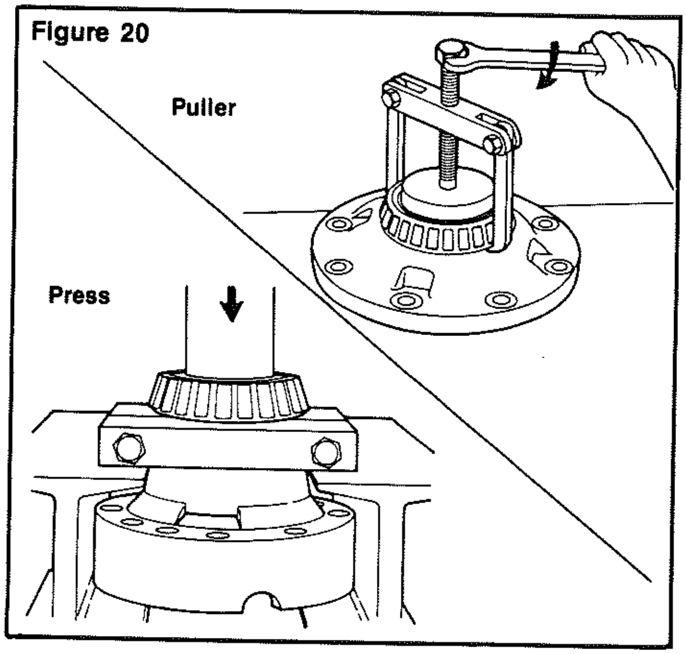
Figure 19



**Some Rockwell carriers do not have the parts described.*

8. If the differential bearings need to be replaced, remove the bearing cones from the case halves. Use a bearing puller or press. **Figure 20.**

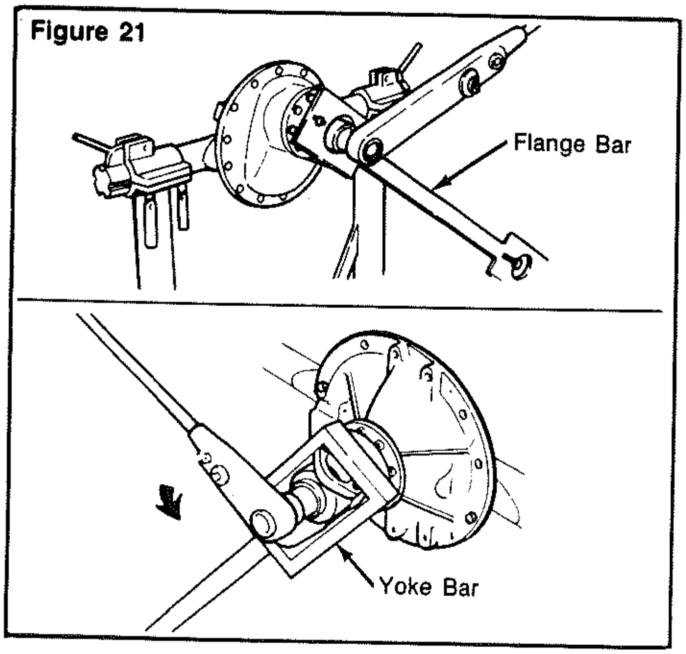
Figure 20



Remove the Drive Pinion and Bearing Cage From Carrier

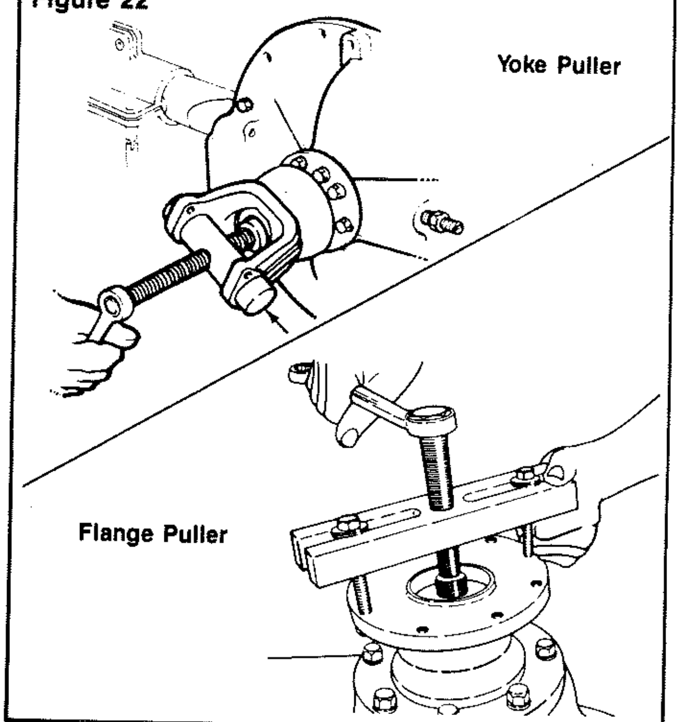
1. Fasten a yoke or flange bar to the input yoke or flange. The bar will hold the drive pinion in position when the nut is removed. **Figure 21.**

Figure 21



2. Remove the nut and washer* from the drive pinion. **Figure 21.**
3. Remove the yoke or flange bar.
4. Remove the yoke or flange from the drive pinion. If the yoke or flange is tight on the pinion, use a puller for removal. **Figure 22.**

Figure 22

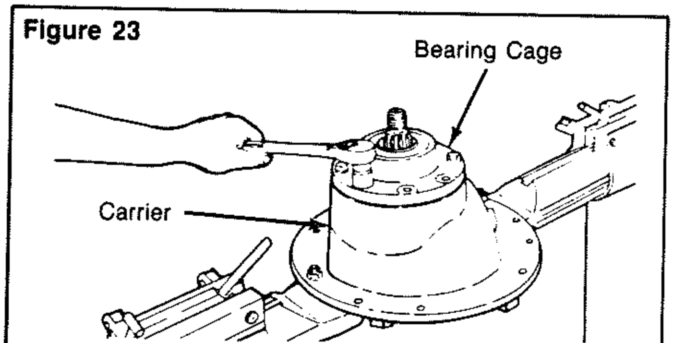


CAUTION:

Do not use a hammer or mallet to loosen and remove the yoke or flange. A hammer or mallet can damage the parts and cause runout or alignment problems.

5. Remove the capscrews and washers that hold the bearing cage in the carrier. **Figure 23.**

Figure 23



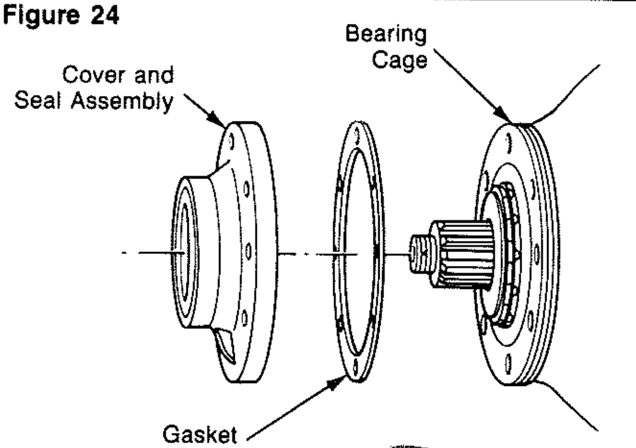
**Some Rockwell carriers do not have the parts described.*

WARNING:

Wear safe eye protection. Do not hit steel parts with a steel hammer. Parts can break and cause injury.

6. Remove the cover* and seal assembly and gasket* from the bearing cage. If the cover* is tight on the bearing cage, use a brass drift and hammer for removal. **Figure 24.**

Figure 24

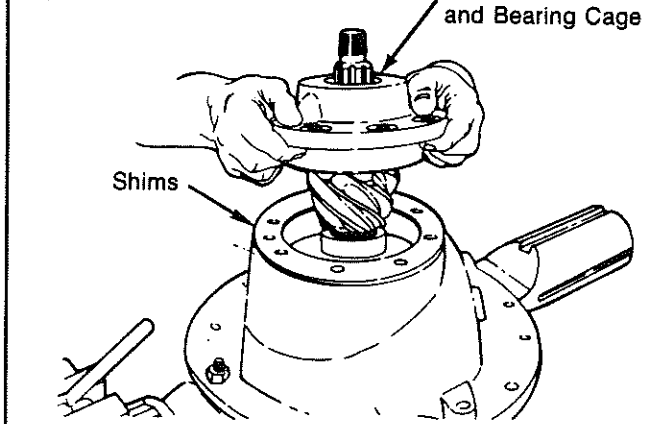


7. If the pinion seal is damaged, remove the seal from the cover*. Use a press and sleeve or seal driver. If a press is not available, use a screwdriver or small pry bar for removal. Discard the pinion seal.

NOTE:

If the carrier does not have a cover and seal assembly the pinion seal will be mounted in the outer bore of the bearing cage. Remove the seal after the drive pinion is removed from the bearing cage.

Figure 25



8. Remove the drive pinion, bearing cage and shims from the carrier. If the bearing cage is tight in the carrier, use the following procedures to loosen the cage. **Figure 25.**

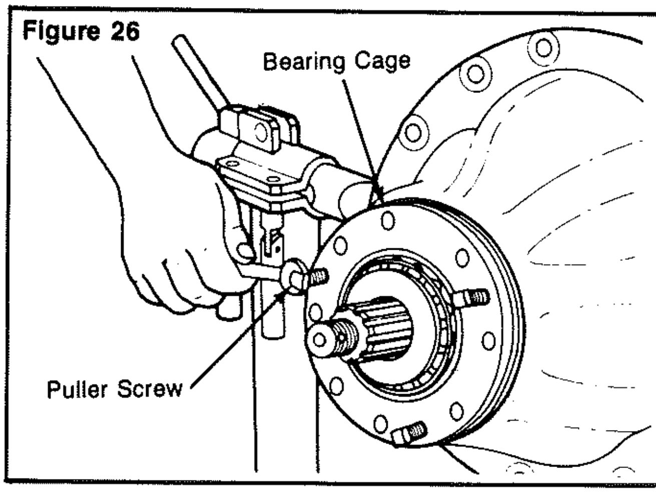
WARNING:

Wear safe eye protection. Do not hit steel parts with a steel hammer. Parts can break and cause injury.

A. Hit the bearing cage at several points around the flange area with a leather, plastic or rubber mallet.

B. Some bearing cages have threaded puller screw holes* in the mounting flange. Puller screws can be used to loosen and pull a tightly fitted cage from the carrier. If puller screws are used, clean the threaded holes before the puller screws are installed. **Figure 26.**

Figure 26



CAUTION:

Do not use a pry bar to remove the bearing cage from the carrier. A pry bar can damage the bearing cage, shims and carrier.

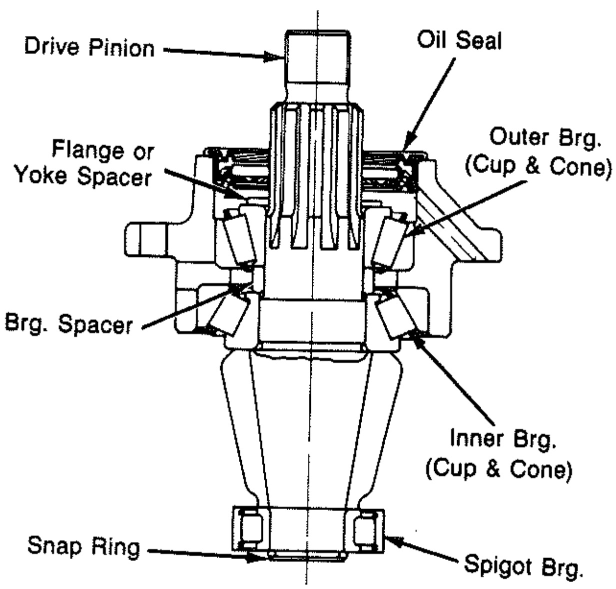
9. If the shims are in good conidtion, keep the shims together for use later when the carrier is assembled.

10. If shims are to be discarded because of damage, first measure the total thickness of the pack. Make a note of the dimension. The dimension will be needed to calculate the depth of the drive pinion in the carrier when the gear set is installed.

**Some Rockwell carriers do not have the parts described.*

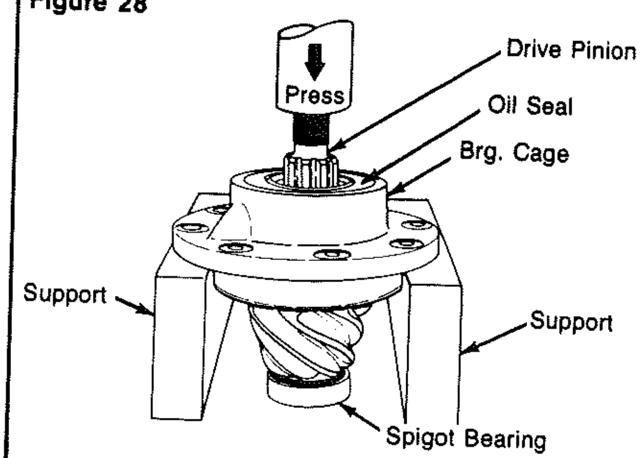
Disassemble The Drive Pinion And Bearing Cage

Figure 27 — (Pinion & Bearing Cage Assembly)



1. Put the drive pinion and bearing cage in a press. The pinion shaft must be toward the top of the assembly. **Figure 28.**

Figure 28



2. Support the bearing cage under the flange area with metal or wood blocks. **Figure 28.**
3. Press the drive pinion through the bearing cage. **Figure 28.**

NOTE:

The inner bearing cone and bearing spacer or spacers will remain on the pinion shaft.

WARNING:

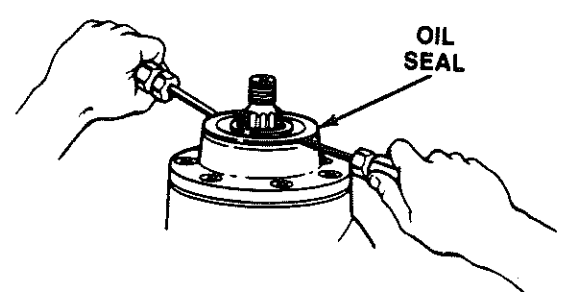
Wear safe eye protection. Do not hit steel parts with a steel hammer. Parts can break and cause injury.

4. If a press is not available, use a leather, plastic or rubber mallet to drive the pinion through the bearing cage.
5. If the pinion oil seal is mounted directly in the outer bore of the bearing cage, remove the seal at this time. Be careful that you do not damage the mounting surfaces of the bearing cage. **Figure 29.**

   If the seal is a one piece design (without mounting flange), discard the seal.

   If the oil seal is a triple-lip design (with flange), inspect the seal for damage. If the surfaces of the seal and the yoke or flange are smooth and not worn or damaged, you can use the seal again when you assemble the carrier.

Figure 29



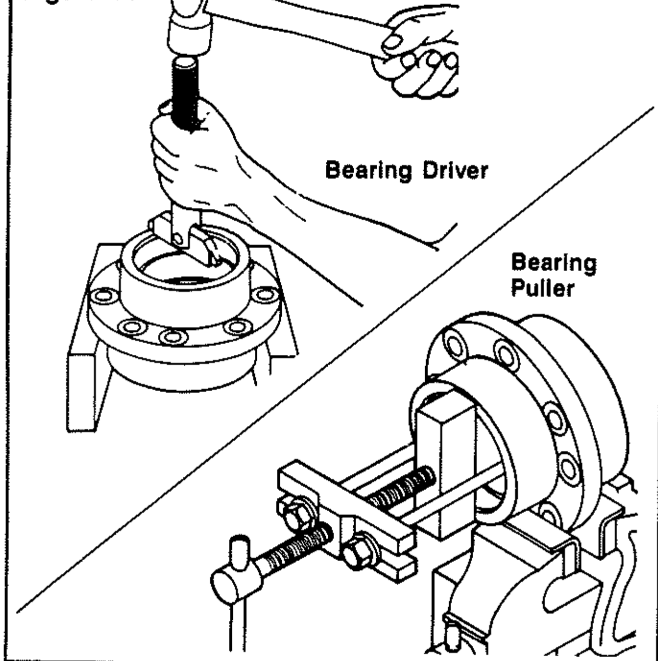
CAUTION:

Be careful when using a screwdriver or pry bar to remove the seal. Do not damage the wall of bore. Damage to the bore can cause oil leaks.

6. If the pinion bearings need to be replaced, remove the inner and outer bearing cups from the inside of cage. Use a press and sleeve, bearing puller or a small drift and hammer. The type of tool used depends on the design of the bearing cage. **Figure 30.**

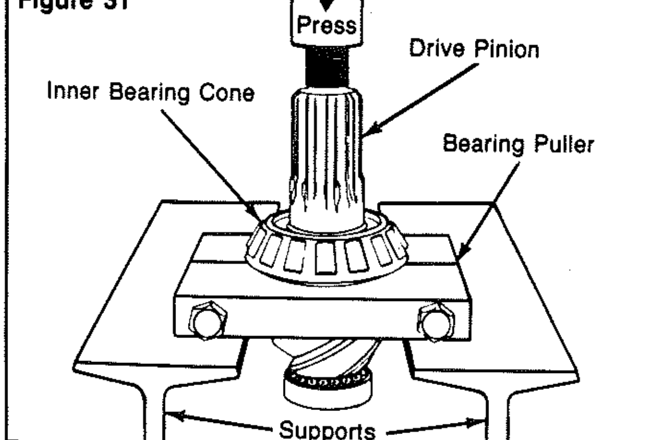
   When a press is used, support the bearing cage under the flange area with metal or wood blocks.

Figure 30



7. If the pinion bearings need to be replaced, remove the inner bearing cone from the drive pinion with a press or bearing puller. The puller MUST fit under the inner race of the cone to remove the cone correctly without damage. **Figure 31.**

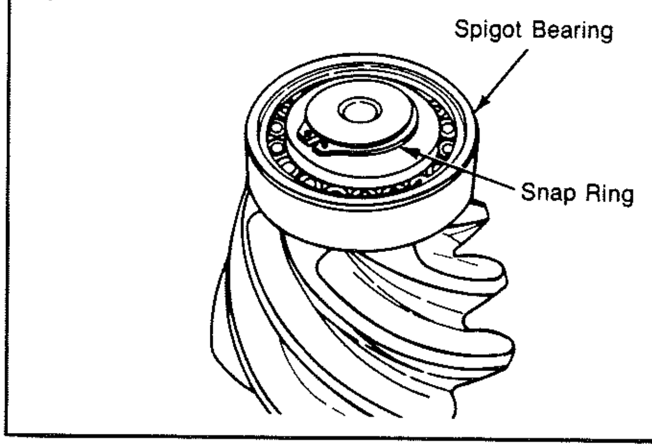
Figure 31



8. If the spigot bearing needs to be replaced, put the drive pinion in a vise. Install a soft metal cover over each vise jaw to protect the drive pinion.

9. Remove the snap ring* from the end of drive pinion with snap ring pliers that expand. **Figure 32.**

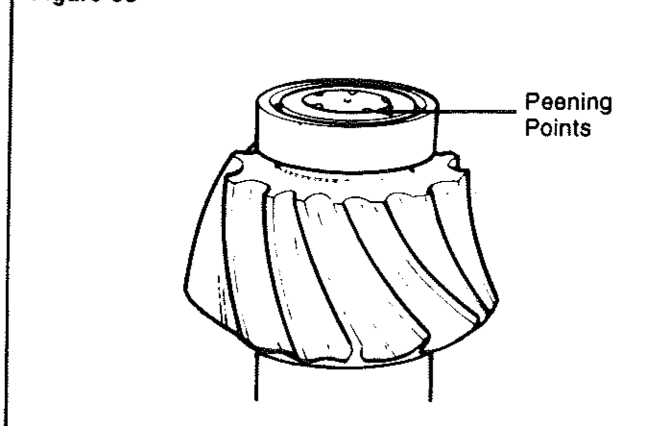
Figure 32



NOTE:

Some spigot bearings are fastened to the drive pinion with a special peening tool. Figure 33.

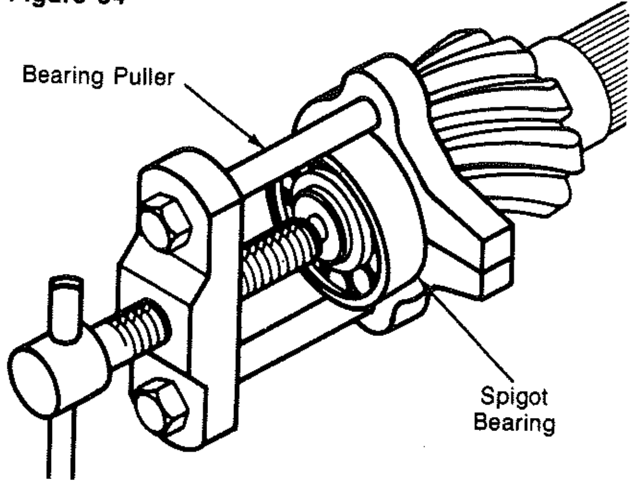
Figure 33



**Some Rockwell carriers do not have the parts described.*

10. Remove the spigot bearing from the drive pinion with a bearing puller. **Figure 34.**

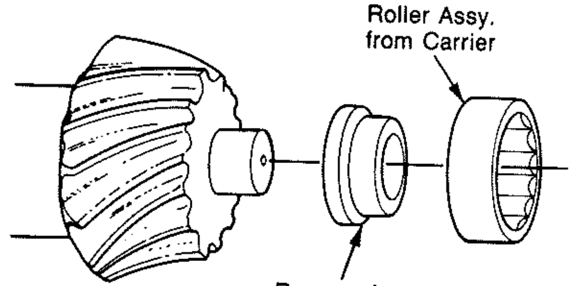
Figure 34



NOTE:

Some spigot bearings are a two-piece assembly. Remove the inner race from the pinion with a bearing puller. Remove the outer race/roller assembly from carrier with a drift or a press. Figure 35.

Figure 35



Prepare Parts for Assembly section 3

Clean Ground and Polished Parts:

1. Use a cleaning solvent to clean ground or polished parts or surfaces. Kerosene or diesel fuel oil can be used for this purpose. DO NOT USE GASOLINE.

WARNING:

Be careful when using cleaning solvents. Follow the solvent manufacturer's instructions for safe use to prevent injury.

2. Use a tool with a flat blade if required to remove gasket material from parts. Be careful not to damage the ground surfaces.
3. DO NOT clean ground or polished parts in a hot solution tank, water, steam or alkaline solutions.

Clean Rough Parts:

1. Clean rough parts the same as cleaning ground and polished parts.
2. Rough parts can be cleaned in hot solution tanks with a weak alkaline solution.
3. Parts must remain in hot solution tanks until completely cleaned and heated.

WARNING:

Be careful when using hot solution tanks and alkaline solutions. Follow the alkaline manufacturer's instructions for safe use to prevent injury.

4. Parts must be washed with water until the alkaline solution is removed.

Clean Axle Assemblies:

1. A complete axle assembly can be steam cleaned on the outside to remove dirt.
2. Before the axle is steam cleaned, close or put a cover over all openings in the axle assembly. Examples of openings are breathers or vents in air chambers.

Dry Parts That Have Been Cleaned:

1. Parts must be dried immediately after cleaning and washing.
2. Dry the parts using soft clean paper or cloth rags.
3. Except for bearings, parts can be dried with compressed air.

CAUTION:

Damage to bearings can be caused if dried by rotating with compressed air.

Prevent Corrosion and Rust on Cleaned Parts:

1. Apply axle lubricant to cleaned and dried parts that are not damaged and are to be assembled.
2. To store parts, apply a special material that prevents corrosion and rust to all surfaces. Wrap them in a special paper that prevents corrosion and rust.

Inspect Parts:

It is very important to inspect all parts carefully and completely before the axle or carrier is assembled. Check all parts for wear and replace damaged parts. Replacement of damaged or worn parts now, will prevent failure of the assembly later.

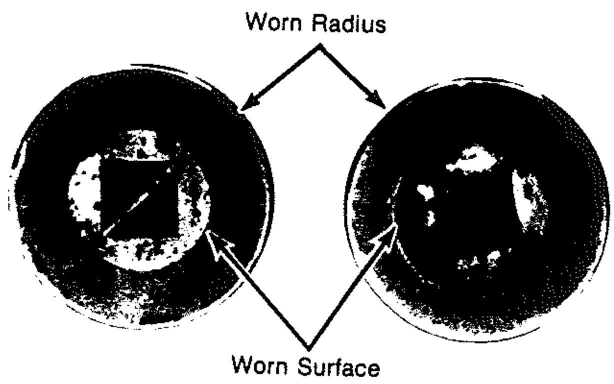
1. Inspect Tapered Roller Bearings:

   Inspect the cup, cone, rollers and cage of all tapered roller bearings in the assembly. If any of the following conditions exist, the bearing MUST be replaced.

section 3 Prepare Parts for Assembly

A. The center of large diameter end of rollers worn level with or below the outer surface. **Figure 36.**

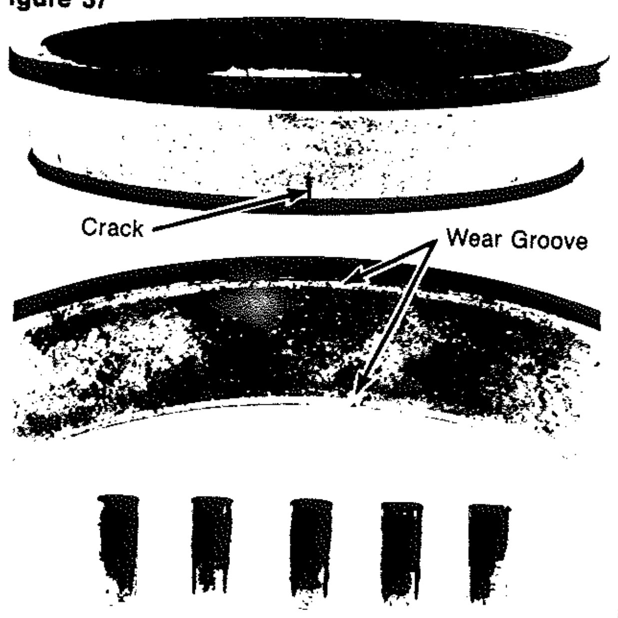
Figure 36



B. The radius at large diameter end of rollers worn to a sharp edge. **Figure 36.**

C. A visible roller groove in the cup or cone inner race surfaces. The groove can be seen at the small or large diameter end of both parts. **Figure 37.**

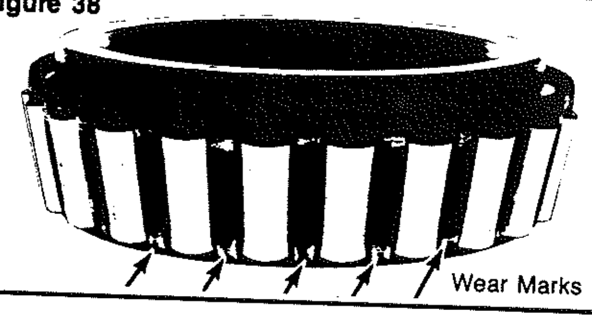
Figure 37



D. Deep cracks or breaks in the cup, cone inner race or roller surfaces. **Figure 37.**

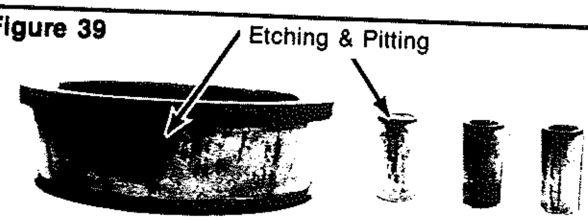
E. Bright wear marks on the outer surface of the roller cage. **Figure 38.**

Figure 38



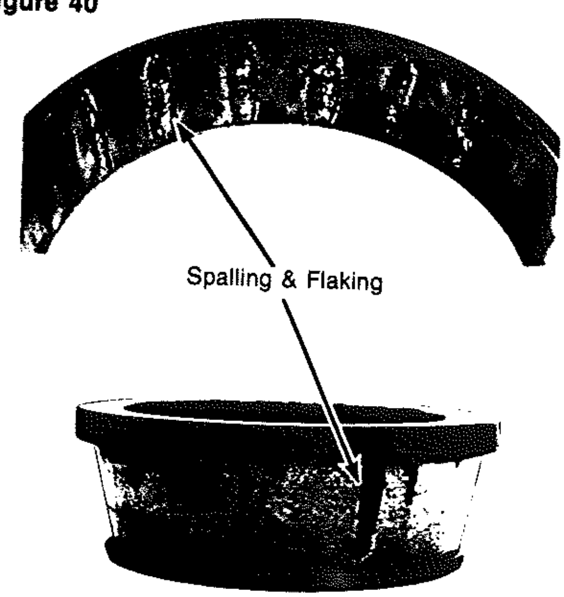
F. Damage on rollers and on surfaces of the cup and cone inner race that touch the rollers. **Figure 39.**

Figure 39



G. Damage on the cup and cone inner race surfaces that touch the rollers. **Figure 40.**

Figure 40



2. Inspect Hyproid Drive Pinion and Ring Gear Sets:

   A. Inspect hypoid pinions and gears for wear or damage. Gears that are worn or damaged MUST be replaced.

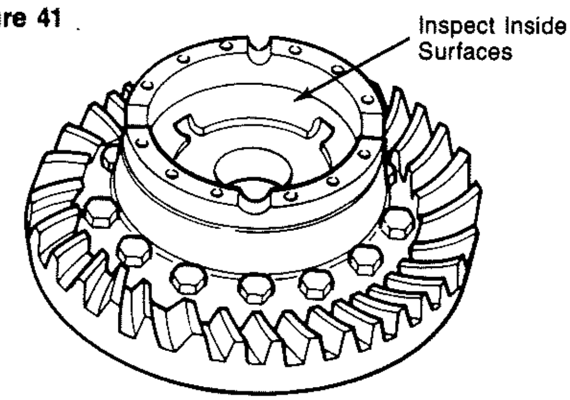
CAUTION:

Hypoid drive pinions and ring gears are machined in matched sets. When a drive pinion or ring gear of a hypoid set needs to be replaced, both drive gear and pinion must be replaced at the same time.

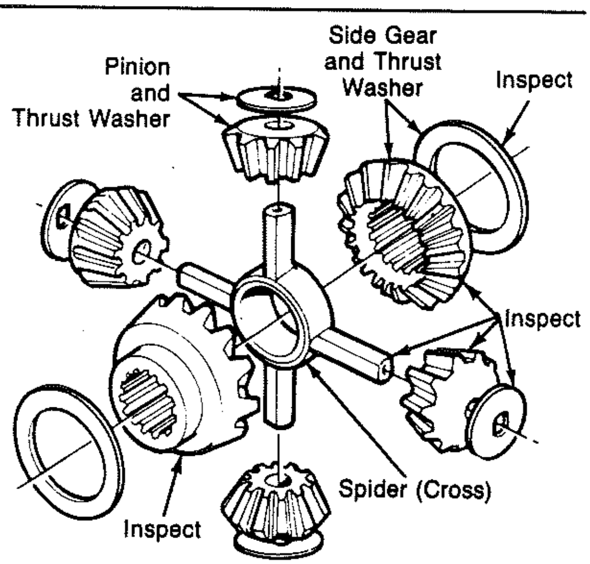
3. Inspect the Main Differential Assembly:

   Inspect the following parts for wear or stress. Parts that are damaged MUST be replaced. **Figure 41.**

Figure 41



DIFFERENTIAL CASE HALVES



DIFFERENTIAL GEAR NEST ASSEMBLY

   A. Inside surfaces of both case halves.

   B. Both surfaces of all thrust washers.

   C. The four trunnion ends of the spider (cross).

   D. Teeth and splines of both differential side gears.

   E. Teeth and bore of all differential pinions.

CAUTION:

Always replace thrust washers, differential side gears and pinion gears in sets. A higher stress on parts and early failure of the assembly will occur if a new part is used with parts that are old or worn.

4. Inspect Axle Shafts:

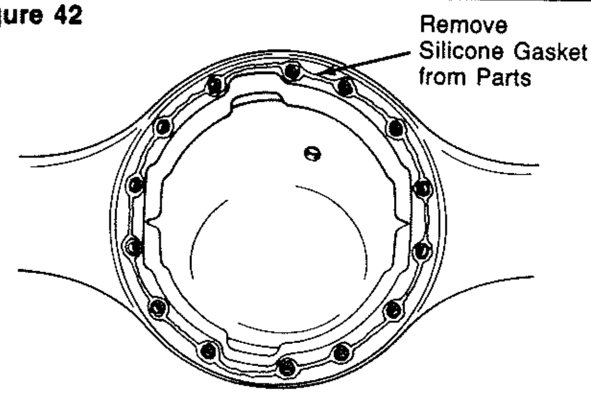
   A. Inspect axle shafts for wear and cracks at the flange, shaft and splines. Replace axle shaft if required.

Repair or Replace Parts General:

Replace worn or damged parts of an axle assembly. The following are some examples to check for, repair or replace.

1. Replace any fastener if corners of the head are worn.
2. Replace washers if damaged.
3. Replace gaskets, oil seals or grease seals at the time of axle or carrier repair.
4. Clean parts and apply new silicone gasket material where required when axle or carrier is assembled. **Figure 42.**

Figure 42



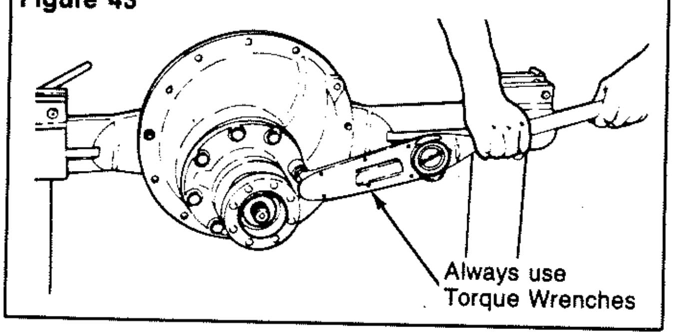
5. Remove nicks, mars and burrs from parts having machined or ground surfaces. Use a fine file, india stone, emery cloth or crocus cloth for this purpose.
6. Clean and repair threads of fasteners and holes. Use a die or tap of the correct size or a fine file for this purpose.

CAUTION:

Threads must be without damage and clean so that accurate adjustments and correct torque values can be applied to fasteners and parts.

7. Tighten all fasteners to the correct torque values. See the chart on page 65 for torque values of fasteners. **Figure 43.** T

Figure 43



8. DO NOT repair rear axle housings by bending or straightening.

WARNING:

Repair of axle housings by bending or straightening will cause poor or unsafe operation of the axle and early failure.

Repair Axle By Welding:

1. Rockwell International will permit repairing drive axle housing assemblies by welding ONLY in the following areas:

   A. Cover welds.

   B. Snorkel welds.

   C. Housing seam welds between the suspension attaching brackets.

CAUTION:

Welding can be used when the crack or damaged area is within the old weld material. Replace the axle housing if the crack extends into the metal next to the old weld. A housing that has damage in the seam weld or cover weld because of overload conditions can be repaired. A repaired housing must be used in correct applications.

WARNING:

Using wrong welding procedures or welding at locations other than the three areas permitted by Rockwell will make the heat-treated component weak. A weak component will cause poor or unsafe operation of the axle and early failure. The following procedure must be used.

2. Welding Procedure

   A. Drain the lubricant from the axle assembly.

   B. Remove the axle shafts and differential carrier from the axle housing.

WARNING:

Be careful when using a cleaning solvent. Follow the solvent manufacturer's instructions for safe use to prevent injury.

   C. Clean the damaged area inside and outside the housing. Cleaning solvent can be used.

   D. Grind the damaged weld to the base metal.

   E. Warm the complete axle housing to a temperature of 70° F - 80° F (21° C - 27° C) or higher.

   F. Before you start welding, heat the damaged area to be repaired to approximately 300° F (149° C).

   G. Use a 70,000 psi tensile weld material and the correct voltage and amperage for the diameter weld rod used. Examples of weld rods that can be used are E-7018 or ER-70S-3.

CAUTION:

If the E-7018 weld rod is used, the rod must be kept dry. Electrodes that are not stored in the correct sealed containers must be heated at 700° F (371° C) for one hour before welding. Wet electrodes must be dried at 180° F (82° C) for one to two hours and then heated at 700° F (371° C) for one hour before welding.

H. Fill in the Weld Gap as Follows:

CAUTION:

Do not connect the ground cable at any point on the axle assembly that will put a bearing between the ground cable and weld area. If a bearing is between the ground cable and weld, the bearing will be damaged because of electricity arcing. A good location to connect the ground cable is the spring mounting pad of the housing.

1. The snorkle weld MUST be a .375 inch (9.5 mm) fillet.
2. The opening in cover welds MUST be filled level with the old weld.
3. The opening in seam welds MUST be ground out to 70% of the wall thickness. The wall thickness can be measured at the carrier opening of housing.
4. Clean the new weld area. Carefully remove all the rough weld material.
5. Install the differential carrier and axle shafts.
6. Fill the axle assembly with the correct amount of lubricant. See page 62 or Rockwell Field Maintenance Manual No. 1 for information on lubricants.

NOTE:

To weld brackets or other components to the axle housing, use the procedure in Rockwell Technical Service Aid, TSA-2-95.

Bending or Straightening Drive Axle Housings:

Rockwell International is emphatically opposed to any attempt to correct or modify drive axle housings by bending or straightening. All damaged drive axle housings should be replaced.

Also, Rockwell will allow *repair welding only* in the following areas: cover welds, snorkel welds, and housing seam welds between the suspension attaching brackets. Repair welding should be performed only if the crack/porosity is located within the weld material.

Replace any housing assemblies where cracks have worked into the parent metal. Also, any housings that have seam weld or cover weld cracks, due to known overloading of the axle, should not be repair welded.

CAUTION:

Bending, straightening, improper repair welding procedures or repair welding at locations other than those indicated above, may result in premature housing failure and affect the safe operation of the axle assembly.

For further information regarding Repair Welding, refer to page 18.

section 4 General Procedures

Use of Dri-Loc Fasteners and Rockwell Liquid Adhesive 2297-C-3747 or Loctite 277

Install New Dri-Loc Fasteners.

1. Clean the oil and dirt from threaded holes. There is no special cleaning required.
2. Assemble parts using the new Dri-Loc fasteners.

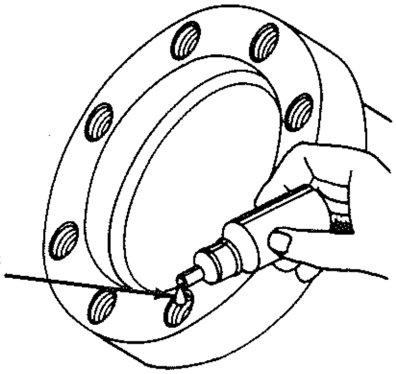
CAUTION:
Do not apply adhesives or sealants on new Dri-Loc fasteners or in the threaded holes. If other adhesives or sealants are used, the new Dri-loc adhesive will not function correctly.

3. Tighten the Di-Loc fasteners to the required torque valve for that size fastener. There is no special procedure or torque value required. See the torque chart on page 65. T

NOTE:
There is no drying time required for Dri-loc fasteners.

Install Old Dri-Loc Fasteners using Rockwell Liquid Adhesive 2297-C-3747 or Loctite 277.

Figure 44

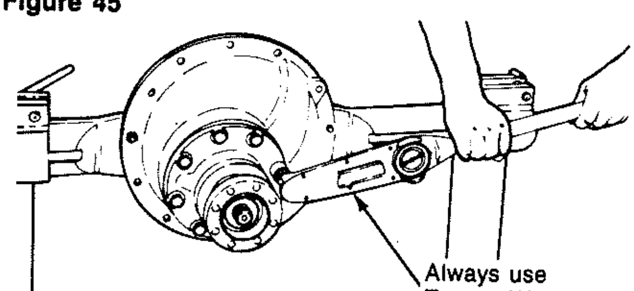


1. Clean the oil and dirt from threaded holes. There is no special cleaning required and it is not necessary to remove the old Dri-Loc adhesive from threads.
2. Apply four or five drops of Rockwell Liquid Adhesive or Loctite 277 to threaded holes ONLY. Make sure the adhesive is on the threads. **Figure 44.**

CAUTION:
Do not apply adhesive to the fastener threads. Air pressure in the hole will push the adhesive out as the fastener is installed.

3. Tighten the fasteners to the required torque value for that size fastener. There is no special procedure or torque value required. See the torque chart on page 65. **Figure 45.** T

Figure 45



NOTE:
There is no drying time required for Rockwell Liquid Adhesive 2297-C-3747 or Loctite 277.

Check Torque Values of Dri-Loc Fasteners not requiring removal.

CAUTION:
If Dri-Loc fasteners do not require removal from components, check the fasteners for correct torque value as follows:

1. Apply the MINIMUM amount of torque required for that size fastener. See the torque chart on page 65. The fastener MUST NOT rotate. **Figure 45.**
2. If the fastener rotates any amount, remove the fastener from the component and apply adhesive to the threaded hole. Follow the procedure for installing old Dri-Loc fasteners.

Remove Dri-Loc Fasteners.

If it is difficult to remove Dri-Loc fasteners from components, the strength of Dri-Loc, Rockwell adhesive or Loctite 277 can be decreased by heating. Use the following procedure:

1. Heat the fastener for three to five seconds ONLY and try to loosen the fastener with a wrench. DO NOT use an impact wrench to loosen the fastener or hit the fastener with a hammer.
2. Repeat step 1 until the fastener can be removed.

CAUTION:

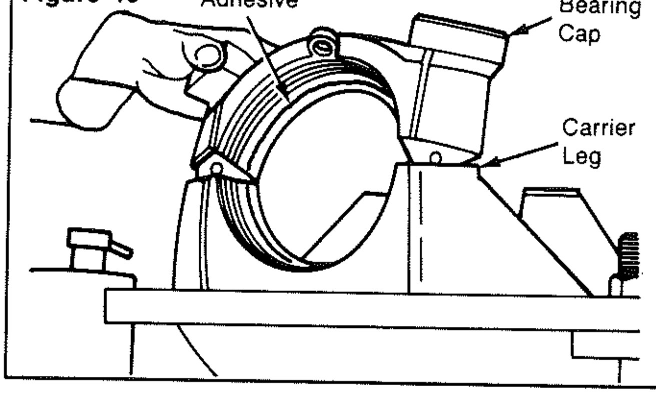
Do not exceed 350° F (+177° C) maximum. Heating must be done slowly to prevent thermal stresses in the other components.

Application of Rockwell Adhesive 2297-T-4180 or 1199-Z-3250 in Bearing Bores for the Differential

- Use adhesive 1199-Z-3250 for SQ series axles.
- Use adhesive 2297-T-4180 for all other axles.

1. Clean the oil and dirt from outer diameters of bearing cups and bearing bores in the carrier and bearing caps. There is no special cleaning required.
2. Apply axle lubricant to the bearing cones and the inner diameters of the bearing cups of the main differential. DO NOT get oil on the outer diameter of the bearing cup and DO NOT permit oil to drip on the bearing bores.
3. Apply a single continuous bead of the adhesive to the bearing bores in the carrier and bearing caps. Apply the adhesive 360° around the smooth, ground surfaces ONLY. DO NOT put adhesive on threaded areas. **Figure 46.**

Figure 46



NOTE:

The Rockwell adhesives will become hard (dry) in approximately two hours. The following two steps of the procedure must be done in two hours from the time the adhesive was applied. If two hours have passed since application, clean the parts again and apply new adhesive.

4. Install the main differential assembly, bearing cups and bearing caps into the carrier. Use the normal procedure, see page 42.
5. Adjust preload of the differential bearings, backlash and tooth contact patterns of the gear set as required using the normal procedures. See pages 43-51.

Application of Silicone Gasket Material

NOTE:

The following silicone gasket products can be used on Rockwell components.

a. Dow Corning Silicone Rubber Sealant, No. 732 Black.

b. General Electric No. RTV-1473 Black.

c. From Rockwell International:

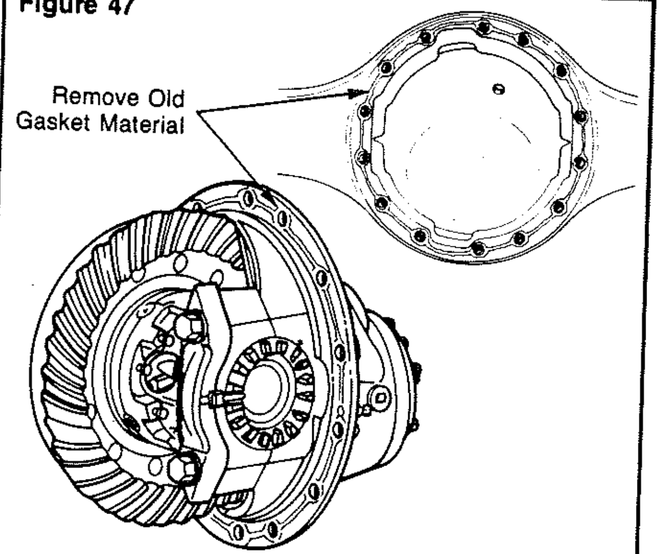
- 40 pound containers, Part No. 1199-Q-2981
- Ten ounce tubes, Part No. 1250-X-388
- Three ounce tubes, Part No. 1199-T-3842

WARNING:

Small amounts of acid vapor are present when applying silicone gasket material. For this reason, be sure there is good ventilation in the work area. If the silicone gasket material gets in the eyes, flush the eyes with water for 15 minutes. Have the eyes checked by a doctor.

1. Remove all old gasket material from both surfaces. **Figure 47.**

Figure 47



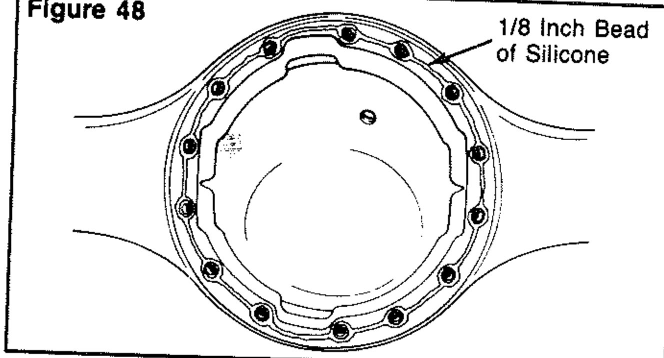
Housing and Carrier Shown

2. Clean the surfaces where silicone gasket material will be applied. Remove all oil, grease, dirt and moisture.

3. Dry both surfaces.

4. Apply a 1/8 inch diameter continuous bead of the silicone gasket material around one surface. Also apply the gasket material around the edge of all fastener holes in that surface. **Figure 48.**

Figure 48



CAUTION:

The amount of silicone gasket material applied must not exceed a 1/8 inch diameter bead. Too much gasket material can block lubrication passages.

5. Assemble the components immediately to permit the silicone gasket material to compress evenly between the parts. Tighten fasteners to the required torque value for that size fastener. There is no special procedure or torque value required. See Torque Chart on page 65. T

6. Wait 20 minutes before the assembly is filled with lubricant.

NOTE:

The Rockwell adhesive and gasket products are available from:

Rockwell International Corp.
Florence Distribution Center
7975 Dixie Highway
Florence, Kentucky 41042

Installing Tight Fit Yokes using the Three Piece Pilot Tool

NOTE:

A three piece installation tool is required to correctly install yokes with interference fit splines. The yoke installation tools are not available from Rockwell International but can be purchased from OTC Tool and Equipment Division, 655 Eisenhower Drive, Owatonna, MN 55060. Specify the Rockwell axle model when ordering. See the following list.

Axle Series	Position	OTC Tool Number
H-172		D80T-4859-A
L-172		D80T-4859-A
P-174		D80T-4859-A
R-155		D80T-4859-A
R-255		D80T-4859-A
R-170		D80T-4859-B
R-270		D80T-4859-A
S-170		D80T-4859-B
U-170		D80T-4859-B
U-240		D80T-4859-A
U-270		D80T-4859-A
U-280		D80T-4859-A
W-280		D80T-4859-A
RS-13-120*		D89T-4859-B
RS-15-120*		D89T-4859-B
RS-15-210*		D89T-4859-B
RS-17-140*		D89T-4859-B
RS-17-220*		D89T-4859-B
RS-19-145*		D89T-4859-B
RS-20-230*		D89T-4859-B
RS-21-145*		D89T-4859-B
RS-23-160*		D89T-4859-A
RS-23-180*		D89T-4859-A
RS-23-240*		D89T-4859-B
RS-26-180*		D89T-4859-A
RS-30-180*		D89T-4859-A
RT-34-145*	Forward Input	D89T-4859-B
	Forward Output	D89T-4859-B
	Rear Input	D89T-4859-B
RT-40-145*	Forward Input	D89T-4859-B
	Forward Output	D89T-4859-B
	Rear Input	D89T-4859-B
RT-44-145*	Forward Input	D89T-4859-B
	Forward Output	D89T-4859-B
	Rear Input	D89T-4859-B
RT-46-160*	Forward Input	D89T-4859-A
	Forward Output	D89T-4859-B
	Rear Input	D89T-4859-A
RT-48-180**	Forward Input	D80T-4859-B
	Forward Output	D80T-4859-A
	Rear Input	D89T-4859-A

Axle Series	Position	OTC Tool Number
RT-52-160*	Forward Input	D89T-4859-A
	Forward Output	D89T-4859-B
	Rear Input	D89T-4859-A
RT-52-180**	Forward Input	D80T-4859-B
	Forward Output	D80T-4859-A
	Rear Input	D89T-4859-A
RT-58-180**	Forward Input	D80T-4859-B
	Forward Output	D80T-4859-A
	Rear Input	D89T-4859-A
SL-100	Forward Input	D80T-4859-A
	Forward Output	D80T-4859-B
	Rear Input	D80T-4859-B
SQ-100	Forward Input	D80T-4859-A
	Forward Output	D80T-4859-A
	Rear Input	D80T-4859-A
SQR-100	Forward Input	D80T-4859-A
	Forward Output	D80T-4859-A
	Rear Input	D80T-4859-A
SSHD	Forward Input	D80T-4859-B
	Forward Output	D80T-4859-A
	Rear Input	D80T-4859-A
STHD	Forward Input	D80T-4859-B
	Forward Output	D80T-4859-A
	Rear Input	D80T-4859-A
SR-170	Forward Input	D80T-4859-B
	Forward Output	D80T-4859-A
	Rear Input	D80T-4859-B
ST-170	Forward Input	D80T-4859-B
	Forward Output	D80T-4859-A
	Rear Input	D80T-4859-B
SU-170	Forward Input	D80T-4859-B
	Forward Output	D80T-4859-A
	Rear Input	D80T-4859-B
SR-270/280	Forward Input	D80T-4859-B
	Forward Output	D80T-4859-A
	Rear Input	D80T-4859-A
ST-270/280	Forward Input	D80T-4859-B
	Forward Output	D80T-4859-A
	Rear Input	D80T-4859-A
SU-270/280	Forward Input	D80T-4859-B
	Forward Output	D80T-4859-A
	Rear Input	D80T-4859-A
SW-280	Forward Input	D80T-4859-B
	Forward Output	D80T-4859-A
	Rear Input	D80T-4859-A
SFDD-4640	Forward Input	D80T-4859-B
	Forward Output	D80T-4859-A
	Rear Input	D80T-4859-A

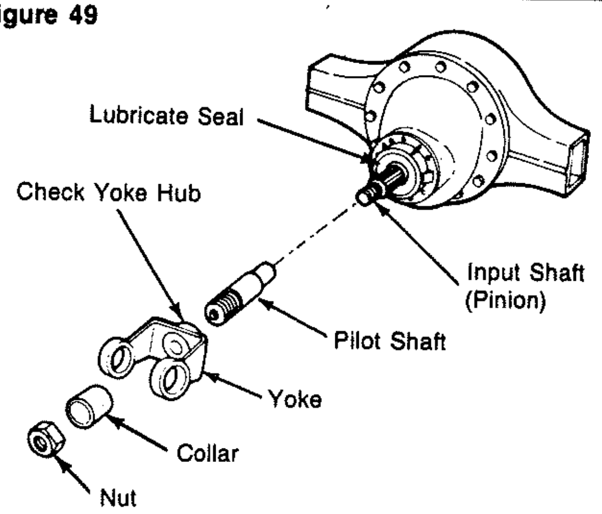
*Axle models have metric size threads on drive pinions, input shafts and output shafts.
**Metric threads only on drive pinions of rear/rear axles.

CAUTION:

Do not install tight fit yokes on shafts using a hammer or mallet. A hammer or mallet will damage the yoke.

1. Apply axle lubricant on the yoke seal.
2. Check all surfaces of the yoke hub for damage. If necessary, polish the yoke hub with an india stone, emery cloth or crocus cloth.
3. Install the pilot shaft on the input shaft of the assembly. **Figure 49.**

Figure 49



4. Slide the yoke over the pilot shaft. Align the yoke splines with the shaft splines.
5. Put the collar on the pilot shaft and slide it against the yoke.
6. Install the nut on the pilot shaft and against the collar. Tighten the nut against collar until the yoke is completely in position on the shaft. Sometimes a torque value of 200 lb.—ft. on the nut is required to install the yoke correctly.

CAUTION:

Do not use the assembly yoke nut for installation purposes. Use the nut that is supplied with the three piece pilot tool.

7. Remove all parts of the pilot tool from the shaft. (Pilot shaft, collar and nut).
8. Install the washer (if required) and yoke nut on the shaft. Tighten the nut to the required torque value. See the torque chart on page 65. T

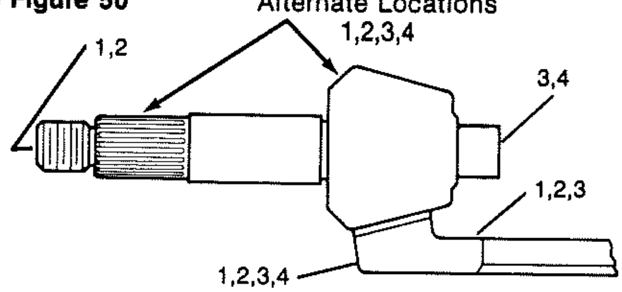
Gear Set Information (Drive Pinion and Ring Gear Marks)

NOTE:

Before a new gear set is installed in the carrier, read the following information. Always check the gear set for correct marks to make sure the gears are a matched set.

The location of the marks are shown in Figure 50.

Figure 50



1. Part Number
   A. Examples of gear set part numbers: Conventional ring gear, 36786. Conventional drive pinion, 36787. Generoid ring gear, 36786 K or 36786 K2. Generoid drive pinion, 36787 K or 36787 K2.

NOTE:

The last digit in part numbers for Generoid gears is a letter or letter and number.

B. Location on Drive Pinion: End at threads.

C. Location on Ring Gear: Front face or outer diameter.

2. Tooth Combination Number

A. Example of a tooth combination number: 5-37.

NOTE:

A 5-37 gear set has a 5 tooth drive pinion and a 37 tooth ring gear.

B. Location on Drive Pinion: End at threads.

C. Location on Ring Gear: Front face or outer diameter.

3. Gear Set Match Number

Rockwell drive pinions and ring gears are available only as matched sets. Both gears of a set have a match number.

A. Example of a gear set match number: M29.

NOTE:

A gear set match number has any combination of a number or letter and number.

B. Location on Drive Pinion: End of gear head.

C. Location on Ring Gear: Front face or outer diameter.

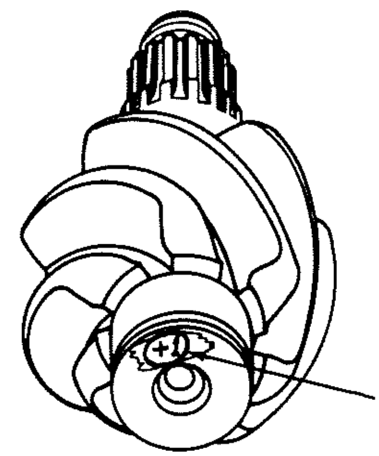
4. Pinion Cone Variation Number

NOTE:

The pinion cone variation number is not used when checking for a matched gear set. The number is used when you adjust the depth of the pinion in the carrier. See the procedure for adjusting the shim pack thickness under the pinion cage on pages 35-37.

A. Examples of pinion cone variation numbers: PC+3, PC-5, +2, -1, +.01mm or -.02mm. **Figure 51.**

Figure 51



B. Location on Gear Set: End of pinion gear head or outer diameter of ring gear.

Vehicle Towing Instructions :

When towing or "piggybacking" a vehicle with the wheels of one or both drive axles on the ground, it is possible to damage the axles or cause additional damage if the wrong procedure is used before towing begins. Rockwell recommends that you use the following procedure.

Before Towing:

1. If the drive axle(s) are equipped with a main differential lock, shift the differential to the unlocked (disengaged) position. The differential lock light in the cab of the vehicle will go out.

NOTE:

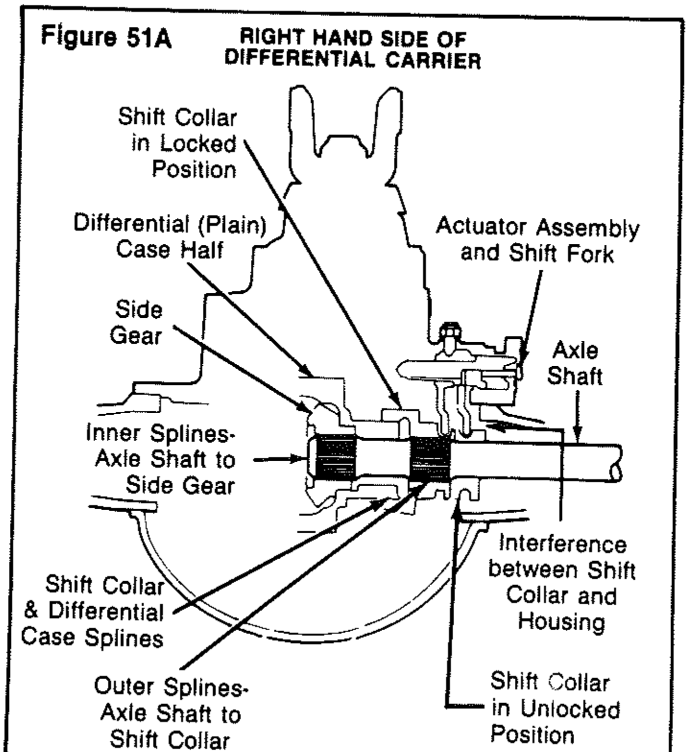
If the air supply to the differential lock is damaged, the differential will unlock (disengage) when air pressure is lost.

2. Identify each axle shaft so that they can be installed in the same location after repair is completed.
3. Remove both axle shafts of drive axles that will remain on the ground while the vehicle is being towed. Follow the procedures described in the Disassembly section of this manual.

NOTE:

If the axle(s) are equipped with main differential lock, the left-hand front axle shaft and right-hand rear axle shaft of tandem axles and the right-hand axle shaft of single axles have two sets of splines. One set of splines is engaged with the side gear and one set is engaged with the shift collar. It may be necessary to rotate the shaft when pulling it through the shift collar. **Figure 51A** ***(single or rear of tandem axle shown).***

Figure 51A



4. Install a cover over the openings of both hubs to retain the lubricant and keep dirt from entering the hub.

Before Operating the Vehicle:

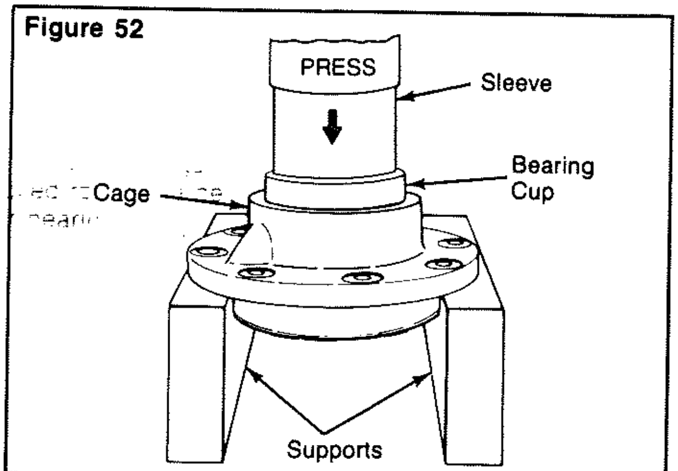
1. Remove the covers from the hubs.
2. If the drive axle(s) are equipped with a main differential lock, shift the differential to the unlocked (disengaged) position. Install the axle shafts with two sets of splines and new gaskets in the correct locations as follows:
   A. Push the axle shaft and gasket into the hub and housing until the shaft stops against the shift collar.
   B. Push down and in on the axle shaft flange and rotate the shaft until the splines of the shaft and collar are engaged.
   C. Push the axle shaft further into the housing until the shaft stops against the differential side gear.
   D. Push down on the axle shaft flange and rotate the shaft until the splines of the shaft and side gear are engaged.
   E. Push the axle shaft completely into the housing until the flange and gasket are flush against the hub.
3. Install the other axle shafts at the locations from where they were removed. Follow the procedures described in the Assembly section of this manual.
4. Check the lubricant level in the axles and hubs where the axle shafts were removed. Add lubricant if necessary. See the Lubrication section of this manual for information.

Assembly section 5

Assemble the Drive Pinion, Bearings and Bearing Cage

1. Put the bearing cage in a press. **Figure 52.**

Figure 52



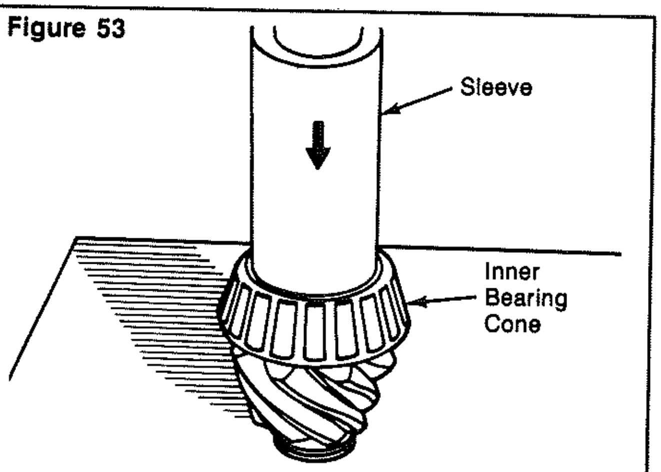
2. Support the bearing cage with metal or wood blocks.
3. Press the bearing cup into the bore of bearing cage until cup is flat against bottom of bore. Use a sleeve of the correct size to install bearing cup. **Figure 52.**

NOTE:

Use the same procedure for both bearing cups.

4. Put the drive pinion in a press, gear head (teeth) toward the bottom. **Figure 53.**

Figure 53



5. Press the inner bearing cone on the shaft of the drive pinion until the cone is flat against the gear head. Use a sleeve of the correct size against the bearing inner race.

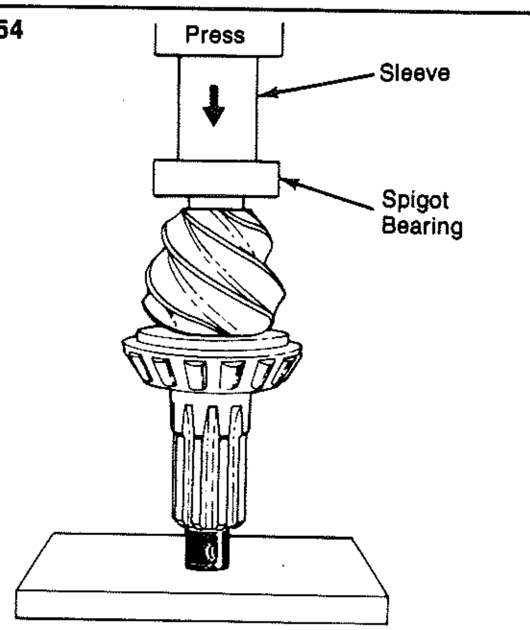
NOTE:

Some spigot bearings are fastened to the drive pinion with a snap ring, some are fastened with a peening tool, and some are a two-piece bearing assembly with the inner race pressed on the nose of the pinion and the outer race pressed into its bore in the carrier. Use one of the following procedures to install the spigot bearing, then continue with steps 6 through 9 on page 31.

Install One-Piece Spigot Bearing Assemblies

A. Put the drive pinion in a press, gear head (teeth) toward the top. **Figure 54.**

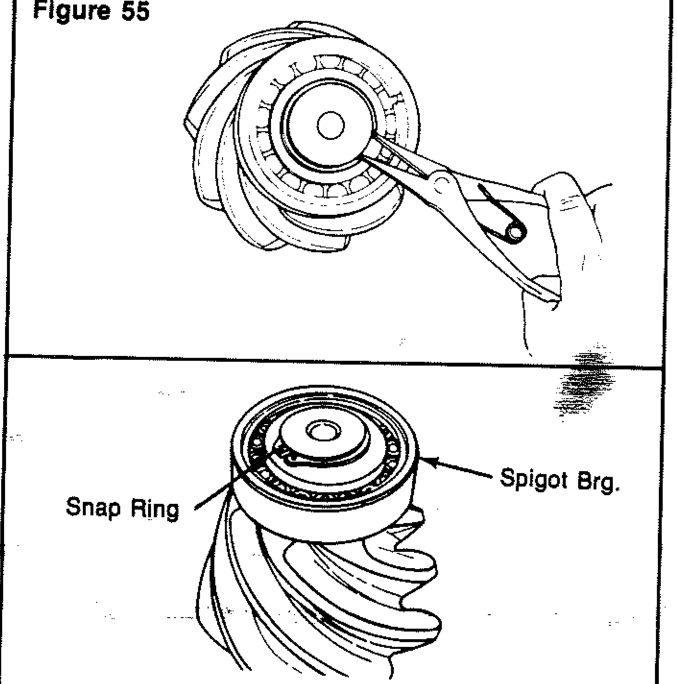
Figure 54



B. Press the spigot bearing on the end of drive pinion until the bearing is flat against the gear head. Use a sleeve of the correct size against the bearing inner race. **Figure 54.**

C. Install the snap ring* into groove in end of drive pinion with snap ring pliers. **Figure 55.**

Figure 55

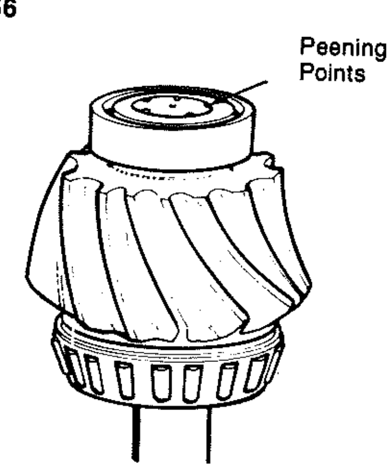


NOTE:

***Some spigot bearings are held in position by peening the end of the drive pinion. Use the following procedure.* Figure 56.**

Peen the Spigot Bearing on Drive Pinion

Figure 56



Specification:

Apply 3,000 kg (6,614 lb.) pressure on a 10 mm or .375 inch ball.
Peen the end of drive pinion at a minimum of five points. **Figure 56.**

When a peen tool and press are used, calculate the pressure required on the tool as follows.

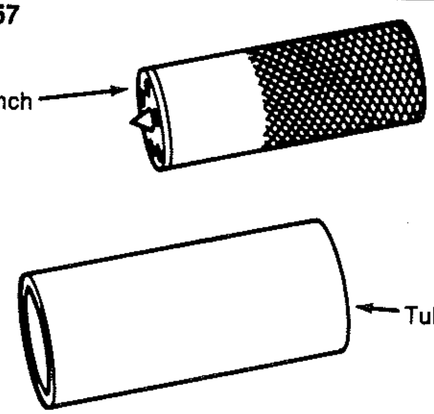
3,000 kg (6,614 lb.) x amount of balls in tool = kilograms or pounds

Example: 6,614 lb. x 3 balls = 19,842 pounds

For information about the peen tool write to Rockwell International, Communications Department, 2135 West Maple Road, Troy, Michigan 48084.

A peen tool, **Figure 57,** part number J 26883, is available from Kent-Moore, Heavy-Duty Division, 29784 Little Mack, Roseville, Michigan 48066-2298.

Figure 57

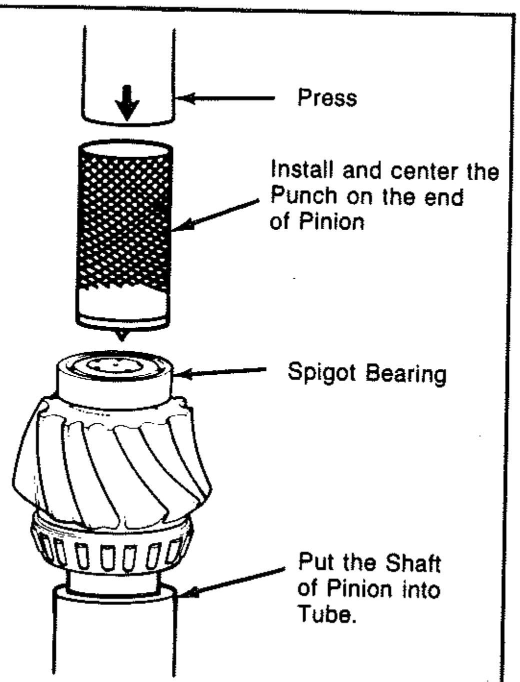


**Some Rockwell carriers do not have the parts described.*

A. Put the drive pinion and the tube of the peen tool in a press, spigot bearing toward the top. **Figure 58.**

B. Calculate the amount of pressure that will be required on the peen tool. See specification and example calculation.

Figure 58



C. Put the punch of the peen tool over the end of the pinion and spigot bearing. Apply the required amount of pressure on the punch. **Figure 58.**

CAUTION:

Do not align new points with grooves in end of drive pinion or in old points. If the new peen points are put in the wrong areas, the spigot bearing will not be held correctly on the pinion.

D. Rotate the punch as many times as required for a minimum of five points. Repeat step C for each point.

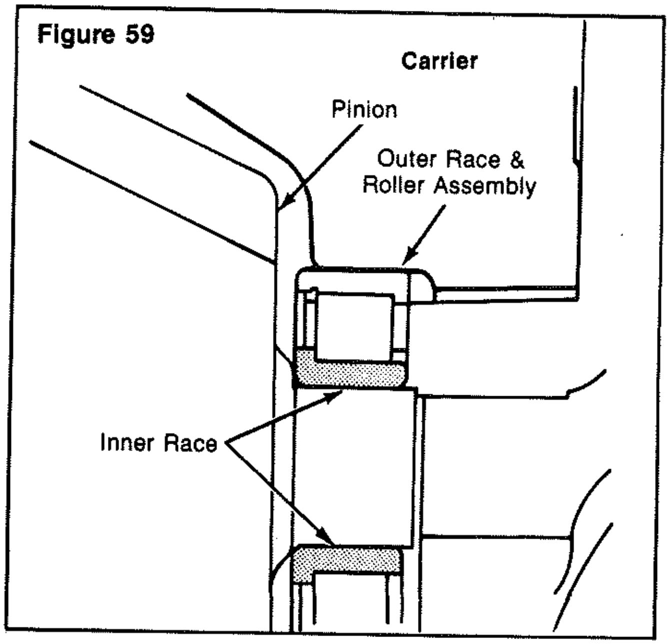
NOTE:

If a three ball peen tool is used, rotate the tool 180° (degrees).

Install Two-piece Spigot Bearing Assemblies

A. With a press or a soft mallet and sleeve, install the inner race of the spigot bearing on to the nose of the pinion. Use a sleeve of the correct size and press the bearing race until it is squarely against its shoulder on the nose of the pinion. **Figure 59.**

Figure 59



B. With a press or a soft mallet and sleeve, install the outer race and roller assembly into its bore in the carrier. Use a sleeve that is the same size as the outer race and press the bearing until it is squarely against the shoulder in the bottom of its bore. **Figure 59.**

Install and Stake Pinion Spigot Bearings on RS-160 Series Axles

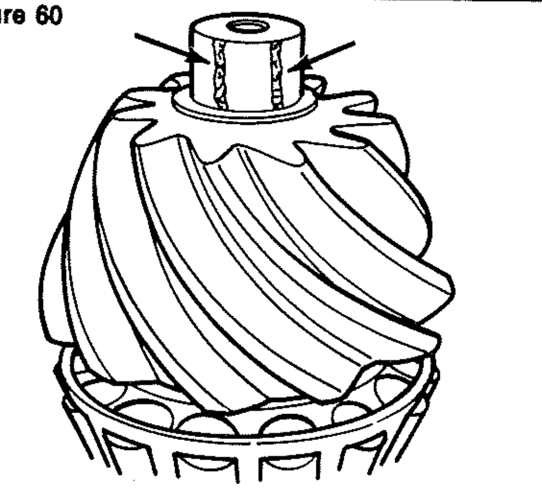
The inner race of two-piece spigot bearings must be staked in place on RS and RR-160 series rear axles. Before you stake the pinion, you must heat the pinion stem to soften it.

NOTE:

Kent-Moore Kit J-39039 includes the staking tool, temperature indicating liquid, heating shield and plastigage needed for this job.

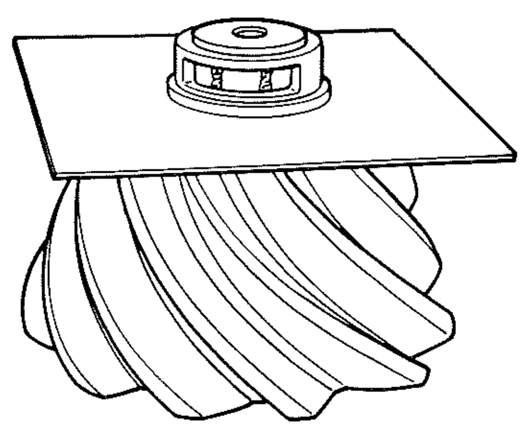
A. Apply two stripes of temperature indicating liquid on the pinion stem from the top to the bottom. **Figure 60.** Apply a green stripe to indicate 400°F and a blue stripe to indicate 500°F.

Figure 60



B. Put the heating shield over the pinion stem so that you can see the temperature indicating liquid through the hole in the shield. **Figure 61.**

Figure 61



WARNING:

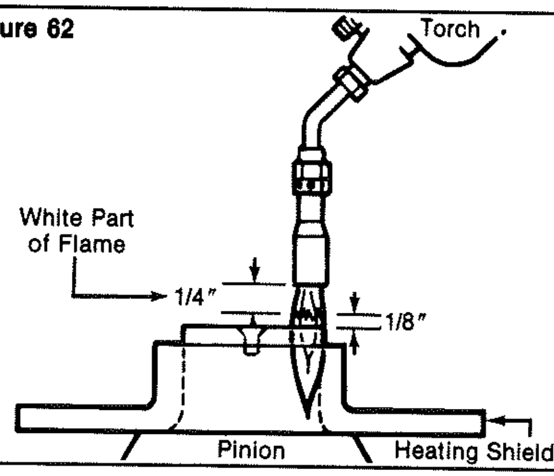
To protect yourself from injury, wear safety glasses when you do steps C-F. Wear heat resistant gloves while you do steps C and D.

CAUTION:

Do not heat the pinion stem without the heat shield in place. Also, do not overheat the pinion stem or you will weaken the metal which can cause early failure. Correct heating will take approximately 25-35 seconds, depending on how hot the torch is.

C. Light and adjust the torch until the white part of the flame is approximately 1/4 inch long. Keep the white part of the flame approximately 1/8 inch from the top of the stem. **Figure 62.** Move the flame around the outer diameter of the top of the pinion stem. The green temperature indicating liquid will turn black before the blue liquid does. Heat the stem until the blue liquid turns black at a point in the middle of the window.

Figure 62



D. Remove the flame and the heat shield from the pinion. Let the pinion air cool for 10 minutes. Use a razor blade to remove the temperature indicating liquid.

CAUTION:

Do not press or hit directly on the new inner race in step E or you will damage the bearing.

E. Use a press, if available, or a brass hammer to install the new inner race. Use the old inner race as a sleeve. The race is completely seated when you cannot fit a 0.002 inch feeler gauge between the race and the pinion shoulder.

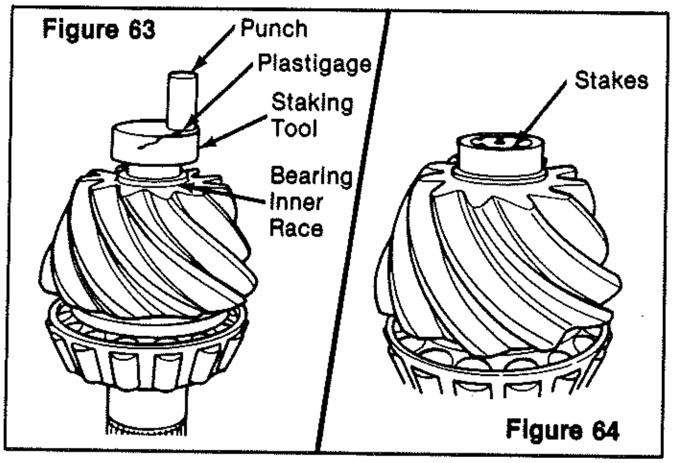
NOTE:

If you cannot hold the races in place, try using the staking tool instead of the old race to start the new race on the stem. But, use the old race to completely seat the new race.

NOTE:

In Step F, you do not need to use the plastigage for every stake. Just use it until you are sure you are hitting the punch with the correct force.

F. Put the staking tool over the bearing race. Cut a one inch piece from the green plastigage strip and put it between the punch and the staking tool. **Figure 63.** Hit the punch with a two-three pound brass hammer to upset the end of the pinion stem. Then, remove the strip and measure its thickness against the gauge on the wrapper that the strip came in. The strip must not be less than 0.003 inch thick. This thickness indicates that you are using enough force when you hit the punch. If the strip is too thin, then you must hit the punch harder so the stake will hold the race in place. Rotate the tool and repeat this procedure until there are six evenly spaced stake marks around the stem. **Figure 64.**

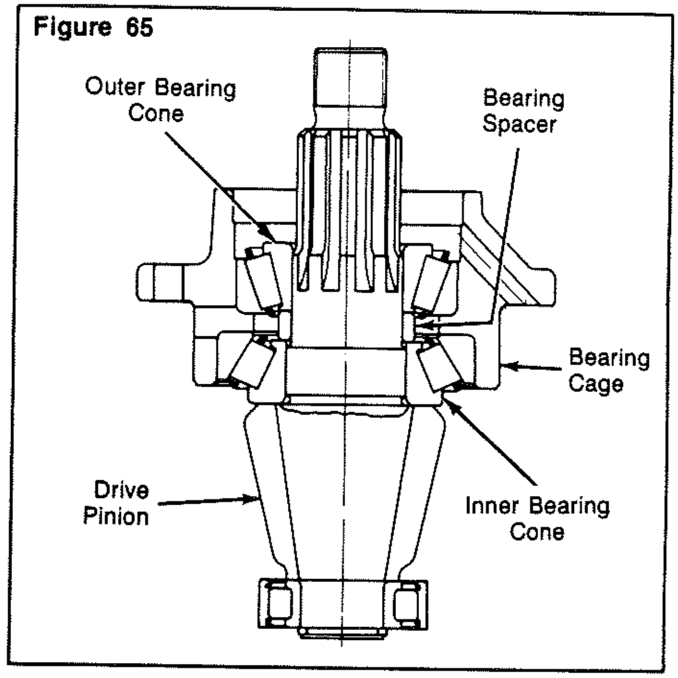


G. With a press or a soft mallet and sleeve, install the outer race and roller assembly into its bore in the carrier. Use a sleeve that is the same size as the outer race and press the bearing until it is squarely against the shoulder in the bottom of its bore.

6. Apply axle lubricant on bearing cups in the cage and bearing cones.

7. Install the drive pinion into the bearing cage.

8. Install the bearing spacer or spacers on pinion shaft against the inner bearing cone. **Figure 60.**



NOTE:

The spacer or spacers control the preload adjustment of the drive pinion bearings.

9. Install the outer bearing cone on pinion shaft against the spacer. **Figure 65.**

NOTE:

DO NOT install pinion seal in bearing cage. Continue with adjusting preload of pinion bearings.

Adjust Preload of Pinion Bearings

Specifications:

New pinion bearings - 5 to 45 lb.-in. (.56 to 5.08 N.m) torque.

Used pinion bearings in good condition - 10 to 30 lb.-in. (1.13 to 3.39 N.m) torque.

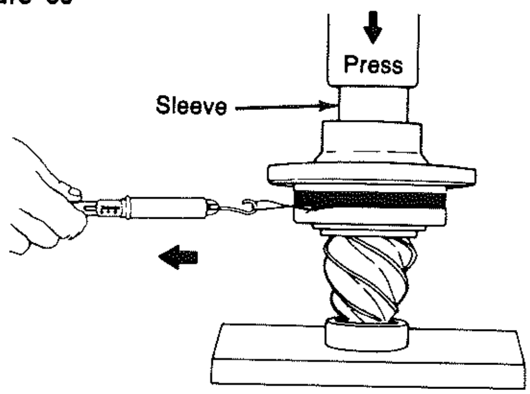
Press Method

NOTE:

If a press is not available, or the press does not have a pressure gauge, use the yoke or flange method to adjust preload. See page 33.

A. Put the drive pinion and cage assembly in a press, gear head (teeth) toward the bottom.

Figure 66



B. Install a sleeve of the correct size against the inner race of the outer bearing. **Figure 66.**

C. Apply and hold the correct amount pressure to the pinion bearings. See chart 1. As pressure is applied rotate the bearing cage several times so that bearings make normal contact.

D. While pressure is held against the assembly, wind a cord around the bearing cage several times.

E. Attach a spring scale to the end of the cord.

F. Pull the cord with scale on a horizontal line. As the bearing cage rotates, read the value indicated on scale. Make a note of reading. **Figure 66.**

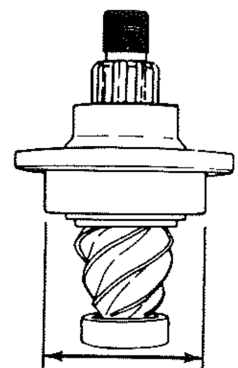
NOTE:

Do not read starting torque. Read only the torque value after the cage starts to rotate. Starting torque will give a false reading.

G. Measure the diameter of bearing cage where the cord was wound. Measure in inches or centimeters. **Figure 67.**

H. Divide the dimension in half to get the radius. Make a note of radius dimension.

Figure 67



I. Use the following procedure to calculate the bearing preload (torque).

Pounds pulled x Radius (inches) =
lb.-in. preload x .113 = N.m preload OR
Kilograms pulled x Radius (centimeters) =
kg-cm preload x .098 = N.m preload

Examples:
Reading from spring scale = 7.5 pounds (3.4 kg)
Diameter of bearing cage = 6.62 inches (16.8 cm)
Radius of bearing cage = 3.31 inches (8.4 cm)

7.5 lb. x 3.31 in. = 24.8 in.-lb. preload x .113 = 2.8 N.m preload OR
3.4 kg x 8.4 cm = 28.6 kg-cm preload x .098 = 2.8 N.m preload

J. If the preload (torque) of pinion bearings is not within specifications, do the following procedure then repeat steps A to I.

To increase preload, install a thinner bearing spacer. To decrease preload, install a thicker bearing spacer.

K. Check the bearing preload with the drive pinion and cage assembly installed in the carrier. Follow the procedures to adjust preload of pinion bearings, yoke or flange method.

CHART 1

Thread Size of Pinion Shaft	Press Pressure Needed on Bearings for Correct Preload. pounds/tons (kg/metric tons)	T Torque Value Needed on Pinion Nut for Correct Bearing Preload. lb.-ft. (N.m)
7/8"-20	22,000 / 11 (9979 / 10)	200-275 (271-373)
1"-20	30,000 / 15 (13608 / 13.6)	300-400 (407-542)
1 1/4"-12	54,000 / 27 (24494 / 24.5)	700-900 (949-1220)
1 1/4"-18	54,000 / 27 (24494 / 24.5)	700-900 (949-1220)
1 1/2"-12	54,000 / 27 (24494 / 24.5)	800-1100 (1085-1491)
1 1/2"-18	54,000 / 27 (24494 / 24.5)	800-1100 (1085-1491)
1 3/4"-12	50,000 / 25 (22680 / 22.7)	900-1200 (1220-1627)
2"-12	50,000 / 25 (22680 / 22.7)	1200-1500 (1627-2034)

Yoke or Flange Method

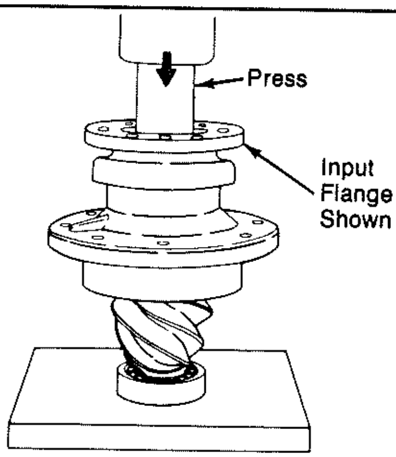
A. Install the input yoke or flange, nut and washer* on the drive pinion. The yoke or flange MUST be against the outer bearing.

NOTE:

If the fit between the yoke or flange splines and drive pinion splines are tight, use a press to install the yoke or flange. Figure 68.

If a press is not available, use the three piece pilot tool for installation. See the procedure on page 22.

Figure 68

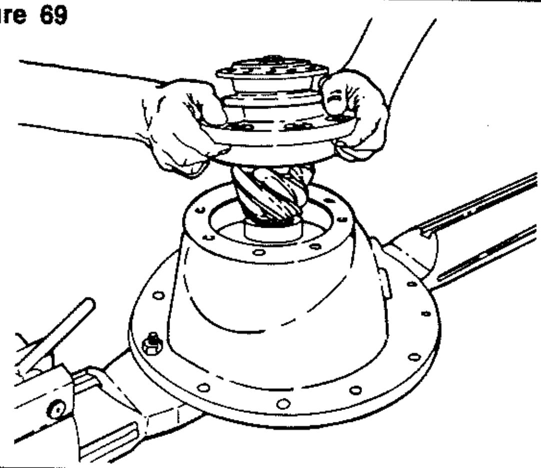


CAUTION:

Do not install tight fit yokes or flanges on shafts using a hammer or mallet. A hammer or mallet will damage the yoke or flange.

B. Temporarily install the drive pinion and cage assembly in the carrier. Do not install shims under the bearing cage. **Figure 69.**

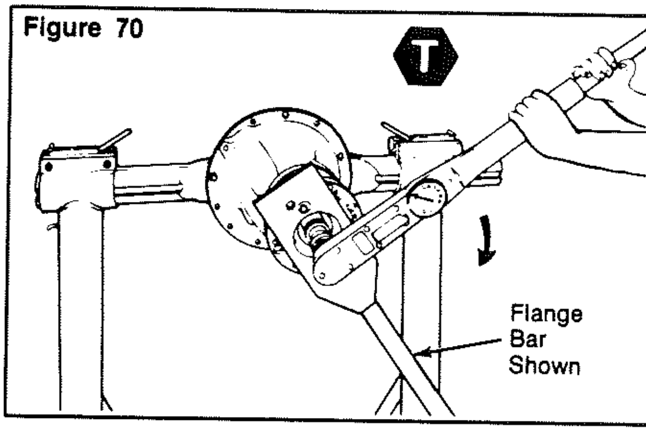
Figure 69



C. Install the bearing cage to carrier capscrews. Washers are not required at this time. Tighten the capscrews hand tight.

D. Fasten a yoke or flange bar to the input yoke or flange. The bar will hold the drive pinion in position when the nut is tightened. **Figure 70.**

Figure 70

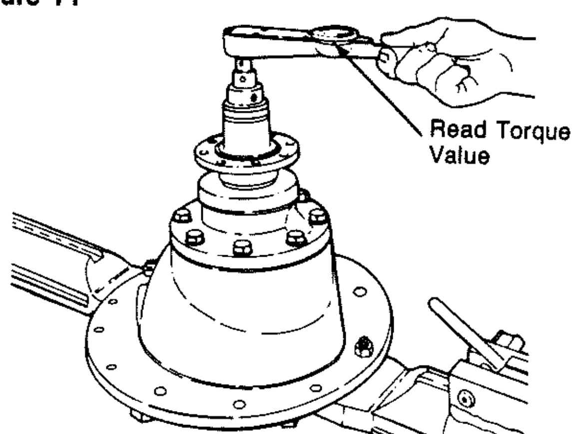


E. Tighten the nut on drive pinion to the correct torque value. **Figure 70.** T
See chart 1 on page 32.

F. Remove the yoke or flange bar.

G. Attach a torque wrench on the drive pinion nut. Rotate the drive pinion and read the value indicated on torque wrench. **Figure 71.**

Figure 71



**Some Rockwell carriers do not have the parts described.*

H. If the preload (torque) of pinion bearings is not within specifications, remove the pinion and cage assembly from carrier. Do the following procedure then repeat steps A to G.

To increase preload, install a thinner bearing spacer.

To decrease preload, install a thicker bearing spacer.

10. After adjusting preload of pinion bearings, remove the drive pinion and bearing cage from carrier. Follow steps 1 to 5 on page 10.

11. If the carrier has a cover and seal assembly over the bearing cage, install a new seal into cover as follows.

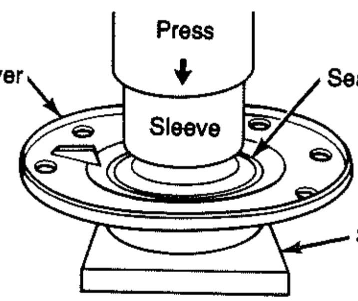
A. Apply Lubriplate or grease used for wheel bearings to the seal lips and cavities between lips. The Rockwell specification for grease is O-617-A, O-617-B or equivalent.

B. Apply a sealing compound on the outer diameter of seal.

C. Put the cover in a press, large diameter toward the top.

D. Support the cover under the small diameter opening with metal or wood blocks. **Figure 72.**

Figure 72



E. Press the seal into cover until seal is flat against the bottom of bore. Use a sleeve or seal driver of the correct size that fits against the metal retainer of seal. **Figure 72.**

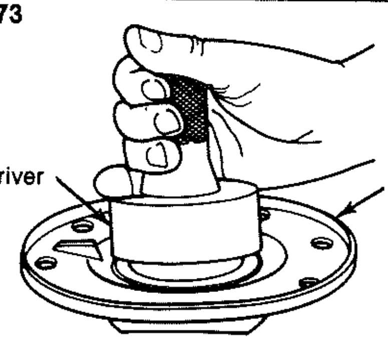
NOTE:

***If a press is not available, use a mallet and the sleeve or driver to install the seal.* Figure 73.**

WARNING:

Wear safe eye protection. Do not hit steel parts or tools with a steel hammer. Parts or tools can break and cause injury.

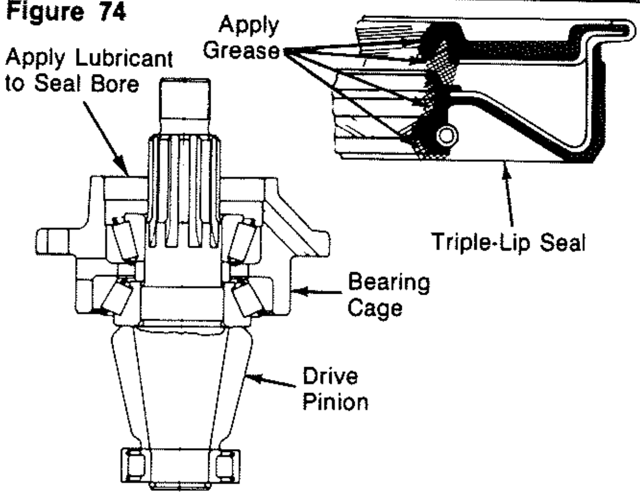
Figure 73



12. If the pinion seal mounts directly into the bearing cage, install a new triple-lip seal as follows.

A. The old triple-lip seal can be installed into the bearing cage if the seal is not worn or damaged. See page 12.

Figure 74



B. Apply the same lubricant used in the axle housing to the outer surface of the seal and the seal bore in the bearing cage. **Figure 74.**

CAUTION:

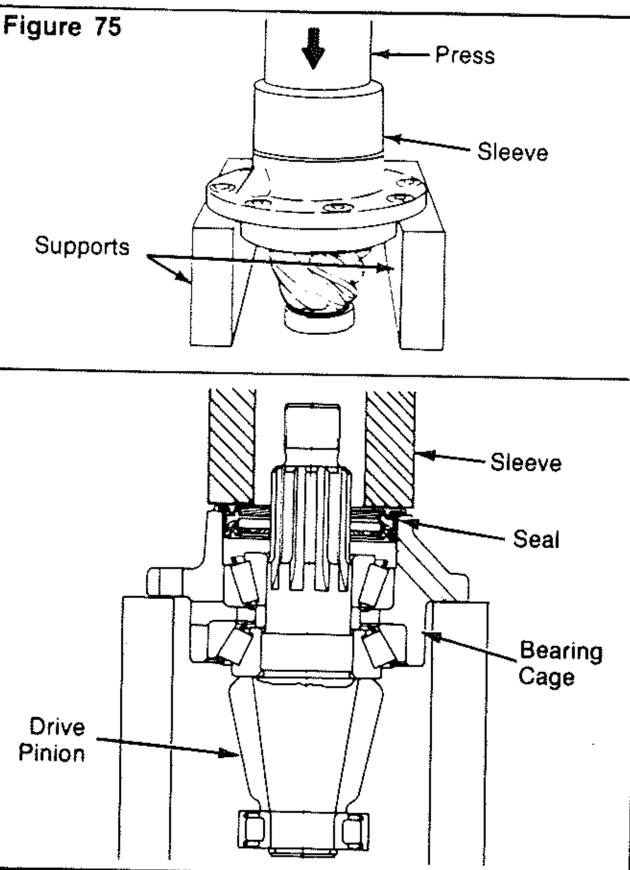
Make sure that the seal lips are clean and free from dirt and particles that will cause a leak between the yoke and the seal.

C. On reused seals, apply Lubriplate or wheel bearing grease to the seal lips.

D. Put the drive pinion and cage assembly in a press, seal bore toward the top.

E. Press the seal into bearing cage until flange of seal is flat against the top of bearing cage. Use a sleeve or seal driver of the correct size that fits against the metal flange of seal. The diameter of the sleeve or driver MUST be larger than the diameter of the flange. **Figure 75.**

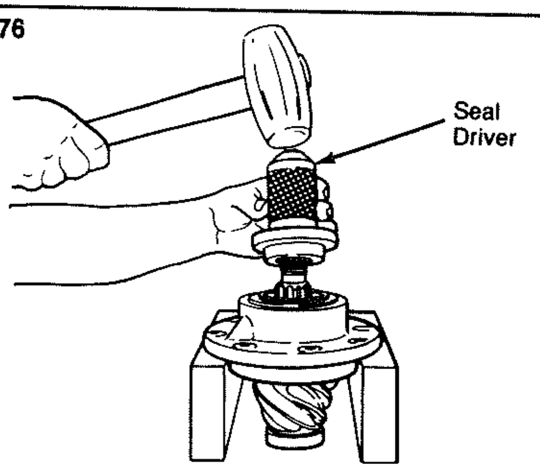
Figure 75



NOTE:

If a press is not available, use a mallet and the sleeve or driver to install the seal. Figure 76.

Figure 76

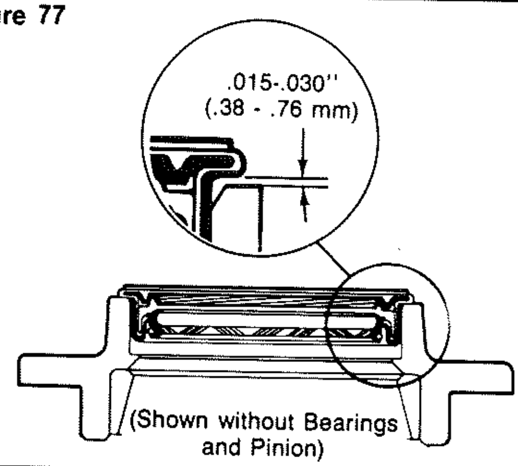


WARNING:

Wear safe eye protection. Do not hit steel parts or tools with a steel hammer. Parts or tools can break and cause injury.

F. After the triple-lip seal is installed, a gap of approximately .015 to .030 inch (.38 to .76 mm) between the flange and bearing cage is normal. **Figure 77.**

Figure 77



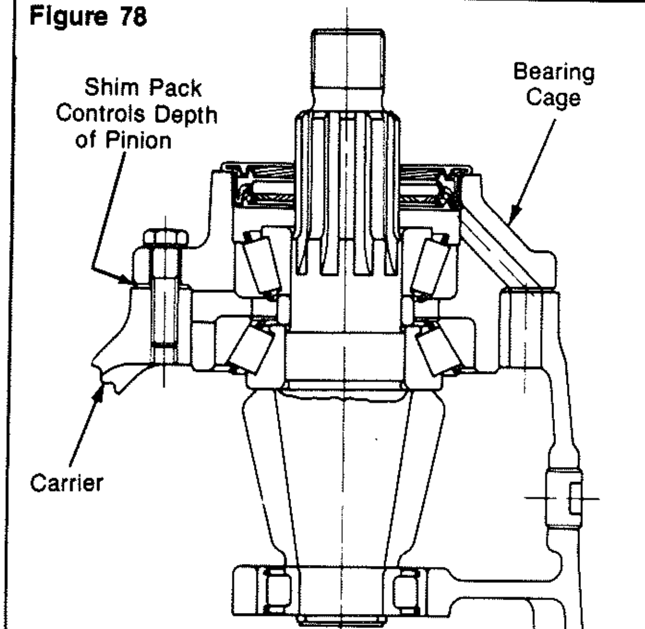
Check the gap with a feeler gauge at several points around the seal. The gap must be within .015 to .030 inch (.38 to .76 mm). The difference between the largest and smallest gap measurement MUST NOT exceed .010 inch.

Adjust Thickness of Shim Pack for the Pinion Cage (Depth of Pinion)

NOTE:

Use this procedure if a new drive pinion and ring gear set is installed, or if the depth of the drive pinion has to be adjusted. Figure 78.

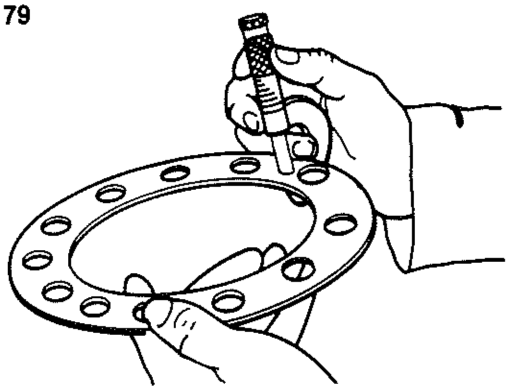
Figure 78



section 5 Assembly

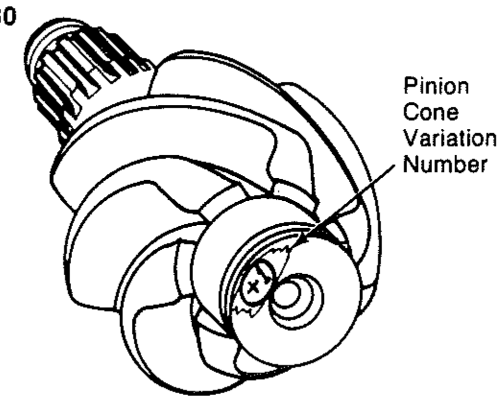
1. Measure the thickness of the old shim pack that was removed from under the pinion cage with a micrometer. Record the measurement for later use. **Figure 79.**

Figure 79



2. Look at the pinion cone ("PC") variation number on the old drive pinion that is being replaced. See Gear Set Information, step 4 on page 25 for examples and location of the number. Record the number for later use. If ("PC") variation number cannot be located, assemble gear set with shim pack thickness found in step 1. **Figure 80.**

Figure 80



NOTE:

The pinion cone number can be either 1,000ths of an inch or 100ths of a millimeter. See the following examples.

PC+3, PC-3, +3 or -3 equal .003 inch.
PC+.03, PC-.03 mm, +.03 mm or -.03 equal .03 mm

To change inches to millimeters, multiply inches by 25.40
To change millimeters to inches, multiply millimeters by 0.039

3. If the old pinion cone number is a plus (+), subtract the number from the old shim pack thickness that was measured in step 2.
4. If the old pinion cone number is a minus (-), add the number to the old shim pack thickness that was measured in step 2.

NOTE:

The value calculated in step 3 or 4 is the thickness of the standard shim pack, without a variation.

5. Look at the pinion cone ("PC") variation number on the new drive pinion that will be installed. Record the number for later use.
6. If the new pinion cone number is a plus (+), add the number to the standard shim pack thickness that was calculated in step 3 or 4.
7. If the new pinion cone number is a minus (-), subtract the number from the standard shim pack thickness that was calculated in step 3 or 4.

NOTE:

The value calculated in step 6 or 7 is the thickness of the new shim pack that will be installed. See the following examples, Chart 2.

Chart 2

Examples:	Inches	mm
1. Old Shim Pack Thickness	.030	.76
Old PC Number, PC+2(+.05 mm)	- .002	- .05
Standard Shim Pack Thickness	.028	.71
New PC Number, PC+5(+.13 mm)	+ .005	+ .13
New Shim Pack Thickness	.033	.84
2. Old Shim Pack Thickness	.030	.76
Old PC Number, PC-2 (-.05 mm)	+ .002	+ .05
Standard Shim Pack Thickness	.032	.81
New PC Number, PC+5(+.13 mm)	+ .005	+ .13
New Shim Pack Thickness	.037	.94
3. Old Shim Pack Thickness	.030	.76
Old PC Number, PC+2(+.05 mm)	- .002	- .05
Standard Shim Pack Thickness	.028	.71
New PC Number, PC-5 (-.13 mm)	- .005	- .13
New Shim Pack Thickness	.023	.58
4. Old Shim Pack Thickness	.030	.76
Old PC Number, PC-2 (-.05 mm)	+ .002	+ .05
Standard Shim Pack Thickness	.032	.81
New PC Number, PC-5 (-.13 mm)	- .005	- .13
New Shim Pack Thickness	.027	.68

IMPORTANT: Remember, that Rockwell drive pinions and ring gears MUST be replaced as matched sets.

8. Install the drive pinion, bearing cage and new shim pack into the carrier.

Install the Drive Pinion, Bearing Cage and Shim Pack into the Carrier

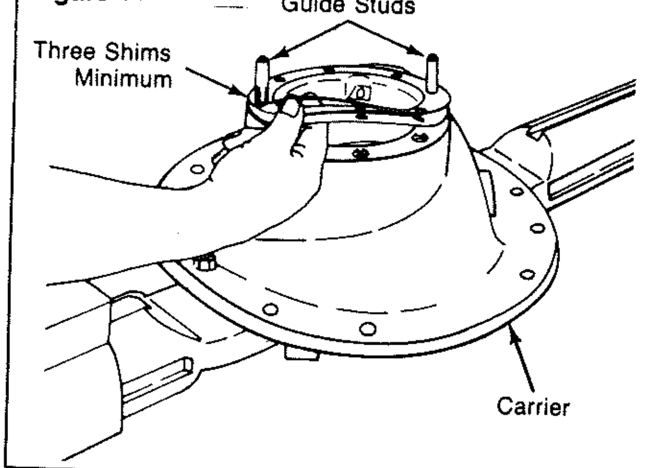
NOTE:

If a new drive pinion and ring gear set is installed, or if the depth of the drive pinion has to be adjusted, calculate the thickness of the shim pack. See the procedure to Adjust Thickness Of Shim Pack For The Pinion Cage on page 35.

1. Install the correct shim pack between the bearing cage and carrier. **Figure 81.**

2. Align the oil slots in the shims with oil slots in the bearing cage and carrier. The use of guide studs will help align the shims. **Figure 81.**

Figure 81

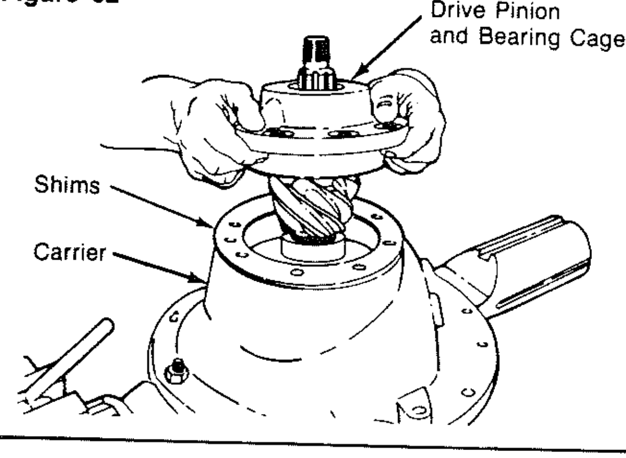


NOTE:

Use a minimum of three shims in a pack. If the pack is made from different thickness shims, install the thinnest shims on both sides of the pack for maximum sealing.

3. Install the drive pinion and bearing cage into the carrier. If necessary, use a rubber, plastic or leather mallet to hit the assembly into position. **Figure 82.**

Figure 82

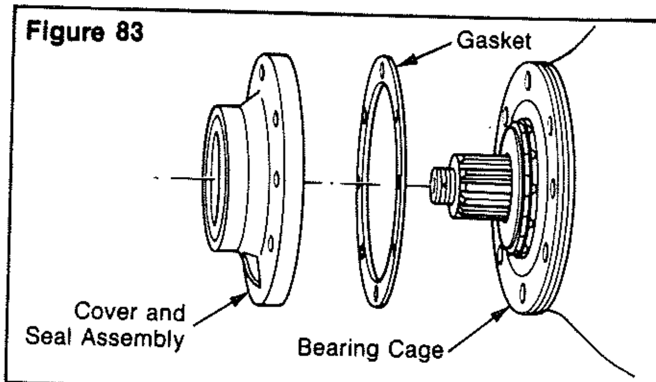


WARNING:

Wear safe eye protection. Do not hit steel parts with a steel hammer. Parts can break and cause injury.

4. If used, install the cover* and seal assembly and gasket* over the bearing cage. **Figure 83.**

Figure 83

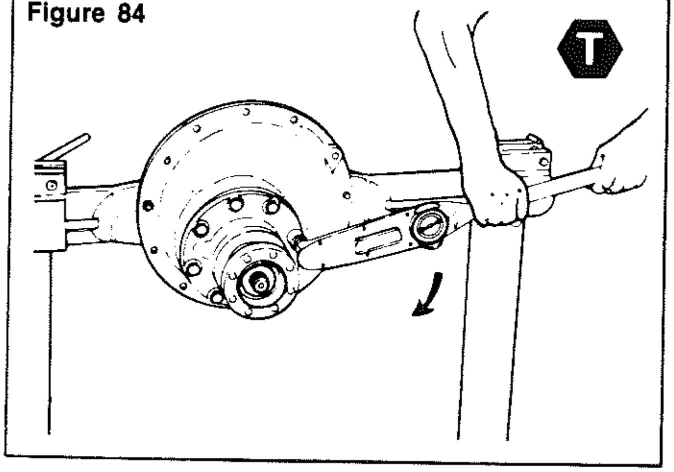


5. Align the oil slots in the cover* and gasket* with oil slot in the bearing cage.

**Some Rockwell carriers do not have the parts described.*

6. Install the bearing cage to carrier capscrews and washers. Tighten capscrews to correct torque value. See the torque chart on page 65. **Figure 84.** T

Figure 84



7. Install the input yoke or flange, nut and washer* on the drive pinion. The yoke or flange MUST be against the outer bearing.

NOTE:

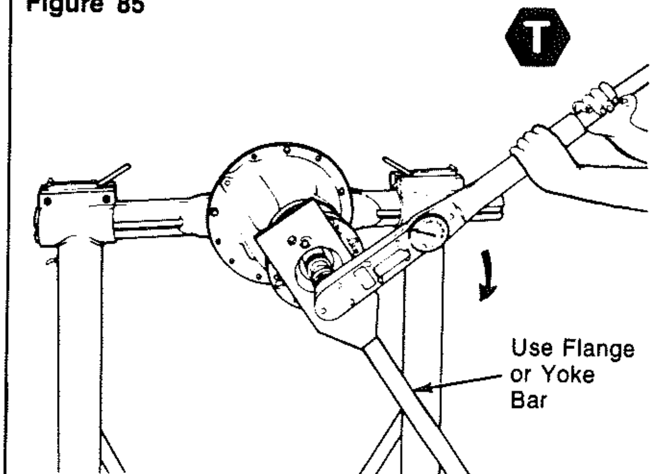
If the fit between the yoke or flange splines and drive pinion splines is tight, use the three-piece pilot tool for installation. See the procedure on page 22.

CAUTION:

Do not install tight fit yokes or flanges on shafts using a hammer or mallet. A hammer or mallet will damage the yoke or flange.

8. Tighten the pinion nut to the correct torque value. See the torque chart on page 65. **Figure 85.** T

Figure 85



Assemble the Main Differential and Ring Gear Assembly

CAUTION:

Do not press a cold ring gear on the flange case half. A cold ring gear will damage the case half because of the tight fit. Metal particles between the parts will cause gear runout that exceeds the Rockwell specification of .008 inch (0.2 mm)

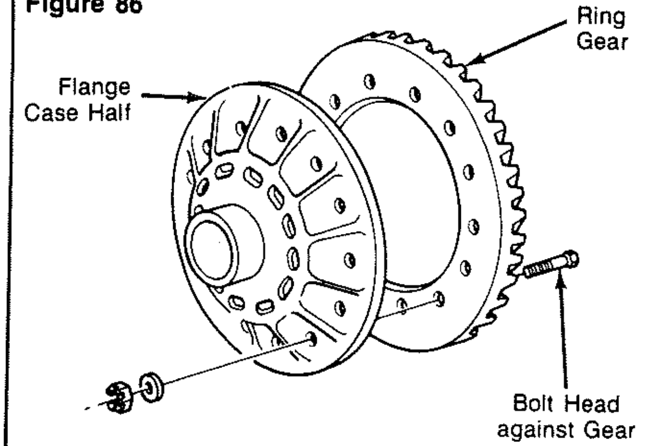
1. Expand the ring gear by heating the gear in a tank of water to a temperature of 160°F to 180°F (71°C to 82°C) for 10 to 15 minutes.

WARNING:

Wear safe clothing and gloves that will protect you from injury when you touch the hot ring gear.

2. Safely lift the ring gear from the tank of water using a lifting tool.
3. Install the ring gear on the flange case half immediately after the gear is heated. If the ring gear does not fit easily on the case half, heat the gear again. Repeat step 1.
4. Align fastener holes of the ring gear and flange case half. Rotate the ring gear as needed.
5. Install the bolts*, nuts* and washers* that hold the ring gear to the flange case half. Install the bolts from the gear side of the assembly. The bolt heads MUST be against the ring gear. **Figure 86.**

Figure 86



6. Tighten the bolts* and nuts* to the correct torque value. See the torque chart on page 65. T
7. If rivets* are used to hold the ring gear to the flange case half, install the rivets* as follows:

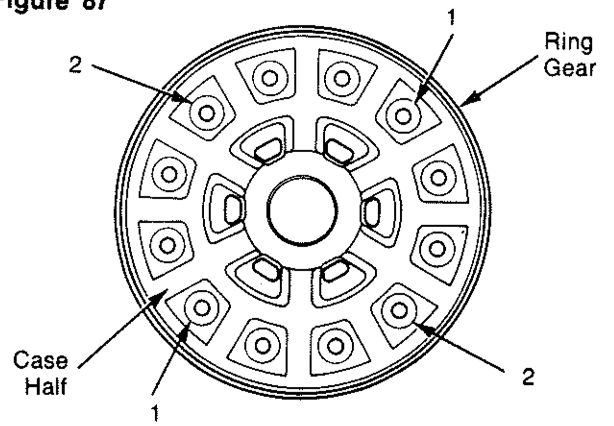
Some Rockwell carriers do not have the parts described.

CAUTION:

Do not heat rivets before installation. Use only cold rivets to fasten the ring gear correctly on the flange case half.

A. Install the correct size rivets* in pairs opposite each other from the case half side of the assembly. The rivet* heads MUST be against the flange case half. **Figure 87.**

Figure 87



B. Press the rivets* into position from the ring gear side of the assembly. Use a riveter machine and apply the correct amount of pressure. See Chart 3 for rivet pressures.

Chart 3

Diameter of Rivet Body	Press Pressure Needed to Install Rivets	
Inch (mm)	**pounds / tons**	**kilograms / metric tons**
.438 (11.13)	44,000 / 22	19958 / 20
.500 (12.70)	60,000 / 30	27216 / 27.2
.563 (14.30)	72,000 / 36	32659 / 32.7
.625 (15.88)	90,000 / 45	40824 / 40.8

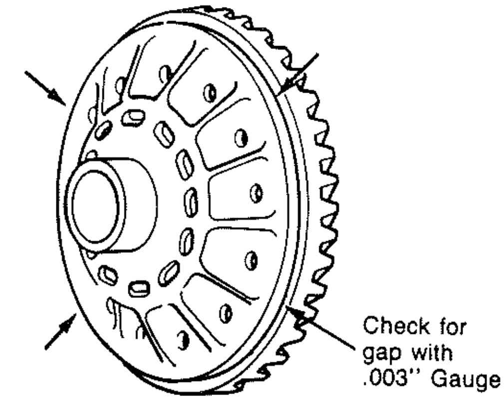
CAUTION:

The pressure on rivets must be held for approximately one minute so that the rivet body will fill the hole.

C. After the rivets are installed, check for gaps between the back surface of the ring gear and the case flange. Use a .003 inch (.08 mm) feeler gauge and check at four points around the assembly. **Figure 88.**

If the gauge fits more than one half the distance between the outer diameter of the flange and the pilot diameter of the gear, remove the ring gear. See the procedure on page 9 and the following steps D and E. If the gap is less than .003 inch (.08 mm), continue by following step 8.

Figure 88

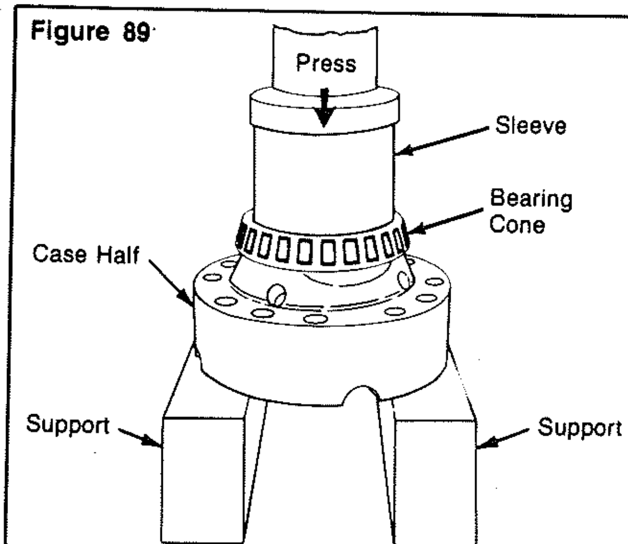


D. Check the flange case half and ring gear for the problem that causes the gap. Repair or replace parts.

E. After the parts are repaired or replaced, assemble the ring gear on the flange case half. Repeat the procedure on page 38, and steps A to C on this page.

8. Install the bearing cones on both of the case halves. Use a press and sleeve of the correct size. **Figure 89.**

Figure 89



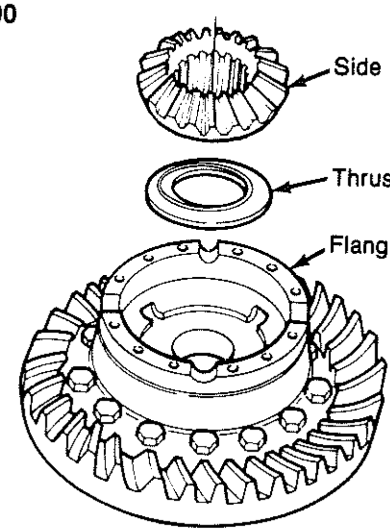
9. Apply axle lubricant on the inside surfaces of both case halves, spider (cross), thrust washers, side gears and differential pinions.

10. Put the flange case half on a bench, ring gear teeth toward top.

**Some Rockwell carriers do not have the parts described.*

11. Install one thrust washer and side gear into the flange case half. **Figure 90.**

Figure 90

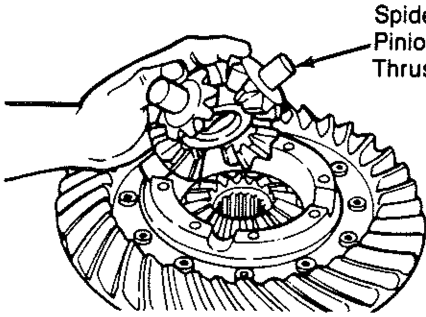


CAUTION:

The side gears in some carrier models have hubs of different lengths. Install the correct length side gear into the flange case half.

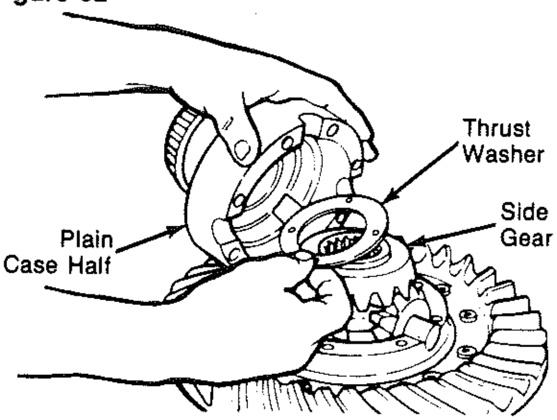
12. Install the spider (cross), differential pinions and thrust washers into the flange case half. **Figure 91.**

Figure 91



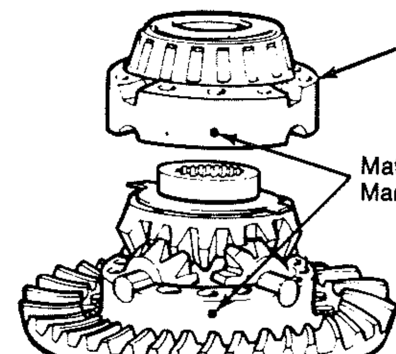
13. Install the second side gear and thrust washer over spider and differential pinions. **Figure 92.**

Figure 92



14. Put the plain half of the differential case over the flange half and gears. Rotate the plain half as needed to align the match marks. **Figure 92 and 93.**

Figure 93

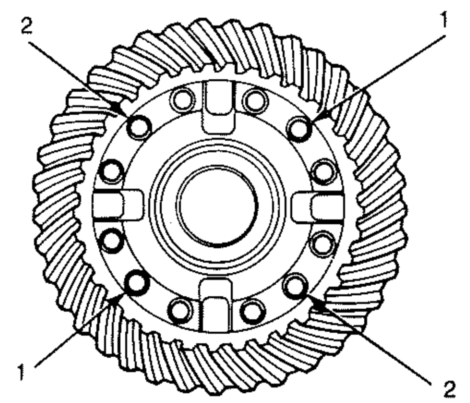


15. Install Dri-Loc fasteners into the case halves. See the procedures on page 20 and the following steps A and B.

   A. Install four capscrews* and washers* or bolts*, nuts* and washers* into the case halves. The distance between the fasteners MUST be equal. Tighten the fastners to the correct torque value in a pattern opposite each other. **Figure 94** and see torque chart on page 65. T

**Some Rockwell carriers do not have the parts described.*

Figure 94



B. Install the other fasteners into the case halves. Tighten the fasteners to the correct torque value. See the torque chart on page 65. T

16. Check the rotating resistance of the differential gears. Use the following procedure.

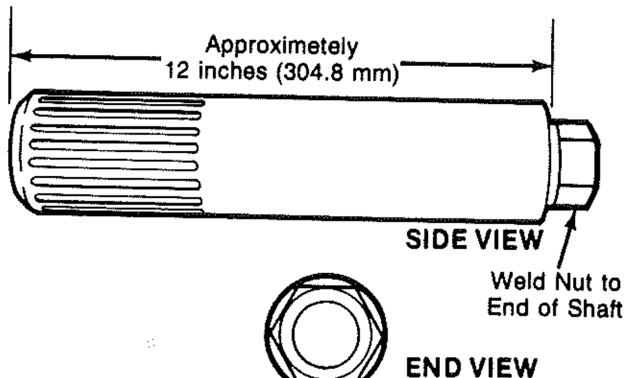
Rotating Resistance Check of Differential Gears

Specification:
50 lb.-ft. (67.8 N.m) torque maximum applied to one side gear.

NOTE:

Make a tool for checking the rotating resistance of the differential gears. The tool can be made from an axle shaft that matches the spline size of the differential side gear. See Figure 95.

Figure 95

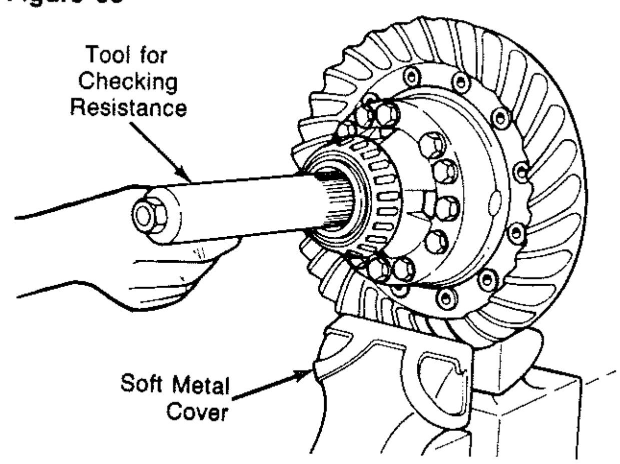


A. Install soft metal covers over vise jaws to protect the ring gear. **Figure 96.**

B. Put the differential and ring gear assembly in the vise.

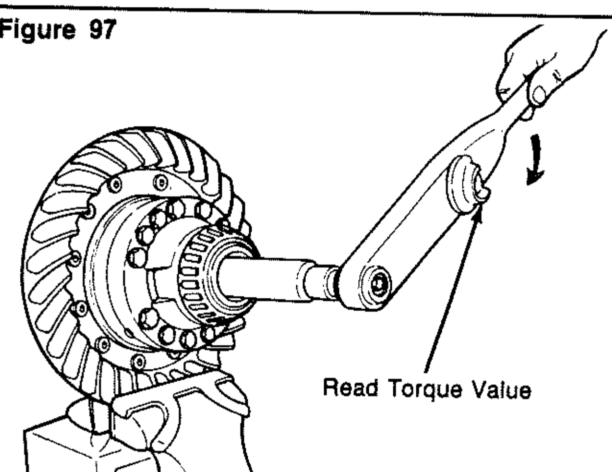
C. Install the tool into the differential until the splines of the tool and one side gear are engaged. **Figure 96.**

Figure 96



D. Attach a torque wrench to the nut of the tool and rotate the differential gears. As the differential gears rotate, read the value indicated on the torque wrench. **Figure 97.**

Figure 97



E. If the torque value exceeds the specification, disassemble the differential gears from the case halves.

F. Check the case halves, spider, gears and thrust washers for the problem that causes the torque value to exceed the specification. Repair or replace parts.

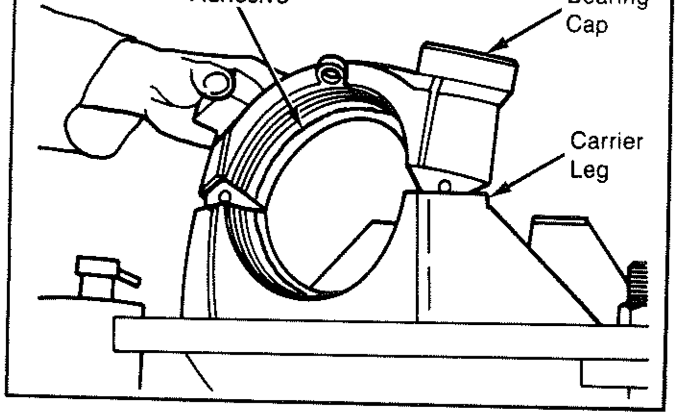
17. After the parts are repaired or replaced, assemble the parts and repeat steps A to F.

**Some Rockwell carriers do not have the parts described.*

Install the Differential and Ring Gear Assembly

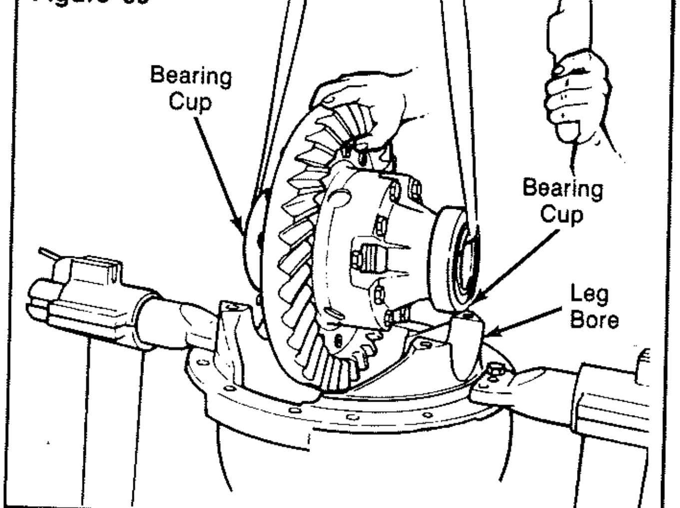
1. Clean and dry the bearing cups and bores of the carrier legs and bearing caps.
2. Apply axle lubricant on the inner diameter of the bearing cups and on both bearing cones that are assembled on the case halves.
3. Apply Rockwell Adhesive in the bearing bores of the carrier legs and bearing caps. See the procedure on page 21. **Figure 98.**

Figure 98



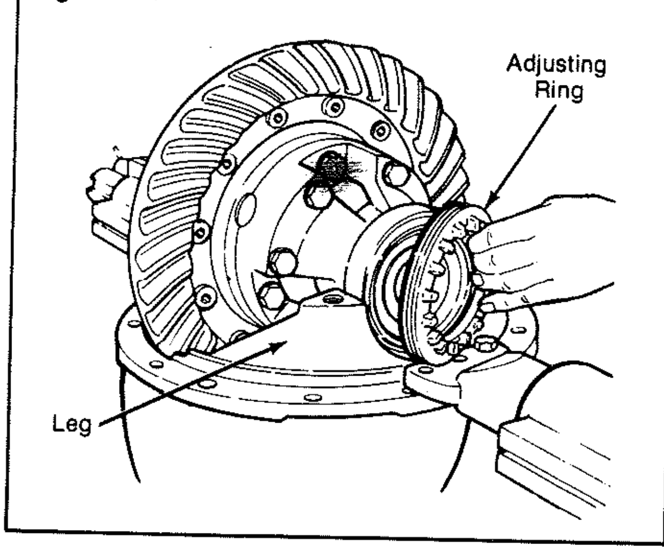
4. Install the bearing cups over the bearing cones that are assembled on the case halves. **Figure 99.**

Figure 99



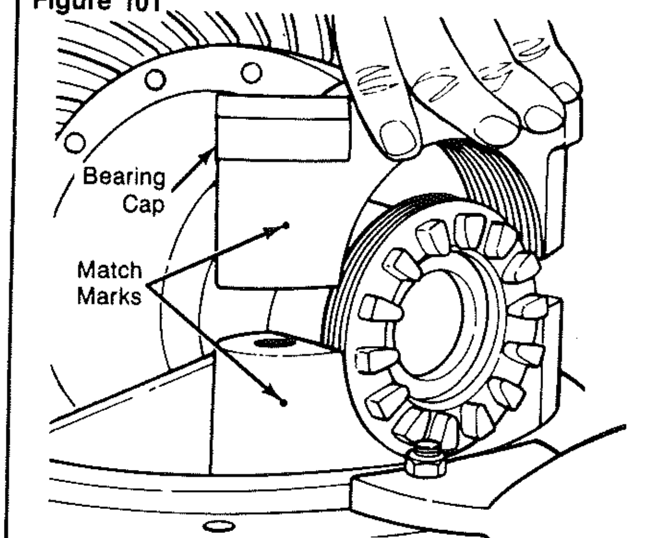
5. Safely lift the differential and ring gear assembly and install into the carrier. The bearing cups MUST be flat against the bores between the carrier legs. **Figure 99.**
6. Install both of the bearing adjusting rings into position between the carrier legs. Turn each adjusting ring hand tight against the bearing cup. **Figure 100.**

Figure 100



7. Install the bearing caps over the bearings and adjusting rings in the correct location as marked before removal. **Figure 101.**

Figure 101



WARNING:

Wear safe eye protection. Do not hit steel parts with a steel hammer. Parts can break and cause injury.

8. Hit each bearing cap into position with a light leather, plastic or rubber mallet. The caps MUST fit easily against the bearings, adjusting rings and carrier. DO NOT FORCE THE BEARING CAPS INTO POSITION.

CAUTION:

If bearing caps are not installed in correct locations, the bores and threads in caps will not match the carrier. You will have problems assembling the caps on the carrier and damage to parts can occur. Do not force the bearing caps into position.

9. If bearing caps do not correctly fit into position, check the alignment of match marks between caps and carrier. Remove the caps and repeat steps 6 to 8.

10. Install the capscrews and washers that hold bearing caps to the carrier. Tighten the capscrews by hand four to six turns, then tighten the capscrews to the correct torque value. See the torque chart on page 65. T

NOTE:

Do not install the cotter keys*, pins* or lock plates* that hold the bearing adjusting rings in position. Continue by adjusting the preload of differential bearings, adjust backlash of the hypoid gear and check tooth contact patterns.

Adjust Preload of Differential Bearings

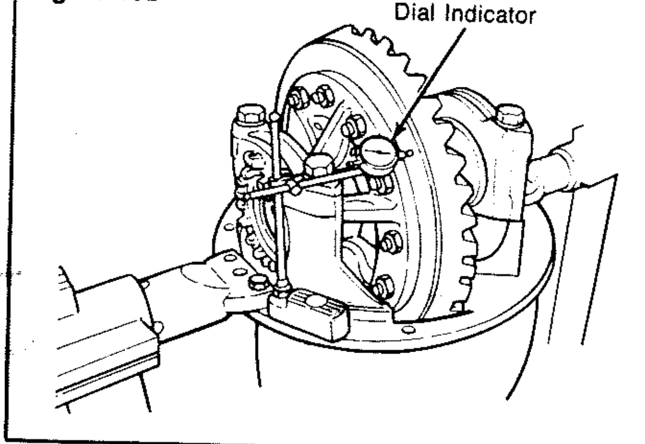
Specifications:
Preload of differential bearings - all carrier models - 15 to 35 lb.-in. (1.7 to 3.9 N.m) torque.
or
Expansion between bearing caps -
RS-140 and RS-145 carrier models - .003 to .009 inch (.08 to .22 mm)
All other carrier models - .006 to .013 inch (.15 to .33 mm)

Method 1.

1. Attach a dial indicator on the mounting flange of the carrier.

2. Adjust the dial indicator so that the plunger or pointer is against the back surface of the ring gear. **Figure 102.**

Figure 102

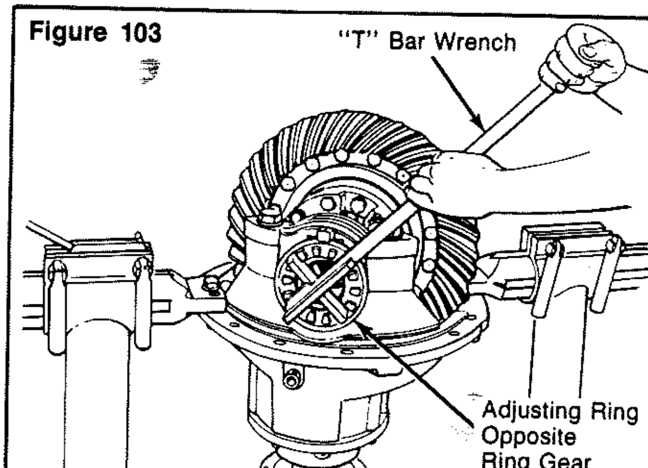


CAUTION:

When you turn the adjusting rings, always use a tool that engages two or more opposite notches in the ring. A "T" bar wrench can be used for this purpose. If the tool does not correctly fit into the notches, damage to the lugs will occur. **Figure 103.**

3. Loosen the bearing adjusting ring that is opposite the ring gear so that a small amount of end play shows on the dial indicator. **Figure 103.** Move the differential and ring gear to the left and right with pry bars while you read the dial indicator. Use the following step A or B.

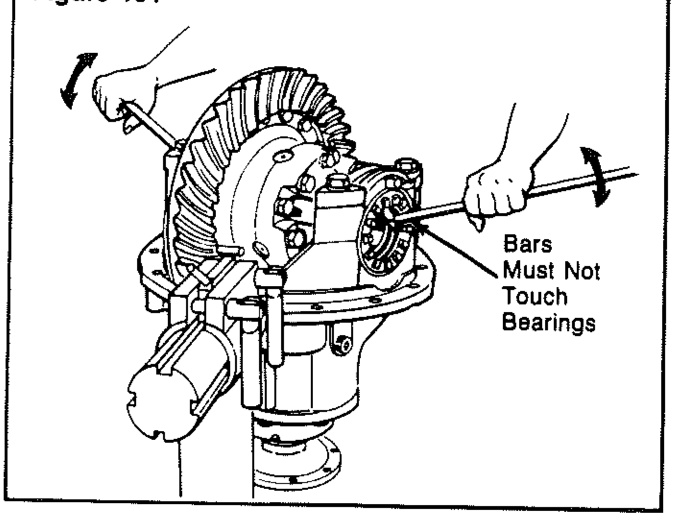
Figure 103



**Some Rockwell carriers do not have the parts described.*

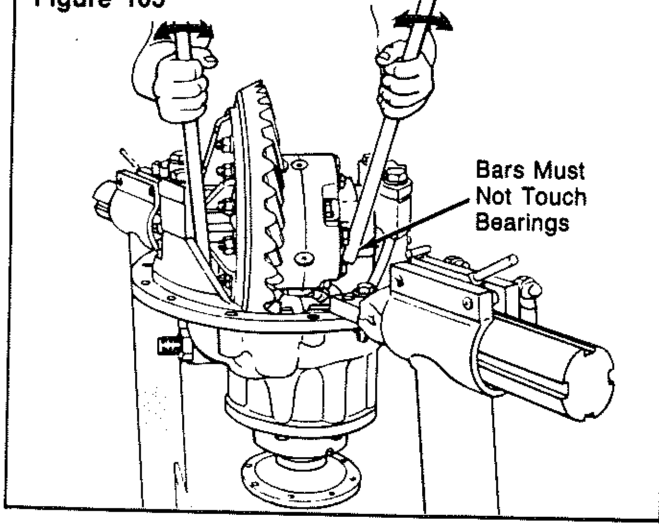
A. Use two pry bars that fit between the bearing adjusting rings and ends of the differential case. The pry bars MUST NOT touch the differential bearings. **Figure 104.**

Figure 104



B. Use two pry bars between the differential case or ring gear and the carrier at locations other than described in step A. The pry bars MUST NOT touch the differential bearings. **Figure 105.**

Figure 105



4. Tighten the same bearing adjusting ring so that no end play shows on the dial indicator. Move the differential and ring gear to the left and right as needed. Repeat step A or B.

5. Tighten each bearing adjusting ring one notch from the zero end play measured in step 4.

6. Continue by checking runout of the ring gear.

Method 2.

A second method of checking preload is to measure the expansion between the bearing caps after you tighten the adjusting rings. Use the following procedure.

1. Turn both adjusting rings hand tight against the differential bearings.

2. Measure the distance X or Y between opposite surfaces of the bearing caps. Use a large micrometer of the correct size. **Figures 106 and 107.** Make a note of the measurement.

Figure 106

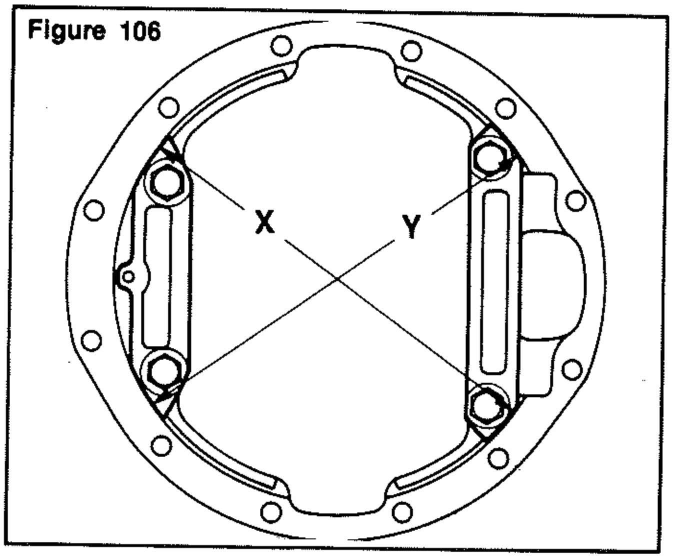
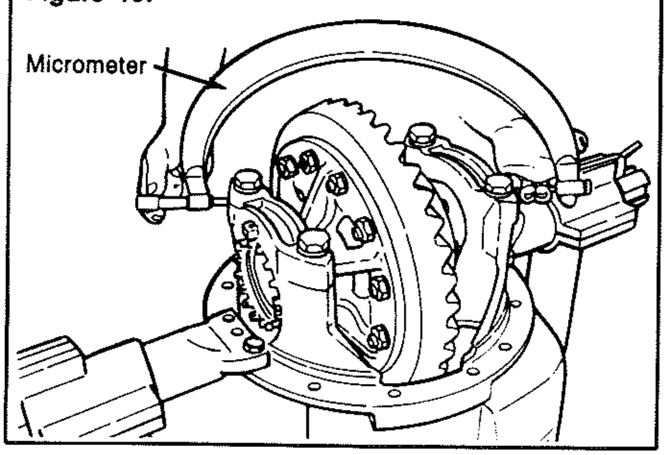


Figure 107



3. Tighten each bearing adjusting ring one notch.

4. Measure the distance X or Y again. Compare the dimension with the distance X or Y measured in step 2. The difference between the two dimensions is the amount the bearing caps have expanded.

Example: Measurements of a Q-100 carrier.

Distance X or Y before tightening adjusting rings = 15.315 inch (389.00 mm).
Distance X or Y after tightening adjusting rings = 15.324 inch (389.23 mm)

15.324 inch - 15.315 inch = .009 inch (.23 mm) difference.

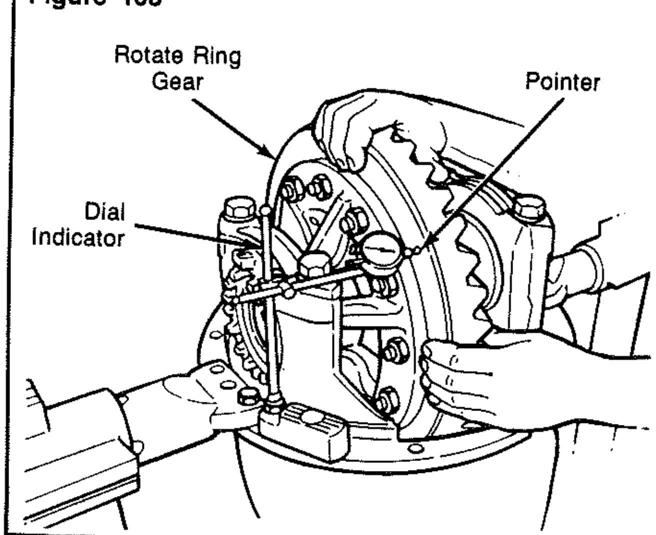
If the dimension is within specifications, continue by checking runout of the ring gear. If the dimension is less than specifications, repeat step 3 and 4 as needed.

Check Runout of Ring Gear

Specification:
.008 inch (.20 mm)

1. Attach a dial indicator on the mounting flange of the carrier. **Figure 108.**

Figure 108



2. Adjust the dial indicator so that the plunger or pointer is against the back surface of the ring gear.

3. Adjust the dial of the indicator to zero (0).

4. Rotate the differential and ring gear while you read the dial indicator. The runout of the ring gear MUST NOT EXCEED .008 inch (.20 mm). **Figure 108.**

If runout of the ring gear exceeds specifications, remove the differential and ring gear assembly from the carrier. See the procedure on page 5 and the following steps 5 and 6.

5. Check the differential parts including the carrier for the problem that causes the runout of gear to exceed specifications. Repair or replace parts.

6. After the parts are repaired or replaced, install the differential and ring gear into the carrier. See the procedure on page 42.

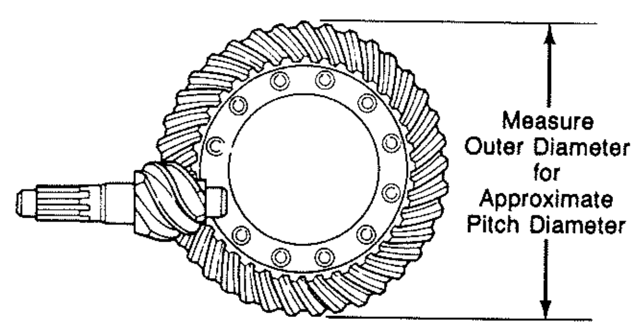
7. Repeat preload adjustment of differential bearings.

Adjust Backlash of the Ring Gear

Specifications:
Ring gears that have a pitch diameter of less than 17 inches (431.8 mm).
Range of backlash setting - .008 to .018 inch (.20 to .46 mm).
Backlash setting for new gear sets - .012 inch (.30 mm).

Ring gears that have a pitch diameter of 17 inches (431.8 mm) or greater than 17 inches.
Range of backlash setting - .010 to .020 inch (.25 to .51 mm)
Backlash setting for new gear sets - .015 inch (.38 mm)

Figure 109



NOTE:

***Measure the outer diameter of ring gear for approximate pitch diameter.* Figure 109.**

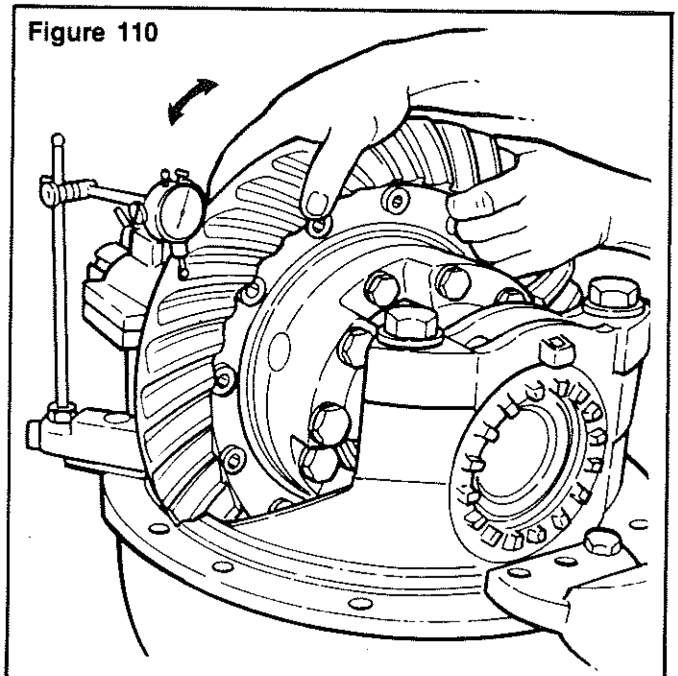
If the old gear set is installed, adjust the backlash to the setting that was measured before the carrier was disassembled.

If a new gear set is installed, adjust the backlash to the correct specification for new gear sets.

During the check of tooth contact patterns, the backlash can be adjusted within specification limits, if needed, to change the location of the pattern.

1. Attach a dial indicator on the mounting flange of the carrier. **Figure 110.**

Figure 110

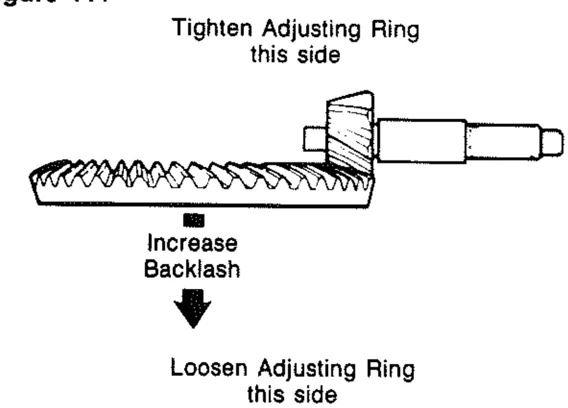


2. Adjust the dial indicator so that the plunger or pointer is against the tooth surface. **Figure 110.**
3. Adjust the dial of the indicator to zero (0).
4. Hold the drive pinion in position.
5. While you read the dial indicator, rotate the differential and ring gear a small amount in both directions, against teeth of the drive pinion. If the backlash reading is within specification, continue by checking tooth contact patterns. If the backlash reading is not within specifications, adjust backlash as needed. Continue by following steps 6 and 7.

NOTE:

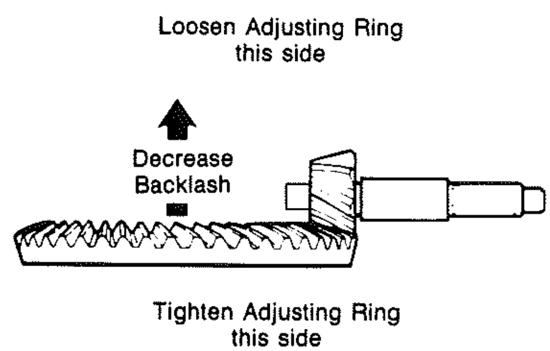
Backlash is increased by moving the ring gear away from the drive pinion. **Figure 111.**
Backlash is decreased by moving the ring gear toward the drive pinion. **Figure 112.**

Figure 111



6. Loosen one bearing adjusting ring one notch then tighten the opposite ring the same amount. **See Figures 111 and 112.**

Figure 112



NOTE:

When you adjust backlash, move the ring gear ONLY. DO NOT move the drive pinion.

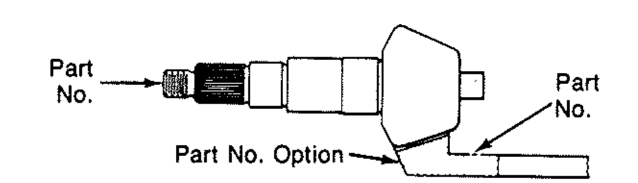
7. Repeat steps 2 to 6 until the backlash is within specifications.

Check Tooth Contact Patterns of the Gear Set

General Information

Rockwell carriers can have a conventional hypoid gear set or a GENEROID hypoid gear set. The tooth contact patterns for each type of gear set are different. Look at the part numbers to see what type of gear set is in the carrier. See **Figure 113** for the location of part numbers.

Figure 113

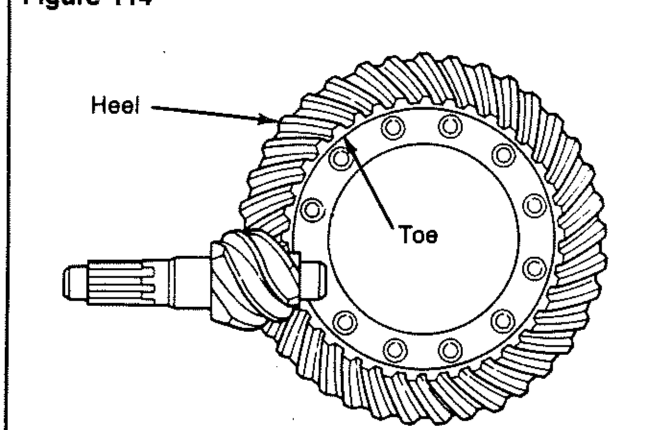


Examples of part numbers for conventional gear sets.
36786 for the ring gear.
36787 for the drive pinion.

Examples of part numbers for GENEROID gear sets.
36786-K or 36786-K2 for the ring gear.
36787-K or 36787-K2 for the drive pinion.

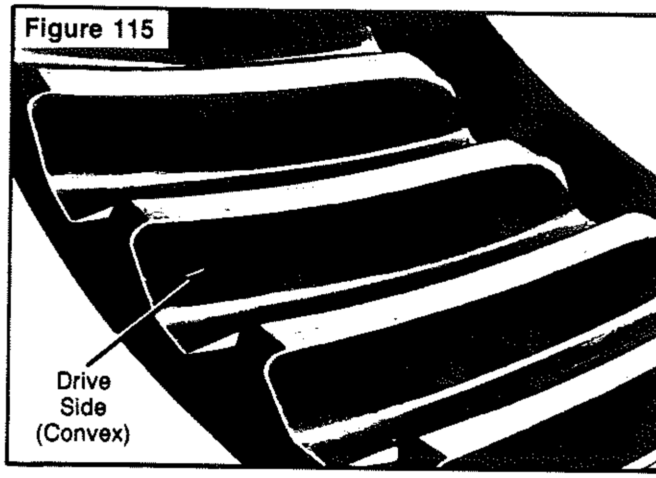
In the following procedures, movement of the contact pattern in the length of the tooth is indicated as, toward the "heel' or "toe" of the ring gear. **Figure 114.**

Figure 114



Always check tooth contact patterns on the drive side of the gear teeth. **Figure 115.**

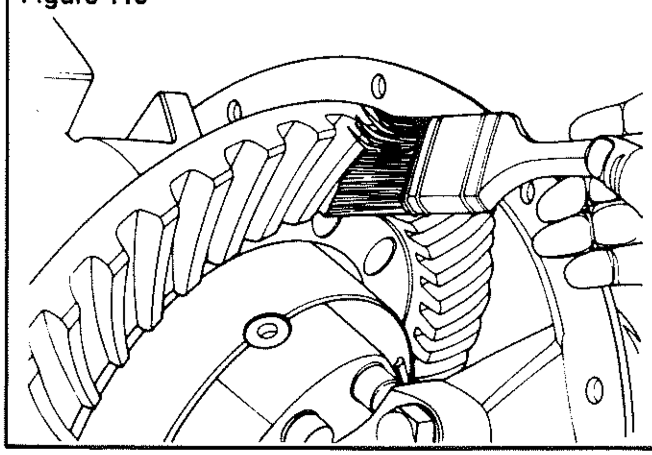
Figure 115



Tooth Contact Patterns of Conventional Hypoid and Generoid Hypoid Gear Sets

1. Adjust the backlash of a new gear set to either .012 inch (.30 mm) or .015 inch (.38 mm) depending on the size of the ring gear. Adjust the backlash of an old gear set to the setting that was measured before the carrier was disassembled. See the procedure on page 45.
2. Apply a marking compound to approximately 12 gear teeth of the ring gear. Rotate the ring gear so that the 12 gear teeth are next to the drive pinion. **Figure 116.**

Figure 116



3. Rotate ring gear forward and backward so that the 12 gear teeth go past the drive pinion six times to get the contact patterns. Repeat if needed to get a more clear pattern.

Conventional Gears

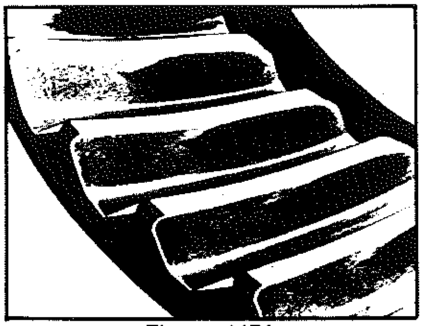


Figure 117A
Good Hand Rolled Pattern

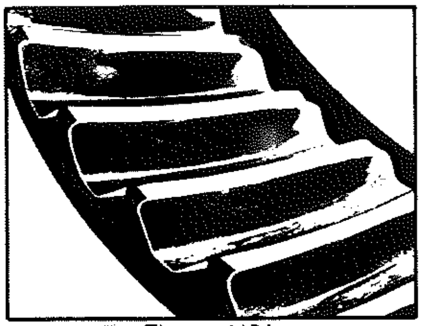


Figure 118A
High Pattern

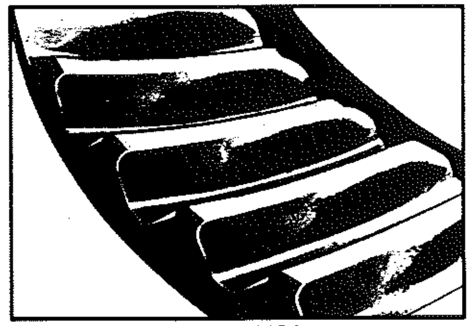


Figure 119A
Low Pattern

Generoid Gears

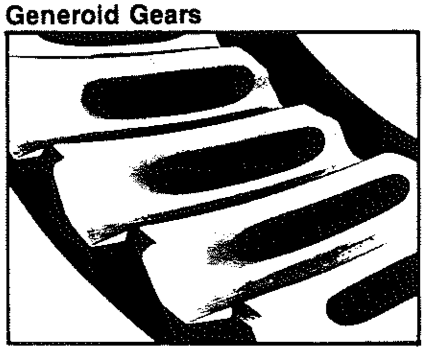


Figure 117B
Good Hand Rolled Pattern

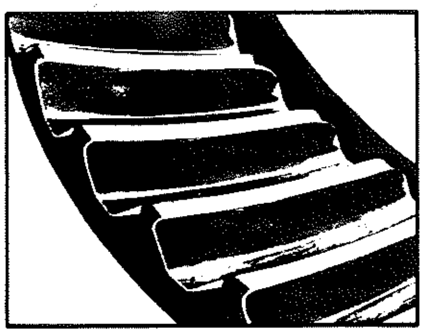


Figure 118B
High Pattern

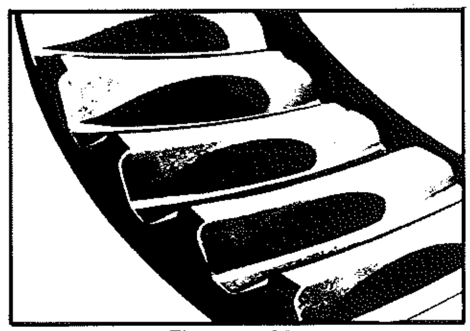


Figure 119B
Low Pattern

4. Look at the contact patterns on the ring gear teeth. Compare the patterns to **Figures 117A or B, 118A or B and 119A or B.**

The Location of Good Hand Rolled Contact Patterns.

New Conventional and Generoid Gear Sets - toward the toe of the gear tooth and in the center between the top and bottom of the tooth. **See Figures 117A and 117B.**

When the carrier is being operated, a good pattern will extend approximately the full length of the gear tooth. The top of the pattern will be near the top of the gear tooth. **See Figure 120A or B.**

The location of a good hand rolled contact pattern for an old gear set MUST match the wear pattern in the ring gear. The contact pattern will be smaller in area than the wear pattern.

If the contact patterns require adjustment, continue by following step 5 to move the contact patterns between the top and bottom of the gear teeth. If the contact patterns are in the center of the gear teeth, continue by following step 6.

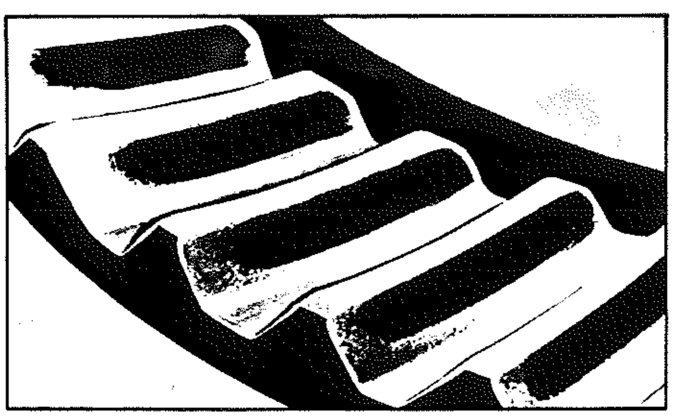


Figure 120A
Good Pattern in Operation
Conventional Gears

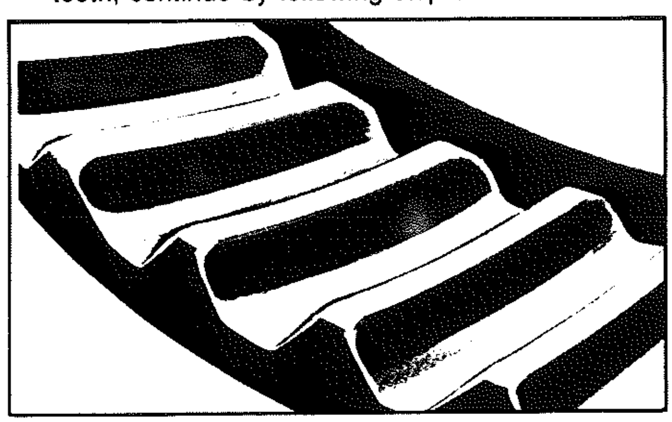


Figure 120B
Good Pattern in Operation
Generoid Gears

5. Change the thickness of the shim pack under bearing cage to move the contact patterns between the top and bottom of the gear teeth. Use the following procedure.

NOTE:

A high contact pattern indicates that the drive pinion was not installed deep enough into the carrier. A low contact pattern indicates that the drive pinion was installed too deep in the carrier.

A. Remove the drive pinion and bearing cage from the carrier. See the procedure on page 10.

B. To correct a high contact pattern, **Figure 118A or B** decrease the thickness of the shim pack under the bearing cage. When you decrease the thickness of the shim pack, the drive pinion will move toward the ring gear. **Figure 121.**

To correct a low contact pattern, **Figure 119A or B** increase the thickness of shim pack under the bearing cage. When you increase the thickness of the shim pack, the drive pinion will move away from the ring gear. **Figure 122.**

Figure 121

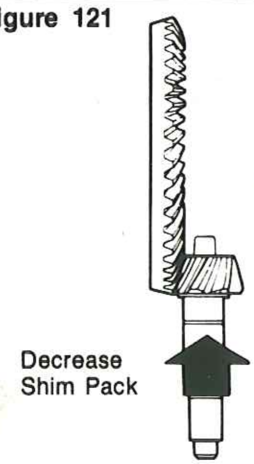
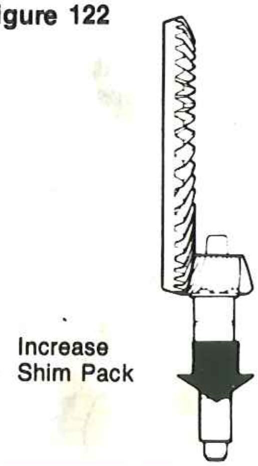


Figure 122



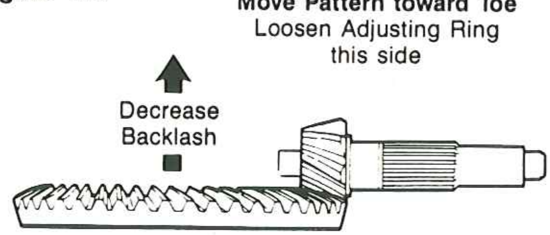
C. Install the drive pinion, bearing cage and shims into the carrier. See the procedure on page 35.

D. Repeat steps 2 to 5 until the contact patterns are in the center between the top and bottom of the gear teeth.

6. Adjust backlash of the ring gear within specification range to move the contact patterns to the correct location in the length of the gear teeth. See the procedure on page 45.

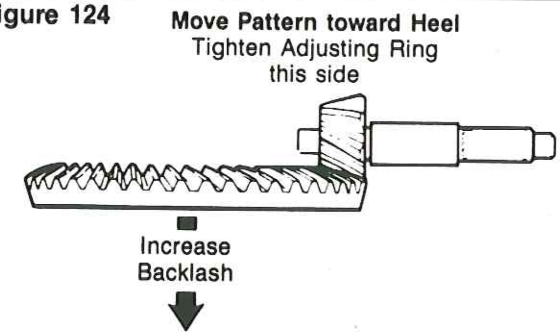
A. Decrease backlash to move the contact patterns toward the toe of the ring gear teeth. **Figure 123.**

Figure 123



B. Increase backlash to move the contact patterns toward the heel of the ring gear teeth. **Figure 124.**

Figure 124



C. Repeat steps 2 to 4 and 6 until the contact patterns are at the correct location in the length of the gear teeth.

7. Install cotter keys*, pins*, or lock plates* that hold the two bearing adjusting rings in position. Use the following procedures.

CAUTION:

If your carrier was built using cotter keys, lock the adjusting rings only with cotter keys. If your carrier was built using roll pins, reuse the roll pins or lock the adjusting rings with cotter keys. Do not force a roll pin into a cotter key hole.

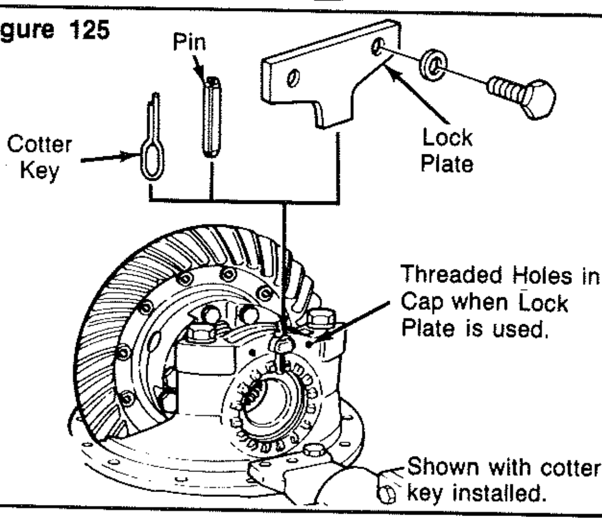
A. Cotter keys* - Install cotter keys between lugs of the adjusting ring and through the boss of the bearing cap. Bend the two ends of the cotter key around the boss. **Figure 125.**

B. Pins* - Install pin through boss of the bearing cap until the pin is between lugs of the adjusting ring. Use a drift and hammer to install the pin. **Figure 125.**

**Some Rockwell carriers do not have the parts described.*

C. Lock Plates* - Install lock plate on bearing cap so that the tab is between lugs of the adjusting ring. Install the two capscrews that hold the lock plate to the bearing cap. Tighten the capscrews to correct torque value. See the torque chart on page 65. **Figure 125.**

Figure 125



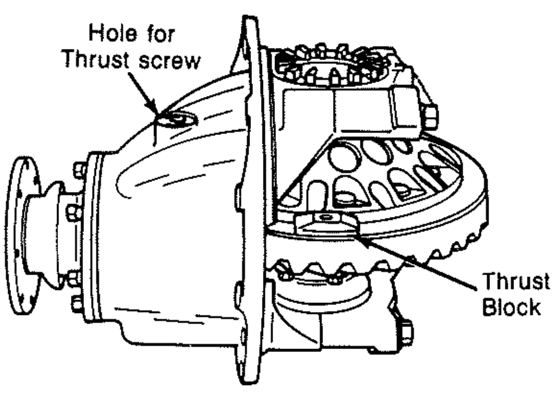
Install and Adjust the Thrust Screw*

Specification:
Clearance between thrust screw or block and ring gear - .025 to .045 inch (.65 to 1.14 mm). Loosen the thrust screw 1/2 turn, 180°.

If the carrier does not have a thrust block*, start at step 4.

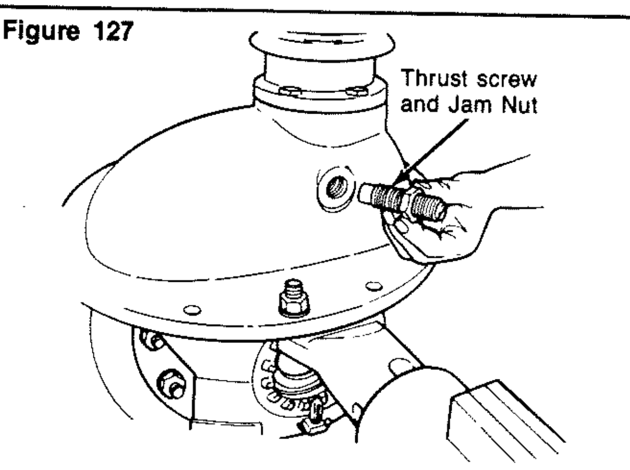
1. Rotate the carrier in the repair stand until the back surface of ring gear is toward the top.

Figure 126



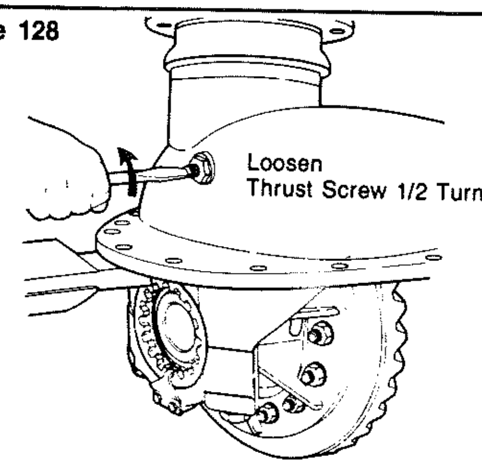
2. Put the thrust block* on the back surface of the ring gear. The thrust block* MUST be in the center between the outer diameter of gear and differential case.
3. Rotate the ring gear until the thrust block* and hole for thrust screw, in carrier, are aligned. **Figure 126.**
4. Install the jam nut* on the thrust screw*, one half the distance between both ends. **Figure 127.**

Figure 127



5. Install the thrust screw* into the carrier until the screw stops against the ring gear or thrust block*. **Figure 127.**
6. Loosen the thrust screw* 1/2 turn, 180°. **Figure 128.**

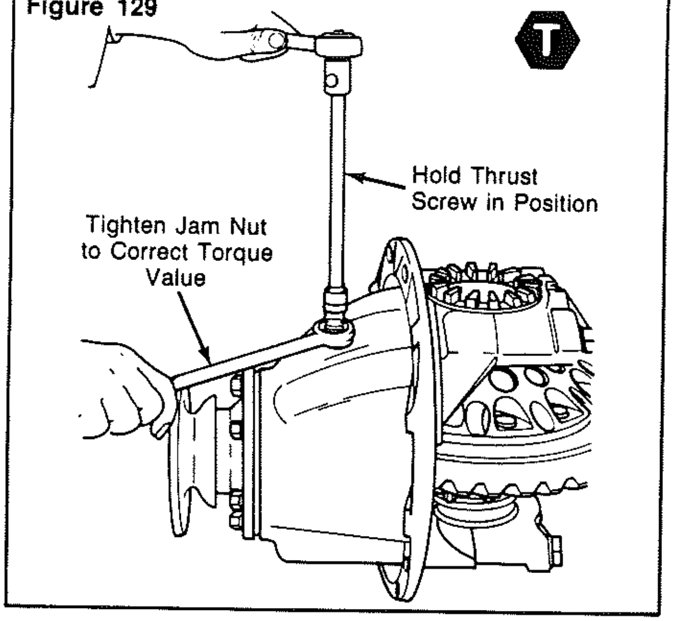
Figure 128



Some Rockwell carriers do not have the parts described.

7. Tighten the jam nut* to the correct torque value against the carrier. See the torque chart on page 65. **Figure 129.** T

Figure 129



IMPORTANT: To complete the assembly of axles equipped with driver controlled main differential locks, see pages 57 through 61. Start with "Install Differential Shift Assembly" page 57.

Install Differential Carrier into Axle Housing

WARNING:

Be careful when using cleaning solvents. Follow the solvent manufacturer's instructions for safe use to prevent injury.

1. Clean the inside of axle housing and the mounting surface where the carrier fastens. Use a cleaning solvent and rags to remove dirt. Blow dry the cleaned areas with air. Also see the procedure on page 15.

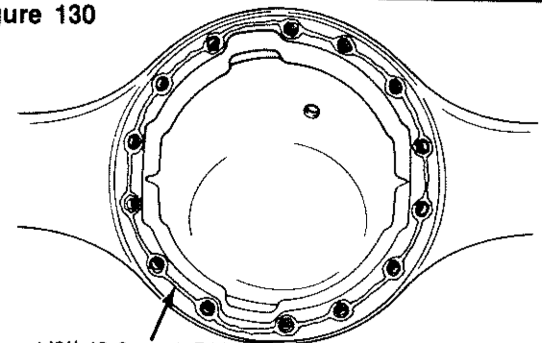
2. Inspect the axle housing for damage. Repair or replace the axle housing. See the procedure on pages 17 to 19.

3. Check for loose studs* in the mounting surface of the housing where the carrier fastens. Remove and clean the studs* that are loose.

4. Apply liquid adhesive to the threaded holes and install the studs* into axle housing. See the procedure on page 20. Tighten studs* to correct torque value. See the torque chart on page 65. T

5. Apply silicone gasket material to the mounting surface of the housing where the carrier fastens. See the procedure on page 21. **Figure 130.**

Figure 130



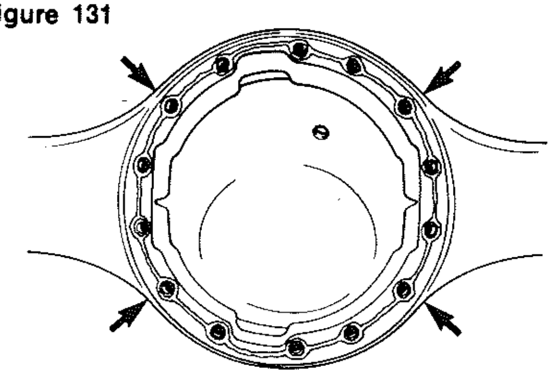
6. Install the carrier into the axle housing. Use a hydraulic roller jack or a lifting tool.

CAUTION:

Do not install the carriers using a hammer or mallet. A hammer or mallet will damage the mounting flange of carrier and cause oil leaks.

7. Install nuts* and washers or capscrews and washers in the four corner locations around the carrier and axle housing. Tighten the fasteners hand tight at this time. **Figure 131.**

Figure 131



**Some Rockwell carriers do not have the parts described.*

8. Carefully push the carrier into position. Tighten the four fasteners two or three turns each in a pattern opposite each other. **See Figure 131.**

9. Repeat step 8 until the four fasteners are tightened to the correct torque value. See the torque chart on page 65. T

10. Install the other fasteners and washers that hold the carrier in the axle housing. Tighten fasteners to the correct torque value. See the torque chart on page 65. T

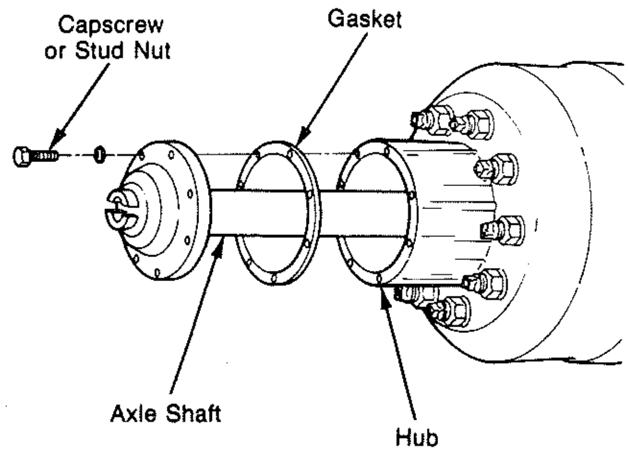
11. Connect the driveline universal joint to the pinion input yoke or flange on the carrier.

12. Install the gaskets and axle shafts into the axle housing and carrier. The gasket and flange of the axle shafts MUST fit flat against the wheel hub. **Figure 132.**

13. Install the capscrews and washers that hold the axle shaft to the wheel hub. Tighten capscrews to the correct torque value. See the torque chart on page 65. T

14. If the wheel hubs have studs*, install the tapered dowels* at each stud and into the flange of the axle shaft. Use a punch or drift and hammer if needed.

Figure 132



15. Install the nuts* and washers on the studs*. Tighten nuts* to the correct torque value. See the torque chart on page 65. T

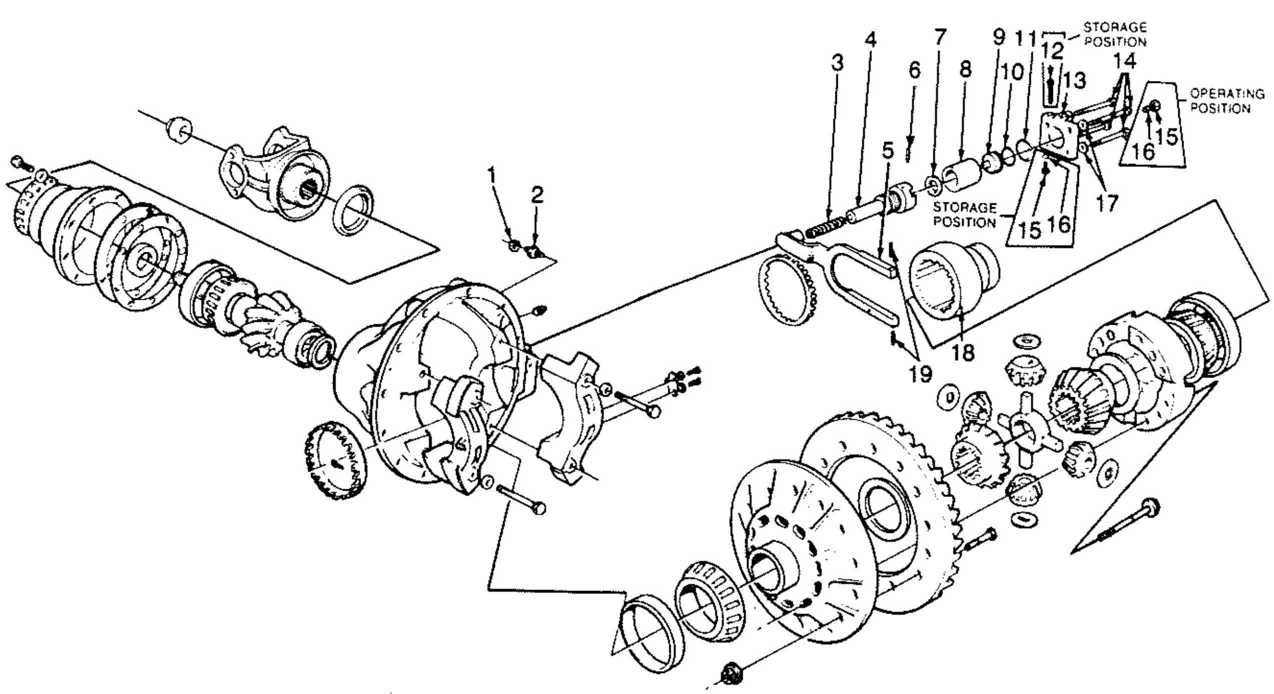
**Some Rockwell carriers do not have the parts described.*

Driver Controlled Main Diff. Lock

section 6

Driver Controlled Main Differential Lock

Figure 133



1. Lock Nut - Sensor Switch
2. Sensor Switch
3. Shift Shaft Spring
4. Shift Shaft
5. Shift Fork
6. Spring Retaining Pin
7. Flat Washer (or silastic as reqd.)
8. Air Cylinder Tube
9. Piston
10. Piston "O" Ring
11. Cover Copper Gasket
12. Capscrew - Manual Actuation
13. Cylinder Cover
14. Cover Capscrews
15. Cover Plug
16. Plug Gasket
17. Washers
18. Shift Collar
19. Shift Fork Roll Pins

Some Rockwell drive axle models have a driver controlled main differential lock. This differential lock is operated by a carrier mounted, air actuated shift unit. When activated, the shift unit moves a sliding collar which is installed on the splines of the axle shaft. When engaged, the collar locks the axle shaft to a second set of splines on the differential case. **Figure 133.**

NOTE:

The Rockwell carrier models with driver controlled differential lock equipment are manufactured in metric dimensions and sizes. When these carriers are serviced, it is important to use the correct metric size tools on the fasteners. See the metric torque chart at the back of this manual.

section 6 Driver Controlled Main Differential Lock

1. Remove the axle shafts before the vehicle is towed. See the procedures on pages 25 and 26.

CAUTION:

If the vehicle must be towed to a service facility with the drive axle wheels on the ground, it is necessary to remove the axle shafts before the vehicle is towed.

2. Install the axle shafts after the vehicle is towed. See the procedure on page 26.

3. If the differential carrier must be removed from the axle housing, use the following procedures.

Remove Differential Carrier From Axle Housing

Before the differential carrier can be removed or installed, the differential lock MUST be shifted into and held in the locked (engaged) position. The locked position gives enough clearance between the shift collar and the axle housing to permit the removal or installation of the carrier.

NOTE:

If the axle shafts were removed for towing with the differential in the unlocked (disengaged) position, install the right-hand axle shaft into the housing before continuing. Follow steps 1 and 2 of "Install Axle Shafts After the Vehicle is Towed" on page 26.

To shift into the locked position, use either of the following "Air Pressure" or the "Manual Engaging" methods.

Air Pressure Method:

1. Remove the drain plug from the bottom of the housing and drain the lubricant.

2. Raise the right hand wheel of the drive axle off the floor with a hoist or jack.

WARNING:

Do not start the vehicle engine and engage the transmission with one wheel raised from the floor. When the differential is in locked (engaged) position, power will go to the wheel on the floor and cause the vehicle to move.

3. Put a jack stand under the right-hand spring seat to hold the vehicle in the raised position.

WARNING:

Do not work under a vehicle supported only by jacks. Jacks can slip or tip over and cause injury.

4. Disconnect the driveline from the pinion input yoke.

5. Disconnect the vehicle air line from the differential lock actuator assembly.

6. Connect an auxiliary air supply to the differential lock actuator assembly.

NOTE:

If an auxiliary air supply is not available, continue to "Manual Engaging Method" of locking the differential.

7. Apply and hold air pressure to the actuator assembly. The air pressure will move the shift collar to engage with the splines on the differential case half and lock the assembly.

8. Make sure that the shift collar has moved the full distance on the splines of the differential case half. Rotate the drive pinion or the right-hand wheel until the right-hand wheel makes one complete rotation (forward or backward).

   Continue to hold the main differential in the locked position with air pressure until the carrier assembly is completely removed from the axle housing.

9. Remove the axle shafts from the housing. Follow Steps 1-3 of "Remove Axle Shafts Before The Vehicle is Towed" on page 26.

10. Remove the carrier from the housing as described in Steps 8 through 15 on page 5.

11. After the carrier is removed from the axle housing, release the air pressure from the actuator assembly.

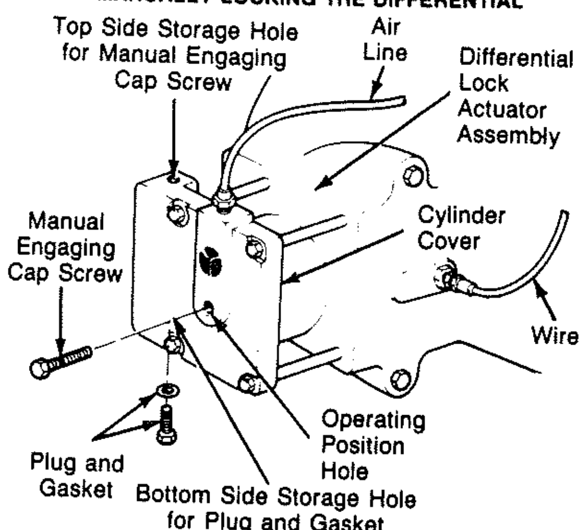
Manual Engaging Method:

If an auxiliary air supply is not available or if the differential carrier is to be stored for later use, use this manual engaging method. **Figure 134.**

1. Follow Steps 1 through 5 of the "Air Pressure Method".

Figure 134

POSITION OF CAP SCREW AND PLUG WHEN MANUALLY LOCKING THE DIFFERENTIAL



2. Remove the plug and gasket from the hole in the center of the cylinder cover.

3. Remove the manual engaging cap screw from the top storage hole in the cylinder cover.

4. Install the plug and gasket into the bottom storage hole in the cylinder cover.

NOTE:

The storage hole for the plug and gasket is the opposite end of the storage hole for the manual engaging cap screw.

5. Install the manual engaging capscrew into the threaded hole in the center of the cylinder cover.

6. Turn the manual adjusting capscrew to the right until the head is approximately 1/4 inch from the cylinder cover. DO NOT turn the capscrew beyond its normal stop. The capscrew is now in the service position and the main differential lock is completely engaged.

CAUTION:

There will be a small amount of spring resistance felt when you turn in the manual engaging capscrew. If a high resistance is felt before reaching the locked (engaged) position, STOP TURNING THE CAPSCREW, or the cover and capscrew threads will be damaged.

A high resistance on the capscrew indicates that the splines of the shift collar and the differential case half are not aligned or engaged. To align the splines use the following procedure:

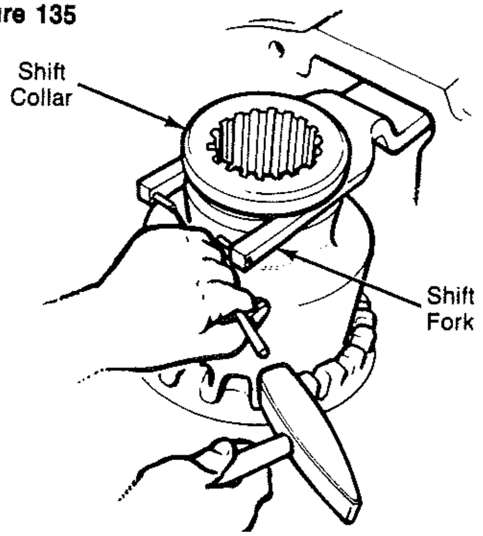
A. Rotate the drive pinion or right-hand wheel to align the splines of the shift collar and case half while you turn in the manual engaging capscrew.
B. When the normal amount of spring resistance is again felt on the capscrew, the splines are engaged. Continue to turn in the manual engaging capscrew until the head is approximately 1/4 inch from the cylinder cover.

7. Remove the carrier from the axle housing as described in steps 8 through 15 on page 5.

Remove Differential And Gear Assembly

1. To remove the differential lock sliding shift collar, tap out the two retainer roll pins until they are level with the inner face of the shift fork. Release the differential lock if it is manually engaged. **Figure 135.**

Figure 135

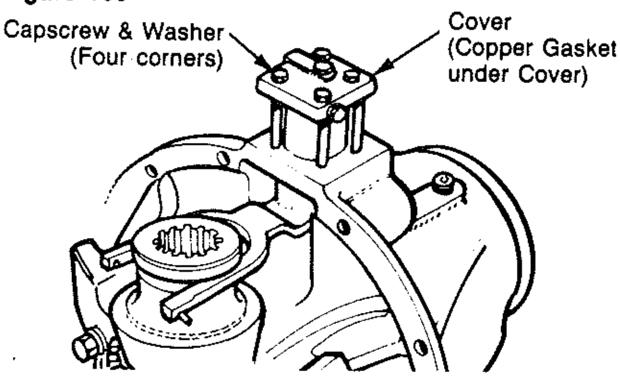


2. If required, remove the differential lock shift unit.

   A. Remove the sensor switch and lock nut.

   B. Remove the four capscrews and washers that hold the cylinder cover. Remove the cover and copper gasket. **Figure 136.**

Figure 136



   C. Remove the shift unit-cylinder and piston. Remove the O-ring from the piston.

   D. Remove the shift shaft from the shift fork. The shaft may be loctited to the fork, use the heating procedure to breakdown loctite. The recommended procedure is similar to "Remove Dri-Lock Fasteners" on page 21.

   E. Remove the shift shaft spring and flat washer.

NOTE:

Some models use silastic seal instead of the flat washer in Step E.

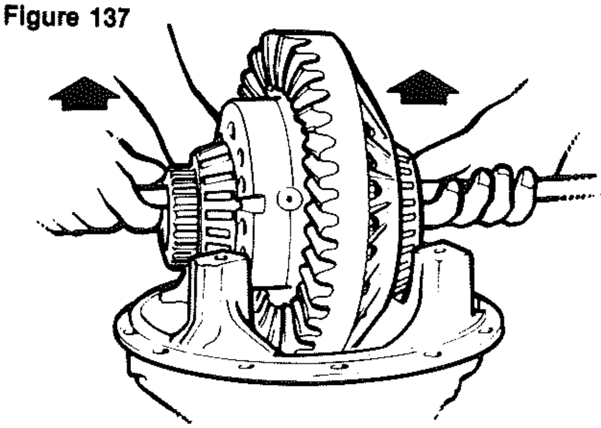
   F. Remove the shift fork.

NOTE:

A roll pin is installed in the shift shaft and is used as a stop for the shift shaft spring. It is not necessary to remove this roll pin during a normal disassembly.

3. Remove the cotter keys*, pins* or lock plates* that hold the two bearing adjusting rings in position. Use a small drift and hammer to remove pins. Each lock plate is held in position by two capscrews.
4. Match mark one bearing cap and one carrier leg so that these parts will be assembled in the correct positions. Remove the bearing cap capscrews and washers, the bearing caps and the adjusting rings.
5. Lift the differential and gear assembly from the carrier. Tilt the assembly as required to permit the ring gear to clear the support for the pinion spigot bearing. **Figure 137.**

Figure 137



**Some Rockwell carriers do not have the parts described.*

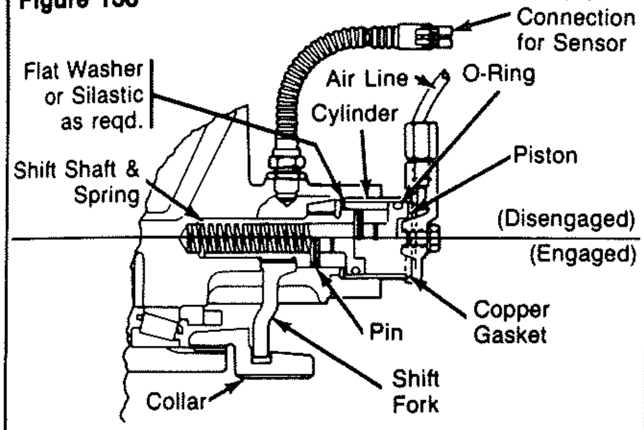
FURTHER DISASSEMBLY OF THESE CARRIERS IS THE SAME AS AXLES WITHOUT THE DRIVER CONTROLLED MAIN DIFFERENTIAL LOCK. TO CONTINUE DISASSEMBLY FOLLOW THE PROCEDURES STARTING ON PAGE 8.

PREPARE PARTS FOR ASSEMBLY, ADJUSTMENTS, AND CARRIER ASSEMBLY (UP TO THE POINT OF "INSTALL DIFFERENTIAL CARRIER INTO AXLE HOUSING" ON PAGE 51) ARE ALSO THE SAME FOR BOTH AXLES.

Install Differential Shift Assembly

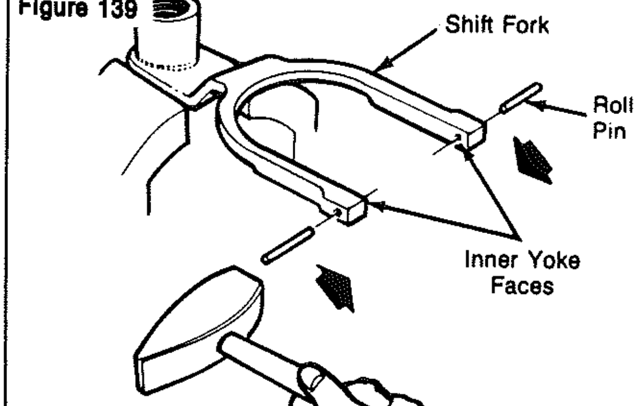
Install the differential shift assembly after the differential carrier is assembled and the gear and bearing adjustments are made. Parts of the shift assembly are shown in **Figure 138.**

Figure 138



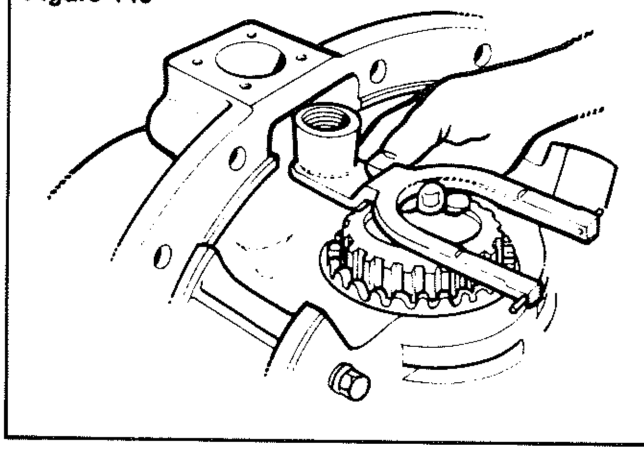
1. Install the two roll pins into the ends of the shift fork. Tap the pins into position until they are level with the inner yoke face. **Figure 139.** Do not install completely at this time.

Figure 139



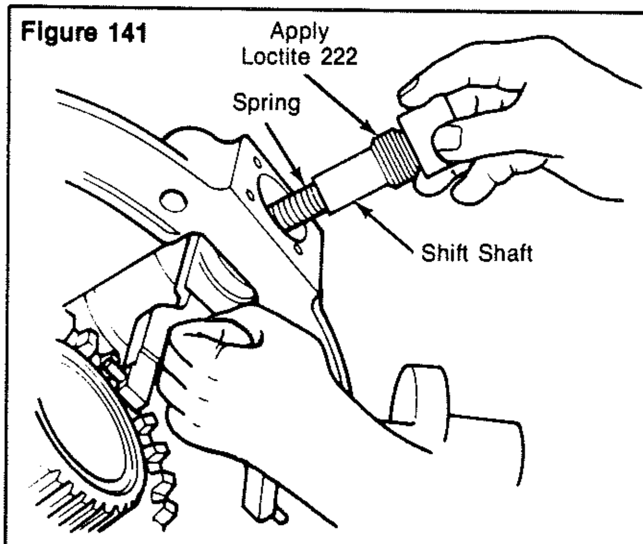
2. If the spring stop roll pin was removed from the head of the shift shaft, install the pin at this time.
3. Apply Loctite 222 (Rockwell Part No. 2297-B-6112) to the threads of the shift shaft.
4. Install the shift fork into its correct position in the carrier case. **Figure 140.**

Figure 140



5. Hold the shift fork in position and install the shift shaft spring into the shift shaft opening in the carrier, through the shift fork bore and into the bore for the shift shaft spring. **Figure 141.**

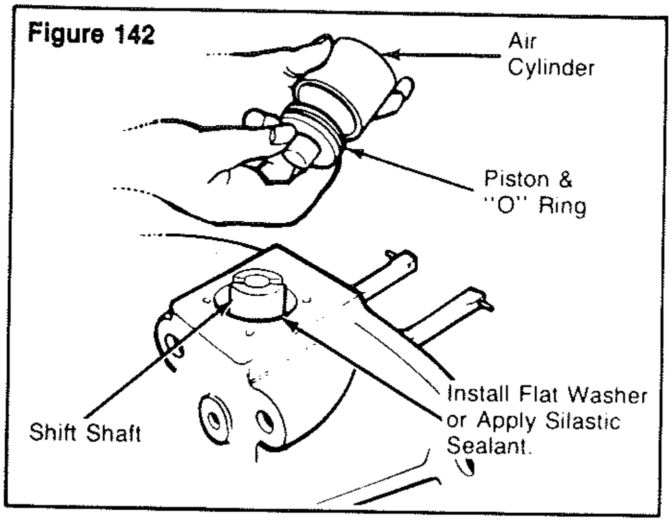
Figure 141



6. Slide the shift shaft over the spring and install the shaft into the shift fork. Tighten to 20-25 lb. ft. (27-34 N.m) torque. T
7. Install the flat washer (when used) or apply silastic sealant (Rockwell Part No. 1199-Q-2981) to the bottom of the cylinder bore. **Figure 142.**

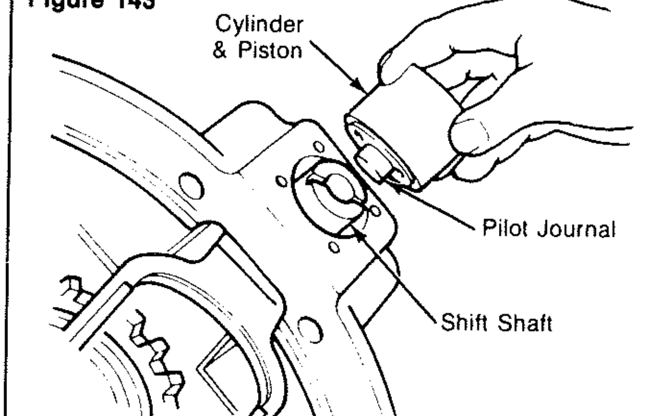
8. Install the O-ring into its groove on the piston. Lubricate the O-ring with axle lubricant. Install the piston into the air cylinder. **Figure 142.**

Figure 142



9. Install the cylinder into the housing bore. Make sure that the pilot journal on the piston is against its bore on the shift shaft. **Figure 143.**

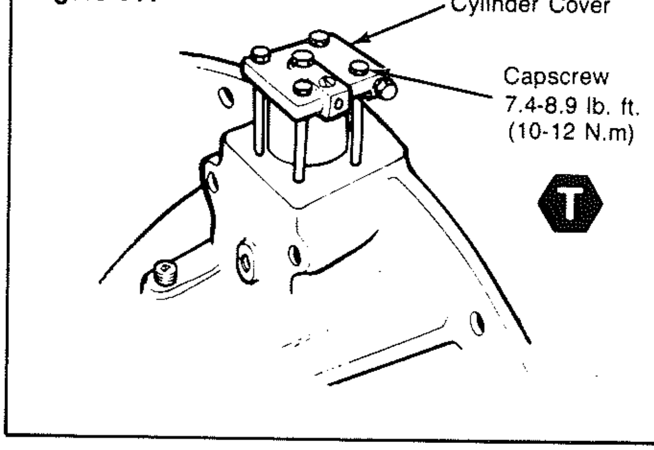
Figure 143



10. Install the copper gasket into its bore on the inside of the cylinder cover. Put the cover in position over the cylinder so that the air intake port will point up when the carrier is installed into the housing. Install the cover with the four attaching capscrews and washers. Tighten to 7.4-8.9 lb. ft. (10-12 N.m) torque. **Figures 138 and 144.** T

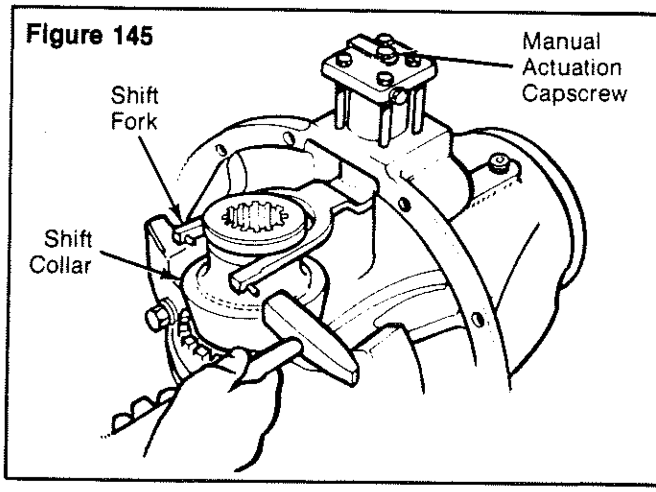
11. Slide the shift collar into the fork and engage the shift collar splines with the splines of the differential case. Use the manual actuation capscrew to move the shift collar splines into the differential case splines. See "Manual Engaging Method" on page 60.

Figure 144



12. Hold the shift collar in the locked (engaged) position and tap in the two roll pins in the shift fork ends until they are level with the outer yoke faces. **Figure 145.**

Figure 145



13. While the shift collar is still in the locked position, put the sensor switch (with the lock nut loosely attached) into its hole.

14. Connect a battery/bulb tester to the sensor switch and rotate the switch into its hole until contact with the shift fork causes the light to go on. Turn the switch one additional revolution and tighten the lock nut to 26-33 lb. ft. (35-45 N.m) torque. T

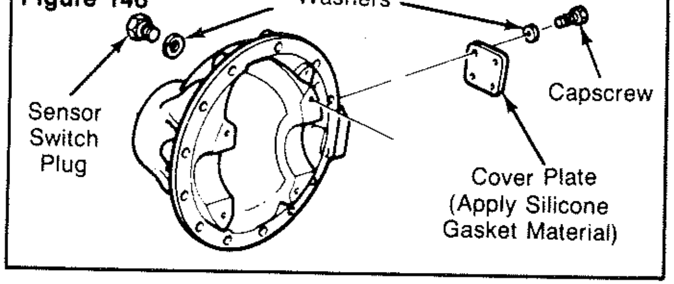
NOTE:

For carriers without the differential lock (Less Air Shift), assemble the sensor switch plug and cover plate as follows:

1. Install the washer and plug into the hole for the sensor switch. Tighten the plug to 45-55 lb. ft. (60-74 N.m). **Figure 147.** T

2. Apply silicone gasket material to the cover plate mounting surface on the carrier. (See procedures on page 21).
3. Install the four washers and capscrews. Tighten the capscrews to 7.4-8.9 lb. ft. (10-12 N.m). Figure 146.

Figure 146



NOTE:

When the carrier is to be installed into the axle housing, the shift collar must be held in the engaged position. This can be done by keeping the air pressure applied to the shift cylinder (see "Air Pressure Method" on page 60), or by using the manual engaging bolt (see "Manual Engaging Method" on page 60). Failure to keep the differential in the locked (engaged) position will make it impossible to install the carrier assembly into the axle housing.

After the carrier is installed into the axle housing, shift the differential into the unlocked (disengaged) position to permit the installation of the right hand axle shaft.

Install Carrier Into Axle Housing

1. Clean the inside of the axle housing and the mounting surface where the carrier fastens. Use a cleaning solvent and rags to remove the dirt. Blow dry the cleaned areas with compressed air. (See procedures on page 15).

WARNING:

Be careful when using cleaning solvent. Follow the solvent manufacturer's instructions for safe use to prevent injury.

2. Inspect the axle housing for damage. If necessary, repair or replace the housing. (See procedures on pages 17 to 19).
3. Check for loose studs in the mounting surface of the housing where the carrier fastens. Remove and replace the studs where required.
4. Install the differential carrier into the housing. Use one of the following procedures.

Air Pressure Method:

A. Before the carrier is installed into the housing, install the right-hand axle shaft through the shift collar and into the side gear. (The axle shaft is being used as a spline alignment tool).

NOTE:

A similar tool can be made from a damaged right-hand axle shaft by cutting off approximately 24 inches from the spline end.

B. Align the splines of the shift collar and differential case half by rotating the axle shaft tool or drive pinion.

WARNING:

Do not use your hands to hold the collar in position. Injury can result when air pressure is applied to the actuator.

C. Connect an auxiliary air supply to the actuator assembly.

D. Apply and hold pressure to the actuator assembly. The air pressure will move the shift collar to engage the differential case half and lock the assembly.

E. If the shift collar has not moved the full distance on the splines of the differential case half, rotate the axle shaft tool or the drive pinion one complete rotation to the right or left.

F. Remove the axle shaft tool from the carrier.

Driver Controlled Main Differential Lock

NOTE:

Continue to hold the main differential in the locked (engaged) position with air pressure until the carrier is completely installed in the axle housing. If no air supply is available, use the "Manual Engaging Method" on this page to lock (engage) the differential.

G. Apply silicone gasket material to the mounting surface of the housing where the carrier fastens. (See procedures on page 21).

H. Install the carrier into the axle housing. Follow steps 6-10 on page 51.

I. Release the air pressure from the differential lock actuator and disconnect the auxiliary air supply.

J. Proceed to Step 5 on page 61.

Manual Engaging Method:

A. Align the splines of the shift collar and the differential case half. This can be done by hand or by installing the right-hand axle shaft through the shift collar and into the side gear. See Steps A and B of the "Air Pressure Method" on this page.

B. Install the manual engaging capscrew into the threaded hole in the center of the cylinder cover.

C. Turn the manual adjusting capscrew to the right until the head of the capscrew is approximately 1/4 inch from the cylinder cover. DO NOT turn the capscrew beyond its normal stop. The capscrew is now in the service position and the main differential lock is completely engaged.

CAUTION:

There will be a small amount of spring resistance felt when you turn in the manual engaging capscrew. If a high resistance is felt before reaching the locked (engaged) position, STOP TURNING THE CAPSCREW, or the cover, fork and capscrew threads will be damaged.

A high resistance on the capscrew indicates that the splines of the shift collar and the differential case half are not aligned or engaged.

Lift the shift collar as required and rotate to align the splines of collar and case half while you turn in the manual engaging capscrew. When the normal amount of spring resistance is again felt on the capscrew, the splines are engaged. Continue to turn in the manual engaging capscrew.

D. Install and fasten the carrier into the axle housing. Follow Steps G and H of the "Air Pressure Method" on page 60.

E. Remove the plug and gasket from their position. Remove the manual engaging capscrew from its service position.

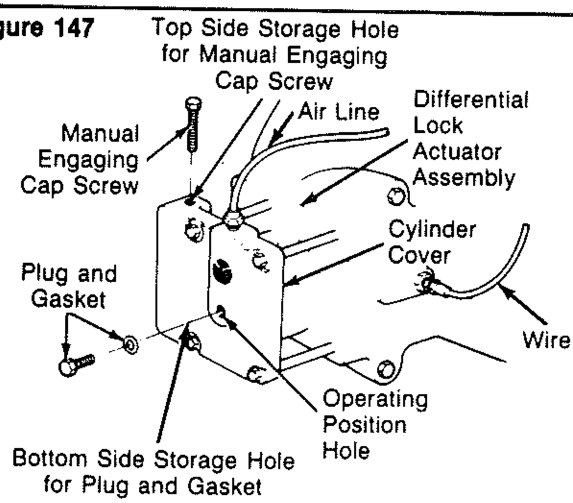
NOTE:

When the manual engaging capscrew is removed from the service position in the actuator, the main differential lock becomes disengaged.

F. Clean the plug, gasket, cylinder cover, and threaded hole in the center of the cylinder cover.

G. Install the plug and gasket into their operating position in the cylinder cover. Install the manual engaging capscrew into its storage position. See **Figure 147.**

Figure 147



H. Tighten the plug to 44-55 lb. ft. (60-75 N.m) torque. Tighten the manual engaging capscrew to 22-28 lb. ft. (30-38 N.m).

5. Connect the vehicle air line to the differential lock actuator assembly.

6. Install the electrical connection on the sensor switch located in the carrier, below the actuator assembly.

7. Install the right and left-hand axle shafts. Follow the procedures in Steps 2 through 4 of "Before Towing" on page 26.

8. Remove the jack stand from under the drive axle and lower the vehicle to the floor.

Check the Differential Lock

1. Shift the vehicle transmission to neutral and start the engine to get the system air pressure to the normal level.

WARNING:

Do not start the vehicle engine and engage the transmission with one wheel raised from the floor. When the differential is in locked (engaged) position, power will go to the wheel on the floor and cause the vehicle to move.

2. Put the differential lock switch (in the cab of the vehicle) in the unlocked (disengaged) position.

3. Drive the vehicle at 5-10 MPH (8-16 kmph) and check the differential lock indicator light. The light must be off when the switch is in the unlocked position.

4. Continue to drive the vehicle and put the differential lock switch in the locked (engaged) position. Let up on the accelerator to remove the driveline torque and permit the shift. The light must be on when the switch is in the locked position.

NOTE:

If the indicator light remains "on" with the switch in the unlocked position, the differential is still in the locked position. Check to make sure that the manual engaging capscrew was removed from the cylinder cover of the actuator assembly. See Steps E through H of "Manual Engaging Method" on this page.

Driver Caution Label

Figure 148

Check to see that the "Driver Caution" label is installed in the vehicle cab. The caution label must be put in a location that is easily visible to the driver. A recommended location is on the instrument panel, next to the differential lock switch and lock indicator light. Driver Caution labels (TP-86101) are available from Rockwell International, Troy, Michigan. **Figure 148.**

section 7

Lubrication

NOTE:

For complete information on lubricating drive axles and carriers, see Rockwell Field Maintenance Manual No. 1.

See the following charts 4, 5 and 6 for standard information on lubricants, schedules and capacities.

Chart 4

LUBRICANT CROSS REFERENCE (VISCOSITY) AND TEMPERATURE CHART

Rockwell Lubricant Specification	Description	Cross Reference	Minimum Outside Temperature	Maximum Outside Temperature
0-76-A	Hypoid Gear Oil	GL-5, S.A.E. 85W/140	− 12.2°C (+ 10°F)	- - -**
0-76-B	Hypoid Gear Oil	GL-5, S.A.E. 80W/140	− 26.1°C (− 15°F)	- - -**
0-76-D	Hypoid Gear Oil	GL-5, S.A.E. 80W/90	− 26.1°C (− 15°F)	- - -**
0-76-E	Hypoid Gear Oil	GL-5, S.A.E. 75W/90	− 40°C (− 40°F)	- - -**
0-76-J	Hypoid Gear Oil	GL-5, S.A.E. 75W	− 40°C (− 40°F)	+ 1.6°C (+ 35°F)
0-76-L	Hypoid Gear Oil	GL-5, S.A.E. 75W/140	− 40°C (− 40°F)	- - -**

There is no upper limit on these outside temperatures, but the axle sump temperature **MUST NEVER EXCEED + 121°C (250°F)

Chart 5

LUBRICATION SCHEDULE

• Heavy-Duty On-Highway • On and Off Highway • Off-Highway		• Common Carrier On-Highway	
Less than 60,000 miles (96,000 Km) a year	More than 60,000 miles (96,000 Km) a year	Less than 100,000 miles (160,000 Km) a year	More than 100,000 miles (160,000 Km) a year
Two Times A Year	25,000 to 30,000 miles (40,000 to 48,000 Km)	One Time A Year	100,000 miles (160,000 Km)

NOTE: If operation is continuous heavy-duty, check lubricant each 1,000 miles (1,600 Km).

CHART 6

LUBRICANT CAPACITIES

Use the following lubricant capacities as a guide only. The capacities are measured with the drive pinion in the horizontal position. When the angle of the drive pinion changes, the lubricant capacity of the axle will change.

AXLE MODEL	CAPACITY	
	U.S. Pints	Liters
Single Drive Axles		
A-150	5.5	2.6
B-100	10	4.7
B-140	12	5.7
B-150	3.5	1.7
C-100	12.5	5.9
D-100	12.5	5.9
D-140	12.5	5.9
E-100	15	7.1
E-105	12.5	5.9
E-150	9	4.3
F-100	13	6.2
F-106	13	6.2
F-120	15	7.1
F-121	15	7.1
F-140	14	6.6
FDS-75	14	6.6
FDS-85	15	7.1
FDS-90	14	6.6
FDS-750	7	3.3
FDS-1600	23	10.9
FDS-1800	35	16.6
FDS-1805	35	16.6
G-161	21	9.9
H-100	20	9.5
H-140	21	9.9
H-150	11	5.2
H-162	20	9.5
H-170	27*	12.8*
H-172	27	12.8
L-100	23	10.9
L-140	24	11.4
L-155	24	11.4
L-172	27	12.8
M-172	27	12.8
QT-140	24	11.4
Q-100	31	14.7
Q-145	24	11.4
RL-170	48	22.7
R-100	30	14.2
R-140	28	13.2
R-155	28	13.2
R-160	28	13.2
R-163	34	16.1
R-170	43	20.3
S-170	43	20.3
U-140	24	11.4
U-170	43	20.3
W-170	43	20.3
RS-13-120	15	7.2
RS-15-120	15	7.2
RS-16-141	31	14.7
RS-17-140	32	15.4
RS-17-141	31	14.7
RS-19-145	36	17.3
RS-21-145	35	16.9
RS-23-160	43/41	20.7/19.5

AXLE MODEL	CAPACITY	
	U.S. Pints	Liters
RS-23-180	39	18.6
RS-26-160	51	24.2
RS-26-180	38	18.3
RS-30-180	38	18.3
Rear Axle Of Tandems		
SDHD (DHR rear)	16	7.6
SFHD (FHR rear)	16.5	7.8
SHHD (HHR rear)	26	12.3
SL-100 (LR-100 rear)	37	17.5
SLHD (LHR rear)	32	15.1
SQ-100 (QR-100 rear)	33	15.7
SQHD (QHR rear)	31	14.7
SQHP (QAR rear)	36	17
SR-170 (RR-170 rear)	43	20.3
SRHD (RHR rear)	36	17
SSHD (SHR rear)	28	13.2
ST-170 (TR-170 rear)	43	20.3
STHD (THR rear)	28	13.2
SU-170 (UR-170 rear)	43	20.3
SUHD (UHR rear)	28	13.2
SW-170 (WR-170 rear)	43	20.3
RT-34-140 (RR-17-140)	35	16.9
RT-34-145 (RR-17-145 rear)	36	17.1
RT-40-140 (RR-20-140)	35	16.9
RT-40-145 (RR-20-145 rear)	36	17.3
RT-44-145 (RR-22-145 rear)	35	16.9
RT-46-160 (RR-23-160 rear)	43/41	20.7/19.5
RT-52-160 (RR-26-160 rear)	51	24.2
RT-48-180 (RR-24-180 rear)	39	18.6
RT-52-180 (RR-26-180 rear)	39	18.3
RT-58-180 (RR-29-180 rear)	39	18.3

**Includes 1 pint (0.97 liter) for each wheel end and with drive pinion angle at 3°.*

section 8 Fastener Torque Info.

Torque Values for Fasteners

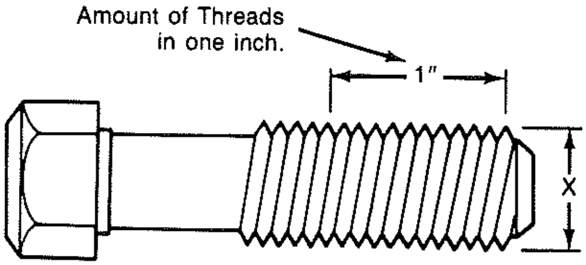
General Information.

1. The torque values in chart 7 are for fasteners that have a light application of oil on the threads.
2. If the fasteners are dry, increase the torque values by ten percent (10%).
3. If the fasteners have a heavy application of oil on the threads, decrease the torque values by ten percent (10%).
4. If you do not know the size of the fastener that is being installed, measure the fastener. Use the following procedure.

American Standard Fasteners

A. Measure the diameter of the threads in inches, dimension X. **Figure 149.**

Figure 149



X Dimension = (Example 1/2")

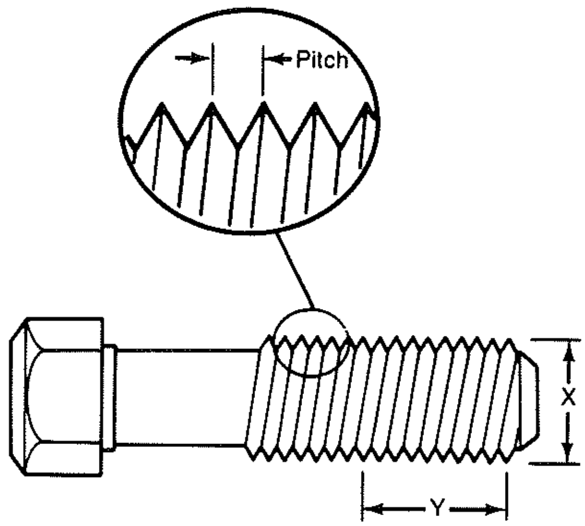
B. Count the amount of threads there are in one inch (1.0 inch). **Figure 150.**

Example of an American Standard size fastener is .50 - 13.
The .50 is the diameter of the fastener in inches or dimension X.
The 13 is the amount of threads in one inch (1.0 inch).

Metric Fasteners

A. Measure the diameter of the threads in millimeters (mm), dimension X. **Figure 150.**

Figure 150



X Dimension = (Example M8 or 8.mm)
Y Dimension = Distance of 10 Threads

B. Measure the distance of ten (10) threads, point to point in millimeters (mm), dimension Y. Make a note of dimension Y. **Figure 151.**

C. Divide dimension Y by ten (10). The result will be the distance between two threads or pitch.

Example of a Metric size fastener is M 8 x 1.25.

The M 8 is the diameter of the fastener in millimeters (mm) or dimension X.

The 1.25 is the distance between two threads or pitch.

5. Compare the size of fastener measured in step 4 to the list of fasteners in chart 7 to find the correct torque value.

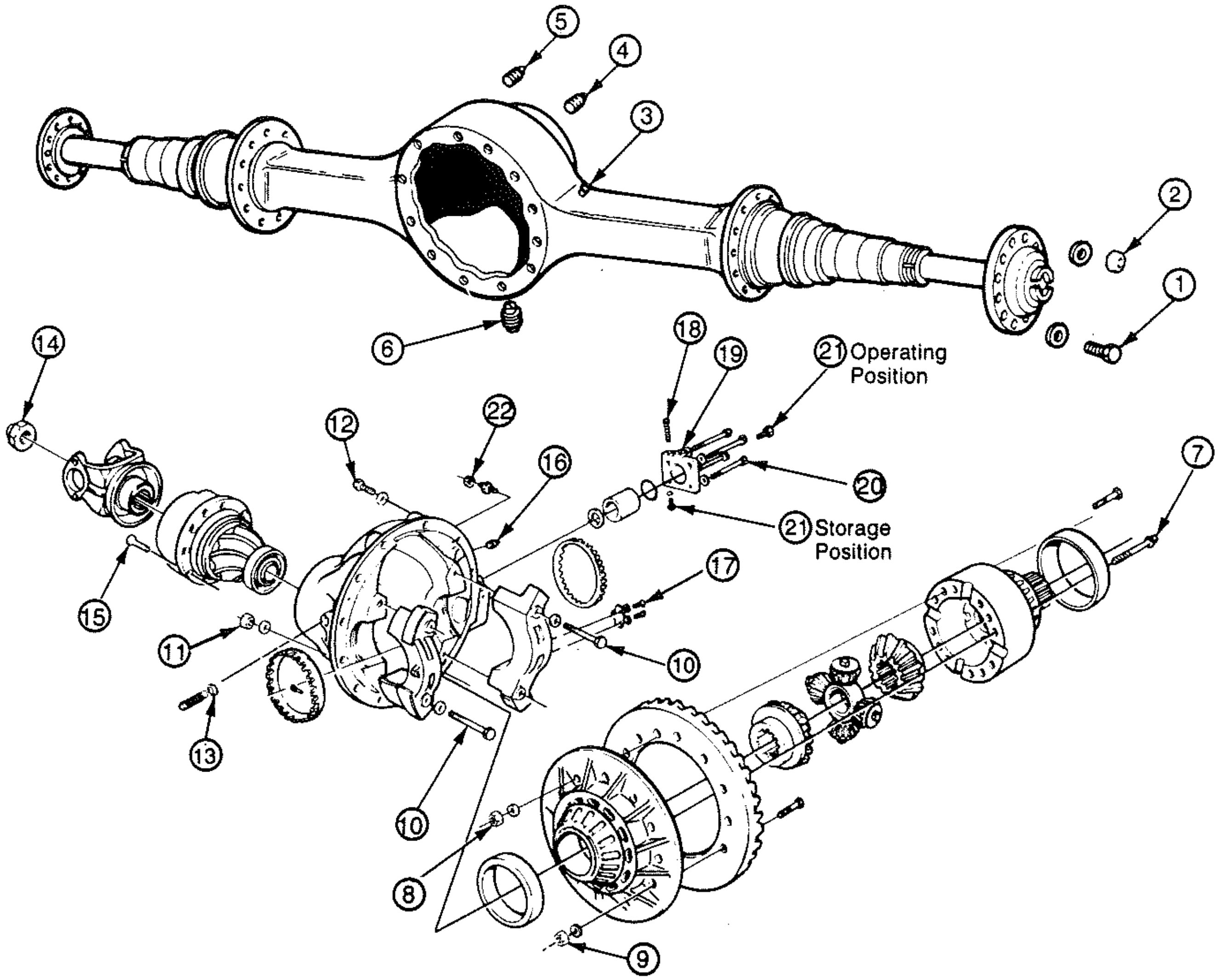


CHART 7

FASTENER TORQUE CHART

	FASTENER	THREAD SIZE	TORQUE VALUE lb-ft (N.m)	
1.	*Capscrew, Axle Shaft	.31-24 .50-13	18-24 85-115	(24-33) (115-156)
2.	*Nut, Axle Shaft Stud	Plain Nut .44-20 .50-20 .56-18 .62-18 Lock Nut .44-20 .50-20 .56-18 .62-18	 50-75 75-115 110-165 150-230 40-65 65-100 100-145 130-190	 (68-102) (102-156) (149-224) (203-312) (54-88) (88-136) (136-197) (176-258)

** Some Rockwell carriers do not have the parts described.*

Fastener Torque Information

CHART 7 (Continued)

	FASTENER	THREAD SIZE	TORQUE VALUE lb-ft (N.m)
3.	Breather	.38-18	20 minimum (27 minimum)
4.	*Plug, Oil Fill (Housing)	.75-14	35 minimum (47.5 minimun)
5.	*Plug, Heat Indicator	.50-14	25 minimum (34 minimum)
6.	Plug, Oil Drain	.50-14	25 minimum (34 minimum)
7.	Capscrew, Differential Case	.38-16 .44-14 .50-13 .56-12 .62-11	35-50 (48-68) 60-75 (81-102) 85-115 (115-156) 130-165 (176-224) 180-230 (244-312)
	Grade 10.9 Flange Head	M12 x 1.75	85-103 (115-140)
	Grade 10.9 Standard Hex Head	M12 x 1.75	75-95 (100-130)
	Grade 12.9 Standard Hex Head	M12 x 1.75 M16 x 2	105-125 (143-169) 203-251 (275-340)
8.	*Nut, Differential Case Bolt	.50-13 .50-20 .62-11 .62-18 M12 x 1.75	75-100 (102-136) 85-115 (115-156) 150-190 (203-258) 180-230 (244-312) 74-96 (100-130)
9.	*Nut, Ring Gear Bolt	.50-13 .50-20 .62-11 .62-18 M12 x 1.25 M12 x 1.75	75-100 (102-136) 85-115 (115-156) 150-190 (203-258) 180-230 (244-312) 66-81 (90-110) 77-85 (104-115)
	Flange Head	M16 x 1.5	192-214 (260-290)
	Standard Hex Head	M16 x 1.5	190-225 (260-305)
10.	Capscrew, Bearing Cap	.56-12 .62-11 .75-10 .88-14 .88-9 M16 x 2 M20 x 2.5 M22 x 2.5	110-145 (149-197) 150-190 (203-258) 270-350 (366-475) 360-470 (488-637) 425-550 (576-746) 181-221 (245-300) 347-431 (470-585) 479-597 (650-810)
11.	Nut, Housing to Carrier Stud	.44-20 .50-20 .56-18 .62-18	50-75 (68-102) 75-115 (102-156) 110-165 (149-224) 150-230 (203-312)
12.	Capscrew, Carrier to Housing	.44-14 .50-13 .56-12 .62-11 .75-10 M12 x 1.75 M16 x 2	50-75 (68-102) 75-115 (102-156) 110-165 (149-224) 150-230 (203-312) 270-400 (366-542) 74-89 (100-120) 181-221 (245-300)

** Some Rockwell carriers do not have the parts described.*

CHART 7 (Continued)

	FASTENER	THREAD SIZE	TORQUE VALUE lb-ft (N.m)
13.	*Jam Nut, Thrust Screw	.75-16 .88-14 1.12-16 M22 x 1.5 M30 x 1.5	150-190 (203-258) 150-300 (203-407) 150-190 (203-258) 148-210 (200-285) 236-295 (320-400)
14.	Nut, Drive Pinion	.88-20 1.0-20 1.25-12 1.25-18 1.50-12 1.50-18 1.75-12 M32 x 1.5 M39 x 1.5 M45 x 1.5	200-275 (271-373) 300-400 (407-542) 700-900 (949-1220) 700-900 (949-1220) 800-1100 (1085-1491) 800-1100 (1085-1491) 900-1200 (1220-1627) 738-918 (1000-1245) 922-1132 (1250-1535) 996-1232 (1350-1670)
15.	Capscrew, Bearing Cage	.38-16 .44-14 .50-13 .56-12 .62-11 M12 x 1.75	30-50 (41-68) 50-75 (68-102) 75-115 (102-156) 110-165 (149-224) 150-230 (203-312) 74-96 (100-130)
16.	*Plug, Oil Fill (Carrier)	.75-14 1.5-11.5 M24 x 1.5	25 minimum (34 minimum) 120 minimum (163 minimum) 35 minimum (47 minimum)
17.	*Capscrew, Lock Plate	.31-18 M8 x 1.25	20-30 (27-41) 21-26 (28-35)

THE FOLLOWING FASTENERS AND TORQUE VALUES ARE FOR DIFF. LOCK CARRIERS ONLY

18.	Capscrew, Manual Actuation (Storage Position)	M10 x 1.5	15-25 (20-35)
19.	Adapter, Air Cylinder	M12 x 1.5	22-30 (30-40)
20.	Capscrew, Air Cylinder Cover	M6 x 1	7.4-8.9 (10-12)
21.	Capscrew/Plug, Air Cylinder Cover (Operating Position) (Storage Position)	M10 x 1.5	 15-25 (20-35) 15-25 (20-35)
22.	Lock Nut, Sensor Switch	M16 x 1	26-33 (35-45)

** Some Rockwell carriers do not have the parts described.*

section 9 Adjustments and Specifications

DRIVE PINION BEARINGS - PRELOAD

		PAGE
Specification:	New bearings - 5 to 45 lb-in (.56 to 5 08 N m) torque Used bearings in good condition - 10-30 lb-in (1.13 to 3.39 N.m) torque	31
Adjustment:	Preload is controlled by the thickness of the spacer between bearings. To increase preload install a thinner spacer To decrease preload install a thicker spacer	

DRIVE PINION - DEPTH IN CARRIER

Specification:	Install the correct amount of shims between the bearing cage and carrier. To calculate, use old shim pack thickness and new and old pinion cone numbers.	35-37
Adjustment:	Change the thickness of the shim pack to get a good gear tooth contact pattern	

HYPOID GEAR SET - TOOTH CONTACT PATTERNS (HAND ROLLED)

Specification:	Conventional gear set - Toward the toe of the gear tooth and in the center between the top and bottom of the tooth Generoid gear set - Between the center and toe of the tooth and in the center between the top and bottom of the tooth	47-49
Adjustment:	Tooth contact patterns are controlled by the thickness of the shim pack between the pinion bearing cage and carrier and by ring gear backlash To move the contact pattern lower, decrease the thickness of the shim pack under the pinion bearing cage To move the contact pattern higher, increase the thickness of the shim pack under the pinion bearing cage To move the contact pattern toward the toe of the tooth decrease backlash of the ring gear To move the contact pattern toward the heel of the tooth increase backlash of the ring gear	

MAIN DIFFERENTIAL BEARINGS - PRELOAD

Specification:	15 to 35 lb-in (1.7 to 3.9 N.m) torque OR Expansion between bearing caps - RS-140 and RS-145 carrier models - .003 to .009 inch (.08 to .22 mm) All other carrier models - .006 to .013 inch (.15 to .33 mm)	43
Adjustment:	Preload is controlled by tightening both adjusting rings after zero end play is reached	

MAIN DIFFERENTIAL GEARS - ROTATING RESISTANCE

	PAGE
Specification: 50 lb-ft (68 N.m) torque applied to one side gear	41

RING GEAR - BACKLASH

Specification: Ring gears that have a pitch diameter of less than 17 inches (431.8 mm) Range - .008 to .018 inch (.20 to .46 mm) .012 inch (.30 mm) for a new gear set Ring gears that have a pitch diameter of 17 inches (431.8 mm) or greater Range - .010 to .020 inch (.25 to .51 mm) .015 inch (.38 mm) for a new gear set **Adjustment:** Backlash is controlled by the position of the ring gear. Change backlash within specifications to get a good tooth contact pattern. To increase backlash, move the ring gear away from the drive pinion To decrease backlash, move the ring gear toward the drive pinion	45

RING GEAR - RUNOUT

Specification: .008 inch (.20 mm) maximum	45

SENSOR SWITCH - INSTALLATION (CARRIERS WITH DIFF. LOCK ONLY)

Specification: Shift the differential to the locked position. Tighten the sensor switch into the carrier until the test light comes on. Tighten the sensor switch one additional turn and tighten lock nut to correct torque value.	58 Steps 13&14

SPIGOT BEARING - PEENING ON THE DRIVE PINION

Specification: Apply 3,000 kg (6,614 lb) load on a 10 mm or .375 inch ball. Peen the end of the drive pinion at a minimum of five points.	28-31
Softening of the pinion stem end by heating may be required.	30

THRUST SCREW OR THRUST BLOCK - CLEARANCE

Specification: .025 to .045 inch (.65 to 1.14 mm) OR Loosen the thrust screw 1/2 turn after tightening the thrust screw, hand tight, against the ring gear	50

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12

BRAKES AND AIR SYSTEM

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AIR SYSTEM

Description

The air system of the vehicle provides a means for braking, suspension, and for operating controls and accessories. This section deals with brake operation and some air-operated systems. The other air-operated systems are covered in their respective section. Details of the suspension system are covered in section 16 of this manual.

The basic air system consists of a compressor (which is mounted on and driven by the engine), air reservoirs, valves, filters, and the necessary fittings and piping.

AIR LINES

Air line diagram

For the complete description and location of all air system components, fittings and tubings, refer to the air line diagram annexed to this maintenance manual.

Air lines

Copper tubing, nylon-reinforced tubing, and flexible hoses are used to connect the units in the pressurized air system, including air brake system, suspension system, and accessory systems such as door, fresh air damper cylinder, air horns etc. Furthermore, the nylon tubing is color coded to ease identification. Refer to figure 1 for the complete color identification code. Service instructions for each type of air line are also provided under the applicable headings.

COLOR	CIRCUIT
Red	Secondary
Green	Primary & Delivery
Yellow	Parking Brake
Blue	Suspension
Black	Accessory
White	Entrance Door

FIG. 1 - Air line color code chart

Copper tubing

Annealed copper tubing with three-piece compression type fittings are used in the engine compartment where nonflexible hoses are required, but must be heat resistant. Connections should be checked for leakage at least every 5,000 miles (8 000 km), and tightened or replaced if necessary. When replacing copper tubing, the tubing must be free of burrs, copper cuttings, and dirt. Blow out tubing with compressed air. Any of the above-mentioned particles will destroy sealing seats in air control units. New tubing must be of the same size as the old one.

Always use new tubing ring when replacing a tubing. When tightening tube connector nuts, tighten to the specified torque to ensure an airtight connection (refer to heading *"Fitting tightening torques"* at the end of this section). Overtightening will cause leakage. Apply SAE 10 oil or spray white grease (Prevost part No. 68-0343) to ball sleeves, tubes, and male threads, then torque to the minimum value and check for leaks. If leaking, back off tube nut about 1/2 turn and retorque to a higher than minimum value.

Nylon tubing

Nylon tubing is used for air lines in areas where usage of this material is suitable. Nylon tubing is flexible, durable, and weather resistant. When replacing an air line, use nylon tubing only where it has been used previously. Teflon-braided stainless steel hoses used in the engine compartment must be replaced only with similar hoses.

CAUTION: Nylon air lines should be used to replace existing nylon lines only, and must comply with the color identification code to ease pneumatic system troubleshooting.

Nylon air lines must never be routed in areas where temperature could exceed 200 °F (93 °C).

Flexible hoses

A flexible hose is used normally where it is impractical to use copper or nylon tubing due to constant flexing during operation, such as brake chamber hoses or belt tensioner air cylinder hoses. Hose connections should be tested for leakage at least every 5,000 miles (8 000 km), and tightened or replaced if necessary. Any hose which is chafed, worn or kinked should be replaced.

Air line serviceability test

Operating test

If any trouble symptom such as slow brake application or slow brake release indicates a restricted or clogged air line, disconnect the suspected tube or hose at both ends and blow through it to clear the passage. Inspect tubing and hose for partial restriction that may be caused by dents or kinks. If such a condition is found, the tubing or hose should be replaced.

Leakage test

With air system fully charged and the brakes applied, coat all tubing and hose connections with a soapy solution to check for air leakage. No leakage is permissible. Leakage can sometimes be corrected by tightening the connection. If this fails to correct the leakage, new fittings, nylon tubing, copper tubing, teflon-braided stainless steel and flexible hoses must be installed as applicable.

Maintenance

Inspect all lines for cuts, swelling, kinks or other damage or deterioration. Check for lines being pinched by other components. Retaining clips and ties must be in place. Any support or bracket should be in good condition and mounted firmly in position. Hose spring guards should be in usable condition and not distorted. Particular attention should be given to long lines. Any supporting component (clips, ties, grommets, etc.) must be secured to prevent unnecessary vibrations and eventual loosening of connections. Any leak detected should be attended to. Be sure nylon lines are not near areas of intense heat. Check for any missing grommets or loom material where chafing or cutting may occur. Replace with new material as required. In general, lines should be securely located in position and free from any binding condition which would hinder air flow.

Air brake troubleshooting

The following tests and check lists have been designed to identify the cause(s) of a sluggish performance and/or leaks in the system. These tests require very little time to perform, and give you a general idea of the system condition. Each test is provided with a corresponding check list, that will guide you to the most common causes of problems.

Perform the following checks before carrying out the tests:

1. Examine all tubing for kinks or dents.

2. Examine all hoses for signs of wear, drying out or overheating.

WARNING: When working on or around brake system and its related components, the following precautions should be observed.

1. Always block vehicle wheels. Stop engine when working under a vehicle. Keep hands away from chamber push rods and slack adjusters as they may apply when system pressure drops.

2. Never connect or disconnect a hose or line containing air pressure. It may whip as air escapes. Never remove a component or pipe plug unless you are sure all system pressure has been depleted.

3. Never exceed recommended air pressure and always wear safety glasses when working with air pressure. Never look into air jets or direct them at anyone.

4. Never attempt to disassemble a component until you have read and understood the recommended procedures. Some components contain powerful springs and injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to the use of those tools.

5. Always clean connecting piping and/or fittings, and coat pipe threads with teflon pipe sealant before installing any air brake system component.

Pressure buildup / low pressure warning / cutoff point / governor cutout

CONDITION: Vehicle parked, wheels chocked

1. Drain air reservoirs to 0 psi (0 kPa).

2. Start engine, run at fast idle; low pressure warning lights should be *"On"*.

3. Start checking pressure at 50 psi (344 kPa).

4. Low pressure warning lights and buzzer should go off at or above 60 psi (415 kPa).

5. At 85 psi (586 kPa), run engine at full rpm, then check that build up time to 100 psi (690 kPa) is 30 seconds or less.

6. Governor cutout. Cuts out at correct pressure 120-125 psi (826-861 kPa).

7. Governor cut-in. Reduce service air pressure to governor cut-in. The difference between cut-in and cut-out pressures should not exceed 25 psi (172 kPa).

For common corrections, see the following check list.

If the low-pressure indicator cutout point is high or low:

1. Check dash gauge with a test gauge known to be accurate.
2. Repair or replace the defective low pressure indicator switches.
3. Repair or replace buzzer or light bulb, and check wiring.

If the governor cutout is early or late:

1. Check dash gauge with a test gauge known to be accurate.
2. Adjust governor to desired cutout.

OR

3. Repair or replace governor as necessary after checking that compressor unloader mechanism is operating correctly.

If pressure requires more than 30 seconds to build up from 85 to 100 psi (586-690 kPa) at full engine rpm:

1. Check dash gauge.
2. If compressor strainer or inlet line is restricted, clean or replace element or faulty line.
3. If compressor head or discharge line is carbonized or otherwise restricted, clean or replace.
4. If discharge valves are leaking, pull head and correct or replace cylinder head.
5. If drive is slipping, change gear as indicated.
6. If inlet valves are stuck, open or leaking severely, replace unloader kit, inlet valves and/or seats as necessary.
7. If drain cock is found open, close it.
8. If governor leaks when *"unloaded"*, clean or replace inlet valve or replace governor.
9. Listen for air leaks and repair.

Retest to check out all items repaired or replaced.

Air supply reservoir leakage

CONDITION: Full pressure, engine stopped, parking brake applied

1. Allow at least 1 minute so that pressure will stabilize.
2. Observe pressure gauge, time for 2 minutes and note any pressure drop.
3. Pressure drop should not be more than 3 psi (20 kPa) in 1 minute.

For common corrections, see the following check list.

If there is excessive leakage on reservoirs:

1. If discharge valves and/or discharge line check valve is leaking, repair or replace cylinder head and/or check valve as necessary.
2. If stoplight switch(es) is (are) leaking, repair or replace as necessary.
3. If foot brake is leaking, repair or replace inlet valve or replace unit.
4. If supply or inlet valve, or relay or relay emergency valve is leaking, replace the defective parts or replace valve.
5. If safety valve is leaking, clean or replace parts or replace valve.
6. If governor leaks when *"unloaded"*, clean or replace parts or replace valve.
7. Listen for leaks in *"pressure"* or *"reservoir"* side of system, and correct as required.

Retest to check out all items repaired or replaced.

Service air delivery leakage

CONDITION: Full pressure, engine stopped, parking brake released

1. Apply foot brake, allow at least 1 minute so that pressure will stabilize.
2. Hold foot valve application, observe gauge and time for 2 minutes.
3. Pressure drop should not be more than 4 psi (27 kPa) in 1 minute.

For common corrections, see the following check list.

If there is excessive leakage on the service side:

1. If foot exhaust valve is leaking, repair or replace valve or replace unit. If one or the other valves leaks in released position when other valve is applied, check for leaking double check valve, and repair or replace device.
2. If stoplight switch(es) is (are) leaking, repair or replace as necessary.
3. If exhaust valve, relay piston, or diaphragm in relay is leaking, clean or replace parts or replace as necessary.
4. If quick release valve is leaking, clean or replace parts or replace as necessary.
5. If brake chamber diaphragm is leaking, replace it.
6. Listen for any other leak in *"application"* side of system and correct as necessary.

Retest to check out all items repaired or replaced.

BRAKE OPERATION

Description

The vehicle braking system uses both service and parking air-operated brakes. The air system is divided in two (2) independent circuits to isolate the front axle brakes and the rear axle brakes (drive and tag), thus providing safe braking operation in the event that one circuit of the system fails. The primary circuit is connected to the drive and tag axle brakes, while the secondary circuit is connected to the front axle brakes. The tag axle service brakes operate only when the axle is in the normal driving (loaded) position. The spring-type emergency brakes are mounted on the drive axle, and will apply automatically if primary system pressure falls below 40 psi (276 kPa). The optional parking brake override system can cancel the parking brakes, in order that the driver moves the vehicle to a safe parking place. To operate this system, push down and hold the control knob located on the R.H. lateral console (See *"Operator's Manual"* for more details).

Furthermore, the brake application sequence, which is speeded up by a pneumatic relay valve (R-12), will start with the rear axles and will then be followed by the front axle, thus providing uniform braking on a very slippery road. The vehicle may also be equipped with an **A**nti-Lock **B**raking **S**ystem (ABS), which is detailed later in this section.

AIR COMPRESSOR

Maintenance and repair information on the TU-FLO 750 air compressor are supplied in the applicable booklet annexed to this section under reference number SD-01-344.

GOVERNOR

Maintenance and repair information on D-2 governor are supplied in the applicable booklet annexed to this section under reference number SD-01-16.

PUSH-PULL CONTROL VALVE (PP-2)

A push-pull control valve mounted on the R.H. lateral console is provided for parking brake application or release. Maintenance and repair information on this valve are supplied in the applicable booklet annexed to this section under reference number SD-03-61.

FLIP-FLOP CONTROL VALVE (TW-1)

A flip-flop control valve mounted on the R.H. lateral console is provided to unload tag axle air springs (and to lift tag axle if vehicle so equipped). Maintenance and repair information on this valve are supplied in the applicable booklet annexed to this section under reference number SD-03-64.

DUAL BRAKE APPLICATION VALVE (E-10)

Brake pedal adjustment

After brake pedal replacement or repair, install the pedal to its proper position according to the following procedure:

Situation 1: The dual brake application valve (E-10) has been changed.

1. Without the linkage between brake pedal and service brake valve (E-10), adjust the brake pedal maximum travel according to figure 2. When maximum travel ends, pedal resistance will increase abruptly.
2. If maximum travel is incorrect, unscrew the locknut at the bottom of valve pivot (refer to fig. 2) and loosen or tighten the adjusting screw to obtain a maximum travel of 9/16" (15 mm), then tighten the locknut.
3. Replace the linkage, loosen threaded rod locknuts, and screw or unscrew the threaded adjustment rod in order to obtain a brake pedal inclination corresponding to 45° (refer to fig. 2). Tighten threaded rod locknuts.

Situation 2: Only brake pedal has been changed.

1. When only the brake pedal has been removed, proceed with step 3, i.e the adjustment of brake pedal inclination (45° angle).

Dual brake application valve maintenance

Maintenance and repair information on the E-10 dual brake application valve are supplied in the applicable booklet annexed to this section under reference number SD-03-5.

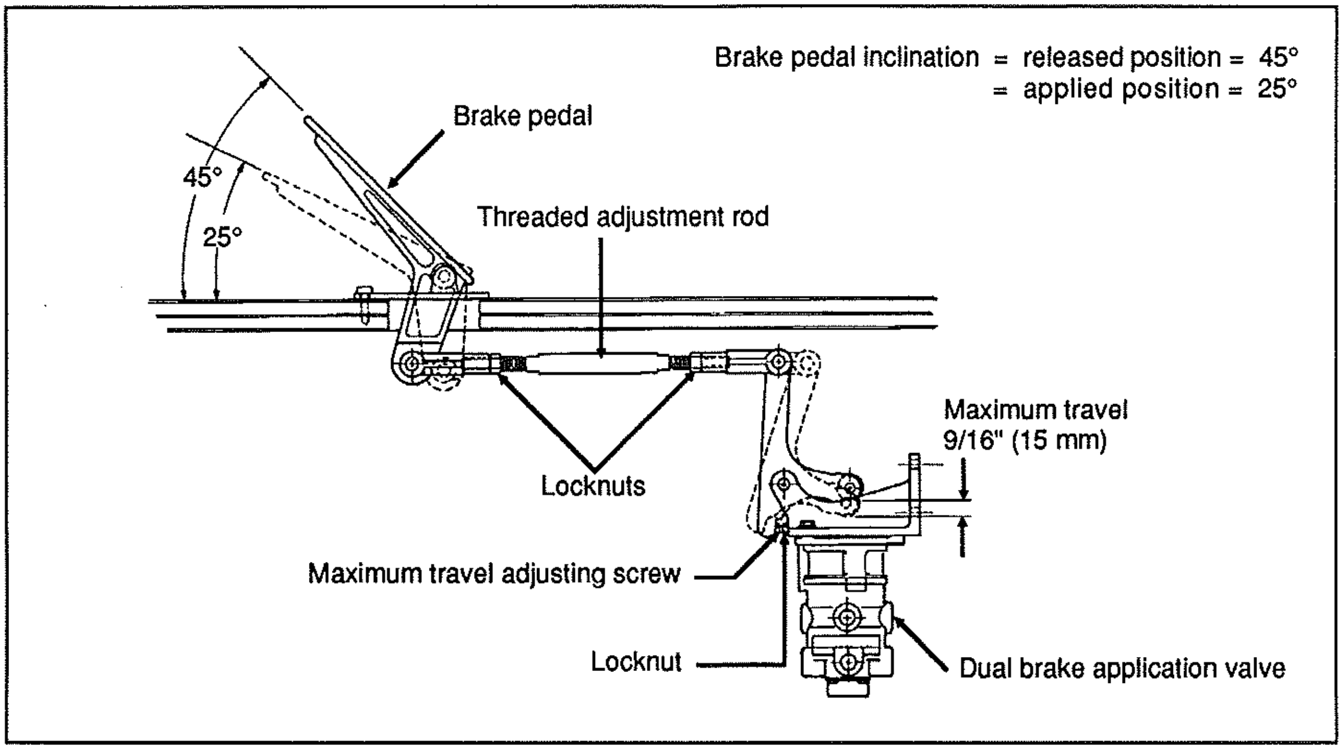

FIG. 2 - Brake pedal adjustment

STOPLIGHT SWITCHES

Two electro-pneumatic stoplight switches are mounted on the dual brake application valve (E-10). The upper one is used for the primary air circuit while the lower one is used for the secondary air circuit. Both switches are connected in parallel and have the same purpose, i.e. completing the electrical circuit and lighting the stoplights when a brake application is made. The switches are designed to close their contacts before 6 psi (41 kPa). The switches are not a serviceable item; if found defective, the complete unit must be replaced.

BRAKE RELAY VALVES (R-12)

Three brake relay valves are provided on this vehicle; one is mounted on the drive axle service brake air line, while the two other ones are mounted on the tag axle service brake air line and act as interlock valves. Maintenance and repair information on these valves are supplied in the applicable booklet annexed to this section under reference number SD-03-31.

QUICK RELEASE VALVES (QR-1)

Two quick release valves are provided on this vehicle; one is mounted on the front axle service brake air line, while the other one is mounted on the drive axle emergency brake air line. Maintenance and repair information on these valves are supplied in the applicable booklet annexed to this section under reference number SD-03-69.

SPRING BRAKE VALVE (SR-1)

Maintenance and repair information on the spring brake valve are supplied in the applicable booklet annexed to this section under reference number SD-03-87. This valve is installed on the valve mounting plate, which is located on the R.H. side in the front service compartment (see fig. 3 for location, and 4 for details).

PRESSURE PROTECTION VALVE (PR-2)

Maintenance and repair information on the pressure protection valve are supplied in the applicable booklet annexed to this section under reference number SD-03-55. This valve is installed on the valve mounting plate, which is located on the R.H. side in the front service compartment (see fig. 3 for location, and 4 for details). The primary function of this valve is to protect the main air system by ensuring at all times a sufficient air pressure in the main system (i.e. air delivered to the accessories will be shut off in case of a decrease in pressure). This valve remains closed until a preset pressure is reached (approximately 60 psi (415 kPa)). It then opens and passes air out the delivery port.

LOW PRESSURE INDICATORS (LP-3)

Maintenance and repair information on the low pressure indicators are supplied in the applicable booklet annexed to this section under reference number SD-06-2. These switches are installed on the valve mounting plate, which is located on the R.H. side in the front service compartment (see fig. 3 for location, and 4 for details).

SHUTTLE-TYPE DOUBLE CHECK VALVE (DC-4)

Maintenance and repair information on the shuttle-type double check valve are supplied in the applicable booklet annexed to this section under reference number SD-03-67. This valve is installed on the valve mounting plate, which is located on the R.H. side in the front service compartment (see fig. 3 for location, and 4 for details).

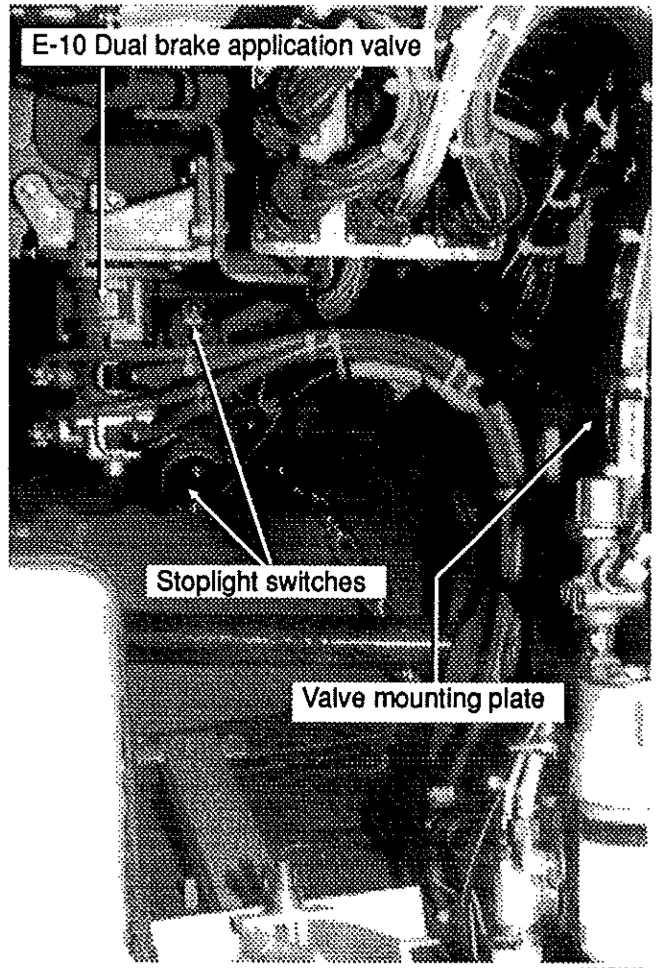

FIG. 3 - Front service compartment

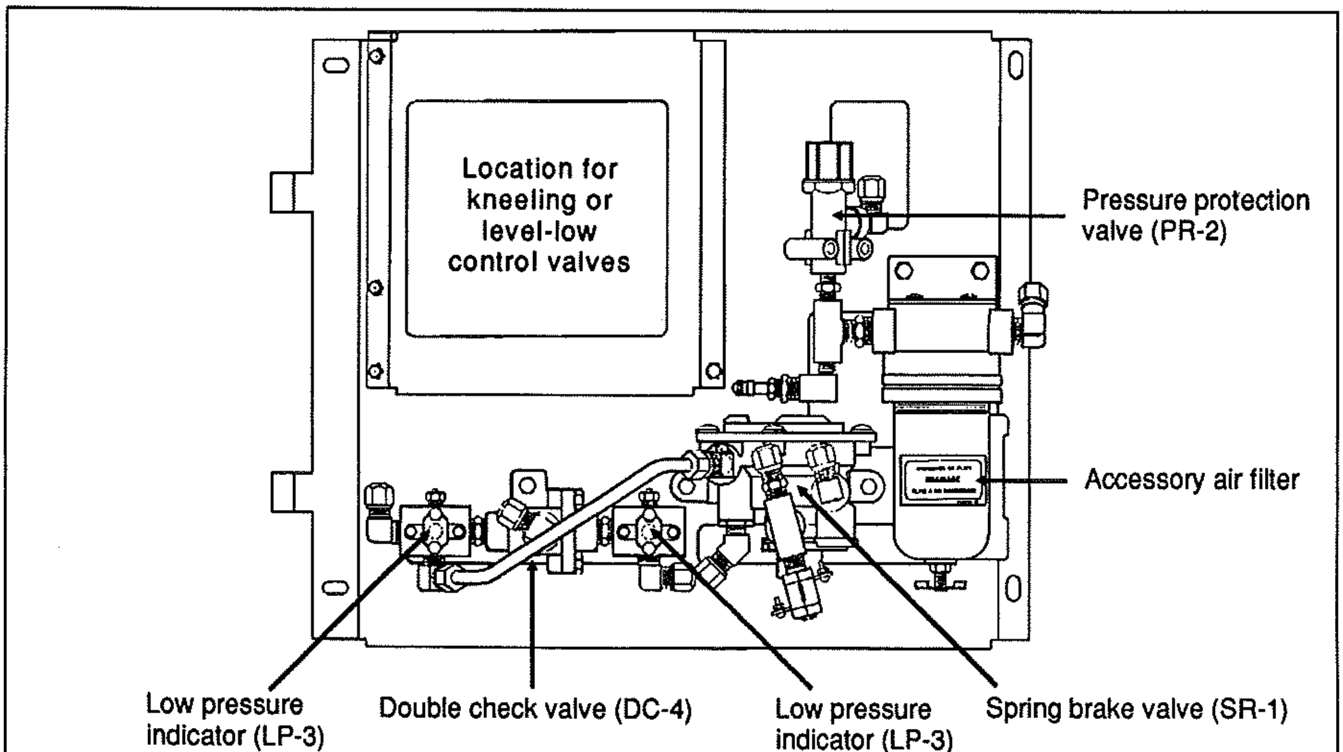

FIG. 4 - Valve identification on mounting plate

AIR GAUGES (PRIMARY AND SECONDARY)

The air pressure gauges, located on the central dashboard panel (see *"Operator's Manual"*), are connected to the DC-4 double check valve, which is located on the R.H. side of the front service compartment. The latter is connected to the air lines running from the primary and secondary air tanks, as shown on the pneumatic system diagram annexed to this manual.

The vehicle should never be set in motion until the buzzer alarm and warning lights turn off, i.e when air pressure registers at least 65 psi (448 kPa). Moreover, if pressure drops below 65 psi (448 kPa), the *"Low air pressure"* warning lights will turn on, and the *"Low air pressure"* buzzer will sound. Stop the vehicle immediately, determine and correct the cause(s) of pressure loss. Check the gauges regularly with an accurate test gauge. Replace the gauge with a new unit if there is a variation of 4 psi (27 kPa) and over in reading.

DOOR EMERGENCY RELEASE VALVE

The entrance door of the vehicle is provided with an emergency release valve (located over the door), in the event of possible malfunction of its main control or failure of its internal components. The emergency release valve cuts off the air supply to the door spindle drive motor, and simultaneously exhausts the delivery line air and the spindle drive motor remaining air, thus allowing door to be manually operated during an emergency. The door emergency release valve should be checked periodically for leakage by applying a soapy solution to the exhaust ports while the valve is closed. Internal leakage will be evident with the appearance of bubbles. If leakage is noted, or valve fails to operate properly, remove and repair, or replace valve.

Removal and installation

1. Remove the three snap caps and retaining screws from the door column upper mounting support cover, then remove cover.
2. Remove the valve T-handle screw.
3. Remove screw retaining the curtain R.H. slide to the windshield post molding.
4. Remove the two snap caps and retaining screws from the R.H. windshield post molding, then remove molding.
5. Disconnect the supply and delivery air lines from valve.
6. Remove the two screws retaining the valve support to the door frame, then the two screws retaining valve to its support.
7. Repair valve or replace as necessary.

To install, reverse removal procedure.

FRONT AXLE BRAKE CHAMBER

Preventive maintenance

Every 8000 miles (13 000 km) or 300 operating hours, depending on type of operation.

1. Check push rod travel and adjust travel at the slack adjuster if required. Push rod travel should be as short as possible without brakes dragging. Excessive push rod travel reduces braking efficiency, shortens diaphragm life, gives slow braking reponse and wastes air.
2. Check push rod to slack adjuster alignment from release to full stroke position, to ensure push rod moves out and returns properly without binding to the non-pressure plate hole or with other structures.
3. Check tightness of mounting nuts. Ensure that cotter pins are in place.
4. Check all hoses and lines. They should be secure and in good condition.

Every 100,000 miles (160 000 km) or 3600 operating hours, depending on type of operation.

1. Disassemble and clean all parts.
2. Install new diaphragm or any other part if worn or deteriorated. When the diaphragm, spring, or both are replaced, they should be replaced in the corresponding chamber on the same axle.

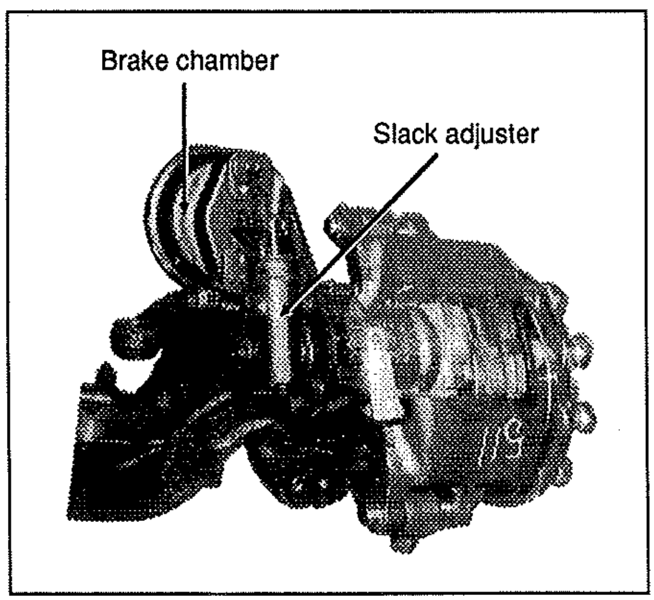

FIG. 5 - Front axle brake chamber and slack adjuster installation

Operating and leakage tests

Operating test

1. Apply brakes and observe the push rods move out promptly without binding.

2. Release brakes, and observe that the push rods return promptly and without binding to the released position.

3. Check push rod travel. Push rod travel should be as short as possible without brakes dragging. Adjust travel of push rod at slack adjuster if necessary.

Leakage test

1. Make and hold a full brake application.

2. Coat clamping ring(s) with a soapy solution. If leakage is detected, tighten clamping ring only enough to stop leakage. ***Do not overtighten*** as this can distort sealing surface or clamping ring. Coat area around push rod hole (loosen boot if necessary). No leakage is permitted. If leakage is detected, the diaphragm must be replaced.

Removal and installation

Removal

1. Block vehicle wheels.
2. Release air pressure in all reservoirs.
3. Disconnect the chamber air hose.
4. Remove the yoke pin.
5. Remove the brake chamber.

Installation

1. Mount brake chamber to mounting bracket.

2. Install yoke (if removed) and yoke pin.

3. Check the angle formed by the centerline of the push rod and the slack adjuster. This angle should be greater than 90° in released position and lower than 90° in applied position.

4. Connect air hose to chamber. Check that hoses are properly supported and clamped as necessary to provide proper clearance.

Disassembly

Clean exterior of brake chamber and mark position of parts with respect to each other, so that it may be reassembled in the same way.

NOTE: If the brake chamber is to be dismantled without removing the non-pressure plate from vehicle, slack adjuster should be backed-off.

1. Pull out (or push out with air pressure) push rod and clamp it to the non-pressure plate. If using *"vise grip"* pliers, push rod should be protected so that it will not be damaged.

2. Remove clamp ring nut and bolt (refer to fig. 6 for details).

3. Spread the ring slightly, just enough to slip it off the plate. Care should be used so that clamp ring is not distorted.

4. Remove pressure plate and diaphragm.

5. Remove yoke locknut and yoke from push rod, then release pressure on push rod, being careful to hold the push plate and the non-pressure plate until the return spring load is released.

6. Remove push rod assembly and spring.

7. Remove boot or O-ring (if applicable).

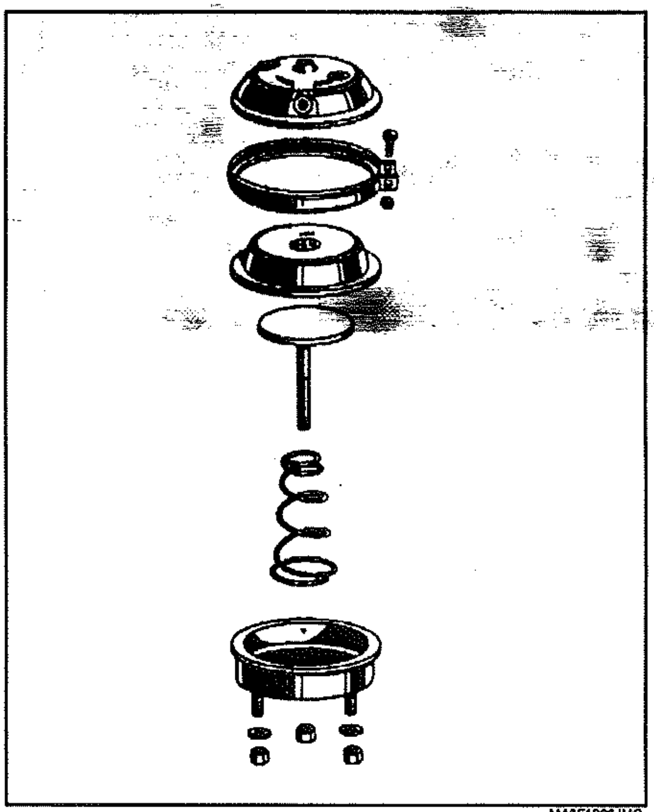

FIG. 6 - Disassembly of front axle brake chamber

Cleaning and inspection

1. Clean all metal parts in cleaning solvent, taking care to remove all rust and scale. All diaphragm sealing surfaces should be smooth and clean.

2. Inspect carefully all metal parts for cracks, distortion or damage.

3. Replace all rubber parts and any other part not considered serviceable.

Assembly

1. Place push rod assembly upright on a flat surface.

2. Position return spring on push rod.

3. Install boot or O-ring (if applicable) on non-pressure plate.

4. Position non-pressure plate on push rod, and press plate down against spring tension until plate bottoms on flat surface. Clamp rod with *"vise grip"* pliers (while protecting rod) to the plate.

5. Position ring over clamping surface of non-pressure plate.

6. Check alignment marks (made before disassembly), position diaphragm in pressure plate and place assembly on non-pressure plate.

7. Work the clamp ring over the clamping surface of the pressure plate and draw the clamp lugs together with *"vise grip"* pliers or a similar tool. Install bolt and nut in clamp and tighten, tapping with a soft-faced mallet to center the clamp ring if necessary. Release pressure on push rod and install remaining bolt and nut.

8. Tighten nut and bolt evenly and sufficiently to eliminate leakage.

Testing of a rebuilt brake chamber

Perform tests outlined under heading *"Operating and Leakage Tests"*.

DRIVE AXLE BRAKE CHAMBER

Description

The drive axle brake chamber combines the functions of a conventional service brake chamber, along with a secondary diaphragm and locking mechanism to give emergency and parking operation (see fig. 7 for details).

WARNING: Spring brake chambers contain an extreme high pressure spring, which can possibly cause serious injuries if special precautions are not taken when working around this area. To avoid such injuries, the following recommendations must be applied:

1) Prevost recommends the installation of a new spring brake chamber if it is found defective.

2) Spring brake chamber maintenance and/or repairs must be performed by a trained and qualified personnel only.

3) Before manually releasing spring brakes, visually check spring brake chambers for cracks and/or corrosion.

4) Check that the cross pin of the release tool is securely inserted and seated in pressure plate receptacle before turning the nut to cage the spring.

5) Never stand in the axis line of the spring brake chambers, especially when compressing the spring.

Maintenance

Every 5,000 miles (8 000 km) depending on type of operation:

1) Check push rod travel and adjust travel at the slack adjuster as necessary. Push rod travel should be as short as possible without brake dragging.

2) Check push rod to slack adjuster alignment from release to full stroke position, to ensure that push rod moves out and returns properly without binding. Also check the angle formed by the slack adjuster arm and the push rod. It should be 90° or greater when the chamber is in the released position.

3) Check tightness of mounting nuts. Check that cotter pins are in place.

4) Check all hoses and lines. They should be secure and in good condition.

Every year or after 100,000 miles (160 000 km), depending on type of operation:

1) Disassemble and clean all parts.

2) Install new diaphragm or any other part if worn or deteriorated.

NOTE: When the diaphragm, spring, or both are replaced, they should be replaced with the corresponding chamber on the same axle.

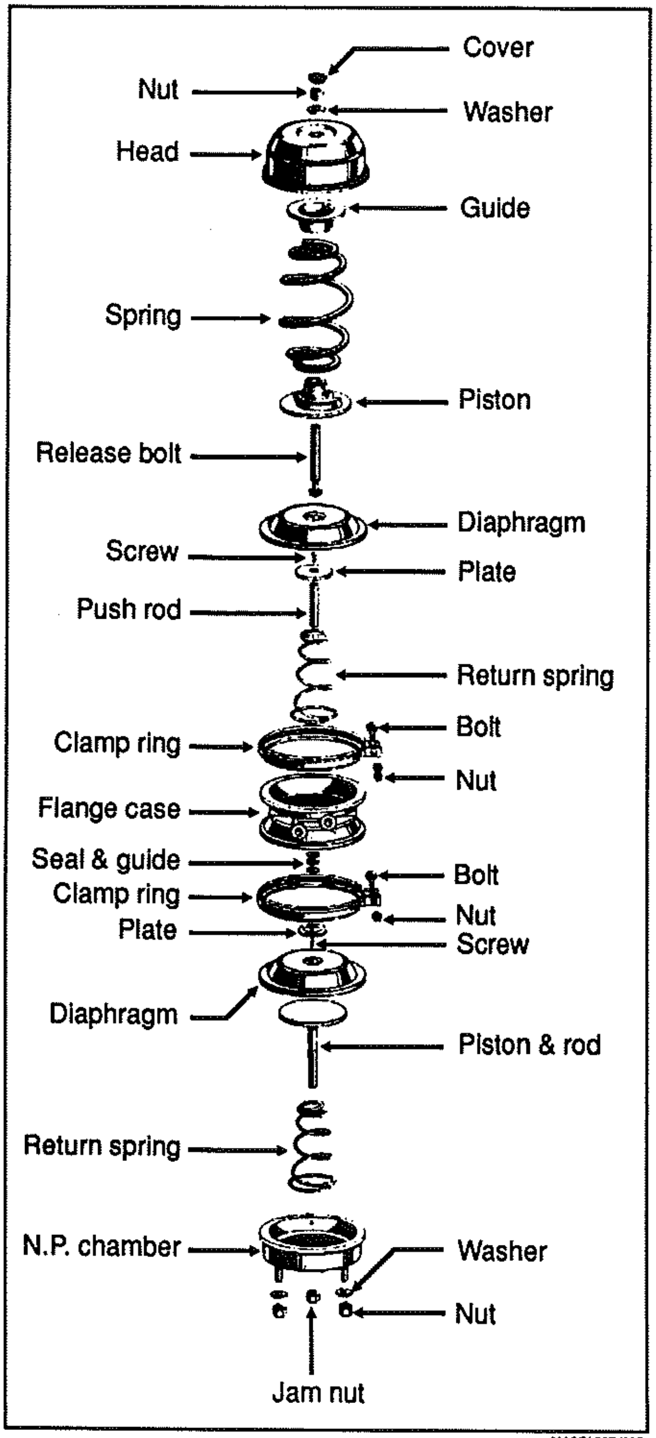

FIG. 7 - Disassembly of spring brake chambers

Leakage test

1) Make and hold a full brake application.

2) Coat clamping ring(s) with a soapy solution. If leakage is detected, tighten clamping ring(s) only enough to stop leakage. ***Do not overtighten*** as this can distort clamping ring. Coat area around push rod hole. No leakage is permitted. If leakage is detected, the diaphragm must be replaced.

Removal and installation

Removal

1) Block and hold vehicle wheels by means other than the parking brake.

2) Apply parking brake.

3) Release spring brakes mechanically.

4) Disconnect air lines from chamber.

5) Remove the yoke pin.

6) Unscrew brake chamber retaining bolts, then remove the brake chamber.

Installation

1) Mount brake chamber to mounting bracket and tighten retaining bolts.

2) Install yoke pin.

3) Check the angle formed by the push rod and the slack adjuster arm. It should be greater than 90° in the released position.

4) Connect air lines to chamber. Check that hoses are properly supported in order to provide proper clearance.

Diaphragm replacement

1) Clean exterior of brake chamber and mark port position with respect to each other so that it may be assembled in the same manner.

2) Release spring brakes mechanically.

3) Remove spring brake clamps and/or service brake clamps depending on which diaphragm has to be replaced.

4) Remove chamber assembly.

5) Discard old diaphragm from chamber and replace with new diaphragm.

6) To reassemble the unit, reverse the procedure. Tap clamps to insure proper seating.

TAG AXLE BRAKE CHAMBER

Since the tag axle brake chambers are similar to those on front axle (except for size), refer to previous heading *"Front axle Brake Chamber"* in this section for maintenance and service.

AIR RESERVOIRS

Location & function

Refer to figure 8 for location of the five air reservoirs. Each reservoir has a specific function: one serves as the wet tank, one for the primary brake system, one for the secondary brake system, and the remaining two are respectively for the pneumatic accessories and the optional kneeling system.

Maintenance

The accessory and wet air tanks must be drained daily before operating vehicle, while the primary and secondary air tanks (as well as the kneeling air tank, if so equipped) must be drained each time the engine oil and filter are changed (10 000 miles (16 000 km) maximum intervals).

The accessory air tank is installed at ceiling of the spare tire compartment. To ease maintenance routine, its drain cock is mounted in front service compartment (see fig. 9). The wet tank is installed over the drive axle (L.H. side) and provided with a drain cock at its bottom; furthermore, another drain cock, indirectly connected to this tank, is mounted in engine compartment and is accessible from the engine compartment R.H. side door in order to ease routine maintenance (see fig. 10). The other tanks which require less maintenance are only provided with a bottom drain cock.

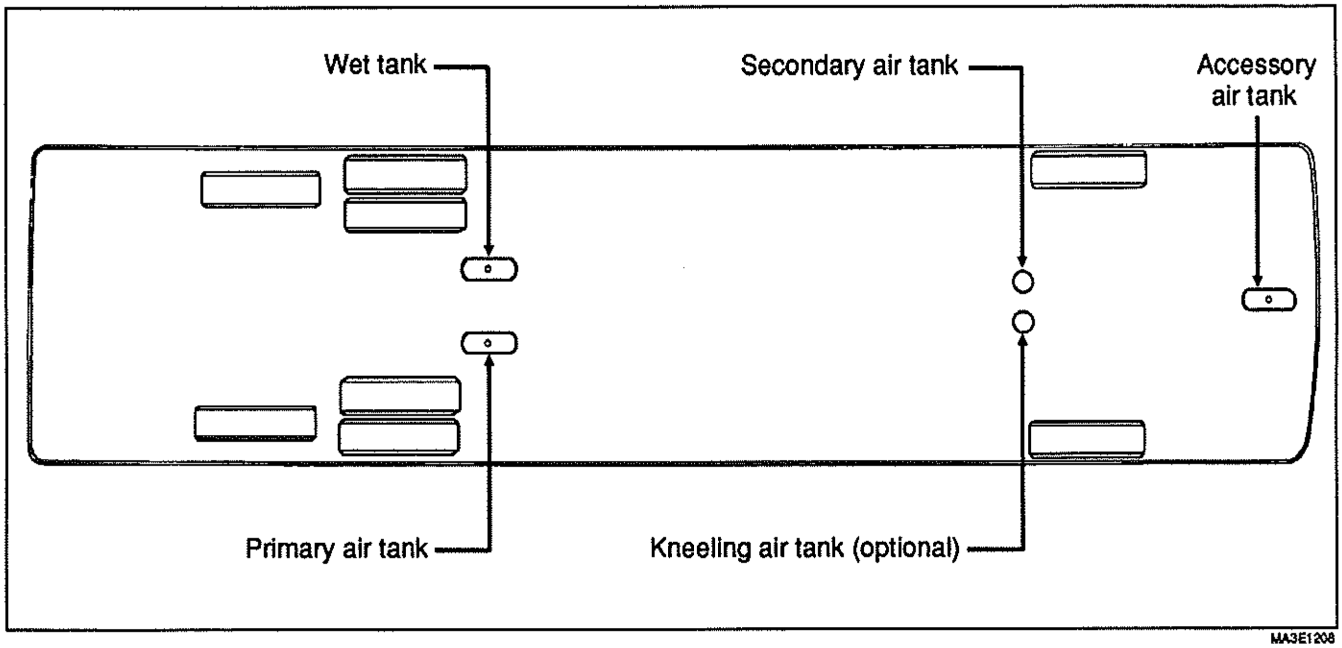

FIG. 8 - Location and function of air reservoirs

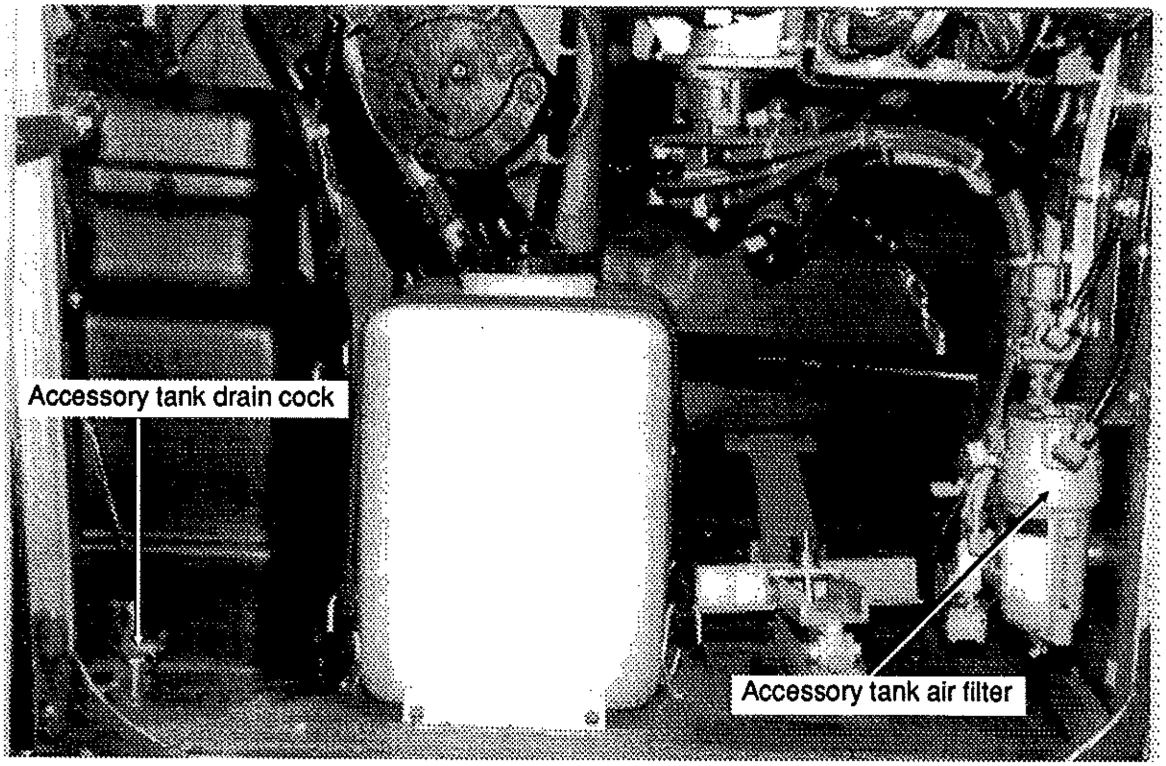

FIG. 9 - Front service compartment

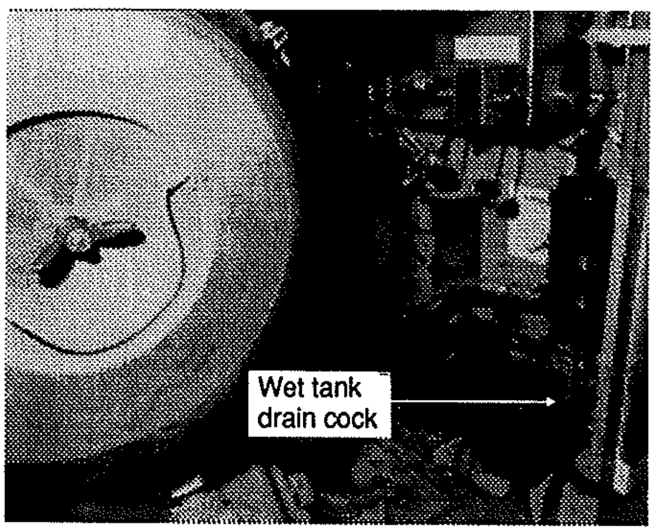

FIG. 10 - Engine compartment

ACCESSORY AIR FILTER

Description

This filter is located inside the front service compartment (see previous fig. 9), and its main function consists in straining the air supply of the accessory air reservoir, when it is connected to an external air supply line. The filter is also provided with a sight glass indicator, thus giving the condition of the pneumatic system at a glance.

Maintenance

Maintenance of this filter is limited to the replacement of the cartridge element, whenever differential pressure exceeds 15 psi (103 kPa) between the inlet and the outlet.

Cleaning

1. Clean bowl using warm water only. Clean other parts using warm water and soap.

2. Dry parts and blow out internal passages in body using clean dry compressed air. Blow air through filter element from the inside towards the outside to dislodge surface contaminants. Replace filter element when plugged.

3. Inspect all parts carefully and replace damaged parts.

AIR DRYER (AD-4)

Maintenance and repair information on the air dryer are supplied in the applicable booklet annexed to this section under reference number SD-08-4. Air dryer is mounted on the rear subframe right over the drive axle (see fig. 11).

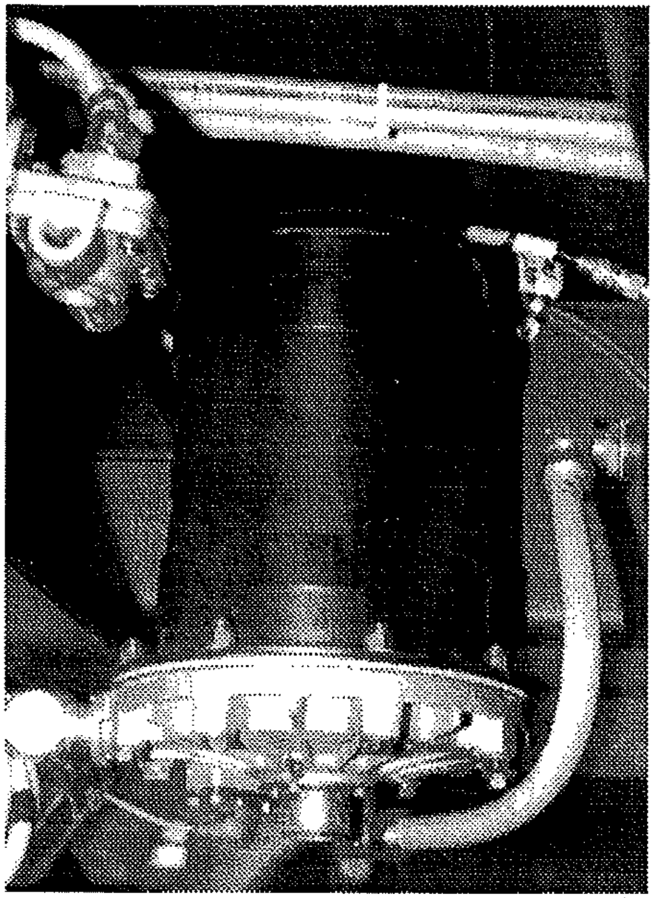

FIG. 11 - Air dryer installation (AD-4)

BELT TENSIONER PRESSURE REGULATING VALVE

Description

A pressure regulating valve located on the structure post at left of the oil reserve tank in engine compartment (see fig. 12) is used to limit the air pressure in belt tensioners to 75 psi (517 kPa). The pressure regulating valve controls pressure in both belt tensioner cylinders as these latters are paralleled mounted.

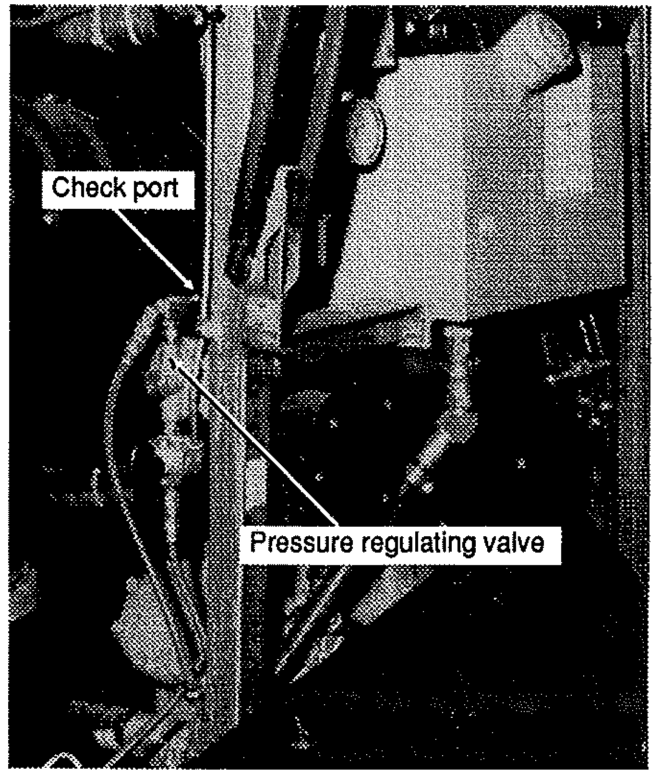

FIG. 12

Maintenance

Every 50,000 miles (80 000 km) or yearly, disassemble valve and wash all metal parts in a cleaning solvent (refer to fig. 13 for details). Examine the diaphragm; if cracked, worn or damaged, replace with new diaphragm. If the valve is excessively grooved or pitted, it should be replaced. Replace any other parts that appear worn or damaged. After valve is assembled, adjust the valve to the specified pressure setting and check for air leakage.

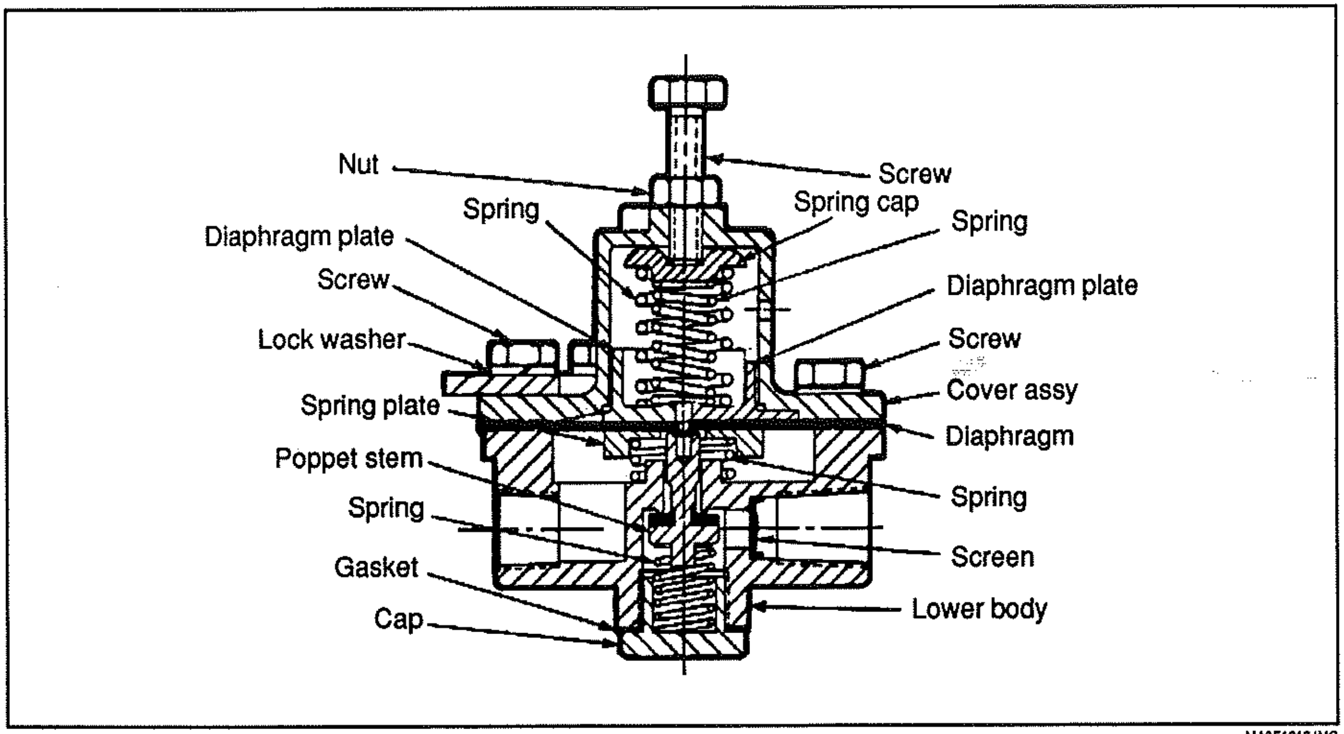

FIG. 13 - Air pressure regulator

Pressure setting procedure

Remove the dust cap from the pressure check port. Attach a pressure gauge at this port and check the pressure reading. If the pressure reading is not correct, it can be adjusted by means of the screw on top of the regulating valve as follows:

1. Loosen the locknut, turn the adjusting screw counterclockwise to decrease pressure approximately 10 psi (69 kPa) below the required pressure (75 psi (517 kPa)).

2. Turn the adjusting screw clockwise to increase the pressure slowly until the required pressure setting (75 psi (517 kPa)) is reached. Tighten the locknut.

3. Replace dust cap on the pressure check port.

AIR BRAKES

Description

The Rockwell *"Dura-Master"* air disc brakes are used on front and tag axles. These ventilated-type discs are actuated by 24 square inch effective area air brake chambers on the front axle, and 16 square inch effective area air brake chambers on the tag axle. As for the drive axle, 30-36 Anchorlok spring brakes actuate standard Rockwell drum brakes. Since the disc brakes are very sensitive to adjustment, automatic slack adjusters are standard equipment on all axles. Furthermore, all the brake lining material is asbestos free.

From a maintenance point of view, disc brake pad replacement is much more easier since only the wheels have to be removed to gain access to the brake pads; the brake pads are identified (inner & outer), and wear indicators are provided to ease inspection. The manufacturer's brochure (Field Maintenance Manual No 4M), annexed to this section, will give you all the necessary information related to the maintenance of the disc brakes and brake pad replacement. As for the drive axle brake drum, it is of a conventional design; so the maintenance and brake shoe replacement should be made according to the standard procedures.

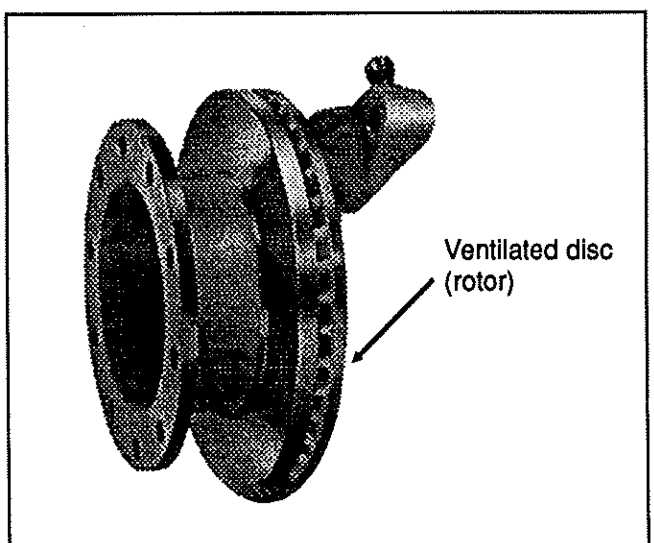

FIG. 14

RECOMMENDED BRAKE SERVICE PROCEDURES TO REDUCE EXPOSURE TO NON-ASBESTOS FIBER DUST

Description

Most brake linings no longer contain asbestos fibers. Non-asbestos brake linings use one or more of the following fibers instead of asbestos: fiberglass, mineral wool, aramid, ceramic or carbon. Current OSHA (Occupational Safety and Health Administration) regulations do not cover all non-asbestos fibers. Medical experts do not agree about the possible long term risks of working with and breathing non-asbestos fibers. However, some experts think that long term exposure to some non-asbestos fibers could cause pneumonconiosis, fibrosis and cancer. Therefore, lining suppliers recommend that workers use caution to avoid dust when working on brakes that contain non-asbestos materials.

WARNING:

1. Whenever possible, work on brakes in a separate area away from other operations.

2. Always wear a respirator approved by NIOSH (National Institute of Occupational Safety and Health) or MSHA (Mine Safety and Health Administration) during all brake service procedures. Wear the respirator from removal of the wheels through assembly.

3. NEVER use compressed air or dry brushing to clean brake parts or assemblies. OSHA recommends that you use cylinders that enclose the brake. These cylinders have vacuums with high efficiency (HEPA (Health and Environment Protection Agency)) filters and worker's arm sleeves. But, if such equipment is not available, carefully clean parts and assemblies in the open air.

4. Clean brake parts and assemblies in the open air. During disassembly, carefully place all parts on the floor to avoid getting dust into the air. Use an industrial vacuum cleaner with an HEPA filter system to clean dust from the brake drums, backing plates and other brake parts. After using the vacuum, remove any remaining dust with a rag soaked in water and wrung until nearly dry.

5. Grinding or machining brake linings. If you must grind or machine brake linings, take additional precautions because contact with fiber dust is higher during these operations. In addition to wearing an approved respirator, do such work in an area with exhaust ventilation.

6. Cleaning the work area. NEVER use compressed air or dry sweeping to clean the work area. Use an industrial vacuum with an HEPA filter and rags soaked in water and wrung until nearly dry. Dispose of used rags with care to avoid getting dust into the air. Use an approved respirator when emptying vacuum cleaners and handling used rags.

7. Worker clean-up. Wash your hands before eating, drinking or smoking. Do not wear your work clothes home. Vacuum your work clothes after use and then launder them separately, without shaking, to prevent fiber dust from getting into the air.

8. Material safety data sheets on this product, as required by OSHA, are available from Rockwell.

BRAKE PAD REPLACEMENT

Replace brake pads as explained in the Rockwell brochure entitled *"Field Maintenance Manual No 4M"* annexed to this section. Furthermore, keep in mind the following recommendations:

1. The gap between the pads and the disc must vary between .030" (0,76 mm) and .045" (1,14 mm) on each side of the disc, or between .060" (1,52 mm) and .090" (2,29 mm) for a total gap.

2. After each pad replacement, the pads should have a conditioning ("burnishing") in order to reach the normal friction coefficient. This conditioning is obtained by rubbing the pads against the rotor. Perform the procedure hereafter following pad replacement.

BRAKE CONDITIONING ("BURNISHING")

NOTE: The following procedure should be performed following drum as well as disc brake lining replacement.

WARNING: Proceed with brake lining *"burnishing"* on a road where there is very light traffic, and ensure there is no vehicle following you during this procedure to avoid possible accident.

1. With the transmission in the highest gear, make 10 *"snub"* brake applications at exactly every one-half mile regular interval as you decelerate from 50 to 30 mph (80 to 50 km/h).

2. Check drum and rotor temperatures immediately after completing the above burnishing. Any drum or rotor that is significantly cooler than the others indicate a lack of braking effort on those wheels; in this case, repeat burnishing.

3. Allow all the wheel-end brakes to completely cool, thus having them return to the ambient temperature.

4. Repeat 10 more brake snubs at the same above one-half mile intervals while reducing speed from 50 to 30 mph (80 to 50 km/h).

A constant light brake application over a certain distance constitutes a light brake drag. This is not desirable. Depending upon the brake lining condition during the drum / lining contact, this dragging exacerbates pulsating forces which may develop due to the *"slip-stick"* phenomenon. This condition could *"sprag"* (violent high amplitude uncontrollable vibration), causing permanent damage to brake components such as spider, chamber brackets, etc.

NOTE: A brake lining glazing due to the underutilization of brakes (especially a motorhome equipped with a retarder) may be experienced during winter months when vehicle is in storage or is seldom used. To solve this problem, run the vehicle, observe the previous warning and repeatedly apply the brakes until they produce a light smoke.

BRAKE INSPECTION AND OVERHAUL

Refer to *"Rockwell Field Maintenance Manual No 4M"* annexed to this section.

BRAKE INITIAL ADJUSTMENT

Refer to *"Rockwell Field Maintenance Manual No 4M"* annexed to this section.

BRAKE LUBRICATION AND PREVENTIVE MAINTENANCE

Refer to *"Rockwell Field Maintenance Manual No 4M"* annexed to this section.

TROUBLESHOOTING CHART

Refer to *"Rockwell Field Maintenance Manual No 4M"* annexed to this section.

BRAKE SPECIFICATIONS AND ADJUSTMENTS

Refer to *"Rockwell Field Maintenance Manual No 4M"* annexed to this section.

AUTOMATIC SLACK ADJUSTER

The manufacturer's brochure (*"Field Maintenance Manual No 4B"*), annexed to this section, will give you all the necessary information related to the maintenance of this type of slack adjuster.

ANTI-LOCK BRAKING SYSTEM (ABS)

Description

This device has been designed to ensure stability and steerability of vehicle during braking, and to minimize its stopping distance whatever the road conditions. On slippery roads and more generally in emergency situations, overbraking frequently induces wheel locking. The anti-lock braking system provides maximum braking performance while maintaining adequate steerability on slippery roads.

The ABS monitors continuously the wheel behaviour during braking. Sensors on each wheel of front and drive axles transmit data to a four channel electronic processor which senses when any wheel is about to lock. Modulator valves quickly adjust the brake pressure (up to 5 times per second) to prevent wheel locking. Each wheel is therefore controlled according to the grip available between its tire and the road.

With this device, the vehicle is brought to a halt in the shortest possible time, while remaining stable and under the driver's control.

Since the vehicle braking system has dual circuits, the ABS is also provided with a secondary system should a fault develop in the ABS. Anti-lock systems are fail safe. Should the system cut out due to a malfunction, the braking system reverts to normal non anti-lock controlled operation. But since ABS consists of two diagonally related circuits, only the half sytem which has sustained damage or other fault is switched off (i.e. wheels return to normal non-ABS braking). The other diagonal half remains under full ABS control.

ABS COMPONENTS

The main components of the ABS system are listed hereafter. Refer to each component for its specific function in the system and its maintenance.

Electronic control unit

This control unit is located in the front electric compartment (see *"Operator's Manual"* for compartment location). According to the data transmitted by the sensors (number of pulses/sec is proportional to the speed of each wheel), the electronic control unit determines which wheel is accelerating or decelerating. It then establishes a reference speed (average speed) from each wheel data, and compares the speed of each wheel with this reference speed to determine which wheel is accelerating or decelerating.

As soon as wheel deceleration or wheel slip threshold values are exceeded, the electronic control unit signals a solenoid control valve to limit the excessive brake pressure produced by the driver in the brake chamber.

Maintenance

No specific maintenance is required for the electronic control unit. When it is found defective, replace it.

CAUTION: In order to protect the ABS electronic control unit from voltage surges, always disconnect its connector before performing any welding procedure on vehicle.

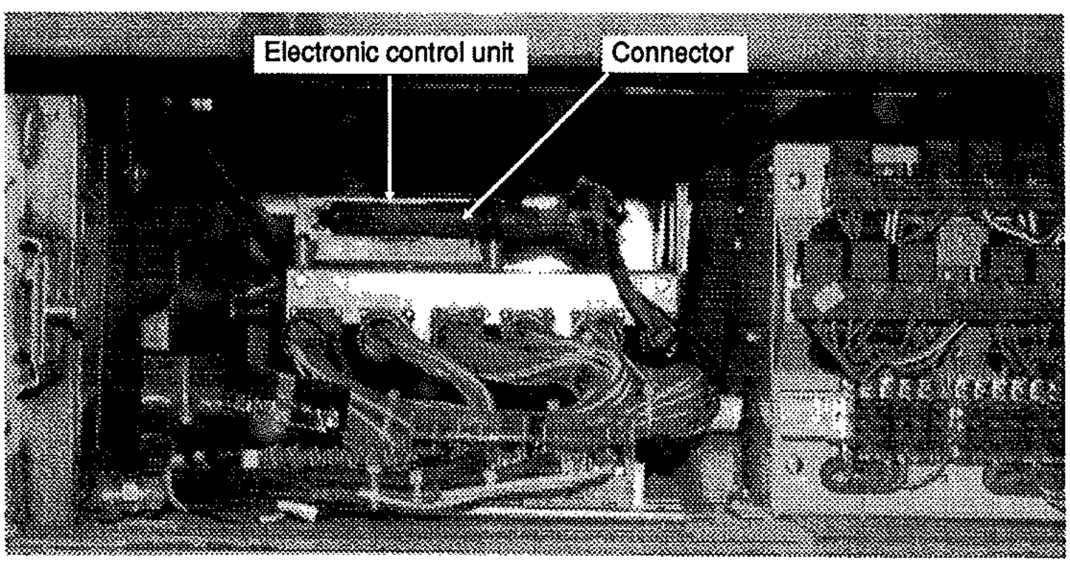

FIG. 15 - Front electrical compartment

Solenoid control valve

This ABS system is equipped with four series-mounted solenoid control valves, located between the brake chamber and the relay valve or quick release valve. Note that there is only one solenoid valve controlling the drive and tag axle wheels on the same side. This is an *"On/Off"* type valve, i.e., at brake application, the valve exhausts air from the brake chamber when the electronic unit senses that the corresponding wheel speed decreases according to the other wheels.

Maintenance

Like the electronic control unit, no specific maintenance is required for the solenoid control valve.

Sensors

The sensors are mounted on the front and drive axle wheel hubs. The inductive sensors consist essentially of a permanent magnet with a round pole pin and a coil. The rotation of the toothed wheel alters the magnetic flux picked up by the coil, and thereby produces an alternating voltage, the frequency of which is proportional to the wheel speed. When a wheel has a tendency to decrease due to the braking coefficient, the magnetic flux produced and sensed afterwards by the electronic control unit will be less. Consequently, the electronic control unit will command the solenoid control valve to decrease the pressure at the corresponding brake chamber.

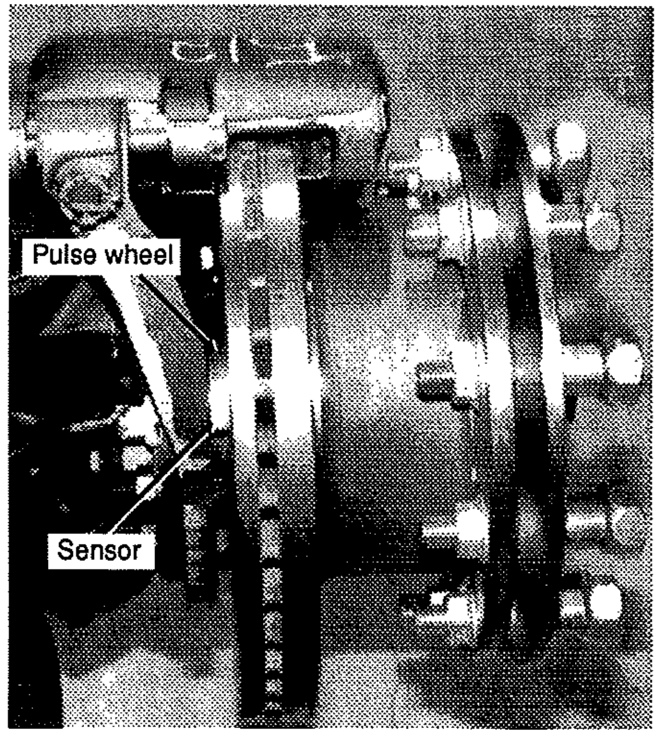

FIG. 17 - Sensor installation on wheel hub

Maintenance

No specific maintenance is required for sensors, except if the sensors have to be removed for axle servicing. In such case, sensors should be lubricated with a special grease before their reinstallation. Refer to *"Sensor installation"* described hereafter for details.

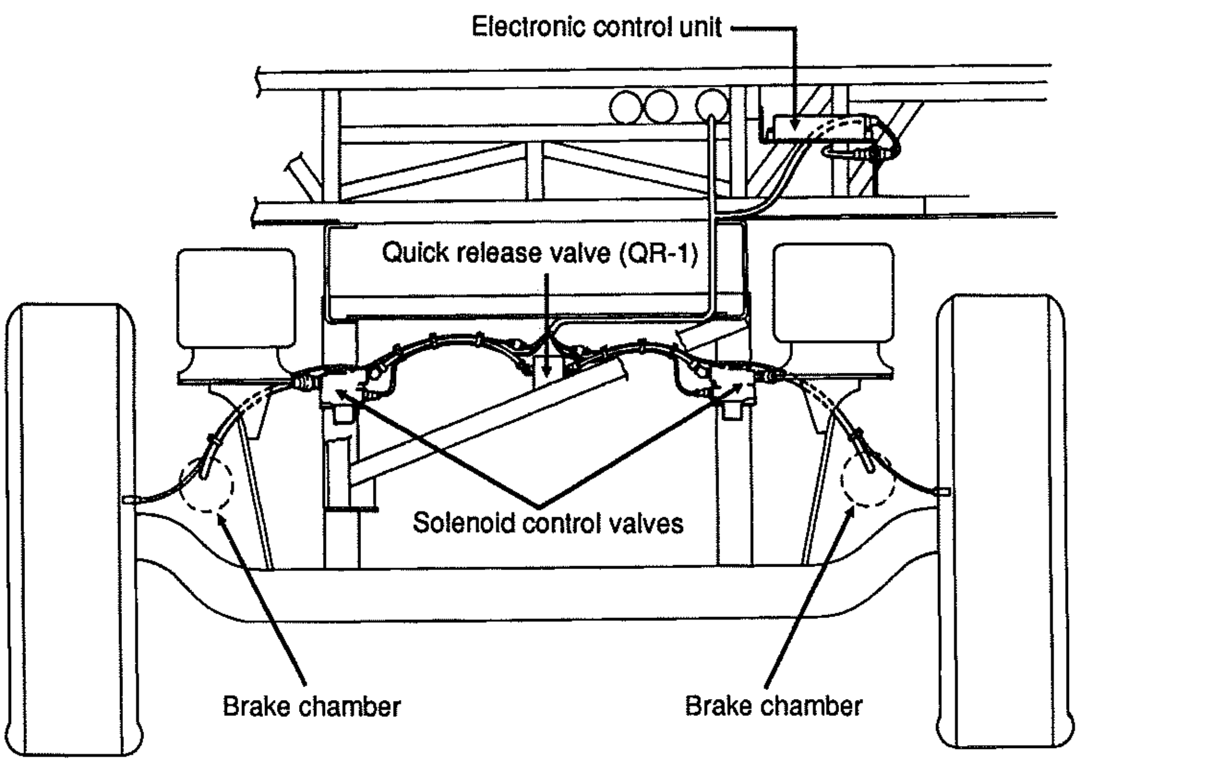

FIG. 16

NOTE: The resistance value, when sensors are checked as a unit, must be equal to 1,75 kohms. To check the sensors for proper output voltage after the sensors and toothed wheels have been assembled to the axle, connect a suitable AC voltmeter across the output terminals. With the hubs rotating at 30 rpm, the output voltages should read from 50 to 1999 mV to be acceptable.

Sensor installation

The following procedure deals with sensor installation on the axle wheel hubs. Read procedure carefully before reinstalling a sensor, as its installation must comply with operational tolerances and specifications.

1. Dip clamping bush into the special grease (Prevost part number #68-0460), press clamping bush and insert in the bushing on hub.

CAUTION: Use only this type of grease on the sensors.

2. Install sensor inside the clamping bush, then push on assembly to seat it on the pulse wheel. Ensure mounting is rigid, as it is an important criterion for an adequate sensor operation.

NOTE: This installation should be of the *"press fit"* type.

Clamping bush

The clamping bush retains the sensor in its mounting bracket close to the toothed pulse wheel. The gap between the sensor end and teeth is set automatically by pushing the sensor in its bush hard up against the pole wheel, and the latter knocks back the sensor to its adjusted position.

Maintenance

The clamping bush requires no specific maintenance.

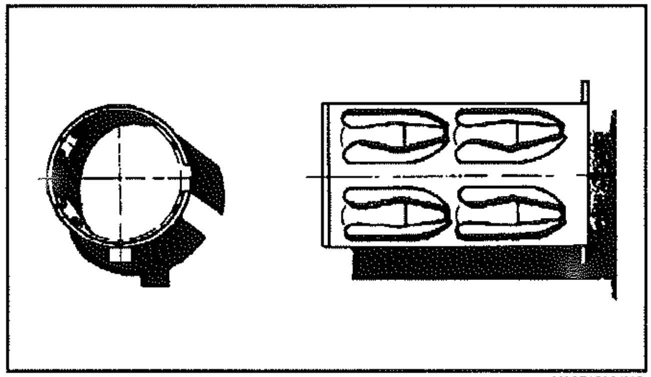

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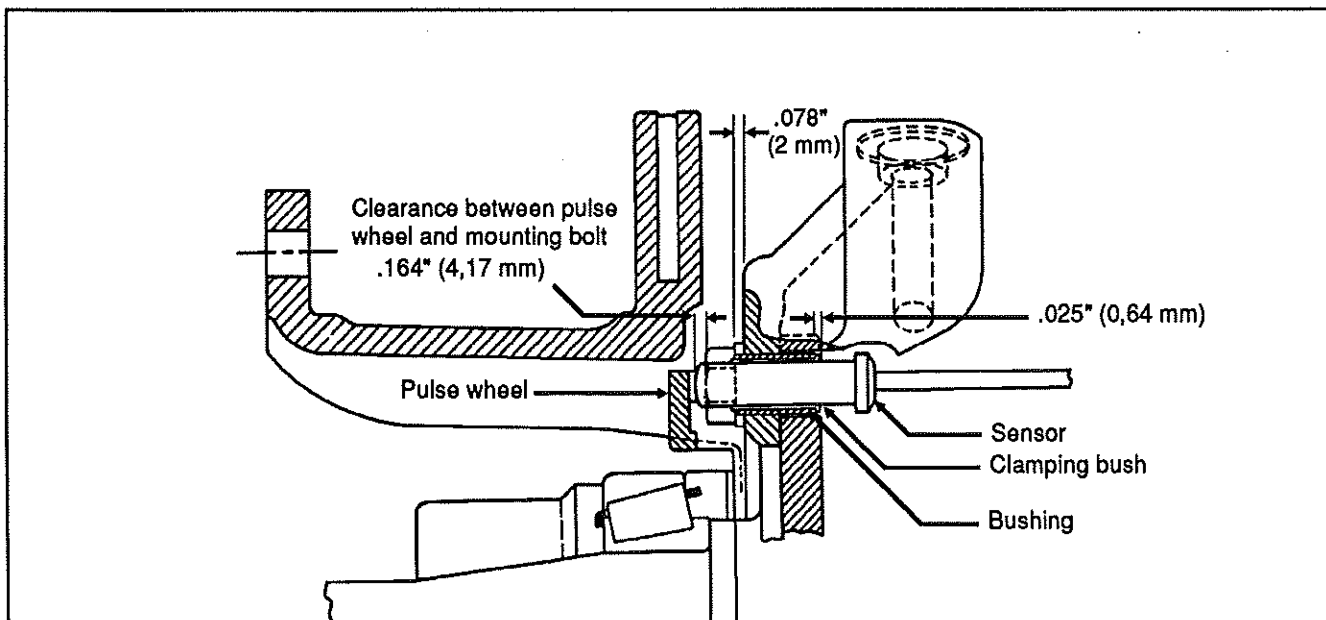
FIG. 19 - Clamping bush

ABS TEST EQUIPMENT

Testing the anti-lock braking system is made easy with the specially developed test device. Wabco's manual of step-by-step test instructions provides a schedule for routine checking or diagnostic tests, in the event of a malfunction being indicated by the vehicle warning light.

Each page explains to the technician what is being tested, which buttons on the test unit should be pressed and the correct digital display. An incorrect reading indicates the area of the fault. The electronic control unit is self checking; the functioning of all other components and the integrity of the wiring is checked by the test device.

Refer to *"Wabco, Step by Step Test Instructions"* manual annexed to this section.

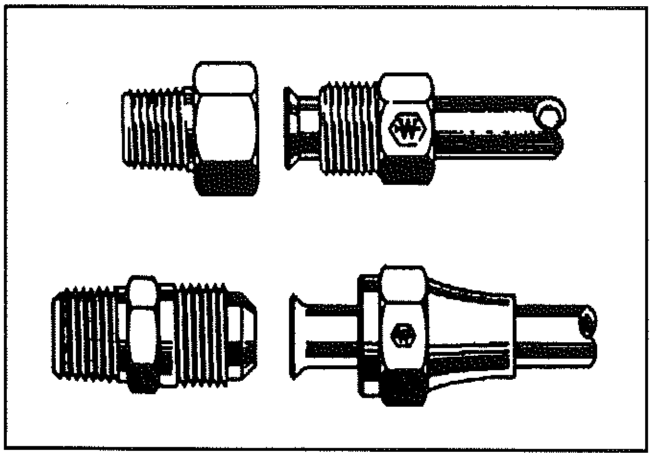


MA3E1218

FIG. 18 - Sensor installation on front axle wheel hub

FITTING TIGHTENING TORQUES

1. 45° flare and inverted flare: Tighten assembly with a wrench until a solid feeling is encountered. From that point, tighten one 1/6 turn.



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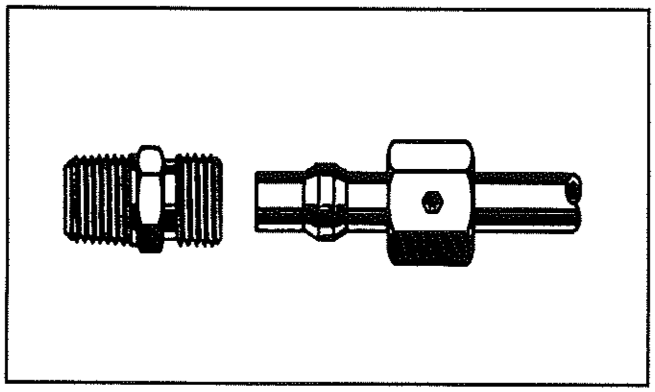
2. Compression: Tighten nut hand tight. From that point, tighten with a wrench the number of turns indicated in the chart hereafter.



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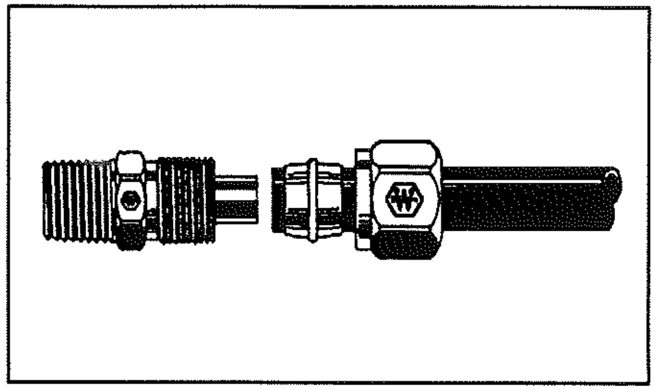
Fitting size	Pipe diameter	Number of additional turns required following manual tightening
2	1/8"	1 1/4
3	3/16"	1 1/4
4	1/4"	1 1/4
5	5/16"	1 3/4
6	3/8"	2 1/4
8	1/2"	2 1/4
10	5/8"	2 1/4
12	3/4"	2 1/4
16	1"	2 1/4

3. NTA-type plastic tubing: Tighten nut hand tight. From that point, tighten with a wrench the number of turns indicated in the chart hereafter.



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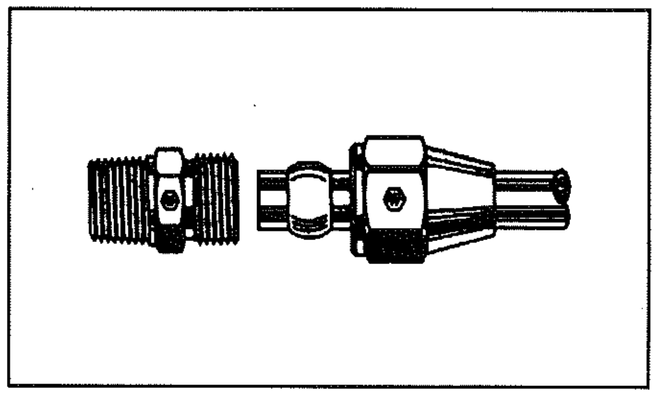
Tubing diameter	Number of additional turns required following manual tightening
1/4"	3
3/8 to 1/2"	4
5/8 to 3/4"	3 1/2

4. AB-type copper piping: Tighten nut hand tight. From that point, tighten with a wrench the number of turns indicated in the chart hereafter.



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Piping diameter	Number of additional turns required following manual tightening
1/4", 3/8", 1/2"	2
5/8", 3/4"	3

5. Piping tightening: All connections must be tightened hand tight. From that point, tighten a minimum of 2 1/2 additional turns.

SPECIFICATIONS

AIR COMPRESSOR

Make	Bendix Westinghouse
Model	Tu-Flo 750
Capacity (at 1250 rpm)	16.5 cfm (0,467 m^3/min)
Supplier number	107812
Prevost number	64-1190

GOVERNOR

Make	Bendix Westinghouse
Model	D-2
Cut-in pressure	95-105 psi (655-724 kPa)
Cutout pressure	120-125 psi (827-861 kPa)
Supplier number	284358
Prevost number	64-0964

PUSH-PULL CONTROL VALVE (Parking Brakes)

Make	Bendix Westinghouse
Model	PP-2
Automatic release pressure	40 psi (275 kPa) nominal
Supplier number	285833
Prevost number	64-1185

FLIP-FLOP CONTROL VALVE

Make	Bendix Westinghouse
Model	TW-1
Type	On-Off
Supplier number	229635
Prevost number	64-0136

DUAL BRAKE APPLICATION VALVE

Make	Bendix Westinghouse
Model	E-10
Supplier number	101270
Prevost number	64-1122

STOPLIGHT SWITCHES

Make	Bendix Westinghouse
Model	SL-5
Contact close (ascending pressure)	6 psi (41,4 kPa)
Supplier number	286392
Prevost number	64-0852

BRAKE RELAY VALVES

Make	Bendix Westinghouse
Model	R-12H
Supplier number	102852
Prevost number	64-1088

QUICK RELEASE VALVE

Make	Bendix Westinghouse
Model	QR-1
Supplier number	229859
Prevost number	64-1014

SPRING BRAKE VALVE

Make	Bendix Westinghouse
Model	SR-1
Supplier number	286364
Prevost number	64-0870

PRESSURE PROTECTION VALVE

Make	Bendix Westinghouse
Model	PR-2
Nominal closing pressure	60 psi (415 kPa)
Supplier number	277226
Prevost number	64-0439

LOW PRESSURE INDICATORS

Make	Bendix Westinghouse
Model	LP-3
Contact close	66 psi (455 kPa)
Supplier number	288522
Prevost number	64-0975

SHUTTLE-TYPE DOUBLE CHECK VALVE

Make . . . . Bendix Westinghouse
Model DC-4
Supplier number 277988
Prevost number 64-1015

AIR DRYER

Make . . . . Bendix Westinghouse
Model AD-4
Heater consumption . . . . 120 watts
Supplier number 103386
Prevost number 64-1138
Desiccant cartridge kit supplier number 103981
Desiccant cartridge kit Prevost number 64-1139

AIR PRESSURE REGULATOR

Make . . . . Williams Air Controls
Adjustable output range . . . . 0-80/85 psi (0-552/586 kPa)
Recommended pressure setting . . . . 75 psi (517 kPa)
Supplier number WM-279-E1
Prevost number 64-0938

PNEUMATIC AIR FILTER

Make . . . . .Norgren
Type . . . . .with manual drain
Supplier number F12-300-M3D
Prevost number 64-1135

FRONT AXLE BRAKE CHAMBERS

Make . . . . Rockwell
Type 24
Effective diaphragm area . . . . 24 sq.in. (154,8 sq.cm)
Supplier number 3299Y6213
Prevost number 61-0915

DRIVE AXLE BRAKE CHAMBERS

Make . . . . Anchorlok division
Type 30-36
Effective diaphragm area . . . . 30 sq.in (193,5 sq.cm) as service
. . . . 36 sq.in (232,3 sq.cm) as emergency
Supplier number 3036SB164318
Prevost number 64-1181

TAG AXLE BRAKE CHAMBERS

Make . . . . Bendix Westinghouse
Type 16
Effective diaphragm area . . . . .16 sq.in. (103,2 sq.cm)
Supplier number 289647
Prevost number 64-1193

AUTOMATIC SLACK ADJUSTER (FRONT & TAG AXLES)

Make . . . . Rockwell
Supplier number (L.H. side) A29-593-86TB-051
Supplier number (R.H. side) A29-599-86TB-077
Prevost number (L.H. side) 61-0881
Prevost number (R.H. side) 61-0880

AUTOMATIC SLACK ADJUSTER (DRIVE AXLE)

Make . . . . Rockwell
Supplier number (L.H. side) A33275Y701
Supplier number (R.H. side) A33275Z702
Prevost number (L.H. side) 62-1408
Prevost number (R.H. side) 62-1409

SOLENOID CONTROL VALVE (ANTI-LOCK BRACKING SYSTEM)

Make . . . . Wabco
Voltage . . . . 24 V
Supplier number 472 195 006 0
Prevost number 64-1097

SERVICE BULLETINS AND SERVICE INFORMATION LETTERS

Service Bulletins and Service Information Letters will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of publications pertaining to this section should be noted below as soon as received. These should then be filed for future reference.

NUMBER	DATE	SUBJECT

Bendix
Heavy Vehicle Systems Group

Service Data SD-03-61

PUSH-PULL TYPE CONTROL VALVES PP-1, PP-2, PP-5, PP-8, & RD-3

OPERATION

The PP valves are push-pull manually operable on-off air control valves with an exhaust function. Most are pressure sensitive, so that they will automatically move from the applied to the exhaust position as supply pressure is reduced to a certain minimum, depending on the spring installed. The exception to this is the PP-8 valve and some PP-1 valves which have no spring. The PP-8 valve also has a larger diameter shaft for button mounting, so that when installed on the same panel with other PP valves the buttons cannot be inadvertantly mixed. It is normally used to operate tractor spring brakes independently from the trailer.

The PP-5 is unique in having an auxiliary piston in the lower cover which, upon receiving a pneumatic signal of 18 psi or more, will cause the valve to move from the applied to the exhaust position from a 100 psi application.

The RD-3 differs slightly in that it normally remains in the exhaust position and requires a constant manual force to hold it in the applied position.

The PP-2 has an auxiliary port which may be plumbed into a service brake line to release the spring brakes if a service application is made, preventing compounding of forces on the foundation brakes.

The chart in Figure 3 outlines these various functions.

PP-1

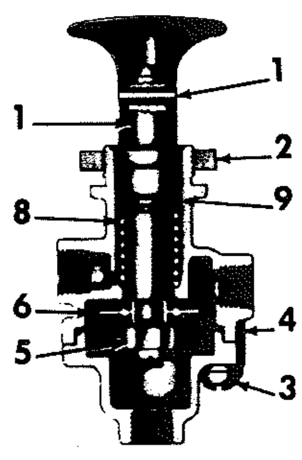
PREVENTIVE MAINTENANCE

Every six months, 50,000 miles or 1800 operating hours, disassemble, clean and replace parts if necessary.

REMOVAL

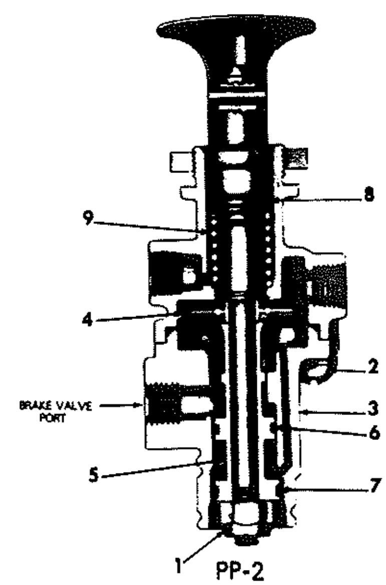
Block and/or hold the vehicle by a means other than air brakes and drain all reservoirs.

1. Drive the button roll-pin (1) Figure 1 out with a punch and remove the button.
2. Unplumb the air connections, remove the panel mounting nut (2) and remove the valve.



PP1

FIG. 1



PP-2

FIG. 2

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	Automatic Exhaust	Momentary Apply	Pilot Trip Feature	Non-Automatic
PP-1	20, 30, 40 or 60 psi			
PP-2	40 psi			
PP-5	40 psi		18 psi	
RD-3		Must be held manually		
PP-8				Will remain in either position

FIG. 3

INSTALLING

1. Install valve in panel, securing with the panel mounting nut.
2. Re-connect the air lines.
3. Install the operating button. Secure the operating button by installing the roll pin (1).

DISASSEMBLY - PP-1, PP-8 and RD-3 (Figure 1)

1. Remove the two cap screws (3) which retain the lower cover and remove cover. Remove the sealing ring (4).
2. Insert a small punch through the roll pin hole in the stem and remove the lock nut (5) with a 7/16" wrench.
3. Remove inlet-exhaust valve (6) and plunger (7) and spring (8) (if any).
4. Remove O-Ring (9) from plunger.

DISASSEMBLY PP-5 (Figure 5)

1. Perform same operations as for PP-1.
2. Remove inlet seal (3) Figure 5 form lower cover. Remove the ring diaphragm (4) from the inlet seat.
3. Remove piston (1) Figure 5 and O-Ring (2).

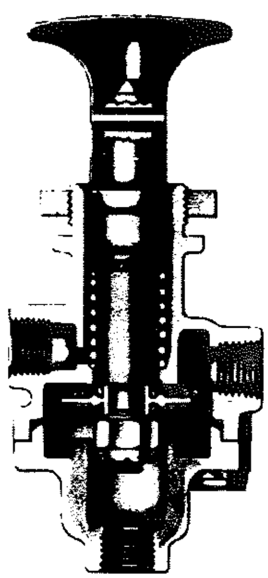
DISASSEMBLY PP-2 (Figure 2)

1. Insert a small punch through the roll pin hole in the plunger and remove the lock nut (1) from the plunger.
2. Withdraw the plunger and remove the spring (9) and O-Ring (8).
3. Remove the two machine screws (2) and remove the lower cover (3).
4. Remove the inlet-exhaust valve (4), and piston (5).
5. Remove O-Rings (6&7) from piston.

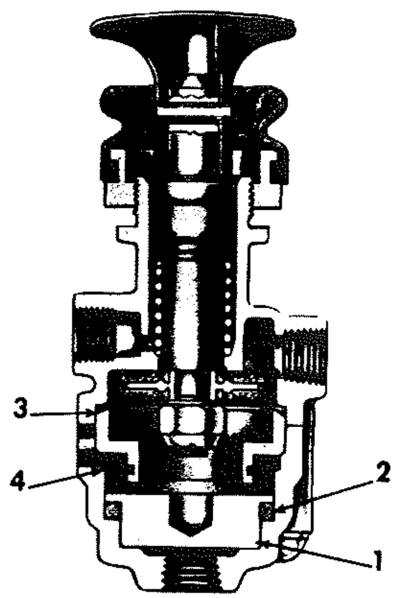
OPERATING AND LEAKAGE TESTS

PP-1, PP-8, RD-3

1. Connect a 120 psi air source to the supply port. An accurate test gauge should be tee'd into the supply line and a means of controlling the supply pressure provided. A small volume with a gauge should be connected to the delivery port.
2. With 120 psi supply pressure, the button pulled out (exhaust position), leakage at the exhaust port should not exceed a 1" bubble in five seconds; at the plunger stem a 1" bubble in five seconds. There should be no leakage between upper and lower body.



RD-3 FIG. 4



PP-5 FIG. 5

3. Push the button in (applied position). Leakage at the exhaust port should not exceed a 1" bubble in 3 seconds; at the plunger a 1" bubble in three seconds. (The RD-3 will have to be manually held in this position.)
4. Reduce the supply pressure. At a pressure from 60 to 20 psi depending on the spring installed the button should pop out automatically, exhausting the delivery volume. (This does not apply to the RD-3, PP-8 or some PP-1's).

PP-5

1. Proceed as for PP-1 through Step 3.
2. Connect a modulated source of air pressure to the pilot air inlet. With the button pushed in (applied position) with 125 psi supply pressure and a gradually increasing pressure applied at the pilot air port the valve should move to the release position with a pilot pressure of not more than 18 psi. Leakage in this mode should not exceed a 1" bubble in three seconds at the exhaust port and a 1" bubble in five seconds at the plunger stem.

PP-2

1. Proceed as for PP-1 through Step 1.
2. With the button pulled out (exhaust position), leakage at the brake valve port or at the plunger stem should not exceed a 1" bubble in five seconds.
3. Push the button in. Supply pressure should be present in the delivery volume. Leakage at the exhaust port or around the plunger stem should not exceed a 1" bubble in five seconds.
4. Pull the button out and apply supply pressure at the brake valve port. Supply pressure should be present in the delivery volume and leakage at the exhaust port should not exceed a 1" bubble in five seconds.

   NOTE: If any of the above push-pull valves do not function as described or if leakage is excessive, it is recommended they be returned to the nearest Bendix H.V.S.G. authorized distributor for a factory rebuilt or new valve.

IMPORTANT! PLEASE READ:

When working on or around air brake systems and components, the following precautions should be observed:

1. Always block vehicle wheels. Stop engine when working under a vehicle. Depleting vehicle air system pressure may cause vehicle to roll. Keep hands away from chamber push rods and slack adjusters; they may automatically apply as system pressure drops.
2. Never connect or disconnect a hose or line containing air pressure. It may whip as air escapes. Never remove a component or pipe plug unless you are certain all system pressure has been depleted.
3. Never exceed recommended air pressure and always wear safety glasses when working with air pressure. Never look into air jets or direct them at anyone.
4. Never attempt to disassemble a component until you have read and understand recommended procedures. Some components contain powerful springs and injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to use of those tools.
5. Use only genuine Bendix replacement parts and components.
   A. Only components, devices, mounting and attaching hardware specifically designed **for use in air brake systems** should be used.
   B. Replacement hardware, tubing, hose, fittings, etc. should be of equivalent size, type length, and strength as the original equipment.
   C. Make certain that when replacing tubing or hose, all supports, clamps or suspending devices that were originally installed by the vehicle manufacturer are reinstalled.
6. Devices with stripped threads or damaged parts should be replaced. Repairs requiring machining should not be attempted.

Bendix Heavy Vehicle Systems Group

Service Data SD-01-16

D-2 GOVERNOR

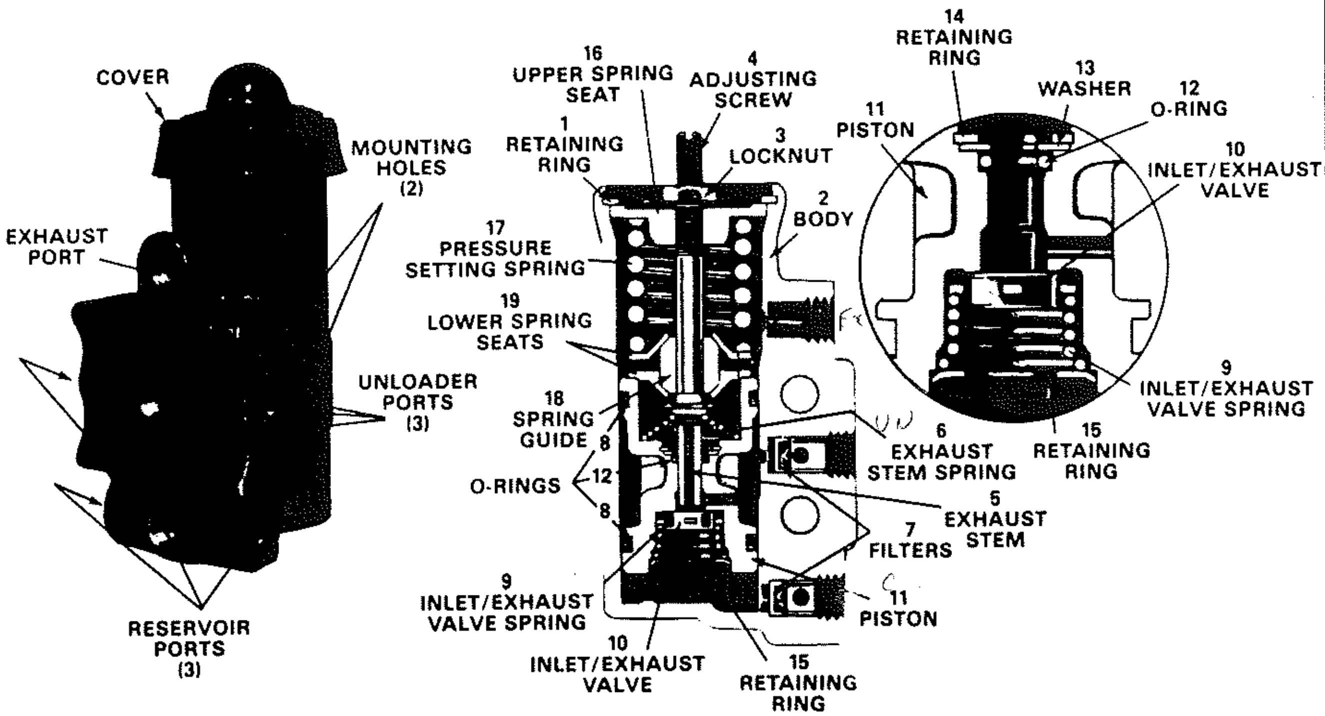
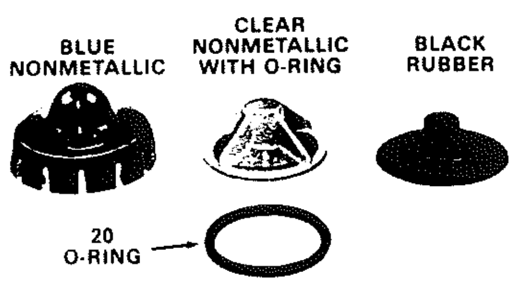
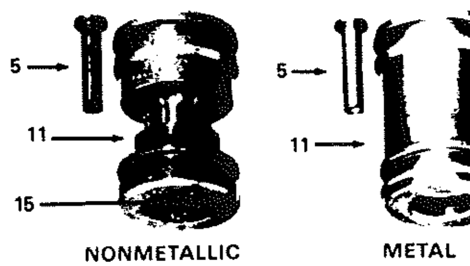


Figure 1 D-2 GOVERNOR



TYPES OF COVERS
Figure 2



TYPES OF PISTONS
Figure 3

DESCRIPTION

The D-2 Governor, operating in conjunction with the compressor unloading mechanism, automatically controls the air pressure in the air brake or air supply system between a maximum (cut-out) pressure and a minimum (cut-in) pressure. The compressor runs continually while the engine runs, but the actual compression of air is controlled by the governor actuating the compressor unloading mechanism which stops or starts the compression of air when the maximum or minimum reservoir pressures are reached.

D-2 governors are provided with mounting holes which allow direct mounting to the compressor or remote mounting.

Porting consists of 3 reservoir ports (1/8 inch P.T.), 3 unloader ports (1/8 inch P.T.) and 1 exhaust port (1/8 inch P.T.).

OPERATION

Reservoir air pressure enters the D-2 Governor at one of its reservoir ports and acts on the piston and inlet/exhaust valve. As the air pressure builds up, the piston and valve move together against the resistance of the pressure setting spring. When the reservoir air pressure reaches the cut-out setting of the governor, the exhaust stem seats on the inlet/exhaust valve, closing the exhaust passage, and then opens the inlet passage. Reservoir air pressure then flows around the inlet valve, through the passage in the piston and out the unloader port to the compressor unloading mechanism. Air also flows around the piston which is slightly larger at the upper end. The added force resulting from this larger area assures a positive action and fully opens the inlet valve

As the system reservoir air pressure drops to the cut-in setting of the governor, the force exerted by the air pressure on the piston will be reduced so that the pressure setting spring will move the piston down. The inlet valve will close and the exhaust will open With the exhaust open, the air in the unloader line will escape back through the piston, through the exhaust stem and out the exhaust port.

PREVENTIVE MAINTENANCE

Every 6 months, 50,000 miles or 1800 operating hours, perform operating and leakage tests.

SERVICE TESTS

OPERATING TESTS

Start the vehicle engine and build up air pressure in the air brake system and check the pressure registered by a dash or test gauge at the time the governor cuts-out, stopping the compression of air by the compressor. The cut-out pressure should be in accordance with the pressure setting of the piece number being used. (Common cut-out pressures are between 105-125 psi.)

With the engine still running, make a series of brake applications to reduce the air pressure and observe at what pressure the governor cuts-in the compressor. As in the case of the cut-out pressure, the cut-in pressure should be in accordance with the pressure setting of the piece number being used. (Common cut-in pressures are between 90-105 psi.)

Never condemn or adjust the governor pressure settings unless they are checked with an accurate test gauge or a dash gauge that is registering accurately. If the pressure settings of the D-2 Governor are inaccurate or it is necessary that they be changed, the adjustment procedure follows. NOTE: If the governor cover is marked nonadjustable and the adjusting stem has been sheared off, this is a nonserviceable governor and must be replaced with a new or remanufactured unit.

A. Remove the top cover from the governor.

B. Loosen the adjusting screw locknut.

C. **To raise the pressure settings,** turn the adjusting screw counter-clockwise.

   To lower the pressure settings, turn the adjusting screw clockwise.

   NOTE: Be careful not to overadjust. Each 1/4 turn of the adjusting screw raises or lowers the pressure setting approximately 4 psi.

D. When proper adjustment is obtained, tighten the adjusting screw locknut and replace the cover.

(NOTE: THE PRESSURE RANGE BETWEEN CUT-IN AND CUT-OUT IS NOT ADJUSTABLE.)

LEAKAGE TEST

Leakage tests on the D-2 governor should be made in both cut-in and cut-out positions.

CUT-IN POSITION

Apply soap solution around the cover and to the exhaust port. Slight bubble leakage permitted. Excessive leakage indicates a faulty inlet valve or lower piston O-ring.

CUT-OUT POSITION

Apply soap solution around the cover and to the exhaust port. Slight bubble leakage permitted. Excessive leakage indicates a faulty exhaust valve seat, exhaust stem O-ring, or O-ring at the top of the piston.

If the governor does not function as described or leakage is excessive, it is recommended that it be replaced with a new or remanufactured unit, or repaired with genuine Bendix parts available at Bendix outlets.

IMPORTANT! PLEASE READ:

When working on or around air brake systems and components, the following precautions should be observed:

1. Always block vehicle wheels. Stop engine when working under a vehicle. Depleting vehicle air system pressure may cause vehicle to roll. Keep hands away from chamber push rods and slack adjusters; they may automatically apply as system pressure drops.
2. Never connect or disconnect a hose or line containing air pressure. It may whip as air escapes. Never remove a component or pipe plug unless you are certain all system pressure has been depleted.
3. Never exceed recommended air pressure and always wear safety glasses when working with air pressure. Never look into air jets or direct them at anyone.
4. Never attempt to disassemble a component until you have read and understand recommended procedures. Some components contain powerful springs and injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to use of those tools.
5. Use only genuine Bendix replacement parts and components.
   A. Only components, devices, mounting and attaching hardware specifically designed **for use in air brake systems** should be used.
   B. Replacement hardware, tubing, hose, fittings, etc. should be of equivalent size, type length, and strength as the original equipment.
   C. Make certain that when replacing tubing or hose, all supports, clamps or suspending devices that were originally installed by the vehicle manufacturer are reinstalled.
6. Devices with stripped threads or damaged parts should be replaced. Repairs requiring machining should not be attempted.

REMOVING AND INSTALLING

REMOVING

1. Block and hold vehicle by means other than air brakes.
2. Drain air brake system.

3. If the governor is compressor-mounted type, disconnect reservoir air line. If the governor is remote-mounted, disconnect both the unloader and reservoir air lines.
4. Remove governor mounting bolts, then governor.

   CAUTION: Prior to disassembly, it is required to have the proper maintenance kit available to replace parts to be discarded during disassembly.

DISASSEMBLY

1. Clean the governor exterior of dirt and grease.
2. If the governor cover is marked nonadjustable and the adjusting screw has been sheared off, this is a nonserviceable governor and must be replaced with a new or remanufactured unit.
3. If the governor has a blue nonmetallic cover, (Refer to Figure 2) hold governor with one hand, with the other hand grip cover from the top and pull up with thumb until cover disengages from the governor body. If top cover on governor is made of rubber or clear nonmetallic material unscrew cover until it releases from the adjusting screw (4) of governor. Remove O-ring (20, Figure 2) if present. NOTE: O-ring (20) is used on Hi-Temp and Waterproof governors only.
4. With a pair of retaining ring pliers, remove the spring assembly retaining ring (1) and save.
5. Pull the adjusting screw (4) and spring assembly out of the governor body (2).

   NOTE: Disassembly of the spring assembly normally is not required. (Reuse and do not wash the assembly because lubrication may be removed.) If Disassembly of the spring assembly is necessary, the following instructions apply; otherwise, proceed to Step 6.

   Remove the lock nut (3), then the hex-shaped upper spring seat (16) from the adjusting screw (4). Remove the pressure setting spring (17), lower spring seat (19), spring guide (18) and the other lower spring seat (19) from the adjusting screw (4).
6. Gently tap the open end of the valve body on a flat surface to remove the exhaust stem (5), the exhaust stem spring (6), and piston assembly (11). Items 5 and 11 may be made of metal or nonmetallic material.
7. Remove and discard the two O-rings (8) on the piston O.D. and with a hooked wire remove and discard the O-ring (12) from the piston I.D. On nonmetallic piston, washer (13) and retaining ring (14) may be removed to facilitate removal of O-ring (12).
8. If piston assembly is nonmetallic (Figure 3), use a small screwdriver and carefully insert blade of screwdriver between two of the ears of the retainer ring in the bottom of the piston (11) and pry retainer ring (15) out of the piston and discard. Remove inlet/exhaust valve spring (9) and the inlet/exhaust valve (10) and discard. If piston assembly is metallic, disengage inlet/exhaust valve spring (9) from recess in bottom of piston (11), remove inlet/exhaust valve spring (9), and the inlet exhaust valve (10) and discard.
9. Remove and discard filters (7) from unloader and reservoir ports in governor body.

CLEANING AND INSPECTION

1. Clean all remaining parts in mineral spirits.
2. Inspect body for cracks or other damage. Be particularly careful that all air passages in the body, exhaust stem, and piston are not obstructed.
3. Check springs for cracks, distortion, or corrosion.
4. Replace all parts which are worn or damaged.

ASSEMBLY

Prior to assembly, lubricate the two lower body bores, all O-rings and O-ring grooves with lubricant provided. NOTE: Also spring guide and adjusting screw (if disassembled).

1. Install O-ring (12) in piston (11). Replace washer (13) and retaining ring (14) on nonmetallic piston if removed during disassembly.
2. Drop the inlet/exhaust valve (10) into place at the bottom of the piston (11).
3. **Nonmetallic Piston:** Install the inlet/exhaust valve spring (9) with the small end against the valve, place the retaining ring (15) on top of the large end of the valve spring (9) [concave side of retaining ring (15) facing away from piston (11)], press into piston with thumb, making sure ears of retaining ring (15) are seated into piston (11) as far as possible.

   NOTE: Do not use a press or hammer to install retaining ring. Excessive force may damage the piston.

   Metallic Piston: Install the inlet/exhaust valve spring (9) with the small end against the valve. Press the spring down until the larger coiled end snaps into the recess inside the piston (11).
4. Install the piston o-rings (8) on the piston (11).
5. Install the exhaust stem spring (6) in the piston (11) with the large coil end next to the piston.
6. Install the exhaust stem (5) through spring (6) and into piston (11).
7. Install assembled piston (11) into the governor body (2).
8. If the spring assembly was not disassembled, proceed to Step 9. If the spring assembly was disassembled, the following instructions apply: install on the adjusting screw (4) in this order; lower spring seat (19), spring guide (18), spring seat (19), pressure setting spring (17), hex-shaped upper spring seat (16). Screw the upper spring seat onto the adjusting screw until the distance from the top of the seat to the bottom of the adjusting screw head is approximately 1-7/8 inches. Install the lock nut(3).
9. Install the adjusting screw (4) and spring assembly into the governor body (2).
10. Install retaining ring (1) making certain that it seats completely into the groove in the governor body (2).
11. If cover provided in kit is black rubber, (Refer to Figure 2) install by pushing it onto the adjusting screw.

    If cover provided in kit is clear nonmetallic, install O-ring (20) and screw cover onto the adjusting screw. Tighten until cover bottoms on governor body. NOTE: O-ring (20) is used only on Hi-Temp and waterproof governors.

    If cover provided in kit is blue nonmetallic place cover over one edge of top of governor; with index finger catch knob on top of cover and pull until cover snaps into place.

    NOTE: Nonmetallic cover should be at room temperature for ease of assembly. Do not attempt to force cover on square to the governor body.
12. Install filters (7) in governor body. The head of a pencil makes a satisfactory installation tool.

INSTALLATION

1. If the governor is compressor-mounted, clean the mounting pad on both the compressor and governor. Clean connecting line, or lines. Be certain the unloading port is clear and clean.

   If the governor is mounted remotely, it should be positioned so that its exhaust port points down. It should be mounted higher than the compressor so that its connecting lines will drain away from the governor.
2. Install governor.
3. If compressor-mounted type, use the governor mounting gasket provided.
4. Connect air lines to governor.
5. Perform operating and leakage tests as outlined under Service Tests section.

Ch. 12

Installation and Adjustment

section 3

Preparations for Installation

1. Check the brake camshaft or powershaft and bushings and seals for wear and corrosion. If necessary, replace the camshaft, powershaft, bushings or seals. Make sure the brake operates smoothly. Make sure that you can turn the camshaft or powershaft by hand. If the camshaft or powershaft does not turn easily, inspect and repair the camshaft, powershaft, bushings or seals as required.

2. Check the return spring in the air chamber to make sure the spring has enough tension. Apply the service brake and the spring brake several times. Make sure the return spring quickly and completely retracts the push rod. If necessary, replace the return spring or the air chamber.

3. The new slack adjuster must be the same length as the old one. The table below shows the length of slack adjuster used with each size of brake chamber.

LENGTH OF SLACK ADJUSTER (INCHES)	SIZE OF CHAMBER (SQUARE INCHES)
5	9*, 12*, 16, 20, 24, 30
5-1/2	9*, 12*, 16, 20, 24, 30, 36
6	24, 30, 36
6-1/2	30, 36
*Use an auxiliary spring on slack adjusters used with these size chambers. A size 9 or 12 chamber return spring cannot supply enough spring tension to completely retract the slack adjuster.	

4. Put blocks in front of and behind the wheels of the vehicle so that the vehicle cannot roll.

⚠ *WARNING*

Carefully follow the service instructions supplied by the manufacturer of the spring brake when you work on this component in step 5. The spring brake can activate and cause injury.

⚠ *CAUTION*

Make sure the brake is completely released during the installation and adjustment procedures except when the directions indicate that the brake must be applied. If the brake is not completely released when the clevis and the slack adjuster are installed and adjusted, the slack adjuster will not adjust the brake correctly.

5. If the brake has a spring brake, compress and lock the spring so that the brake is completely released. Make sure there is no air pressure in the service half of the brake air chamber.

⚠ *WARNING*

Do not work under a vehicle supported only by jacks. Jacks can slip or fall over and cause injury.

6. If necessary, raise the vehicle in order to remove the old slack adjuster and install the new one. Support the vehicle with safety stands.

⚠ *WARNING*

In steps 7 and 8, if you remove a clevis pin that has a spring on it, hold the spring with pliers. The spring can disengage from the clevis with enough force to cause injury.

7. Remove the old slack adjuster and clevis. Leave the jam nut on the push rod.

8. Remove the clevis from the new slack adjuster.

NOTE:

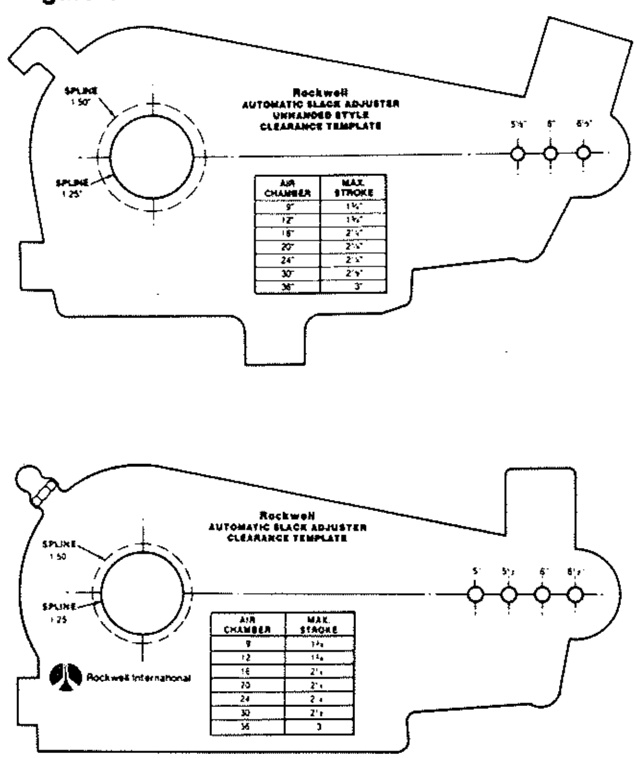
If you have a quick connect clevis, install the collar into the clevis.

9. Install the clevis on the push rod. Do not tighten the jam nut against the clevis.

NOTE:

Two clearance templates are available for use with Rockwell automatic slack adjusters. Figure 5. One clearance template (TP-ASAT) is for slack adjusters that have the pawl on the side. The other clearance template (TP-8404) is for slack adjusters that have the pawl on the front. Use the template to make sure you can fit the new slack adjuster on the vehicle. Follow the directions printed on the template. If you do not have the clearance template, check for clearance when you install the new slack adjuster.

Figure 5

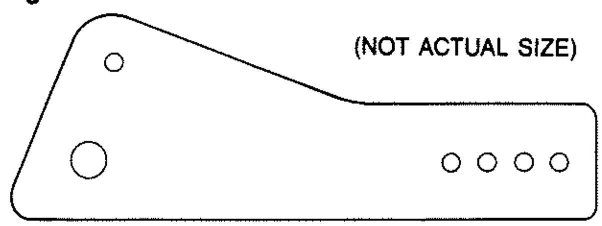


Adjustment of the Clevis Position

NOTE:

Five installation templates are available for use when you install Rockwell automatic slack adjusters. Figure 6. Three of the templates are for use with drum brakes. Two of the templates are for use with disc brakes.

Figure 6



Color of Template	Part Number	Use To Install Slack Adjusters On:
Dark brown	TP-4786	Trucks or tractors with drum brakes
Tan	TP-4787	Trailers with drum brakes
White	TP-4781	Coaches with drum brakes
Green	TP-4788	Disc brakes with type 16 or smaller air chambers
Yellow	TP-4789	Disc brakes with type 20 or larger air chambers

CAUTION

The clevis MUST be installed in the correct position on the push rod or the slack adjuster will not adjust the brake correctly. The templates ARE NOT interchangeable. You MUST use the correct template and you MUST adjust the clevis position exactly as described in the following procedures. If you use the wrong template, you will install the clevis in the wrong position and the slack adjuster will not adjust the brake correctly.

1. Measure the length of the slack adjuster with the template. **Figure 7.** The marks by the holes in the small end of the template indicate the length of the slack adjuster.

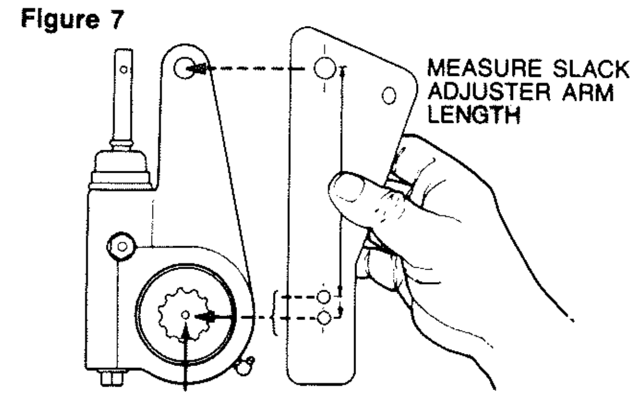


Figure 7

2. Use the template to install the clevis in the correct position as follows. **Figure 8.**

   A. Put the large clevis pin through the large holes in the template and the clevis.

   B. Select the hole in the template that matches the length of the slack adjuster. Hold that hole on the center of the camshaft or powershaft.

   C. Look through the slot in the template. The small hole in the clevis MUST be completely visible.

   D. If necessary, adjust the position of the clevis on the push rod until the small hole in the clevis is completely visible through the slot in the template.

   E. There must be at least 1/2 inch (12.7 mm) of thread engagement between the clevis and the push rod. Also, the push rod must not extend through the clevis more that 1/8 inch (3.18 mm). **Figure 9.**

   F. If necessary, cut the push rod or install a new push rod or a new air chamber.

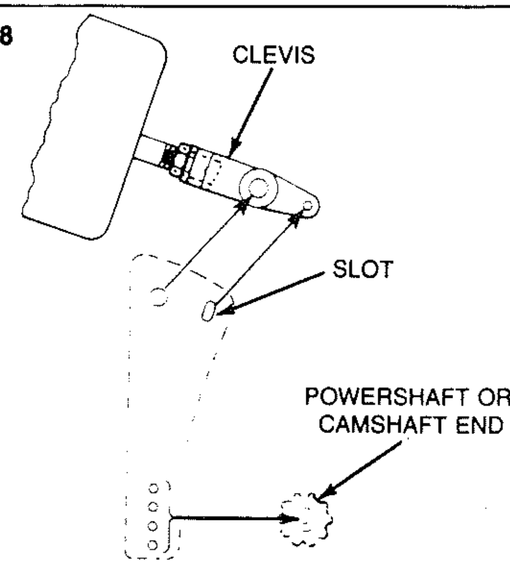


Figure 8

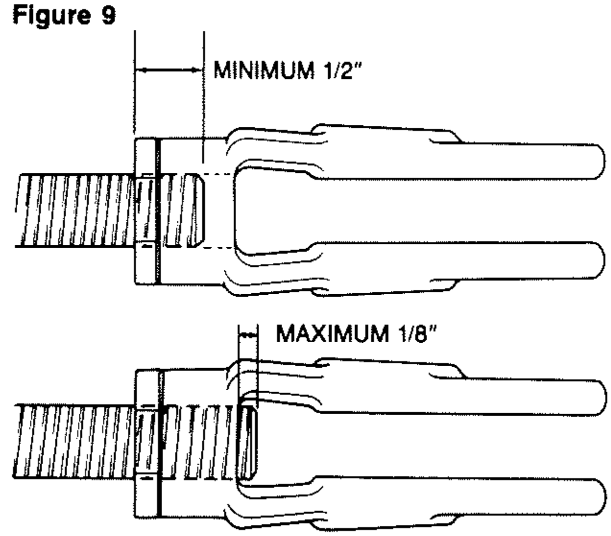


Figure 9

3. T Tighten the jam nut against the clevis to hold the clevis in the correct position.

   - For 1/2-20 threads, tighten the jam nut to a torque of 20-30 lb-ft (27-41 N•m).

   - For 5/8-18 threads, tighten the jam nut to a torque of 25-50 lb-ft (34-68 N•m).

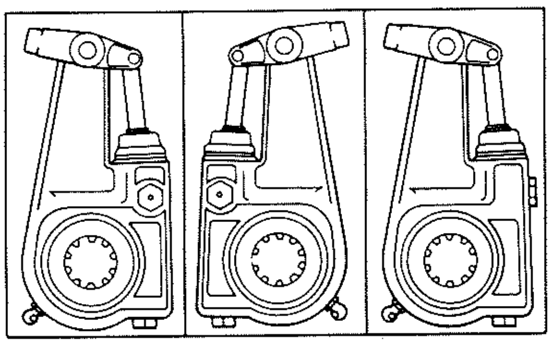
Installation of the Slack Adjuster

1. Lubricate the splines on the slack adjuster gear and the splines on the camshaft or the powershaft with anti-seize compound. Use Rockwell lubricant 0-637, Southwest SA 8249496, or equivalent.

NOTE:

The pawl assembly can be on either side of the housing or on the front of the housing.* Figure 10. *Make sure the pawl assembly can be removed after the slack adjuster is installed. The pawl assembly must sometimes be removed when the slack adjuster is serviced.

Figure 10



2. Install the slack adjuster on the camshaft or the powershaft.
3. Install spacing washers and the snap ring until there is a maximum clearance of 0.062 inch (1.57 mm) between the washer and the snap ring.
4. Remove the pawl assembly from the slack adjuster.

CAUTION

If you do not remove the pawl, you will damage the teeth when you turn the manual adjusting nut in step 5.

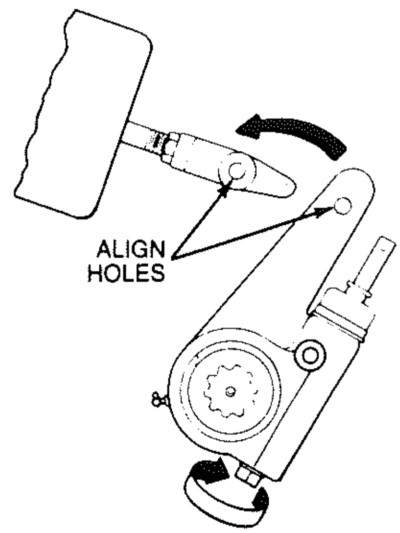
5. Use a wrench to turn the manual adjusting to align the hole in the arm of the slack adjuster with the large hole in the clevis. **Figure 11.**

NOTE:

If you used the clearance template earlier, skip step 6.

6. Use your hand to rotate the slack adjuster the same distance as the maximum stroke of the chamber. Make sure there are no obstructions that will prevent the slack adjuster from rotating when the brakes are applied. The chart below shows the maximum stroke of each size chamber.

Figure 11



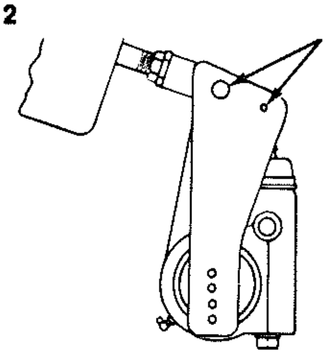
NOTE:

The maximum stroke shown in the chart is for clearance only. The adjusted chamber stroke will be shorter than the maximum stroke.

SIZE OF CHAMBER (SQUARE INCHES)	MAXIMUM STROKE AVAILABLE (INCHES)
9	1 3/4
12	1 3/4
16	2 1/4
20	2 1/4
24	2 1/4
24 long stroke	2 1/2
30	2 1/2
36	3

7. Install both clevis pins through the template, slack adjuster and clevis. Check again to make sure the clevis is installed in the correct position. **Figure 12.** Adjust the clevis if necessary.

Figure 12



8. Remove the template. Apply anti-seize compound to the two clevis pins. Install the clevis pins and install the cotter pins to hold the clevis pins in place.

CAUTION:
You must adjust the brake after you install the slack adjuster. The brakes will not stop the vehicle unless the brakes are adjusted.

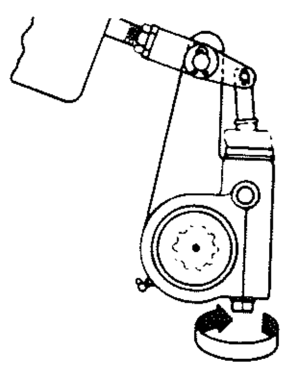
Adjustment of the Brake

CAUTION:
The pawl must be removed before you turn the manual adjusting nut or you will damage the pawl teeth.

NOTE:
If you are adjusting the brake after installing a new slack adjuster or after lubricating, relining or overhauling the brake, do steps 1-5. If you are checking the stroke as part of preventive maintenance, do steps 2 and 4.

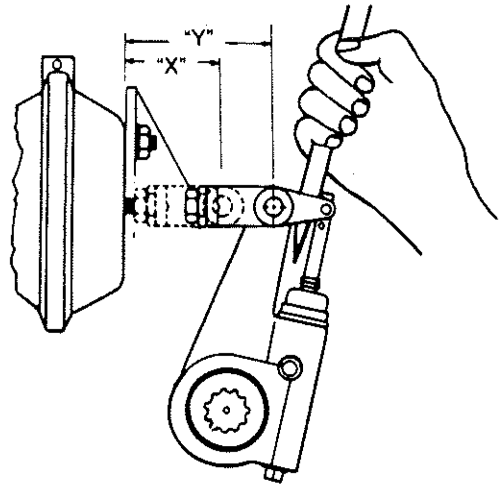
1. Set the stroke to its approximate length and set the approximate clearance between the linings and the drum or rotor as follows:
   - Turn the manual adjusting nut in the direction shown in **Figure 13** until the linings touch the drum or rotor.
   - For a DRUM BRAKE, turn the adjusting nut 1/2 turn in the opposite direction.
   - For a DISC BRAKE, turn the adjusting nut 3/4 turn in the opposite direction.

Figure 13



2. Measure the "free stroke" as follows. **Figure 14.**
   A. Measure the distance from the bottom of the air chamber to the center of the large clevis pin while the brake is released ("X").
   B. Use a pry bar to move the slack adjuster and apply the brake. While the brake is applied, measure the same distance again ("Y").

Figure 14 MEASURE "FREE STROKE" WITHOUT TEMPLATE



DRUM BRAKE: Y minus X must = 5/8" to 3/4"
INITIAL DISC BRAKE: Y minus X must = 7/8" to 1 1/8"
IN SERVICE DISC BRAKE: Y minus X must = 3/4" to 1"

   C. The difference between the measurements is the free stroke. The free stroke sets the clearance between the linings and the drum or rotor.

   Drum brakes:
   - Both the INITIAL and the IN SERVICE free stroke on a drum brake MUST be 5/8 - 3/4 inch (15.9 - 19.1 mm).

   Disc brakes:
   - The INITIAL free stroke on a disc brake MUST be 7/8 - 1 1/8 inch (22.2 - 28.6 mm).
   - The IN SERVICE free stroke on a disc brake MUST be 3/4 - 1 inch (19.1 - 25.4 mm).

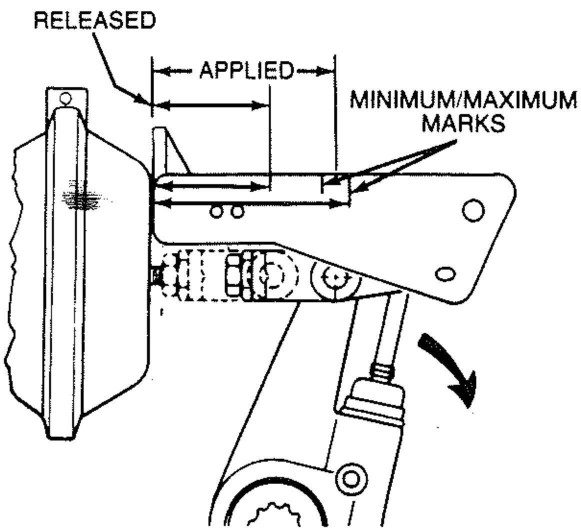
NOTE:
There are two different free stroke settings for the Rockwell Dura-Master disc brake. Use the INITIAL free stroke setting when you adjust the brake after relining or other service.
Use the IN SERVICE setting when you check the free stroke during preventive maintenance.

   D. If the IN SERVICE free stroke is not within specifications, use the troubleshooting chart on page 5 to correct the problem. Then to adjust the stroke or set the INITIAL free stroke, go to step 3.

NOTE:

On a disc brake you can use the correct template to check the IN SERVICE free stroke (NOT the INITIAL free stroke) as follows: **Figure 15.**

Figure 15 MEASURE IN SERVICE "FREE STROKE" WITH TEMPLATE



A. Put the narrow end of the template against the bottom of the air chamber. The center of the large clevis pin must be at the mark on the template indicated "CL of large clevis pin."

B. If the clevis pin is not at the mark, check to make sure that the clevis is installed in the correct position.

C. Use a pry bar to move the slack adjuster and apply the brake. When the brake is applied, the center of the large clevis pin MUST be between the "MIN" and "MAX" marks on the template.

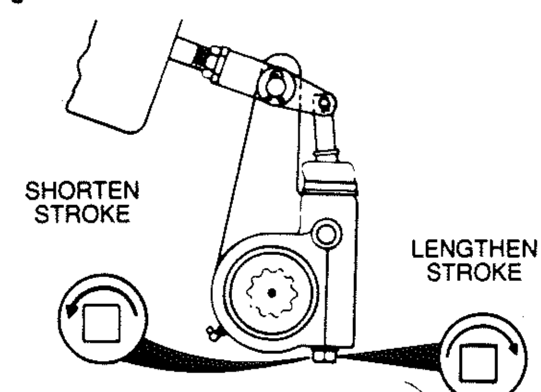
D. If the free stroke is not between the marks, use the troubleshooting chart in Section 2 to correct the cause of the problem before you adjust the stroke.

⚠ *CAUTION*

DO NOT set the free stroke shorter than the specified minimum. If the free stroke is too short, the linings can drag and damage the brake.

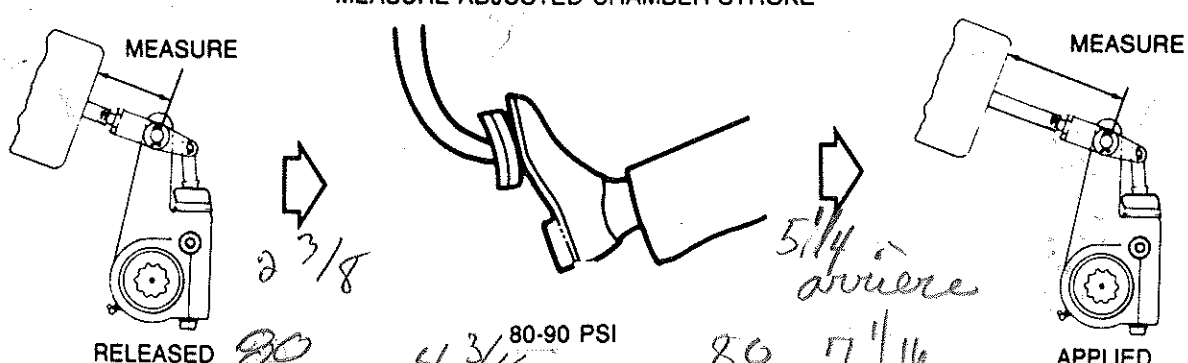
3. To adjust the stroke, turn the adjusting nut 1/8 turn in the direction shown in **Figure 16** and check the stroke again. Continue to measure and adjust the stroke until it is adjusted correctly.

Figure 16



4. Double check for correct installation of the slack adjuster and correct operation of the brake as follows. **Figure 17.**
   A. Measure the distance from the bottom of the air chamber to the center of the large clevis pin.
   B. Another person must apply the brakes using 80-90 psi of air pressure.

Figure 17 MEASURE ADJUSTED CHAMBER STROKE



2 3/8 5 1/4 arrière

80 4 3/16 80 7 1/16

AVANT 90 4 1/4 90 7 1/8

100 4 5/16 100 7 3/16

NOTE:
If the vehicle does not have an application pressure gauge, build tank pressure to 100 psi, shut off the engine, and then make and hold a full brake application. This will give 80-90 psi in the air chamber.

C. Measure the distance from the air chamber to the center of the large clevis pin while the brakes are applied.

D. The difference between the measurements is the adjusted chamber stroke.

E. The adjusted chamber stroke MUST NOT be greater than the distance shown in **Figure 18.**

Figure 18

CHAMBER TYPE (SIZE)	ROCKWELL RECOMMENDED MAXIMUM ADJUSTED CHAMBER STROKE. 80-90 PSI AIR PRESSURE IN THE AIR CHAMBER. (CLAMP TYPE AIR CHAMBERS)	
	CAM BRAKES	**DISC BRAKES***
9	not greater than 1-3/8 inches	not currently used
12	not greater than 1-3/8 inches	not currently used
16	not greater than 1-3/4 inches	not greater than 2 inches
20	not greater than 1-3/4 inches	not greater than 2 inches
24	not greater than 1-3/4 inches	not greater than 2 inches
24 long stroke	not greater than 2 inches	not greater than 2-1/4 inches
30	not greater than 2 inches	not greater than 2-1/4 inches
36	not greater than 2-1/4 inches	not currently used

* NOTE: The U.S. Department of Transportation, Office of Motor Carrier Standards is now reviewing the maximum adjusted stroke dimensions for disc brakes and may publish a Federal regulation specifying stroke limits.

F. If necessary, shorten the adjusted chamber stroke. See step 3. Make the adjusted chamber stroke as short as possible, but NOT so short that the free stroke is less than the distance specified in step 2C. See the CAUTION before step 3.

5. Install the pawl assembly. Tighten the capscrew to a torque of 15-20 lb-ft (20-27 N.m).

After Installation and Adjustment

1. Lubricate the slack adjuster through the grease fitting until new grease flows from the pressure relief valve in the capscrew.

WARNING
Carefully follow the service instructions supplied by the manufacturer of the spring brake when you work on this component in step 2. The spring brake can activate and cause injury.

2. If the vehicle has spring brakes, release the springs.
3. Remove the jack stands from under the vehicle.

section 4 # Removal and Disassembly

Removal

1. Put blocks in front of and behind the wheels of the vehicle so that the vehicle cannot roll.

WARNING
Carefully follow the service instructions supplied by the manufacturer of the spring brake when you work on this component in step 2. The spring brake can activate and cause injury.

2. If the brake has a spring brake, lock the spring so that it is completely released. Make sure there is no air pressure in the service half of the air chamber.

WARNING
Do not work under a vehicle supported only by jacks. Jacks can slip or fall over and cause injury.

3. If necessary, raise the vehicle in order to remove the slack adjuster. Support the vehicle with safety stands.

4. Remove the pawl assembly from the slack adjuster.

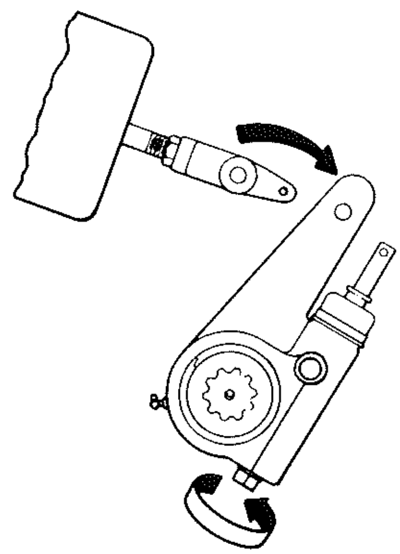
WARNING
In step 5, if you remove a clevis pin that has a spring on it, hold the spring with pliers. The spring can disengage from the clevis with enough force to cause injury.

5. Remove both clevis pins.

CAUTION
If you did not remove the pawl in step 4, you will damage the teeth when you turn the manual adjusting nut in step 6.

6. Use a wrench to turn the manual adjusting nut in the direction shown in **Figure 19** and move the slack adjuster away from the clevis.

Figure 19



7. Remove the snap ring and washers from the camshaft or the powershaft. Remove the slack adjuster from the camshaft or the powershaft.

8. If necessary, remove the clevis from the push rod.

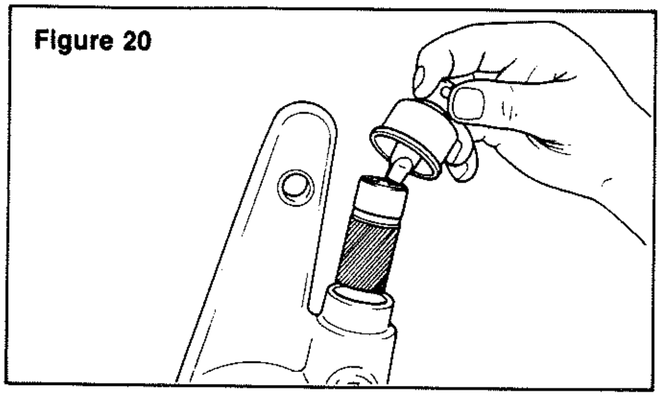
NOTE:
You do not have to remove the clevis if it is in good condition and it will be used again.

Disassembly

1. Cut the clamp and remove it from the boot. Replace the clamp and boot with new parts when you assemble the slack adjuster.

2. Remove the boot from the housing. Pull the actuator assembly from the housing. **Figure 20.**

Figure 20



3. Use a small screwdriver and pliers to remove the piston retaining ring. **Figure 21**.

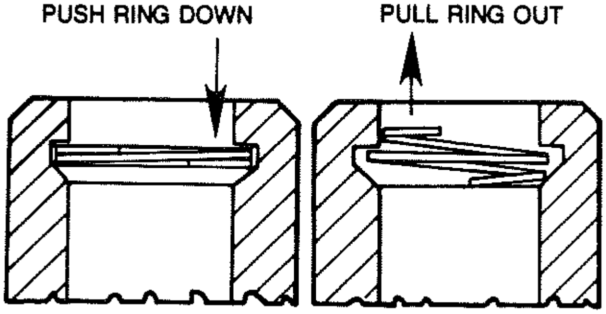
   A. Push down on the ring and force it out of the groove.

   B. Extend the coils of the ring.

   C. Use pliers to unwind the ring and pull it out of the groove.

   D. Use a new ring when you assemble the slack adjuster.

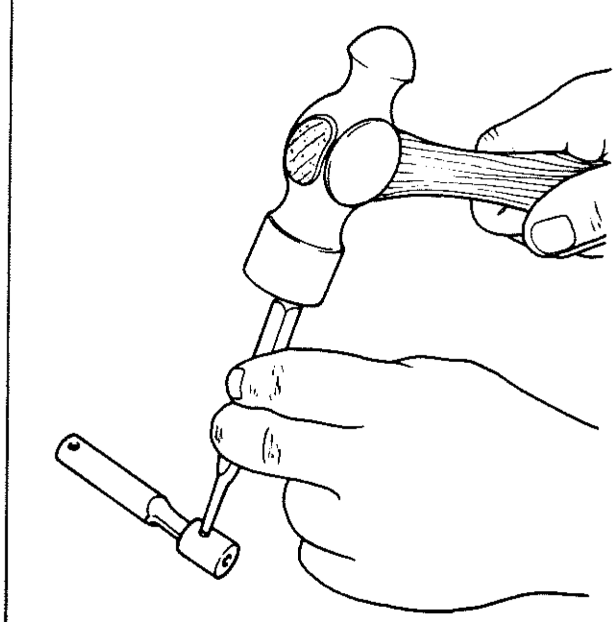
Figure 21



4. Pull the actuator rod, piston and pin from the actuator.

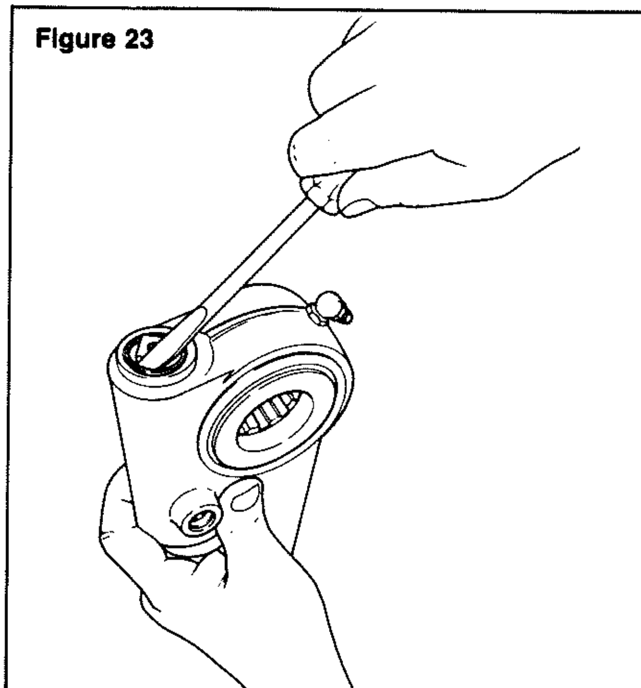
5. Remove the pin from the rod and piston, if necessary. **Figure 22**.

Figure 22



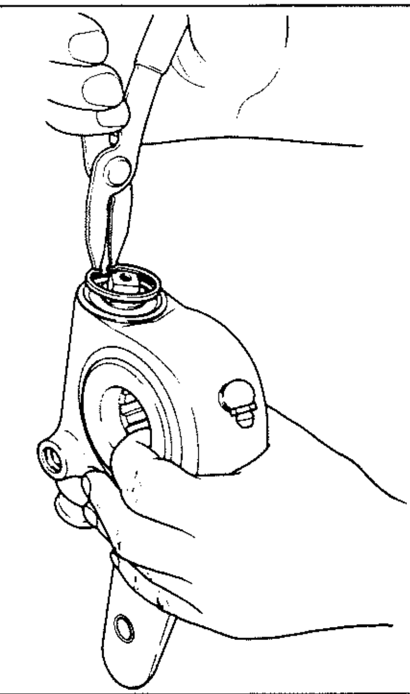
6. Use a small screwdriver to remove the grease seal from around the worm. **Figure 23**. Discard the seal. Use a new seal when you assemble the slack adjuster.

Figure 23



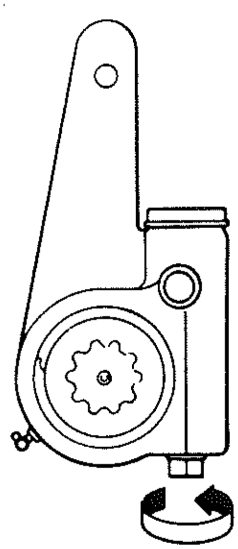
7. Use snap ring pliers to remove the retaining ring from the worm. **Figure 24**.

Figure 24



8. Use a wrench to turn the manual adjusting nut and wind the worm out of the bore. **Figure 25**.

Figure 25



9. Remove the retaining rings and thrust washers from both sides of the gear.

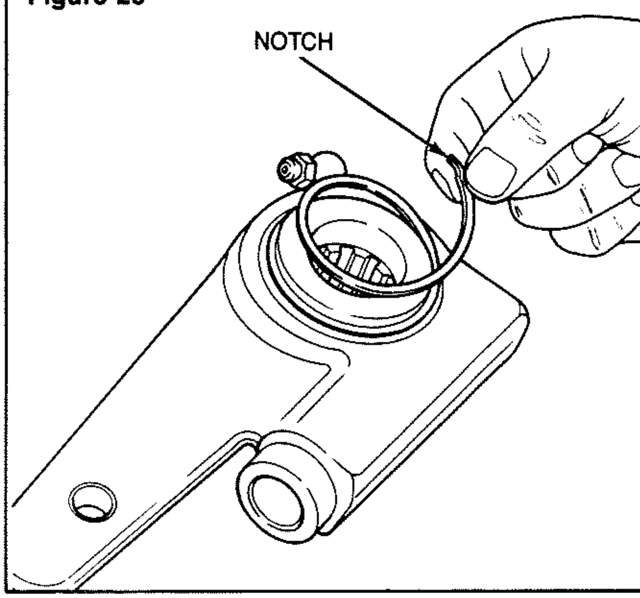
   A. Fit a small screwdriver into the notch at the end of the retaining ring.

   B. Remove the end of the retaining ring from the groove.

   C. Unwind the ring by hand and pull it out of the groove. **Figure 26**.

   D. Remove the thrust washer.

Figure 26



10. Push the gear out of the housing only until you can reach and remove one gear seal.

11. Push the gear out of the opposite side of the housing and remove the other seal.

13. Push the gear out of the housing.

14. Inspect the seals. Discard the seals if they show any signs of damage.

15. Inspect the condition and fit of the bushing in the arm of the slack adjuster. Do not remove the bushing unless it is worn or egg-shaped. Use a mallet and a 9/16 inch (14.3 mm) diameter metal rod to remove the bushing.

Cleaning, Inspection and Corrosion Protection

Section 5

Cleaning

Clean all parts of the automatic slack adjuster after disassembly. Follow the procedures below.

WARNING

Solvent cleaners can be flammable, poisonous, and cause burns. Examples of solvent cleaners are emulsion cleaners, carbon tetrachloride, or petroleum cleaners.

- ***Wear eye protection.***
- ***Wear clothing that protects your skin.***
- ***Make sure there is enough ventilation.***
- ***Do not use gasoline or solvents that contain gasoline.***
- ***Follow the instructions of the manufacturer for safe use of the solvent.***

Metal Parts With Polished Surfaces

CAUTION

Do not clean ground or polished parts in a hot solution tank. Do not use water and alkaline solutions. Hot solution tanks, water and alkaline solutions will damage ground or polished surfaces.

Use solvent cleaners to clean all metal parts that have ground or polished surfaces. Examples of parts that have ground or polished surfaces are the gear, the worm, and the inner bores of the housing.

Parts Not Made of Metal

CAUTION

Do not use solvent cleaners on parts that are not made of metal. Solvent cleaners will damage parts that are not made of metal.

Use soap and water to clean parts that are not made of metal.

Completely dry all parts immediately after you clean them. Use soft, clean paper or cloth to dry the parts. Make sure the paper or cloth does not contain any dirt, grease, oil or abrasives.

Inspection

It is very important that you carefully inspect all parts of the slack adjuster before assembly. Inspect all parts for any signs of wear or damage. Replace any part that shows signs of wear or damage.

Corrosion Protection

If you assemble parts immediately after you clean them, lubricate the parts with grease to prevent corrosion. Make sure you clean, dry and inspect all parts before you lubricate them.

If you store any parts after you clean them, apply a material that prevents corrosion to the parts. Store the parts in special paper or other material that prevents corrosion.

section 6 Assembly

NOTE:

Before you assemble any parts, make sure you remove any material that was applied to the parts to prevent corrosion.

1. Lubricate the gear bore in the housing with grease.

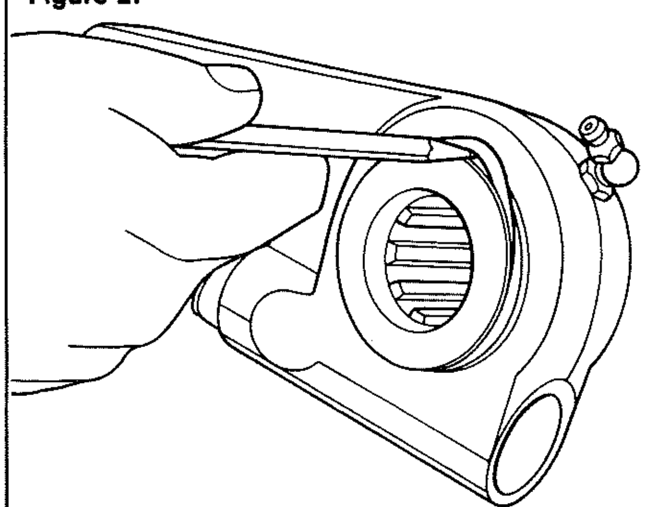
CAUTION

In step 2, do not install the gear into the housing with the seals in place. The sharp edges of the worm bore can damage the seals.

2. Install the gear, without the seals, into the housing but keep one seal groove outside the housing. Make sure the gear goes straight into the bore. If necessary, use a mallet to tap the gear into place.

3. Install a seal into the groove. **Figure 27.**

Figure 27



4. Lubricate the seal with grease. Compress the seal in its groove and push the gear into the housing.

CAUTION

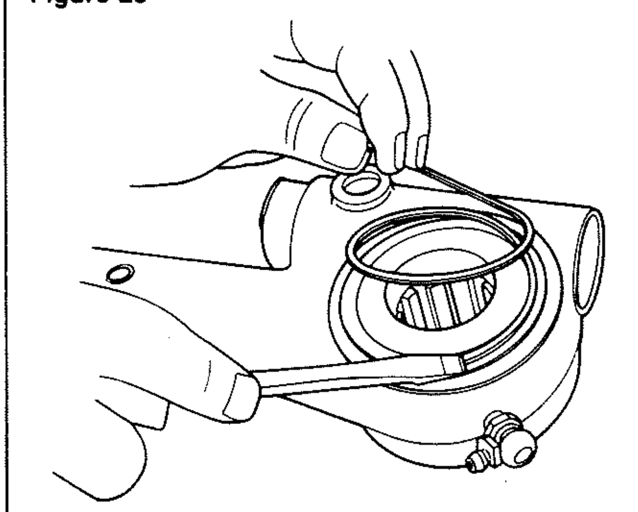
In step 5, do not push the gear seal out the opposite side of the housing or you will damage the seal.

5. Push the gear out the opposite side of the housing only until the other seal groove is visible. Repeat steps 3 and 4 to install the second seal. Make sure you return the gear to the center of the housing.

6. Lubricate a thrust washer with grease. Install the washer around the gear.

7. Expand the retaining ring coil. Put one end of the coil into the groove in the outer diameter of the gear. Work around the gear and press the coil into the groove. **Figure 28.**

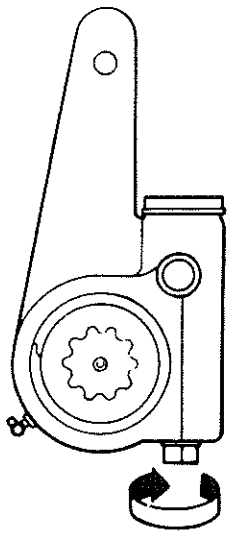
Figure 28



8. Repeat steps 6 and 7 for the opposite side of the gear.

9. Put the worm into the bore and turn the adjusting nut to wind the worm to the bottom of the bore. **Figure 29.**

Figure 29

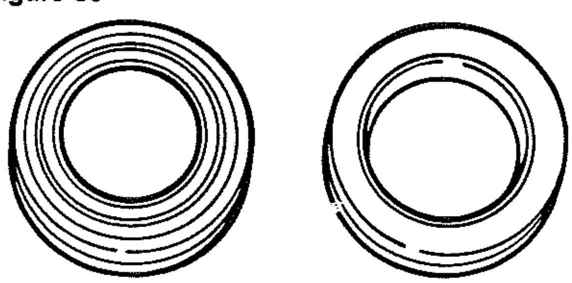


10. Use snap ring pliers to install the retaining ring into the worm bore.

CAUTION

In step 11, you must install the seal with its lips toward the outside and the metal retainer toward the inside.* Figure 30. *If the seal is installed backward, contamination can enter the housing.

Figure 30

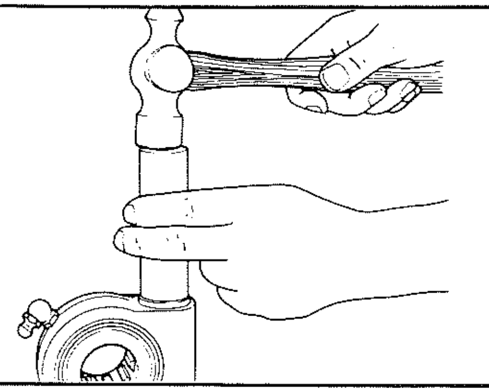


CAUTION

Do not hit the seal after it reaches the bottom of the bore or you will damage the seal.

11. Put the seal directly over the worm bore. Use a hammer and a 1-3/16-inch (30.2 mm) diameter seal driver to install the seal. **Figure 31.** Make sure the seal goes in straight.

Figure 31



12. If removed, install the pin to hold the piston and actuator rod together.

13. Install the actuator rod and piston assembly into the actuator (adjusting sleeve).

14. Install the piston retaining ring as follows:

    A. Slide the ring over the rod.

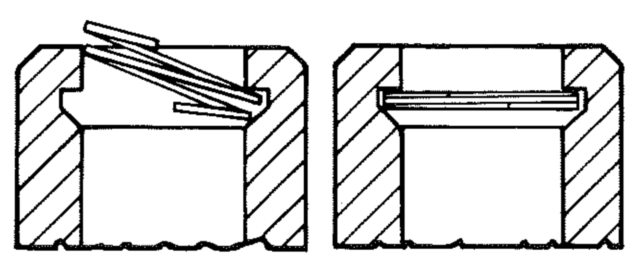
    B. Extend the coils of the ring.

    C. Use a small screwdriver and press one end of the ring into the groove. **Figure 32.**

    D. Keep the coil extended. Press on the ring and work around the groove until the ring is completely in the groove.

    E. Check to make sure the ring is correctly in the groove. You cannot pull the piston out of the actuator if the ring is in the groove correctly.

Figure 32



15. Install the actuator assembly into the housing so that the actuator slides along the splines of the worm.

16. Install the boot as follows:

    A. Lubricate the rod with grease. Slip the boot over the rod.

    B. Fasten the boot to the housing with a silastic sealant and a retaining clamp.

    C. Make sure the top of the boot fits on the round part, not the tapered part, of the rod.

    D. Seal the top of the boot to the rod with a silastic sealant.

17. If necessary, install a new bushing into the hole in the arm of the slack adjuster. Use the same hammer and metal rod you used to remove the old bushing.

18. Install the pawl assembly into the housing. Tighten the capscrew to a torque of 15-20 lb-ft (20-27 N•m). T

19. Hold the actuating rod to keep it from moving. Lubricate the slack adjuster through the grease fitting until grease flows from the relief valve in the capscrew.

CAUTION

In step 20, turn the adjusting nut only in the direction shown in* Figure 33. *If you turn the adjusting nut in the opposite direction while the pawl is installed, you will damage the pawl teeth.

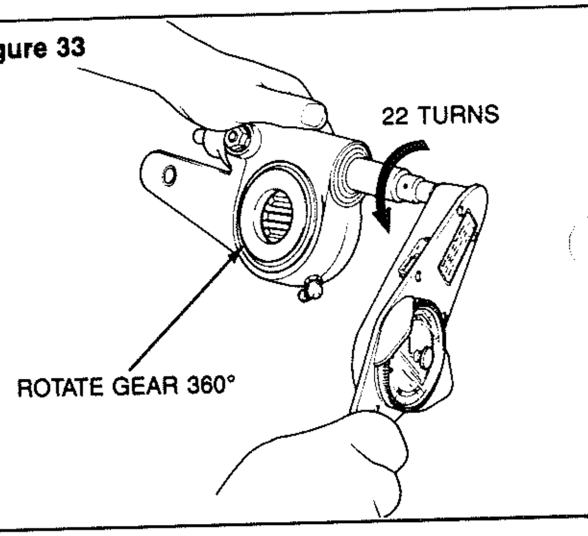
20. Use a torque wrench that measures lb-in and turn the adjusting nut in the direction shown in **Figure 33**. Read the torque scale while you turn the wrench and rotate the gear 360 degrees (22 turns of the wrench).

    - The torque value must remain less than 25 lb-in (2.83 N•m) during the complete 360 degree rotation of the gear.

    - If the torque value remains less than 25 lb-in, the slack adjuster is working correctly.

    - If the torque value exceeds 25 lb-in, the slack adjuster is not working correctly. Disassemble the slack adjuster and check for the correct assembly and alignment of parts.

Figure 33



21. See Section 3 for directions on how to install and adjust the slack adjuster.

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Bendix

Heavy Vehicle Systems Group

Service Data

SD-03-5

Formerly SD-65

E-6, E-10 DUAL BRAKE VALVE

E-6 DUAL BRAKE VALVE

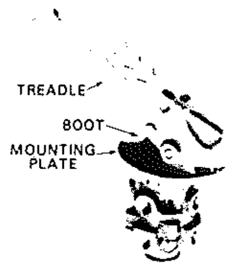


Figure 1

E-10 DUAL BRAKE VALVE

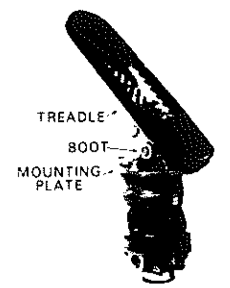
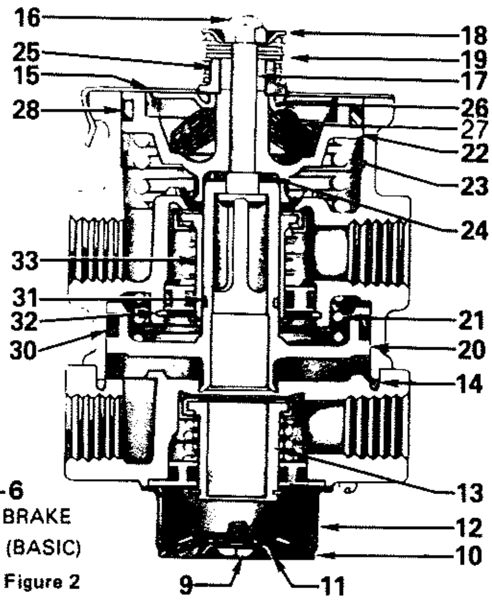
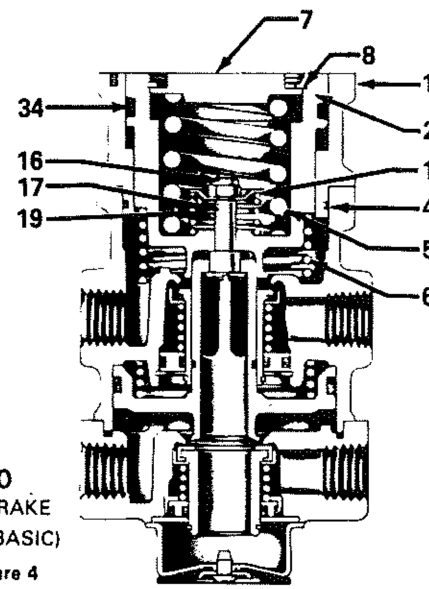


Figure 3



E-6 DUAL BRAKE VALVE (BASIC)

Figure 2



E-10 DUAL BRAKE VALVE (BASIC)

Figure 4

DESCRIPTION

The E-6 (Fig. 1) and E-10 (Fig. 3) Dual Brake Valves are floor mounted, treadle-operated type brake valve with two separate supply and delivery circuits for service and secondary braking, which provides the driver with a graduated control for applying and releasing the vehicle brakes.

The E-10 Dual Brake Valve (Fig. 3) is similar to the E-6 Dual Brake Valve except that a metal coil spring housed in an upper body assembly replaces the rubber spring used in the E-6 valve. The use of a metal coil spring (and the upper body assembly) provides greater travel and, therefore, provides the driver with a less sensitive "feel" when making a brake application. The E-10 Dual Brake Valve is generally used on busses, where smooth brake applications contribute to passenger comfort.

The circuits in the E-6/E-10 Dual Brake Valves are identified as follows: The No. 1 circuit portion is that portion of the valve between the spring seat which contacts the plunger and the relay piston; the No. 2 circuit portion is that portion between the relay piston and the exhaust cavity.

The No. 1 circuit portion of the valve is similar in operation to a standard single-circuit air brake valve, and under normal operating conditions the No. 2 circuit portion is similar in operation to a relay valve.

Both No. 1 and No. 2 circuit portions of the Brake Valve use a common exhaust protected by an exhaust diaphragm.

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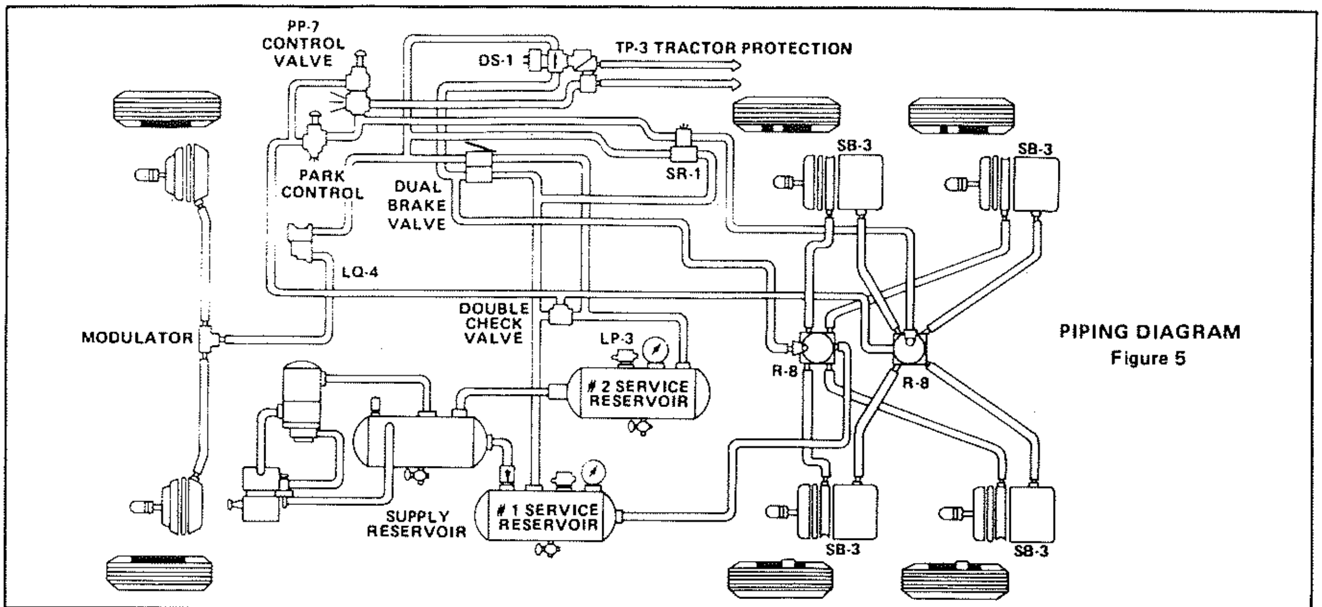


PIPING DIAGRAM
Figure 5

OPERATION

APPLYING: NORMAL OPERATION - NO. 1 CIRCUIT PORTION

When the brake treadle is depressed, the plunger exerts force on the spring seat, graduating spring, and No. 1 piston. The No. 1 piston which contains the exhaust valve seat, closes the No. 1 exhaust valve. As the exhaust valve closes, the No. 1 inlet valve is moved off its seat allowing No. 1 air to flow out the No. 1 delivery port.

APPLYING: NORMAL OPERATION - NO. 2 CIRCUIT PORTION

When the No. 1 inlet valve is moved off its seat, air is permitted to pass through the bleed passage and enters the relay piston cavity. The air pressure moves the relay piston, which contains the exhaust seat and closes the No. 2 exhaust valve. As the No. 2 exhaust valve closes, the No. 2 inlet valve is moved off its seat allowing the No. 2 air to flow out the No. 2 delivery port. Because of the small volume of air required to move the relay piston, action of the No. 2 circuit portion of the valve is almost simultaneous with the No. 1 circuit portion.

APPLYING: LOSS OF AIR IN THE NO. 2 CIRCUIT

Should air be lost in the No. 2 circuit, the No. 1 circuit portion will continue to function as described above under "Normal Operation: No. 1 Circuit Portion".

APPLYING: LOSS OF AIR IN THE NO. 1 CIRCUIT

Should air be lost in the No. 1 circuit, the function will be as follows: As the brake treadle is depressed and no air pressure is present in the No. 1 circuit supply and delivery ports, the No. 1 piston will mechanically move the relay piston allowing the piston to close the No. 2 exhaust valve and open the No. 2 inlet valve and allow air to flow out the No. 2 delivery port.

BALANCED: NO. 1 CIRCUIT PORTION

When the No. 1 delivery pressure acting on the piston equals the mechanical force of the brake pedal application, the No. 1 piston will move and the No. 1 inlet valve will close, stopping the further flow of air from the No. 1 supply line through the valve. The exhaust valve remains closed preventing any escape of air through the exhaust port.

BALANCED: NO. 2 CIRCUIT PORTION

When the air pressure on the No. 2 side of the relay piston approaches that being delivered on the No. 1 side of the relay piston, the relay piston moves closing the No. 2 inlet valve and stopping further flow of air from the supply line through the valve. The exhaust remains closed as the No. 2 delivery pressure balances the No. 1 delivery pressure.

When applications in the graduating range are made, a balanced position in the No. 1 portion is reached as the air pressure on the delivery side of the No. 1 piston equals the effort exerted by the driver's foot on the treadle. A balanced position in the No. 2 portion is reached when air pressure on the No. 2 side of the relay piston closely approaches the air pressure on the No. 1 side of the relay piston.

When the brake treadle is fully depressed, both the No. 1 and No. 2 inlet valves remain open and full reservoir pressure is delivered to the actuators.

RELEASING: NO. 1 CIRCUIT PORTION

With the brake treadle released, mechanical force is removed from the spring seat, graduating spring, and No. 1 piston. Air pressure and spring load moves the No. 1 piston, opening the No. 1 exhaust valve, allowing air pressure in the No. 1 delivery line to exhaust out the exhaust port.

RELEASING: NO. 2 CIRCUIT PORTION

With the brake treadle released, air is exhausted from the No. 1 circuit side of the relay piston. Air pressure and spring load move the relay piston, opening the No. 2 exhaust valve allowing air pressure in the No. 2 delivery line to exhaust out the exhaust port.

PREVENTIVE MAINTENANCE

EVERY 3 MONTHS, 25,000 MILES OR 900 OPERATING HOURS

Clean any accumulated dirt, gravel, or foreign material away from the heel of the treadle, plunger boot, and mounting plate.

Using light oil, lubricate the treadle roller, roller pin, and hinge pin.

Check the rubber plunger boot for cracks, holes or deterioration and replace if necessary. Also, check mounting plate and treadle for integrity.

Apply 2 to 4 drops of oil between plunger and mounting plate – do not over oil!

EVERY YEAR, 100,000 MILES, OR 3,600 OPERATING HOURS

Disassemble, clean parts with mineral spirits, replace all rubber parts or any part worn or damaged. Check for proper operation before placing vehicle in service.

SERVICE CHECKS

OPERATING CHECK

Check the delivery pressure of both No. 1 and No. 2 circuits using test gauges known to be accurate. Depress the treadle to several positions between the fully released and fully applied positions, and check the delivered pressure on the test gauges to see that it varies equally and proportionately with the movement of the brake pedal.

After a full application is released, the reading on the test gauges should fall off to zero promptly. It should be noted that the No. 1 circuit delivery pressure will be about 2 PSI greater than the No. 2 circuit delivery pressure with both supply reservoirs at the same pressure. This is normal for this valve.

IMPORTANT – A change in vehicle braking characteristics or a low pressure warning may indicate a malfunction in one or the other brake circuit, and although the vehicle air brake system may continue to function, the vehicle should not be operated until the necessary repairs have been made and both braking circuits, including the pneumatic and mechanical devices are operating normally. Always check the vehicle brake system for proper operation after performing brake work and before returning the vehicle to service.

LEAKAGE CHECK

1. Make and hold a high pressure (80 psi) application.
2. Coat the exhaust port and body of the brake valve with a soap solution.
3. Leakage permitted is a one inch bubble in 3 seconds.

If the brake valve does not function as described above or leakage is excessive, it is recommended that it be replaced with a new or remanufactured unit, or repaired with genuine Bendix parts available at Bendix outlets.

REMOVAL

1. Check the vehicle wheels or park the vehicle by mechanical means. Drain all air system reservoirs.
2. Identify and disconnect all supply and delivery lines at the brake valve.
3. Remove the brake valve and treadle assembly from the vehicle by removing the three cap screws on the outer bolt circle of the mounting plate. The basic brake valve alone can be removed by removing the three cap screws on the inner bolt circle.

DISASSEMBLY (Fig. 2)

1. If the entire brake valve and treadle assembly was removed from the vehicle, remove the three cap screws securing the treadle assembly to the basic brake valve.
2. Remove the Phillips head screw (9) securing the exhaust diaphragm (10) and washer (11) to the exhaust cover (12).
3. Remove the four screws that secure the exhaust cover (12) to the lower body.
4. Remove the No. 2 inlet and exhaust valve assembly (13) from the lower body.
5. Remove the four hex head cap screws securing the lower body to the upper body and separate the body halves.
6. Remove the rubber seal ring (14) from the lower body.
7. E-6 VALVE ONLY – While applying thumb pressure to the No. 1 piston, lift out and up on the three lock tabs of the No. 1 piston retainer (15).

   E-10 VALVE ONLY (Fig. 4)
8. A. While depressing spring seat (7), remove retaining ring (8).

   B. Remove spring seat and coil spring (5).
9. Using a 3/8" wrench, hold the lock nut (16) on the threaded end of the stem (17) in the primary piston (2). Insert a screwdriver in the exhaust passage through the center of the valve and engage the slotted head of the stem.
10. Remove lock nut (16), spring seat (18), stem spring (19), primary piston (2), and primary piston return spring (6). Remove O-ring (34).
11. Remove adapter (1). Remove O-ring (4) from adapter. CAUTION: Before proceeding with the disassembly, refer to Figure 4 and note that the lock nut and stem are used to contain the No. 1 piston return spring, stem spring and the relay piston spring. The combined force of these springs is approximately 50 pounds and care must be taken when removing the lock nut as the spring forces will be released. It is recommended that the primary piston and relay piston be manually or mechanically contained while the nut and stem are being removed.

E-6 VALVE ONLY –

12. Using a screwdriver to restrain the stem, as in step nine, remove the lock nut (16), spring seat (18) and stem spring (19).

13. Remove the relay piston (20), relay piston spring (21), primary piston and primary piston return spring (23) from the upper body. Use care so as not to nick seats.

    NOTE: Certain E-6 valves do not have a relay piston spring (21). If none is found, none should be replaced.

14. On valves manufactured after October 7, 1976, a small washer (24) will be found in the cavity in the lower side of the primary piston (22).

15. Disassemble the primary piston by rotating the spring seat nut (25) counterclockwise. Separate the spring seat nut, spring seat (26), rubber spring (27) and remove the piston O-ring (28).

16. Remove the large (30) and small (31) O-rings from the relay piston (20).

17. Remove the retaining ring (32) securing the No. 1 inlet and exhaust valve assembly (33) in the upper body and remove the valve assembly.

CLEANING AND INSPECTION

1. Wash all metal parts in mineral spirits and dry.
2. Inspect all parts for excessive wear or deterioration.
3. Inspect the valve seats for nicks or burrs.
4. Check the springs for cracks or corrosion.
5. Replace all rubber parts and any part not found to be serviceable during inspection, using only genuine Bendix replacement parts.

ASSEMBLY

Prior to reassembling, lubricate all O-rings, O-ring grooves, piston bores and metal to metal moving surfaces with Dow Corning 55-M pneumatic grease (Bendix piece number 291126).

NOTE: All torques specified in this manual are assembly torques and can be expected to fall off, after assembly is accomplished. Do not retorque after initial assembly torques fall.

1. Install the No. 1 inlet and exhaust assembly (33) in the upper body and replace the retaining ring (32) to secure it. Be sure the retaining ring is seated completely in its groove.

2. Install the large (30) and small (31) O-rings on the relay piston.

3. Install the primary piston O-ring (28) in the piston O-ring groove.

   E-6 VALVE ONLY –

4. Install the rubber spring (27), concave side down in the primary piston (22) and place the spring seat (26), flat side up, over the rubber spring.

5. Install the primary piston spring seat nut (25), with its hex closest to the spring seat, and rotate clockwise until the top surface of the spring seat is even with the top surface of the piston. Set aside.

6. Install large (30) and small (31) O-rings on relay piston (20).

7. Place relay piston, spring (21) (if used) in concave portion of relay piston and install relay piston through No. 1 inlet/exhaust assembly (33) and into under side of upper body.

8. Place screwdriver, blade up, in vise. Place stem (17) in relay piston - upper body sub-assembly over the blade of the screwdriver with blade engaged in the slot in the head of the stem.

9. Place the washer (24) over the stem. This washer should be installed in all valves.

10. Install primary return spring (23) in upper body piston bore.

11. Install the primary piston - rubber spring sub-assembly (steps 4 & 5) over the stem, into the upper body piston bore.

12. Compress the primary and relay pistons into the upper body from either side and hold them compressed, either manually or mechanically. SEE THE CAUTIONARY NOTE UNDER STEP 11 IN THE "DISASSEMBLY" SECTION OF THIS MANUAL.

13. Place the stem spring (19) over the spring seat nut (25) and the spring seat (18) over the stem.

14. Install the lock nut (16) on the stem and torque to 20-30 inch pounds.

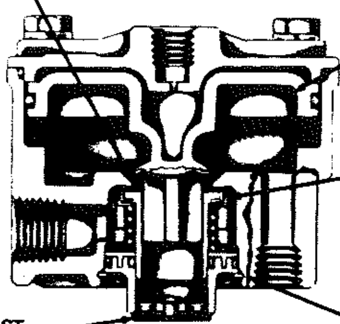
15. Install the primary piston retainer (15) over the piston, making certain all three lock tabs have engaged the outer lip of the body.

IMPORTANT! PLEASE READ

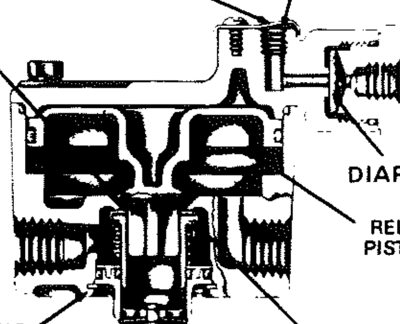
When working on or around brake systems and components, the following precautions, should be observed:

1. Always block vehicle wheels. Stop engine when working under a vehicle. Keep hands away from chamber push rods and slack adjusters; they may apply as system pressure drops.
2. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or pipe plug unless you are certain all system pressure has been depleted.
3. Never exceed recommended pressure and always wear safety glasses when working.
4. Never attempt to disassemble a component until you have read and understand recommended procedures. Some components contain powerful springs and injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to use of those tools.
5. Use only genuine Bendix replacement parts and components.
   A. Only components, devices and mounting and attaching hardware specifically designed **for use in hydraulic brake systems** should be used.
   B. Replacement hardware, tubing, hose, fittings, etc. shoud be of equivalent size, type and strength as the original equipment.
6. Devices with stripped threads or damaged parts should be replaced. Repairs requiring machining should not be attempted.

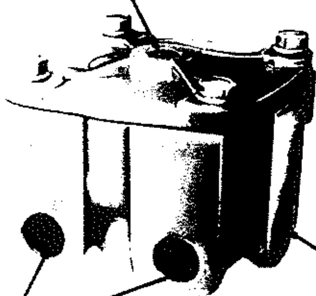
R-12 AND R-14 RELAY VALVES



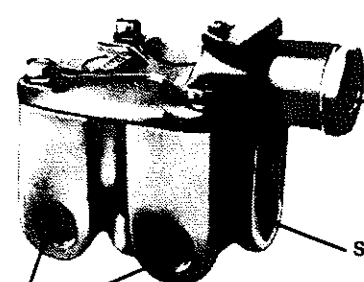
SECTIONAL - R-12V



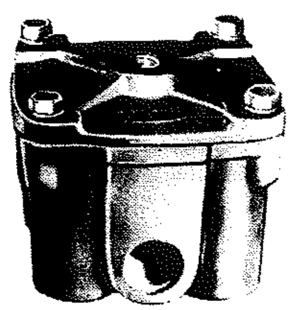
SECTIONAL R-14H



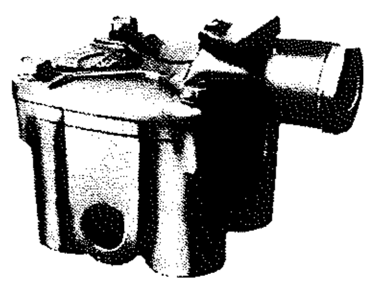
EXTERIOR - R-12H



EXTERIOR - R-14H



EXTERIOR - R-12V



EXTERIOR - R-14V

Figure 1

IMPORTANT! PLEASE READ:

When working on or around air brake systems and components, the following precautions should be observed:

1. Always block vehicle wheels. Stop engine when working under a vehicle. Depleting vehicle air system pressure may cause vehicle to roll. Keep hands away from chamber push rods and slack adjusters; they may apply as system pressure drops.
2. Never connect or disconnect a hose or line containing air pressure. It may whip as air escapes. Never remove a component or pipe plug unless you are certain all system pressure has been depleted.
3. Never exceed recommended air pressure and always wear safety glasses when working with air pressure. Never look into air jets or direct them at anyone.
4. Never attempt to disassemble a component until you have read and understand recommended procedures. Some components contain powerful springs and injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to use of those tools.

DESCRIPTION

The Relay Valve in an air brake system functions as a relay station to speed up the application and release of the brakes. The valve is normally mounted at the rear of the vehicle in proximity to the chamber it serves. The valve operates as a remote controlled brake valve that delivers or releases air to the chambers in response to the control air delivered to it from the foot brake valve or other source.

The R-12 and R-14 Relay Valves are designed for either reservoir or frame mounting. A universal mounting bracket is furnished that permits easy interchange with other Bendix or competitive relay valves. Both valves are available in the two body styles illustrated in Figure 1. The R-14 differs from the R-12 in that it incorporates a quick release and anti-compounding feature located above its horizonal service port. The R-14's anti-compound feature allows it to be conveniently used as either a service or spring brake relay valve. An exhaust cover is installed that protects the 1/8" balance port when the R-14 anti-compound feature is not in use.

All parts are interchangeable between the R-12 and R-14 with the exception of the detail components of the R-14 cover. Both valves make extensive use of non-metallic internal components. For ease of servicing, the inlet/exhaust valve can be replaced without the need for line removal.

OPERATION

APPLICATION

Air pressure delivered to the service port enters the small cavity above the piston and moves the piston down. The exhaust seat moves down with the piston and seats on the inner or exhaust portion of the inlet/exhaust valve, sealing off the exhaust passage. At the same time, the outer or inlet portion of the inlet/exhaust valve moves off its seat, permitting supply air to flow from the reservoir, past the open inlet valve and into the brake chambers.

BALANCE

The air pressure being delivered by the open inlet valve also is effective on the bottom area of the relay piston. When air pressure beneath the piston equals the service air pressure above, the piston lifts slightly and the inlet spring returns the inlet valve to its seat. The exhaust remains closed as the service line pressure balances the delivery pressure. As delivered air pressure is changed, the valve reacts instantly to the change holding the brake application at that level.

EXHAUST OR RELEASE

When air pressure is released from the service port and air pressure in the cavity above the relay piston is exhausted, air pressure beneath piston lifts the relay piston and the exhaust seat moves away from the exhaust valve, opening the exhaust passage. With the exhaust passage open, the air pressure in the brake chambers is then permitted to exhaust through the exhaust port, releasing the brakes.

ANTI COMPOUNDING (SIMULTANEOUS SERVICE AND PARK APPLICATION)

In those applications where the R-14 Relay Valve is used to control spring brake chambers, the anti-compound feature may be utilized. With the anti-compound feature of the R-14 connected, a service application made while the vehicle is parked is countered by a release of the parking brakes. To utilize this feature, the exhaust cover of the quick release portion of the R-14 is removed and a line is installed which is connected to the delivery of the service brake valve or relay valve. With no air pressure at the service port of the R-14, the parking brakes are applied. If a service brake application is made, air from the service brake valve enters the exhaust port of the quick release of the R-14 and moves the diaphragm, blocking the service port. Air then proceeds into the cavity above the relay piston, forces the piston down, closing the exhaust and opening the inlet to deliver air to the spring brake cavity as described under the section of this manual entitled APPLICATION.

PREVENTIVE MAINTENANCE

1. Every three months; 25,000 miles or 900 operating hours, check for proper operation.
2. Every twelve months; 100,000 miles or 3600 operating hours, disassemble valve, clean parts with mineral spirits. Replace all rubber parts and any part worn or damaged. Check for proper operation before placing vehicle in service.

OPERATIONAL AND LEAKAGE TEST

1. Chock the wheels, fully charge air brake system and adjust the brakes.
2. Make several brake applications and check for prompt application and release at each wheel.
3. Check for inlet valve and O-Ring leakage.
   A. Make this check with the service brakes released when the R-12 or R-14 is used to control the service brakes.
   B. Make the check with the spring brakes applied (PARK) when the R-14 is used to control the spring brakes.

   Coat the exhaust port and the area around the retaining ring with a soap solution; 1" bubble in 3 seconds leakage is permitted.
4. Check for exhaust valve leakage.
   A. Make this check with the service brakes fully applied if the R-12 or R-14 control the service brakes.
   B. Make this check with the spring brakes fully released if the R-14 is used to control the spring brakes.

   Coat the exhaust port with a soap solution; 1" bubble in 3 seconds leakage is permitted.

   Coat the outside of the valve where the cover joins the body to check for seal ring leakage; no leakage is permitted.

5. If the R-14 is used to control the spring brakes, place the park control in the released position and coat the balance port with a soap solution to check the diaphragm and its seat. Leakage equivalent to a 1" bubble in 3 seconds is permitted.

   NOTE: If the anti-compound feature is in use, the line attached to the balance port must be disconnected to perform this test.

   If the valves do not function as described above, or if leakage is excesive, it is recommended that the valves be replaced with a new or remanufactured units or repaired with genuine Bendix parts available at Bendix H.V.S.G outlets.

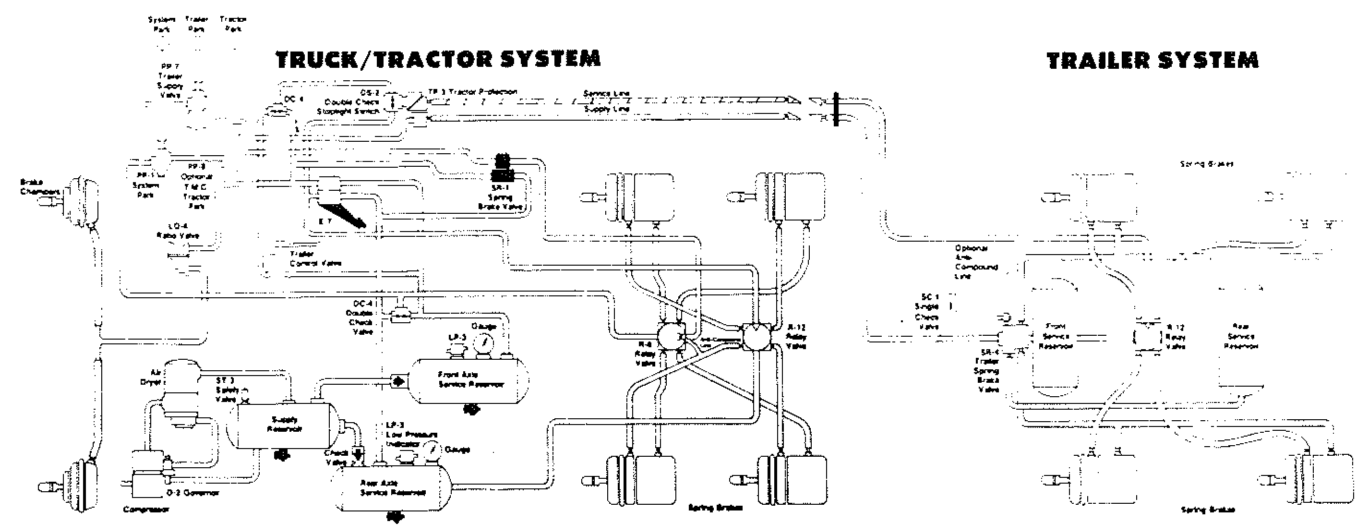


Figure 2 - SCHEMATIC

REMOVAL AND INSTALLATION

REMOVAL

1. Block and hold vehicle by means other than air brakes.
2. Drain air brake system reservoirs.
3. If entire valve is to be removed, identify air lines to facilitate installation.
4. Disconnect air lines from valve*.
5. Remove valve from reservoir or if remotely mounted, remove mounting bolts and then valve.

*It is generally not necessary to remove entire valve to service the inlet/exhaust valve. The inlet/exhaust valve insert can be removed by removing the snap ring, exhaust cover assembly and then inlet/exhaust valve. CAUTION: Drain all reservoirs before attempting to remove the inlet exhaust valve.

DISASSEMBLY

NOTE: Prior to disassembly, mark the location of the mounting bracket to the cover and the cover to the body.

1. Remove the four (4) cap screws and lockwashers securing the cover to the body.
2. Remove the cover, sealing ring, and mounting bracket.
3. Remove the piston and O-Ring from the body.
4. While depressing the exhaust cover, remove the retaining ring and slowly relax the spring beneath the exhaust cover.
5. Remove the exhaust cover assembly and O-Rings.
6. Remove the inlet/exhaust valve return spring from the body.
7. Remove the inlet/exhaust valve from the body.
8. Remove the valve retainer from the inlet/exhaust valve.
9. Remove the Phillips head screw and exhaust cover from the R-14 cover.
10. Remove the service port cap nut and O-Ring from the R-14.
11. Remove the diaphragm from the R-14 cover.

CLEANING AND INSPECTION

1. Wash all metal parts in mineral spirits and dry them thoroughly.

   (NOTE: When rebuilding, all springs and all rubber parts should be replaced.)

2. Inspect all metal parts for deterioration and wear, as evidenced by scratches, scoring and corrosion.
3. Inspect the exhaust valve seat on the relay piston for nicks and scratches which could cause excessive leakage.
4. Inspect the inlet valve seat in the body for scratches and nicks, which could cause excessive leakage.
5. Inspect the exhaust seat of the quick release diaphragm in the R-14 cover and make sure all internal air passages in this area are open and clean and free of nicks and scratches.
6. Replace all parts not considered serviceable during these inspections and all springs and rubber parts. Use only genuine Bendix replacement parts which are available from Bendix H.V.S.G. outlets.

ASSEMBLY

NOTE: All torques specified in this manual are assembly torques and can be expected to fall off slightly after assembly. Do not retorque after initial assembly torques fall. For assembly, hand wrenches are recommended.

Prior to assembly, lubricate all O-Rings, O-Ring bores and any sliding surface with a silicone lubricant equivalent to Dow Corning #10.

1. Install large piston O-Ring on piston.
2. Install inner and outer O-Rings in the exhaust cover assembly.
3. Install the sealing ring on the cover.
4. Install piston in body, taking care not to damage the piston O-Ring.
5. Noting the reference marks made during disassembly, install the cover on the valve body and the mounting bracket on the cover.
6. Secure the mounting bracket and cover to the body using the four (4) cap screws and lockwashers. Torque to 80-120 inch pounds.
7. Install the valve retainer on the inlet/exhaust valve and install in the body.
8. Install the inlet/exhaust valve return spring in the body.
9. Install the exhaust cover assembly in the body taking care not to damage the O-Ring.
10. While depressing the exhaust cover, install the retaining ring. Make certain the retainer is completely seated in its groove in the body.
11. Install the R-14 service port cap nut O-Ring on the cap nut.
12. Install the diaphragm in the R-14 cover making certain it is positioned between the guide ribs in the cover.
13. Install the service port cap nut and torque to 150 inch pounds.
14. If the quick release exhaust port was protected with an exhaust cover, install the cover using the #10-24 Phillips head screw. Torque to approx. 15-25 inch pounds.
15. Test the valves as outlined in the "Operational and Leakage Tests" section before returning the valve to service.

INSTALLATION

1. Clean air lines.
2. Inspect all lines and/or hoses for damage and replace as necessary.
3. Install valve and tighten mounting bolts.
4. Connect air lines to valve (plug any unused ports).
5. Test valve as outlined in "Operational and Leakage Tests."

TU-FLO 750 COMPRESSOR

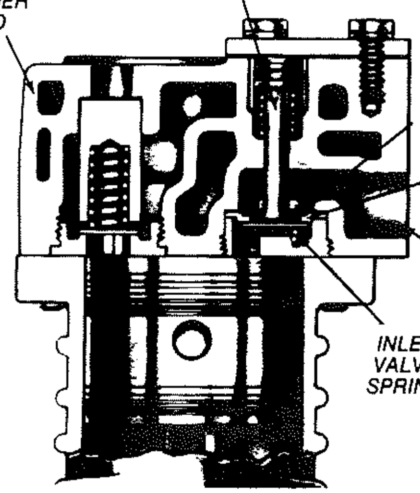
DESCRIPTION

The function of the air compressor is to provide and maintain air under pressure to operate devices in the air brake and/or auxiliary air systems.

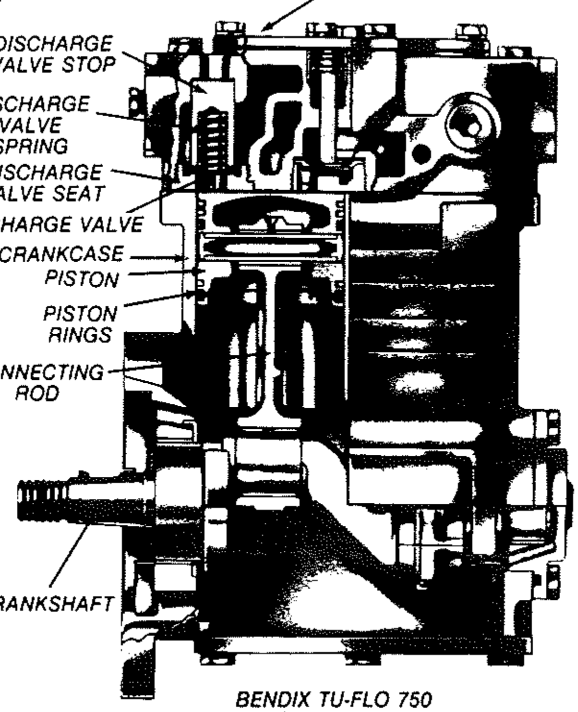
The Tu-Flo 750 compressor is a two cylinder single stage, reciprocating compressor with a rated displacement of 16.5 cubic feet per minute at 1250 RPM.

The compressor assembly consists of two major subassemblies, the cylinder head and the crankcase. The cylinder head is an iron casting which houses the inlet, discharge, and unloader valving. (See fig. 1) The cylinder head contains the air inlet port and is designed with both top and side air discharge ports. Three water

BENDIX TU-FLO 750 COMPRESSOR (EXTERIOR)



END VIEW OF CYLINDER HEAD



BENDIX TU-FLO 750 COMPRESSOR (CROSS SECTION)

coolant ports provide a choice of coolant line connections. Governor mounting surfaces are provided at both the front and the rear of the cylinder head. The head is mounted on the crankcase and is secured by six cap screws. The Tu-Flo 750 compressor is designed such that the cylinder head can be installed in one of two positions which are 180 degrees apart. The crankcase houses the cylinder bores, pistons, crankshaft and main bearings, and provides the flange or base mounting surface.

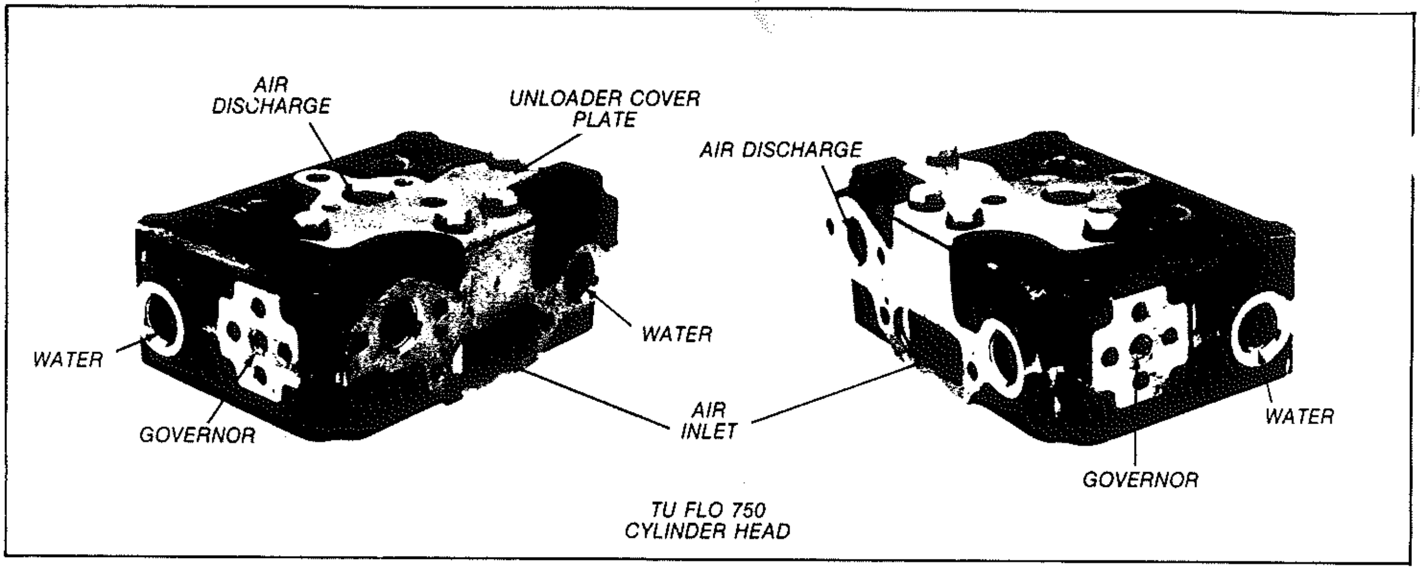


FIG. 1 **CYLINDER HEAD**

Various mounting and drive configurations, as shown in figure 2, are supplied as required by the vehicle engine designs.

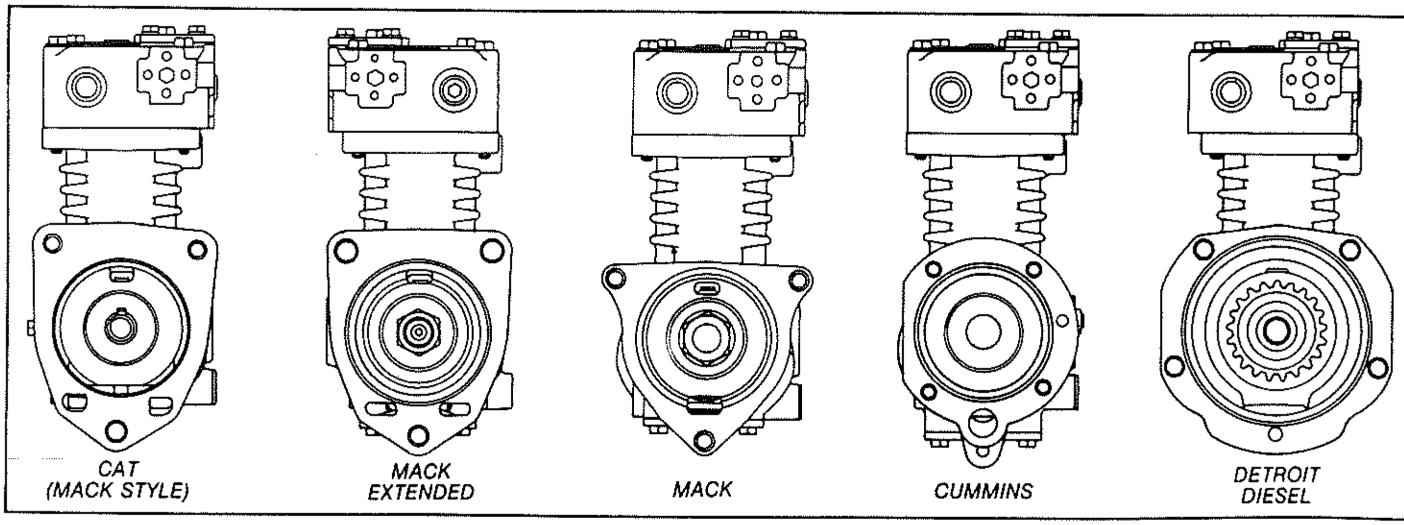


FIG. 2 **MOUNTING CONFIGURATIONS**

A nameplate identifying the compressor piece number and serial number is attached to the side of the crankcase. (Reference fig. 3)

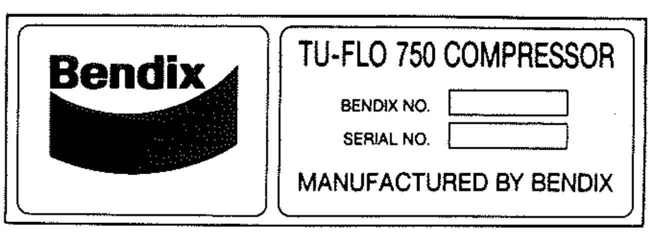


FIG. 3 **NAMEPLATE**

OPERATION

The compressor is driven by the vehicle engine and is operating continuously while the engine is running. Actual compression of air is controlled by the compressor unloading mechanism and the governor. The governor which is generally mounted on the compressor maintains the brake system air pressure to a preset maximum and minimum pressure level.

INTAKE AND COMPRESSION OF AIR (LOADED)

During the down stroke of the piston, a slight vacuum is created between the top of the piston and the cylinder head, causing the inlet valve to move off its seat and open. (Note: The discharge valve remains on its seat.) Atmospheric air is drawn through the air strainer and the open inlet valve into the cylinder (see fig. 4). As the piston begins its upward stroke, the air that was drawn into the cylinder on the down stroke is being compressed. Air pressure on the inlet valve plus the force of the inlet spring, returns the inlet valve to its seat and closes. The piston continues the upward stroke and compressed air pushes the discharge valve off its seat and air flows by the open discharge valve, into the discharge line and to the reservoirs (see fig. 5). As the piston reaches the top

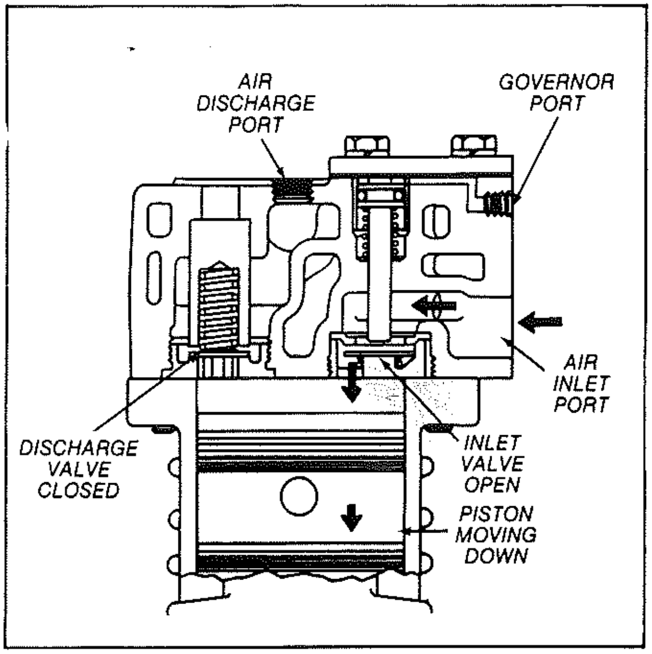


FIG. 4 **OPERATIONAL-LOADED (INTAKE)**

of its stroke and starts down, the discharge valve spring and air pressure in the discharge line returns the discharge valve to its seat. This prevents the compressed air in the discharge line from returning to the cylinder bore as the intake and compression cycle is repeated.

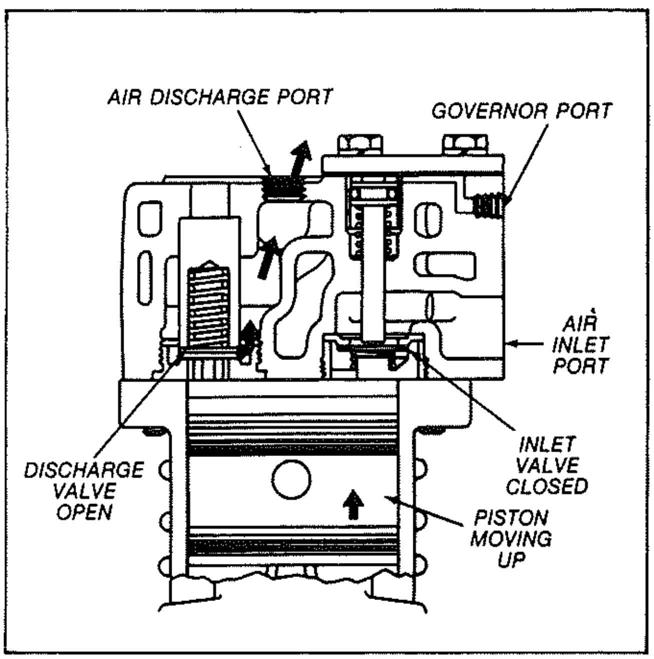


FIG. 5 **OPERATIONAL-LOADED (COMPRESSION)**

NON-COMPRESSION OF AIR (UNLOADED)

When air pressure in the reservoir reaches the cut-out setting of the governor, the governor allows air to pass from the reservoir, through the governor and into the cavity above the unloader pistons. The unloader pistons move down holding the inlet valves off their seats. (See fig. 6)

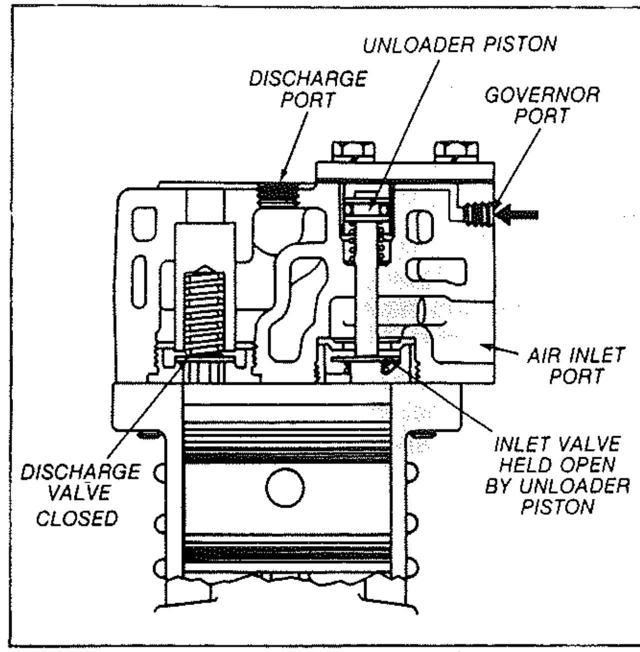


FIG. 6 **OPERATIONAL-UNLOADED**

With the inlet valves held off their seats by the unloader pistons, air is pumped back and forth between the two cylinders, and the discharge valves remain closed. When air pressure from the reservoir drops to the cut-in setting of the governor, the governor closes and exhausts the air from above the unloader pistons. The unloader springs force the pistons upward and the inlet valves return to their seats. Compression is then resumed.

LUBRICATION

The vehicle's engine provides a continuous supply of oil to the compressor. Oil is routed from the engine to the compressor oil inlet. An oil passage in the compressor crankshaft allows oil to lubricate the connecting rod crankshaft bearings. Connecting rod wrist pin bushings and crankshaft ball bearings are spray lubricated. An oil return line connected from the compressor drain outlet to the vehicle engine crankcase allows for oil return. On flange mounted models the oil drains back directly to the engine thru the mounting flange.

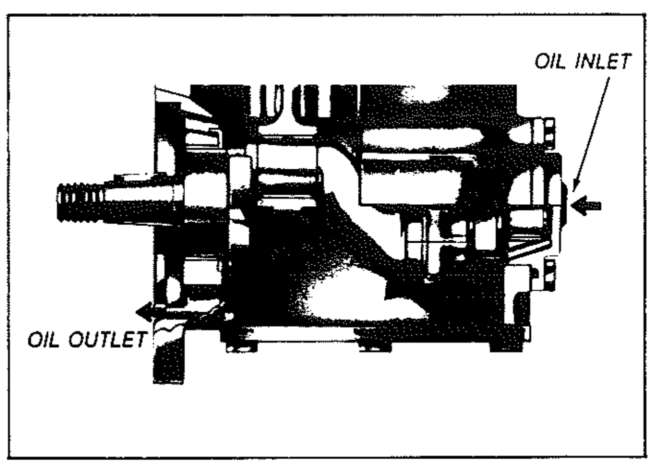


FIG. 7 **LUBRICATION**

COOLING

Air flowing through the engine compartment from the action of the engine's fan and the movement of the vehicle assists in cooling the compressor. Coolant flowing from the engine's cooling system through connecting lines enters the head and passes through internal passages in the cylinder head and is returned to the engine. Proper cooling is important in maintaining discharge air temperatures below the maximum recommended 400 degrees Fahrenheit.

Figure 8 illustrates the various approved coolant flow connections. See the tabulated technical data in the back of this manual for specific requirements.

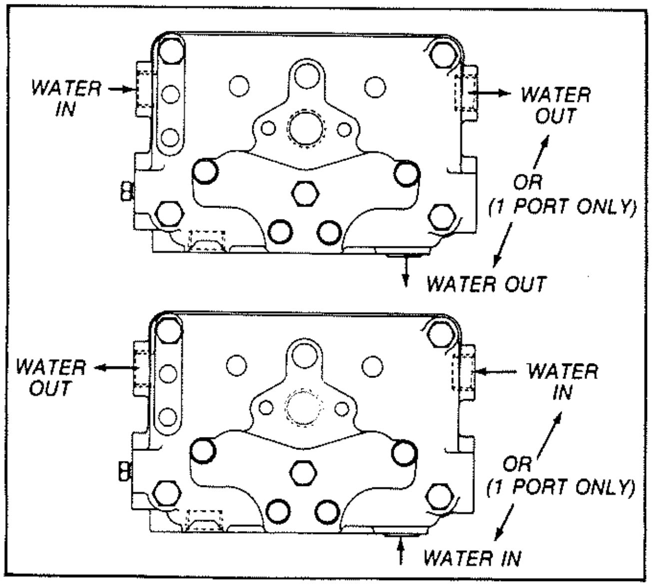


FIG. 8 **COOLING**

AIR INDUCTION

There are three methods of providing clean air to the Tu-Flo 750 compressor;

1. Naturally aspirated - Compressor utilizes its own attached air strainer (polyurethane sponge or pleated paper dry element).
2. Naturally aspirated - Compressor inlet is connected to the engine air cleaner or the vacuum side (engine air cleaner) of the supercharger or turbocharger.
3. Pressurized induction - Compressor inlet is connected to the pressure side of the supercharger or turbocharger.

See the tabulated technical data in the back of this manual for specific requirements for numbers 2 and 3 above.

If a previously unturbocharged compressor is being turbocharged, it is recommended that the inlet cavity screen 238948 be installed with an inlet gasket (291909) on both sides of the screen.

COMPRESSOR TURBOCHARGING PARAMETERS

Air entering the compressor inlet during the loaded cycle must not exceed 250 degrees Fahrenheit (121 degrees Celsius). A metal inlet line is suggested to help meet this parameter.

The following compressor crankshaft rotative speed and inlet pressure relationships may not be exceeded.

CRANKSHAFT R.P.M.	MAXIMUM COMPRESSOR INLET PRESSURE
1900 RPM	30.0 psi (207 kPa)
2000 RPM	27.5 psi (190 kPa)
2100 RPM	24.0 psi (165 kPa)
2200 RPM	21.0 psi (145 kPa)
2300 RPM	19.0 psi (131 kPa)
2400 RPM	16.0 psi (110 kPa)

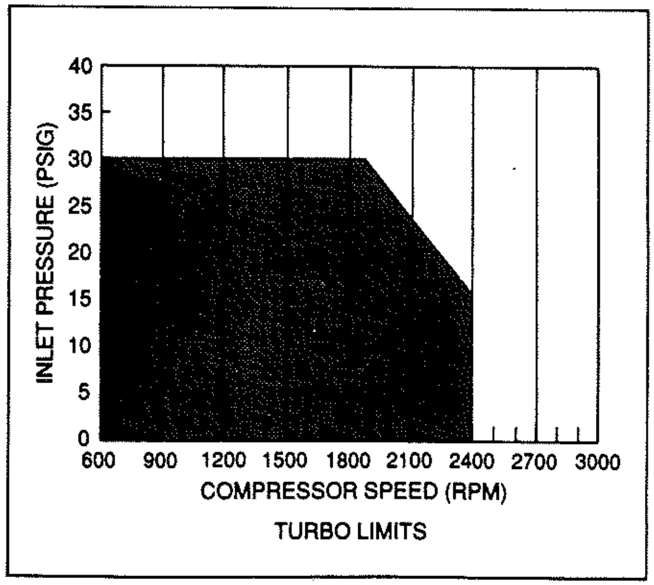


FIG. 9 **TURBO LIMITS CURVE**

PREVENTATIVE MAINTENANCE

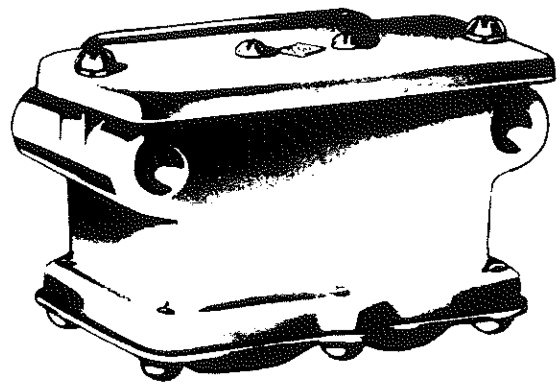
AIR INDUCTION

One of the single most important aspects of compressor preventive maintenance is the induction of clean air. The type and interval of maintenance required will vary depending upon the air induction system used.

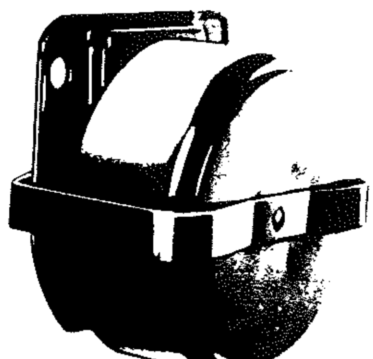
The intervals listed under the headings below pertain to typical highway and street operation. **More frequent maintenance will be required for operation in dusty or dirty environments.**

POLYURETHANE SPONGE STRAINER

Every month, 150 operating hours or 5,000 miles, whichever occurs first, remove and wash all of the parts. The strainer element should be cleaned or replaced. If the element is cleaned, it should be washed in a commercial solvent or a detergent and water solution. The element should be saturated in clean engine oil, then squeezed dry before replacing it in the strainer. Be sur to replace the air strainer gasket if the entire strainer is removed from the compressor intake.



POLYURETHANE SPONGE STRAINER



PAPER AIR STRAINER DRY ELEMENT-PLEATED

FIG. 10 **STRAINERS**

DRY ELEMENT - PLEATED PAPER STRAINER

Every two months, 800 operating hours or 20,000 miles whichever occurs first, loosen the spring clip from the unhinged side of the mounting baffle and open the cover. Replace the pleated paper filter and secure the cleaned cover, making sure the filter is in position. Be sure to replace the air strainer gasket if the entire air stainer is removed from the compressor intake.

INTAKE ADAPTER

When the engine air cleaner is replaced; Some compressors are fitted with compressor intake adapters, which allow the compressor intake to be connected to the engine air induction system. In this case, the compressor receives a supply of clean air from the engine air cleaner. When the engine air filter is changed, the compressor intake adapter should be checked. If it is loose, remove the intake adapter, clean the strainer plate, if applicable, and replace the intake adapter gasket, and reinstall the adapter securely. Check line connections both at the compressor intake adapter and at the engine. Inspect the connecting line for ruptures and replace it if necessary.

COMPRESSOR COOLING

Every 6 months, 1800 operating hours or after each 50,000 miles whichever occurs first, inspect the compressor discharge port, inlet cavity and discharge line for evidence of restrictions and carboning. If excessive buildup is noted, thoroughly clean or replace the affected parts and closely inspect the compressor cooling system. Check all compressor coolant lines for kinks and restrictions to flow. **Minimum** coolant line size is 3/8" I.D. Check coolant lines for internal clogging from rust scale. If coolant lines appear suspicious, check the coolant flow and compare to the tabulated technical data present in the back of this manual. Carefully inspect the air induction system for restrictions.

LUBRICATION

Every six months, 1800 operating hours or 50,000 miles which ever occurs first; check external oil supply and return lines, if applicable, for kinks, bends, or restrictions to flow. Supply lines must be a minimum of 3/16" I.D. and return lines must be a minimum of 1/2" I.D. Oil return lines should slope as sharply as possible back to the engine crankcase and should have as few fittings and bends as possible. Refer to the tabulated technical data in the back of this manual for oil pressure minimum values.

COMPRESSOR DRIVE

Every six months, 1800 operating hours or 50,000 miles, whichever occurs first, check for noisy compressor operation, which could indicate a worn drive gear coupling, a loose pulley or excessive internal wear. Adjust and/or replace as necessary.

If the compressor is belt driven, check for proper belt and pulley alignment and belt tension. Check all compressor mounting bolts and retighten evenly if necessary. Check for leakage and proper unloader mechanism operation. Repair or replace parts as necessary.

EVERY 24 MONTHS, 7200 OPERATING HOURS OR AFTER EACH 200,000 MILES Perform a thorough inspection, and depending upon the results of this inspection or experience, disassemble the compressor, clean and inspect all parts thoroughly, replace all worn or damaged parts using only genuine Bendix replacements or replace the compressor with a genuine Bendix remanufactured unit.

GENERAL SERVICE CHECKS
OPERATING TESTS

Vehicles manufactured after the effective date of FMVSS 121, with the minimum required reservoir volume, must have a compressor capable of raising air system pressure from 85-100 psi in 25 seconds or less. This test is performed with the engine operating at maximum recommended governed speed. The vehicle manufacturer must certify this performance on new vehicles with appropriate allowances for air systems with greater than the minimum required reservoir volume.

AIR LEAKAGE TESTS

Compressor leakage tests need not be performed on a regular basis. These tests should be performed when; it is suspected that discharge valve leakage is substantially affecting compressor build-up performance, or when it is suspected that the compressor is "cycling" between the load and unloaded modes due to unloader piston leakage.

These tests must be performed with the vehicle parked on a level surface, the engine not running, the entire air system completely drained to 0 P.S.I., and the inlet check valve detail parts removed, if applicable.

UNLOADER PISTON LEAKAGE

The unloader pistons can be checked for leakage as follows: with the cylinder head removed from the compressor and the inlet flange securely covered, apply 120 psi of air pressure to the governor port. Listen for an escape of air at the inlet valve area. An audible escape of air should not be detected.

DISCHARGE VALVE LEAKAGE

Unloader piston leakage must be repaired before this test is performed. Leakage past the discharge valves can be detected as follows: Remove the discharge line and apply shop air back through the discharge port. Listen for an escape of air at the compressor inlet cavity. A barely audible escape of air is generally acceptable.

If the compressor does not function as described above or if the leakage is excessive, it is recommended that it be returned to the nearest authorized Bendix distributor for a factory remanufactured compressor. If it is not possible, the compressor can be repaired using a genuine Bendix cylinder head maintenance kit. Retest the cylinder head after installation of the kit.

REMOVAL AND DISASSEMBLY

GENERAL

The following disassembly and assembly procedure is presented for reference purposes and presupposes that a major rebuild of the compressor is being undertaken. Several maintenance kits are available which do not require full disassembly. The instructions provided with these parts and kits should be followed in lieu of the instructions presented here.

REMOVAL

These instructions are general and are intended to be a guide, in some cases additional preparations and precautions are necessary.

1. Block the wheels of the vehicle and drain the air pressure from all the reservoirs in the system.
2. Drain the engine cooling system and the cylinder head of the compressor. Identify and disconnect all air, water and oil lines leading to the compressor.
3. Remove the governor and any supporting bracketry attached to the compressor and note their positions on the compressor to aid in reassembly.
4. Remove the discharge and inlet fittings, if applicable and note their position on the compressor to aid in reassembly.
5. Remove the flange or base mounting bolts and remove the compressor from the vehicle.
6. Remove the drive gear(s) or pulley from the compressor crankshaft using a gear puller. Inspect the pulley or gear and associated parts for visible wear or damage. Since these parts are precision fitted, they must be replaced if they are worn or damaged.

PREPARATION FOR DISASSEMBLY

Remove road dirt and grease from the exterior of the compressor with a cleaning solvent. Before the compressor is disassembled, the following items should be marked to show their relationship when the compressor is assembled. Mark the rear end cover in relation to the crankcase. Mark the base plate or base adapter in relation to the crankcase.

A convenient method to indicate the above relationships is to use a metal scribe to mark the parts with numbers or lines. Do not use marking methods such as chalk that can be wiped off or obliterated during rebuilding.

CYLINDER HEAD

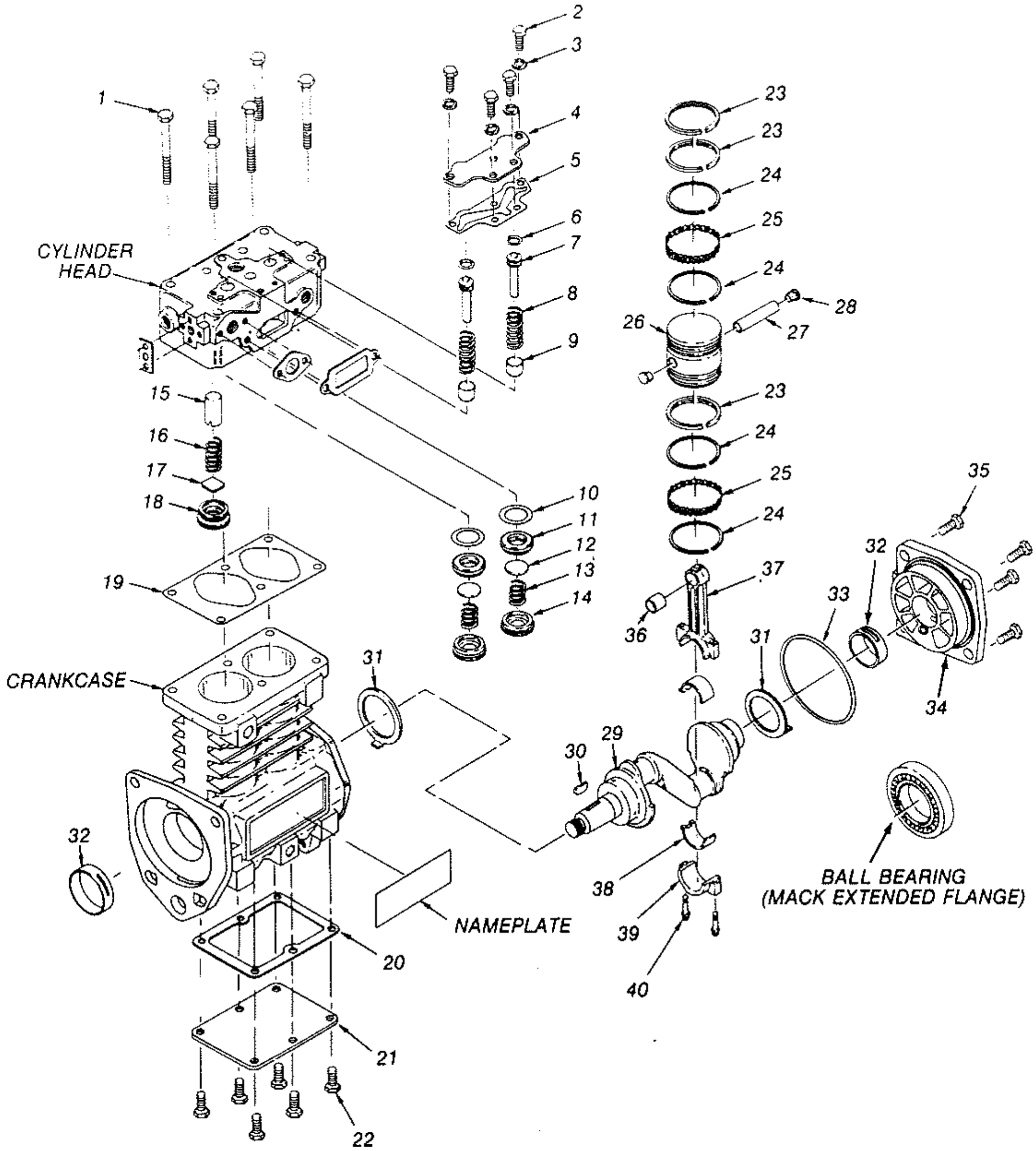
Remove the six cylinder head cap screws(1) and tap the head with a soft mallet to break the gasket seal. Remove the unloader cover plate cap screws(2), lockwashers(3) and the unloader cover plate(4). Scrape off any gasket material(5) from the cover plate, cylinder head and crankcase.

1. Remove the unloader pistons(7), o-rings(6) and springs(8).
2. Inspect the unloader piston bushings(9) for nicks, wear, corrosion and scoring. It is recommended that the compressor be replaced if it is determined that the unloader bushing is damaged or worn excessively.

Before disassembling the discharge valve mechanism, measure and record the discharge valve travel (from closed to completely open).

3. If the measured discharge valve travel EXCEEDS .046 inches, the compressor should be replaced. If the discharge valve travel does not exceed .046, using a 9/16" Allen wrench, remove the discharge valve seats(18), valves(17) and valve springs(16).
4. Remove the inlet valve stops(14),valves(17), valve seats(11), valve springs(12) and gaskets(10). It is recommended that a tool such as a J-25447-B, produced by Kent Moore Tool Division Roseville Michigan phone 1-800-328-6657, be used to remove the inlet valve stop.

FIG. 11 EXPLODED VIEW



Item	Qty.	Description	Item	Qty.	Description
1	6	Cylinder Head Cap Screws	21	1	Base Plate
2	4	Unloader Plate Cap Screws	22	6	Base Plate Cap Screws
3	4	Unloader Plate Lock Washers	23	6	Standard Piston Rings
4	1	Unloader Plate	24	8	Oil Ring
5	1	Unloader Plate Gasket	25	4	Expander Ring
6	2	O-Ring	26	2	Piston
7	2	Unloader	27	2	Wrist Pin
8	2	Spring	28	4	Wrist Pin Button
9	2	Unloader Bushing	29	1	Crankshaft
10	2	Gasket	30	1	Crankshaft Key
11	2	Inlet Valve Seat	31	2	Thrust Washer
12	2	Inlet Valve	32	2	Sleeve Bearing
13	2	Inlet Valve Spring	33	1	End Cover Seal
14	2	Inlet Valve Stop	34	1	End Cover
15	2	Discharge Valve Stop	35	4	End Cover Cap Screw
16	2	Discharge Valve Spring	36	2	Wrist Pin Bushing
17	2	Discharge Valve	37	2	Connecting Rod
18	2	Discharge Valve Stop	38	2	Connecting Rod Inserts (Sets)
19	1	Cylinder Head Gasket	39	2	Connecting Rod Caps
20	1	Base Gasket	40	4	Connecting Rod Bolts

CRANKCASE BOTTOM COVER OR ADAPTER DISASSEMBLY

1. Remove the cap screws(22) securing the bottom cover or adapter(21). Tap with a soft mallet to break the gasket seal. Scrape off any gasket material(20) from the crankcase and bottom cover or adapter.

CONNECTING ROD DISASSEMBLY

Before removing the connecting rod, mark the connecting rods(37) and their caps(39) to ensure correct reassembly. The connecting rod and cap are a matched set therefore the caps must not be switched or rotated end for end.

1. Remove the connecting rod bolts(40) and bearing caps(39).
2. Push the pistons(26) with the connecting rods(37) attached out the top of the cylinder bore of the crankcase. Replace the bearing caps on the connecting rods.
3. Remove the piston rings(23-25) from the piston. If the piston is to be removed from the connecting rod, remove the wrist pin teflon plugs(28) and press the wrist pin(27) from the piston and connecting rod.
4. If the piston is removed from the rod, inspect the wrist pin bore in the piston and bronze wrist pin bushing(36) in the connecting rod. If excessive wear is noted or suspected, replace the connecting rod and piston.

COMPRESSOR CRANKCASE DISASSEMBLY

1. Remove the key or keys(30) from the crankshaft(29) and any burrs from the crankshaft where the key or keys were removed. (NOTE: Through drive compressors may have a crankshaft key at both ends.)
2. Remove the four cap screws(35) and lockwashers or nuts and lockwashers that secure the rear end cover(34) to the crankcase.
3. Remove the rear end cover(34), thrust washer(31) and end cover oil seal ring(33), taking care not to damage the bearing if present in the end cover.
4. If the compressor has ball type main bearings, press the crankshaft(29) and ball bearings from the crankcase, then press the ball bearings from the crankshaft.
5. Press the oil seal out of the compressor crankcase, if so equipped.

CLEANING OF PARTS

GENERAL

All parts should be cleaned in a good commercial grade of solvent and dried prior to inspection.

CYLINDER HEAD

Remove carbon deposits from the discharge cavity and rust and scale from the cooling cavities of the cylinder head body. Scrape all foreign matter from the body surfaces and use shop air pressure to blow the dirt particles from the cavities. Clean carbon and dirt from the inlet and unloader passages. Use shop air to blow the carbon and dirt deposits from the unloader passages.

OIL PASSAGES

Thoroughly clean all oil passages through the crankshaft, crankcase, end covers, base plate or base adapter. Inspect the passages with a wire to be sure. Blow the loosened foreign matter out with air pressure.

INSPECTION OF PARTS

CYLINDER HEAD BODY

Inspect the cylinder head for cracks or damage. With the cylinder head and head gasket secured to a flat surface or crankcase, apply shop air pressure to one of the coolant ports with all others plugged, and check for leakage by applying a soap solution to the exterior of the body. If leakage is detected, replace the compressor.

END COVERS

Check for cracks and external damage. If the crankshaft main bearing(32) is installed in the end cover(34), check for excessive wear and flat spots and replace if necessary.

CRANKCASE

Check all crankcase surfaces for cracks and damage. On compressors where ball bearing main bearings are used the difference between the O.D. of the outer race and the I.D. of the crankcase hole should be .0003 in. tight to .0023 in. loose. This is to maintain the correct fit. The compressor must be replaced if the fit is too loose.

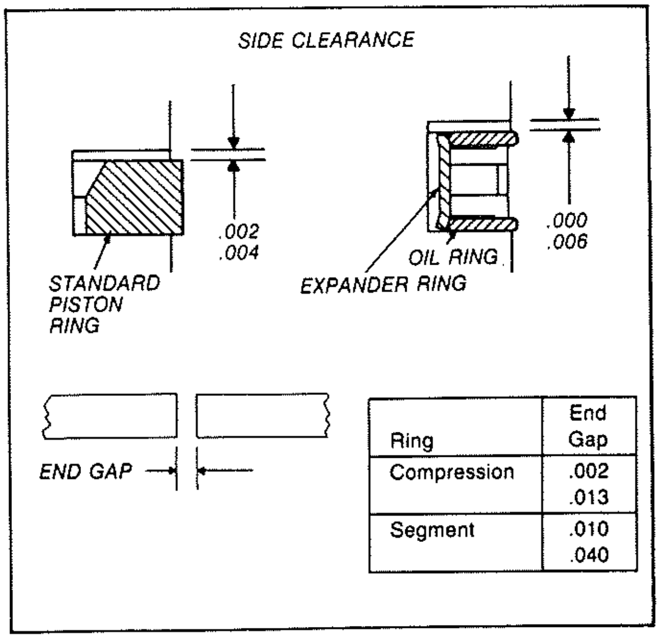
On compressors fitted with precision, sleeve main bearings, the difference between the O.D. of the crankshaft journal and the main bearing I.D. must not exceed .005 in. If the clearance is greater than .005 in. the bearing must be replaced.

The cylinder bores should be checked with inside micrometers or calipers. Cylinder bores which are scored or out of round by more than .0005 in. or tapered more than .0005 in. should be rebored or honed oversize. Oversized pistons and piston rings are available in .010 in., .020 in. and .030 in. oversizes. Cylinder bores must be smooth, straight and round. Clearance between the cast iron pistons and cylinder bores should be between .002 in. minimum and .004 in. maximum.

PISTON RINGS

Check the pistons for scores, cracks or enlarged ring grooves; replace the pistons if any of these conditions are found. Measure each piston with a micrometer in relation to the cylinder bore diameter to be sure the diametrical clearance is between .002 in. minimum and .004 in. maximum.

Check the fit of the wrist pins to the pistons and connecting rod bushings. The wrist pin should be a light press fit in the piston. If the wrist pin is a loose fit, the piston and pin assembly should be replaced. Check the fit of the wrist pin in the connecting rod bushing by rocking the piston. This clearance should not exceed .0007 in. Replace the connecting rod and cap assembly which includes the wrist pin bushings if excessive clearance is found. Check the fit of the rings in the piston ring grooves. Check the ring gap with the rings in-stalled in the cylinder bores. Refer to Fig. 12 for correct gap and groove clearances.



Ring	End Gap
Compression	.002 .013
Segment	.010 .040

FIG. 12 **RING CONFIGURATION**

CRANKSHAFT

Check the crankshaft threads, keyways, tapered ends and all machined and ground surfaces for wear, scores, or damage. Standard crankshaft journals are 1.1242 in. - 1.1250 in. in diameter. If the crankshaft journals are excessively scored or worn or out of round and cannot be reground, the compressor must be replaced. Connecting rod bearing inserts are available in .010 in., .020 in. and .030 in. undersizes for compressors with reground crankshafts. Main bearing journals must be maintained so the ball bearings are a snug fit or so that no more than .005 in. clearance exists between the precision sleeve main bearing and the main bearing journals on the crankshaft. Check to be sure the oil passages are open through the crankshaft.

CONNECTING ROD BEARINGS

Used bearing inserts must be replaced. The connecting rod and cap are a matched set and therefore the caps must not be switched or rotated end for end. The solid inserts must be installed in the rod and the slotted inserts into the cap. Make sure the locating tangs on the inserts engage with the locating notches in the rod and cap. Clearance between the connecting rod journal and the connecting rod bearing must not be less than .0003 in. or more than .0021 in. after rebuilding.

REPAIRS

UNLOADER

A new cylinder head maintenance kit should be used when rebuilding. The unloader pistons in the kit are prelubricated with a special lubricant piece number 239379 and need no additional lubrication. Install the springs and unloader pistons in their bores being careful not to cut the o-rings. Install the unloader cover gasket and unloader cover and secure the cover cap screws. Tighten the cap screws to 175 -225 in. lbs. in a crossing pattern after first snugging all screws.

DISCHARGE VALVES, VALVE STOPS AND SEATS

If the discharge valve seats merely show signs of slight wear, they can be dressed by using a lapping stone, grinding compound and grinding tool however it is recommended that a cylinder head maintenance be used. Install new discharge valve springs and valves. Screw in the discharge valve seats, and tighten to 70 - 90 ft.-lbs. Discharge valve travel should be between .030 in. to .046 in. To test for leakage by the discharge valves, apply 100 psi to the cylinder head discharge port and apply a soap solution to the discharge valve and seats. Leakage in the form of soap bubbles is permissible. If excessive leakage is found, leave the air pressure applied and with the use of a fiber or hardwood dowel and a hammer, tap the discharge valves off their seats several times. This will help the valves to seat and should reduce the leakage. With the air pressure still applied at the discharge port of the cylinder head, check for leakage around the discharge valve stop on the top of the cylinder head casting. No leakage is permitted.

INLET VALVES AND SEATS

Inlet valves and springs should be replaced. However, if the inlet valve seats show signs of slight nicks or scratches, they can be redressed with a fine piece of emery cloth or by lapping with a lapping stone, grinding compound and grinding tool. If the seats are damaged to the extent that they cannot be reclaimed, they must be replaced.

ASSEMBLY

GENERAL NOTE: All torques specified in this manual are assembly torques and typically can be expected to fall off after assembly is accomplished. DO NOT RE-TORQUE after initial assembly torques fall unless instructed otherwise. A compiled listing of torque specifications is presented at the end of this manual.

To convert inch pounds of torque to foot pounds of torque, divide in pounds by 12.

inch pounds / 12 = foot pounds

To convert foot pounds of torque to inch pounds of torque, multiply foot pounds by 12.

foot pounds × 12 = inch pounds

INSTALLING CRANKSHAFT

Press new sleeve bearings in the end cover and crankcase. Ensure that the slot in the bearings line up with the oil passages in the end cover or crankcase. If you have a model with no oil passage present in the crankcase, press the sleeve bearing into the crankcase with the slot located 90 degrees from vertical.

Install the front thrust washer with the tang inserted in the slot toward the flange. Insert the crankshaft and the rear thrust washer with the tang toward the rear of the compressor.

Place the oil seal ring on the boss of the rear end cover and install the end cover making sure not to pinch the seal ring. Ensure the tang of the thrust washer is inserted in the slot of the end cover. Fasten the end cover to the crankcase with the four cover cap screws. Torque the cap screws to 175-225 inch pounds in a cross pattern.

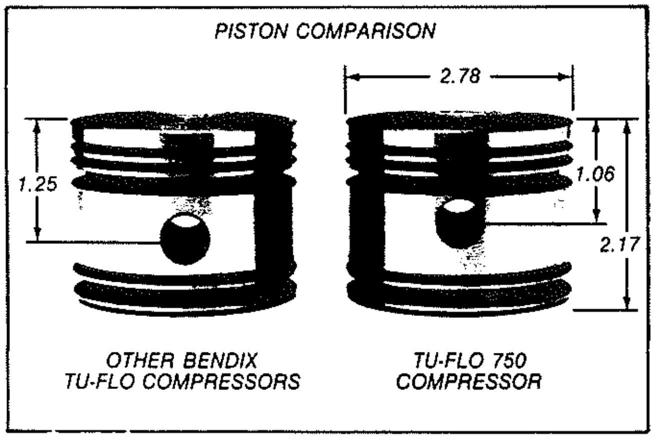


FIG. 13 **PISTON COMPARISON**

PISTONS AND CONNECTING RODS

If the pistons are to be replaced ensure that the correct pistons are being installed. Note that the pistons for the Tu-Flo 750 compressor are similar to those of other Bendix compressor models but may be identified by the piston diameter and the distance to the center of the wrist pin from the top of the piston as shown in figure (13).

PISTON RINGS

Check each ring end gap in a cylinder bore before installation. Place the ring in the top of the cylinder bore and using the piston, push the ring to the mid-point of the cylinder bore and check the ring gap. If the end gaps are incorrect either the wrong repair size has been purchased or the compressor is worn beyond specification and should be replaced.

Install the rings on the pistons per the following instructions starting at the center of the piston and moving outward.

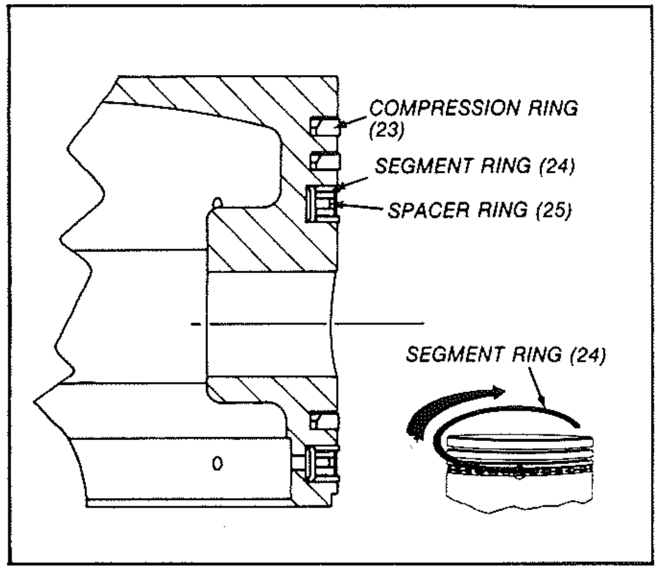


FIG. 14 **PISTON & RINGS**

1. Install the spacer and segment rings as follows. Place the spacer ring(25) in the piston groove, the ends of the spacer must butt and not overlap. Install the top segment(24) by inserting one end above the spacer in the ring groove, 120 degrees from the spacer ends and wind the segment into position. Install the bottom segment in the same manner beneath the spacer making sure the gap is staggered 120 degrees from both the top ring segment and the spacer end gaps. Before using be sure both painted ends of the spacer are visible and butted. (Refer to fig. 14.)
2. Install the compression rings(23) in the proper grooves with the bevel or "pip" mark (if any) toward the top of the piston. (Refer to fig. 14.)

Check the ring side clearance of each ring in the piston ring groove. (Refer to fig. 12.) If the side clearance is too large, the piston ring groove is worn beyond specifications and the piston must be replaced.

Rotate the piston rings in their respective groove so that each end gap is at least 90 degrees from the previous ring's end gap.

Lubricate the wrist pin(22) and wrist pin bushing in the connecting rod with engine oil. Assemble the upper portion of the connecting rods and the pistons with the wrist pins. Insert the wrist pin buttons(28) in the ends of the wrist pin. Lubricate the pistons and rings with engine oil and insert the piston in the cylinder bore.

Turn the crankshaft so that one of its connecting rod journals is in the downward, center position. Install the crankshaft journal bearing segments(38) on the connecting rod(37) and connecting rod cap(39). Tighten the connecting rod bolts(40) evenly and torque to 150 - 170 inch pounds. Install the other connecting rod and piston in the same manner. It is recommended that new connecting rod cap screws be used.

Before replacing the cylinder head on the crankcase ensure the correct pistons have been used by turning the crankshaft one complete revolution such that each piston moves to its maximum upward stroke. At the maximum upward stroke position each piston should move to the top of the crankcase. If the piston does not approach the top of the crankcase the piston is incorrect and if not replaced could result in compressor damage.

BASE PLATE OR BASE ADAPTER

Position the base plate or base adapter gasket(20) on the crankcase and install the base plate or base adapter(21) as marked before disassembly. Tighten the six cap screws(22) securing the cast iron base adapter evenly to a torque of 175-225 inch pounds for base plate or cover in a crossing pattern after first snugging all 6 screws.

CYLINDER HEAD

Place the cylinder head gasket(19) and cylinder head on the compressor crankcase and install the six cylinder head cap screws. If the cylinder head gasket has a bead on one side, install the gasket on the crankcase with the beaded side up. Snug the cylinder head cap screws prior to torquing the cap screws to 440-500 in. lbs. in a cross pattern. Re-torque the unloader cover cap screws to 170-225 in. lbs.

FINAL COMPRESSOR ASSEMBLY

Install all crankshaft keys making certain to support the crankshaft to avoid bearing damage. Install the crankshaft nut where applicable. When installing drive couplings or gears, DO NOT EXCEED 120 foot pounds torque on the crankshaft nut.

Use covers, plugs, or masking tape to protect all ports if compressor is not to be installed immediately. Protect the ends of the crankshaft against damage by wrapping with masking tape or friction tape.

TESTING REBUILT COMPRESSOR

In order to properly test a compressor under operating conditions, a test rack for correct mounting, cooling, lubricating, and driving the compressor is necessary. Such tests are not compulsory if the unit has been carefully rebuilt by an experienced person. A compressor efficiency or build up test can be run which is not too difficult. An engine lubricated compressor must be connected to an oil supply line of at least 15 P.S.I. pressure during the test and an oil return line must be installed to keep the crankcase drained.

Connect to the compressor discharge port, a reservoir with a volume of 1500 cubic inches, including the volume of the connecting line. With the compressor operating at 2100 R.P.M., the time required to raise the reservoir(s) pressure from 85 psi to 100 psi should not exceed 5 seconds. During this test, the compressor should be checked for gasket leakage and noisy operation, as well as unloader operation and leakage.

If the compressor functions as indicated re-install on the vehicle connecting all lines as as marked in the disassembly procedure.

TU-FLO 750 SPECIFICATIONS

Average weight	53
Number of cylinders	2
Bore size	2.78 In.
Stroke	1.87 In.
Displacement at 1250 RPM	16.5
CFM Maximum recommended RPM	2400 RPM
Minimum coolant flow (water cooled) at	
Maximum RPM	2.5 GPM
Minimum RPM	.5 GPM
Approximate horsepower required at 1250 RPM at 120 PSIG (naturally aspirated)	3.2
Turbocharge limits See Compressor Turbocharging Parameters	
Maximum inlet air temperature	250° F
Maximum discharge air temperature	400° F
Minimum pressure required to unload (naturally aspirated)	60 PSIG
Minimum oil pressure required at engine idling speed	15 PSIG
Minimum oil pressure required at maximum governed engine speed	15 PSIG
Minimum discharge-line size	½" I.D.
Minimum coolant-line size	⅜" I.D.
Minimum oil-supply line size	$\frac{3}{16}$" I.D.
Minimum oil-return line size	½" I.D.
Minimum air-inlet line size	⅝" I.D.
Minimum unloader-line size	$\frac{3}{16}$" I.D.

TORQUE SPECIFICATIONS

Bolt, Nut or Screw	Assembly Torque (in. lbs.)
Cylinder Head	440 - 500
Unloader Cover Plate	175 - 225
Discharge Valve Seat	840 - 1080(70-90 ft. lbs.)
Inlet Valve Stop	840 - 1080(70-90 ft. lbs.)
End Cover	175 - 225
Connecting Rod	150 - 170
Bottom Cover	175 - 225
Air Strainer	125 - 150
Inlet Fitting	175 - 225
Discharge Fitting	175 - 225

Governor or Governor Adapter .... 175 - 225

Pipe Plugs

1/16	35 - 50
1/8	85 - 105
1/4	130 - 170
3/8	160 - 200
1/2	200 - 270

Pipe Bushing

1/2	175 - 225

Crankshaft Nut.

Marsden or Castle	1200 - 1440 (100-120 ft. lbs.)
P/N 298125 (Metric Thread)	2640 - 3048 (220-254 ft. lbs.)

DIMENSIONAL DATA

Port Sizes

Water inlet	1/2-14 NPT
Water outlet	1/2-14 NPT
Air discharge	1/2-14 NPT
Governor	1/8-27 NPT
Oil inlet (end cover)	1/8-27 NPT
Oil return Base mount	1/2-14 NPT

Piston

(standard)	2.77825 in.
(.010 oversize)	2.78825 in.
(.020 oversize)	2.79825 in.
(.030 oversize)	2.80825 in.

Cylinder bore

(standard)	2.7810 in.
(.010 oversize)	2.7910 in.
(.020 oversize)	2.8010 in.
(.030 oversize)	2.8110 in.

MAINTENANCE KITS AND AVAILABLE SERVICE PARTS

Cylinder Maintenance Kit
Piston Ring Kit (standard and oversizes)
Piston and Rod Kit (standard and oversizes)
Crankshaft Bearing Kit

IMPORTANT! PLEASE READ:

When working on or around a vehicle, the following general precautions should be observed.

1. Park the vehicle on a level surface, apply the parking brakes, and always block the wheels.
2. Stop the engine when working around the vehicle.
3. If the vehicle is equipped with air brakes, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle.
4. Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that removes all electrical power from the vehicle.
5. When working in the engine compartment the engine should be shut off. Where circumstances require that the engine be in operation, **EXTREME CAUTION** should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated, or electrically charged components.
6. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.
7. Never exceed recommended pressures and always wear safety glasses.
8. Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.
9. Use only genuine Bendix replacement parts, components, and kits. Replacement hardware, tubing, hose, fittings, etc. should be of equivalent size, type, and strength as original equipment and be designed specifically for such applications and systems.
10. Components with stripped threads or damaged parts should be replaced rather than repaired. Repairs requiring machining or welding should not be attempted unless specifically approved and stated by the vehicle or component manufacturer.
11. Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.

COMPRESSOR TROUBLESHOOTING CHART

SYMPTOMS	CAUSE	REMEDY
1. Compressor passes excessive oil as evidenced by presence of oil at exhaust ports of valving or seeping from air strainer.	A. Restricted air intake.	A. Check engine or compressor air cleaner and replace if necessary. Check compressor air inlet for kinks, excessive bends and be certain inlet lines have the minimum specified inside diameter. Recommended minimum inlet line inside diameter is ⅝″. Recommended maximum air inlet restriction is 25″ of water.
	B. Restricted oil return (to engine).	B. Oil return to the engine should not be in any way restricted. Check for excessive bends, kinks and restrictions in the oil return line. Minimum recommended oil return line size is ⅝″ O.D. tubing or equivalent I.D. (½″ minimum). Return line must CONSTANTLY DESCEND from the compressor to the engine crankcase. Make certain oil drain passages in the compressor and mating engine surfaces are unobstructed and aligned. Special care must be taken when sealants are used with, or instead of, gaskets.
	C. Poorly filtered inlet air.	C. Check for damaged, defective or dirty air filter on engine or compressor. Check for leaking, damaged or defective compressor air intake components (i.e., induction line, fittings, gaskets, filter bodies, etc.). The compressor intake should not be connected to any part of the exhaust gas recirculation (E.G.R.) system on the engine.
	D. Insufficient compressor cooling (compressor runs hot).	D. For air-cooled portions of the compressor: 1. Remove accumulated grease, grime or dirt from the cooling fins. Replace components found damaged. 2. Check for damaged cooling fins. Replace components found damaged. For water-cooled compressor or water-cooled portions of the compressor: 1. Check for proper coolant line sizes. Minimum recommended size is ½″ O.D. tubing. 2. Check the coolant flow through the compressor. Minimum allowable flow is 2.5 gallons per minute at engine governed speed. If low coolant flow is detected, inspect the coolant lines and fittings for accumulated rust scale, kinks and restrictions.

COMPRESSOR TROUBLESHOOTING CHART CONT.

SYMPTOMS	CAUSE	REMEDY
		3. Water temperature should not exceed 200 degrees Fahrenheit. 4. Optimum cooling is achieved when engine coolant flows, as shown in Fig. 8 of this manual.
	E. Contaminants not being regularly drained from system reservoirs.	E. Check reservoir drain valves to to insure that they are functioning properly. It is recommended that the vehicle should be equipped with functioning automatic drain valves, or have all reservoirs drained to zero (0) psi daily, or optimally to be equipped with a desiccant-type air dryer prior to the reservoir system.
	F. Compressor runs loaded an excessive amount of time.	F. Vehicle system leakage should not exceed industry standards of 1 psi pressure drop per minute without brakes applied and 3 psi pressure drop per minute with brakes applied. If leakage is excessive, check for system leaks and repair.
	G. Excessive engine crankcase pressure.	G. Test for excessive engine crankcase pressure & replace or repair ventilation components as necessary. (An indication of crankcase pressure is a loose or partially lifted dipstick.)
	H. Excessive engine oil pressure.	H. Check the engine oil pressure with a test gauge and compare the reading to the engine specifications. Bendix does not recommend restricting the compressor oil supply line because of the possibility of plugging the restriction with oil contaminants. Minimum oil supply line size is 3/16" I.D. tubing.
	I. Faulty compressor.	I. Replace or repair the compressor only after making certain none of the preceding installation defects exist.
2. Noisy compressor operations.	A. Loose drive gear or pulley.	A. Inspect the fit of the drive gear on pulley on the compressor crankshaft. The pulley on gear must be completely seated and the crankshaft nut must be tight. If the compressor crankshaft surface or its keyway are damaged, it is an indication of loose drive components. If damage to the compressor crankshaft is detected, replace the compressor. When in stalling the drive gear or pulley, torque the crankshaft nut to the appropriate torque specifications. DO NOT BACK OFF THE CRANKSHAFT NUT TO ALIGN THE COTTER PIN AND CASTELLATED NUT. (Some compressors do not use castellated nuts.) DO NOT USE IMPACT WRENCHES.

COMPRESSOR TROUBLESHOOTING CHART CONT.

SYMPTOMS	CAUSE	REMEDY
	B. Excessively worn drive couplings or gears.	B. Inspect drive gear and couplings and engine for excessive wear. Replace as necessary. (Non-metallic gears should be replaced when the compressor is changed.)
	C. Compressor cylinder head or discharge line restrictions.	C. Inspect the compressor discharge port and discharge line for carbon build-up. If carbon is detected, check for proper cooling to the compressor. (See Cause and Remedy (D) under Symptom #1.) Inspect the discharge line for kinks and restrictions. Replace discharge line as necessary.
	D. Worn or burned out bearings.	D. Check for proper oil pressure in the compressor. Minimum required oil pressure; 15 psi engine idling, 15 psi maximum governed engine rpm. Check for excessive oil temperature—should not exceed 240 degrees Fahrenheit.
	E. Faulty compressor.	E. Replace or repair the compressor after determining none of the preceding installation defects exist.
3. Excessive build-up and recover time. Compressor should be capable of building air system from 85-100 psi in 40 seconds with engine at full governed rpm. Minimum compressor performance is certified to meet Federal requirements by the vehicle manufacturer. Do not downsize the original equipment compressor.	A. Dirty induction air filter.	A. Inspect engine or compressor air filter and replace if necessary.
	B. Restricted induction line.	B. Inspect the compressor air induction line for kinks and restrictions and replace as necessary.
	C. Restricted discharge line or compressor discharge cavity.	C. Inspect the compressor discharge port and line for restrictions and carbon build-up. If a carbon build-up is found, check for proper compressor cooling. Replace faulty sections of the discharge line.
	D. Slipping drive components.	D. Check for faulty drive gears and couplings and replace as necessary. Check the condition of drive belts and replace or tighten, whichever is appropriate.
	E. Excessive air system leakage.	E. Test for excessive system leakage and repair as necessary. Use the following as a guide: Build system pressure to governor cutout and allow the pressure to stabilize for one minute. Using the dash gauge, note the system pressure and the pressure drop after two minutes. The pressure drops should not exceed: 1. 2 psi in each reservoir for a single vehicle. 2. 6 psi in each reservoir for a tractor and trailer.

COMPRESSOR TROUBLESHOOTING CHART CONT.

SYMPTOMS	CAUSE	REMEDY
		3. 8 psi in each reservoir for a tractor and 2 trailers.
	F. Sticking unloader pistons.	F. Check the operation of the unloading mechanism. Check the proper operation of the compressor air governor. If the governor is operating properly, replace the unloader mechanism. Inspect for bent, linked or blocked tubing leading to or from the governor.
	G. Faulty compressor.	G. Replace or repair the compressor after determining none of the preceding installation defects exist.
4. Compressor fails to unload.	A. Faulty governor or governor installation.	A. Test the governor for proper operation and inspect air lines to and from the governor for kinks or restrictions. Replace or repair the governor or its connecting air lines.
	B. Faulty or worn unloader pistons or bores.	B. Inspect for worn, dirty or corroded unloader pistons and their bores. Replace as necessary.
5. Compressor leaks oil.	A. Damaged mounting gasket.	A. Check the compressor mounting bolt torque. If the mounting bolt torque is low, replace the compressor mounting gasket before retorquing the mounting bolts.
	B. Cracked crankcase or end cover.	B. Visually inspect the compressor exterior for cracked or broken components. Cracked or broken crankcases or mounting flanges can be caused by loose mounting bolts. The end cover can be cracked by overtorquing fitting or plugs installed in the end cover. Replace or repair the compressor as necessary.
	C. Loose end cover cap cover.	C. Check the cap screw torques and tighten as necessary.
	D. Loose oil supply or return line fittings.	D. Check the torque of external oil line fittings and tighten as necessary.
	E. Porous compressor casting.	E. Replace the compressor if porosity is found.
	F. Mounting flange or end cover, o-ring or gasket gasket—missing, cut or damaged.	F. Replace as necessary.
6. Compressor constantly cycles (compressor remains unloaded for a very short time.)	A. Leaking compressor unloader pistons.	A. Remove the compressor inlet air strainer or fitting. With the compressor unloaded (not compressing air), check for air leakage. Replace as necessary.
	B. Faulty governor.	B. Test the governor for proper operation and repair or replace as necessary.

COMPRESSOR TROUBLESHOOTING CHART CONT.

SYMPTOMS	CAUSE	REMEDY
	C. Excessive system leakage.	C. Test for excessive system leakage as instructed in Symptom #3, Remedy E. Reduce leakage wherever possible.
	D. Excessive reservoir contaminants.	D. Drain reservoirs.
7. Compressor leaks coolant.	A. Improperly installed plugs and coolant line fittings.	A. Check torque of fittings and plugs and tighten as necessary. Over-torque fittings and plugs can crack the head or block casting.
	B. Freeze cracks due to improper antifreeze strength.	B. Test antifreeze and strengthen as necessary. Check coolant flow through compressor to assure the proper antifreeze mixture reaches the compressor.
	C. Faulty compressor (porous castings).	C. If casting porosity is detected, replace the compressor.
8. Compressor head gasket failure.	A. Restricted discharge line.	A. Clear restriction or replace line.
	B. Loose head bolts.	B. Tighten evenly to a torque of 25-30 foot pounds.
	C. Faulty compressor or head gasket.	C. Check for rough or poorly machined head or block surfaces. Replace compressor as necessary.

Bendix Heavy Vehicle Systems

13

WHEELS, HUBS AND TIRES

CONTENTS OF THIS SECTION

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FRONT AND TAG AXLE WHEEL HUBS . . . . 13 - 4
DRIVE AXLE WHEEL HUBS . . . . 13 - 4
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WHEEL AND TIRE BALANCING . . . . 13 - 6
TIRE ROTATION . . . . 13 - 6

DESCRIPTION

This vehicle is equipped with stud-mounted wheels on all axles. Wheel studs and nuts on left side of vehicle have left-hand threads, while wheel studs and nuts on right side of vehicle are provided with right-hand threads. The vehicle is provided with standard steel wheels, and aluminum-polished wheels are available as optional equipment.

Both steel and aluminum wheel dimensions are 22.50 x 8.25" (571,5 x 209,5 mm) for the following recommended tire dimensions (in order of preference):

315/80 R 22.5

12.75 R 22.5

1200 R 22.5

CAUTION: Each tire should have a minimum capacity of 7,200 lbs @ 115 psi.

WHEEL MAINTENANCE

The wheel maintenance consists of periodic inspections to ensure that wheel nuts are tightened to the proper torque. In the case of a new vehicle, or after a wheel installation, stud nuts should be tightened every 100 miles (160 km) for the first 500 miles (800 km) to allow setting in of clamping surfaces.

Wheel studs and nuts must be kept free from grease and oil. No lubricant whatsoever should be used. Cleanliness of wheel and its rotor or brake drum mating surfaces is important for proper wheel mounting.

It is also important that wheel stud nuts be tightened alternately on opposite sides of wheel. Refer to figure 1 for the suggested tightening sequence.

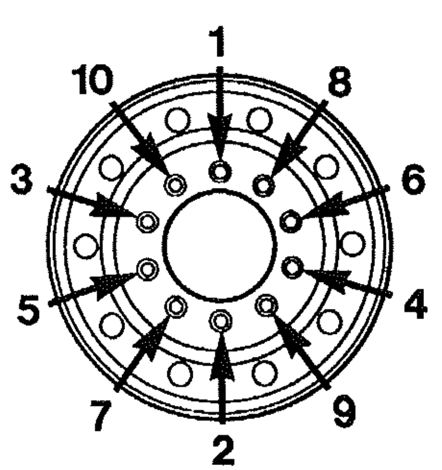

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Fig. 1 - Tightening sequence

Single wheel installation

1. Run in lightly the hex stud nuts referring to figure 1 for sequence, so that wheel will position itself concentrically with hub. This is important, otherwise wheel may be eccentric with hub and will not run straight. In this initial step, run the nuts up only as necessary to correctly position wheel.

2. Tighten stud nuts progressively as shown in figure 1. The final tightening should be done with a torque wrench. Tighten stud nuts to 450 - 500 ft•lbs (610 - 680 N•m) for aluminum as well as steel wheel.

Single wheel inspection procedure

Repeat step 2 in previous heading.

Dual wheels

Inner wheel installation

1. Run in lightly the inner cap nuts (shown in fig. 2) and refer to fig. 1 for sequence, so that wheel will position itself concentrically with hub.

2. Tighten inner cap nuts progressively according to sequence shown in figure 1. The final tightening should be done with a torque wrench. Tighten inner cap nuts to 450 - 500 ft•lbs (610 - 680 N•m) for aluminum as well as steel wheel.

Outer wheel installation

Tighten the hex head nuts (shown in fig. 2) using the single wheel installation procedure described previously.

Dual wheel inspection procedure

1. Loosen a hex head nut three turns (see fig. 2).

2. Tighten the inner cap nut to the correct torque (450 - 500 ft•lbs (610 - 680 N•m)).

3. Tighten the hex head nut to the correct torque (450 - 500 ft•lbs (610 - 680 N•m)).

4. Repeat the 3 previous steps for each of the 10 *"hex head nut - inner cap nut"* assemblies according to the tightening sequence in figure 1.

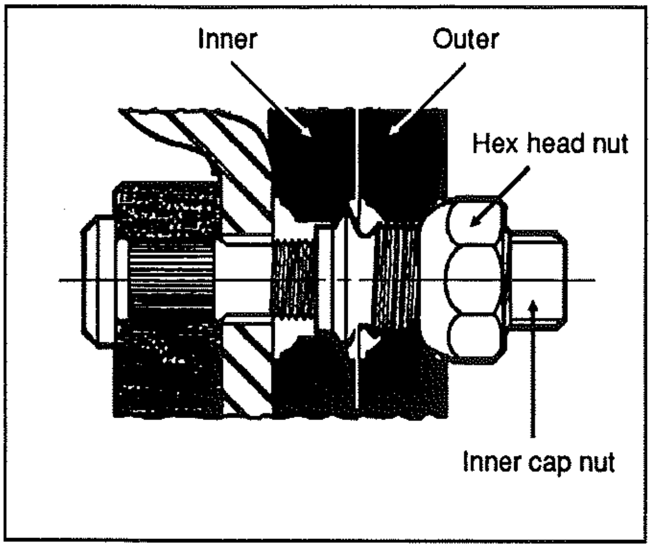


Fig. 2 - Dual wheel installation

CAUTION: Do not attempt to tighten an inner cap nut without having loosened previously the hex head nut.

NOTE: When mounting rear dual wheels, care should be taken to position the tire valve stems 180° apart so that access to both inner and outer tire valves may be obtained.

Corrosion protection of aluminum wheels

1. Clean wheels often by means of a high pressure water jet. Cleaning may be accelerated with mild soap. Do not use concentrated alkaline cleaning products.

2. When tire is removed, clean and inspect wheel completely. Remove foreign matters on rim by means of a wire brush. Do not use a wire brush to remove dirt and corrosion on the outer surface of wheel.

3. Take the following measures to maintain original appearance of the aluminum wheels:

A) Use a sponge, a soft cloth, or a soft fiber brush, and a mild soap and warm water solution to wash the wheel outer surfaces.

B) Rinse thoroughly with clean water.

C) Wipe and dry thoroughly to prevent water stains.

D) Wax surface with *"Simonize Body Guard"*, *"Dupont 7 New Car Wax"*, or an equivalent product.

E) Clean aluminum wheels as required to maintain original look.

WARNING: Wheel surfaces may have sharp or cutting edges which may cause injuries to the hands. To prevent contacting sharp edges, it is strongly recommended to wear rubber gloves when washing or polishing wheels.

Checking for distorted wheel on vehicle

1. Raise axle at side to be checked and place a safety support underneath.

2. Check the rim for lateral runout. Install a dial gauge as shown in figure 3, then rotate the wheel one full turn. As the wheel turns, note any variation on the dial gauge.

CAUTION: Take care not to damage the dial gauge as it may interfere with the balancing weights on the wheel.

3. The variation should not exceed .125" (3,2 mm). If the rim is distorted beyond this dimension, the wheel must be replaced.

4. If doubt exists whether wheel or hub is distorted, hub may be checked as follows:

Replace the existing wheel with a wheel known to be correct. Revolve the wheel and make the previously mentioned tests. If tests are within limits, the hub is satisfactory, but the wheel is sprung.

CAUTION: NEVER STRAIGHTEN ALUMINUM WHEELS. Never heat aluminum wheels for the purpose of repairing damages incurred after hitting a curb or resulting from other causes. The special alloy in wheels has been heat treated, and any uncontrolled heating could alter wheel structure. Furthermore, never weld aluminum-forged wheels for any reason whatsoever.

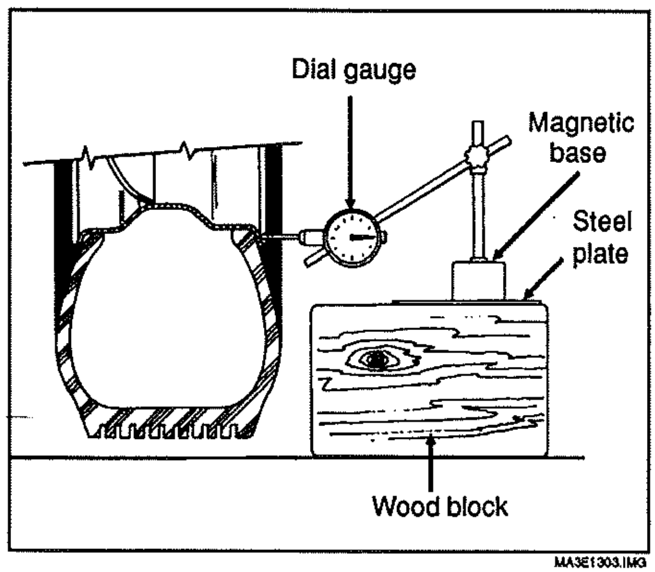


Fig. 3 - Suggested dial gauge installation

WHEEL STUDS

Stripped threads may be the result of excessive torquing, or a result of damage during wheel installation, when placing the wheel over the studs. Where a damaged thread is discovered, the stud must be replaced. Broken studs are a direct result of operating with loose stud nuts or improperly seated wheels. When a broken stud is replaced, the adjacent studs on each side of the broken stud must also be replaced because they could have been subjected to excessive strain and may have become fatigued.

When installing wheel studs to hubs, check nuts retaining the wheel stud to wheel hub and if they are deformed, damaged or severely corroded, install new parts. Install nut (and washer where applicable) to new stud and torque to 110 - 130 ft•lbs (150 - 177 N•m) for studs mounted on front and tag axle wheel hubs and torque to 450 - 500 ft•lbs (610 - 680 N•m) for those mounted on drive axle wheel hubs.

NOTE: Wheel studs and nuts must be kept free from grease and oil. No lubricant whatsoever should be used.

SPARE WHEEL

The spare wheel and tire are stored in a compartment directly behind the reclining front bumper. The access is obtained by unscrewing the nut located at each extremity below the bumper, then by pushing them upwards. Lower bumper slowly as it is quite heavy.

NOTE: It is recommended that two persons perform the above operation.

WARNING: This compartment has not been designed for storage. Never leave any loose object in this area as it may interfere with steering linkage mechanism.

Removing spare wheel and tire from compartment

To pull out spare wheel and tire, open reclining bumper according to previous instructions. Loosen turn buckle of the holding chain to release the wheel and dolly assembly. Open the front service compartment, unscrew the wing nut retaining the support and rail extension assembly, then take out the assembly. Fix it by matching its two holes to the corresponding mounting pins located in front center of spare tire compartment. Pull out spare wheel using the strap as illustrated in figure 4. Remove tire covering, then separate spare wheel from its dolly by unscrewing the two mounting wing nuts.

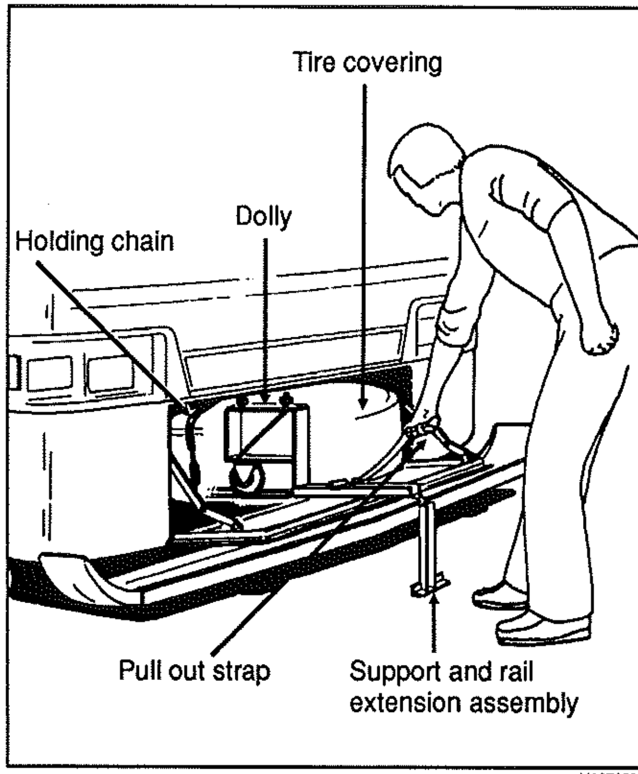


Fig. 4 - Spare wheel installation

NOTE: Reinstall support and rail extension assembly and fix tire with holding chain before moving vehicle.

CAUTION: Check that the bumper is safely hooked in place, and that retaining nuts are firmly tightened after bumper compartment has been closed.

Spare wheel maintenance

Maintenance of spare wheel consists in ensuring that tire is inflated to the recommended pressure: 110 psi (760 kPa). Inspect rim to ensure there is no important corrosion, then check if spare wheel cover is in good condition.

CAUTION: If spare wheel must be installed elsewhere than on front axle, deflate tire to the recommended pressure as outlined under heading *"Recommended tire inflation pressure"*.

FRONT AND TAG AXLE WHEEL HUBS

Description

Front and tag axle wheel hubs use oil lubrication which eliminates periodic grease repacking of the hubs. A sight glass is provided for convenient check of oil level. Level should be checked daily and must be maintained to the level mark in the sight glass. If oil is not visible through the sight glass, general purpose gear lubricant SAE 90 (A.P.I. spec. GL5) must be added by removing the snap plug in center of the hub cap to bring oil to the correct level. To check oil level after vehicle has been driven, wait at least 15 minutes to ensure that oil has settled.

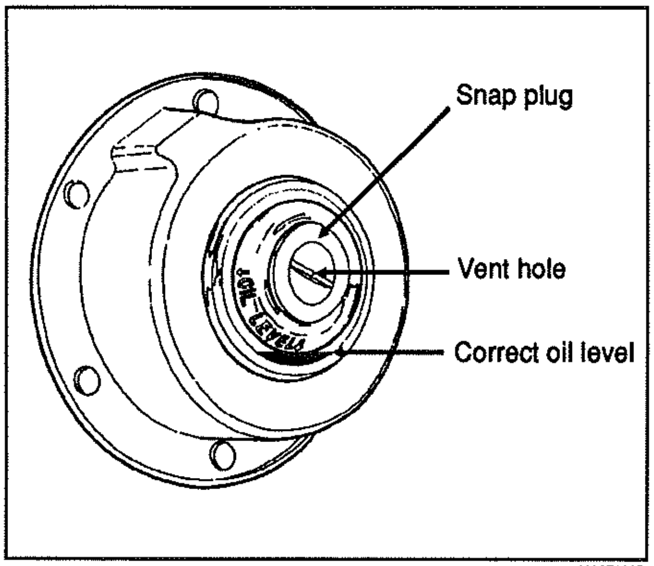


Fig. 5

CAUTION: Hub oil fill cap is provided with a very small vent hole in its center. Insert occasionally a small tip to avoid hole restriction, as it prevents overpressure in bearing housing.

Hub bearing maintenance

For the maintenance of the wheel hub bearing, refer to *"Rockwell Maintenance Manual No. 2 - Front Non-Drive Steering Axles"* annexed to the end of section 10 in this maintenance manual.

DRIVE AXLE WHEEL HUBS

Description

Drive wheels use a single oil-seal assembly and are lubricated from the oil supply in the differential housing. Bearings are tapered roller, adjustable to compensate wear. Maintain differential oil level with general purpose gear lubricant (refer to *"Lubrication Chart and Service Check Points"* in section 24 for proper oil grade selection) to ensure adequate oil supply to wheel bearings at all times.

Bearing adjustment

To adjust drive wheel bearings, raise vehicle until both dual wheels may be turned freely (approximately 6" from ground). Position jack stands under drive axle, then lower vehicle approximately 2" in order to avoid that entire weight of the axle be supported by the suspension air bellows and the shock absorber pins.

Remove axle shaft as indicated in *"Rockwell Field Maintenance Manual no. 5"* entitled *"Single Reduction Differential Carriers"* annexed to the end of section 11 in this maintenance manual. Remove gaskets. Unscrew lock nut and remove adjusting nut lock ring.

To adjust, tighten adjusting nut until the wheel binds, rotate the wheel while tightening so that all surfaces are in proper contact. Back off adjusting nut approximately 1/4 to 1/3 turn to assure 0.001" to 0.007" end play and to ensure that wheel turns freely. Replace lock ring, and adjust nut dowel pin in one of the holes. The ring may be turned over if necessary to allow more accurate adjustment of bearings. Tighten lock nut and recheck bearing adjustment. Replace the axle shaft using a new gasket.

Disassembly and repair

Jack vehicle as outlined above under heading *"Bearing adjustment"* and remove axle shaft as indicated in *"Rockwell Field Maintenance Manual no. 5"* entitled *"Single Reduction Differential Carriers"* annexed to the end of section 11 in this maintenance manual. Remove wheels and tires.

CAUTION: Always mark the position of the wheel on the axle prior removal, so you can replace wheel at the same location, thus avoiding a new balancing of wheel.

Remove lock nut, lock ring and adjusting nut from axle housing, taking care to prevent the outer bearing from falling out. Remove outer bearing cone and roller assembly.

Remove screws attaching inner oil seal retainer to hub, and remove inner oil seal assembly. Remove inner bearing cone and roller assembly. Bearing cups can be removed from the hub using a hammer and a long brass drift.

All parts should be thoroughly cleaned. Bearing cone and roller assemblies can be cleaned in a suitable cleaning solvent using a stiff brush to remove old lubricant.

If excessive wear, deterioration, cracking, or pitting are present on the bearing cups, rollers, or cones, the bearings should be replaced. Seals should be replaced every time they are removed from the hub. To install new oil seal, use a suitable adapter and drive the seal into the retainer bore until it bottoms.

When installing wheel on spindle, center the wheel hub with spindle to avoid damaging the seal with end of the spindle. Push wheel straight over the spindle until inside diameter of seal pressfits on wiper ring. Prefill hub cavity with general purpose gear lubricant (refer to *"Lubrication Chart and Service Check Points"* in section 24 for proper oil grade selection). Lubricate outer bearing cone and assemble. Adjust bearing and lock. Assemble axle flange to axle using a new gasket. Apply sealant in stud area. After both wheels have been assembled according to above procedure, fill the differential to the proper factory recommended level.

NOTE: During regular inspection do not forget to check lubricant level in differential. Clean thoroughly or replace vent as required.

TIRE MAINTENANCE

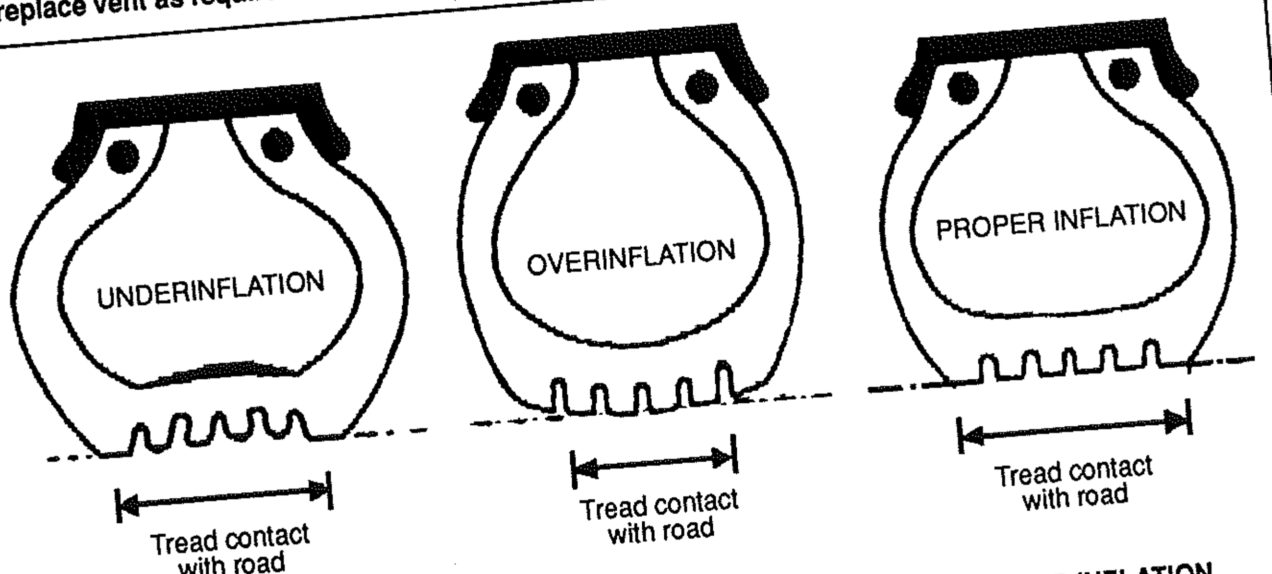
The most critical factor in tire maintenance is proper inflation. No tire is completely impervious to loss of air pressure. To avoid the hazards of underinflation, lost air must be replaced.

WARNING: Driving on any tire that does not have the correct inflation pressure is dangerous and will result in tire damage.

Any underinflated tire builds up excessive heat that may result in sudden tire destruction thus resulting in possible loss of vehicle control. Check inflation pressure on all the tires, including spare, at least once a week before driving when tires are cold. This is especially important in cases where vehicle is operated by more than one driver.

WARNING: Failure to maintain correct tire inflation pressure may result in sudden tire destruction, improper vehicle handling, and will cause rapid and irregular tire wear. Therefore, inflation pressures should be checked weekly and always before long distance trips.

Pressures should be checked when tires are cold; in other words, before they have been driven on. Driving, even for a short distance, causes tires to heat up and air pressure to increase.



UNDERINFLATION

Causes abnormal tire deflection which builds up heat and causes irregular wear.

OVERINFLATION

Causes tires to run hard and be more vulnerable to impacts. It also causes irregular wear.

PROPER INFLATION

The correct profile for fu contact with the road fo traction, braking capabilit and safety.

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Fig. 6

Never bleed air from hot tires as tires will then be underinflated. Use an accurate tire gauge to check pressures. (Do not hit tires as an inflation check; this is an unreliable method).

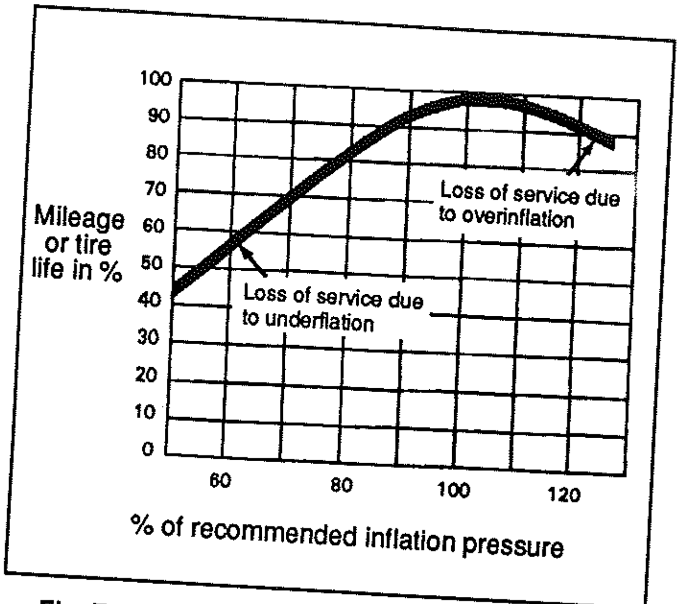

Fig. 7 - Effects of inflation pressure on tire life

Recommended tire inflation pressure (cold)

Front axle: 110 psi (760 kPa)

Drive axle: 95 psi (655 kPa)

Tag axle: 85 psi (585 kPa)

TIRE MATCHING

Unmatched tires on drive axle will cause tire wear and scuffing, as well as possible damage to the drive unit. Consequently, we recommend that tires be matched within 1/8" of the same rolling radius, and 3/4" of the same rolling circumference.

WHEEL AND TIRE BALANCING

Balance tires on vehicle by following the equipment manufacturer's instructions carefully. Balance drive axle tires as follows:

1. Raise vehicle sufficiently by its jacking points on the body (see section 18 *"Body"* under heading *"Vehicle jacking points"*) so that wheels do not touch the ground, install balancing equipment under the wheel, then chock the other drive axle wheel.

2. With engine running, release the parking brake, select third range of transmission, then balance the wheel by spinning it to a maximum of 35 mph (56 km/h) as indicated on the speedometer.

WARNING: Drive wheel spin should be limited to 35 mph (56 km/h) as indicated on the speedometer. This limit is necessary because speedometer only indicates half of the actual wheel speed when one drive wheel is spinning and the other drive wheel is stopped. Unless care is taken in limiting drive wheel spin, the spinning wheel can reach excessive speeds, resulting in possible tire disintegration or differential failure, which could cause personal injury or extensive vehicle damage.

CAUTION: When balancing wheel, a maximum of 16 ounces in weights may be required for each wheel; however, if more than 16 ounces are required on a wheel, check and correct cause.

TIRE ROTATION

The radial tires should be rotated only when necessary. If the tires are wearing evenly, there is no need to rotate. If irregular wear becomes apparent or if the wear rate on the tires is perceptively different (from axle to axle), then the tires should be rotated in such a manner as to alleviate the condition.

NOTE: There is no restriction on criss-cross rotation.

SERVICE BULLETINS AND SERVICE INFORMATION LETTERS

Service Bulletins and Service Information Letters will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of publications pertaining to this section should be noted below as soon as received. These should then be filed for future reference.

NUMBER	DATE	SUBJECT

14

STEERING SYSTEM

CONTENTS OF THIS SECTION

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BLEEDING POWER STEERING HYDRAULIC SYSTEM . . . . 14 - 3
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DESCRIPTION

The steering system consists of the steering wheel, steering column and shaft assembly, power steering gear, pitman arm, drag link and tie rod. A vane-type hydraulic pump, reservoir and filter, allied parts of the tubular front axle, as well as interconnecting system lines and hoses are also part of this system.

Steering and tire wear is affected by air suspension, brakes, wheel bearings, front suspension and front end alignment. These items are covered in their respective sections in this manual.

The integral power steering gear (ROSS HFB-70) incorporates a manual steering mechanism, a hydraulic control valve and a hydraulic power cylinder. The rotary-type control valve directs oil flow from the engine power steering pump to either one of the cylinder cavities. The flow directed to a cavity is dependent upon the speed at which the steering wheel is turned.

Force on the steering wheel is transmitted to the steering gear input shaft. The input is connected to the worm shaft by means of a torsion bar. The torsion bar turns with the input shaft, exerting a rotational force on the worm shaft. The worm shaft in turn transmits the force through a ball nut mechanism to axial force on the rack piston. The rack piston resists this force due to its engagement to the sector shaft. With this resistance, the torsion bar is twisted by the input shaft. Pressurized fluid moves the rack piston axially through the cylinder bore and the rack piston then turns the sector shaft and steers the vehicle.

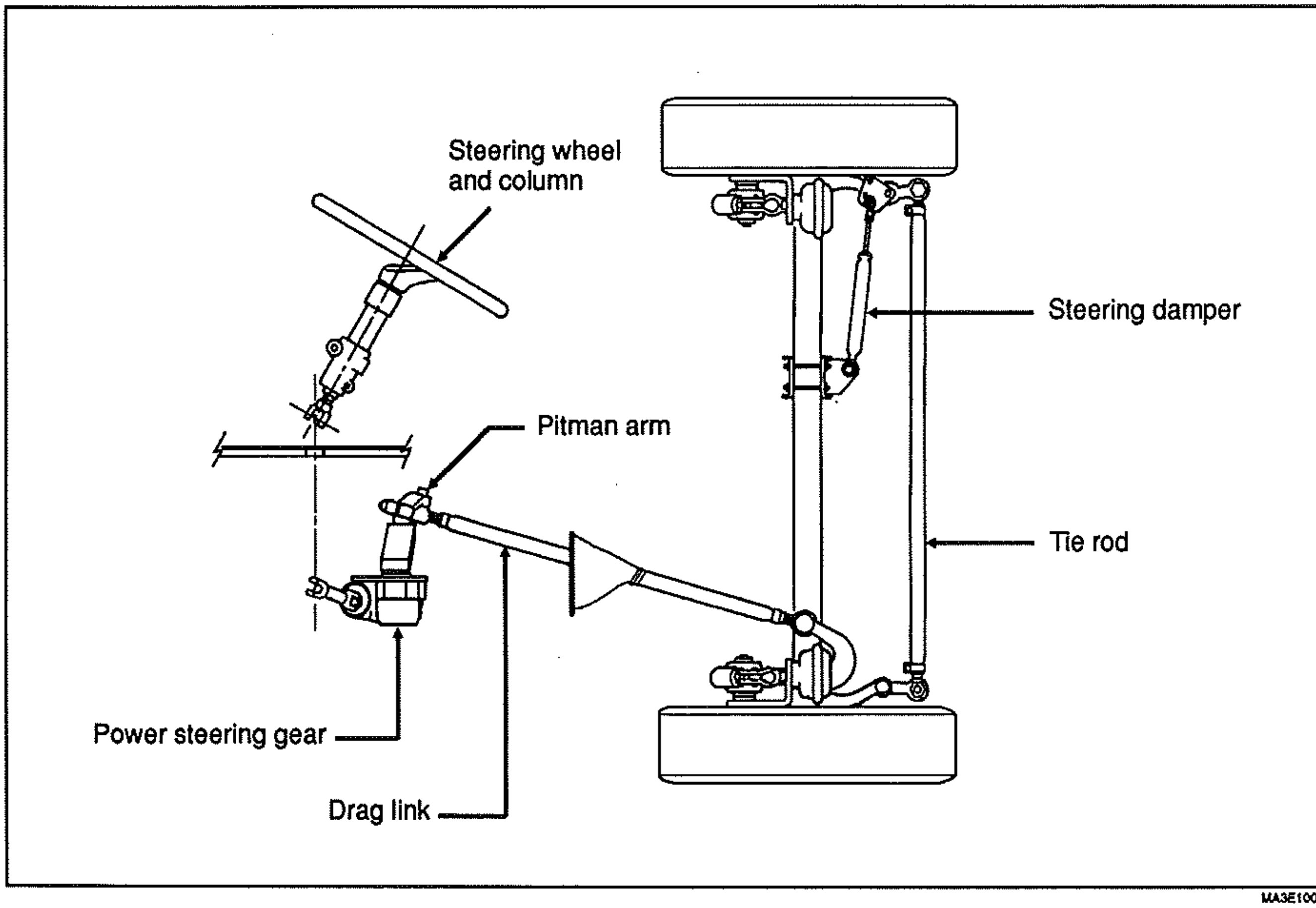

FIG. 1 - Steering system components

If the steered wheels receive a shock load, the shock force is transmitted through the sector shaft to the rack piston and on the worm shaft. This force causes the control valve to send high pressure fluid to the proper cavity to resist the shock force. By hydraulically absorbing the shock, the steering gear prevents kickback at the steering wheel.

The steering gear is equipped with two unloading valves (poppets) at either end of the housing. As the steered wheels approach the axle stop, the corresponding poppet is opened. This reduces heat generated by the pump. The tripped poppet also reduces the load force on the steering linkage. These poppets may be adjusted by the adjusting screws on either end of the steering gear.

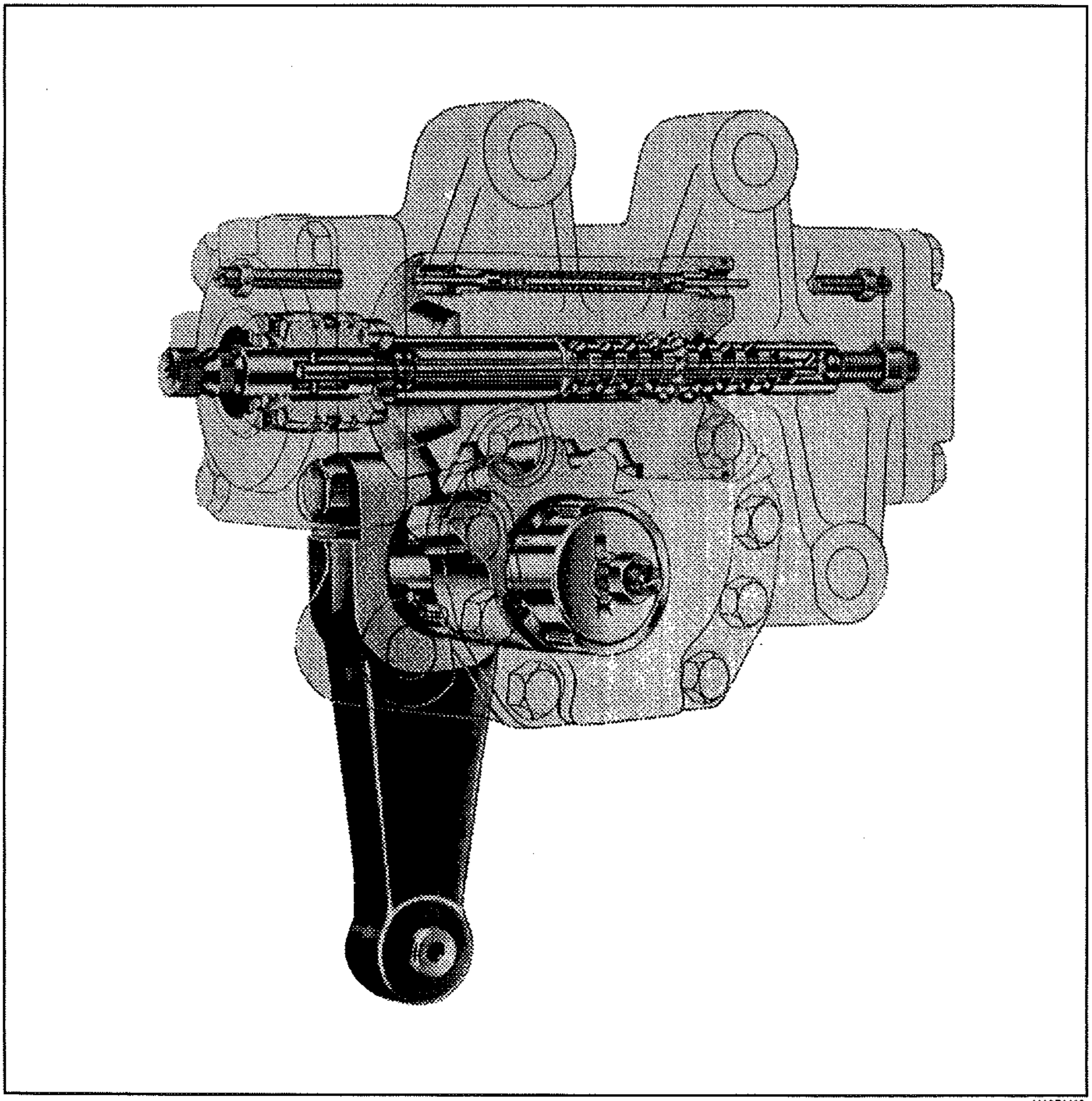

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FIG. 2 - Integral power steering gear

MAINTENANCE

The power steering system requires little maintenance. However, the system should be kept clean to insure maximum operating performance and troublefree service. Periodic inspection should also be made to check for leaks.

At regular intervals, fluid level should be checked in the reservoir and filter assembly, and fluid added when required. Furthermore, the reservoir filter should be replaced every 50,000 mile (80 000 km) intervals.

When the slightest evidence of dirt, sludge or water is discovered in the system, disconnect fluid lines at the power steering gear to drain the system. Drain, and refill the system with *"Dexron"* automatic transmission fluid.

Air in the hydraulic system will cause spongy action and noisy operation. When any hose has been disconnected or when fluid has been lost for any reason, the system must be bled. Bleed system as outlined under heading *"Bleeding power steering hydraulic system"* later in this section.

WARNING: Do not operate the pump without fluid in the power steering fluid reservoir.

If the steering linkage between the steering gear and the two front wheels is out of adjustment, bent, twisted or worn, the steering of the vehicle will be seriously impaired. Whenever any steering linkage part is repaired, replaced or adjusted, steering geometry and front wheel alignment must be checked and necessary corrections made. Refer to section 10 entitled *"Front Axle"* for front end alignment.

At regular lubrication intervals, the steering linkage should be thoroughly inspected for worn or loose components. Refer to *"Lubrication and Servicing Schedule"* in section 24 of this manual.

After the vehicle has been operated continually and high mileage figures have been reached, overhaul of the various steering units will be required. General overhaul procedure normally requires removal of the entire assembly, cleaning and inspection of all parts and final assembly. Careful inspection of all parts during overhaul is very important and must not be neglected.

INTEGRAL POWER STEERING GEAR

Refer to the *"HFB-70 Service Manual"* annexed to this section for the complete description and the maintenance procedure of the power steering gear.

CAUTION: Before attempting to adjust the poppet valves of the power steering gear, properly set the steering stop screws as outlined in section 10 *"Front Axle"* under heading *"Steering stop screw adjustments"*.

BLEEDING POWER STEERING HYDRAULIC SYSTEM

To bleed the power steering hydraulic system, refer to the *"HFB-70 Service Manual"* annexed to this section, under heading *"Filling and air bleeding the system"*.

HYDRAULIC PRESSURE TEST

Perform a pressure test as outlined in the *"HFB-70 Service Manual"* annexed to this section, under heading *"Troubleshooting information"*.

TROUBLESHOOTING

Perform troubleshooting of the steering gear as outlined in the *"HFB-70 Service Manual"* annexed to this section, under heading *"Troubleshooting guide"*.

TROUBLESHOOTING CHECK LIST

Refer to the form *"TRW Troubleshooting Check List"* annexed to this section.

POWER STEERING HYDRAULIC PUMP

Description

The power steering pump is a vane type, gear driven, hydraulic unit which supplies hydraulic pressure for the operation of the steering gear. The pump is mounted over the engine flywheel housing, beside the air compressor. The pressure relief valve is set to 2,000 psi (13 790 kPa).

Removal and installation

CAUTION: At removal of the power steering pump, inspect carefully the drive coupling (fiber component located between the engine gearing and the pump), and replace if necessary. Ensure that drive coupling is correctly positioned before reinstalling steering pump.

The pump is accessible through the engine compartment R.H. side door. To remove the pump, disconnect the inlet and outlet hoses from the pump, then remove the two mounting bolts. Cap hose openings to prevent contamination of hydraulic system. The mounting flange gasket should be replaced whenever pump is removed. To install pump, reverse the removal procedure.

Maintenance

For the maintenance of the power steering hydraulic pump, refer to the *"Overhaul Manual"* annexed to this section.

POWER STEERING RESERVOIR

The power steering reservoir is located on R.H. side of engine compartment back wall, under booster block. It is recommended that the filter element be serviced at 50,000 mile (80 000 km) intervals depending on operating conditions.

CAUTION: After element and gaskets are installed, tighten cover bolt to a maximum torque of 12 lbf•ft (16,3 N•m). Check for leaks after operating the system.

Oil level ckeck procedure

1. Stop engine, then open engine compartment R.H. side door.
2. Unscrew and remove the dipstick located on top of reservoir and wipe with a clean rag.
3. Insert dipstick in reservoir, then remove it again to check level.
4. Adjust level to *"FULL"* mark, using *"Dexron"* automatic transmission fluid.
5. Replace and tighten the dipstick.

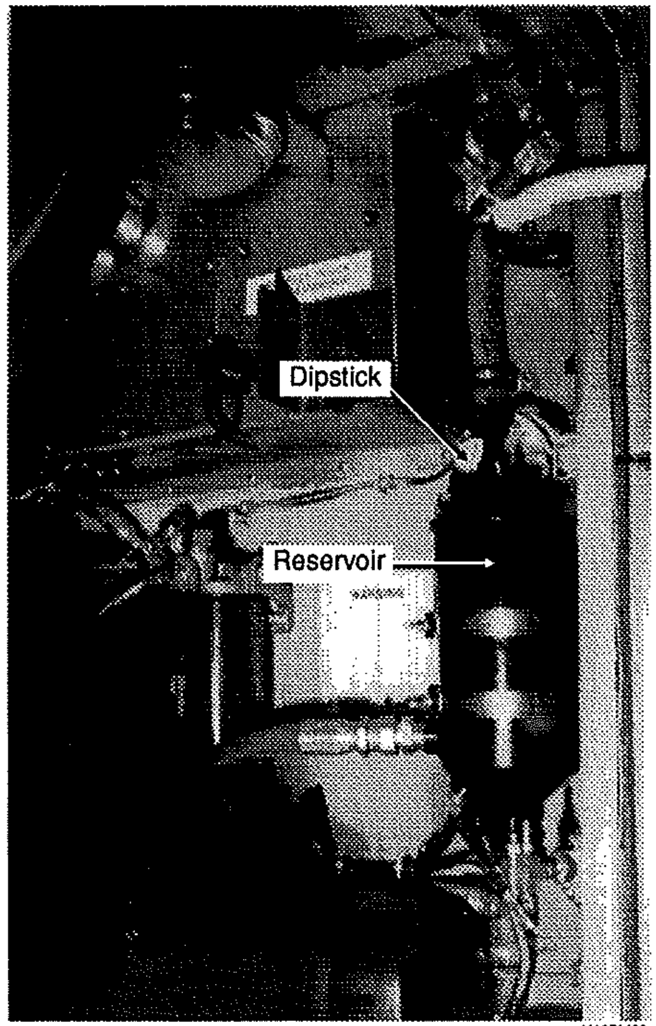


FIG. 3

STEERING WHEEL

Removal

1. Set the battery main disconnect switches to the *"Off"* position.

2. Using a tool, such as a little flat head screwdriver, pry away the electric horn cap.

3. Loosen the small screw in center of cap and the one retaining the black wire, then disconnect the white terminal. Remove horn cap.

4. Loosen and remove the steering wheel nut.

5. Using a suitable puller, remove the steering wheel.

Installation

To install, reverse the removal procedure, then torque steering wheel nut to 35 - 45 lbf•ft (47 - 60 N•m).

STEERING COLUMN

To disassemble the steering column, refer to figure 4 as a guide. The steering column has three lubrication points which must be serviced once a year using molybdenum disulphide grease.

The lower steering column U-joint grease fitting is easily accessible through the front service compartment.

The upper steering column U-joint and the steering slip joint grease fittings are accessible front the driver's area. To gain access to these fittings, proceed as follow:

1. From the driver's area, unfasten and lift the steering column boot, then remove the four snap caps on front of upper steering column cover (refer to fig. 4).

2. Unscrew the four retaining screws on upper steering column cover, then remove cover.

3. Unscrew the three retaining screws on lower steering column cover, then remove cover.

4. Position the steering wheel in order to gain access to the grease fittings.

NOTE: For an easier access to the slip joint grease fitting, lift steering wheel to its maximum position using the release handle located on the left hand side of the steering column.

TURNING ANGLE ADJUSTMENT

To adjust the turning angle, refer to section 10 *"Front Axle"* under heading *"Steering stop screw adjustments"*.

STEERING LINKAGE ADJUSTMENT

To adjust the steering linkage, refer to section 10 *"Front Axle"* under heading *"Front end alignment"*.

PITMAN ARM

To properly adjust the pitman arm on the sector shaft of the steering gear, refer to section 10 *"Front Axle"* under heading *"Pitman arm"*.

STEERING DAMPER

This vehicle is provided with a steering damper cylinder installed on right hand side of front axle. The cylinder is non-repairable, so if oil leakage is evident or cylinder has no resistance, the complete unit must be replaced. Lubricate the steering damper cylinder rod end every 5,000 miles (8 000 km) with molybdenum disulphide grease. Inspect regularly the spherical joint; in case of wear, replace rod end assembly.

LUBRICATION

All lubrication fittings must be clean before applying lubricant. Moreover, always be sure the equipment used in applying lubricant is clean. Every precaution should be taken to prevent entry of dirt, grit, lint or other foreign matter into lubricant containers. Replace fittings that have become broken or damaged. Lubrication intervals, as well as the recommended lubricants for the steering components, are given in the *"Lubrication and servicing schedule"* in section 24 of this manual. The intervals given in the schedule are recommended for normal service. More frequent intervals may be required under severe operating conditions.

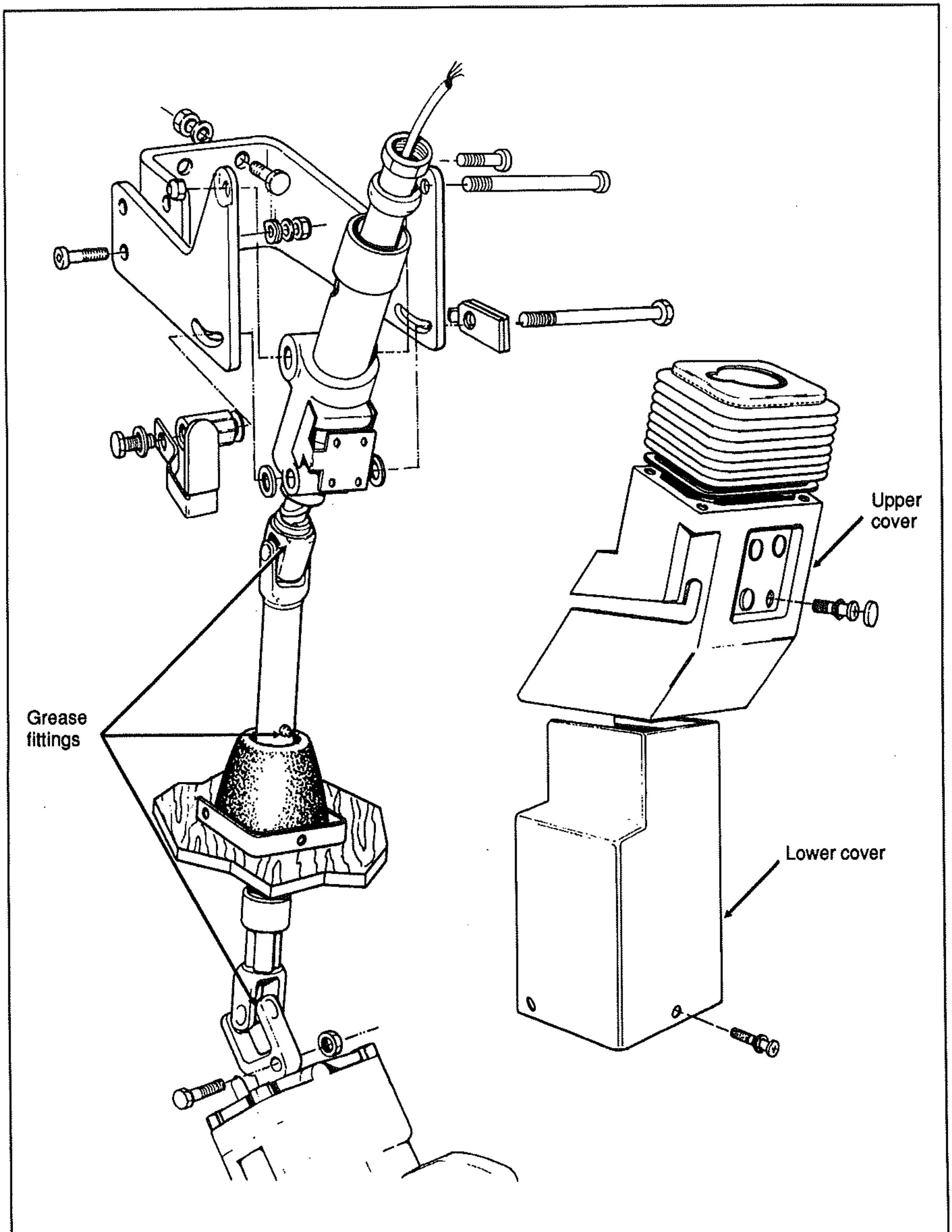


FIG. 4 - Steering column

SPECIFICATIONS

POWER STEERING GEAR

Make . . . . Ross gear
Model HFB70029
Ratio 23.3:1
Prevost number 66-0785

POWER STEERING PUMP

Make . . . . Vickers
Model VTM42-50-55-20-ME-R1-14-S4
Type . . . . Vane
Relief valve setting . . . . 2,000 psi (13 790 kPa)
Capacity . . . . .5 US gal/min. (19 l/min)
Prevost number 66-0917

POWER STEERING RESERVOIR

Make . . . . Dana
Oil capacity . . . . 9.6 US qts (9,1 liters)
Supplier number 31400-1
Prevost number 66-0525
Element filter supplier number 32516
Element filter Prevost number 66-0528

STEERING DAMPER CYLINDER

Make . . . . Gabriel
Extended length . . . . 32.73" (83,13 cm)
Collapsed length . . . . 20.26" (51,46 cm)
Stroke . . . . 12.47" (31,67 cm)
Supplier number 651535
Prevost number 66-0885

STEERING DAMPER CYLINDER ROD END

Make . . . . Aurora
Supplier number . . . . AW 12Z
Prevost number 66-0884

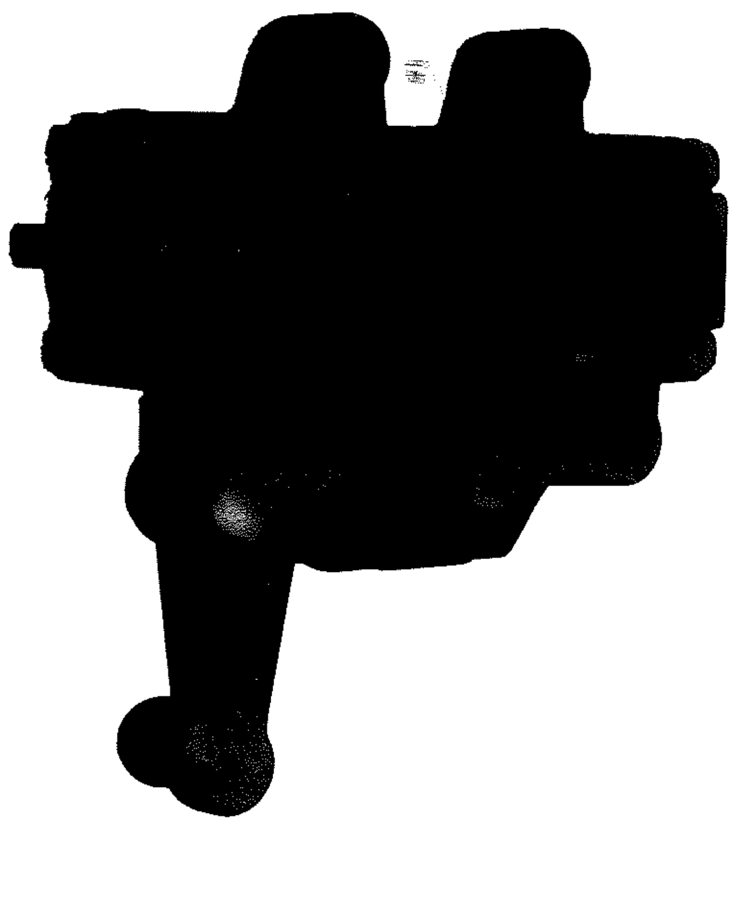
SERVICE BULLETINS AND SERVICE INFORMATION LETTERS

Service Bulletins and Service Information Letters will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of publications pertaining to this section should be noted below as soon as received. These should then be filed for future reference.

NUMBER	DATE	SUBJECT

Hydrapower™
Integral Power Steering Gear

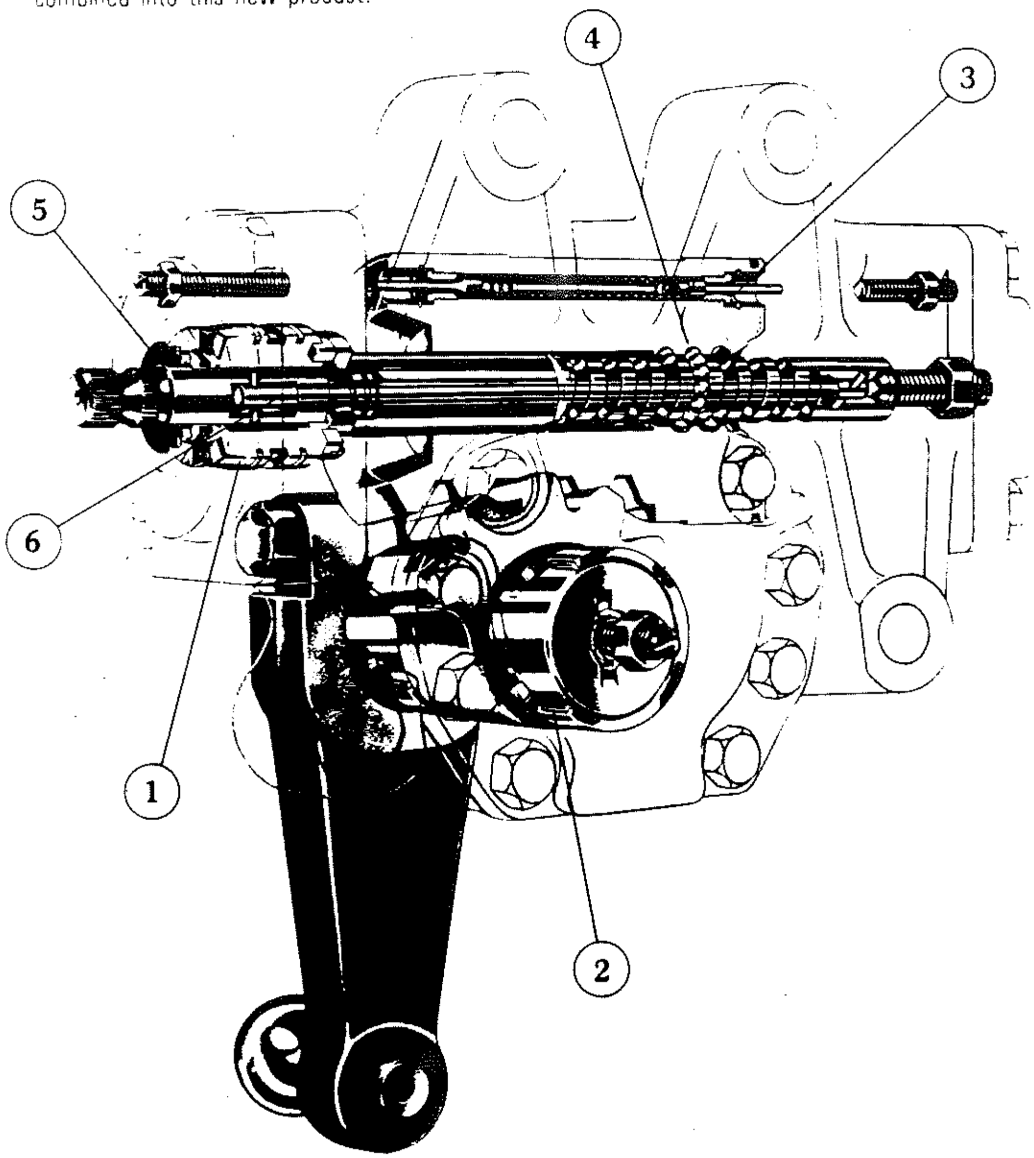
HFB70 Service Manual



TRW Ross Gear Division

HFB70 Integral Hydraulic Power Steering Gear

This steering gear was specifically designed for motor trucks; new design features and our design experience with previous models of integral hydraulic power steering gears have been combined into this new product.



Design Features

1. **Rotary Valve** — This device provides responsive steering control
2. **Precision Roller Bearings** — Allow the steering gear to operate with high efficiency and reversibility
3. **Unloading Valves** — Furnish power steering pump protection and reduce pressure to unload steering linkage at the ends of steering gear travel
4. **Recirculating Balls** — Combines high mechanical efficiency with smooth operation
5. **Dirt and Water Seals** — Lip type seals on both input and output shafts
6. **Torsion Bar** — Provides positive valve centering with definitive "feel of the road"

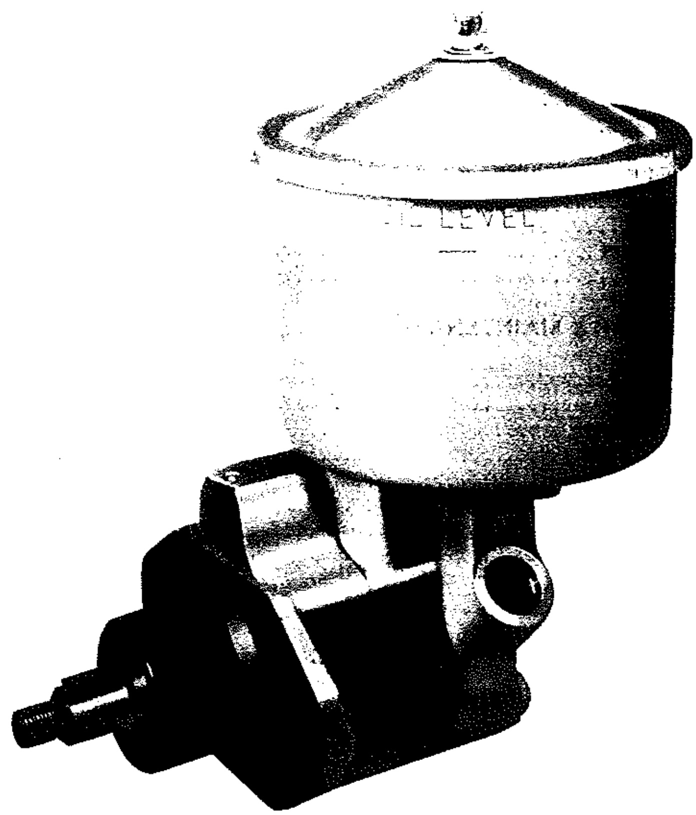
- Balanced Area Cylinder — Back pressures cannot affect steering stability
- High Temperature Seals — These specially developed seals may be operated intermittently at 300°F (148.9°C)
- Manual Steering Capability — Provides for steering control in the event of hydraulic failure
- Compactness — Lowest weight to output torque ratio in the industry
- Auxiliary Porting Available — For auxiliary cylinder control
- Seal Protectors — Provide protection from harsh environment

VICKERS®
A TRINOVA COMPANY

Overhaul Manual

Power Steering Pumps

VTM**-10,-12,-14 Designs



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A. PURPOSE OF MANUAL

This manual has been prepared to assist users of Vickers balanced vane type hydraulic power steering pumps in properly installing, maintaining and repairing their units. In the sections which follow, the power steering pumps are described in detail, their theory of operation is discussed and instructions are given for proper installation, maintenance and overhaul.

The general series of models covered are VTM27, VTM28, VTM40, VTM41 and VTM42. The information given applies to the latest design configurations listed in Table 1. Earlier designs are covered only insofar as they are similar to the present equipment.

B. GENERAL INFORMATION

1. Related Publications - Service parts information and installation dimensions are not contained in this manual. The parts and installation drawings listed in Table 1 are available from any Vickers application engineering office or from:

Vickers, Incorporated
Technical Publications
1401 Crooks Road
Troy, Michigan 48084

2. Model Codes - There are many variations within each basic model series which are covered by variables in the model code. Table 2 is a complete breakdown of the model code covering these units. Service inquiries should always include the complete unit model number, which is stamped on the pump cover.

MODEL SERIES	PARTS DRAWING	INSTALLATION DRAWING
VTM27	M-2052-S	MB-53
VTM28	M-2052-S	MB-53
VTM40	M-2053-S	MB-53
VTM41	M-2053-S	MB-53
VTM42	M-2052-S	MB-53

Table 1. Parts and Installation Drawings

MODEL CODE BREAKDOWN

VT M ** - ** - ** - ** - (F) (S) ** - *1 - 1* - S**

VANE TYPE

MOBILE APPLICATION

SERIES
27 41
28 42
40

CAPACITY
10 - 1.0 US G.P.M.
15 - 1.5 US G.P.M.
20 - 2.0 US G.P.M.
40 - 4.0 US G.P.M.
50 - 5.0 US G.P.M.
60 - 6.0 US G.P.M.

CONTROLLED FLOW (1500 RPM @ 100 PSI)
15 - 1.5 US G.P.M. 45 - 4.5 US G.P.M.
20 - 2.0 US G.P.M. 50 - 5.0 US G.P.M.
25 - 2.5 US G.P.M. 55 - 5.5 US G.P.M.
30 - 3.0 US G.P.M. 60 - 6.0 US G.P.M.
35 - 3.5 US G.P.M. 65 - 6.5 US G.P.M.
40 - 4.0 US G.P.M. 75 - 7.5 US G.P.M.

CONTROL RELIEF VALVE SETTING
02 - 250 PSI 10 - 1000 PSI
03 - 300 PSI 12 - 1250 PSI
05 - 500 PSI 15 - 1500 PSI
07 - 750 PSI 17 - 1750 PSI
08 - 850 PSI 20 - 2000 PSI
35 - 350 PSI

FILTER PARTS

INLET SCREEN

RESERVOIR OR MANIFOLD
07 - 70 CU. IN. RESERVOIR
11 - 115 CU. IN. RESERVOIR
EN - ENCLOSED RESERVOIR (VTM 40-41 ONLY)
MA - MANIFOLD WITH NO BYPASS TUBE
MB - MANIFOLD WITH BYPASS TUBE
MD - MANIFOLD - 90° BEND ON INLET TUBE
ME - CAST MANIFOLD WITH NO BYPASS TUBE
MF - CAST MANIFOLD WITH BYPASS TUBE
MG - MANIFOLD - NO BYPASS SWIVEL COUPLING
MH - MANIFOLD - 90° ON INLET TUBE
MJ - CAST MANIFOLD - NO BYPASS TUBE
MR - MANIFOLD 90° BEND ON INLET AND BYPASS TUBE
MS - MANIFOLD - 90° BEND ON INLET TUBE
NO - SHIPPING CLOSURE

PUMP ROTATION VIEWED FROM SHAFT END
R - CLOCKWISE
L - COUNTERCLOCKWISE

SHAFT
NO. 1

DESIGN
-10, -12, -14

SPECIAL FEATURES

Table 2. Model Code Breakdown

Section II · DESCRIPTION

A. GENERAL

The Vickers power steering pumps are used primarily to supply a flow of hydraulic fluid for operation of power steering mechanisms. Pumps in this series are of the balanced vane type and have a constant rate of delivery per revolution. Direction of pump shaft rotation and pumping capacity may be changed to suit specific applications. The pumps are available with an integral reservoir or with a manifold for remote reservoir installations. Basic operation and performance characteristics are identical. Major differences include: types of reservoirs, manifolds, pump mountings and drive shaft configurations which are found in the model code breakdown shown in Table 2.

B. ASSEMBLY AND CONSTRUCTION

The cutaway/sectional views (Figures 1, 2, 3 and 4) of the pumps in this series illustrate the differences between these units. The VTM40 and VTM41 units are designed with integral type reservoirs. The VTM27, VTM28 and VTM42 pumps have externally mounted reservoirs or can be adapted to manifolds. When manifolds are used, the pump is connected to a reservoir located elsewhere in the circuit. (The VTM27 is not shown but is similar to the VTM42.) Principal components of the pump consist of the reservoir, body, cover, cam ring, rotor, vanes, pressure plate, control valve and drive shaft subassembly. The VTM27, VTM41 and VTM42 series pumps are designed for external mounting and indirect drive; however, special engineering application must be obtained for gear drive operation.

NOTE
Helical gear drives must not be used with the VTM41 series pump.

The VTM28 and VTM40 series pumps are designed for direct mounting. Most of the bearing load is carried by the external mounting.

C. FLOW CONTROL AND RELIEF VALVE

The pumps are equipped with integral cartridge type flow control relief valves. At a volume greater than the rated flow, excess flow is by-passed to the inlet within the pump by the flow control valve. The flow control valve operates on pressure differential. The relief valve also operates on a pressure differential and limits the maximum pressure in the hydraulic circuit.

D. APPLICATION

Pump ratings in USGPM as shown in the model code are at 1200 RPM and 100 PSI. For ratings at other speeds, methods of installation and other application information, Vickers application engineering personnel should be consulted.

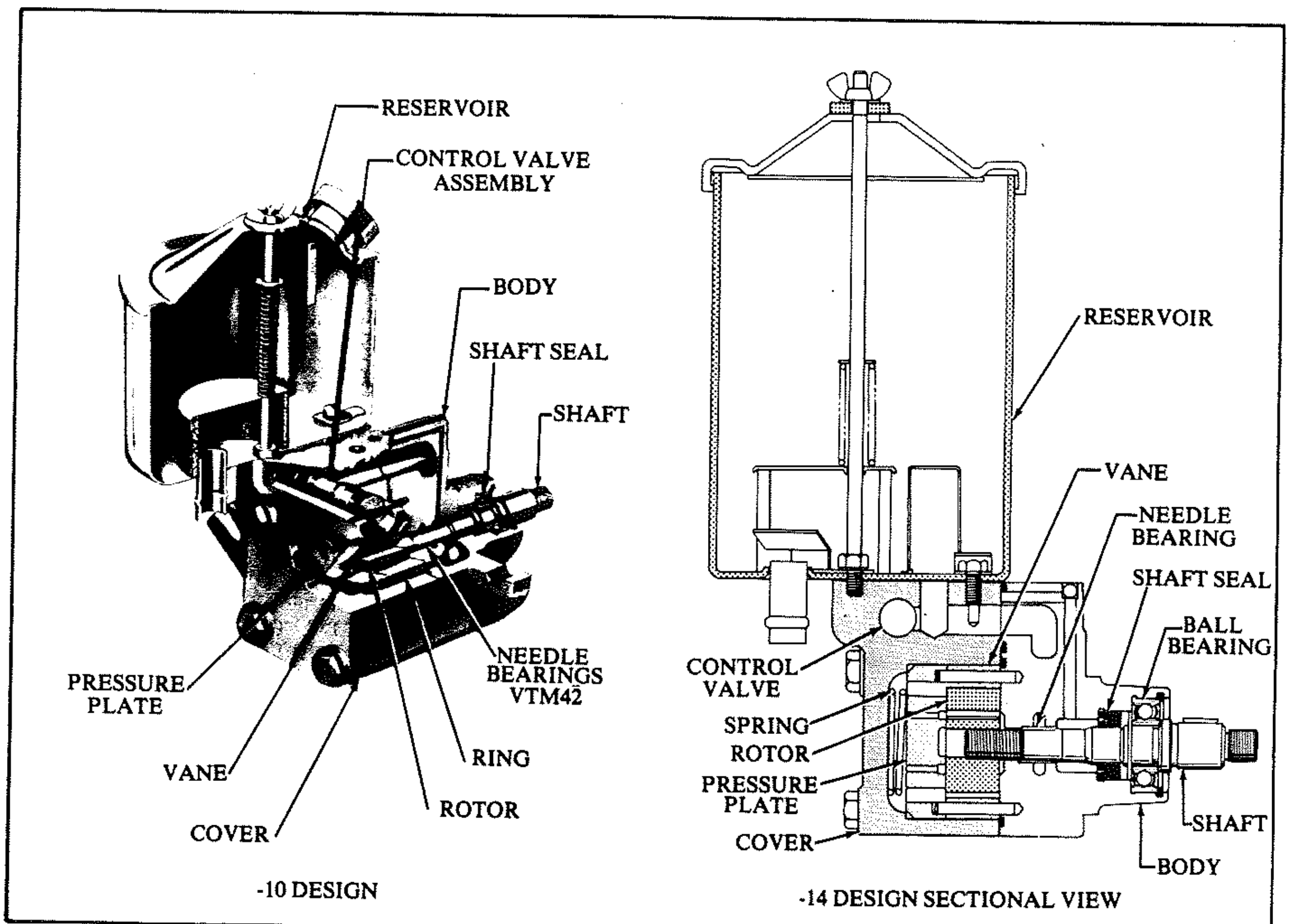


Figure 1. VTM27/42 Pump - Cutaway and Sectional Views

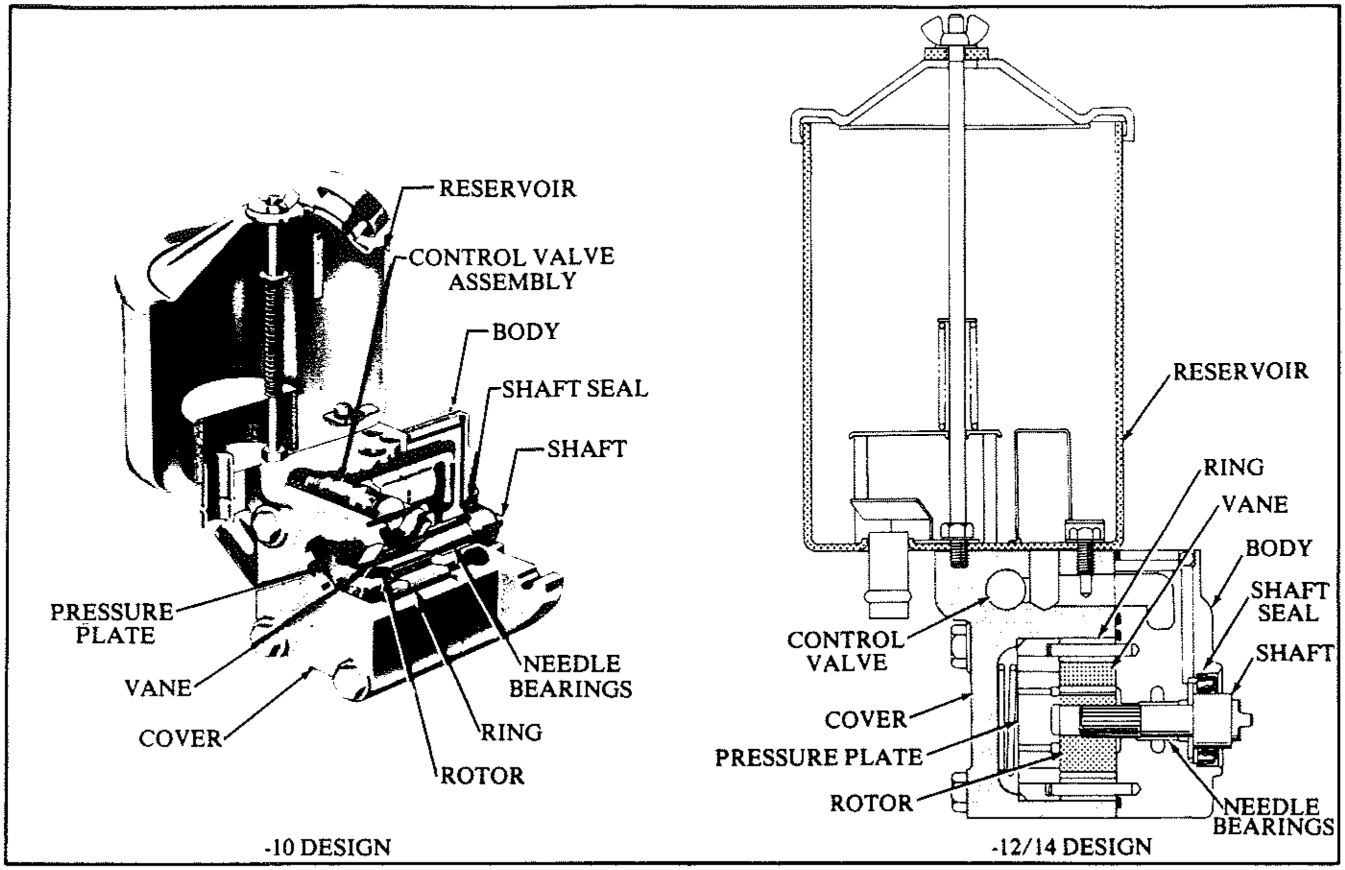


Figure 2. VTM28 Pump - Cutaway and Sectional Views

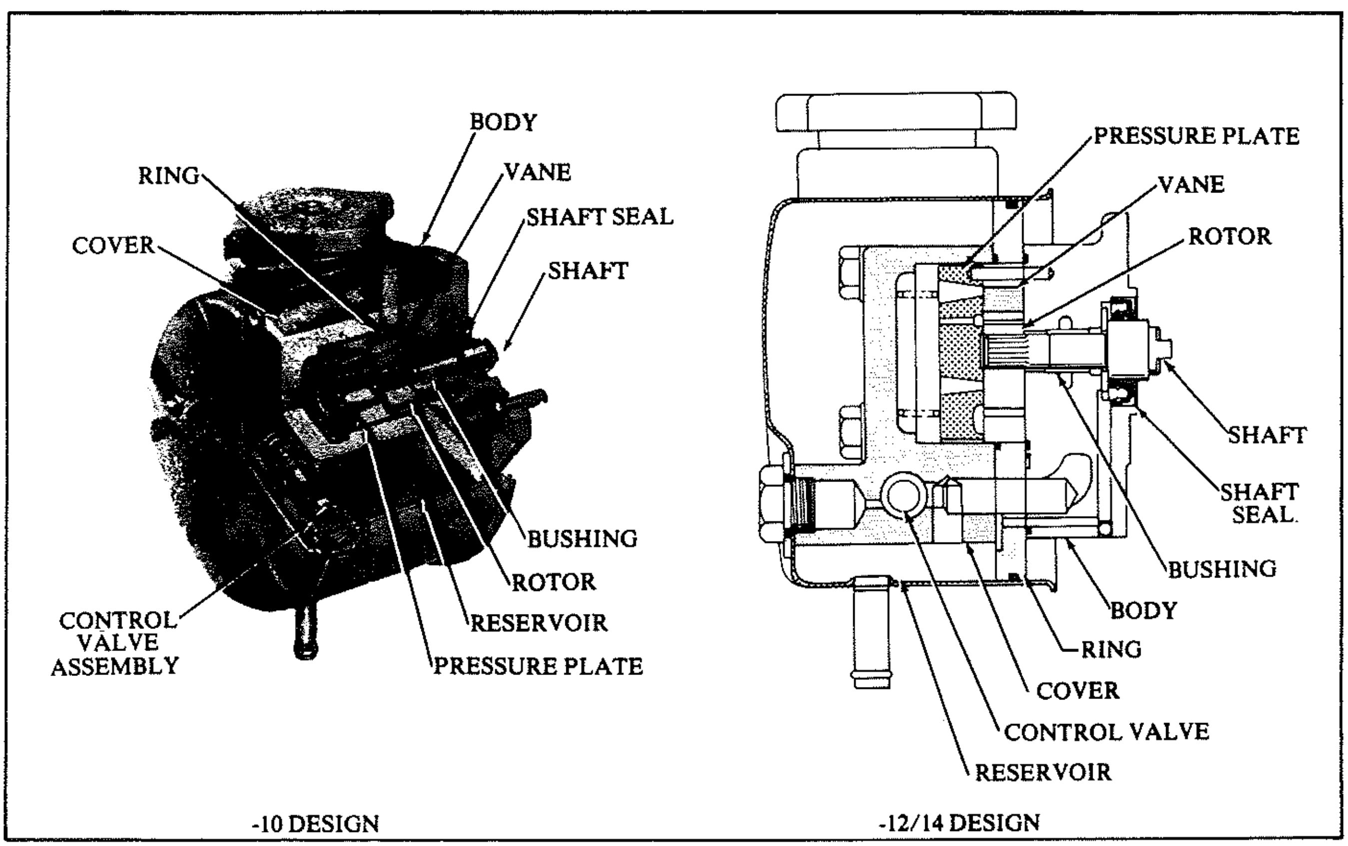


Figure 3. VTM40 Pump - Cutaway and Sectional Views

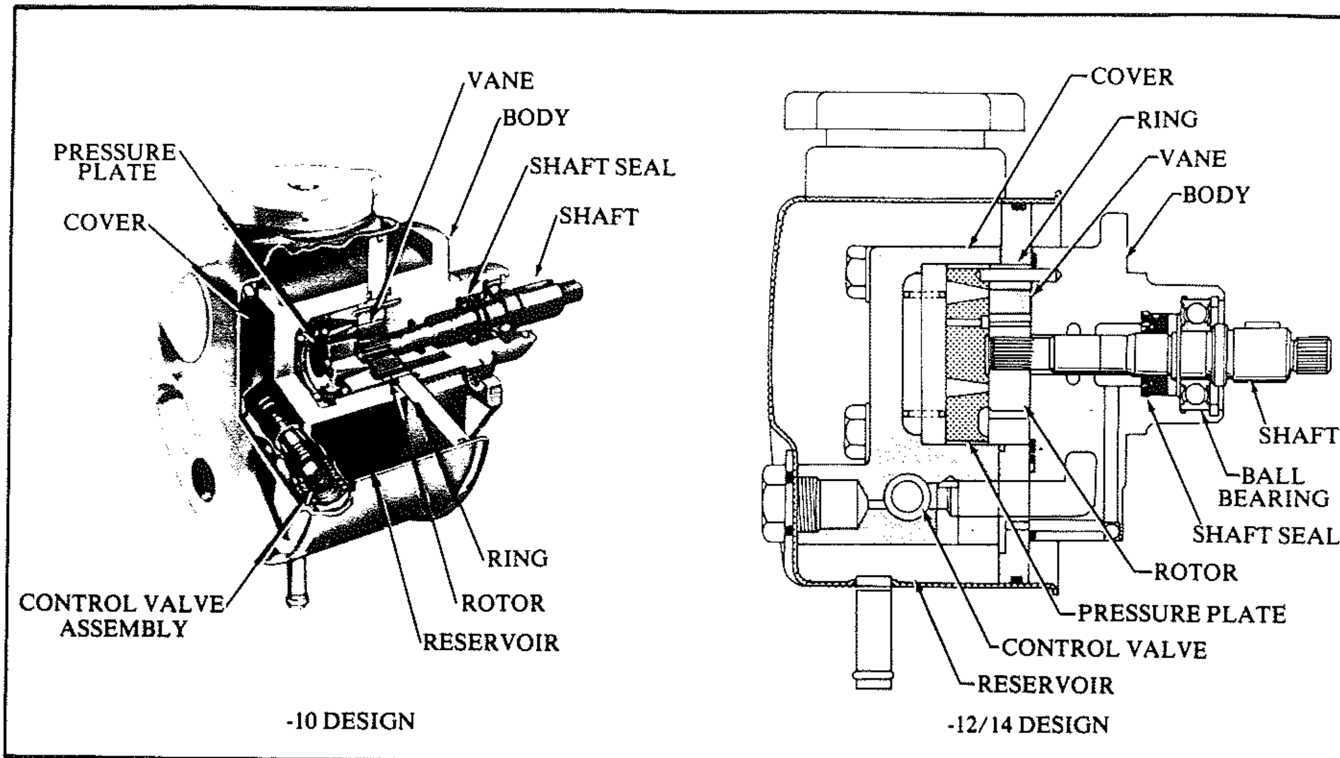


Figure 4. VTM41 Pump - Cutaway and Sectional Views

Section III · PRINCIPLES OF OPERATION

A. PUMPING CARTRIDGE

Fluid flow is developed by the pumping cartridge. The action of the cartridge is illustrated in Figure 5. The rotor is driven within the cam ring by the drive shaft, which is coupled to the power source. As the rotor turns, centrifugal force causes the vanes to follow the elliptical inner surface of the cam ring. Radial movement of the vanes and turning of the rotor causes the chamber volume between the vanes to increase as the vanes pass the inlet sections of the cam ring. This results in a low pressure condition which allows atmospheric pressure to force fluid into the chambers. (Fluid outside the inlet is at atmospheric pressure or higher.)

This fluid is trapped between the vanes and carried past the large diameter or dwell section of the cam ring. As the outlet section is approached, the cam ring diameter decreases and the fluid is forced out into the system. System pressure is fed under the vanes, assuring their sealing contact against the cam ring during normal operation.

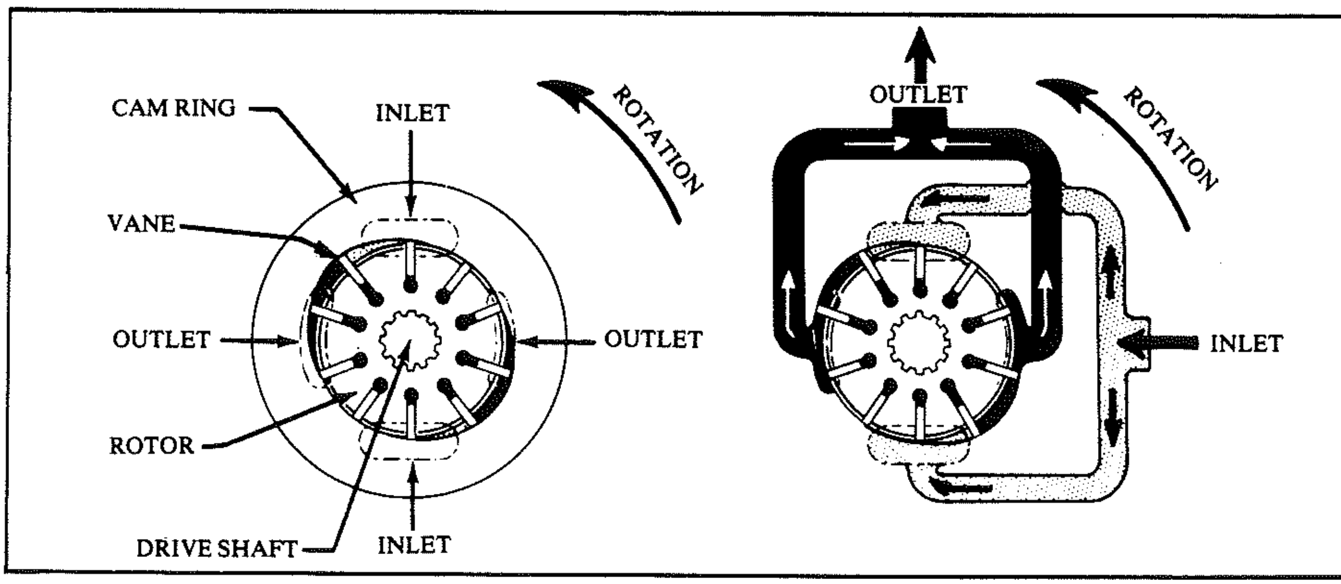


Figure 5. Schematic View Showing Oil Flow and Balance Vane Pump Construction

B. PRESSURE PLATE

The pressure plate seals the pumping chamber. A light spring holds the plate against the cartridge until pressure builds up in the system. System pressure is effective against the area at the back of the plate, which is larger than the area exposed to the pumping cartridge. Thus, an unbalanced force holds the plate against the cartridge, sealing the cartridge and providing the proper running clearance for the rotor and vanes.

C. FLOW CONTROL AND RELIEF VALVES

1. Maximum flow to the operating circuit and maximum system pressure are determined by the integral flow control and relief valve subassembly in a special outlet cover used on pumps in this series. This feature is illustrated pictorially in Figure 6. An orifice in the cover limits maximum flow. A pilot-operated type relief valve shifts to divert excess fluid delivery to tank, thus limiting the system pressure to a predetermined maximum.

2. Figure 6A shows the condition when the total pump delivery can be passed through the orifice. This condition usually occurs only at low drive speeds. The large spring chamber is connected to the pressure port through an orifice. Pressure plus spring load in this chamber slightly exceeds pressure at the other end of the relief valve spool and the spool remains closed. Pump delivery is blocked from the tank port by the spool land.

3. When pump delivery is more than the flow rate determined by the orifice, pressure builds up across the orifice and forces the spool open against the light spring. Excess fluid is throttled past the spool to the tank port as shown in Figure 6B.

4. If pressure in the system builds up to the relief valve setting (Figure 6C), the pilot poppet is forced off its seat. Fluid in the light spring chamber flows through the spool and out to tank. This flow through the small sensing orifice, causes a pressure drop and prevents pressure in the light spring area from increasing beyond the relief valve setting. As pressure against the right end of the spool starts to exceed the relief valve setting, the pressure differential forces the spool to the left, against the light spring, porting the full pump flow to tank.

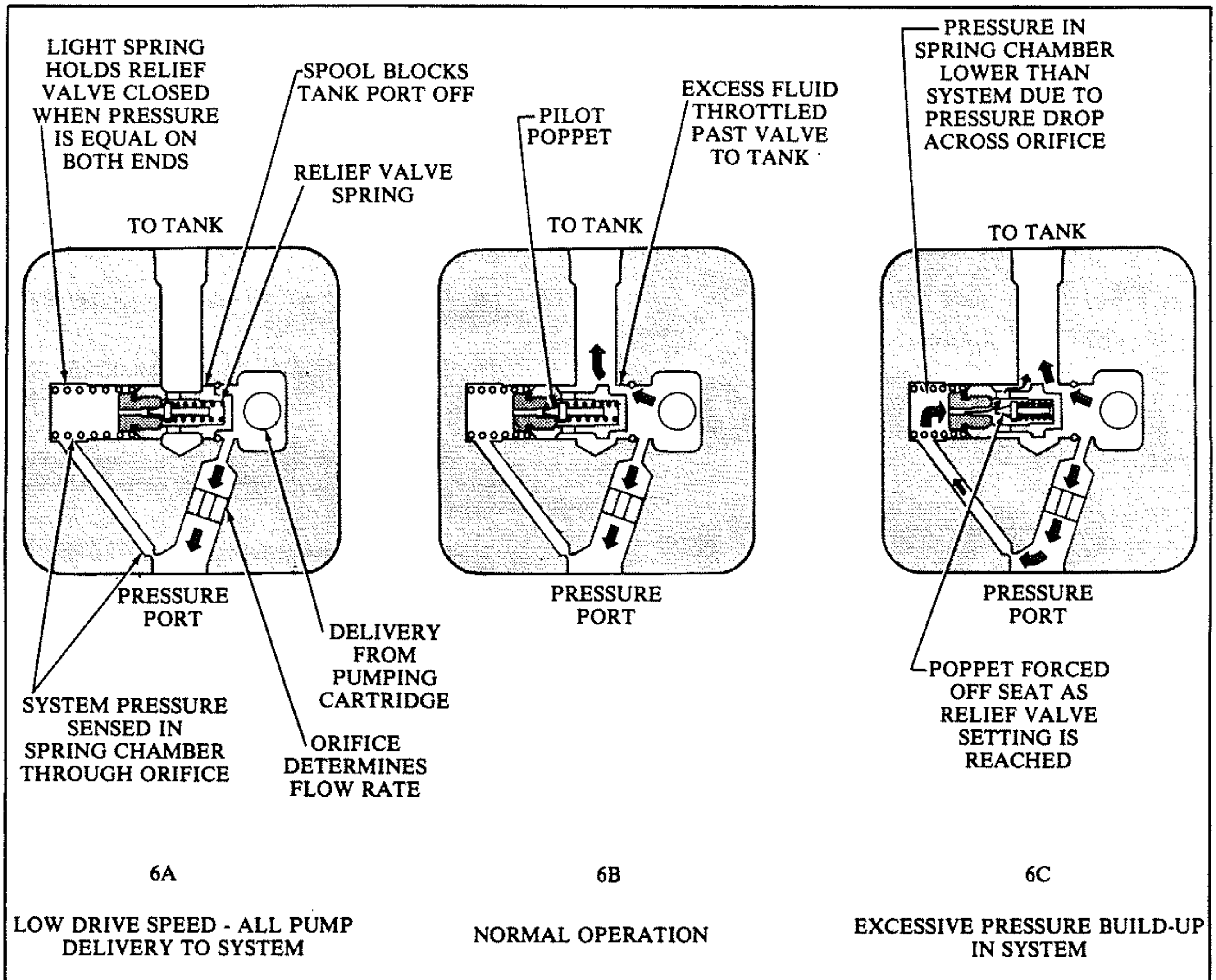


Figure 6. Flow Control Relief Valve Operation

A. INSTALLATION DRAWINGS

The installation drawings listed in Table 1 show the correct installation dimensions and port locations.

B. DRIVE CONNECTIONS

The VTM41 pumps are designed to be indirectly driven, however, a helical drive system must not be used. The VTM28 and VTM40 units must be mounted and coupled to an electric motor or generator. The VTM27 and VTM42 series have the same drive characteristics as the VTM41 pumps but are designed for heavier drive and thrust loads.

1. Direct Drive Mounting - Care should be taken when mounting these pumps to assure correct shaft alignment with the power source. A pilot on the pump mounting flange is provided to assure correct mounting. Make sure the pilot is firmly seated in the accessory pad of the power source. If gaskets are used, they should be installed carefully and lay flat. Shaft keys and couplings must be seated properly to avoid slipping and possible shearing.

2. Indirect Drive - Chain, spur gear or "V" belt pulley drives may also be used with these pumps (VTM27, VTM41 and VTM42 only). Flat belt drives are not recommended because of the possibility of slipping.

To prevent excessive side loads on pump bearings, it is important to check for correct alignment and guard against excessive belt or chain tension. For best results on indirect drive applications, use the largest permissable pulley diameter at the pump and position it close as possible to the pump mounting face. For specific indirect drive application data, contact your Vickers application engineer.

C. SHAFT ROTATION

Pumps are normally assembled for right hand rotation (clockwise) as viewed from the shaft end. A pump made for left hand rotation (counterclockwise) is identified by an "L" in the model code. See Table 2.

NOTE

These pumps must be driven in the direction of the arrows cast into the pump cam ring. If it is desired to change the direction of drive rotation, it is necessary to reverse the ring. See parts drawing noted in Table 1.

CAUTION

Never drive a pump in the wrong direction of rotation. Seizure may result, necessitating expensive repair.

D. PIPING AND TUBING

1. All pipes and tubing must be thoroughly cleaned before installation. Recommended methods of cleaning are sandblasting, wire brushing and pickling. For instructions on pickling, refer to instruction sheet 1221-S.

2. To minimize flow resistance and the possibility of leakage, only as many fittings and connections as are necessary for proper installation should be used.

3. The number of bends in tubing should be kept to a minimum to prevent excessive turbulance and friction of oil flow. Tubing must not be bent too sharply. The recommended radius for bends is three times the inside diameter of the tube.

E. HYDRAULIC FLUID RECOMMENDATIONS

GENERAL DATA

Oil in a hydraulic system performs the dual function of lubrication and transmission of power. It constitutes a vital factor in a hydraulic system, and careful selection of it should be made with the assistance of a reputable supplier. Proper selection of oil assures satisfactory life and operation of system components.

Data sheets for oil selection are available from Vickers, Incorporated, Technical Publications, Troy, MI 48084. For mobile applications, order data sheet M-2950-S. For industrial applications, order data sheet I-286-S. The oil recommendations noted in the data sheets are based on our experience in industry as a hydraulic component manufacturer.

Where special considerations indicate a need to depart from the recommended oils or operating conditions, contact your Vickers representative.

F. CLEANLINESS

To insure the hydraulic system is clean:

1. Clean (flush) entire new system to remove paint, metal chips, welding shot, etc.

2. Filter each change of fluid to prevent introduction of contaminants into the system.

3. Provide continuous fluid filtration to remove sludge and products of wear and corrosion generated during the life of the system.

4. Provide continuous protection of system from entry of airborne contamination, by sealing the system and/or by proper filtration of the air.

5. Proper servicing of filters, breathers, reservoirs, etc. cannot be overemphasized.

6. Good system and reservoir design will insure aeration of fluid is kept to a minimum.

G. SOUND LEVEL

Noise is indirectly affected by the fluid selection, but the condition of the fluid is of paramount importance in obtaining optimum reduction of system sound levels.

Some of the major factors affecting fluid conditions that cause the loudest noises in a hydraulic system are:

1. Very high viscosities at startup temperatures can cause pump noises due to cavitation.

2. Running with a moderately high viscosity fluid will slow the release of entrained air. The fluid will not be completely purged of air in the time it remains in the reservoir and will be recycled through the system.

3. Aerated fluid can be caused by ingestion of air through the pipe joints of inlet lines, high velocity discharge lines, cylinder rod packings, or by fluid discharging above the fluid level in the reservoir. Air in the fluid causes a noise similar to cavitation.

4. Contaminated fluids can cause excessive wear of internal pump parts, which may result in increased sound levels.

H. OVERLOAD PROTECTION

An integral flow control relief valve subassembly limits pressure in the system to a prescribed maximum and protects the components from excessive pressure. The setting of the relief valve is preset at the factory and depends on the work requirements of the system. DO NOT try to readjust the relief valve in the field. On power steering units, the Pitman arm stops should be installed to limit the number of degrees that the Pitman arm can move in either direction. This prevents excessive thrust and cramping of the steering linkage which can cause excessive relief valve operation and overheat the pump.

I. STARTUP

With a minimum drive speed of 600 RPM, a pump should prime almost immediately, if provision is made to initially purge the air from the system. Failure to prime within a reasonable length of time may result in damage due to lack of lubrication. Inlet lines must be tight and free from air leaks; however, it may be necessary to crack a fitting on the outlet side of the pump to purge entrapped air.

Section V - SERVICE, INSPECTION AND MAINTENANCE

A. SERVICE TOOLS

No special tools are required to service these pumps.

B. INSPECTION

Periodic inspection of the fluid condition and tube or piping connections can save time-consuming breakdowns and unnecessary parts replacement. The following should be checked regularly.

1. All hydraulic connections must be kept tight. A loose connection in a pressure line will permit the fluid to leak out. If the fluid becomes so low as to uncover the inlet pipe opening in the reservoir, extensive damage to the pump may result. In suction or return lines, loose connections permit air to be drawn into the system, resulting in noisy and/or erratic operation.

2. Clean fluid is the best insurance for long service life. Therefore, the reservoir should be checked periodically for dirt or other contaminants. If the fluid becomes contaminated, the system should be thoroughly drained and the reservoir cleaned before new fluid is added.

3. Filter elements also should be checked and replaced periodically. A clogged filter element results in a higher pressure drop. This can force particles through the filter which would ordinarily be trapped, or can cause the bypass to open, resulting in a partial or complete loss of filtration.

4. A pump which is running excessively hot or noisy is a potential failure. Should a pump become noisy or overheated, the machine should be shutdown immediately and the cause of improper operation corrected.

C. ADDING FLUID TO THE SYSTEM

When hydraulic fluid is added to replenish the system, it should always be poured through a fine wire screen (200 mesh or finer). It is important that the fluid be clean and free of any substance which could cause any improper operation or wear of the pump or other hydraulic units. Therefore, the use of cloth to strain the fluid should be avoided to prevent lint from getting into the system.

D. ADJUSTMENTS

No periodic adjustments are required, other than to maintain proper shaft alignment or belt tension with the driving medium.

E. LUBRICATION

Internal lubrication is provided by the fluid in the system. Lubrication of the shaft couplings should be as specified by their manufacturers.

F. REPLACEMENT PARTS

Reliable operation throughout the specified operating range is assured only if genuine Vickers parts are used. Sophisticated design processes and materials are used in the manufacture of our parts. Substitutes may result in early failure. Part numbers are shown in the parts drawings listed in Table 1.

G. PRODUCT LIFE

The service life of this product is dependent upon environment, duty cycle, operating parameters and system cleanliness. Since these parameters vary from application to application, the ultimate user must determine and establish the periodic maintenance required to maximize life and detect potential component failure.

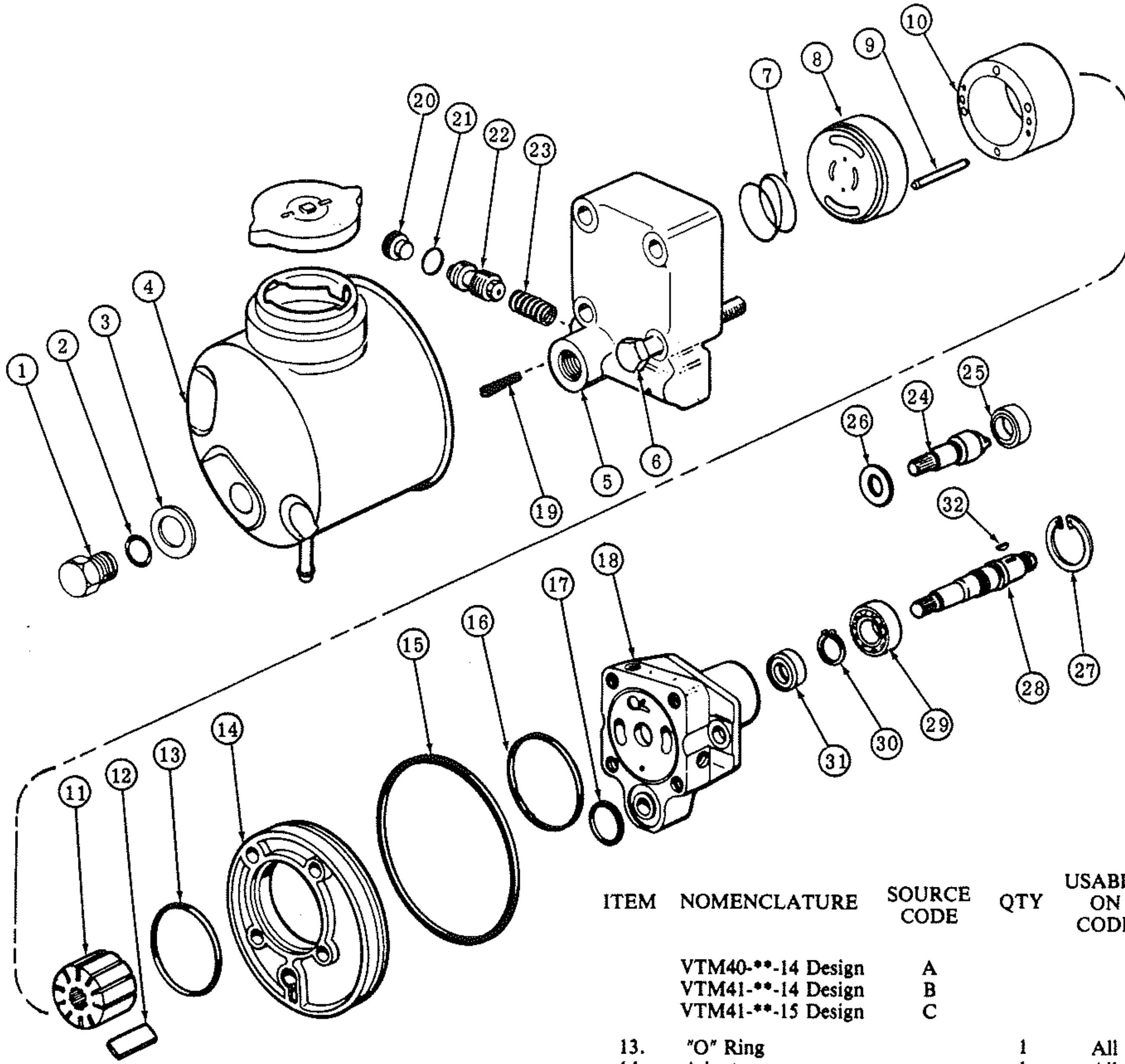
H. TROUBLESHOOTING

Table 3 lists the common difficulties experienced with power steering pumps and hydraulic systems. It also indicates the probable causes and remedies for each of the troubles listed.

It should always be remembered that many apparent pump failures are actually the failure of other components in the system. The cause of improper operation is best diagnosed with adequate testing equipment and thorough understanding of the complete hydraulic system.

Trouble	Probable Cause	Remedy
Pump not delivering fluid	Driven in wrong direction of rotation.	Check direction of pump shaft rotation.
	Pump drive shaft disengaged or sheared. Belt slipped or broken.	Remove pump; determine damage to cartridge parts (see disassembly instructions), replace sheared shaft and needed parts.
	Flow control valve stuck open.	Disassemble pump and wash control valve in a clean solvent. Return valve to its bore and slide it back and forth. No stickiness in movement should occur. If a gritty feeling is noted on the valve O.D., it may be polished with crocus cloth. Avoid removal of excess material or rounding of valve edges during this operation. Do not attempt to polish the valve bore. Wash all parts before reassembly of pump. Flush entire system thoroughly and fill with clean fluid.
	Vane or vanes stuck in rotor slots.	Disassemble pump, examine rotor slots for dirt, grime or small metal chips. Clean rotor and vanes in a good grade solvent (mineral spirits or kerosene). Reassemble parts and check for free vane movement.
	Fluid viscosity too heavy to pick up prime.	Use fluid of the proper viscosity as recommended in fluid data sheets.
	Pump intake partially blocked.	Drain system completely; flush to clear pump passages. Flush and refill system with clean fluid.
	Air vent for reservoir clogged or dirty strainer.	Remove filler cap and clean air vent slot. Check filter or strainer in reservoir for clogged condition. Drain, flush and add clean fluid to system if strainer was clogged.
Pump making noise	Restricted or partially clogged intake line or clogged filter.	Pump must receive intake fluid freely or cavitation will result. Drain system and clean intake line and strainers. Add new fluid and strain by recommended procedures.
	Air leak at pump intake piping joints or pump shaft seal.	Test by pouring fluid on joints and around drive shaft. Listen for change in operation. Tighten joints affected and replace pump drive shaft seal according to service instructions outlined in this manual.
	Coupling misalignment.	Realign and replace shaft seal and bearings if damaged by shaft misalignment.
	Reservoir or manifold seal leakage.	Leakage between manifold or reservoir at replenishing hole due to "O" ring damage. The reservoir inlet tube to pump cover "O" ring should be carefully examined for damage such as cuts, nicks or dirt.

Table 3. Troubleshooting Chart



ITEM	NOMENCLATURE	SOURCE CODE	QTY	USABLE ON CODE
	VTM40-**-14 Design	A		
	VTM41-**-14 Design	B		
	VTM41-**-15 Design	C		
1.	Outlet Fitting		1	All
2.	"O" Ring		1	All
3.	Washer		1	All
4.	Reservoir S/A		1	All
5.	Screws		4	All
6.	Cover S/A		1	All
7.	Spring		1	All
8.	Pressure Plate		1	All
9.	Pins		2	All
10.	Ring		1	All
11.	Rotor		1	All
12.	Vane Kit (10 Vanes)		1	All

ITEM	NOMENCLATURE	SOURCE CODE	QTY	USABLE ON CODE
	VTM40-**-14 Design	A		
	VTM41-**-14 Design	B		
	VTM41-**-15 Design	C		
13.	"O" Ring		1	All
14.	Adapter		1	All
15.	Seal		1	All
16.	"O" Ring		1	All
17.	"O" Ring		1	All
18.	Body S/A		1	A
18.	Body S/A		1	B
18.	Body S/A		1	C
19.	Pin		1	All
20.	Plug		1	All
21.	"O" Ring		1	All
22.	Control Valve		1	All
23.	Spring		1	All
24.	Shaft		1	A
25.	Shaft Seal		1	A
26.	Washer		1	A
27.	Retaining Ring		1	B C
28.	Shaft (Woodruff Key)		1	B C
29.	Bearing		1	B C
30.	Retaining Ring		1	B C
31.	Shaft Seal		1	B C
32.	Woodruff Key		1	B C

Figure 7. VTM 40/41 Exploded View

A. GENERAL

During disassembly, pay particular attention to identification of parts for correct assembly. Figures 7 and 8 exploded views show the proper relationship of parts for disassembly and assembly.

WARNING
Before breaking a circuit connection, make certain that power is off and system pressure has been released. Lower all vertical cylinders, discharge accumulators and block any load whose movement could generate pressure. Plug all removed units and cap all lines to prevent the entry of dirt into the system.

A bearing puller must be used to remove the pulley or spur gear from shaft on indirect drive units to prevent damage to the pump. DO NOT hammer pulley or spur gear from shaft.

B. DISASSEMBLY

A clean work area is most essential for disassembly of the VTM series units. A work bench (6 foot), bench vise (6 inch), cleaning tank and shop air are also useful. Lay clean kraft paper on work bench for disassembled parts. Place parts in an orderly manner on the kraft paper to avoid mixing the parts during assembly. Discard the shaft seal, "O" rings and gaskets removed during disassembly.

1. VTM40 and VTM41 Pump Series Disassembly (Refer to Figure 7).

a. Drain reservoir and clamp pump mounting flange in a bench vise (cover end up), being certain to use protective jaws. To remove enclosed reservoir from the pump, simply remove the discharge fitting (1), "O" ring (2), washer (3) and free the reservoir (4) from the pump.

b. Remove four screws (5) from cover (6) and lift cover (6) from adapter plate (14). Remove spring (7) and pressure plate (8). Remove pins (9), cam ring (10), rotor (11), vanes (12), "O" ring (13), adapter plate (14) and "O" rings (15, 16 and 17) from body (18).

c. Clamp cover (6) into bench vise. Drive out retaining pin (19) with a pin punch. DO NOT allow the control valve plug (20), control valve S/A (22) and spring (23) to fall from the bore. If the plug (20) is not loose, work the plug loose, then remove from the bore. Remove the control valve (22) and spring (23) from the bore of cover (6).

NOTE
Access to the control valve plug and control valve S/A can be gained through the large chamfered hole which leads to the control valve bore from inside the cover.

2. VTM40 Shaft End Removal.

a. Clamp body (18) in bench vise. Remove shaft (24) by gently tapping end of shaft out through the mounting flange of body (18). Remove shaft seal (25) and spacer washer (26) from body (18). Order a new body subassembly (18) if bushing is found defective. The bushing is not field replaceable. Additional machining is required after installing the bushing into the body.

3. VTM41 Shaft End Removal

a. Clamp body (18) in the bench vise. Remove retaining ring (27). Gently tap end of drive shaft (28) out through the mounting flange of body (18). Bearing (29) and retaining ring (30) will be removed with the shaft. Remove shaft seal (31) from body (18). DO NOT remove bearing (29) from shaft (28) unless it is defective. The bearing is a press fit on the shaft and if removed, must be replaced with a new bearing.

This completes disassembly of the VTM40 and VTM41 series units. Wash all parts in clean solvent. Set aside for inspection.

4. VTM27, VTM28 and VTM42 Pump Series Disassembly (Refer to Figure 8).

a. Drain reservoir and clamp mounting flange of body (34) into a bench vise with reservoir up. Remove wing nut (1), washer (2), seal washer (3) and reservoir cover (4).

NOTE
Look into the reservoir. You can have any one of three different arrangements within the reservoir. The "filter option", the "inlet strainer" or the "standard reservoir" with an inlet baffling arrangement.

b. Removal of the "filter option"—Remove cotter pin (5), washer (6), spring (7), retainer (8) and filter element (9) from the reservoir.

c. Removal of the "inlet strainer option"—Remove screw (18) and strainer (19) from the reservoir.

d. Removal of the "standard reservoir" with inlet baffling arrangement—Remove screw (16) and baffle (17). Loosen nut (10) at the bottom of the stud (11). Thread the stud and nut from the cover. Lift out return line baffle (12) and plate (13), then separate reservoir (14) and gasket (15) from cover subassembly (25).

NOTE
Manifolds are used in place of reservoirs on some models of the VTM27, VTM28 and VTM42 series. If the model code contains the letters (M*), a manifold is used. Refer to model code breakdown, Table 2, for manifold type and reservoir size identifications.

CAUTION
To prevent excessive heat generation in "MB" and "MF" models, plumb the bypass connection to the reservoir below the fluid level. If the relief valve is in operation in excess of fifteen (15) seconds without a bypass connection, excessive heat will be generated across the relief valve.

e. To remove a manifold subassembly—Clamp mounting flange of body in the bench vise. Make certain protective jaws are used. Remove three screws (20), copper washer (21), manifold (22) and gasket (23) from cover (25).

f. Remove four screws (24) from cover (25). Separate cover (25) from body (34). Remove spring (26) and pressure plate (27) from the body. Remove cam ring (28), pins (29), rotor (30), vanes (31) and two "O" rings (32 and 33) from body (34).

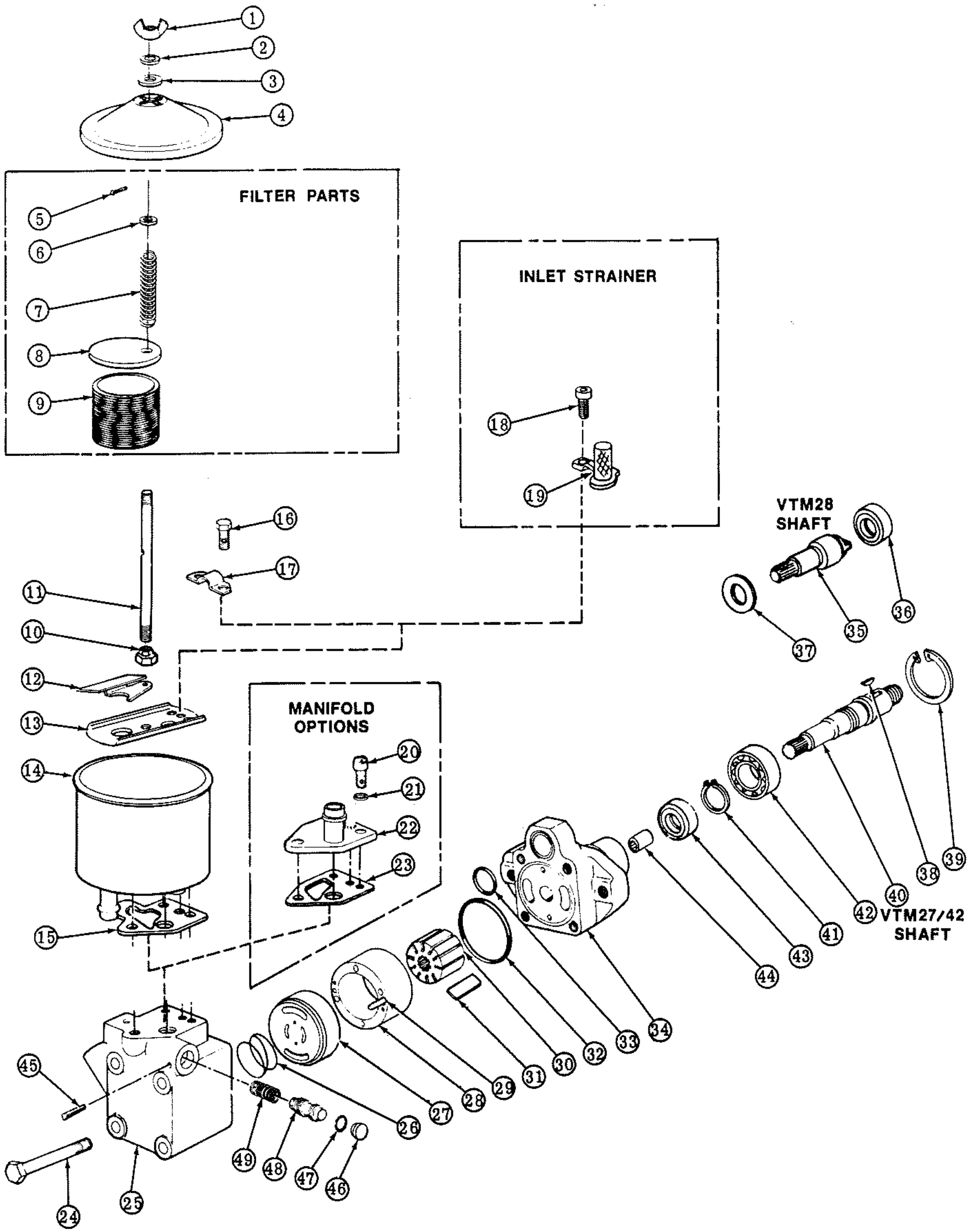


Figure 8. VTM 27/28/42 Exploded View

ITEM	NOMENCLATURE	SOURCE CODE	QUANTITY	USABLE ON CODE
	VTM27-07/11-13	A		
	VTM27-M*-14	B		
	VTM28-07/11-14	C		
	VTM28-M*-14	D		
	VTM42-07/11-14	E		
	VTM42-M*-14	F		
	VTM**-(F)-14	G		
	VTM**-(S)-14	H		
1.	Wing Nut		1	All
2.	Washer		1	All
3.	Seal Washer		1	All
4.	Reservoir Cover		1	All
5.	Cotter Pin		1	G
6.	Washer		1	G
7.	Spring		1	G
8.	Retainer		1	G
9.	Filter Element		1	G
10.	Stud		1	A C E G H
11.	Nut		1	A C E G H
12.	Return Line Baffle		1	A C E G
13.	Reinforcing Plate		1	A C E G H
14.	Reservoir		1	A C E G H
15.	Gasket		1	A C E G H
16.	Screw		1	A C E G
17.	Baffle		1	A C E G
18.	Screw		1	A C E H
19.	Strainer		1	A C E H
20.	Screw		3	B D F
21.	Washer		1	B D F
22.	Manifold		1	B D F
23.	Gasket		1	B D F
24.	Screws		4	All
25.	Cover S/A		1	All
26.	Spring		1	All
27.	Pressure Plate		1	All
28.	Cam Ring		1	All
29.	Pins		2	All
30.	Rotor		1	All
31.	Vane Kit (10 Vanes)		1	All
32.	"O" Ring		1	All
33.	"O" Ring		1	All
34.	Body S/A Kit		1	C D G G
34.	Body S/A Kit		1	E F G H
35.	Shaft		1	C D G H
36.	Shaft Seal		1	C D G H
37.	Washer		1	C D G H
38.	Woodruff Key		1	A B E F G H
39.	Retaining Ring		1	A B E F G H
40.	Shaft		1	A B E F G H
41.	Retaining Ring		1	A B E F G H
42.	Bearing		1	A B E F G H
43.	Shaft Seal		1	A B E F G H
44.	Pin Bearing		1	All
45.	Pin		1	All
46.	Plug		1	All
47.	"O" Ring		1	All
48.	Control Valve S/A		1	All
49.	Spring		1	All

g. To disassemble the control valve for the VTM27, VTM28 and VTM42 series—Place cover (25) in a bench vise. Follow procedure as outlined in 1.c. for the VTM40/41 series.

NOTE

-10 design VTM27 replacement bodies are no longer available from Vickers for service. Service the VTM27 with a VTM42 body subassembly kit. Refer to parts drawing noted in Table 1 for replacement kit information. The VTM27 is rated at 1500 PSI and the VTM42 at 2000 PSI. The increased pressure capability of the VTM42 is due to an extra bearing pressed into the body subassembly and located near the cartridge. The bearing provides added support of the shaft during high pressure operation. Be sure to restamp the nameplate of the pump to reflect VTM42 when the modification is completed.

h. VTM28 shaft end disassembly—Remove shaft (35), shaft seal (36) and spacer (37) from body subassembly (34). If the bushing located in the body subassembly is defective, order a new body subassembly. Installation of the bushing requires added machining.

i. VTM27 and VTM42 shaft end disassembly—Remove retaining ring (39) which holds bearing (42) within body (34). Press shaft (40) and bearing (42) from the body as a subassembly. DO NOT remove retaining ring (41) from shaft (40) unless bearing (42) is defective. The inner bearing (44) and shaft seal (43) are a press fit to the body. If defective, use a pin punch and hammer to tap them from body (34). Remove shaft key (38) from shaft (40).

This completes disassembly of the VTM27, VTM28 and VTM42 series units. Wash all parts in clean solvent. Set aside for inspection.

C. INSPECTION AND REPAIR

CLEANING—All parts must be thoroughly cleaned and kept clean during inspection and assembly. The close tolerances of the parts makes this requirement more stringent than usual. Clean all removed parts using a commercial solvent that is compatible with the system fluid. Compressed air may be used in cleaning, but it must be filtered to remove water and contamination. Clean compressed air is particularly useful in cleaning spools, orifices and cover passages.

1. Discard the used shaft seal and all "O" rings. Wash the metal parts in a solvent, blow them dry with filtered compresed air and place them on a clean surface for inspection.

2. Check the wearing parts of the body, pressure plate, cam ring and rotor for scoring and wear. Replace scored or badly worn parts.

3. Inspect the vanes for burrs, wear and excessive play in the rotor slots. Replace the vanes and rotor if the slots are worn. If you can feel side movement of the vanes in the rotor slots, the slots are worn.

4. Check the bearings for wear and looseness. Rotate the bearings while applying pressure to check for pitted or cracked races. Replace all defective bearings with new ones. VTM27, VTM41 and VTM42 bearings must be replaced if removed.

5. Inspect the shaft seal mating surface on the shaft for scoring and wear. If marks on the shaft cannot be removed by light polishing, replace the shaft.

6. Stone all mating surfaces of body and cover with an Arkansas stone to remove burrs and sharp edges. Wash and blow dry after stoning.

7. Lubricate and insert control valve S/A into its bore within the cover. NO BINDING can be tolerated. Rotate the control valve S/A through 360° while moving in and out of the bore to test for bind. Check the valve for wear and replace if worn or the lands are scratched.

8. Inspect the valve plug torque as follows:

a. Refer to Figure 9 and place the control valve S/A in a bench vise. Tighten the vise enough to prevent the plunger from turning. DO NOT HOLD PLUNGER IN VISE BY THE LARGE LANDS.

b. Use a torque wrench and appropriate socket to check the torque of the control valve seat plug. The plug should be torqued to a value of 5-6 lb. ft.

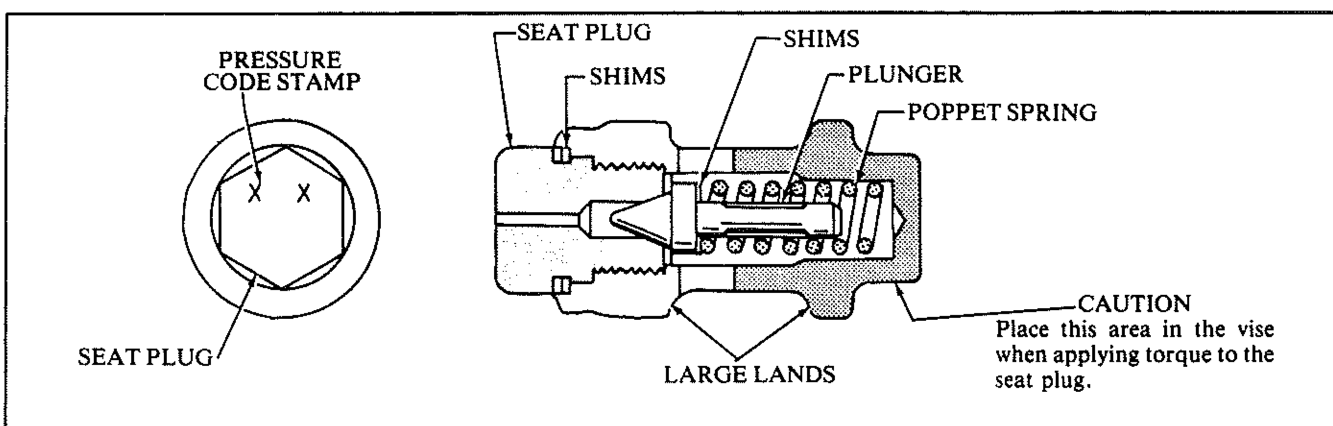


Figure 9. Sectional View of Flow Control Relief Valve S/A

D. ASSEMBLY

NOTE
Immerse all parts in clean hydraulic fluid to facilitate assembly. Refer to Figures 7 or 8 as noted in the following steps.

NOTE
Tools for installing needle bearings can be made from round tubular stock. The outside diameter of the round stock must be slightly smaller than the outside diameter of the bearing to be installed.

1. VTM27, VTM41 and VTM42 Shaft End Assembly.

a. If the needle bearing (44) was found defective during inspection, a new bearing must be pressed into body subassembly (34). Manufacture a needle bearing pressing tool as noted above and press a new bearing in place with an arbor press. The needle bearing must not be misaligned during press or the bearing will be damaged. DO NOT bottom out the needle bearing in its bore with excessive force. Check the rotor running surface of body subassembly (34) to be flat following assembly of the needle bearing.

NOTE
A shaft seal driver must be used to insure installation of the shaft seal without damage. A length of tubular round stock should be machined to proper dimensions. The ends must be square. The outside diameter of the driver should be slightly smaller than the outside diameter of the shaft seal. The inside diameter should be slightly larger then the shaft seal surface of the shaft. The length of the driver should be long enough to press the seal fully in against the shoulder.

b. Manufacture a shaft seal driver as noted above. Refer to Figures 7 and 8 and position shaft seal (43 or 31) with spring side of seal facing body. Press seal in place until it engages the shoulder within the body. This shoulder acts as a positive stop for the shaft seal. DO NOT overpress as damage to the shaft seal will result.

c. If the outer bearing was found defective during inspection and was removed from the shaft, press a new bearing (42 or 29) on shaft (40 or 28) using an arbor press. DO NOT exert pressing force against the outer race of the bearing. All force should be applied to the inner race of the bearing with a piece of tubing or other device.

d. Install the small retaining ring (41 or 30) in place within its groove on the shaft. The sharp break edge of the retaining ring must be facing the bearing at assembly.

e. Lubricate the shaft with system fluid and slide the shaft assembly into body subassembly (34 or 18). BE CAREFUL not to damage shaft seal (43 or 31) during installation.

f. Install large retaining ring (39 or 27) into retaining ring groove of body subassembly (34 or 18). This retaining ring holds the bearing and shaft in place within the body subassembly.

g. Insert woodruff key (38 or 32) into shaft (40 or 28), tap in place with a small hammer to seat the key.

NOTE
VTM28 and VTM40 units with a motor mount option arrangement use the same body subassembly. The shaft bushing located within the body subassembly is not field serviceable. Additional machining is required to fit the bushing to the shaft at assembly. Vickers recommends the complete body subassembly be replaced if a bushing is defective.

2. VTM28 and VTM40 Shaft End Assembly - Refer to Figure 7 for VTM40 and Figure 8 for VTM28.

a. Place spacer washer (37 or 26) over spline end of shaft (35 or 24), then insert shaft into body subassembly (34 or 18). BE CAREFUL not to damage the bushing.

b. Using a shaft seal driver, press shaft seal (36 or 25) over shaft and into body (34 or 18). The spring side of the shaft seal must face into body. The seal should be bottomed against the shoulder of the body at end of press.

3. Assemble the VTM27, VTM28 and VTM42 pump as follows: Refer to Figure 8.

a. Install body (34) mounting flange into the bench vise with shaft end down.

b. Obtain a seal kit for the unit. Seal kits are listed in the parts drawings tabulated in Table 1.

c. Lubricate and install "O" rings (33 and 32) into grooves as shown in Figure 8.

d. Insert vanes (31) into rotor (30) with radius edge toward the cam ring. Use an arkansas stone on each vane edge and on each rotor edge to remove burrs developed during handling. Make sure the vanes do not bind within the rotor. Lubricate and place the rotor and vanes on top of body (34) with the rotor counter-bore toward body (34).

e. Insert pins (29) through cam ring (28) and place the cam ring over rotor and vanes. Check the model code for direction of rotation and position arrow on the cam ring to agree with model code (R - clockwise, L - counterclockwise as viewed from the shaft end).

f. Install pressure plate (27) over pins and up against the cam ring, rotor and vanes.

g. Place spring (26) on top of pressure plate (27), then install cover (25) over spring. Line up cover screw holes with body (34), thread four screws (24) through cover and into body (34). Cross torque screws to 34-41 N.m (25-30 lb. ft.).

h. Insert spring (49) into control valve bore of cover (34).

WARNING
In the following step if the the flow control relief valve S/A is reversed in the cover bore, the unit will malfunction and pressure will rise dangerously high. Make sure that you follow instructions exactly as noted.

i. Install flow control relief valve (48) with the hex head going first into the bore. The hex headed seat plug (Figure 9) must be located within spring (49). Install a new "O" ring (47) on plug (46) and slide the plug into cover. Press plug fully in and insert tapered pin (45) to retain the plug in place. Tap the tapered pin in to lock in place.

NOTE

Covers with control flows from 1.5 to 7.5 USGPM exist in these models. The difference between covers being the flow control orifice. -10 design covers use a threaded orifice plug in the outlet port. -12 and -14 design units do not use an orifice plug; instead, the control flow orifice is drilled into each cover's outlet port. To determine which cover you have, refer to the boss just above the outlet port for a three digit number. Table 4 is a cross reference between this three digit cover number and the model code. See Table 2 for the model code.

Model Designation	Three digit number stamped into boss located above outlet port.
VTM**-**-15-**-**-**-14	113
VTM**-**-20-**-**-**-14	125
VTM**-**-25-**-**-**-14	136
VTM**-**-30-**-**-**-14	149
VTM**-**-35-**-**-**-14	161
VTM**-**-40-**-**-**-14	169
VTM**-**-45-**-**-**-14	185
VTM**-**-50-**-**-**-14	193
VTM**-**-55-**-**-**-14	204
VTM**-**-60-**-**-**-14	213
VTM**-**-65-**-**-**-14	221
VTM**-**-75-**-**-**-14	238

Table 4. Model Code Verses Cover Number

4. Install manifold as shown on Figure 8.

NOTE

Many different manifolds are available from Vickers. These manifolds are listed on the parts drawings and installation drawings shown in Table 1.

a. Install gasket (23) as shown in Figure 8. Locate gasket on top of cover mounting surface.

b. Place manifold (22) over gasket (23) and align holes to cover.

c. Install copper washer (21) over screw (20) as shown and thread screw (20) into cover at location shown in Figure 8. Then, thead the other two screws (20) through the manifold into the cover. Cross torque screws to 10-11 N.m (90-100 lb.in.).

5. Install reservoir with optional return line baffle as follows:

a. Install gasket (15) as shown in Figure 8. Locate gasket on top of cover mounting face.

b. Set reservoir (14) over gasket (15) with return tube located at back of cover.

c. Place reinforcing plate (13) within reservoir with bent edges of plate pointing upward. Align hole in plate to holes in reservoir and threaded hole in cover.

d. Position return line baffle (12) over end of stud (11). Make sure nut (10) is located on the stud. Thread the stud through reinforcing plate (13), reservoir (14) and into cover (25) approximately 3/8 inch.

e. Position baffle (17) as shown in Figure 8 and secure in place with screws (16). Torque screws (16) and nut (10) to 10-11 N.m (90-100 lb. in.).

f. Install reservoir cover (4), seal washer (3), washer (2) and wing nut (1). This completes installation of the return line baffle option.

6. Install reservoir with inlet strainer option as follows:

a. Refer back to step "5" and perform "a" through "d".

b. Position strainer (19) as shown on Figure 8. Insert screws (18) through strainer and into reservoir. Thread strainer in place over the inlet opening of the pump. Torque screws (18) to 10-11 N.m (90-100 lb. in.).

c. Perform step "5f". This completes installation of the inlet strainer option.

7. Install reservoir filter option as follows:

a. Refer back to step "5" and perform "a" through "c".

b. Perform step "5d" except do not install item (12) the return line baffle.

c. Perform step "5e".

d. Install filter (9), retainer (8), spring (7), washer (6) and cotter pin (5) as shown in Figure 8.

e. Install reservoir cover (4), seal washer (3), washer (2) and wing nut (1). This completes installation of the reservoir filter option.

8. Assemble the VTM40 and VTM41 pump as follows: (Refer to Figure 7)

a. Install the flange of body subassembly (18) into a bench vise with the shaft pointing down.

b. Obtain a seal kit for the unit. Seal kits are listed in the parts drawings tabulated in Table 1.

c. Lubricate and install "O" rings (17 and 16) into grooves of body (18) as shown in Figure 7.

d. Insert vanes (12) into rotor (11) with radius edge toward the cam ring. Use an arkansas stone on each vane edge and on each rotor edge to remove burrs developed during handling. Make sure the vanes do not bind within the rotor. Lubricate and place the rotor and vanes on top of body (18) with the rotor counter-bore toward body.

e. Insert pins (9) through cam ring (10) and place the cam ring over rotor and vanes. Check the model code for direction of rotation and position arrow on the cam ring to agree with model code (R - clockwise, L - counterclockwise as viewed from the shaft end).

f. Lubricate and install reservoir seal (15) into groove of adapter (14). Place adapter (14) over cam ring (10) and up against body (18). Align holes of adapter with holes in the body.

g. Slide "O" ring (13) over cam ring (10) and into groove of adapter (14).

h. Place pressure plate (8) over pins (9) and up against the cam ring, rotor and vanes.

i. Place spring (7) on top of pressure plate (8), then install cover (6) over spring. Line up cover screw holes with adapter and body. Thread screws (5) through the cover, adapter and into body. Cross torque the screws to 34-41 N.m (25-30 lb. ft.).

j. Insert spring (23) into control valve bore of cover (6).

NOTE

Covers with control flows from 1.5 to 7.5 USGPM exist in these models. The difference between covers being the flow control orifice. -10 design covers use a threaded orifice plug in the outlet port. -12 and -14 design units do not use an orifice plug; instead, the control flow orifice is drilled into each cover's outlet port. To determine which cover you have, refer to the boss located at the edge of the cover for a three digit number. Table 4 is a cross reference between this three digit cover number and the model code. See Table 2 for the model code.

WARNING

In the following step if the flow control relief valve S/A is reversed in the cover bore, the unit will malfunction and pressure will rise dangerously high. Make sure that you follow instructions exactly as noted.

k. Install flow control relief valve (22) with the hex head going first into the bore. The hex headed seat plug (Figure 9) must be located within spring (23). Install a new "O" ring (21) on plug (20) and slide the plug into cover. Press plug fully in and insert tapered pin (19) to retain the plug in place. Tap the tapered pin in to lock in place.

l. Lubricate the outside of reservoir seal (15) and slide reservoir (4) over the seal and into place against cover (6). Make sure outlet hole in reservoir is aligned with the outlet hole in the cover.

m. Install "O" ring (2) and washer (3) over outlet fitting (1) and thread outlet fitting into body (6). Make sure the outlet fitting seals against the reservoir. This completes the assembly of the VTM40 and 41 pump.

Section VII - TEST

If a test stand is available, the pump should be tested to the specifications noted in the installation drawings (see Table 1).

If testing facilities are not available, test operation of the unit by replacing it on the machine. A WORD OF CAUTION: Make sure the machines hydraulic system is drained, flushed and clean before installation of the rebuilt pump. Metallic debris of any type in the fluid will destroy the pump.

LITHO IN U.S.A.

16

SUSPENSION

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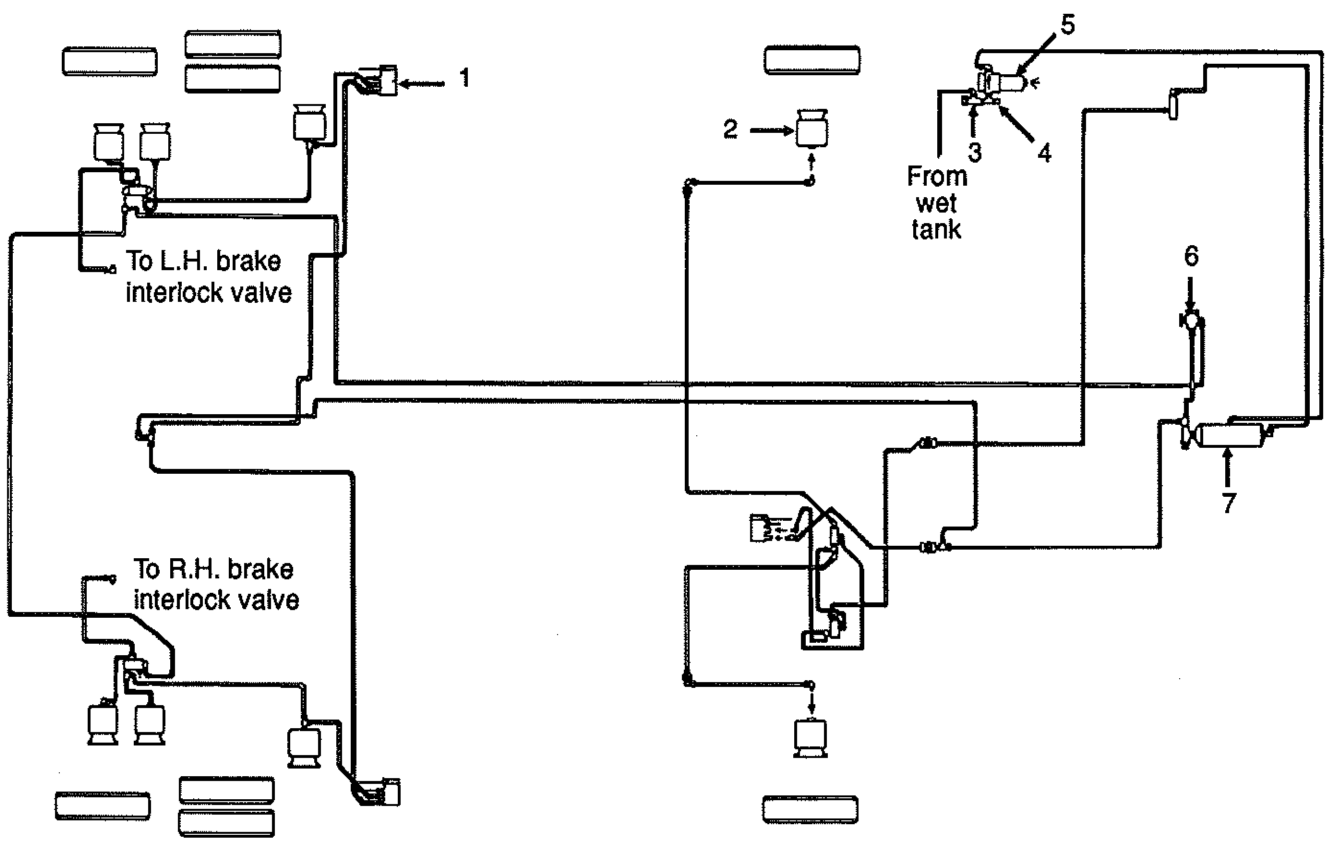
DESCRIPTION

The vehicle is provided with an air suspension system. The system consists of air springs, height control valves, radius rods, sway bar and shock absorbers. The system operation is fully automatic and maintains a constant vehicle height regardless of load, or load distribution. The *"rolling lobe"* type air springs are made from a special compound rubber molded to the proper contour and dimensions. The entire vertical load of the vehicle is supported by these springs. Each of the three axles is provided with identical size of air springs, which are attached to the subframe and to the axles.

Radius rods are used to secure the axles in the proper transversal and longitudinal positions. Five radius rods are provided on the front axle suspension (four longitudinal and one transversal), four on the drive axle suspension (three longitudinal and one transversal) and also four on the tag axle with a layout similar to the drive axle. Refer to figures 2 and 3 for details. These rods transmit both braking and driving forces from the axles to the vehicle body.

Double-action, telescoping-type shock absorbers ensure a smooth ride and enhance vehicle stability on the road. All shock absorbers are eye-type mountings. The front and tag axles are each provided with two shock absorbers while the drive axle is provided with four shock absorbers. Yet, V.I.P. model uses the same type of shock absorber on all axles, while the coach is provided with a firmer type on front axle (refer to heading *"Shock absorber installation"* for more details, later in this section).

A sway bar is provided on the front axle to control lateral motion, thus increasing vehicle stability.



1. Height control valve
2. Air spring
3. Pressure protection valve (PR-2)
4. Accessory air tank fill valve
5. Accessory air filter
6. Tag axle control valve
7. Accessory air tank

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FIG. 1 - Pneumatic suspension component locations (without optional front kneeling)

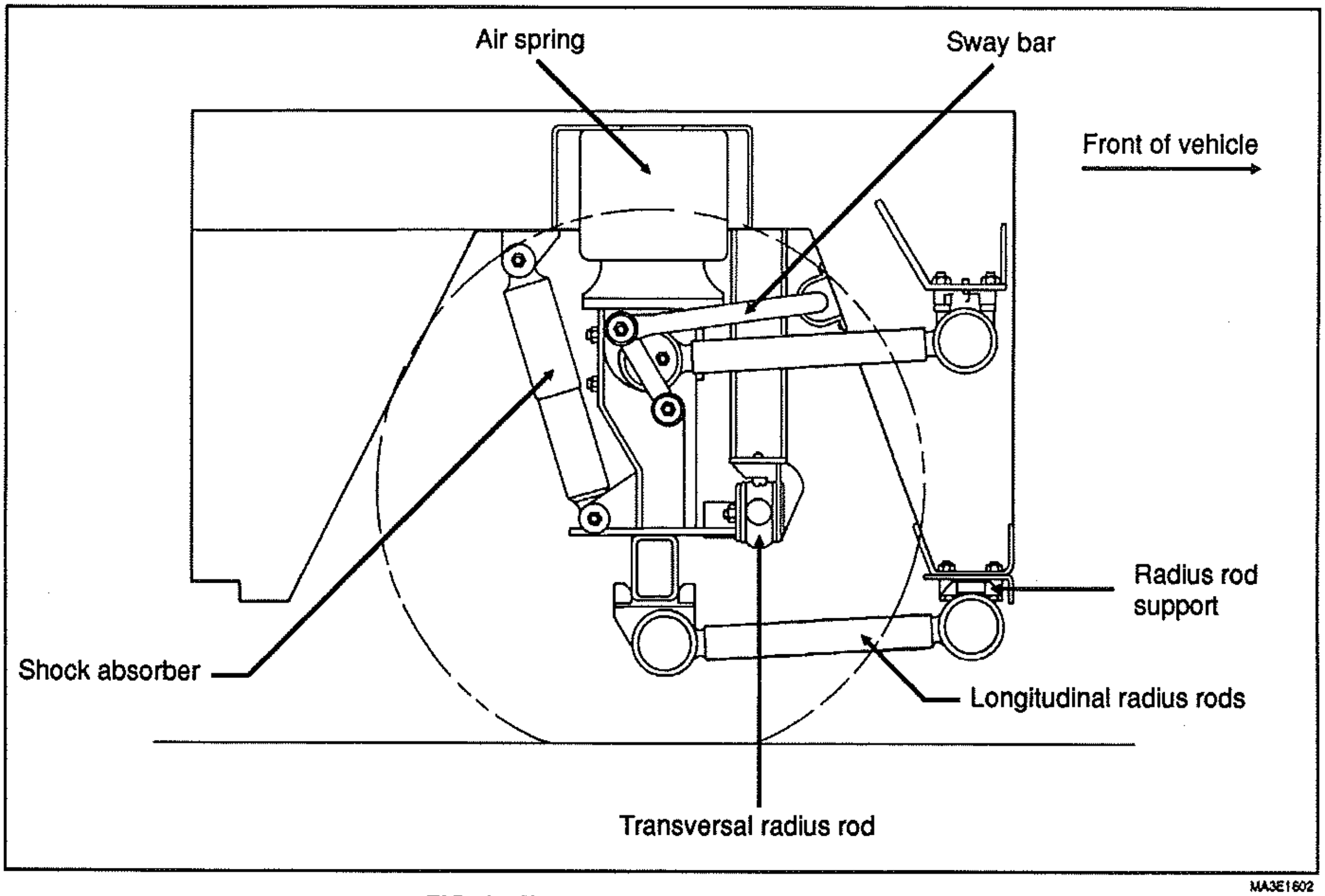

FIG. 2 - Front suspension components

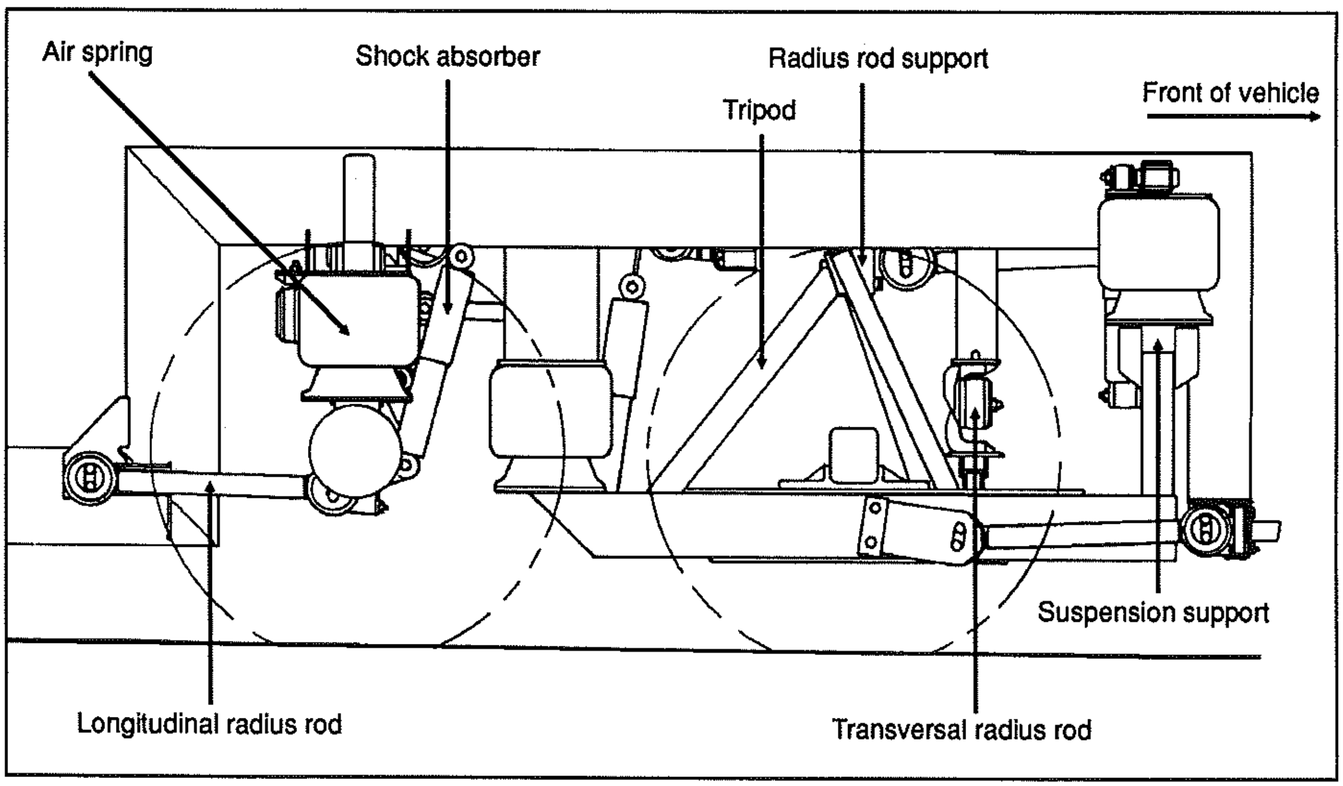

FIG. 3 - Rear suspension components

Delay-type height control valves increase or decrease the air pressure in the suspension system as required. One height control valve is located at center of front axle, and regulates air to front axle air springs in order to maintain the vehicle to the required height. Two are located at the drive axle, one on each inner side of front wheelhouse (see fig. 4 and 5).

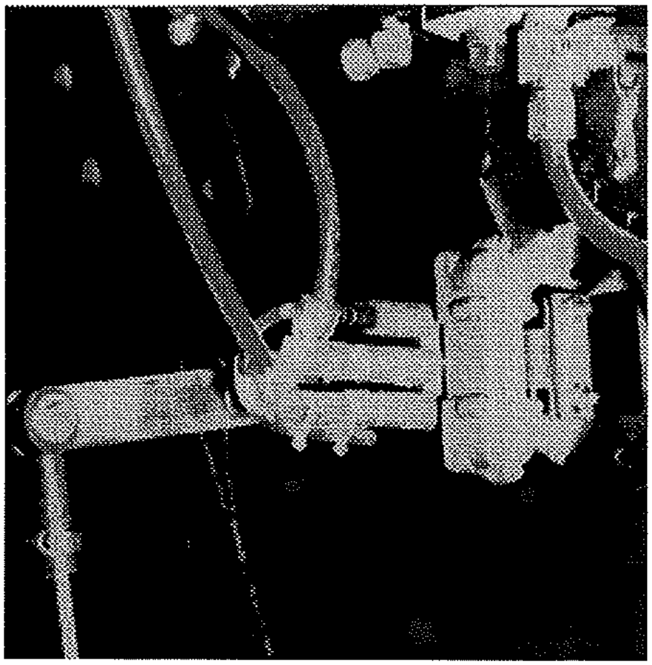

FIG. 4 - Front suspension height control valve installation

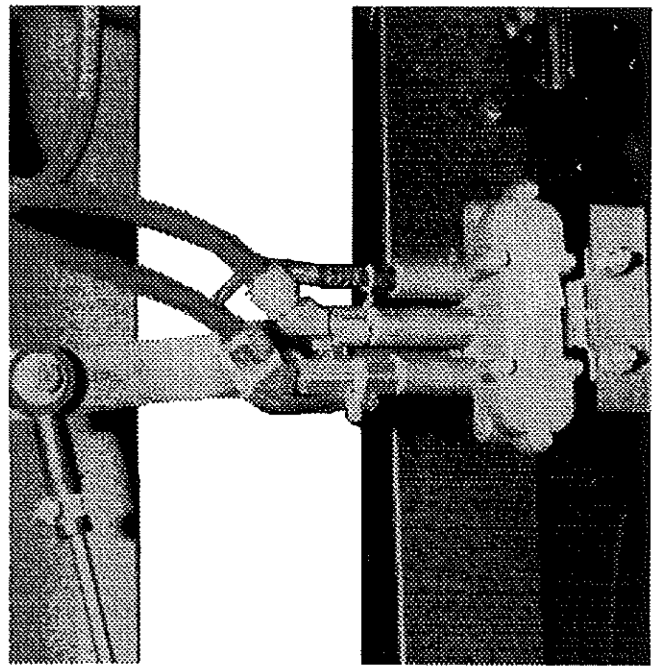

FIG. 5 - Rear suspension height control valve installation

AIR SPRING MAINTENANCE

Air spring removal

NOTE: Suspension air springs (front, drive, and tag axles) can be removed without removing the entire axle assembly.

1. Raise and block the vehicle body on axle which has the defective air spring, according to the procedure outlined under *"Axle removal and replacement"* in the proper section.

2. If system is under pressure, disconnect the height control valve link and pull down the overtravel lever to exhaust air from the air spring.

NOTE: When proceeding with this step, do not change the height control valve overtravel lever adjustment.

3. When air is exhausted, disconnect the air line from the air spring by unscrewing the fitting on top of air spring.

4. At top of air spring, remove the two nuts and washers from the studs which secure the air spring to the subframe.

5. Remove the two air spring lower nuts from suspension support, then the air spring.

Air spring disassembly

WARNING: Use tool #19-0002 to disassemble air spring (see fig. 6).

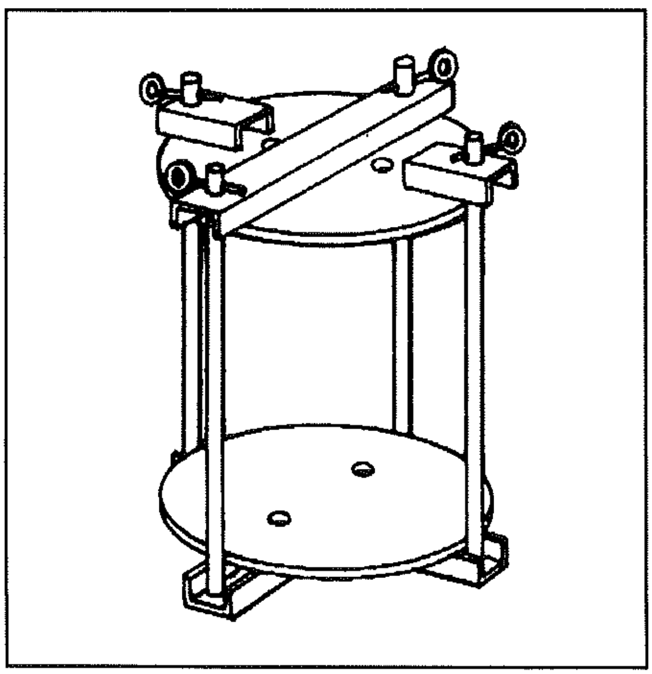

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FIG. 6 - Tool #19-0002

1. Install the air spring as shown, and slowly add air pressure through the fitting in the upper retainer plate. This will disassemble the lower retainer from the bellows (see fig. 7 and 8).

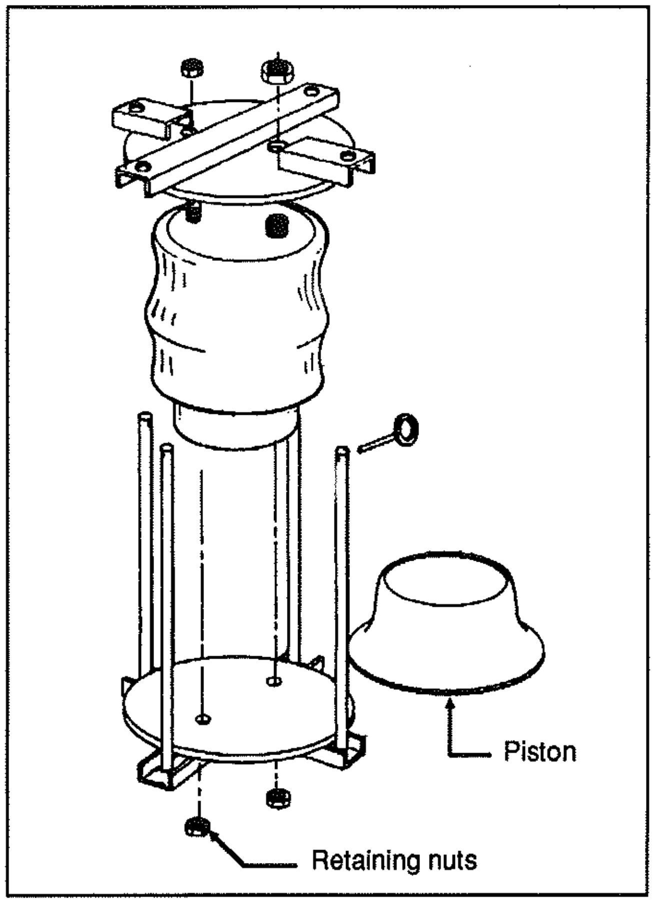

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FIG. 7

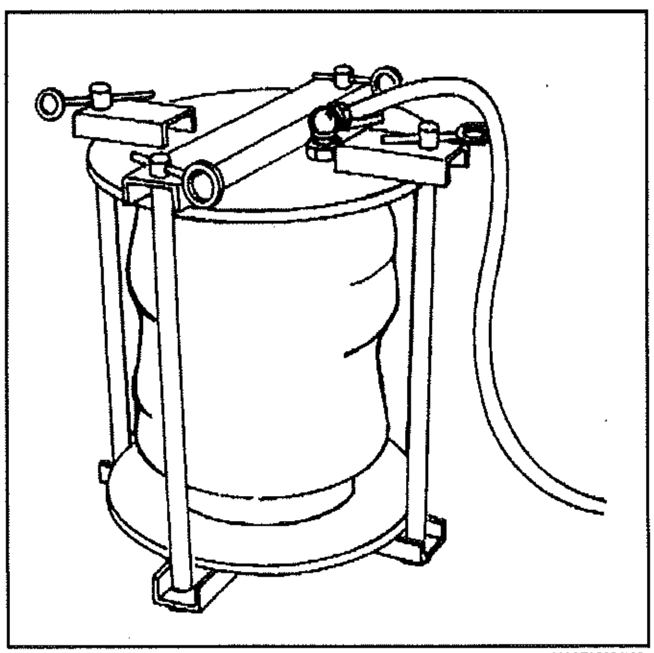

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FIG. 8

2. Remove air spring from tool #19-0002.

3. Proceed with the removal of the upper retainer. Use a rubber hammer and tap on the upper retainer until it is loosened from the bellows bead (see fig. 9).

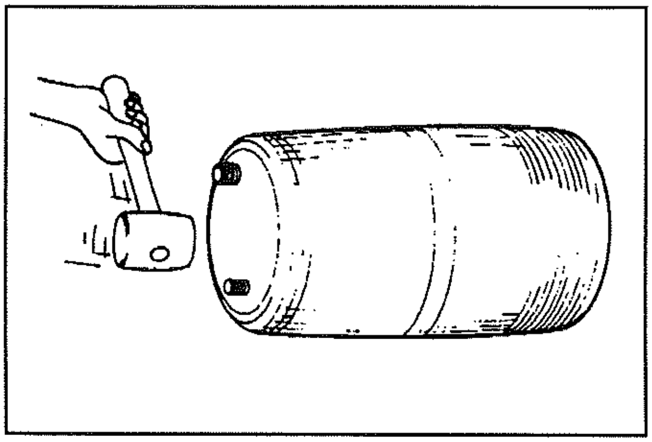

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FIG. 9

4. Rotate upper retainer in order to align its two (2) flat surfaces with the wall of bellows, then press on it to elongate the opening and remove the upper retainer by pulling it out (see fig. 10).

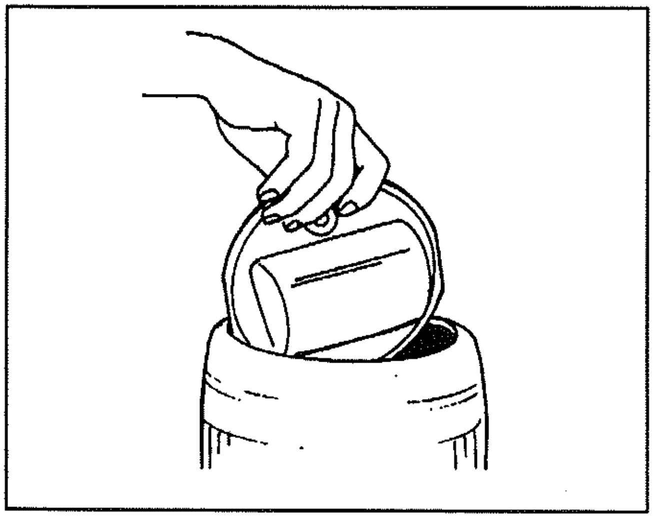

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FIG. 10

5. Apply liquid soap or glycerine to the lower retainer surface at the point of contact with the bellows. Force a screwdriver between the bellows bead and the retainer to allow the fluid to lubricate the bead.

6. When bead is loosened around the entire surface of the lower retainer, the retainer can be forced into the bellows and removed through the upper opening (see fig. 11).

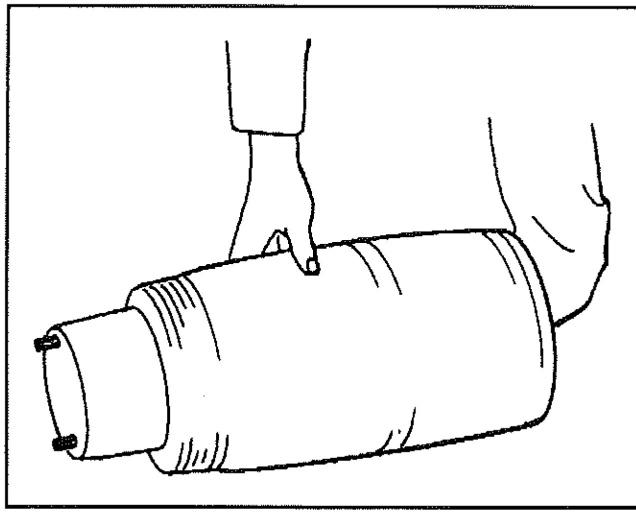

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FIG. 11

Air spring inspection

1. Clean bellows and bellows bead plates thoroughly.

2. Inspect bellows inside and out for evidence of cracks, punctures, deterioration, or chafing. Replace the bellows if any damage is evident.

3. Inspect the lower and upper bellows bead plates and the piston for dents, cracks, burrs or other damage that could cause air leaks. All surfaces contacting the bellows must be smooth to prevent damage to the bellows.

4. Check mounting studs on bead plates for damaged or stripped threads. Threads on fitting holes should be in good condition.

NOTE: Bellows can be lightly inflated and submerged in water to detect any leakage. If any leakage is detected between bellows and bead plates, or in the rubber section, replace the bellows assembly.

WARNING: To prevent personal injury, do not apply more than 10 psi (69 kPa) air pressure with the air spring unmounted.

Air spring reassembly

1. Install the lower retainer through the upper opening of the bellows and position it in the lower opening, seating it as nearly as possible by hand.

NOTE: The use of silicone lubricant is recommended to ease this procedure, and we suggest that you apply a slight pressure on the lower retainer to ensure its complete seating in the bellows skirt.

2. Apply silicone lubricant at top of the skirt, then press the bellows to elongate the opening and insert the upper retainer into the bellows. Position the upper retainer so that the bead will seat when air is applied (see fig. 12).

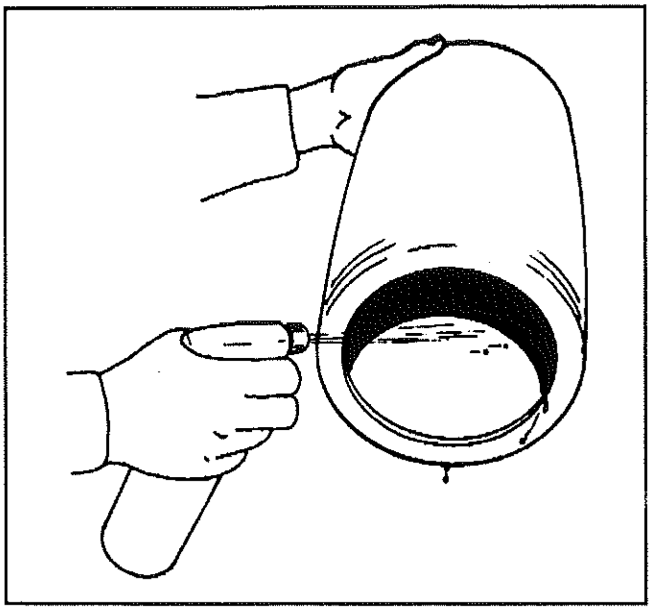

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FIG. 12

CAUTION: Ensure the upper and lower studs and nuts are positioned 90° apart, i.e top studs must be perpendicular to bottom studs.

3. Slowly apply air (10 psi/69 kPa) through the opening in the upper retainer stud to properly seat the lower and upper retainers in the bellows.

4. Release the pressure from the air spring, then place partially assembled air spring on the piston (see fig. 13).

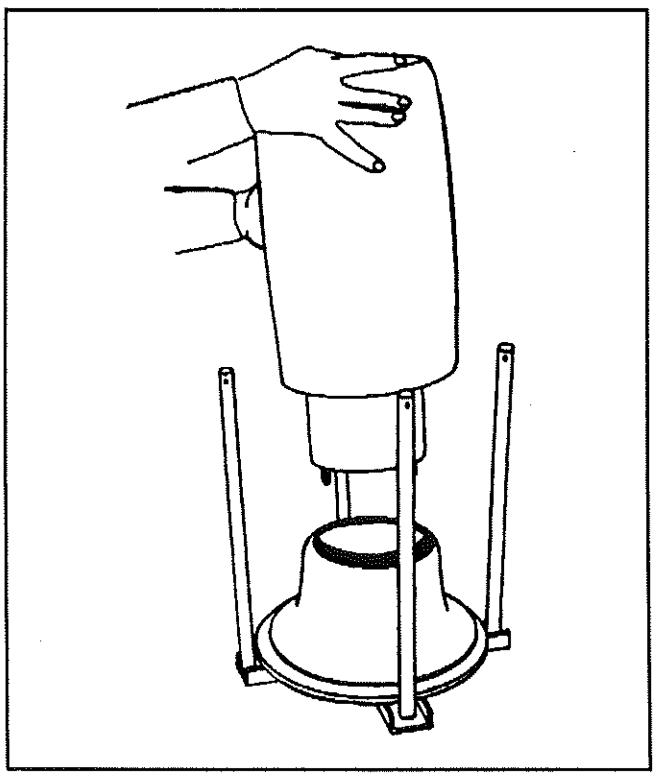

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FIG. 13

5. Use tool #19-0002, place the bellows inside the tool and apply air pressure (90 psi/620 kPa) in order to seat the bellows assembly components (see fig. 14, 15 and 16).

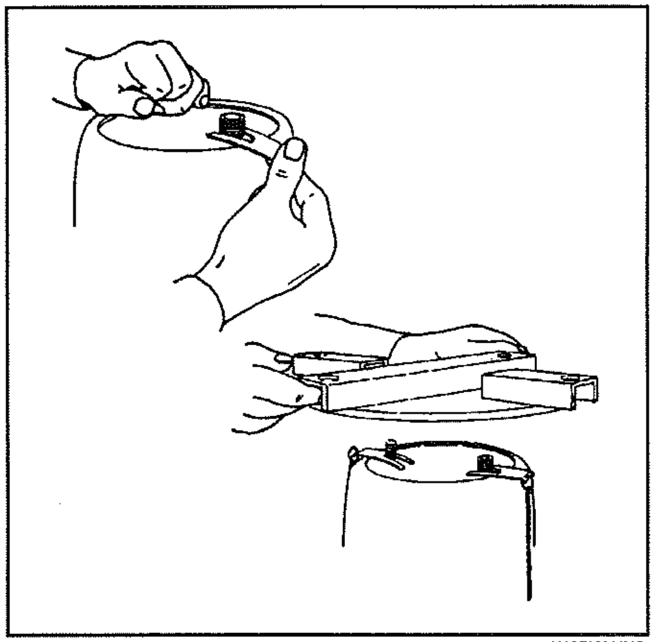

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FIG. 14

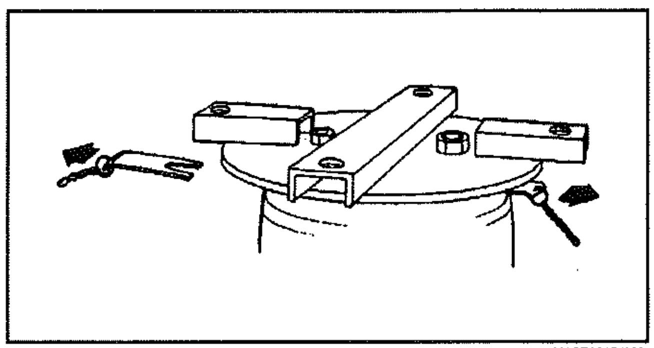

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FIG. 15

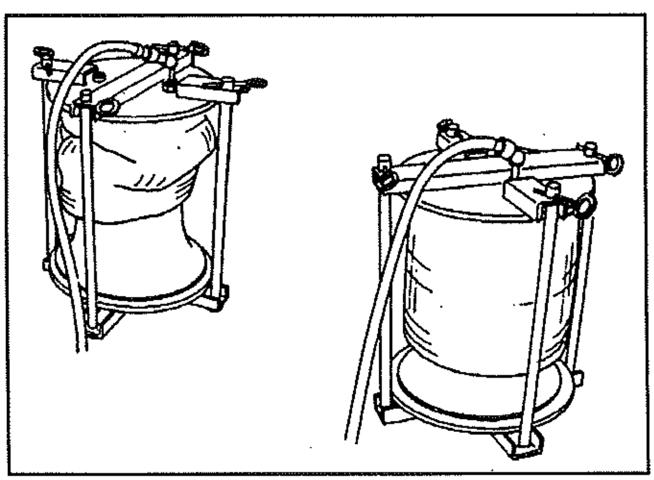

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FIG. 16

6. Remove bellows from tool #19-0002, then roll it down over the piston by placing a thumb over the air fitting, and while pressing down on the bellows with the palm of the hands, allow air to slowly escape from under the thumb.

CAUTION: Be careful not to dislodge the upper retainer from the bellows during this operation.

Air spring installation

1. Compress the air spring assembly, then place the rubber pad on top of the air spring with the upper retainer studs through the holes in the rubber pad.

2. Position the air spring on the bellows support (with air fitting facing you) with the lower bellows bead plate studs through holes in lower support; start nuts to retain bellows to lower support.

3. Position the upper mounting studs through the upper bellows support on subframe, then install and start the nut on small stud.

4. Tighten and torque the lower stud nuts of bellows to 20 - 25 ft•lbs (27 - 34 N•m).

5. Tighten and torque the upper small stud nut to 20 - 25 ft•lbs (27 - 34 N•m).

6. Install the nut on the large hollow stud. Torque the nut to 20 - 25 ft•lbs (27 - 34 N•m).

7. Connect the air line to the hollow stud at the top of the air spring.

8. Reinstall the height control valve link.

9. Build up air pressure in the spring to normal operating pressure.

NOTE: To accelerate this operation, air reservoirs can be filled from an exterior air supply connected to the accessory tank fill valve or to the emergency fill valve.

10. Remove the jack stands from under the vehicle and lower it to the floor.

11. Check operation of bellows, and check for air leaks by coating the upper and lower mountings of the air spring with a soap and water solution. Any leak, showing up as bubbles, must be corrected. No leakage is permissible.

SHOCK ABSORBER MAINTENANCE

Shock absorbers are nonadjustable and non-repairable. Maintenance requirements involve replacement of the rubber mounting bushings, and tightening of all shock absorber pins at the proper torque (350 - 400 ft•lbs (476 - 544 N•m)) when shock absorber replacement occurs. If a shock absorber becomes inoperative, complete unit must be replaced.

CAUTION: When a shock absorber is found defective, always replace with a new set on affected axle, except when covered mileage between them is very close. The following method will help you in determining if both shock absorbers on the same axle have to be replaced.

Loosen lower mounting of both shocks, then carefully attempt to raise and lower the bottom portion of each shock. Note the rate of effort-for-distance of travel. Replace both shocks if a definite differential rate is found.

The shock must be bench checked in an upright, vertical position. If checked in any other position, air will enter the cylinder tube and make the shock absorber appear defective.

Shock absorber diagnosis

Proceed as follows to check shock absorbers:

1. With the shock absorber in a vertical position (top end up), clamp the bottom mount in a vise.

CAUTION: Do not clamp the reservoir tube or the dust tube.

2. Rotate the dust tube. Notice any binding condition (may be compared with new unit). Binding condition indicates a scored rod. Units with scored rods should be replaced.

3. Fully extend shocks and check for leaks in the seal cover area. Shock fluid is a very thin hydraulic fluid which has a characteristic odor and dark brown tint. A slight trace of shock fluid around the seal cover area is not a cause for replacement. The shock seal is designed to permit a very slight seepage to lubricate the rod. Units which leak should be replaced.

4. Visually check shock for dents which could cause the shock to bind. Also, check for a bent rod.

5. Extend and collapse shock to determine that it has control (resistance) in both rebound and compression.

6. Visually inspect the shock mountings and vehicle mountings for:

a) Broken mounts

b) Extreme bushing wear

c) Shifted bushing or sleeve

d) Deep cracks in bushing material (shallow surface cracks are normal)

e) Loose shock absorber pins

f) Presence of convex washers, and position of them according to the rubber bushing.

Shock absorber removal

1. Remove nuts and washers from shock absorbers on upper and lower mounting pins, taking care to identify the inner and outer washers to ease reinstallation. Refer to figure 17 for details.

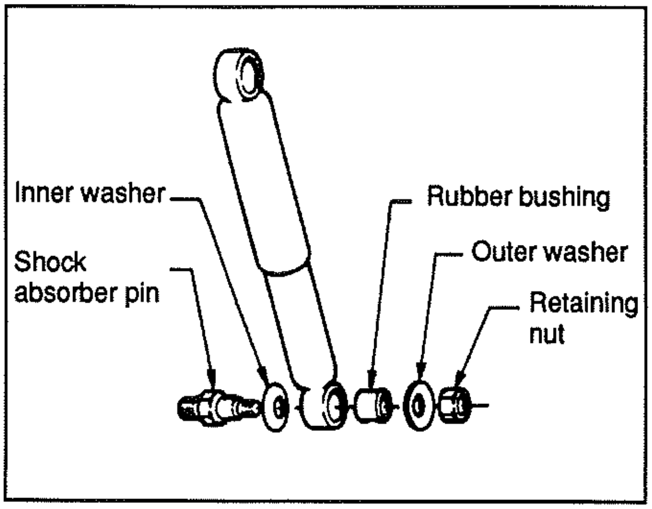

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FIG. 17

2. Remove the shock absorber assembly from pins.

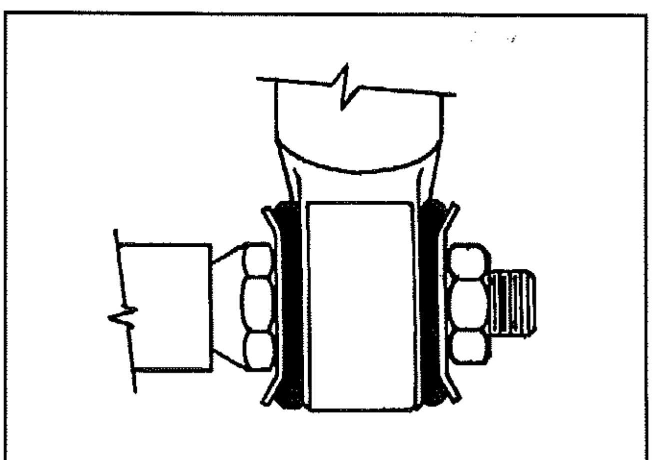
3. Remove the two inner bushings from the shock absorber, then discard them.

Shock absorber installation

1. Ensure that the shock absorber mounting pins are tight and that the threads are not stripped.

2. Install new rubber mounting bushings on shock absorbers (upper & lower).

3. Place the inner washers (with washer convex side facing the shock absorber rubber bushing) on each shock absorber pin (see fig. 18).



MA3E1618.IMG

FIG. 18

4. Install the shock absorber eyes over the mounting pins, then the outer washers (with washer convex side facing the shock absorber rubber bushing) on each shock extremity.

5. Place the lower and upper mounting pin stud nuts and torque them to 100 - 120 ft•lbs (136 - 163 N•m).

RADIUS ROD MAINTENANCE

Radius rod inspection

The following instructions apply to all radius rods used on this vehicle.

1. Clean all parts thoroughly.

2. Inspect radius rods for distortion and cracks. We recommend the *"Magnaflux"* process to detect cracks in the radius rod. Any damaged part should be replaced with a new one.

NOTE: New bushings should be used when rods are replaced.

3. The radius rod bushings should be checked periodically for signs of shearing, deterioration, or damage. Any defective part should be replaced with a new one.

Radius rod removal

1. Flatten the tab washer which secure the two retaining nuts, then unscrew the nuts at each extremity (see fig. 19).

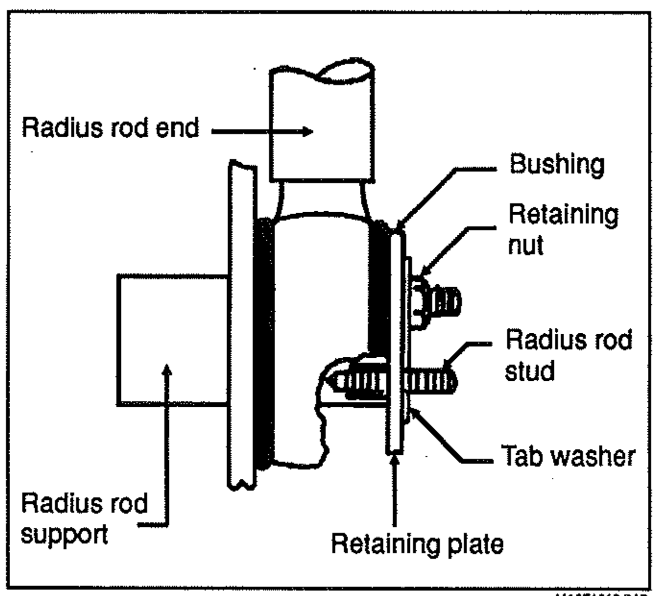


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FIG. 19

2. Remove the retaining plates and radius rod ends from anchor pins, then remove the radius rod.

Radius rod bushing removal

1. Safely support the radius rod as shown in figure 20.

2. Place a flat steel disc, slightly smaller than the outside diameter of the bushing (see fig. 20).

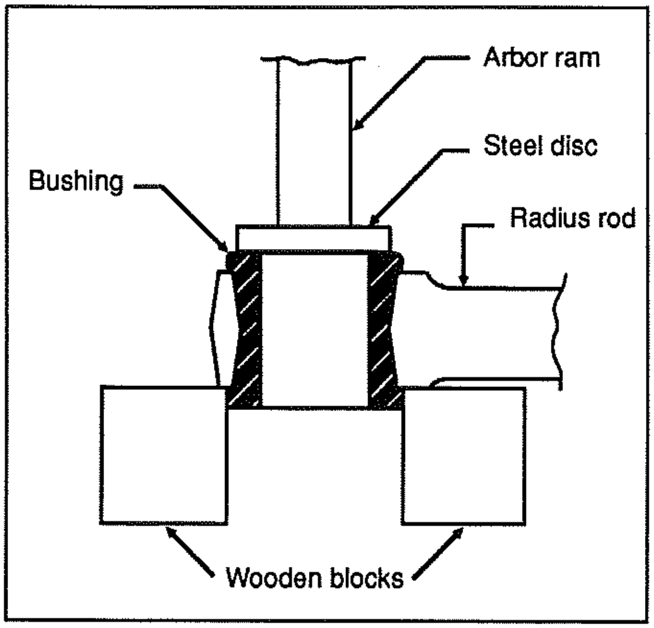

FIG. 20 - Removing radius rod bushing

3. Using an arbor press or a suitable driving tool, press or drive the old bushing out of the rod and discard the bushing.

Radius rod bushing installation

1. Spray lightly the inner and outer surfaces of radius rod bushing with water.

CAUTION: No lubricant whatsoever is to be used on the rubber bushing.

2. Safely support the radius rod, and place new bushing on top of the radius rod end.

3. Place a block of wood on top of bushing and press on it manually.

4. If necessary, use an arbor press or a suitable driving tool; press or drive the bushing into the radius rod end until it extends equally on both sides of the rod.

5. It is also possible to proceed differently. Place radius rod bushing on a plane surface, then spray a light coat of water on the inner and outer surfaces of radius rod bushing.

6. Take radius rod, align the bushing, then tap radius rod on bushing until latter is positioned correctly.

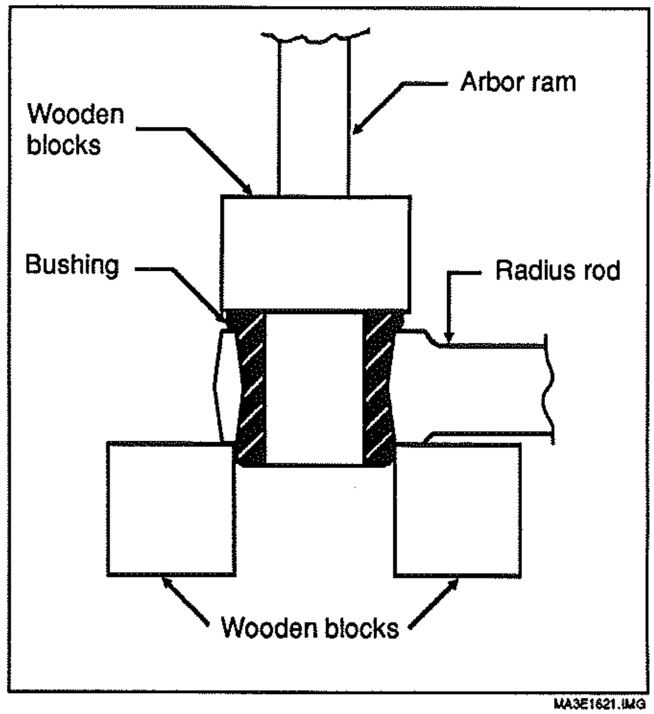

FIG. 21 - Installing radius rod bushing

Radius rod installation

1. Spray lightly the anchor pin with water, then place the radius rod end over the anchor pin.

2. Position the retaining plate, then install the tab washer and nuts.

CAUTION: Always use new tab washers at installation.

3. Tighten the nuts lightly, and repeat at the other end.

4. Refer to heading *"Suspension height adjustment"* later in this section, and set the vehicle to normal ride height.

5. With the vehicle at normal ride height, tighten all radius rod anchor pin nuts to 100 - 110 ft•lbs (136 - 150 N•m).

CAUTION: It is extremely important upon reconnection of the rods that the proper clearance height between the axle and body is maintained, otherwise the rubber bushings in radius rod ends will become preloaded, thus reducing the life of these parts.

SWAY BAR MAINTENANCE

Sway bar removal

1. Remove the nuts and washers from the upper and lower ends of the sway bar link.

2. Repeat step 1 at the opposite side of the sway bar, then remove both sway bar links.

3. Remove the washers on the lower sway bar link studs.

4. Support the sway bar and remove the eight retaining bolts which secure the four sway bar bushing collars to the subframe, then remove the bushing collars.

5. Remove the sway bar from beneath the vehicle.

6. If necessary afterwards, the sway bar bushings may be removed from the sway bar by splitting them apart.

Sway bar installation

1. After replacing bushings, ensure they are properly positioned on the sway bar, then position the sway bar under the vehicle. While supporting the sway bar, mount the sway bar to the vehicle subframe by positioning the four sway bar bushing collars over the four bushings, and secure them to the subframe with the eight retaining bolts. Tighten them manually.

2. Remove any dirt, grease or other foreign matter from the sway bar studs.

3. With the vehicle at normal ride height, (refer to heading *"Suspension height adjustment"* later in this section for details), replace the washer on the lower sway bar link stud, then install the links on each side (see fig. 22).

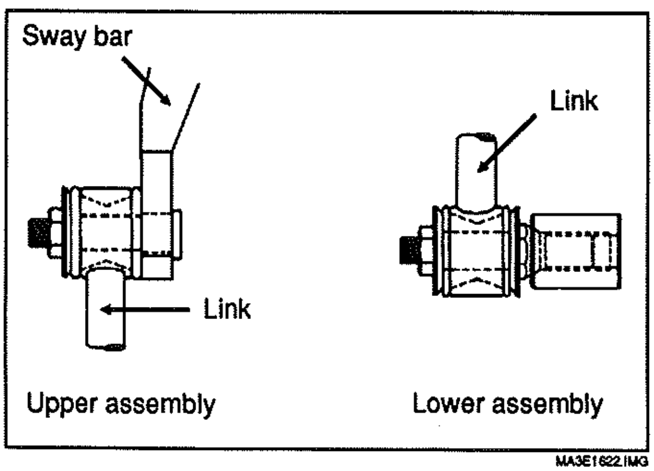

FIG. 22 - Sway bar link installation

4. Replace the washers and nuts, do not tighten.

5. Tighten the eight sway bar bushing collar bolts to 55 - 60 ft•lbs (75 - 82 N•m), then the lower and upper link pin stud nuts to 100 - 120 ft•lbs (136 - 163 N•m).

SUSPENSION AIR SYSTEM MAINTENANCE

System description

The suspension air system has its own air reservoir (accessory tank) which is located in the reclining bumper compartment. (On V.I.P. model, a finishing panel at ceiling of compartment must be removed to gain access to this tank). Pressurized air from the main tank (wet tank) flows through a pressure protection valve (PR-2) and an air filter which are both located in front service compartment, and then flows to the accessory air tank.

The pressure protection valve (PR-2) is mounted to the supply port of the air filter. This valve controls the pressure at which compressed air would be delivered to the accessory air tank. The valve remains closed until a preset pressure is reached (approximately 60 psi (415 kPa)). It then opens and passes air out the delivery port.

The chief use for this valve is to protect the main air system by ensuring at all times a sufficient air pressure in the main system (i.e. air delivered to the accessories will be shut off in case of a decrease in pressure). Maintenance and repair information on the pressure protection valve is supplied in the applicable booklet, annexed to section 12 *"Brakes & air system"* under reference number SD-03-55.

The flow of pressurized air from the accessory air tank to the air springs is controlled by three height control valves. These valves are mounted to the subframe and connected to the axles through an arm and link connection. This connection allows the valves to apportion air pressure in the springs to the vehicle load, maintaining normal ride height. A delay piston in each valve causes time lapse reponse of the valves, so that air pressure in the springs is adjusted only during changes in vehicle load and not during intermittent road bumps.

The front height control valve is interconnected with the kneeling system; when the kneeling system is in use, it will bypass the height control valve. This prevents the height control valve from supplying air to raise the vehicle, while the kneeling system is attempting to lower the front of vehicle.

Suspension system inspection

The following inspection should be performed at established service inspection periods. Performing the procedures will allow substandard performance to be discovered before the condition becomes bad enough to cause operator complaints and failure on a run.

1. Visually inspect the suspension air lines for evidence of chafing on metal parts or other damage.
2. Visually inspect the air springs for cracks, abrasion or other damage.
3. Replace any parts found to be damaged.

Suspension air line test

With the main air system at normal operating pressure, coat all suspension air line connections and air spring mountings with a solution of soap and water. Air leakage will produce soap bubbles. Any leak found must be corrected as no air leakage is permissible.

Suspension air tank maintenance

Refer to section 12 *"Brakes and air system"* under heading *"Air reservoir maintenance"* for complete instructions on air tank maintenance.

SUSPENSION HEIGHT ADJUSTMENT

The appropriate vehicle body height is obtained by measuring the clearance of the air springs installed on the front and drive axles. The clearance should be 12" (305 mm) for the air springs installed on the front axle and 11.5" (292 mm) for those installed on the drive axle. Refer to figure 23 to identify the correct location where the measure has to be taken. At this point, it should not be necessary to make an adjustment under normal service conditions. However, if an adjustment is required, change the position of the overtravel lever in relation to the overtravel control body. The lever should be moved up to raise the height of vehicle, and down to lower it. Check that main air pressure is at normal operating pressure and raise the vehicle to the specified height.

CAUTION: Always adjust on *"fill cycle"*. If it is necessary to lower vehicle height, release sufficient air to be well below height, and adjust to height or fill cycle.

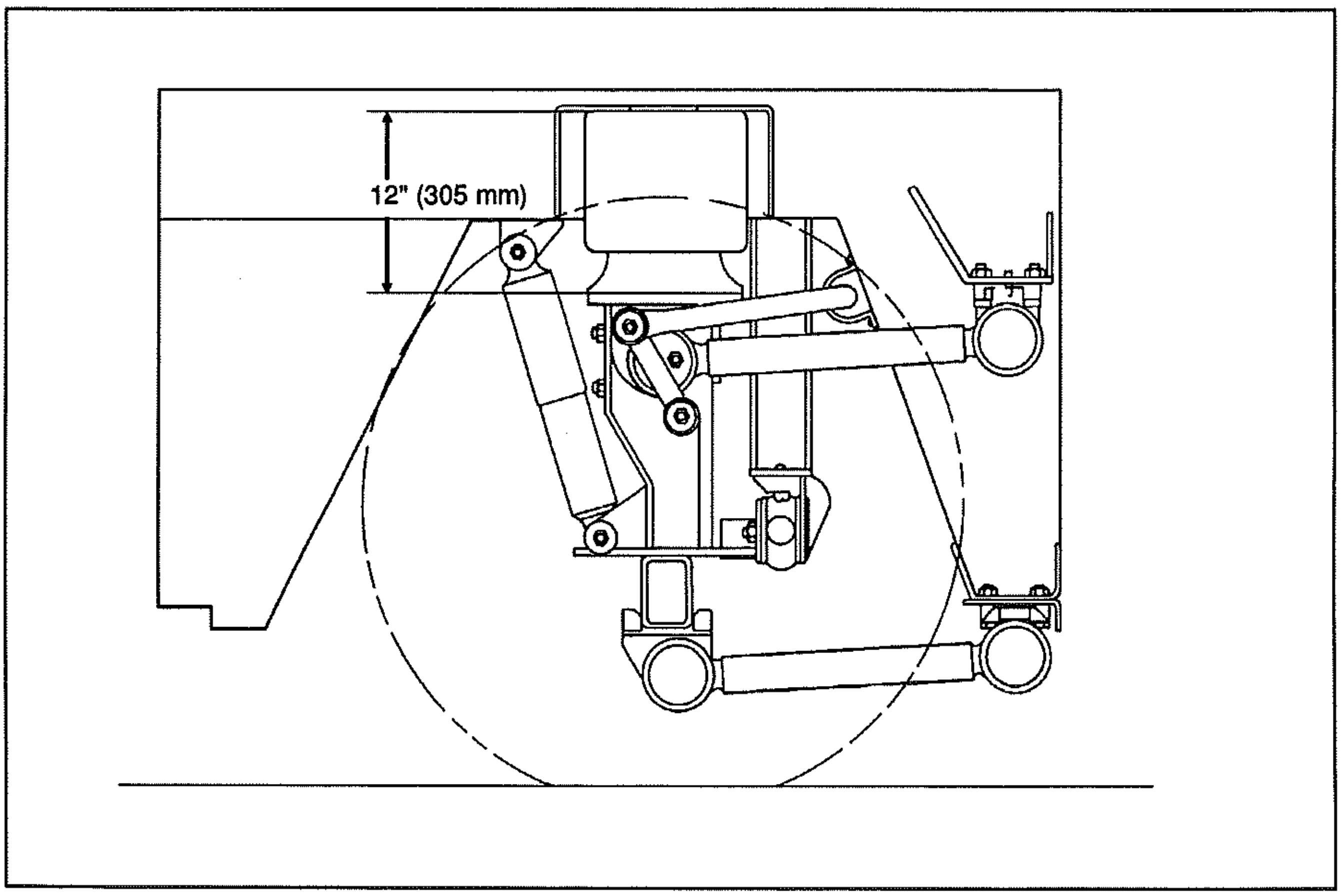

FIG. 23 - Front axle air spring clearance

To adjust suspension height, proceed as follows:

1. With the vehicle at normal operating air pressure, check the air spring clearance as illustrated in figure 23. This clearance should be 12" (305 mm) for the front axle air springs and 11.5" (292 mm) for those on the drive axle.

NOTE: The measure should be taken from under the upper air spring support on subframe to top of the lower air spring support on axle (refer to fig. 23 for more details). If adjustment is required, begin with the drive axle.

2. Loosen the adjusting nut on the height control valve overtravel lever.

3. Raise or lower the overtravel lever to cause the vehicle body to raise or lower until the desired clearance is reached.

NOTE: Allow suspension to stabilize before taking reading.

4. When the desired height is obtained, tighten the adjusting nut.

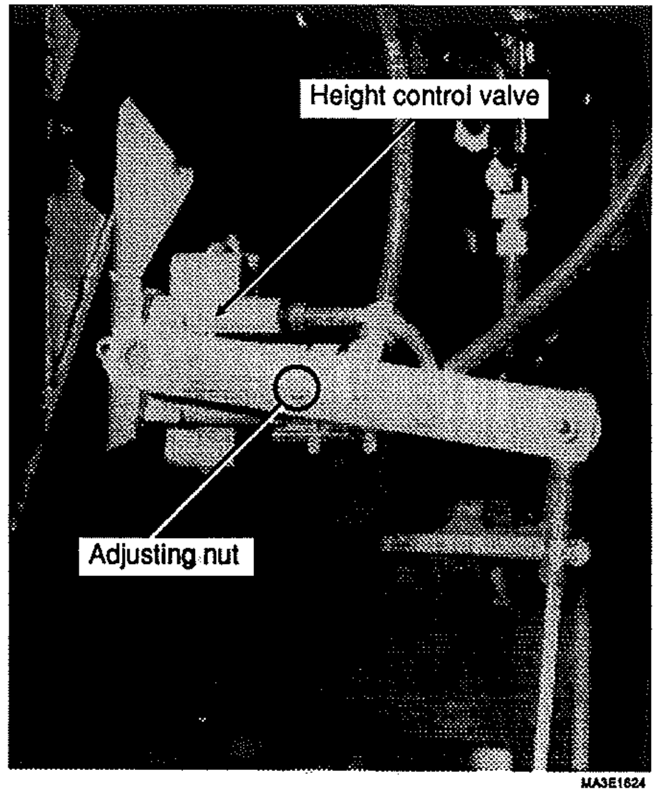

FIG. 24

HEIGHT CONTROL VALVE OPERATION

Figure 25 shows a cross-section of a height control valve in its three operating phases. Valve operation is illustrated as the vehicle is loaded, at normal ride height, and as the vehicle is unloaded. Each valve adjusts independently according to the following conditions:

Loading position

When loaded, body of vehicle settles. Since valve is linked to suspension, and valve is mounted to vehicle body, valve moves downward with body during loading. As overtravel lever and control shaft turn, intake valve lever presses against pin of valve core. As pin is depressed, air pressure flows through height control valve and into air springs. Increased air pressure expands air springs and raises body of vehicle. Intake valve is protected by a check valve which permits air to travel in one direction only.

Neutral position

Increased pressure expands air springs, thus lifting vehicle body and height control valve. The overtravel lever returns to *"NEUTRAL"* as vehicle body approaches normal ride height. Intake valve lever also moves closing valve. The exhaust valve remains closed, and the check valve in intake adaptor prevents air escape from valve body and air springs. This condition remains static until vehicle load is altered, moving overtravel lever to *"NEUTRAL"* for one second or longer, actuating intake or exhaust valve.

Unloading position

When load is lightened, pressure in air springs raises vehicle body. Overtravel lever is pulled downward from *"NEUTRAL"*. This applies a force that slowly moves the delay piston, and opens exhaust valve when lever moves beyond free travel range. Intake valve remains closed, thus allowing air from air springs to exhaust in atmosphere. As air is exhausted from air springs, the vehicle body is lowered until overtravel lever returns to *"NEUTRAL"* position.

When vehicle is in motion with body at normal ride height, overtravel lever is in *"NEUTRAL"* position. Small movements of lever may occur without activating control valve as it must move in excess of 3/16" (4,7 mm) before either valve is opened.

The delay piston, connected through a pin to the overtravel shaft, is contained in a cylinder of silicone-type fluid. The slowing action of this fluid delays from 1 to 6 seconds between the closing of one valve and the opening of the other. The flapper valves allow both valves to close from full-open position within 1 second.

The overtravel piston is held against shaft by two springs (one inside the other) and keeps shaft in proper position relative to the overtravel lever. Purpose of the piston is to prevent damaging the parts inside control valve if lever exceeds normal travel, and to allow the lever to move without moving parts inside the valve.

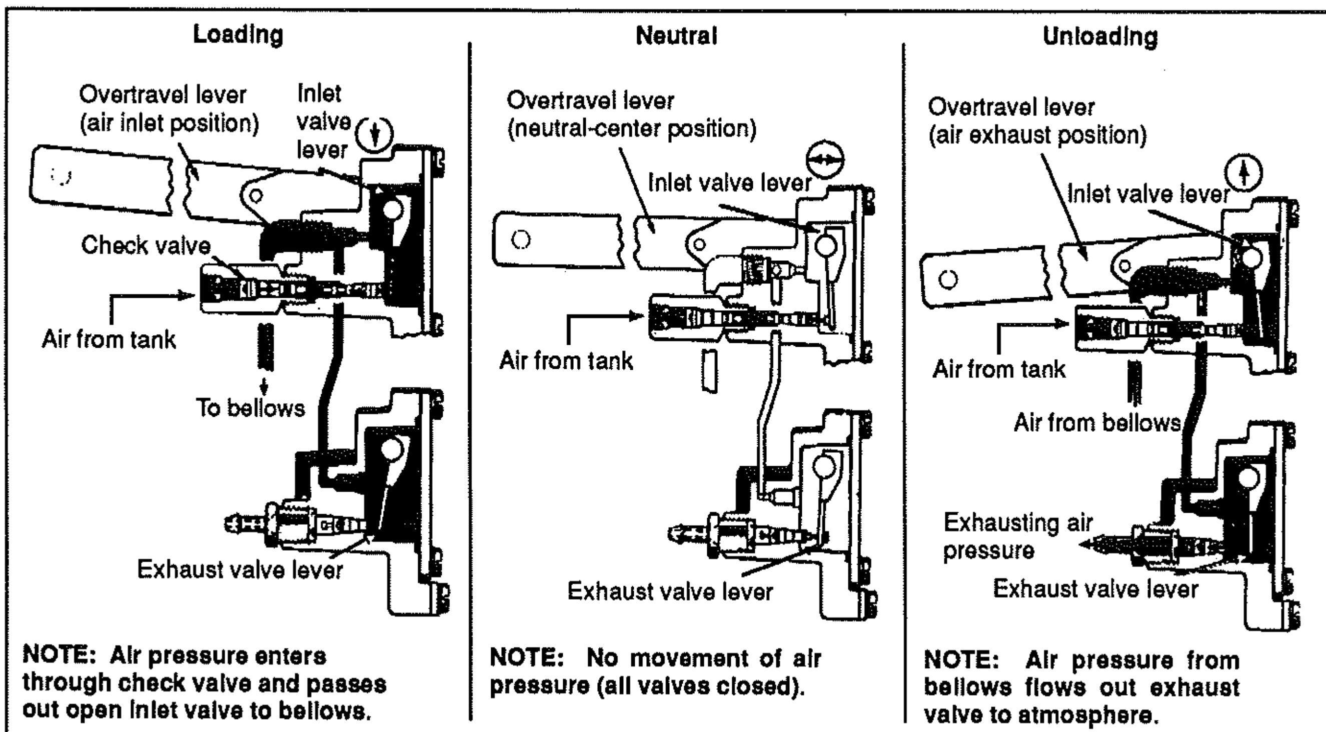

FIG. 25 - Operation of height control valve

Height control valve maintenance

The height control valve requires no periodic maintenance. Height control valve linkage operates on rubber bushings and no lubrication at this point should be attempted.

Height control valve removal

Before disconnecting any height control valve air lines, securely support the vehicle by its jacking points on the body. Refer to heading *"Vehicle jacking points"* in section 18 *"Body"*.

1. Exhaust the air from the air supply system by opening the drain cock on each air reservoir. Remove height control valve as follows.

2. Disconnect overtravel lever from link and pull down lever to exhaust remaining air from air springs.

3. Disconnect air supply and delivery lines from the height control valve, then cover ends of the lines with tape.

4. Remove the two nuts retaining the height control valve to the mounting bracket, then remove valve assembly.

Height control valve installation

Reverse removal procedure to replace height control valve. After installation, check for leakage using soap and water.

Height control valve air leakage check

NOTE: The following procedure applies when valve assembly has been removed from vehicle.

1. Clean the exterior of valve assembly.

2. Connect air pressure line to air inlet port, then allow air pressure buildup (70-100 psi (480-690 kPa)).

3. Dip the valve assembly in a container of water, and watch for air bubbles when the overtravel lever is in the center position. No air should escape from any point of the valve assembly.

4. If bubbles appear from the air spring port, this is an indication that the air inlet valve assembly is defective and must be replaced.

5. Remove air pressure line from air inlet fitting and connect it to the air spring port. If bubbles appear at the air inlet check valve port, this is an indication that check valve unit is defective and must be replaced.

6. If bubbles appear at the exhaust port, this is an indication that the exhaust valve assembly is defective and must be replaced.

7. If bubbles appear around edge of valve cover plate, the cover plate gasket must be replaced.

8. If no leaks are found, remove valve assembly from water, then with air pressure still connected to the air spring port, actuate overtravel lever to remove any excess water which may have entered exhaust valve chamber. Remove air line, connect it to the air inlet port, and repeat operation to remove water from the air inlet valve chamber.

SUSPENSION TROUBLESHOOTING

MALFUNCTION	POSSIBLE CAUSE	CORRECTIVE MEASURE
Bellows deflate over time.	Defective check valve assembly. Defective exhaust valve assembly. Leak in air line and/or bellows. Defective valve cover rubber O-rings or gasket.	Replace check valve assembly. Replace exhaust valve assembly. Replace air line or bellows. Replace valve cover, O-rings or gasket.
Bellows raise to full height and fail to exhaust air pressure.	A clogged exhaust screen in height control valve assembly. A combination clogged exhaust screen and defective air inlet valve assembly.	Remove and clean screen. Clean exhaust screen and replace air inlet valve assembly.
Intermittent hissing noise at height control valve during operation.	Loss of time delay action fluid in height control valve assembly.	Add fluid, then install new cover and delay piston plug, gasket, O-rings.
Erratic valve action.	Dirt or foreign matter in the air valve lever chamber. Defective valves.	Remove valve cover and blow out dirt. Install cover using new gasket. Overhaul height control valve assembly.
Vehicle body fails to level to satisfactory ride height.	Improper height control valve overtravel lever adjustment.	Adjust lever as directed.

KNEELING/HI-BUOY SYSTEM

Description

The kneeling system is used to lower front of vehicle. This allows passengers to board the vehicle with greater ease. The kneeling action is achieved by exhausting air from the front air springs (bellows). This system bypasses the height control valve to provide a fast up and down movement of the front suspension. Only five seconds are required to lower vehicle from normal level to the lower position, and nine seconds to raise the vehicle from lower position to approximately one inch lower than normal position. This quick response is achieved by an auxillary air tank installed beside the secondary air tank (for exact location, refer to section 12 *"Brakes & air system"*). This tank provides sufficient air supply to the kneeling system for at least two successive operations.

The system is provided with two safety features; first, a speed switch will enable the kneeling system to work **only** under 5 mph (8 km/h) and secondly, a limit switch will keep the parking brake on, as long as the vehicle has not returned to a certain height where the driver will be able to manually remove the parking brake.

The hi-buoy system is the opposite of the kneeling system as it is used to raise the vehicle to allow an extra ground clearance for particular situations (ferryboat, avoiding a sidewalk curb, etc.). In normal running condition, the height control valve is in operation and the hi-buoy only can be operated.

Maintenance

As this system is interrelated with the air and electrical systems, refer to the applicable maintenance in sections 12 *"Brakes & air system"* and 06 *"Electrical system"* of this manual.

Problems resulting from an electrical defective part or circuit can often be solved by a careful analysis of the wiring diagram.

For the electric circuits of this system, refer to diagram #19/23 of the master wiring diagrams; as for the pneumatic circuits, refer to the following figures 26 and 27 showing the main components used on the kneeling system. For more details, refer to the complete pneumatic system diagram annexed to section 12 *"Brakes & air system"*.

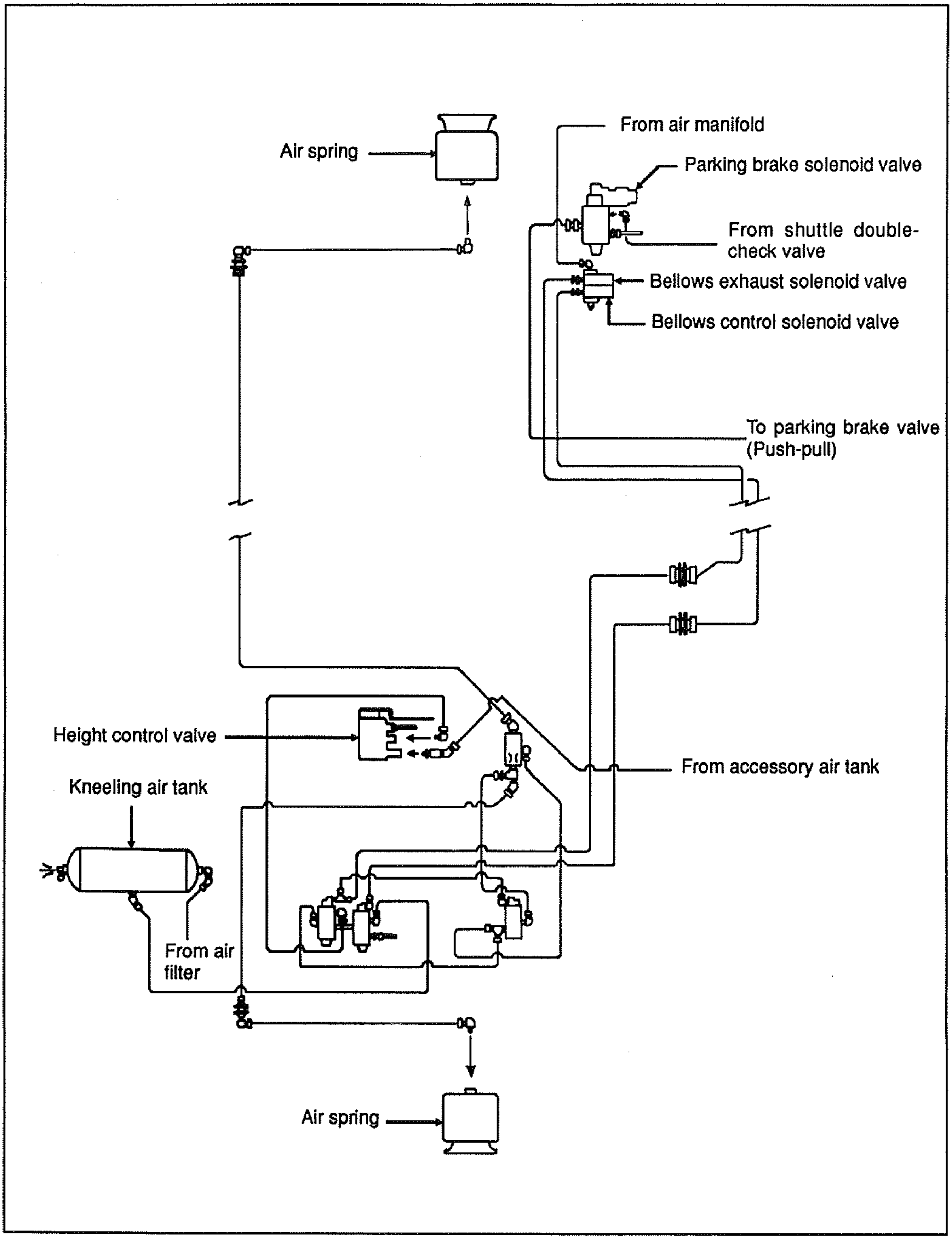

FIG. 26 - Kneeling system pneumatic diagram

Bellows control and exhaust solenoid valves

Removal

1. On the R.H. side of the front service compartment, locate the bellows control and exhaust solenoid valves fixed on the mounting plate (see fig. 27).
2. Disconnect the two solenoid harness connectors.
3. Disconnect the three black hoses connected to these valves.

NOTE: Identify each air hose (black) before disconnection, in order to ease reinstallation procedure.

4. Unscrew the two Phillips-head screws retaining the solenoid valve base to the mounting plate, remove the assembly and place it on a clean working area.
5. Replace the defective part(s).

Replacement

Reverse removal procedure to install these valves.

NOTE: If cable ties have been removed to ease operation, remember to replace them afterwards.

Kneeling sense switch assembly

Removal

1. Disconnect the switch wiring connector, then unscrew the three bolts, washers, and nuts (see fig. 28) which attach the switch assembly to the mounting bracket.
2. Remove switch assembly from vehicle.

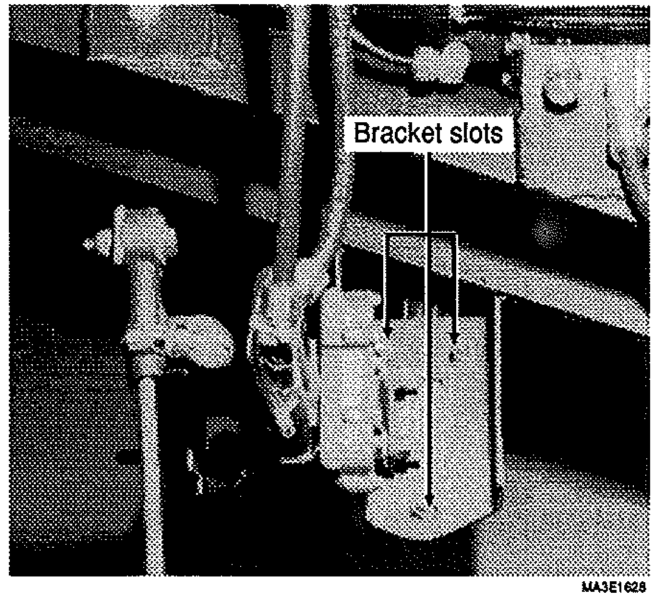

FIG. 28 - Kneeling sense switch installation

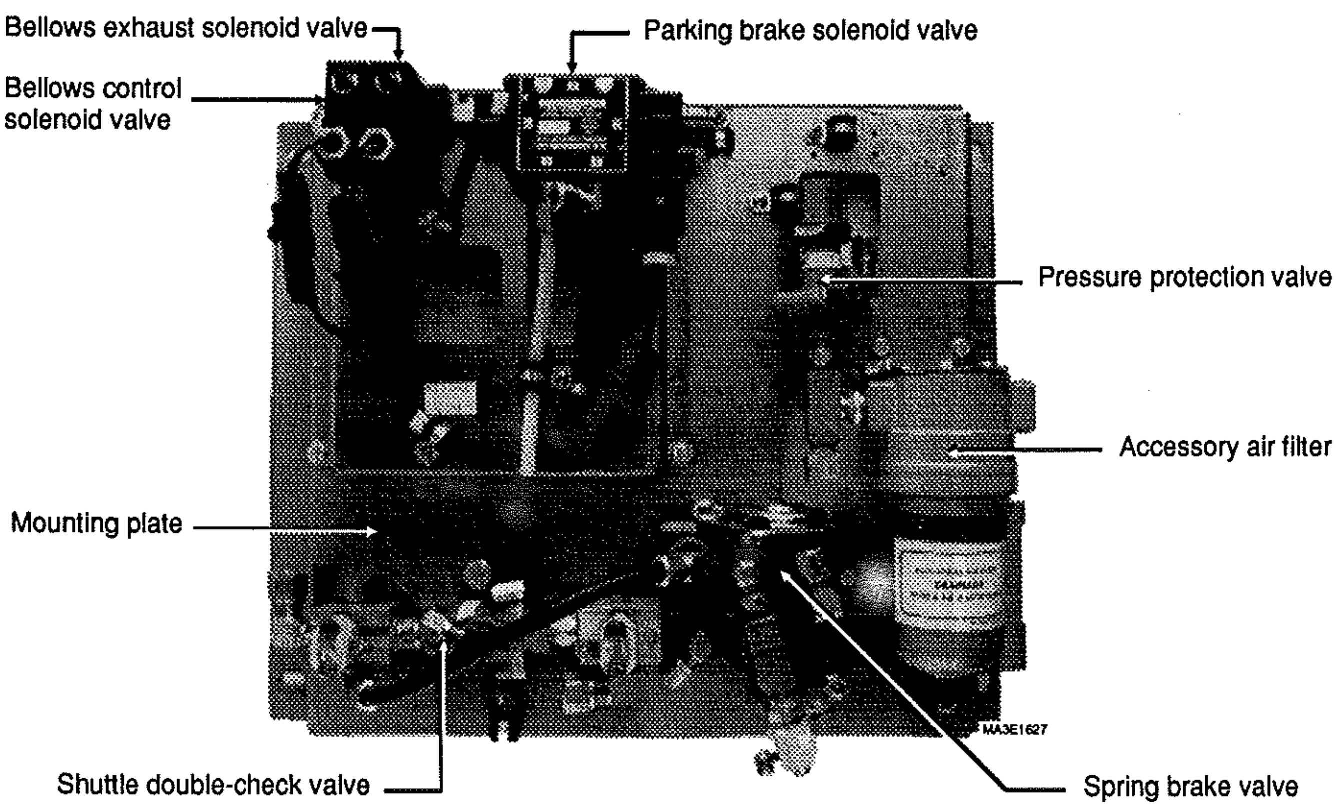

FIG. 27 - Pneumatic component mounting plate

Replacement

1. Install the switch assembly to the mounting bracket with the three bolts, washers, and nuts. Do not tighten.

2. Reconnect the switch wiring connector.

3. With the vehicle at normal ride height, adjust the switch assembly in the bracket slots in order to obtain 1/2" (12,5 mm) clearance between the top of the sense switch actuator and the actuator bracket, then tighten bolts to 95 - 120 in•lbs (10,5 - 13 N•m).

NOTE: Refer to the previous heading *"Suspension height adjustment"* for vehicle normal ride height information.

SPECIFICATIONS

FRONT, DRIVE AND TAG AXLE AIR SPRINGS ON COACH MODEL

Make	Goodyear Tire and Rubber
Model	Roll-over volume can
Type	1100
Diameter	11" (279 mm)
Supplier number	1R11-064
Prevost number	63-0090

FRONT AND TAG AXLE AIR SPRINGS ON V.I.P. MODEL

Make	Goodyear Tire and Rubber
Model	Roll-over volume can
Type	1100
Diameter	11" (279 mm)
Supplier number	566-22-2-50
Prevost number	63-0079

DRIVE AXLE AIR SPRINGS ON V.I.P. MODEL

Make	Goodyear Tire and Rubber
Model	Roll-over volume can
Type	1100
Diameter	11" (279 mm)
Supplier number	1R11-064
Prevost number	63-0090

FRONT AXLE SHOCK ABSORBERS ON COACH MODEL

Make	Gabriel
Color	Black
Collapsed length	15.3" (38,86 cm)
Extended length	23.8" (60,45 cm)
Supplier number	087006
Prevost number	63-0091

DRIVE AND TAG AXLE SHOCK ABSORBERS ON COACH MODEL

Make	Gabriel
Color	Blue
Collapsed length	15.4" (39,12 cm)
Extended length	24.4" (61,98 cm)
Supplier number	680088
Prevost number	63-0001

FRONT, DRIVE AND TAG AXLE SHOCK ABSORBERS ON V.I.P MODEL

Make	Gabriel
Color	Blue
Collapsed length	15.4" (39,12 cm)
Extended length	24.4" (61,98 cm)
Supplier number	680088
Prevost number	63-0001

FRONT AXLE HEIGHT CONTROL VALVE

Make	Neway
Quantity used	1
Supplier number	90554111
Prevost number	63-0085

DRIVE AXLE HEIGHT CONTROL VALVES

Make	Neway
Quantity used	2
Supplier number	90554111 R.H. & L.H. sides
Prevost number	63-0085 R.H. & L.H. sides

KNEELING SENSE SWITCH

Make	Honeywell Ltd
Type	SPDT
Supplier number	BAF1-2RN18-RH
Prevost number	56-1705

BELLOWS CONTROL AND EXHAUST SOLENOID VALVE ASSEMBLY

Make . . . . Norgren

Solenoid valve manifold

Supplier number D0043B

Prevost number 64-1130

Coil

Voltage . . . . 24 V DC

Current draw . . . . .29 ampere

Supplier number 54932-27

Prevost number 64-1144

Valve (3 ways, 2 positions)

Supplier number K41EAOO-KH1-KS6

Prevost number 63-0081

Repair kit (spool)Supplier number 54237-65

Repair kit (spool)Prevost number 64-1169

RADIUS ROD BUSHING

Make . . . . .Prevost

Prevost number 63-0021

SWAY BAR BUSHING

Make . . . . .Prevost

Prevost number 13-0953

SHOCK ABSORBER AND SWAY BAR LINK BUSHINGS

Make . . . . .Monroe

Supplier number 45380

Prevost number 63-0062

TORQUE SPECIFICATIONS

1- Shock absorber pin stud . . . . .350-400 ft•lbs (476-544 N•m)
2- Shock absorber pin stud nut . . . . .100-120 ft•lbs (136-163 N•m)
3- Radius rod stud . . . . 20-40 ft•lbs (27-54 N•m)
4- Radius rod retaining nut . . . . .100-110 ft•lbs (136-150 N•m)
5- Radius rod support nut . . . . .130-140 ft•lbs (177-190 N•m)
6- Suspension support on axle . . . . .280-300 ft•lbs (380-408 N•m)
7- Air spring stud nuts . . . . 20-25 ft•lbs (27-34 N•m)
8- Sway bar link pin stud . . . . .350-400 ft•lbs (476-544 N•m)
9- Sway bar link pin stud nut (lower & upper) . . . . .100-120 ft•lbs (136-163 N•m)
10- Sway bar bushing collar bolt . . . . 55-60 ft•lbs (75-82 N•m)

NOTE: During assembly, use "Loctite 242" (Prevost number 68-0038) with item 1.
During assembly, use "white grease" (Prevost number 68-0343) with item 3.
After assembly, apply "white grease" (Prevost number 68-0343) on fasteners with items 2,4,6,7,9 and 10.

SERVICE BULLETINS AND SERVICE INFORMATION LETTERS

Service Bulletins and Service Information Letters will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of publications pertaining to this section should be noted below as soon as received. These should then be filed for future reference.

NUMBER	DATE	SUBJECT

18

BODY

CONTENTS OF THIS SECTION

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STRUCTURE

The body of the H3-40 is an intregal structure made of 14, 16 and 18 gauge welded and braced high tensile steel and stainless steel members. The roof arches are made with cold rolled, electrically welded (CREW) steel tubes, 1 1/2" x 2" x 14 gauge. The inside is filled with urethane foam and the exterior is primed. The roof is a one-piece aluminum sheet, stretched and riveted all around. The front and rear caps are made of fiber-composite material. The front cap has a carbon-reinforced molded windshield cross-member. The front subframe is made of open sections of high-strength low-alloy steel (Corten). These open sections permit a better application of primer and undercoating, and does not trap moisture. The rear subframe is made of closed sections of carbon steel filled with polyurethane foam. The floor is made of 2 layers of 1/2" (13 mm) thick plywood separated by a 1/8" (3 mm) insulation to reduce power train and road noises.

Welding

The following welding rods should be used when making welding repairs to the structure:

A. Stainless steel to steel or Corten, light gauge:
rod diameter: 3/32" (2,4 mm), AWS No 308.

B. Stainless steel to stainless steel or Corten,
heavy gauge: rod diameter 1/8-5/32" (3,2-4 mm), AWS No 308.

C. Corten to Corten, light gauge:
3/32-1/8" (2,4-3,2 mm), AWS No 6011.

D. Corten to Corten, heavy gauge:
3/32-5/32" (2,4-4 mm), AWS No 7018.

COACH FRONT AND REAR BUMPERS

Repair of superficial damage

This procedure defines a method of repairing bumper surface damages such as superficial scratches or scuffing which are unacceptable in appearance only. For substantial bumper damages such as cracks, tears or holes, refer to heading *"Repair of substantial damages"* in this section.

1. Inspect the damaged area as follows:

a) If a rough edge of paint is apparent immediately surrounding the scratch or scrape, lightly wipe the local area with a tack cloth or very fine steel wool, "000" maximum. This should remove residual flakes or paint buildup.

b) If grease and/or oil contaminants are apparent close to the damaged areas, wipe the surface with any commercially available grease remover.

CAUTION: Do not use silicone-based materials to remove contaminants.

2. Locally wipe the damaged area with mineral spirits or the equivalent, ensuring that any grease remover from step 1(b) is covered. Allow sufficient time for all solvents to vaporize prior to painting (5 to 10 minutes).

3. Apply the recommended repair paint, either aerosol or air spray gun, to the damaged area. The can or spray gun should be kept at a distance of 6 to 10" (150 to 250 mm) from the surface to be covered, with continuous side-to-side motion, sweeping across the damaged area. To ensure a good blend with existing paint, the sweeping motion should begin and end to the side of the area to be covered. Larger areas to be covered will require the back-and-forth sweeping motion to be gradually moved up and/or down, as shown in figure 1.

NOTE: A recommended repair paint is Tempo Color Spray #411, black.

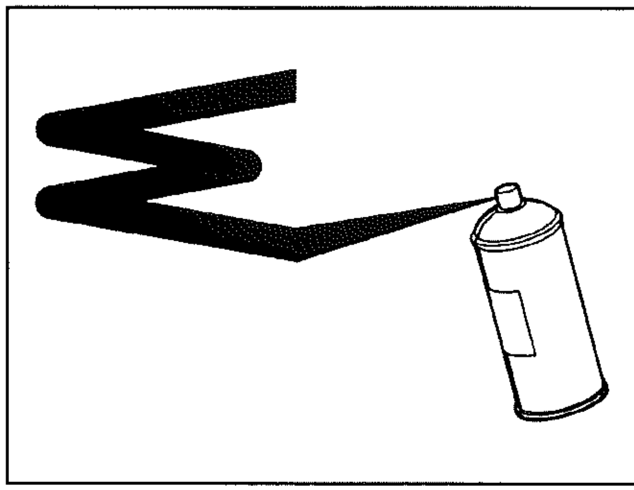


Fig. 1

4. Allow a minimum of 10 to 15 minutes for the paint to dry, 5 minutes for parts which are heated at the time of painting.

Repair of substantial damage

NOTE: The following material can be purchased locally:

- Three kits of 3M #8101 Structural Adhesive, Components A and B

- Applicators

- 3M Auto Body Repair Tape #06935

- Grinder or sanding block with #36 disc or coarse sandpaper

- 220, 320 and 400 grit sandpaper.

- Any generally acceptable oil or grease remover.

1. Wipe the damaged area with solvent to ensure a clean surface.

2. Remove enough surface material using a grinder or rough sanding block to ensure maximum adhesion of repair material.

3. Bevel the front edges of the crack or hole.

4. Featheredge the paint around the abraded area.

5. Clean the repair area with a soft, dry cloth or air gun.

6. Wipe the back side of the repair area with solvent for maximum strength and apply auto body repair tape. Make sure that the edges of the damaged area meet evenly.

7. Mix A and B components of the 3M Structural Adhesive #8101 according to directions.

NOTE: To prevent air bubbles during mixing, the components should be scraped together with downward pressure and spread thinly on the mixing board. Adhesive should be used within 2 minutes. Observe safety precautions.

8. Apply a thin layer of adhesive to the damaged area with an applicator. Allow it to stiffen (approximately 15 minutes). Mix additional adhesive and apply to restore the contour.

NOTE: In restoring the contour, spread the edges toward the center, filling all low areas. If voids, bubbles, or low areas occur, mix more adhesive and apply.

9. Allow a 24-hour room temperature cure for optimal results before sanding. If a faster cure is necessary, application of heat by heat lamp or hot air gun may be utilized.

NOTE: If heat is applied, maintain the temperature between 150 and 200 °F (65-90 °C) for 20 to 30 minutes.

10. Grind or block-sand the repair area to the correct contour. Grind with a #220 disc, followed by 320 sandpaper, followed by 400 wet-or-dry.

11. Recontour any low spots with additional adhesive.

12. Clean off the repaired area and refinish the part according to the instructions under the heading *"Refinishing procedure"* in this section.

Refinishing procedure

Bumpers that are factory painted have a flexible, very tough, abrasion and weather resistant, elastomeric enamel coating that has been baked on at approximately 250 °F (120 °C). There may be collisions or accidents in which the paint is marred to such an extent that refinishing is desirable. When paint baking facilities are not available, air-dry repair systems, such as those used in soft fascia passenger car body repair, are suggested.

Excellent results from the standpoint of flexibility, adhesion to surface material, and gloss may be obtained with two-component urethane enamels. These systems consist of a reactive enamel and an activator.

NOTE: If needed, a reducer may be added. DuPont's Imron is widely used.

Two-component systems generally do not have as high a degree of flexibility as the one-component urethane enamels, but are designed for applications where high temperature baking is not feasible.

Less desirable, but often providing an excellent finish, are the flexibilized acrylic lacquers. These lacquer systems are composed of a base lacquer, a solvent, and an elastomeric additive. PPG's Ditzler is widely used, as well as systems from DuPont and Sherwin Williams. These are readily available at body repair shops and automotive parts dealers.

Surface preparation

Surface preparation is the most important step in repainting. Water soluble dirt should be removed first, followed by a thorough cleaning with a wax and grease removing solvent. Bumpers which have been punctured, cut, or gouged should be repaired according to instructions for the 3M adhesive under the heading *"Repair of substantial damages"* in this section. The patch should be sanded to the level of the surrounding bumper surface.

Painted surfaces, as well as exposed surfaces, should be sanded with a fine grit (400) sandpaper until the enamel finish is dulled. The entire face should be sanded since it is difficult to match colors in spot refinishing. Sanded surfaces should again be cleaned with a good wax and grease removing solvent to ensure good wetting of the surface and to prevent *"fish eyes"* formation.

Prime coat

Most lacquer manufacturers recommend a separate primer coat before applying the color coat to produce maximum adhesion. Check specific directions on the manufacturer's label.

Color coat

In applying final coatings, several wet coats should be sprayed with flash time between coats depending on hiding power and color match. Application information, as well as air-dry time, should be specified on the product container. Repairs should be allowed to dry overnight before putting bumper in service.

WARNING: Proper precautions must be taken when applying air-dry elastomeric paints. Refer to manufacturer's warnings for details.

Front bumper removal and installation

The front bumper is hinged to give access to the spare wheel and tire compartment. Bumper must first be tilted down before its removal. Two persons are required to remove and install the front bumper.

WARNING: Front bumper weighs approximately 220 lbs (100 kg). Use proper lifting equipment to support the bumper during the removal and installation operations to avoid personal injury.

1. Loosen 2 nuts on binding rods from under the bumper while holding the bumper closed. See figure 2.

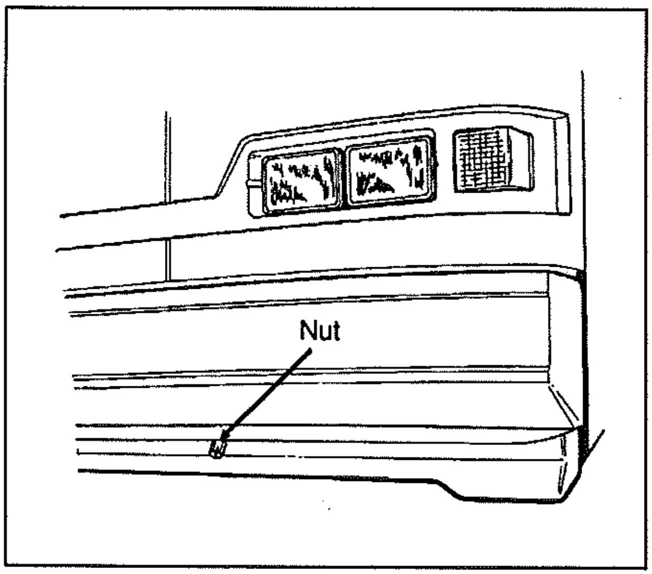


Fig. 2

2. Hold bumper and push binding rods up to remove the 2 binding rod hooks from their respective attaching points. See figure 3.

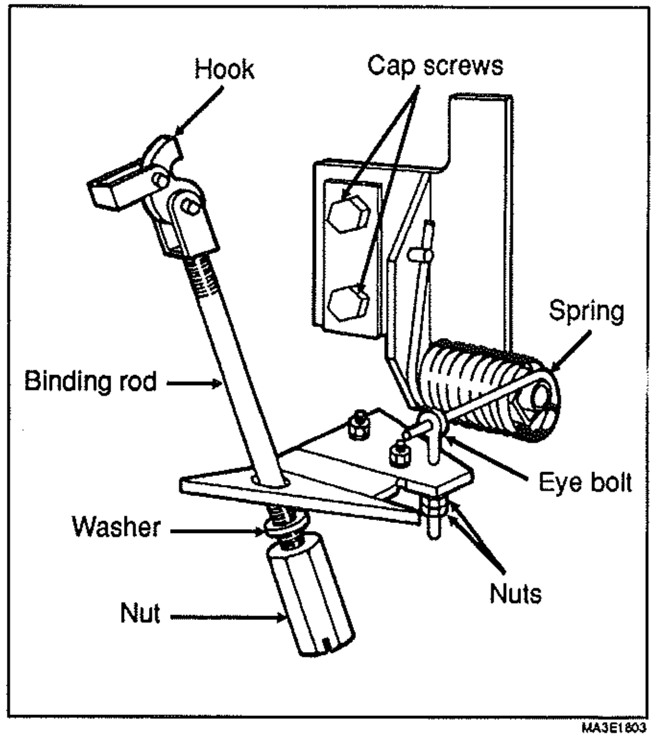


Fig. 3

3. Partly recline the bumper, remove both chain end snap hooks from their attaching points, and let the bumper rest face down on the lifting equipment platform.

4. Ask assistant to relieve spring tension on one eye bolt with proper tool. Remove 2 nuts and eye bolt holding spring and slowly release spring. Repeat procedure for the other eye bolt.

NOTE: A convenient tool to relieve spring tension can be fabricated with 2 lengths of square tubing approximately 30" (75 cm) long, welded together, and fitted at one end with a cut-out adapter to hold the spring. See figure 4.

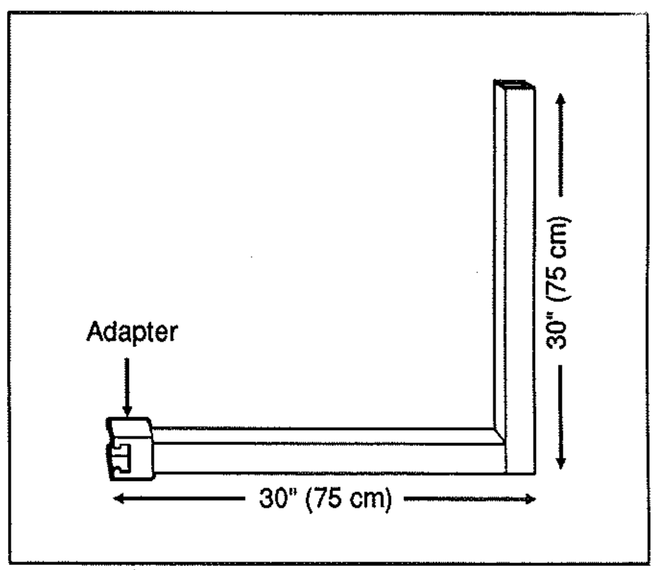


Fig. 4

5. Remove 4 cap screws holding bumper to vehicle and remove bumper.

6. To install bumper, perform the removal procedure in reverse.

CAUTION: Check that binding rod hooks are properly anchored when bumper is tilted up before tightening binding rod nuts. Tighten binding rod nuts firmly.

Rear bumper removal and installation

1. Remove 4 cap screws and washers retaining the rear bumper top panel and remove panel.

2. Remove 6 cap screws and washers holding bumper to engine frame, 3 at each end, under the bumper.

3. Remove 6 cap screws and washers holding bumper to engine frame, 3 at each end, above the bumper and remove bumper.

4. To install bumper, perform the removal procedure in reverse.

ROOF ESCAPE HATCH

Maintenance

The vehicle can be equipped with one or two escape hatches. The escape hatch is designed to provide years of reliable service with a minimum of maintenance. All components are rust proof, and moving parts are Teflon coated to eliminate need for lubrication. Should water infiltrate the vehicle from the escape hatch, refer to the heading *"Sealing"* in this section for procedures on how to seal this area.

CAUTION: Use of lubricants, paints, or other coatings such as graffiti detering sprays is not recommended.

Suggested maintenance includes periodic inspection of attaching fasteners for evidence of loosening due to tampering, and regular cleaning with mild soap and water.

Although there are other cleaning solutions available, some contain solvents and other chemicals that can attack the high strength materials used in the production of the escape hatch.

CAUTION: Ensure that cleaning solutions are compatible with the materials used on the escape hatch.

Graffiti removing cleaners often contain acetone, ether, lacquer thinner, or other solvents known to destroy the high strength properties of many plastics. Use of these cleaners must be avoided.

Graffiti-resisting coatings often leave a sticky residue that interferes with smooth up/down movement of the hatch mechanism. Some of these coatings also contain solvents that will reduce the strength of certain components.

CAUTION: Use of these coatings is at considerable risk and should be avoided.

Repair

All components used in the production of the escape hatch are available as service parts, except for one hinge that represents a possible hazard when improperly reattached to a hidden tapping plate that is often damaged whenever the hinge is damaged. The tapping plate is permanently laminated between the inner and outer cover assemblies, and it cannot be inspected or replaced. It is therefore necessary to replace the entire assembly following damage to the hinge. See figure 5.

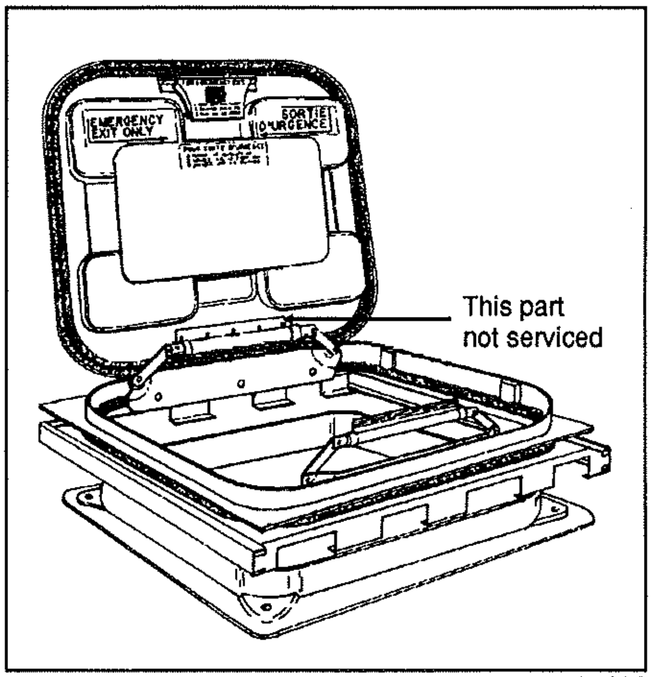


Fig. 5

CAUTION: Hinge assembly is critical and hinge should never be removed from cover assembly. Fasteners used in this assembly are special and have critical torque requirements and tamper-resistant heads to discourage tampering.

Sealing

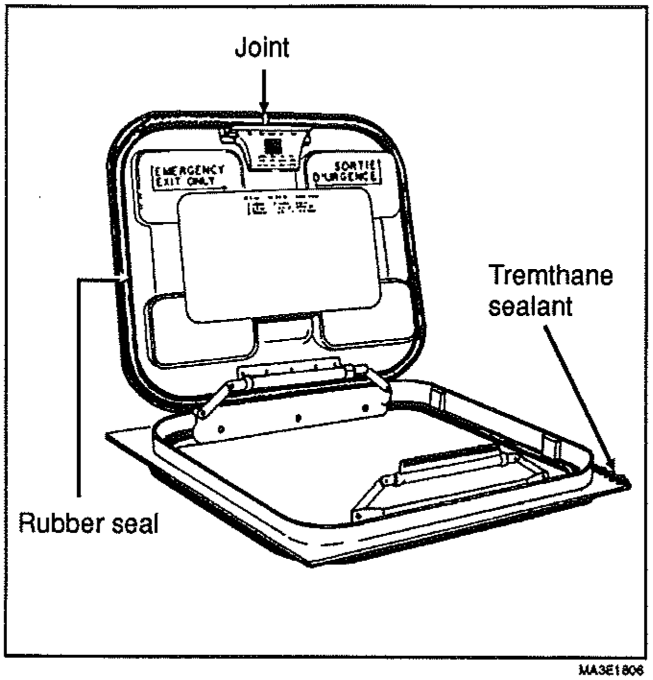


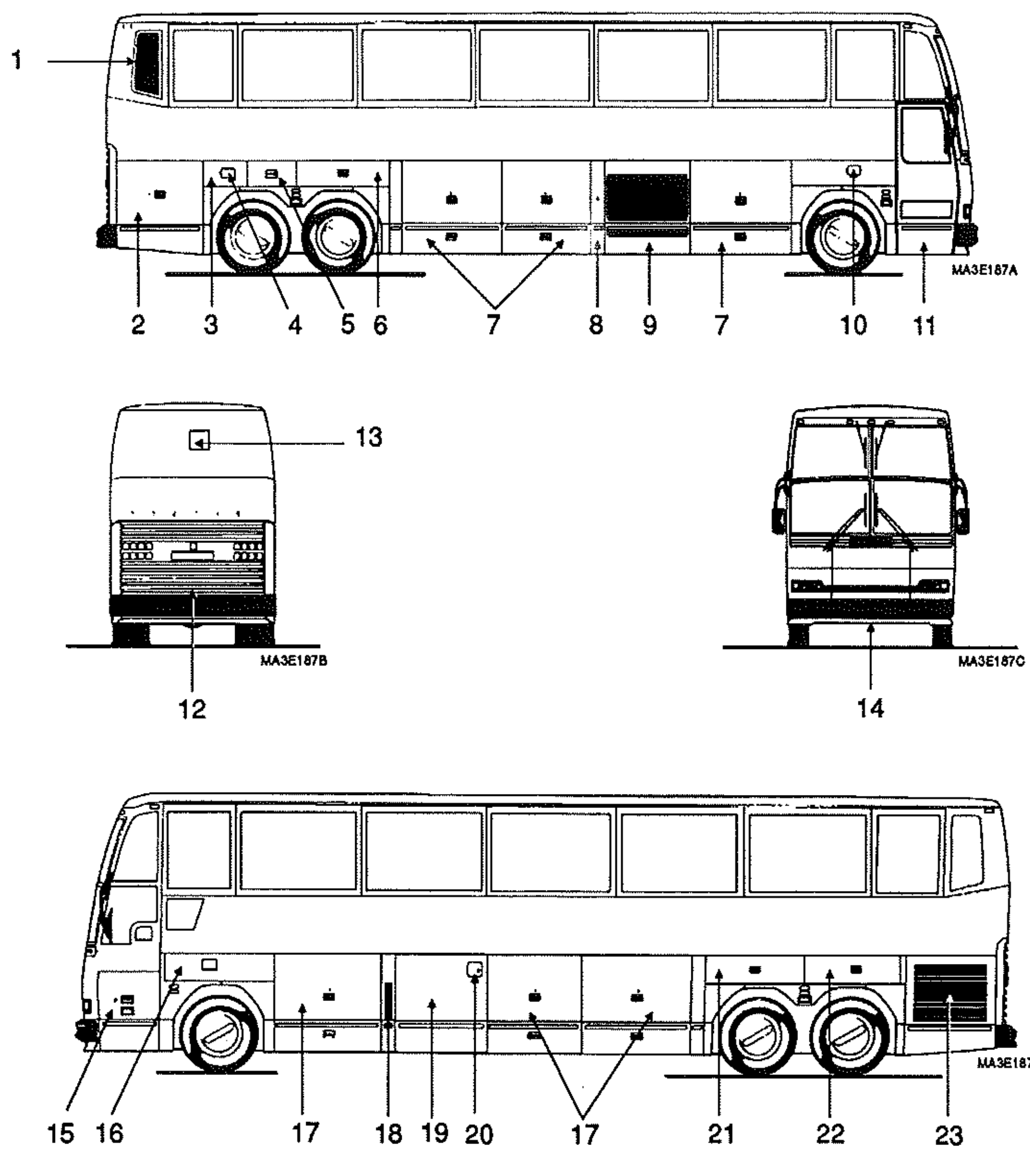
Fig. 6

1. Open and tilt up the escape hatch cover.
2. Join the 2 ends of the rubber seal.
3. Apply Tremthane sealant (68-0747) in the gap between the seal ends.
4. Apply Tremthane sealant (68-0747) along the outline of the escape hatch on the roof of vehicle.

Removal and installation

The frame of the escape hatch is riveted to the roof of the vehicle. The escape hatch panel assembly can be replaced as a unit and a new panel assembly installed in the existing frame. To remove the panel assembly, remove the 4 bolts fastening the 2 hinges to the escape hatch frame and retain the 4 flat washers. Reinstall the panel assembly by fastening the 2 hinges with the 4 bolts and flat washers removed earlier.

COMPARTMENT DOORS



1. Engine air intake duct
2. Engine compartment door (R.H.)
3. Main electrical compartment
4. Battery main disconnect switches
5. Battery compartment
6. Small baggage compartment
7. Baggage compartment
8. Fuel tank filler door
9. A/C condenser compartment
10. Entrance door control switch
11. Entrance door
12. Engine compartment
13. Retractable camera (optional)
14. Spare wheel and tire compartment
15. Front service compartment
16. Front electrical compartment
17. Baggage compartment
18. Fresh air inlet duct
19. HVAC compartment
20. Fuel tank filler door
21. Small baggage compartment
22. Rear electrical compartment
23. Radiator

Fig. 7

COACH ENTRANCE DOOR

Operation

The entrance door is driven by a spindle drive unit attached to the stepwell. Door activation is controlled by a 24-volt electro/pneumatic system which operates a magnetically controlled valve, permitting the flow of pressurized air to the spindle drive actuation piston to open and close the door. The door is controlled by a rocker switch mounted on the L.H. side control panel. The door can also be operated from outside the vehicle by manually actuating the control valve, located behind a trap door on the body panel, next to the entrance door. The spindle drive unit consists of a piston in an air cylinder and a drive unit that converts up and down motion into rotary movement. The door is made of a welded aluminum frame and covered inside and out with an aluminum skin.

In the closing cycle, the spindle drive rotates the door in toward the vehicle and the spindle drive unit is forced up. When the door seats against the door frame, the piston continues to push up, causing the preset spring to compress and allowing the door to rise and lock the side cam locks. In the opening cycle, the piston and door move down allowing the cam locks to disengage. An adjustable tie rod links the bottom of the door to the vehicle. The tie rod guides the door along a path parallel to the side of the vehicle during the opening and closing cycles.

The total rotational movement of the spindle drive is 155 degrees. To rotate the door full open to full close requires 126 degrees of movement, leaving 29 degrees of rotation. To lift the door into the locks requires 18 degrees, leaving 11 degrees of rotation not used. This unused portion of rotation is called the spindle drive reserve.

The rotating column assembly consists of the upper bearing assembly, the rotating column tube, and the coupling joint. See figure 8.

The upper bearing assembly consists of an upper pivot bearing, tension spring, and 3 shim washers. The spring determines the amount of pressure the piston must apply before the door begins to lift into the cam locks. For example, if spring tension is too low, the door will begin to lift before it is fully seated against the door frame.

The rotating column tube acts as a drive shaft for the 2 support arms. The coupling joint links the rotating column to the spindle drive.

Two support arms link the door to the rotating column tube. Each support arm is attached to the door with the use of ball joint assemblies mounted at the end of the support arms, and fastened to 2 slotted brackets on the inside panel of the door. The ball joints are sealed units and are not serviceable.

The upper support arm is attached to the rotating column tube with a one-piece clamp fastened by 2 hex-socket, 10 mm diameter cap screws.

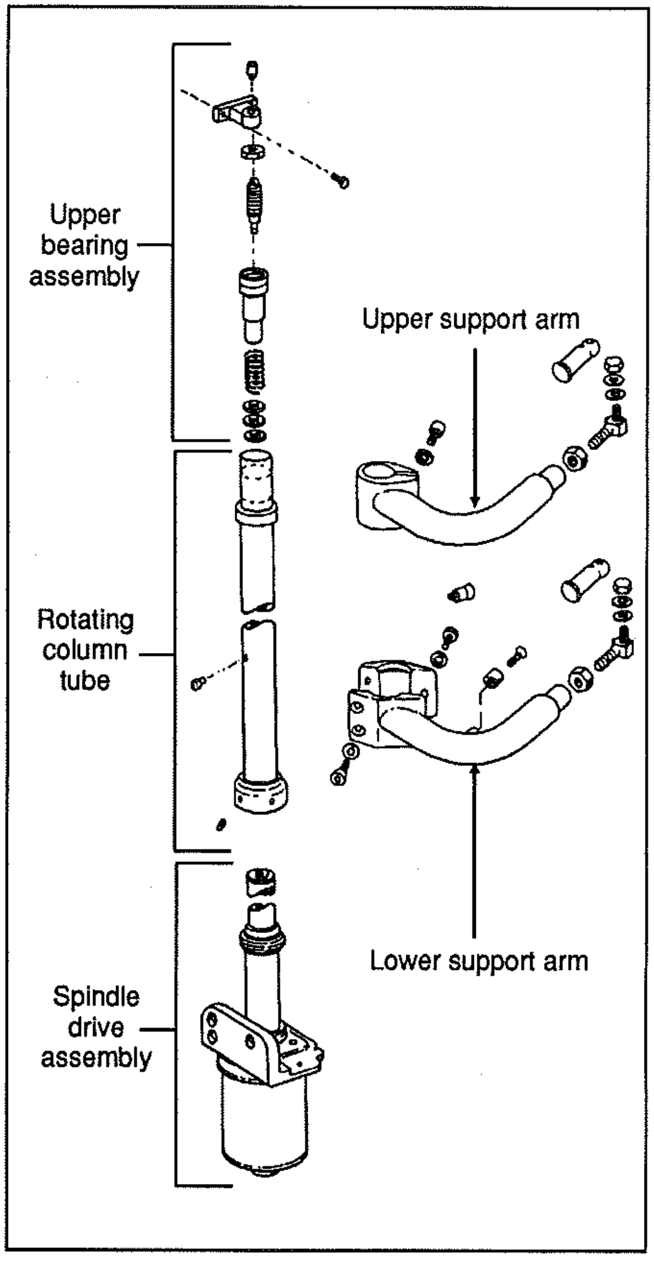


Fig. 8 - Rotating column assembly

The lower support arm clamp is a two-piece clamp assembly, fastened by 2 hex-socket, 8 mm diameter cap screws, and 1 hex- socket, 10 mm diameter cap screw. It acts as a slip joint to protect the spindle drive assembly. Check all screws regularly for proper torque.

NOTE: Torque 8 mm screws to 19 lbf•ft (26 N•m). Torque 10 mm screw to 30 lbf•ft (41 N•m).

Make sure that gap between the 2 mating surfaces of the two-piece clamp is the same on both sides of the rotating column tube when torquing lower support arm clamp.

An adjustable door stop is screwed into the inner radius of the lower support arm. To adjust the length of the door stop, loosen the lock nut, turn the stop in or out as desired and tighten the lock nut.

Adjustments

Spindle drive reserve adjustment

The spindle drive reserve adjustment is made to set the door all the way open, when the piston is within 1/2" (13 mm) from the bottom of the cylinder. The spindle drive reserve adjustment is necessary when the door opens and fails to seat tightly against the stop, or when the door fails to seat snugly against the cam locks when closing.

1. Screw door stop all the way in.
2. Apply air pressure to the cylinder to open the door.
3. Loosen the upper and lower support arm clamps, so that column can rotate freely inside the clamps and rotate column clockwise as far as it will go.
4. Release air pressure in the cylinder with the door still in the open position by turning the emergency exit valve.
5. Rotate column counterclockwise 5/16" (8 mm) while keeping support arms stationary.

NOTE: Reference marks on the column and the spindle drive bracket can be made to measure the amount of movement.

6. Tighten the lower support arm clamp.
7. Close the door to a proper fit in the contour of the opening, leaving a gap of 1/4" (6 mm) at the bottom of the door. Gap will close when upper support clamp is tightened.
8. Tighten upper support clamp, adjust door stop and reset the emergency exit valve.

Spindle drive speed adjustment

Two adjustable regulating valves are used to set spindle drive opening and closing speeds. The upper valve adjusts the opening speed and the lower valve adjusts the closing speed. See figure 9.

1. Release air pressure in the system with the emergency exit valve.
2. Turn the appropriate valve in (clockwise) completely.

NOTE: Do not overtighten the valve when closing.

3. Turn the valve in the reverse direction (counterclockwise) 2 full turns.
4. Reset emergency exit valve, operate door and check speed at normal system pressure.
5. Adjust speed to desired setting by turning valve in or out in 1/4 turn increments.

NOTE: Turn the valve clockwise (in) to decrease speed, turn the valve counterclockwise (out) to increase speed.

6. Repeat for the opposite direction using the other valve and test the adjustment.

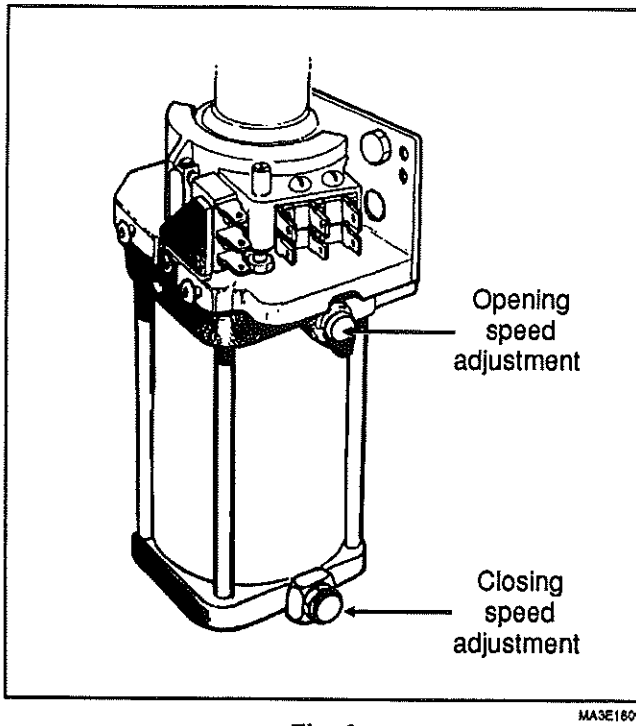


Fig. 9

Cushion adjustment

Restrictions are designed into the unit to slow down the spindle drive before the end of its cycle. The restrictions (cushions) are adjusted by means of 2 slot-head screws. The upper screw adjusts the closing cushion and the lower screw adjusts the opening cushion. See figure 10.

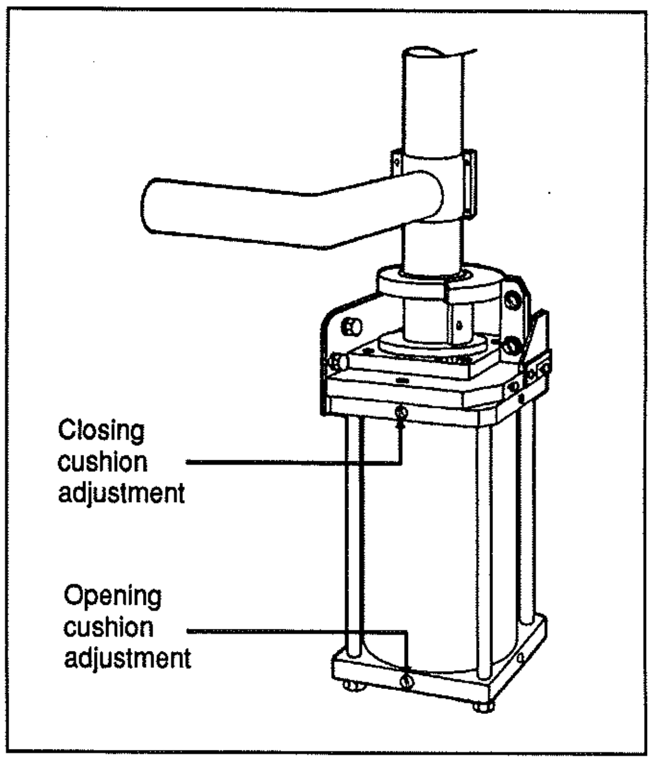


Fig. 10

1. Turn both screws all the way in (clockwise).
2. Turn each screw in the reverse direction (counterclockwise) 1.5 turns.

Door reversing switch adjustment

If the door encounters resistance before the end of the closing cycle, the spindle drive rises and the system reverses the closing cycle to allow removal of the obstruction. This occurs with the actuation of a microswitch by a plastic cam mounted vertically on top of the spindle drive. Adjust the cam to close the microswitch when the door rises a distance of 5/32" to 1/4" (3,5 - 6,5 mm). See figure 11.

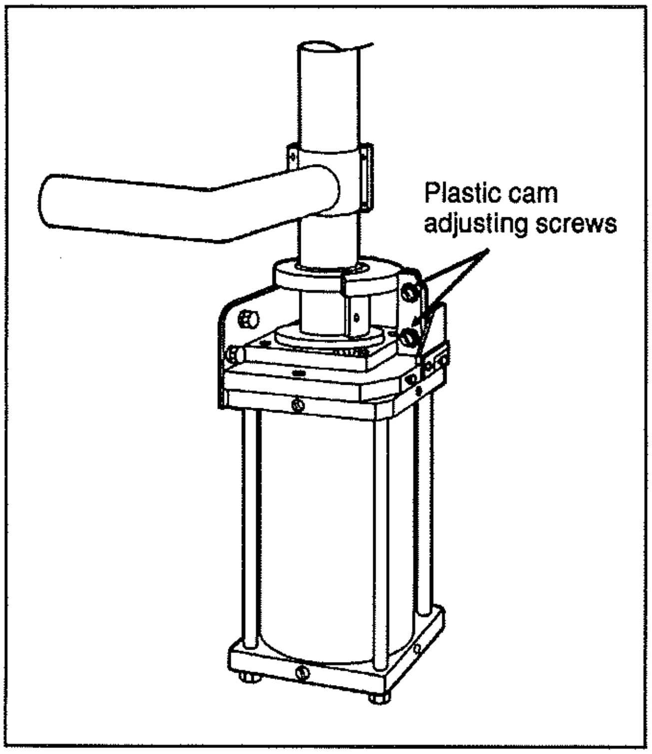


Fig. 11

The door reversing feature of the system must remain operative throughout the complete closing cycle of the door. The cam ring actuated door control switch is part of the door reversing system and must close at the proper moment to ensure good operation of the door reversing system. Refer to heading *"Cam ring adjustment"* in this section for proper adjustment.

Cam ring adjustment

The door control and accessory functions are controlled by 2 switches mounted horizontally on top of the spindle drive assembly. The 2 switches are turned on or off simultaneously by a cam ring at the lower end of the rotating column. As the door opens or closes, the cam ring turns with the rotating column to open or close the switches. The cam ring can be adjusted as follows. See figure 12.

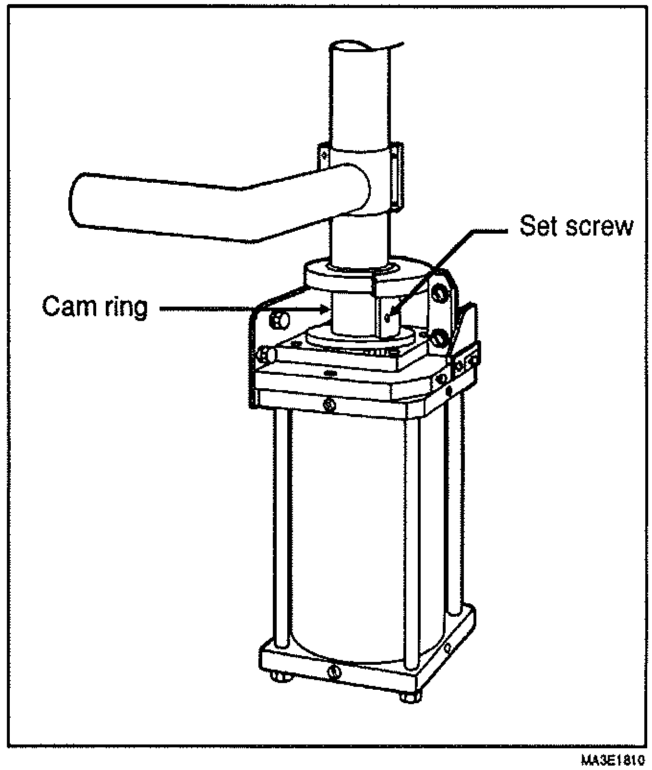


Fig. 12

1. Loosen the set screw on the cam ring.
2. Turn the cam ring to its new position.
3. Tighten the set screw.
4. Test for proper adjustment and correct if necessary.

NOTE: The cam ring should be adjusted to close the switches just before the door starts to lift in the cam locks. This will insure that the door reversing system is operational throughout the closing cycle and the accessories are turned on as soon as the door starts to open.

Door panel adjustment

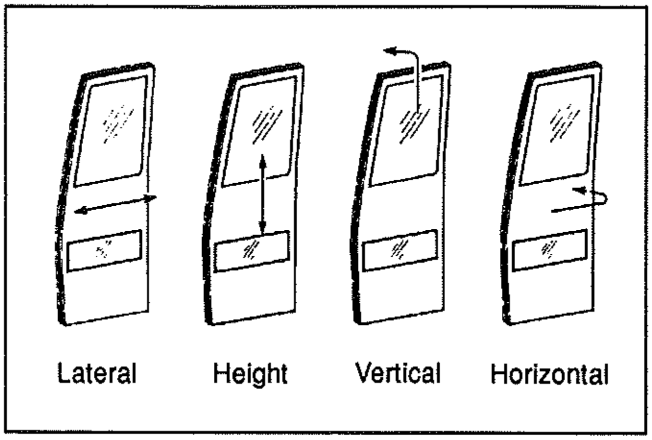


Fig. 13

Lateral adjustment

1. Loosen cap nut holding ball joint assemblies on door slotted brackets. See figure 14.

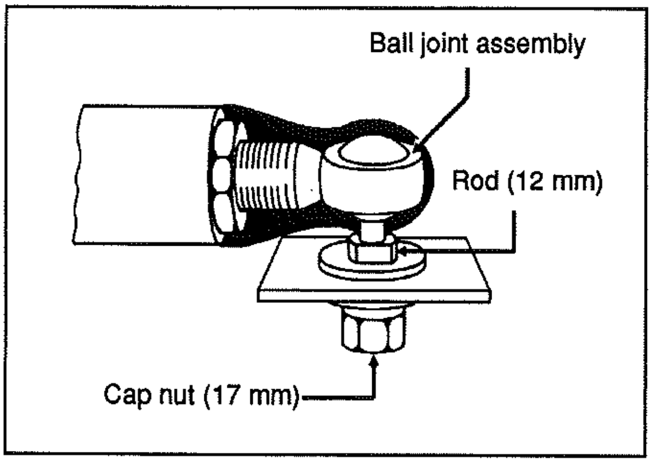


Fig. 14

2. Move ball joint assemblies slightly in the direction opposite the desired door movement. Adjust door so that clearance between door and portal is 3/8" (10 mm).

3. Tighten cap nuts holding ball joint assemblies and test adjustment.

NOTE: Although ball joint assemblies can be lengthened or shortened on the support arms, altering the factory adjustments should not be required.

Height adjustment

1. Release air in the system with the emergency exit valve and open the door.

2. Make reference marks on rotating column to indicate the initial position of the upper and lower support arm clamps.

3. Loosen lower support arm clamp and tap up 1/8 to 1/4" (3 to 6 mm) to raise the door or tap down to lower the door.

4. Tighten lower support arm clamp.

5. Loosen upper support arm clamp and tap up 1/8 to 1/4" (3 to 6 mm) to raise the door or tap down to lower the door.

6. Close the door to a proper fit in the contour of the opening, leaving a gap of 1/4" (6 mm) at the bottom of the door. Gap will close when upper support clamp is tightened.

7. Tighten upper support arm clamp, reset emergency exit valve and test adjustment.

NOTE: When the proper door height adjustment is made, the door seal should be even on top, sides, and bottom of door.

Vertical adjustment

The door vertical adjustment is made to insure that the door seals at the top and bottom when it closes.

NOTE: When doing the door vertical adjustment, loosen upper support clamp only.

1. Release air in the system with the emergency exit valve and open the door.

2. Loosen upper support arm clamp.

3. Close the door to a proper fit in the contour of the opening, leaving a gap of 1/4" (6 mm) at the bottom of the door. Gap will close when upper support clamp is tightened.

4. Tighten upper support arm clamp, reset emergency exit valve and test adjustment.

Horizontal adjustment

The door horizontal adjustment insures that the door will open with the portal edge opening out first and not jamming against the portal of the vehicle, and that the inside edge comes in first when the door closes. The horizontal adjustment is made by shortening or lengthening the tie rod linking the bottom of the door to the vehicle.

NOTE: If the edge hangs up against the portal when opening, shorten the tie rod. If the door is coming in at too much of angle when closing and leaving a gap between the door and the portal edge, lengthen the tie rod.

1. Release air in the system with the emergency exit valve and open the door.

2. Loosen the lock nuts at each end of the tie rod sleeve.

3. Turn sleeve in the desired direction to shorten or lengthen the tie rod.

4. Tighten the 2 lock nuts to secure the sleeve in the new position, reset emergency exit valve and test adjustment.

Door maintenance

1. Clean stepwell daily. Debris on step could affect door operation.

2. Remove spindle drive cover and blow dust and dirt from cover and equipment regularly.

3. Check all hardware regularly for tightness. Replace any missing or broken hardware.

4. Check all pressure lines for leaks. Tighten or replace fittings and gaskets as required.

5. Grease spindle drive with 3 to 5 injections of a SPAR 1 grease gun with high temperature grease such as Shell Alvania No 3 or equivalent.

CAUTION: Do not overgrease as equipment damage may result. Grease at approximately every 6 months.

6. Check all ball joints on tie rod and support arms for wear or damage. Ball joints are adversely affected by operating in an extreme angular position. If necessary, loosen the ball end lock nut, rotate ball end into a vertical position and tighten lock nut.

NOTE: The ball joints are sealed units and require no lubrication.

CAUTION: Damage to the ball joints and their associated fittings occurs when the ball joints are not securely tightened. The end fittings in the tie rod and support arms cause damage to the ball joints when the lock nuts securing them are not tight.

BAGGAGE COMPARTMENT DOORS

The 6 large baggage compartment doors on the vehicle are of identical design. A centrally mounted, key-lockable door handle unlatches the door which can then be pulled out and raised up in a path parallel to the side of the vehicle. The door is held in the fully open position by 2 fully extended gas-charged cylinders, giving clear access to the opening of the baggage compartment.

From its fully raised (open) position, the door can be closed by pulling down on the door panel, which will easily hinge its way back in the contour of the compartment opening and held closed by 2 latches.

Each door can be opened by lifting the centrally mounted handle to unlatch the door and lifting it all the way up. If the door does not remain in the fully open position, one or both cylinders on that door is (are) defective. To test the cylinders, first support the door in the fully open position with proper equipment. Disconnect the rod end of one cylinder and try to retract the rod. If strong resistance is felt, the cylinder is in good condition and can be reinstalled. If the rod retracts with little effort, the cylinder is defective and should be replaced at once. Test the other cylinder on that door in the same way.

The 2 small baggage compartment doors and the rear electrical compartment door open the same way as the larger doors, but hold in the open position by only one gas-charged cylinder each. The cylinders are interchangeable with the ones of the larger baggage compartment doors.

ENGINE COMPARTMENT DOOR

The engine compartment rear door also rises in the same way as the baggage compartment doors and holds open by 3 larger gas-charged cylinders. The engine compartment opens by lifting a handle accessed from the R.H. side of the engine compartment. When pushed up, the handle pulls on 2 steel wires, each steel wire connected to its respective door latch locking the rear door. Both steel wires are looped at the release handle and can be adjusted for proper length to insure positive release of both catches when the handle is raised.

FIBERGLASS REPAIR

All repairs to fiberglass parts consist of filling the damaged area with fiberglass cloth and resin or strand fiberglass and resin. The repair is allowed to harden and then the finishing operations are performed. Use of the various materials is determined by the type of repair to be made. Large holes, torn sections and separate joints require the adhesive qualities of the resin and the reinforcing qualities of the fiberglass. Small dents, scratches or pits can be repaired using resin and strand fiberglass and filler mixed into paste. Instructions for either mix are explained under their respective headings in this section.

For best results when making repairs, temperature should be between 70 and 75 °F (21-24 °C). Some people experience a skin reaction to resins. In such cases, wipe skin off with denaturated alcohol or a good thinner. Use of protective hand cream is recommended.

WARNING: Always wear a respirator and goggles when grinding or sanding.

Extreme care must be taken if the sander is electrically operated, as dust of some resins is combustible when subjected to sparks or open flames. The proper tool for sanding resin is a low speed, air driven disc sander with a water attachment or a dry sander having a vacuum bag. Either will eliminate flying glass and resin dust.

The following additional tools and materials will assist in making repairs: hacksaw blade, assorted files, emery paper or cloth (150 or finer), scissors or tin snips, wax paper or cellophane sheets, a 3" (75 mm) paint roller, paint brush, putty knife, acetone and one or more heat lamps.

Repair with fiberglass cloth

Where necessary, sand paint away around damaged area and scrape away undercoating, if any, and wipe clean with solvent. Grind or file the damaged area to form a "V" at the broken or cracked portion. Sides of "V" should have a shallow pitch for maximum bonding area.

NOTE: Roughening the surface improves adhesion of resin.

If part is warped from original shape, use clamping equipment to straighten the surface. Preheat area to be repaired with one or two heat lamps placed 12 to 15 inches (305-380 mm) from repair.

CAUTION: Temperature should not exceed 200 °F (93 °C) in order to avoid distortion.

Cut fiberglass cloth with scissors or tin snips, 1 to 3 inches (25-75 mm) larger than area to be repaired. Build area to desired height.

Mix resin and hardener following instructions on their containers. Saturate layers of fiberglass with mixture and place laminates over damaged area. Smooth out wrinkles and make sure general contour of area is maintained. Bubbles and wrinkles can be eliminated with a roller.

CAUTION: The pot life of the mix is approximately 15 minutes. Any accidental contamination to the skin, clothing, tools, etc. must be removed within this period. Use acetone to remove uncurred resin.

Heat resin material again by placing heat lamps 12 to 15 inches (305-380 mm) from repaired area. Allow 12 to 15 minutes for repair to cure. After repair is cured, grind, file or sand to contour. Files other than body files may be more suitable. Featheredge and finish sanding.

If small pits or irregularities appear after making repair, correct by using a liberal amount of chopped strand or filler mixed with resin to form a paste. Refer to heading *"Repair with fiberglass paste"* in this section.

Repair with fiberglass paste

Fiberglass paste is used for repairing small dents, scratches, and pits. Paste is made by mixing resin, hardener and fiberglass strand or filler to the consistency of putty. Where necessary, sand paint away around damaged area. On underside of coach, scrape away undercoating from damaged area, and wipe clean with solvent.

Preheat the area to be repaired using heat lamps. Mix desired quantities of resin and hardener according to manufacturer's instructions. Add powdered fiberglass strand into mixture to thicken it into a putty state.

NOTE: If repair is made on a vertical surface, adding powdered filler material to mixture will reduce tendency of hot resin to flow or run.

Apply the material with a putty knife or similar object, building material up to the desired contour. For deep filling and on vertical surfaces, several layers of material may be used.

A hacksaw blade, held flat to adjacent contour and then moved in a sawing action accross the repair when the resin is in a gel state, will remove excess resin from repair. Finish repair with the same procedure as when using fiberglass cloth.

Typical fiberglass repair procedure

Remove all loose particles or damaged material using a power sander or rasp. Clean area, overlapping hole approximately 1" to 1-1/2" (25-40 mm) all around. Remove all dirt, grease and paint from area to ensure good bonding surface. Feather the cleaned area all around. See figure 15.

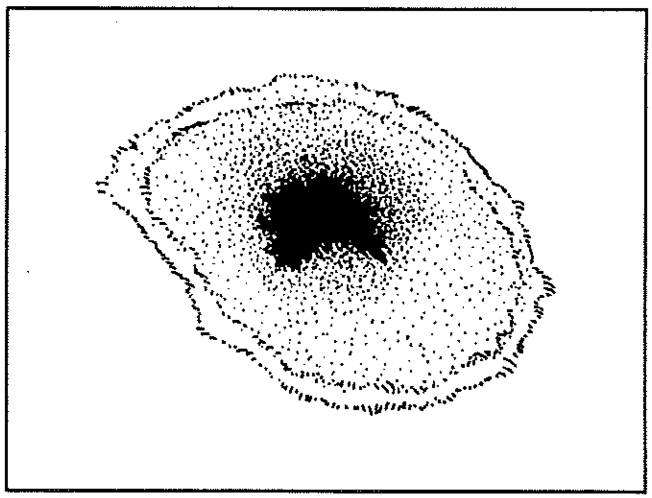
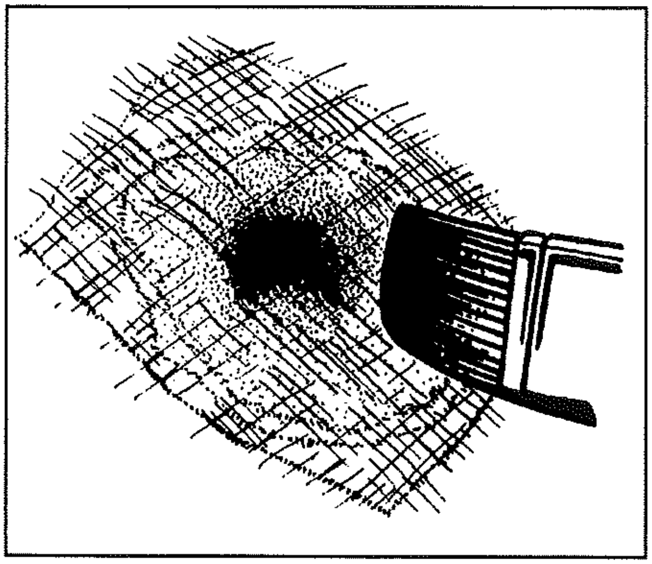


Fig. 15

Cut a piece of fiberglass mat slightly larger than area being repaired. Impregnate mat with general purpose polyester resin catalysed normally. Use a clean paint brush to apply the polyester resin. Apply impregnated mat over hole and press onto surface with brush to obtain good adherence. Another coat of general purpose polyester resin can be applied at this time. See figure 16.

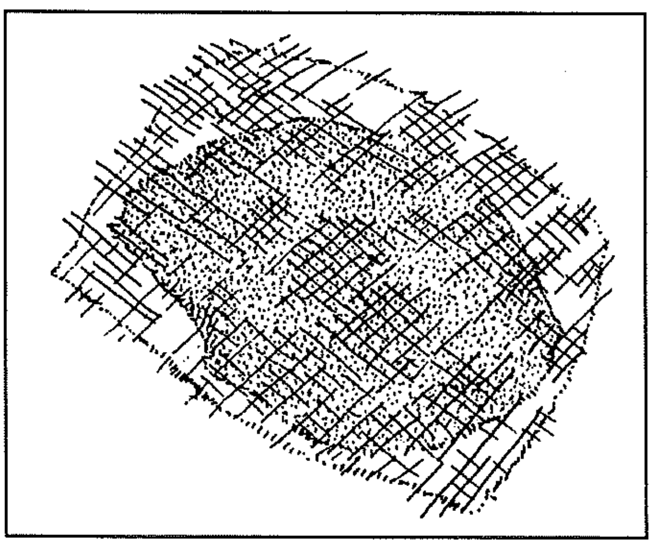


MA3E1816

Fig. 16

NOTE: Remove all air between surfaces being joined. Allow area to harden and sand surface to remove any wax.

Apply another mat, followed by a cloth patch, and another mat. All layers must be thoroughly impregnated with polyester resin, brushed well and free of air. Apply more layers of mat and cloth as required until the desired strength and thickness is obtained, minimum two 1-1/2 oz (43 g) mats and one 9 oz (255 g) cloth. See figure 17.



MA3E1817

Fig. 17

Allow area to harden and contour the area with coarse sandpaper #100. See figure 18.

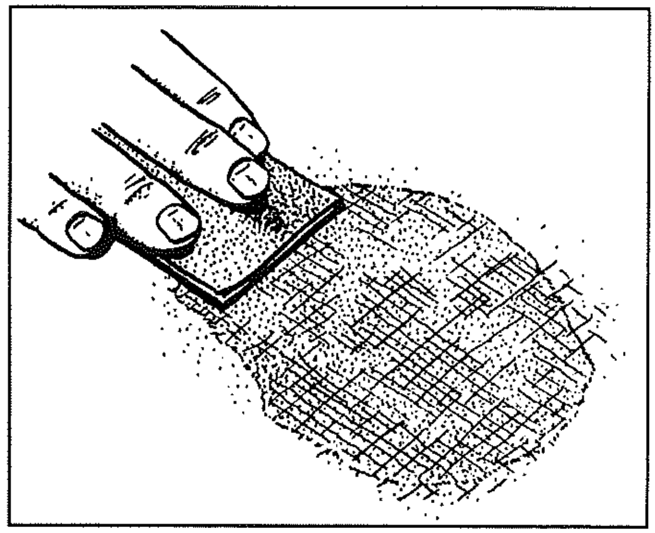


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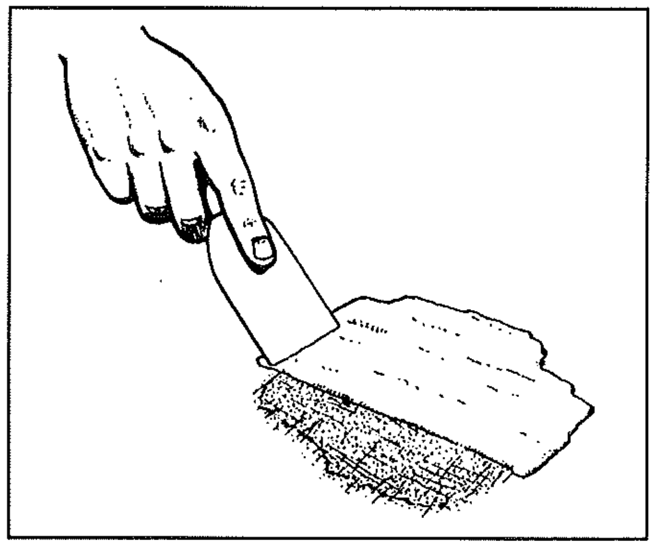
Fig. 18

Cover the area with a layer of resin putty and allow to dry for approximately 15 to 20 minutes. See figure 19.



MA3E1819

Fig. 19

Smooth off surface with coarse sandpaper #100 to desired shape. Further smooth surface with fine sandpaper #120 until repaired surface matches surrounding area panelling. Prime and paint the area to match surrounding paintwork.

PAINTING

The standard paint used on the exterior of the vehicle is DuPont's Imron. It is a high gloss polyurethane enamel finish designed for exposure to extreme conditions. The product is comprised of a pigmented base and an activator. Additional products include a drytime accelerator and a reducer. Allow surfaces to come to room temperature before painting. Other types of paint may be called for as options by the owner, but are not delt with in this section.

Safety

Care should be exercised in storing, handling, mixing, and applying paint and chemicals listed in this manual. The topcoat, primer, solvent, catalysts, accelerators, and cleaners are highly volatile and/or toxic if not properly used. Observe all safety instructions marked on the different packagings, as well as the following:

1. Do not smoke in the paint room or in any adjacent area exposed to residue fumes.
2. Wear respirators approved by the governing safety and health regulations.
3. Maintain adequate ventilation at all times.
4. Dispose properly of any leftover paint mix.
5. Wear rubber gloves, rubber apron, and face shield during all phases of paint and chemical handling.

Surface preparation

New aluminum surfaces

1. Wash with 3812S Enamel Reducer and wipe dry with clean cloths.
2. Mix DuPont M-3 Aluminum Cleaner (68-0183) with two parts of water in a plastic container and apply to the surface with a cloth or sponge. If rust or corrosion is present, use a *"Scotch-Brite"* or similar abrasive pad. While still wet, wipe dry with clean cloths.

NOTE: Work only as much area than can be coated and rinsed before the solution dries. Reapply if the solution dries before rinsing.

3. Rinse by flushing the surface with cold water or mop with a damp sponge or cloth rinsed occasionally in clean water.
4. Wipe dry with clean cloths or air dry.

New fiberglass surfaces

1. Wash the surface with 3919S Klene-Sol (68-0163). While still wet, wipe dry with clean cloths.
2. Sand thoroughly and apply 1020R epoxy primer (68-0483). Refer to heading *"Primer Application"* in this section.

New lower body panels

1. Sand with 320 grit sandpaper.
2. Wash the surface with 3919S Klene-Sol (68-0163). While still wet, wipe dry with clean cloths.
3. Apply 1020R epoxy primer (68-0483). Refer to heading *"Primer Application"* in this section.

Painted surfaces

1. Sand surface lightly with 220 grit sandpaper.
2. Wipe the surface with 3919S Klene-Sol (68-0163) to remove wax, grease and other contaminants. While solvent is wet, wipe dry.
3. Repair flaws in the painted surface by grinding off paint in the damaged areas and fill in body filler if necessary. Featheredge ground-off areas by machine or hand sanding.
4. Apply 1020R epoxy primer (68-0483) as recommended under heading *"Primer application"* in this section.

Primer application

New and painted surfaces

WARNING: Always prepare primer in a well ventilated area.

1. Prepare primer as follows and mix well:

- 4 parts 1020R epoxy primer (68-0483)
- 2 parts 1025R primer reducer (68-0480)
- 1 part 125S primer activator (68-0484).

NOTE: Pot life of primer mix is 1 hour.

2. Adjust gun pressure to 55 psi (380 kPa).
3. Spray 2 wet coats uniformly while holding gun at 8" (20 cm) and perpendicular to the surface.
4. Allow to dry for 2 1/2 hours before sanding.
5. Sand with 320 grit sandpaper and abrasive pad.

Application of DuPont's Imron paint

WARNING: Always prepare paint mix in a well ventilated area.

1. Prepare paint as follows and mix well:

- 3/4 gal (3.5 l) Imron polyurethane enamel paint
- 34 oz (1 l) 192S activator (68-0474)
- 1 oz (120 ml) 189S accelerator (68-0150)

NOTE: Imron paint mix must have a viscosity of 18 to 22 seconds using Zahn #2 viscosity tester.

2. Adjust gun pressure to 55 psi (380 kPa) for solid colors and 65 psi (450 kPa) for metallic colors.

3. Spray a thin first coat and allow to air-dry for 20 minutes.

4. Spray a second wet coat and bake-dry for 30 minutes.

5. Two-toning can be done in 6 to 10 hours at 77 °F (25 °C) and 50% humidity. Sand paint with abrasive pad.

NOTE: Allow paint to harden for 3 days before performing touch-ups, if necessary.

NOTE: Clean all equipment with lacquer thinner or reducer immediately after use.

Decal application

The following drying times should be observed to prevent blistering when applying decals over Imron paint. Overnight drying following 30 minutes drying at 180 °F (82 °C), 60 minutes drying at 140 °F (60 °C), or 120 minutes drying at 110 °F (43 °C). If sufficient time and temperature are allowed in the cure, it is possible to apply decals to the Imron surface without any blistering effect.

PASSENGER SEATS

The H3-40 coach can be equipped with any of 3 basic seat models and installed in a variety of seating arrangements:

1. The *"Tourismo"* seat is the base model and is available in heights of 40" (102 cm) and 42" (107 cm). Seating arrangement includes 2 card tables which can be folded and removed, and pivoting seats ahead of each card table. Each pair of seats is built on a welded steel frame fastened to the side wall and on a track-mounted pedestal. Standard seating capacity is 48 without mini galley and 46 with mini galley.

2. The *"Silhouette"* seat is an optional model with each pair also built on a welded steel frame and mounted the same way as the *"Tourismo"* seat. Standard seating arrangement with the *"Silhouette"* seat includes 2 card tables and 2 pivoting seats. Seating capacity is the same as with the *"Tourismo"* seat.

3. The *"V.I.P."* seat model is an optional seat. *"V.I.P"* seats are mounted on one row of paired seats built on a common frame on one side of the vehicle, and a row of single seats on the other side of the vehicle with an off-center aisle. Each *"V.I.P."* seat has its own set of armrests.

Each seat has a removable bottom cushion with snapped-on upholstery for cleaning or replacement. The *"Tourismo"* and *"Silhouette"* seats have 3 armrests. The aisle armrest is spring loaded to return to its down position when released. The center armrest can be folded up and down manually, while the window armrest is fixed.

Rotating seats

1. Remove 1 wing nut holding each seat bottom cushion from under the seat frame.
2. Lift front part of cushions and remove cushions.
3. Remove 4 wing screws fastening seat assembly to seat frame.
4. Pull seat toward aisle and rotate.
5. Align mounting holes and reinstall 4 wing screws.
6. Reinstall seat bottom cushions with wing nuts.

Removing fixed seats

NOTE: Seats on one row are not interchangeable with seats of the other row.

To remove fixed seats, proceed as follows:

1. Remove 1 elastic stop nut holding each seat bottom cushion from under the front part of the seat frame.

2. Lift front part of cushions and remove cushions.

3. Remove 4 finishing screws holding plastic cover between side wall and seat frame.

4. Remove 2 cap screws, nuts, and washers holding seat frame to side wall and retain the 2 holding brackets. See figure 20.

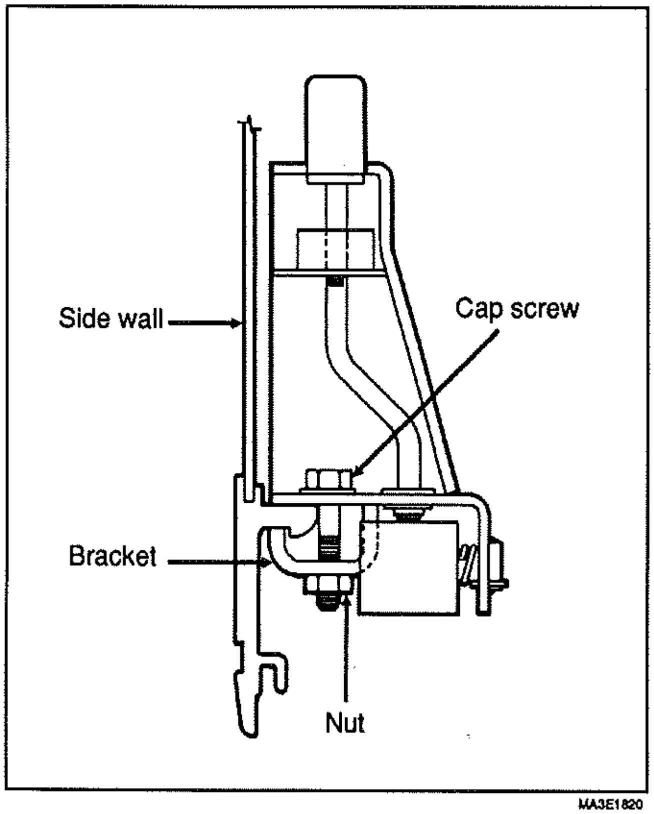


Fig. 20

5. Remove 2 nuts and washers holding seat frame to pedestal rods. See figure 21.

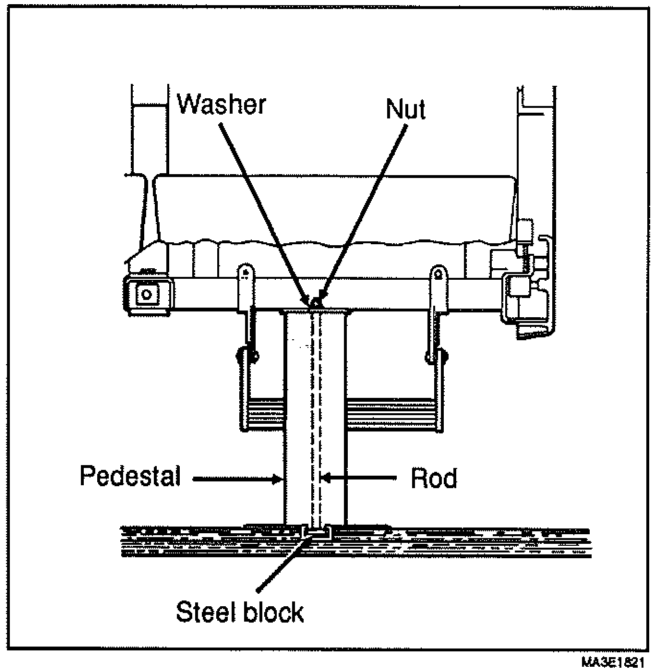


Fig. 21

NOTE: Bottom end of rod is coated with Loctite and threaded in a steel block which slides in the floor track. Removal of rod is possible if loosened from block. Otherwise, slide rod and block assembly to the front end of track after removing all other interfering seats.

6. Remove seat assembly.

7. Reverse the above procedure to install seat assembly.

NOTE: On newer vehicles, the rod consists of a carriage bolt inserted in a square plate sliding in the floor track. Removal is possible only by the front end of track.

COACH SIDE WINDOWS

Two small passenger side windows and five large passenger side windows are provided on each side of the coach. They are made of fixed, single-glazed, heat absorbing AS-3 laminated safety glass mounted in black anodized extruded aluminum frames. Three of the five large windows on each side of the vehicle serve as emergency exits. See figure 22.

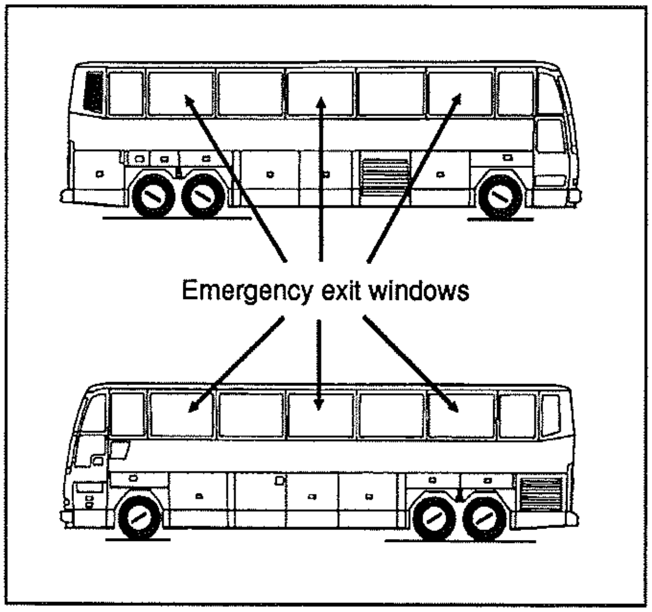


Fig. 22

An emergency exit window can be opened by pulling the lower part of the release bar, which disengages the 2 safety latches, and pushing out the window frame. See figure 23.

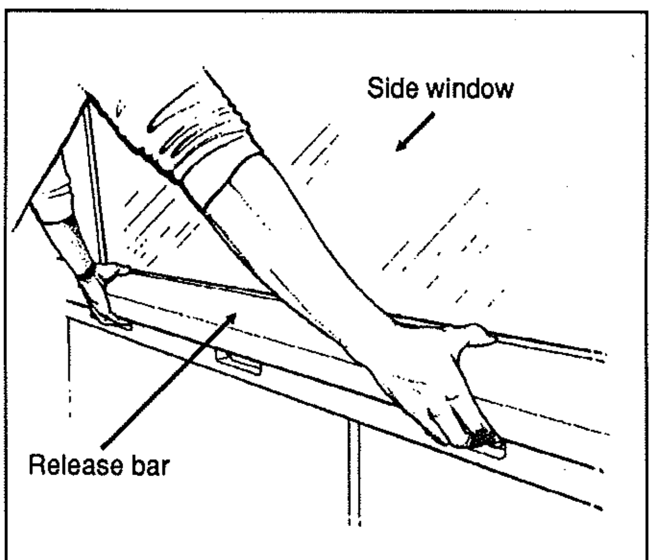


Fig. 23

Emergency operating instruction decals are affixed under each emergency exit window. To close the window, pull the 2 handles on the window frame to securely engage the safety latches in their respective locks. See figure 24.

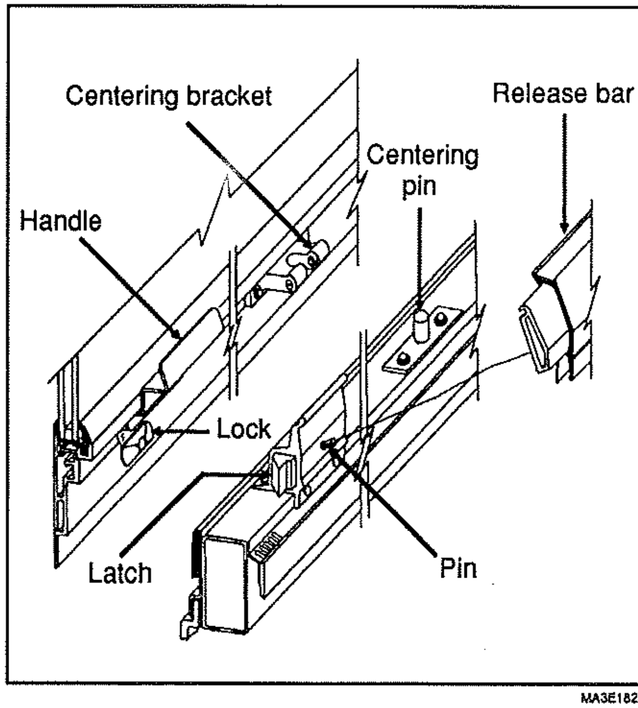


Fig. 24

Removal and installation

The emergency exit windows can be removed from the vehicle with the help of an assistant as follows. See figure 25.

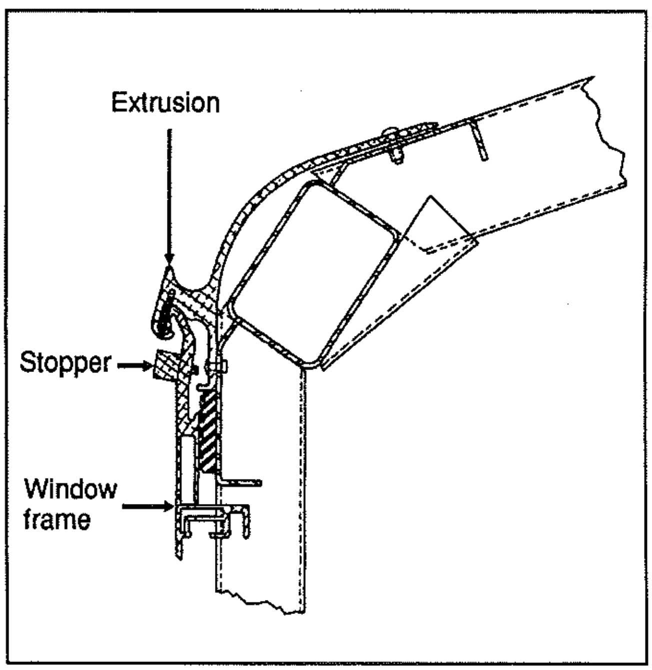


Fig. 25

1. Remove the 2 aluminum stoppers from the window frame outside the vehicle.

2. Unlock the window latches and swing the window out far enough to disengage the frame extrusions.

3. Lower the window assembly from the opening.

4. Perform the removal procedure in reverse to install the window.

The other side windows can be removed in the same way, after first removing 4 cap screws holding the bottom of the window frame to the inside wall of the vehicle. This will permit the window to swing out as an emergency exit window for removal.

Spring pins are inserted in the roof aluminum extrusion on both sides of each window to prevent fore and aft movement of the window when opened. The spring pins do not have to be removed when removing and installing a window.

Emergency exit window adjustment

Emergency exit windows should be checked periodically for easy opening and closing. Pulling the lower part of the release bar with both hands placed near the safety latches should disengage both locks on the window simultaneously. The tension required to release the window should not exceed 20 pounds (9 kg) of force. If too much effort is required to disengage the locks or if only one lock disengages when pulling the release bar, adjustment of the window locking mechanism must be made. Similarly, the window should close tightly and should not be able to shake.

The centering pin and the centering bracket should be correctly positioned before to perform the window locking mechanism adjustment. The window is correctly positioned in the opening when the centering pin aligns with the slot in the centering bracket. The 2 locks threaded in the window frame can be adjusted in or out for proper engagement in the safety latches. If the locks do not engage in the latches or require too much effort, they are threaded in too far. If the window rattles when closed, the locks extend too far out. To adjust the locks, first loosen the lock nuts and rotate the locks in or out in half-turn increments. Tighten the lock nuts when proper adjustment is made.

NOTE: Tangs on the lock must be in a horizontal position.

DRIVER'S WINDOW

The driver's side window is a fixed, double-glazed, heat absorbing AS-2 laminated safety glass mounted in its opening with polyurethane windshield adhesive. To replace a damaged or broken driver's side window, refer to heading *"Driver's window replacement"*, next in this section.

Driver's window replacement

WARNING: Wear disposable vinyl gloves during the procedure. Do not smoke. Dispose of unused toxic material properly. Heed all warnings on containers of the different products.

1. Remove previous window glass and scrape off all remaining material around the opening.

NOTE: Hardened adhesive will not remove easily. A new blade works best to remove all adhesive residue using care not to damage the fiber structure.

2. Place the new window glass in the opening and center it to leave an almost even gap top and bottom, and from side to side.

NOTE: Use small shims to raise the glass in proper position. Factory uses small pieces of Formica placed perpendicular to the window. See figure 26.

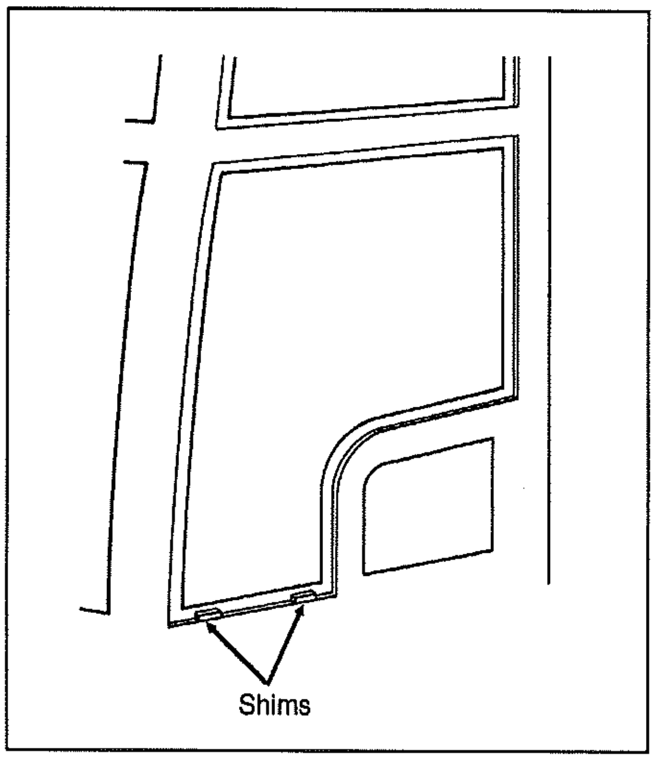


Fig. 26

3. Hold the window glass centered and have an assistant mark the inside contour of the opening on the glass with a china pencil. Remove glass and place it on a table with the pencil mark facing up.

4. Tape the glass inside and all around the outline marked with the pencil. For ease of removal, do not overlap the tape at corners. See figure 27.

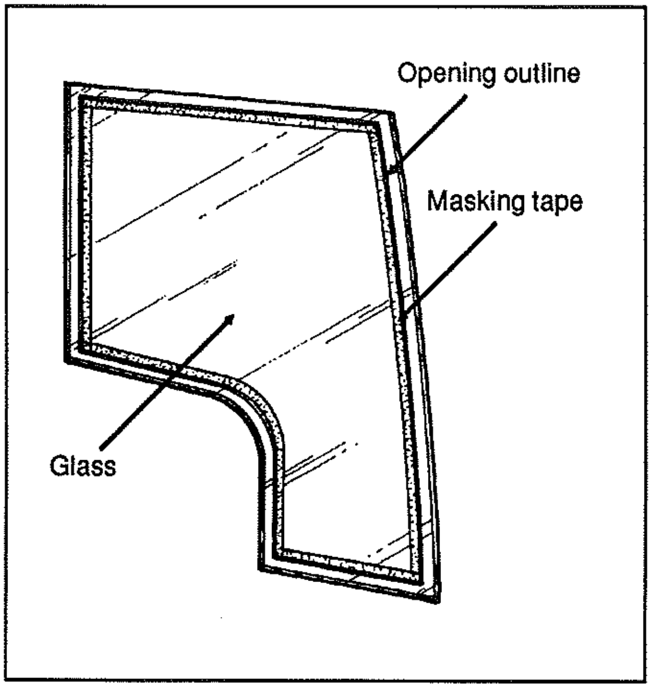


Fig. 27

5. Tape the inner and outer contour of the window opening on the structure, approximately 1/16" (1,5 mm) from the edges of the contour.

6. Clean all around the window opening and the window glass edge with isopropyl alcohol. Let dry 1 to 2 minutes.

7. Apply Tremthane primer (68-1091) all around the window opening and the window glass edge.

8. Apply a generous bead of Sikaflex-255 FC polyurethane adhesive (68-1092) on the sealing surface around the window opening from outside the vehicle. See figure 28.

NOTE: Bead should touch the side surface of the window opening.

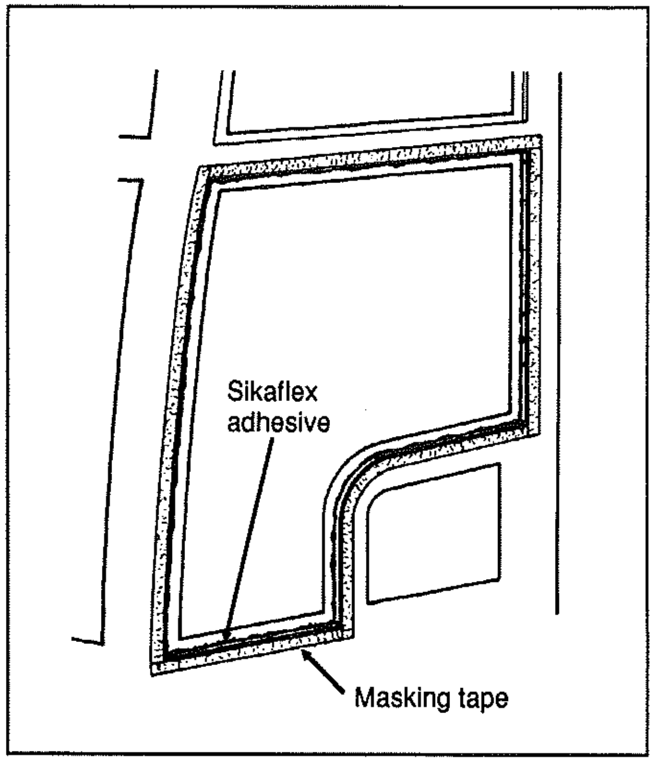


Fig. 28

9. Place shims correctly, and position window glass in the opening while pressing firmly and evenly. Adhesive will overflow between the edge of the glass and the side of the opening.

NOTE: Add adhesive in areas where overflow is minimal or if air bubbles are present.

10. Tool the adhesive to remove excess material around both sides of the window as soon as possible before adhesive dries.

NOTE: Remove most of the adhesive from the scraper or spatula with a cloth, and then dip tool in vanishing oil after each pass for cleaning.

CAUTION: Never use solvent to clean excess adhesive.

11. Remove masking tape at once, clamp window glass suitably and let dry overnight or at least 8 hours.

FRONT UPPER SIDE WINDOWS

Window replacement

WARNING: Wear disposable vinyl gloves during the procedure. Do not smoke. Dispose of unused toxic material properly. Heed all warnings on containers of the different products.

1. Remove previous window glass and scrape off all remaining material around the opening.

NOTE: Hardened adhesive will not remove easily. A new blade works best to remove all adhesive residue using care not to damage the fiber structure.

2. Place the new window glass in the opening and center it to leave an almost even gap top and bottom, and from side to side.

NOTE: Use small shims to raise the glass in proper position. Factory uses small pieces of Formica placed perpendicular to the window. See figure 29.

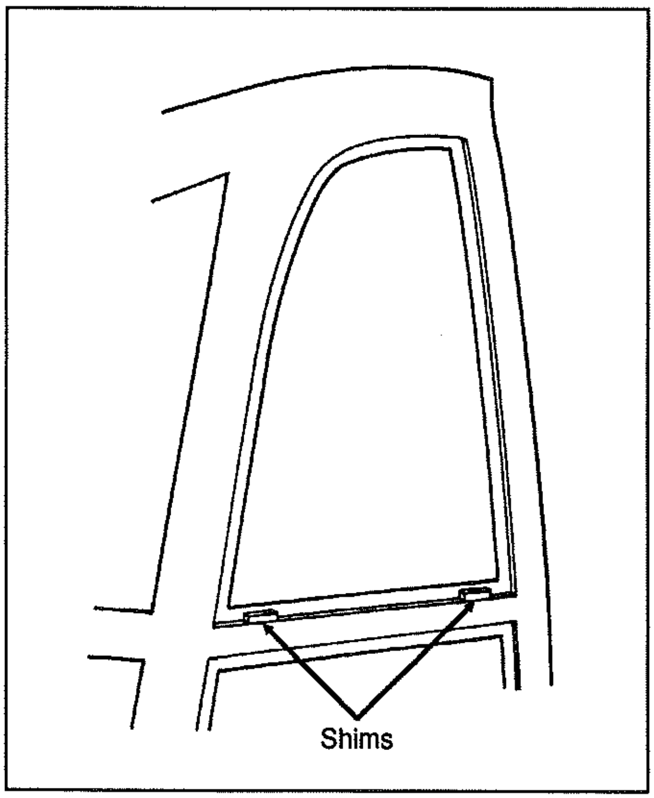


Fig. 29

3. Hold the window glass centered and have an assistant mark the inside contour of the opening on the glass with a china pencil. Remove glass and place it on a table with the pencil mark facing up.

4. Tape the glass inside and all around the outline marked with the pencil. For ease of removal, do not overlap the tape at corners. See figure 30.

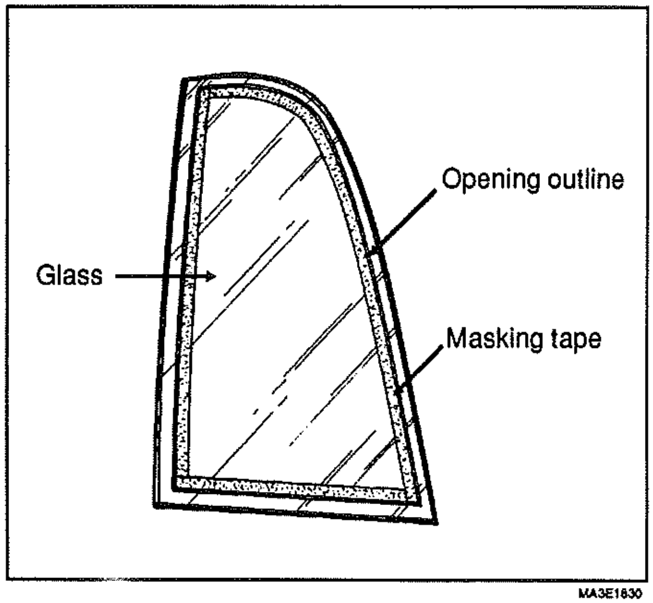


Fig. 30

5. Tape the inner and outer contour of the window opening on the structure, approximately 1/16" (1,5 mm) from the edges of the contour.

6. Clean all around the window opening and the window glass edge with isopropyl alcohol. Let dry 1 to 2 minutes.

7. Apply Tremthane primer (68-1091) all around the window opening and the window glass edge.

8. Install Tremshield tape (68-1089) around the sealing surface of the window opening. See figure 31.

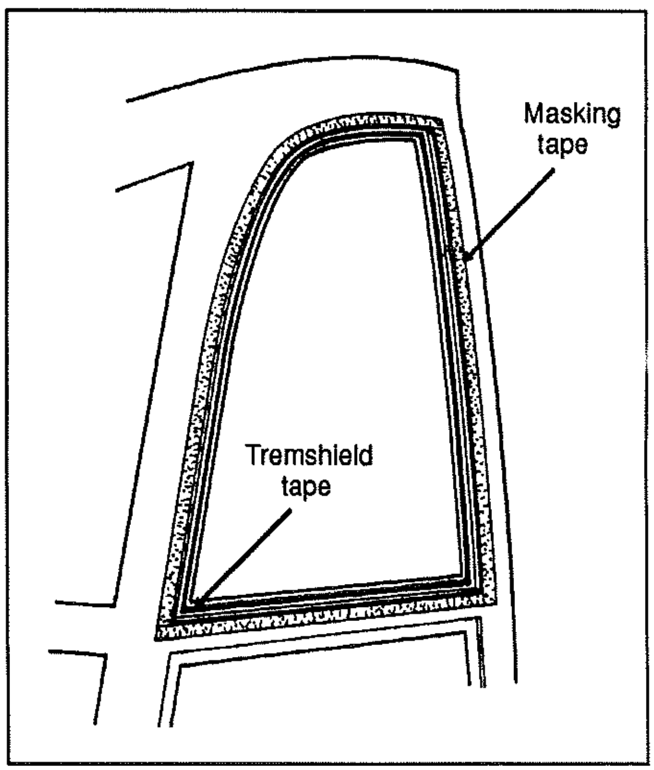


Fig. 31

NOTE: Run tape centered on the sealing surface. Do not overlap tape at corners.

9. Apply a bead of Sikaflex-255 FC polyurethane adhesive (68-1092) on both sides of the Tremshield tape around the window opening from outside the vehicle.

10. Place shims correctly, and position window glass in the opening while pressing firmly and evenly. Adhesive will overflow between the edge of the glass and the side of the opening.

NOTE: Add adhesive in areas where overflow is minimal or if air bubbles are present.

11. Tool the adhesive to remove excess material around both sides of the window as soon as possible before adhesive dries.

NOTE: Remove most of the adhesive from the scraper or spatula with a cloth, and then dip tool in vanishing oil after each pass for cleaning.

CAUTION: Never use solvent to clean excess adhesive.

12. Remove masking tape at once, clamp window glass suitably and let dry overnight or at least 8 hours.

WINDSHIELD

Each windshield is laced to a flange around an opening in the front structure by means of a one-piece black rubber extrusion and sealed with Sikaflex-255 FC polyurethane adhesive (68-1092). Proper installation of the windshields is necessary to insure watertightness. Since glass vary in fit depending on the supplier, we recommend installing replacement windshields obtained from Prevost Car Inc. to insure proper fit. Windshields obtained from another source should be checked for proper size and curvature.

Windshield removal

WARNING: Windshield removal and installation must be performed by more than one person. To avoid personal injury, wear protective gloves when handling the windshield glass.

1. Remove the wiper arms of the affected windshield.

NOTE: Remove the destination sign when replacing the upper R.H. side windshield.

2. Remove the rubber filler strip from the rubber extrusion around the windshield.

3. Run a blunt wood or plastic instrument inside channel of the rubber extrusion where the windshield is inserted, to loosen the windshield from the extrusion, from the inside and outside the vehicle all around the windshield.

4. Pry out the windshield starting at a corner and pushing the windshield out. A person on the outside then lifts the windshield up and out of the opening.

6. Clean the rubber extrusion channel with isopropyl alcohol. Refer to heading *"Windshield installation"* in this section for instructions on how to reinstall windshield.

NOTE: If the rubber extrusion is damaged, remove and discard it, then clean the windshield opening with isopropyl alcohol. Refer to heading *"Rubber extrusion and windshield installation"* in this section for complete reinstallation instructions.

Windshield installation

WARNING: Wear disposable vinyl gloves during the procedure. Do not smoke. Dispose of unused toxic material properly. Heed all warnings on containers of the different products used in this procedure.

1. Clean the rubber extrusion with wiping towels soaked with isopropyl alcohol. Wipe with dry wiping towels and let dry 1 to 2 minutes. See figure 32.

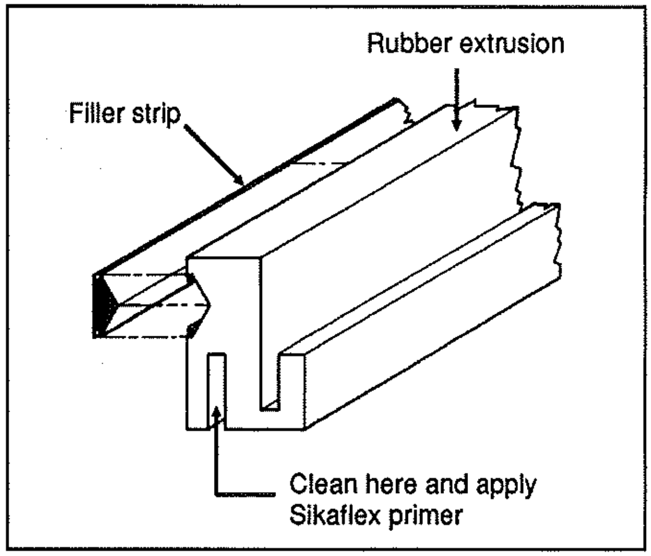


Fig. 32

NOTE: Force the soaked towels in the channels for good cleaning in these critical areas.

2. Apply Sikaflex primer 449/203 (68-1091) with a paint brush or applicator in the channels around the rubber extrusion, and let dry 20 to 25 minutes while proceeding with the next steps.

CAUTION: If more than 8 hours elapse before proceeding with the installation, repeat step 3.

3. Spray the windshield channel of the rubber extrusion with a liquid soap and water solution.

4. Install the windshield in the rubber extrusion, bottom first, and working up the sides to the top using a thin and rounded wooden or plastic piece to force the windshield in its channel. End the installation at one of the upper corners.

NOTE: Two persons should be working on both faces of the windshield simultaneously.

5. Mask the windshield following the contour of the rubber extrusion. See figure 33.

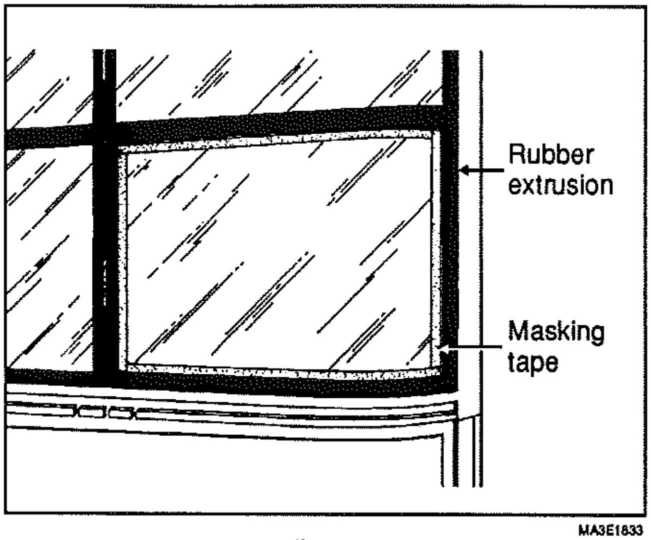


Fig. 33

6. Apply Sikaflex-255 FC polyurethane adhesive (68-1092) generously between windshield and the rubber extrusion, while inserting the tip of the adhesive tube deep in the channel. Scrape excess adhesive from windshield and clean with Klene-Sol or equivalent solvent.

7. Spray V-channel in the rubber extrusion with a liquid soap and water solution, and install filler strips in the rubber extrusion, cutting each end at a 45° angle.

NOTE: Filler strips retract with time. Install ends of filler strips as tight as possible in the V-channel.

8. Remove all masking tape and clean all areas properly. Reinstall windshield wiper and destination sign if applicable.

9. Let dry overnight or at least 8 hours before putting vehicle back into service.

Rubber extrusion and windshield installation

WARNING: Wear disposable vinyl gloves during the procedure. Do not smoke. Dispose of unused toxic material properly. Heed all warnings on containers of the different products used in this procedure.

CAUTION: The black rubber extrusion securing the windshield in the opening fits correctly in only one position. Find the correct position of the rubber extrusion now, and make reference marks with a china marker to avoid seaching for the correct position later in the procedure.

1. Clean the windshield opening sealing surfaces with isopropyl alcohol and let dry 1 to 2 minutes. See figure 34.

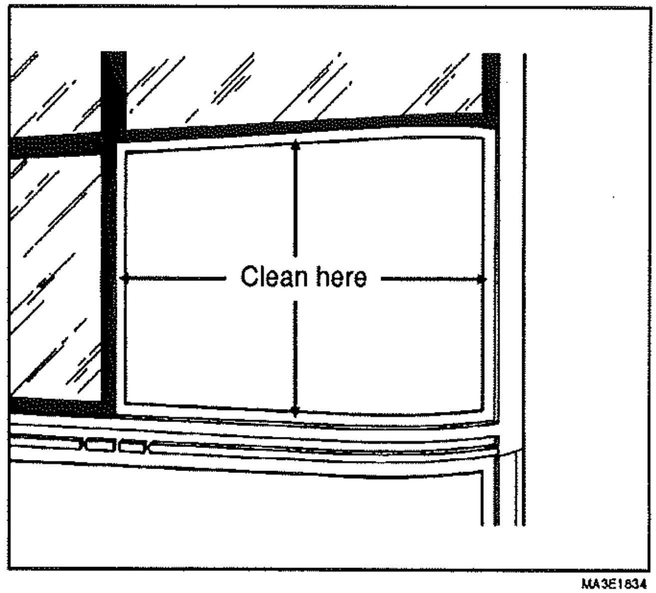


Fig. 34

2. Clean the rubber extrusion with wiping towels soaked with isopropyl alcohol. Wipe with dry wiping towels and let dry 1 to 2 minutes.

NOTE: Force the soaked towels in the channels for good cleaning in these critical areas.

3. Apply Sikaflex primer 449/203 (68-1091) with a paint brush or applicator in the channels around the rubber extrusion, and let dry 20 to 25 minutes while proceeding with the next steps. See figure 35.

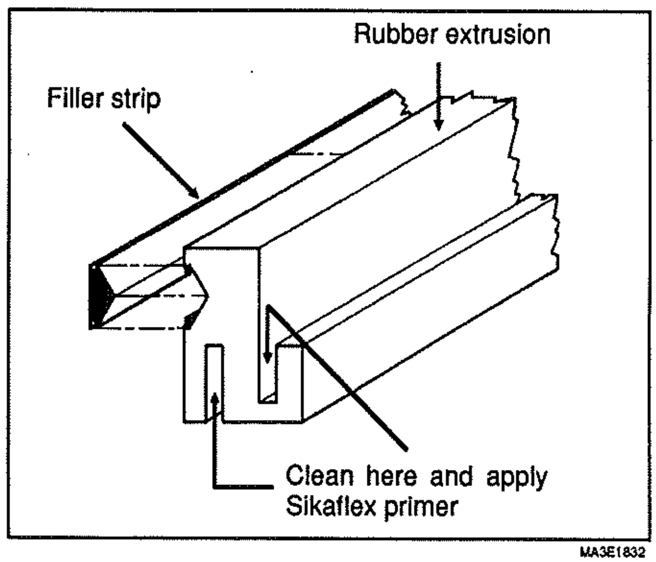


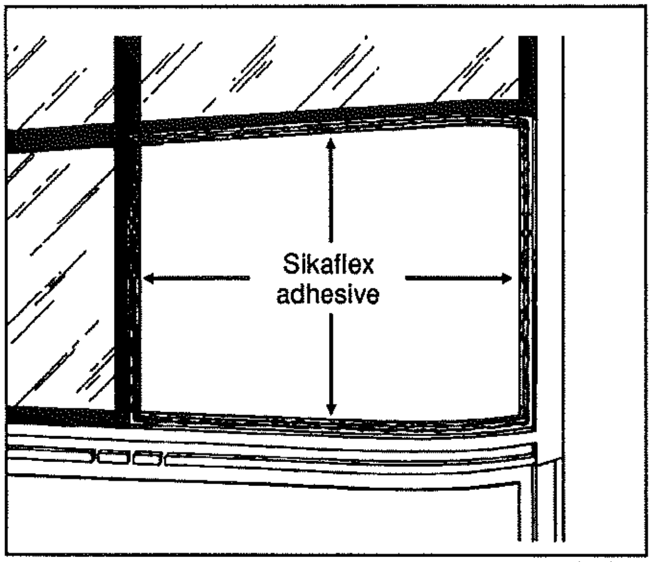
Fig. 35

CAUTION: If more than 8 hours elapse before proceeding with the installation, repeat step 3.

4. Mask the interior side of the windshield opening or apply a coat of petroleum jelly such as Vaseline to aid in removal of adhesive overflow after the installation.

5. Mask the exterior side of the windshield opening on the 2 sides not adjacent to the other windshields.

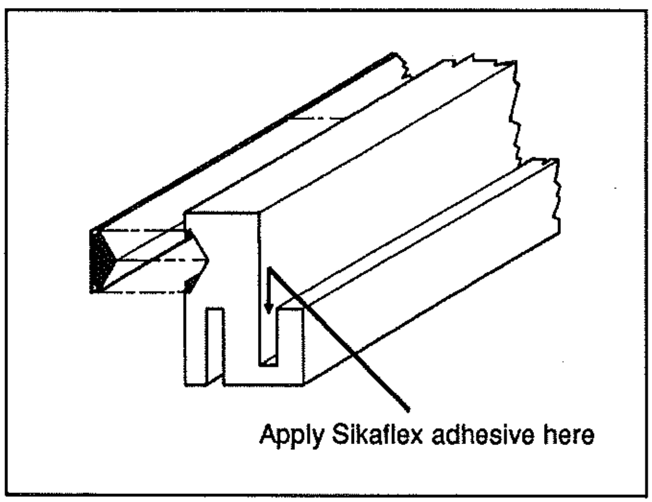
6. Apply 2 beads, parallel but not touching, of Sikaflex-255 FC polyurethane adhesive (68-1092) on the sealing surface of the windshield opening. See figure 36.



MA3E1836

Fig. 36

7. Apply Sikaflex-255 FC adhesive all around the rubber extrusion in the channel for the windshield opening flange. See figure 37.



MA3E1837

Fig. 37

CAUTION: Sikaflex adhesive hardens quickly. Continue installation immediately after application of adhesive is completed.

8. Find the reference marks made earlier and install the rubber extrusion in the windshield opening.

9. Spray the windshield channel of the rubber extrusion with a liquid soap and water solution.

10. Install the windshield in the rubber extrusion, bottom first and working up the sides to the top, using a thin and rounded wooden or plastic piece to force the windshield in its channel. End the installation at one of the upper corners.

NOTE: Two persons should be working on both faces of the windshield simultaneously.

11. Mask the outside of the windshield following the contour of the rubber extrusion.

12. Apply Sikaflex-255 FC adhesive generously between windshield and the rubber extrusion, while inserting the tip of the adhesive tube deep in the channel. Scrape excess adhesive from windshield and clean with Klene-Sol or equivalent solvent.

13. Spray V-channel in the rubber extrusion with a liquid soap and water solution, and install filler strips in the rubber extrusion, cutting each end at a 45° angle.

NOTE: Filler strips retract with time. Install ends of filler strips as tight as possible in the V-channel.

14. Add Sikaflex-255 FC adhesive where the rubber extrusion meets the front structure fiber on the 2 sides not adjacent to the other windshields. Scrape excess adhesive and clean with Klene-Sol or equivalent solvent.

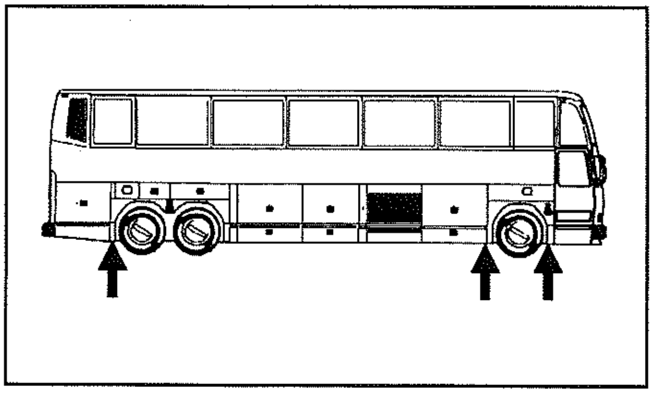
15. Remove all masking tape and clean all areas properly. Reinstall windshield wiper and destination sign if applicable.

16. Let dry overnight or at least 8 hours before putting vehicle back into service.

VEHICLE JACKING POINTS

The vehicle can be jacked by applying pressure under body jacking points or front and drive axle jacking points. When it is necessary to raise the vehicle, care should be taken to ensure that pressure is applied only at the points indicated below. Equipment for lifting the front of the vehicle must have a combined lifting capacity of 13,000 lbs (5 900 kg). Equipment for lifting the rear of the vehicle must have a combined lifting capacity of 25,000 lbs (11 400 kg).

Body jacking points

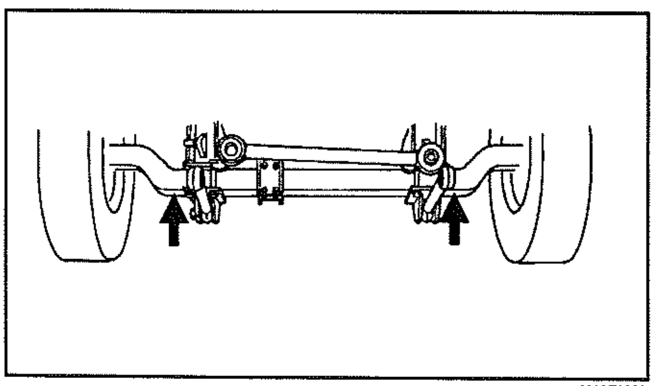


MA3E1838

Fig. 38

WARNING: The suspension of the vehicle must be in the normal ride position before jacking. The *"Level Low"* system on a motorcoach must be in the *"DRIVE"* position prior to turning the ignition key *"OFF"*.

Axle jacking points



MA3E1839

Fig. 39 - Front axle jacking points

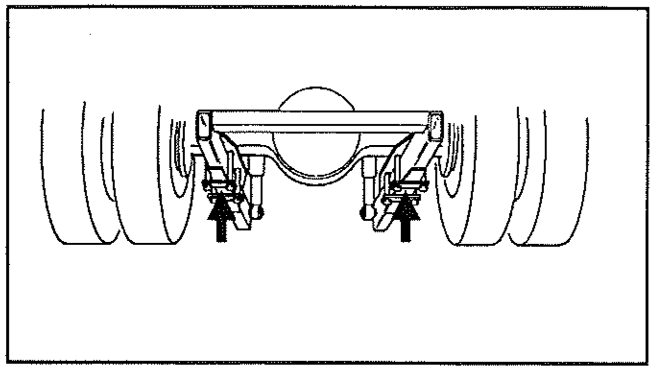


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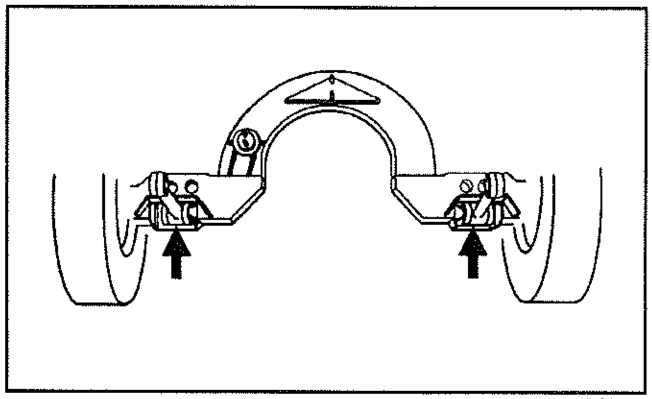
Fig. 40 - Drive axle jacking points

WARNING: Always unload or retract the tag axle before jacking the vehicle from the front and drive axle jacking points to prevent damage to suspension components.

Jacking the tag axle



MA3E1841

Fig. 41

WARNING: The jacking points on the tag axle must be used for raising the tag axle only.

TOWING THE VEHICLE

The vehicle can be transported on a low bed semi-trailer of adequate gross axle weight capacity. When transporting a vehicle, apply parking brake and shut down the engine. Block all wheels and secure vehicle with tie-downs. Check that overall height will clear obstacles on the route to follow, and obtain required permits as required.

The vehicle can also be towed by lifting under the front axle or by towing from the front with all wheels on the ground. These 2 methods are described below under their respective headings. Whatever the method used, the vehicle should be towed by truck operators authorized and experienced in towing intercity coaches.

Observe normal precautions including, but not limited to, the ones listed below when towing the vehicle:

1. Make sure the parking brake is released before towing.

2. Do not allow passengers to ride inside the towed vehicle.

3. Tow the vehicle at a safe speed as dictated by road and weather conditions.

4. Accelerate and decelerate slowly with caution.

Lifting and towing

The towed vehicle must be lifted from under the front axle only. The tow truck must be equipped with the proper lifting equipment to reach under the front axle since no other lifting points are recommended. Lifting and towing from any other points is unauthorized as it may cause serious damage to the structure. **Do not unload or raise the tag axle when lifting and towing to prevent overloading the drive axle.**

1. Remove both drive axle shafts to prevent damage to the transmission. Plug axle tube to prevent oil loss. Refer to Section 11 *"Rear Axle"* in this manual for correct procedure.

CAUTION: Transmission lubrication is inadequate when towing. With either automatic or manual transmission, the drive axle shafts must be removed to avoid serious damage to the transmission.

2. Operate the engine of the vehicle when towing to maintain brake system air pressure. If the engine cannot be operated, connect an external air pressure line from the tow truck to the emergency fill valve in the engine compartment. The emergency fill valve in the front service compartment does not supply air pressure to the brake system. The air pressure must be a minimum of 75 psi (520 kPa), and the line should be attached to the air line with a clip-on chuck.

CAUTION: Do not tow the vehicle without external air pressure applied to the emergency fill valve if the engine does not operate. Without brake system air pressure, the brakes may apply automatically if system air drops below 40 psi (275 kPa). If failure prevents releasing the parking brakes with air pressure, disengage the parking brakes mechanically.

3. Lift the vehicle from under the front axle, and secure adequately the underside to the tow vehicle lifting attachment with chains.

4. Observe safety precautions when towing.

Towing without lifting

CAUTION: When towing without lifting vehicle, use only a tow truck with a solid link tow bar and related equipment. All other means of towing are unauthorized. Tow only from the front of the vehicle.

1. Remove both drive axle shafts to prevent damage to the transmission. Plug axle tube to prevent oil loss. Refer to Section 11 *"Rear Axle"* in this manual for correct procedure.

CAUTION: Transmission lubrication is inadequate when towing. With either automatic or manual transmission, the drive axle shafts must be removed to avoid serious damage to the transmission.

2. Operate the engine of the vehicle when towing to maintain brake system air pressure. If the engine cannot be operated, connect an external air pressure line from the tow truck to the emergency fill valve in the engine compartment. The emergency fill valve in the front service compartment does not supply air pressure to the brake system. The air pressure must be a minimum of 75 psi (520 kPa), and the line should be attached to the air line with a clip-on chuck.

CAUTION: Do not tow the vehicle without external air pressure applied to the emergency fill valve if the engine does not operate. Without brake system air pressure, the brakes may apply automatically if system air drops below 40 psi (275 kPa). If failure prevents releasing the parking brakes with air pressure, disengage the parking brakes mechanically.

3. Position the tow truck so that the tow bar contacts the front bumper of the vehicle.

4. Attach the tow truck chains in the tow eyes of the vehicle under the bumper and take up all the slack.

5. Attach safety chains as applicable.

6. Observe safety precautions when towing.

SERVICE BULLETINS AND SERVICE INFORMATION LETTERS

Service Bulletins and Service Information Letters will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of publications pertaining to this section should be noted below as soon as received. These should then be filed for future reference.

NUMBER	DATE	SUBJECT

PREVOST® Service Information

March 1992 No. 92-15

Subject: SEDAN-TYPE ENTRANCE DOOR **Section: 18**

Application: **Model:** H3-40 coaches equipped with the sedan-type entrance door
VINs: Starting with 2P9H33405N1001183

Description

The purpose of this publication is to explain the operation, the adjustments and the maintenance of the sedan-type entrance door. We recommend that you append this service information to section 18 of your H3-40 maintenance manual.

Operation

The entrance door is driven by a hydraulic cylinder. Door activation is controlled by an electronic module, located in the driver's HVAC unit compartment. This module is supplied through circuit breaker #CB-85 (6 amps). The opening and closing valves transfer the air to the double acting hydro-pneumatic master cylinder located under the stepwell in the spare wheel compartment. The master cylinder drives the door cylinder and the auxiliary air reservoir supplies this system.

The door is controlled by a rocker switch mounted on the R.H. dashboard and by a toggle switch located behind the front door switch access panel (see page 2-25 in the operator's manual). In closing mode, when the proximity switch on the top of the door is facing the upper door catch, it sends a signal to the latching valve which activates the two pneumatic cylinder latches, in order to ensure a solid clamping against the door frame. Refer to the wiring/pneumatic diagram for the understanding of the system.

Emergency exit valves

From inside the vehicle, an emergency exit valve, located on R.H. side of the driver's HVAC unit access panel, releases the pressure from the lock cylinders. From the exterior, an emergency exit valve in the front service compartment, also releases the air from the cylinders. If the door has been locked with the key, a lever on the door can be moved to unlock.

Without air and with or without electricity

If the air pressure drops, and with or without electricity, the spring loaded cylinders will unlatch the door. In such a case, unlock the door by moving the lever on the door or by using the key, then open the door manually.

With air and without electricity

From inside the vehicle, turn the emergency exit valve to the "UNLOCK" position, then move the lever. From the exterior, turn the emergency exit valve to the "UNLOCK" position, then open the door. Close it, lock with the key, then reset the outside emergency exit valve to the "NORMAL" position.

Adjustments and maintenance

The horizontal and vertical positioning and the door depth in its frame are adjustable. The stroke of the door cylinder and the door opening speed are not adjustable. The speed is controlled by a locked pressure regulator.

Horizontal and vertical adjustments

1. Remove the screws and the plastic moulding covering each of the hinges.

NOTE: Ask an assistant to help you to perform the following adjustments.

2. Remove the Allen button head screw and the washer retaining the rod end with bearing to the upper hinge. See figure 1.

3. Support the door with a wooden block and a hydraulic jack.

4. Loosen the horizontal bolts retaining the door to the hinges, adjust the door horizontally and vertically with the jack, tighten the bolts to 30-36 lbf•ft (40-50 N•m), then remove the jack and the wooden bloc.

CAUTION: Make sure the front side door does not interfere with the exterior panel.

5. Pull and fix the rod end to the hinge with the washer and the button screw.

6. Using the screws, fix the plastic mouldings covering the hinges.

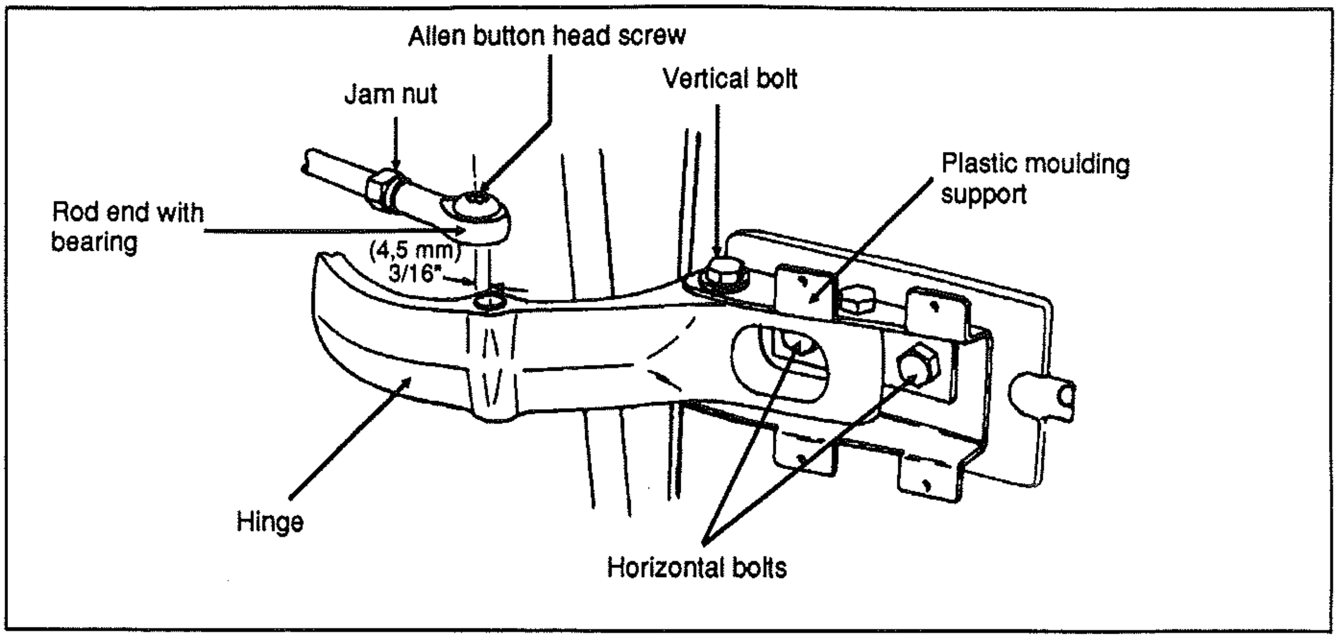


Fig. 1

Depth adjustment

1. Turn the emergency exit valve to the "UNLOCK" position.

2. Remove the screws and the plastic moulding covering each of the hinges.

NOTE: Ask an assistant to help you to perform the following adjustments.

3. Remove the Allen button head screw and the washer retaining the rod end with bearing to the upper hinge. See figure 1.

4. Loosen the vertical bolts on the hinges for the front section, and for the rear section, move the central door catch on the door frame.

5. To adjust the male dovetail on L.H. side of the door, remove the two screws and loosen the two bolts. Slide toward the interior the male dovetail and lightly tighten the two bolts. Close the door slowly but firmly, slowly open it, then tighten the two bolts. Fix dovetail to the door with the screws. See figure 2.

NOTE: The frame dovetail is not adjustable.

6. Pull and fix the rod end to the hinge with the washer and the button screw.

7. Using the screws, fix the plastic the mouldings covering the hinges.

8. Reset the emergency exit valve to the normal position.

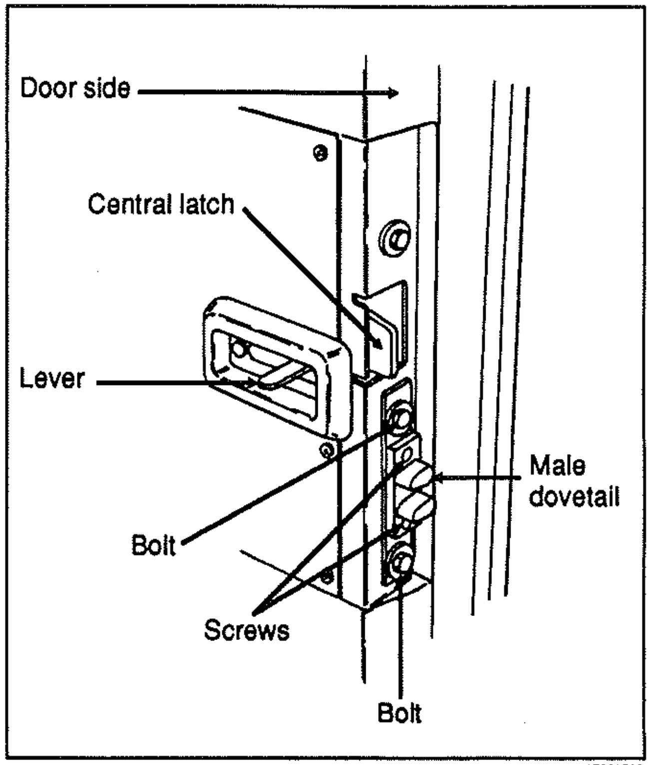


Fig. 2

Rod end with bearing adjustment

1. Turn the emergency exit valve to the "UNLOCK" position.

2. Remove the screws and the plastic mouldings covering the upper and lower hinges.

3. Remove the Allen button head screw and the washer retaining the rod end with bearing to upper hinge. See figure 1.

4. Loosen the jam nut locking the door cylinder rod end with bearing. Close the door firmly, adjust the rod end with bearing center hole in order to be 3/16" (4,5 mm) eccentric toward the left with the hinge hole center, then tighten the jam nut.

5. Pull and fix the rod end to the hinge with the washer and the button screw.

6. Using the screws, fix the plastic mouldings covering the hinges.

7. Reset the emergency exit valve to the normal position.

Proximity switch adjustment

Adjust the proximity switch by removing the screw retaining the plate on the top of the door panel. Carefully lift the plate, loosen the jam nut, then adjust the proximity switch; closer to the door catch will activate the lock cylinder latches earlier. Using the screw, fix the plate.

Lubrication

	Lubricant	Frequency
- Latches - Upper door catch	Multipurpose grease	Each six months
- Door locking mechanism	White grease	Each six months
- Key hole - Bearing of rod end - Hinges	Low viscosity oil	Each six months

CAUTION: Ensure there is no grease on the proximity switch or on the door catch facing the switch because it will not operate.

Hydraulic system filling

The hydraulic system uses a solution of 50% of antifreeze ethylene glycol base and 50% of water. The system contains approximately 1.1 U.S. quart (1 liter).

NOTE: Ask an assistant to help you to perform this procedure.

1. Insert a 3/16" (5 mm) I.D. hose on each drain cock of the door cylinder and on the liquid side of the master-cylinder, then submerge the hose ends in a clear glass container partially filled with a clean antifreeze solution.

2. Open the two door cylinder drain cocks.

3. Open the door and with an adhesive tape, maintain the door switch to the "ON" position to maintain the system under pressure.

4. Close the door manually, then the hydro-pneumatic system should be as shown in figure 3.

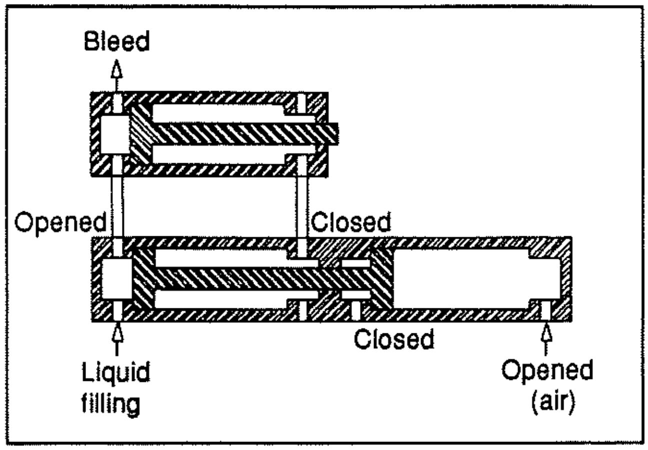


Fig. 3 - Door closed

5. Fill the master cylinder with a low flow rate and pressure pump (less than 75 psi (515 kPa)), through the filling cock. See figure 3.

6 Close the L.H. door cylinder drain cock immediately when the liquid flows into the container, then pump until the door be fully opened, without pressurizing the system. See figure 4.

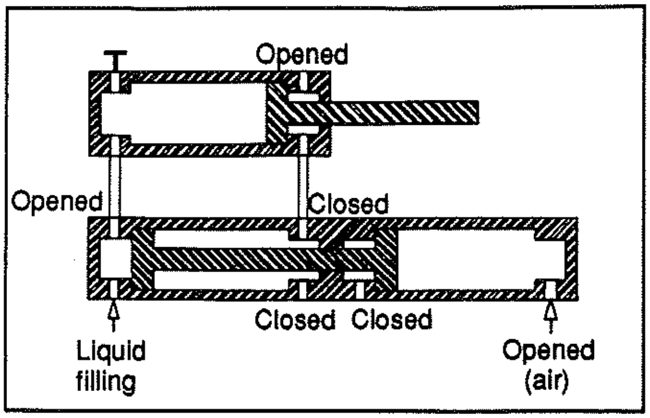


Fig. 4 - Door opened

7. Close the L.H. cock on the master cylinder. See figure 4.

8. Remove the adhesive tape and close the door by pushing the switch.

9. Open the drain cock on the door cylinder and the filling cock on the master cylinder piston side. See figure 5.

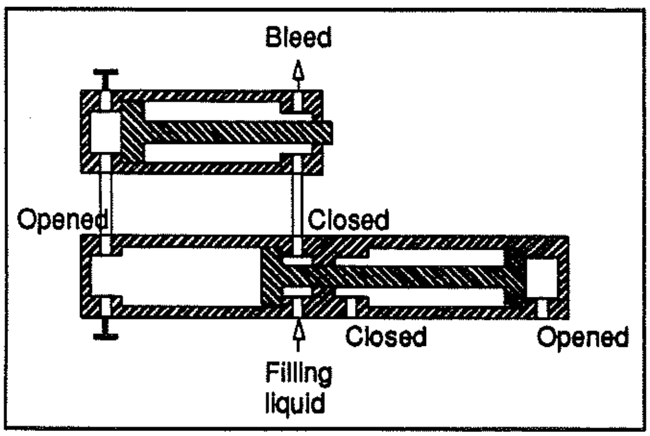


Fig. 5 - Door opened manually

10. Pump the liquid on the system until it flows into the container.

11. While you are pumping, slowly open the door in order to fill the master cylinder while exhausting the air from the cylinder.

12. Once the door is fully opened, close all cocks, then remove the pump.

13. Bleed the system. Refer to the bleeding procedure.

Bleeding procedure

Bleed cycles must be performed after each filling or when the system leaks.

Piston side bleeding

1. Open and close the entrance door to bring air to the door cylinder.

2. Insert a 3/16" (5 mm) I.D. hose on the door cylinder L.H. drain cock.

3. With the door closed, slowly open the L.H. drain cock on the door cylinder, while pressurizing with the pump on the master cylinder through the L.H. cock, then close the door cylinder cock.

4. Repeat steps 1 and 3 until there is no more air in the cylinder.

5. Remove the pump and the hose.

Cylinder side bleeding

1. Open and close the entrance door to bring air to the door cylinder, then fully open the door.

2. Insert a 3/16" (5 mm) I.D. hose on the door cylinder R.H. drain cock.

3. With the door opened, slowly open the R.H. drain cock on the door cylinder, while pressurizing with the pump on the master cylinder through the R.H. cock, then close the door cylinder cock.

4. Repeat steps 1 and 3 until there is no more air in the system.

5. Remove the pump and the hose.

NOTE: Dispose of antifreeze in accordance with the effective municipal, provincial and federal regulations.

Specifications

Master cylinder

Manufacturer . . . . Bimba
Type . . . . Hydro-pneumatic, 1/4 NPT
I.D. . . . . 2" (50 mm)
Stroke . . . . 9" (230 mm)
Prevost number 78-0498

Door cylinder

Manufacturer . . . . Bimba
Type . . . . Hydraulic, double acting, 1/4 NPT
I.D. . . . . 2" (50 mm)
Stroke . . . . 8" (205 mm)
Prevost number 78-0499

Lock cylinder (upper)

Manufacturer . . . . Bimba
Type . . . . Air, single action, 1/8 NPT, hexagonal rod
I.D. . . . . 7/8" (22 mm)
Stroke . . . . 1" (25 mm)
Prevost number 64-1213

Lock cylinder (central)

Manufacturer . . . . Bimba
Type . . . . Air, single action, 1/4 NPT
I.D. . . . . 1 3/4" (45 mm)
Stroke . . . . 1" (25 mm)
Prevost number 64-1209

Manifold solenoid

Manufacturer . . . . Norgren
Type . . . . 4 ports, 1/8 NPT
Voltage . . . . 24 VDC
Power consumption . . . . 6 watts
Maximum pressure . . . . 150 psi (1 035 kPa)
Prevost number 64-1130

Solenoid valve (Latching valve)

Manufacturer . . . . Humphrey
Model 310
Operating range . . . . .0 to 125 psi (0 to 860 kPa)
Voltage . . . . .24 VDC
Voltage tolerance . . . .+10%, -15% of rated voltage
Power consumption . . . . 4 watts
Leak rate (max allowed) . . . . .0.245 in^3/min @ 100 psi (4 cc/ min @ 690 kPa)
Type of operation . . . . Direct solenoid
Lubrication . . . . Not required (factory pre-lubed)
Filtration . . . . 40 micron recommended
Prevost number 64-1217

Pressure regulator

Manufacturer . . . . Norgren
Recommended pressure setting . . . . 100 psi (609 kPa)
Supplier number R07-100-RNKA
Prevost number 64-1219

Proximity switch

Manufacturer . . . . Honeywell
Voltage . . . . 9,6 to 30 VDC
Type . . . . Normally closed
Supplier number 922AB3XM-B9N-L
Prevost number 56-2233

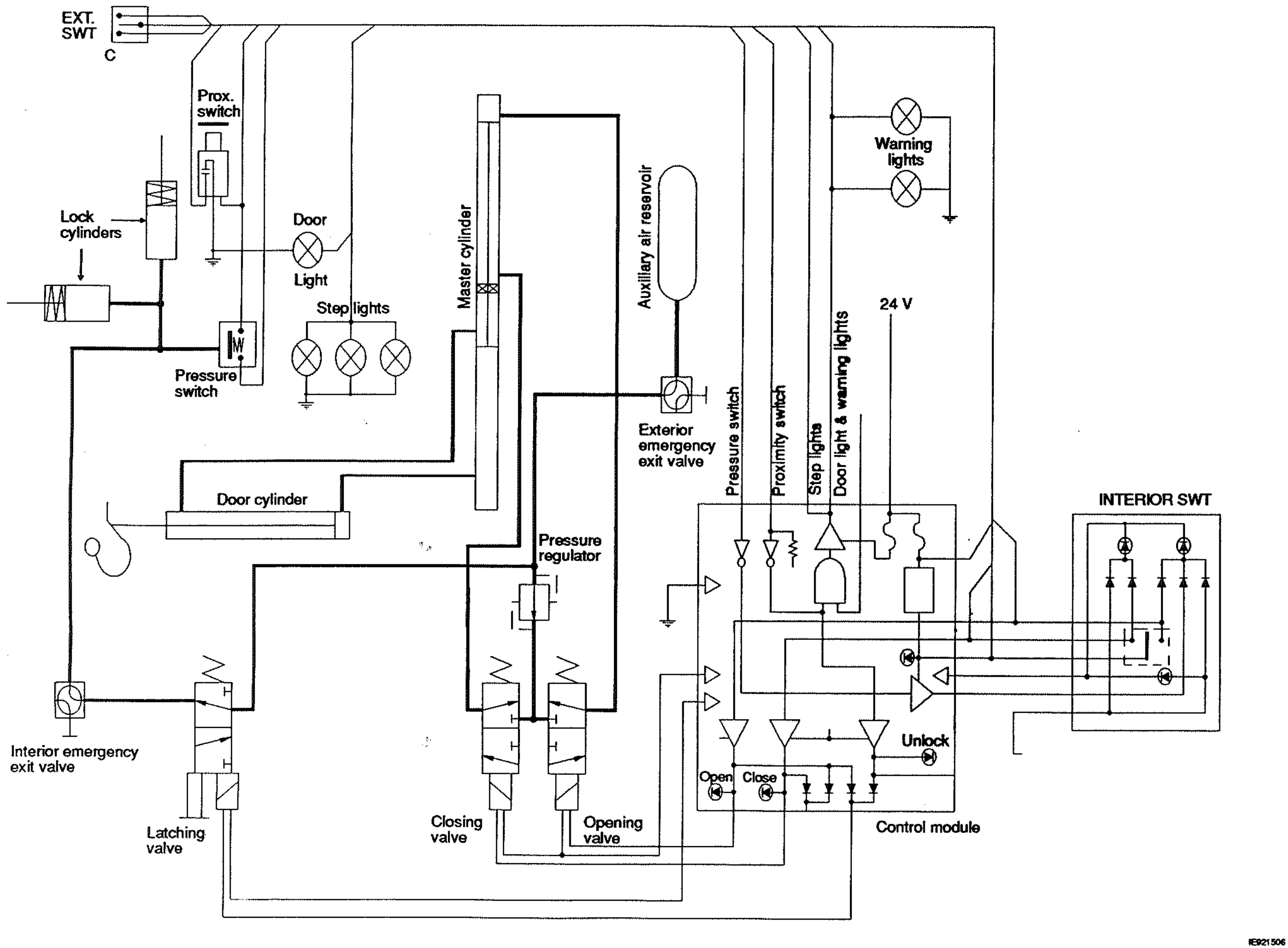
Pressure switch assy

Prevost number 45-2043

Electronic module

Prevost number 06-3188

CONTROL SYSTEM FOR H3-40 HINGED DOOR
DOOR CLOSED WITH AIR AND 24 VDC



22

HEATING AND AIR CONDITIONING

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GENERAL DESCRIPTION

The coach interior is pressurized by its Heating, Ventilation, Air Conditioning (HVAC) units. Air flow and controls divide the vehicle in two sections; driver's and passenger's sections.

The interior of vehicle should always be slightly pressurized to prevent dust and moisture from entering vehicle. Each section has its own fresh air, returning air and discharge air ducting. The exhaust is mainly done through the lavatory ventilator and through normal air-tightness losses.

AIR CIRCULATION

Driver's area

Fresh air is taken from a plenum behind the front bumper and enters the mixing box through an adjustable damper. Returning air is taken through a front dash panel into the mixing box. The *"Driver A/C-heating recirc.-fresh air"* control is located on the R.H. dashboard control panel. Mixed air goes through cooling and heating coils, fans and discharge ducts.

The right discharge duct will defrost about 2/3 of the windshield. The left discharge duct will defrost the rest of the windshield in front of the driver. The driver can also, with the *"Main windshield defroster"* control, diverts this air flow to the console, from which he can direct vent to his feet, knees and/or breast (see fig. 1).

Passenger's section

Fresh air is taken from the left side of vehicle through a two-position damper located between the first and second baggage compartments. The pneumatic control damper can be fully opened for normal operation or partially closed for extreme weather or highly polluted areas; the *"Fresh air damper"* switch is located on the R.H. side lower control panel. Refer to the Operator's Manual for details.

Return air is drawn through the last entrance step riser and from the lower section of the floor ducts in three locations; two in the rear section of vehicle (one on each side) and the other in the front section of vehicle on the L.H. side (see fig. 2).

A double blower fan unit, which is activated by the evaporator motor, draws mixed air through an air filter, cooling and heating coils, then forces this air in the ventilation ducts (upper section) along the walls, and finally exhausts it at the bottom of the windows.

The lavatory ventilator acts as the main exhaust for the whole vehicle, eliminates odors, and finally heats or cools the lavatory with the vehicle ambient air.

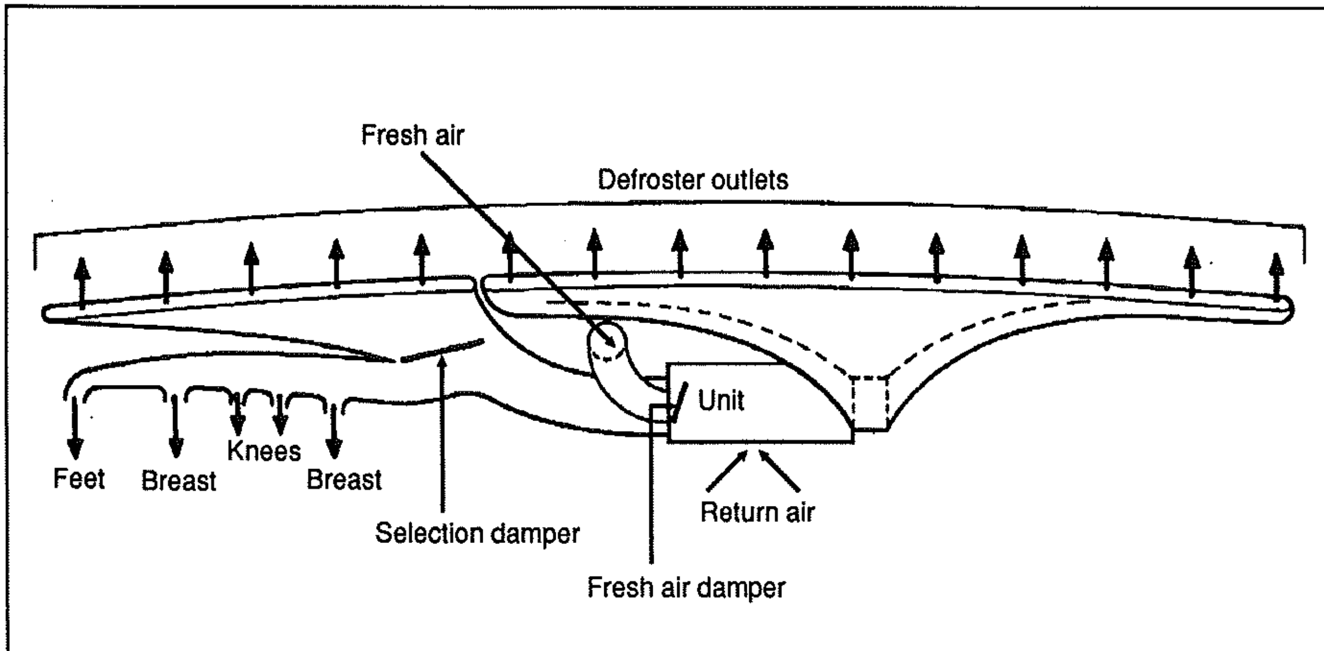

FIG. 1 - Driver's air circulation

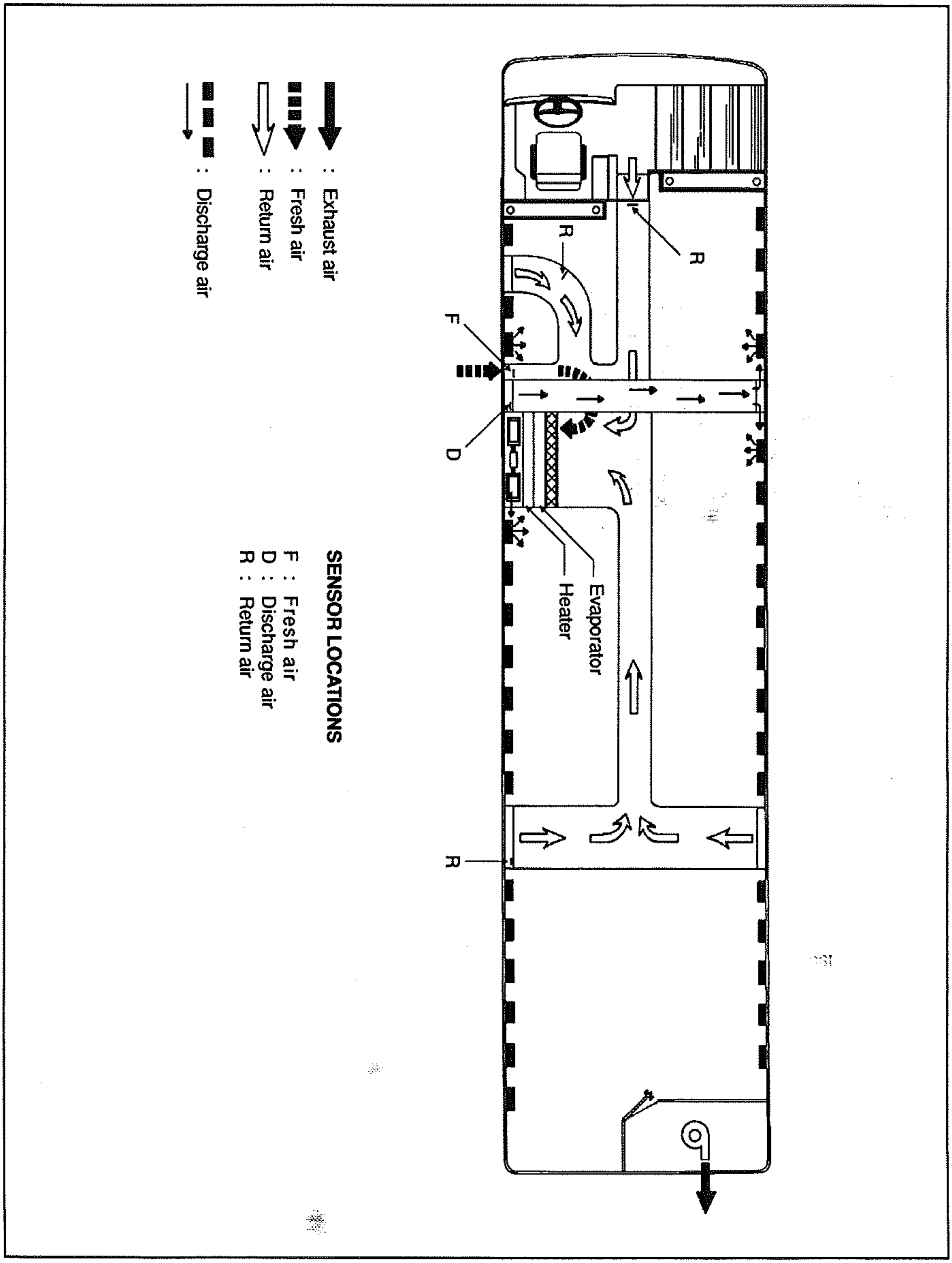

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FIG. 2 - Main HVAC system air circulation

DRIVER'S HVAC SYSTEM OPERATION

The temperature control in the driver's area is provided by the *"Driver's A/C - Heating temperature"* control mounted on the R.H. dashboard control panel, which is in fact a potentiometer, and by a thermistor sensor located under dashboard close to the accelerator pedal. At extreme clockwise position, the temperature control will deliver full heat without any control.

The fan speed will be set by the position of the *"Driver's A/C - Heating ventilation speed"* control, also mounted on the R.H. dashboard control panel which has two functions. The clicking noise produced while turning the control, activates the heating or A/C system according to the *"Driver's A/C - Heating temperature"* control position; this control also acts as a potentiometer. Consequently, it is possible to gradually increase speed of fan motor from 25% to maximum speed. An electronic module, mounted on the driver's HVAC unit, analyzes the value sent to the potentiometer, and thus sets the motor speed. This installation ensures economical operation, and a wide range of speeds.

The driver's HVAC unit piping is paralleled with the main HVAC unit piping. Both units use the same refrigerant and coolant, and are linked to the same condenser and compressor, even if they are individually controlled. It requires the main HVAC unit to engage the A/C compressor magnetic clutch. Consequently, the driver's unit cannot be operated in the A/C mode alone.

MAIN HVAC SYSTEM OPERATION

The *"Passenger A/C - Heating"* switch, located on the R.H. side lower control panel, operates the A/C-heating and ventilation system (HVAC) in passenger's section. The *"Passenger A/C - Heating temperature"* control, located on the R.H. side dashboard control panel, enables the selection of the temperature in passenger's section (refer to the Operator's Manual for details). The evaporator motor installed in evaporator compartment (compartment located between the first and second baggage compartments on L.H. side of vehicle) is protected by a 150 amp, manually-resettable circuit breaker mounted on the Main power junction sliding support (refer to section 06 *"Electrical system"* in this manual for details).

The condenser mounted on the opposite side of the evaporator is ventilated by two axial fans. Each axial fan motor is protected by a manually-resettable 40 amp circuit breaker mounted on the L.H. side wall of the A/C and heating junction box. Furthermore, the feeding circuit of these two breakers is protected by a 150 amp manually-resettable circuit breaker mounted on the Main power junction sliding support.

To operate air conditioning system when coach is stationary, engine should run at fast idle. During operation of air conditioning system, windows should be kept closed and door not left open longer than necessary. In order to prevent battery discharge, A/C-heating system will not operate if vehicle charging system is not working properly.

The heating and cooling components (hot water pump, air solenoid valves, A/C compressor clutch and unloaders, etc) are connected to the HVAC logic panel mounted on the A/C and heating junction box sliding drawer (see fig. 3).

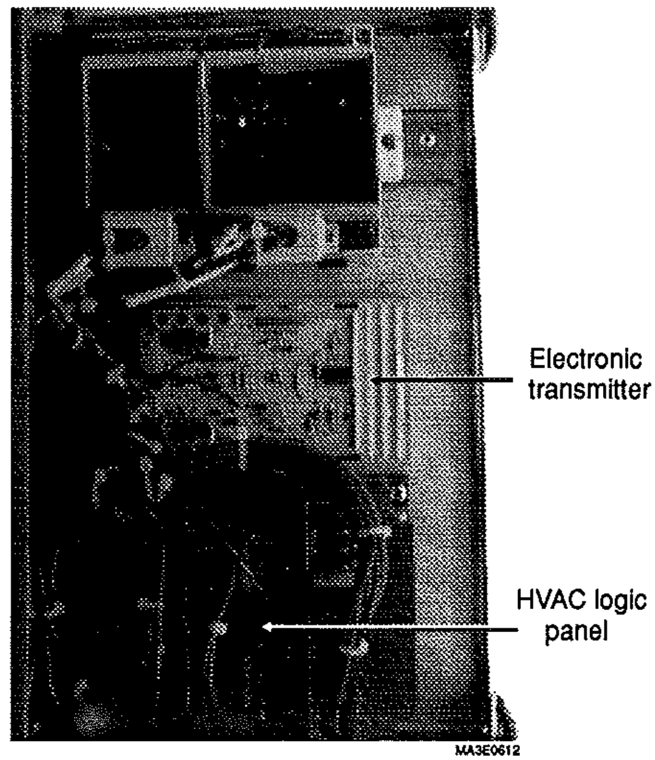
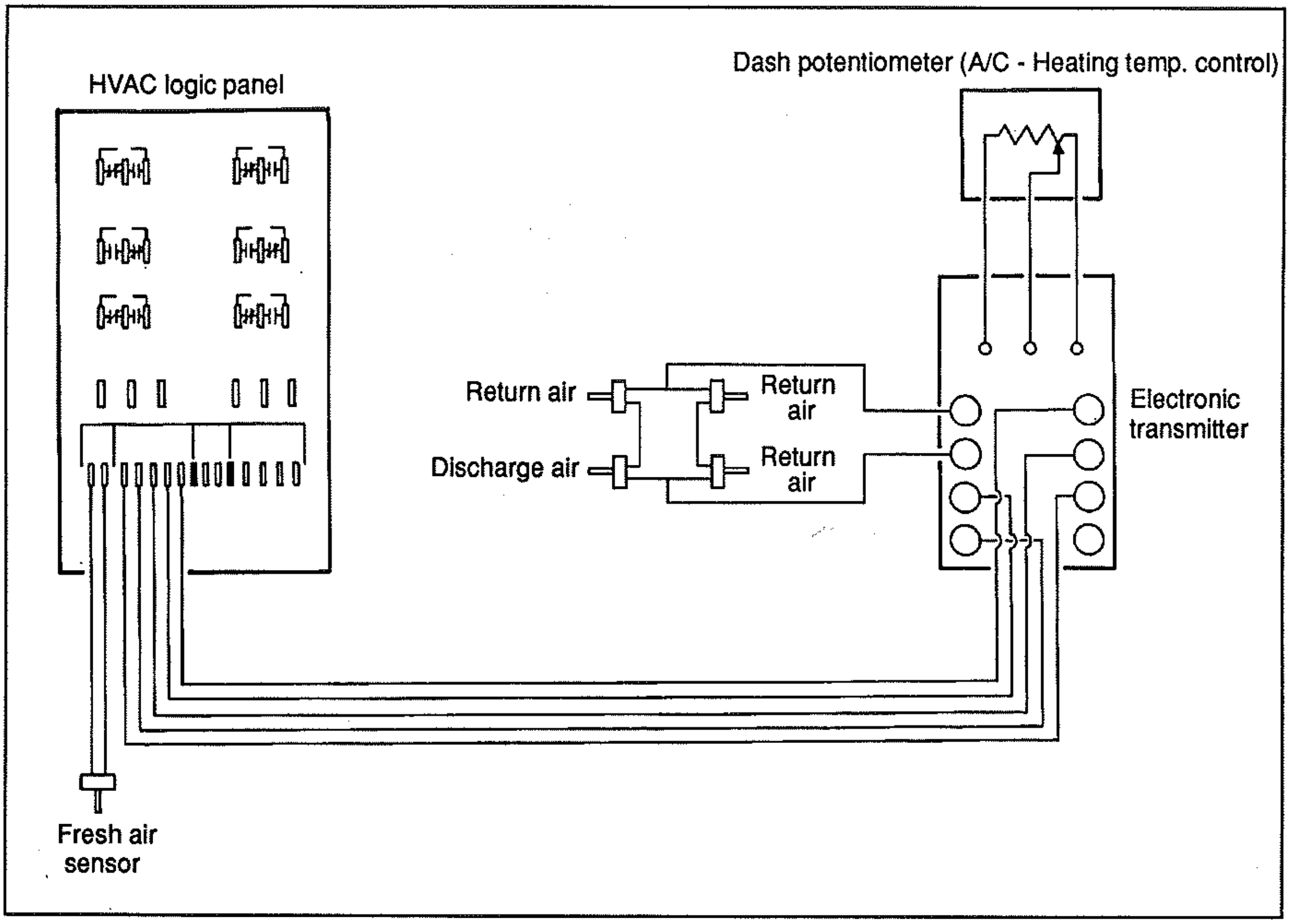


FIG. 3 - A/C and heating junction box sliding drawer

Air temperature is picked up by 3 identical sensors, each one located in one of the 3 returning air ducts, and by another sensor located in the discharging air duct (see previous fig. 2). As shown on figure 4, the sensors are series-parallel connected. The electronic transmitter (see fig. 3 and 4) detects the sensor signal and then compares it with the driver's setpoint (*"Passenger A/C - Heating temperature"* control, which is mounted in R.H. dashboard control panel).

This will result in a voltage range (see fig. 5) for the HVAC logic panel. At this point, a fresh air sensor located in the fresh air damper on L.H. side of vehicle, can modify this range to anticipate any major change in the outside temperature. Afterwards, the HVAC logic panel will select the appropriate mode and staging according to the actual conditions.



HVAC logic panel
Dash potentiometer (A/C - Heating temp. control)
Return air
Discharge air
Return air
Return air
Electronic transmitter
Fresh air sensor
MA3E2204.IMG

FIG. 4

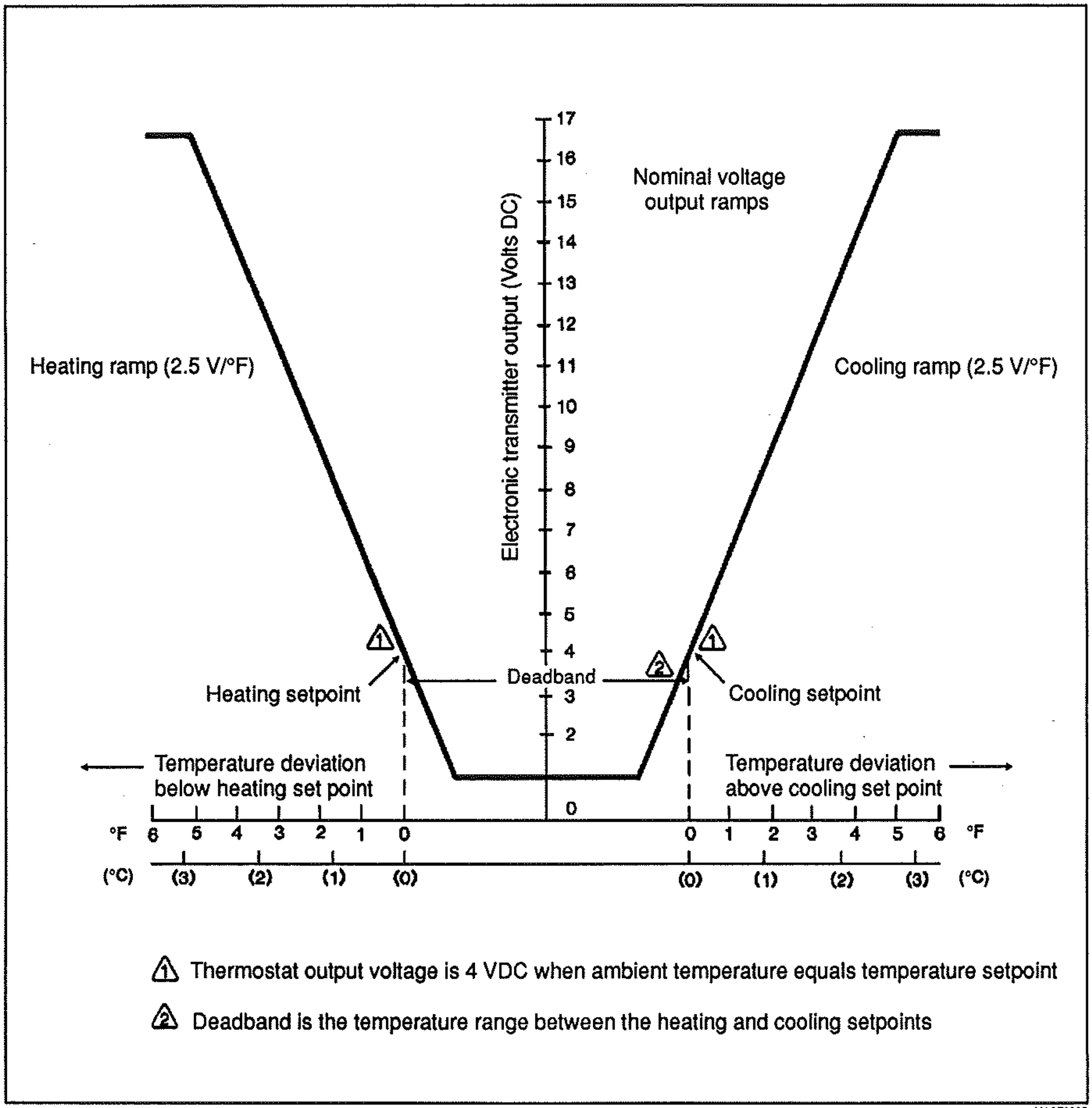


FIG. 5 - Electronic transmitter output voltage ramps

In the heating mode, the stages will be provided by the variable restricted opening of the hot water valve (see fig. 6) and also from the water recirculating pump. Staging will be defined as follows:

NO STAGE : Hot water valve fully closed (air pressure is applied in both air cylinders as both normally-closed air solenoid valves are actuated)

STAGE 1 : Hot water valve 1/3 opened (air pressure is applied only in the long air cylinder as only its normally-closed air solenoid valve is actuated)

STAGE 2 : Hot water valve 2/3 opened (air pressure is applied only in the short air cylinder as only its normally-closed air solenoid valve is actuated)

STAGE 3 : Hot water valve fully opened and water recirculating pump on (air pressure is exhausted from both air cylinders as their normally-closed air solenoid valves are not actuated)

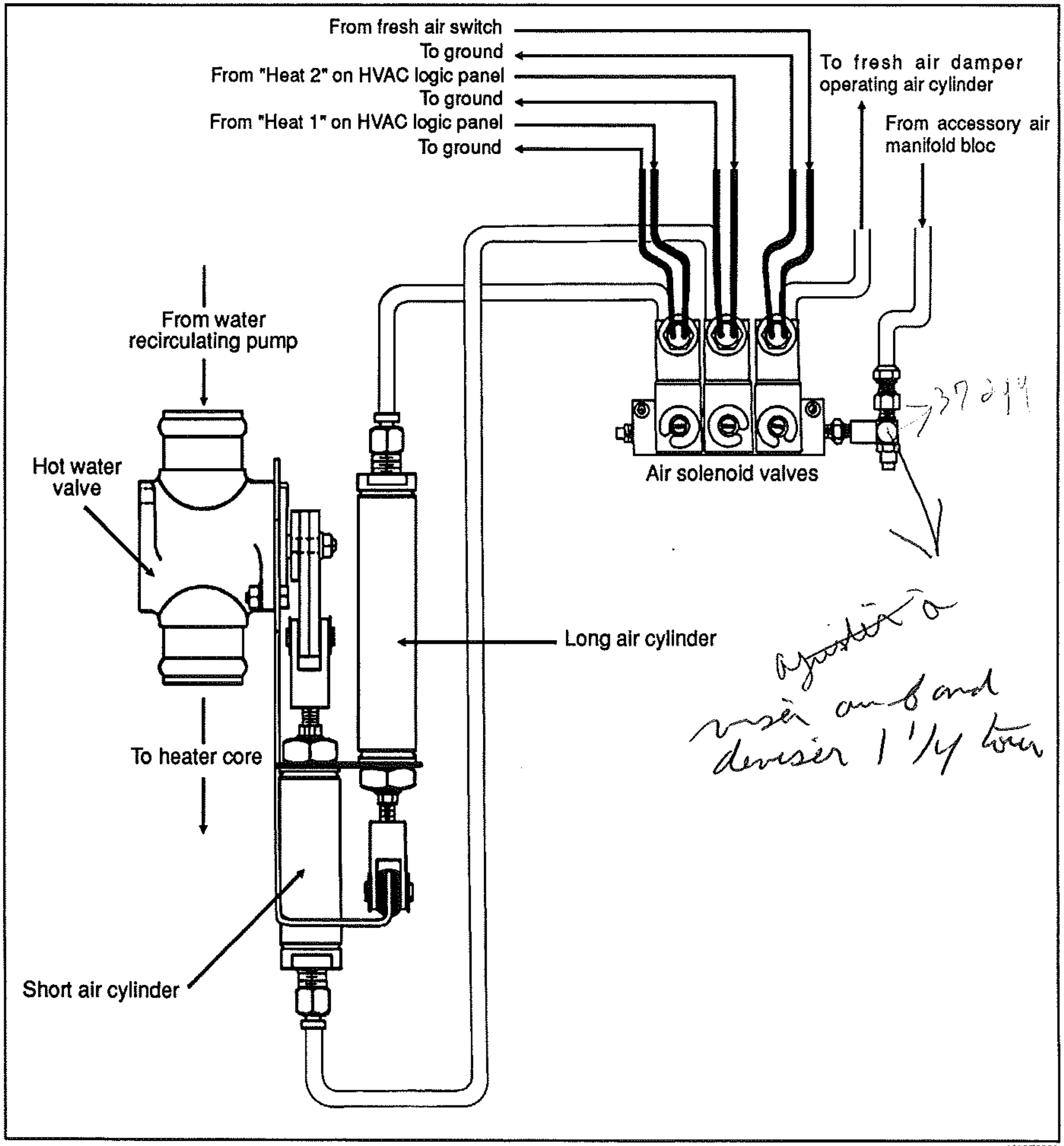


FIG. 6 - Heating system components

In the cooling mode, the stages will vary the number of active cylinders in the compressor by means of electric unloaders. Staging will be defined as follows:

NO STAGE : Compressor clutch is disengaged

STAGE 1 : Compressor clutch is engaged and 2 compressor active cylinders

STAGE 2 : Compressor clutch is engaged and 4 compressor active clinders

STAGE 3 : Compressor clutch is engaged and 6 compressor active cylinders

DIAGNOSIS OF MAIN HVAC UNIT PROBLEMS

Troubleshooting the HVAC system is made easier with the LEDs (light-emitting diodes) integrated in the system, and acting as indicator lights.

The main HVAC unit is equipped with 3 LEDs to indicate the heating mode, and are located as follows:

One red LED located on electronic transmitter and identified *"Heat"* (see fig. 7). The electronic transmitter picks up the sensor signal, and compares it with the setpoint established by the driver (Passenger A/C - Heating temperature control). After analysis, a voltage signal, which value is proportional to the analysis result (sensor vs driver's setpoint), is transmitted to the HVAC logic panel. The red LED on the electronic transmitter will be illuminated according to the voltage value, i.e. red LED may not be illuminated at first, and then will gradually reach its maximum brightness or vice-versa.

Two other red LEDs connected in parallel are located as follows:

One LED is located in driver's compartment, on the center console under the inside thermometer, while the other one is located on the HVAC logic module, which is mounted right over the electronic transmitter (see fig. 8). The two red LEDs operate simultaneously; unlike the LED mounted on the electronic transmitter, they are illuminated or not (*"ON"* or *"OFF"*). Their function is to indicate the output of the HVAC logic panel.

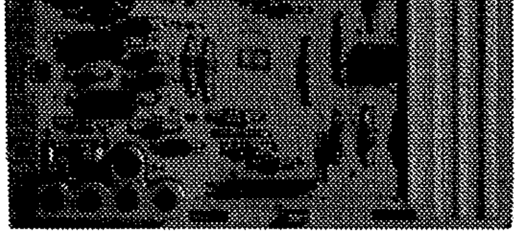


FIG. 7 - Electronic transmitter

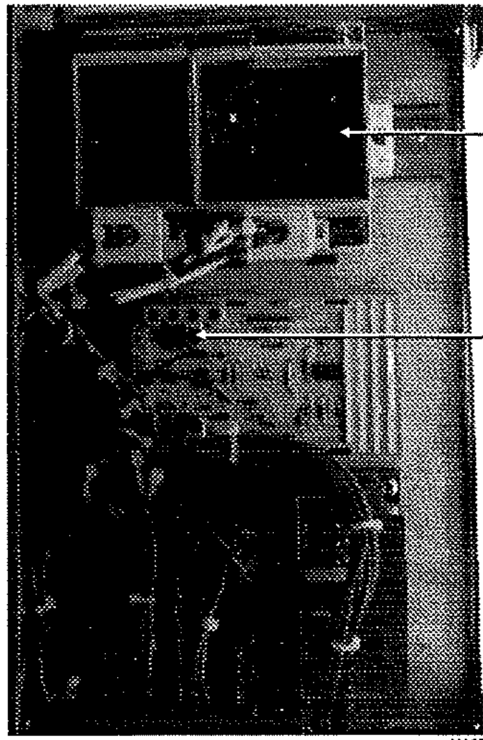


FIG. 8

The HVAC logic panel reads the voltage from the electronic transmitter. As soon as the voltage reaches 4.6 volts, the HVAC logic panel opens the normally-closed contact of its output *"Heat 1"*, de-energizing normally-closed air solenoid valve. This results in the exhaust of air from short air cylinder, and the opening of the hot water valve to 1/3.

At this stage, the two red LEDs will illuminate to indicate that the HVAC logic panel has sent a signal to activate heating system. If the other stages are activated, the two LEDs will remain illuminated.

The red LED on the center console advises the driver that the heating system is operating. The red LED mounted on the HVAC logic module enables the technician to quickly diagnose the problem.

As for the A/C mode, it is almost the same installation, except that the red LED on electronic transmitter is identified *"Cool"*. Its operation is, however, identical.

The significant difference lies in the fact that the two other LEDs connected in parallel are green. One green LED is located in driver's compartment on the center console under the inside thermometer, while the other one is located on the HVAC control module. These two LEDs indicate the operation of the A/C system.

When the humidistat requests the operation of the A/C system to dry ambient air inside vehicle, the two green LEDs will illuminate to indicate the operation of this system. However, the *"Cool"* red LED on the electronic transmitter will not illuminate, because the humidistat control bypasses the electronic transmitter. It is thus normal for the driver who request heat by means of the *"Passenger A/C - Heating temperature"* control, that the red and green LEDs be illuminated simultaneously. This corresponds to the operation of the heating system to heat vehicle, and to the operation of the A/C system to dry air (dehumidification).

NOTE: The dehumidifying function will be operating only when the humidistat requests dehumidification AND the ambient temperature inside vehicle is less than 4 °F (2 °C) from the selected temperature with *"Passenger A/C - Temperature"* control.

In addition to the two LEDs on the electronic transmitter and to the four other ones used to indicate the output of HVAC logic panel, four other LEDs described hereafter have been added on the HVAC control module and HVAC logic module to help the technician in quickly diagnosing the problem.

High pressure orange led

This LED mounted on the HVAC logic module (see fig. 9) is designed to light up when the pressure inside the A/C system (high pressure side) is too high. If this occurs, perform the following checks:

- Too high air inlet temperature to the condenser
- Dirty condenser
- Faulty condenser fans
- Refrigerant overcharge

NOTE: Another indicator light mounted in dashboard will also illuminate in order to inform the driver of this abnormal situation.

Low pressure orange led

This LED also mounted on the HVAC logic module (see fig. 9) is designed to light up when the pressure inside the A/C system (low pressure side) is too low. If this occurs, perform the following checks:

- Too low air inlet temperature to condenser and/or evaporator
- Dirty evaporator air filter
- Dirty evaporator
- Low refrigerant charge
- Expansion valve freeze up

NOTE: Another indicator light mounted in dashboard will also illuminate in order to inform the driver of this abnormal situation.

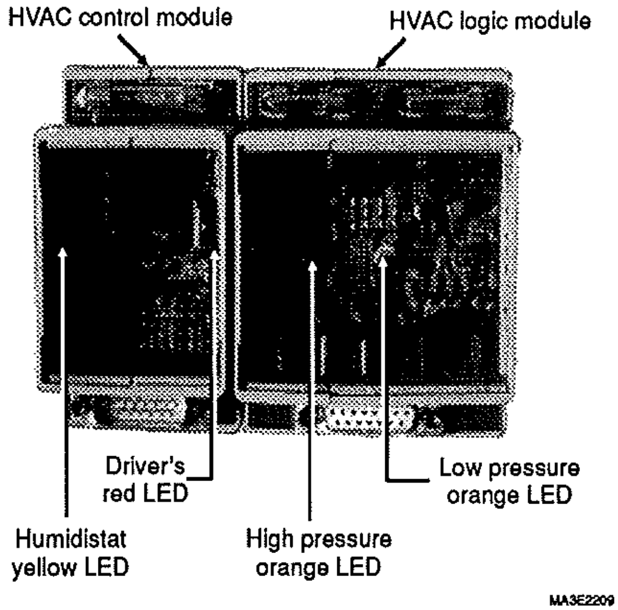


FIG. 9 - HVAC control module

Driver's red led

This LED, mounted on the HVAC control module (see fig. 9), will turn on to indicate the energization of the driver's liquid refrigerant solenoid valve, each time there is a cooling request by the *"Passenger A/C - Heating temperature"* control and the driver's system fan is on.

NOTE: Cooling mode in driver's compartment will remain inoperative as long as central A/C system has not been turned on. Furthermore, central A/C system must be in cooling mode and not in dehumidifying mode, to allow cooling of the driver's compartment as driver's evaporator unit never operates in the dehumidifying mode.

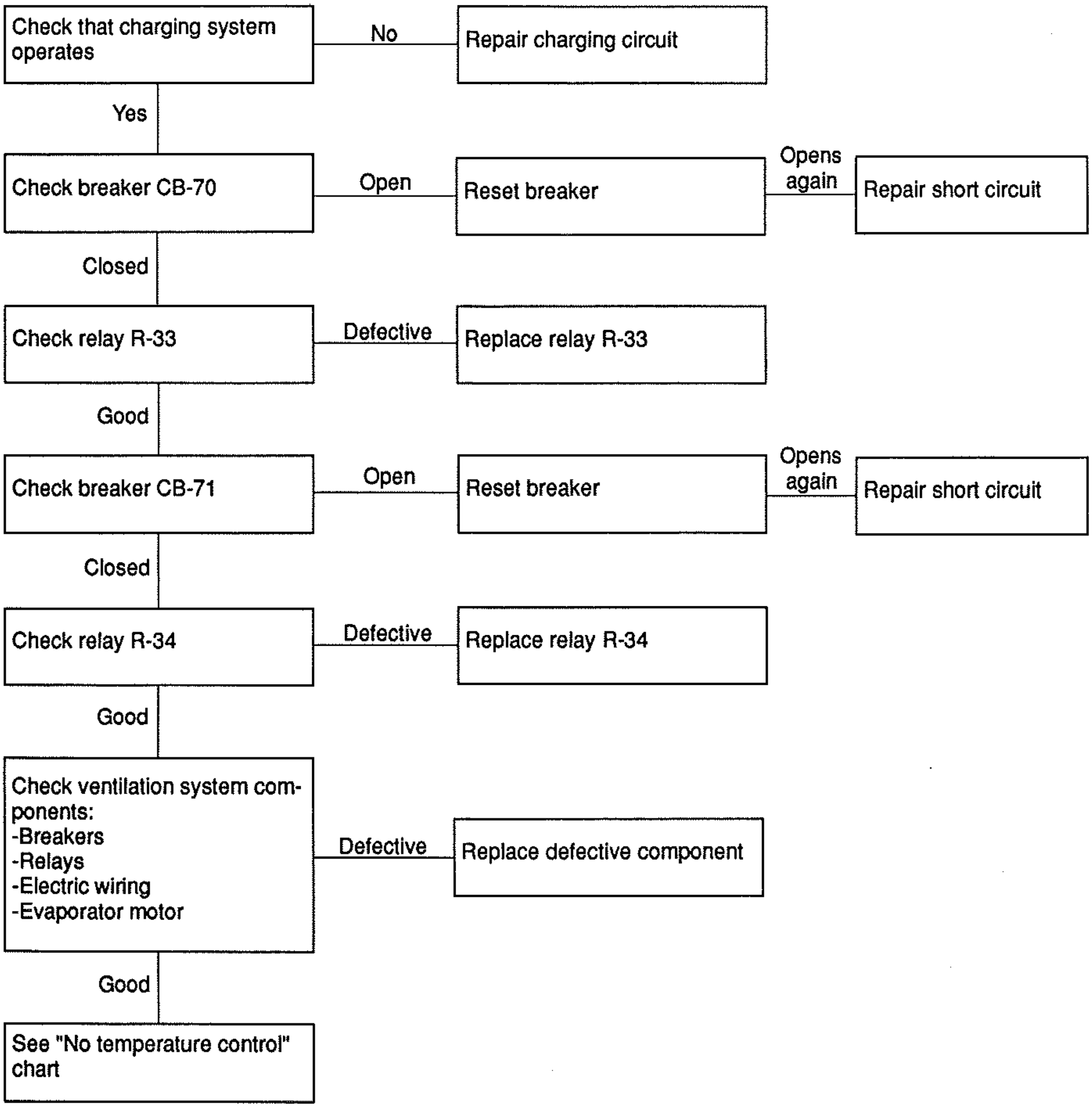
Humidistat yellow led

This LED, mounted on the HVAC control module (see fig. 9), will be turned on (full intensity) during a dehumidifying request. It can also be half illuminated during a heat request.

NOTE: Even if the dehumidifying function is requested, the stage *"Cool 1"* on the HVAC logic panel will not turn on as long as the ambient temperature inside vehicle will not be less than 4 °F (2 °C) from the selected temperature with *"Passenger A/C - Temperature"* control.

MAIN HVAC UNIT TROUBLESHOOTING GUIDE

System does not operate with the "Passenger A/C- Heating" switch to the "ON" position

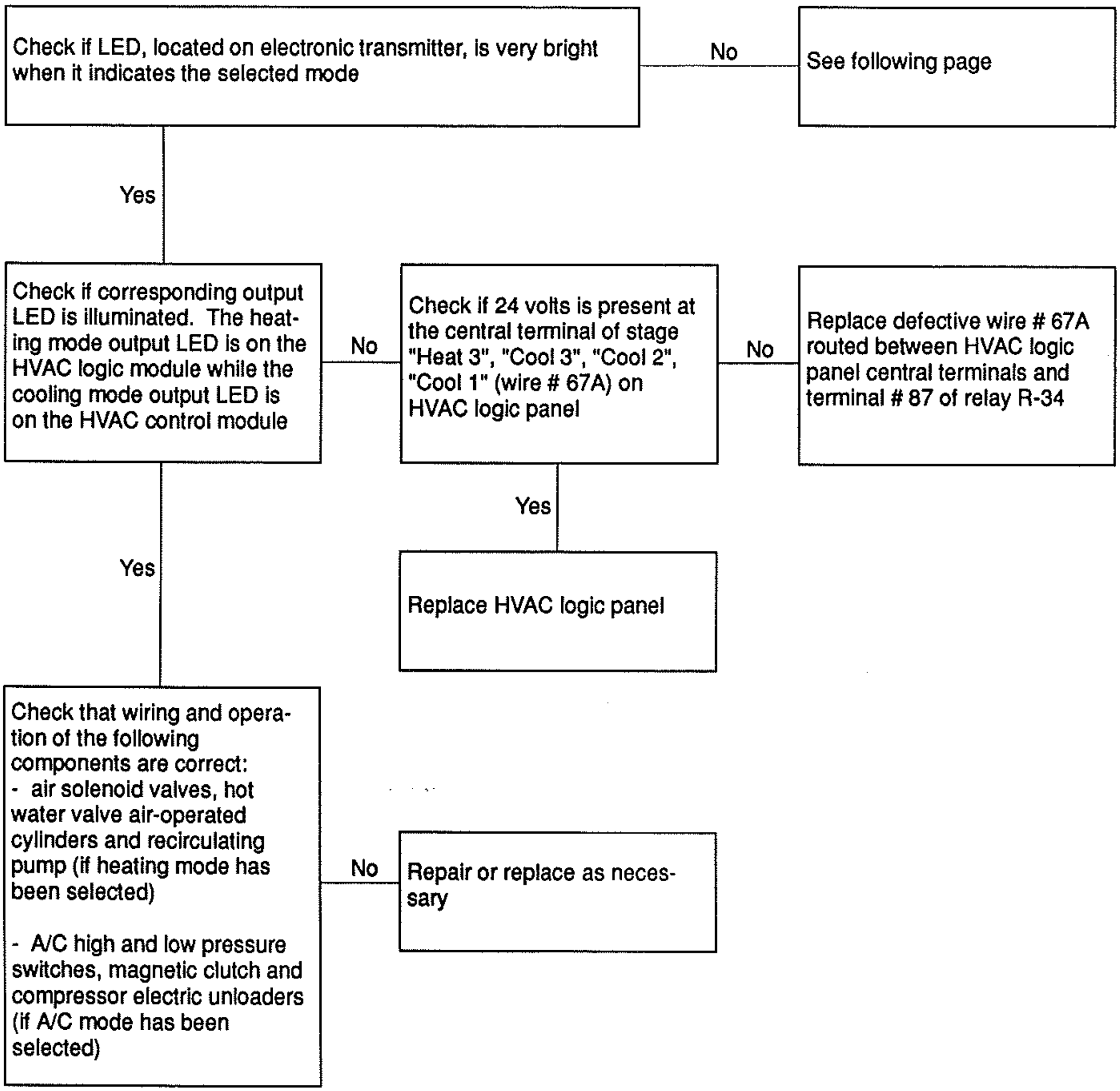


No control temperature chart

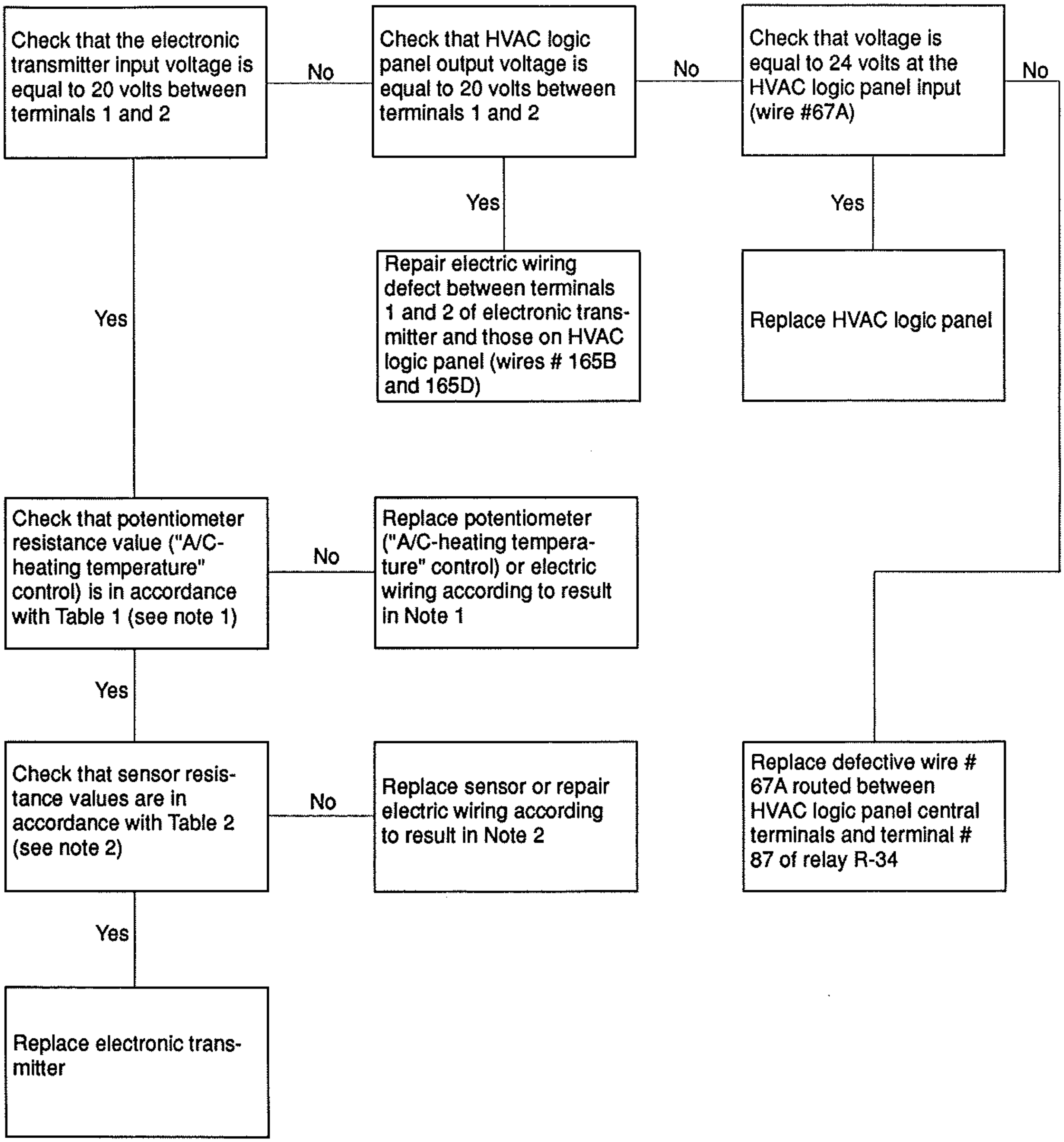
Ventilation operates, but there is *"no temperature control"*

Turn *"Passenger A/C - Heating temperature"* control to extreme clockwise or counterclockwise position (cold or warm)

Set humidistat (located in HVAC compartment over evaporator motor) to its maximum position to inhibit operation of A/C system which could alter data



The LED located on the electronic transmitter and corresponding to the selected mode is poorly or not illuminated



Note 1: Checking potentiometer resistance value

Disconnect 2 pin connector C-137 located on the A/C and heating junction box sliding drawer in back of the electronic transmitter. Locate the corresponding female contact pins for wires #167 and #167A, and using an ohmmeter connected according to the indications given in Table 1, check if readings match with data of Table 1. At location #165D, place the ohmmeter probe on head of screw #1 of electronic transmitter.

NOTE: Readings may be slightly higher than those in Table 1 due to the length of the wires routed between the electronic transmitter and the potentiometer.

If reading does not match, proceed as follows to check if potentiometer or wiring between potentiometer and electronic transmitter is defective:

Disconnect 3 pin connector C-355 located under dashboard, right behind potentiometer. Identify male contact pins corresponding to the green, brown, and pink wires from potentiometer. Using an ohmmeter connected according to the indications given in Table 1 (refer to the following cross reference between wire color and wire number), check if readings match with data of Table 1.

If readings match, trouble is located in wiring between connector C-355 and electronic transmitter. If reading does not match, potentiometer is defective.

WIRE COLOR & NUMBER CROSS REFERENCES

Between connector C-355 and potentiometer	Between connector C-355 and electronic transmitter
Green	165D
Brown	167A
Pink	167

Note 2: Checking the sensor resistance values

Remove the eight screws (#1 to #8) on the electronic transmitter and move it away from its support which holds the junction terminals. Locate terminals #6 and #7 on support, and using an ohmmeter, note the reading between these two terminals. (The board is moved away from its support to isolate the sensor electric circuit from the electronic transmitter. Compare reading with data of Table 2 given in the *"Recirculated Air Sensor"* curve. Temperature at the bottom of Table 2 is the temperature picked up by the sensor at the time of verification.

Reading between terminals 6 and 7 corresponds to the total resistance of the four series-paralleled sensors. Thus, if reading does not match with Table 2, check if problem is located at sensors or wiring.

Testing each sensor

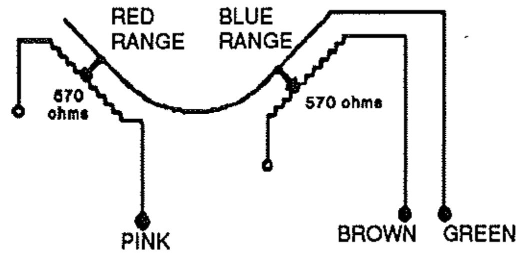
Disconnect each connector from its respective sensor (refer to fig. 2 for sensor location), then with an ohmmeter, note each sensor reading.

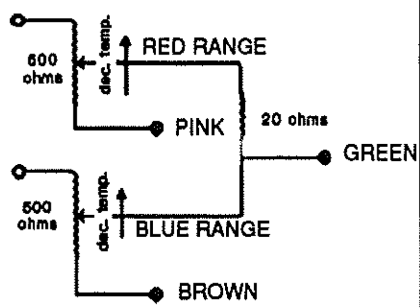
NOTE: To gain access to the connector of the sensor located in the last entrance step riser, remove the six screws retaining grill, the grill, the four bolts securing the sensor mounting plate to the air return duct, then lift the sensor mounting plate.

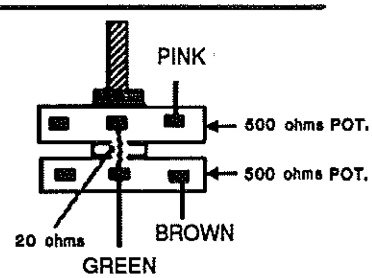
Compare each reading with data of Table 2 given in the *"Recirculated Air Sensor"* curve. The four sensor curve is again used, since each sensor, taken individually, has the same resistance than the four series-paralleled sensors taken together.

If all sensors check good, the problem is located in wiring between terminals 6 and 7 and the sensors.

CIRCUIT DIAGRAM OF DUAL POTENTIOMETER
(A/C-HEATING TEMPERATURE CONTROL)







DUAL POTENTIOMETER

WIRE CONNECTIONS / SELECTED TEMPERATURE		POTENTIOMETER RESISTANCE			
heating	cooling	165D/167		165D/167A	167A/167
Min.	Max.	534 ohms	19 ohms	515 ohms	1046 ohms
		493	20	473	964
		426	24	402	825
		352 ohms	27 ohms	325 ohms	673 ohms
		284	32	252	532
		210	34	176	383
		143 ohms	39 ohms	104 ohms	243 ohms
Max.	Min.	76	45	31	103

TABLE 1

MA3E22T1
MA3E22T2

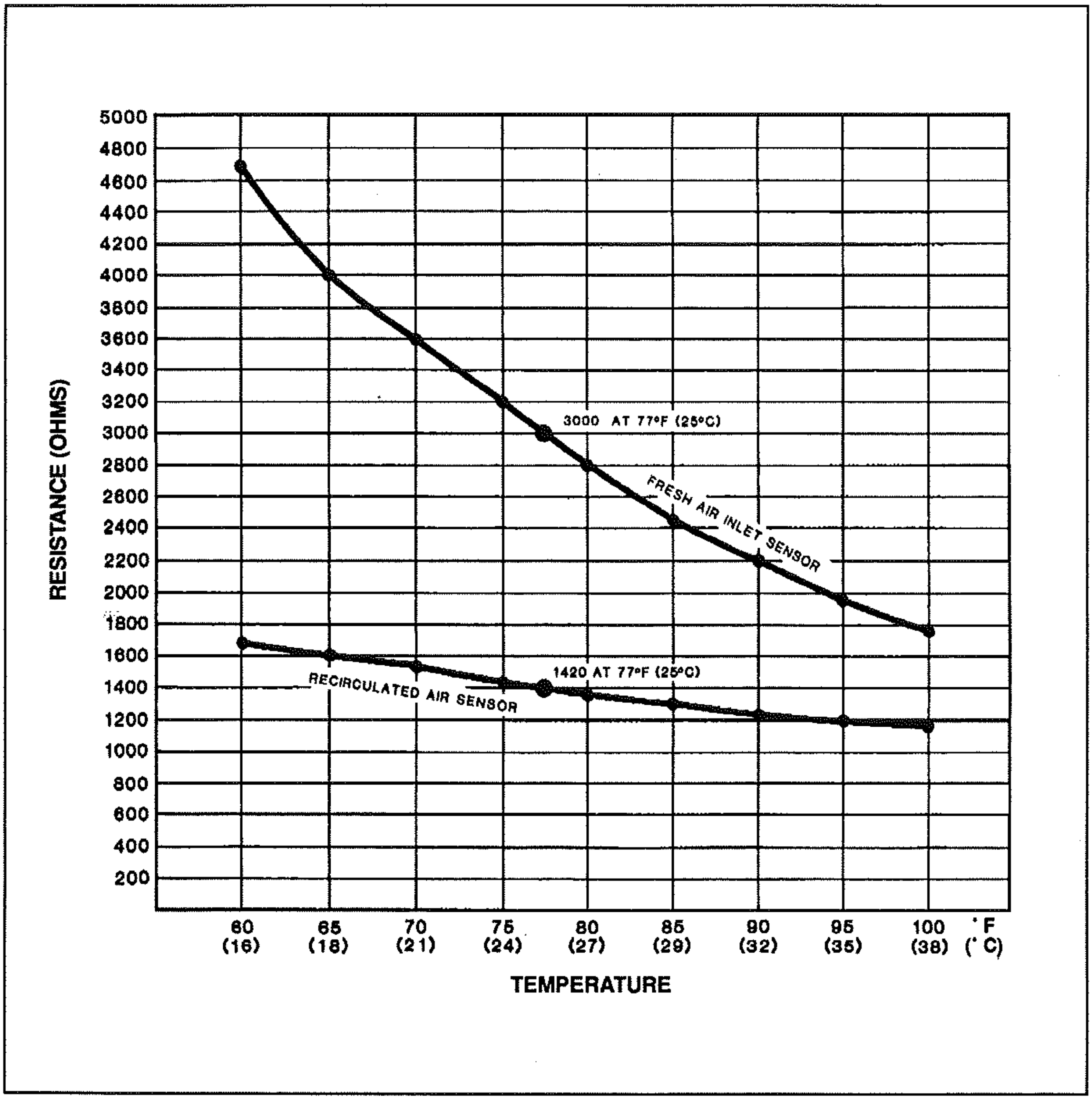


TABLE 2 - Resistance range according to ambient temperature sensors

Fresh air inlet sensor

Description

The main HVAC is provided with a fresh air sensor located in the fresh air damper. The fresh air sensor consists in a thermistor sensing element mounted in a tubular probe. The negative temperature coefficient characteristic of the thermistor element causes its resistance to decrease as the sampled air temperature increases. The fresh air sensor provides heating and cooling anticipation to the system at a sensitivity ratio of 25:1. In other words, a 25 °F (14 °C) increase in fresh air inlet temperature corresponds to a 1 °F (0,6 °C) decrease in set temperature. Thus, if sensor is short-circuited or in an open circuit condition, the control system will be slightly affected, i.e. the temperature inside of vehicle will be about 2 or 3 °F (1 or 2 °C) lower or higher than the temperature selected by the driver with the *"Passenger A/C - Heating temperature"* control.

Checkout

1. Set the ohmmeter scale to R X 1000.

2. At the HVAC logic panel located on the A/C and heating junction box sliding drawer, disconnect wiring terminal "T1" from sensor outlet.

3. Connect a wire of the ohmmeter to terminal "T" of HVAC logic panel, and the other wire of the ohmmeter to the loose wire of sensor.

4. The ohmmeter reading will vary according to the temperature picked up by the sensor. The fresh air inlet sensor resistance must vary between 1600 and 4800 ohms. Refer to Table 2 for the resistance readings at different temperatures. If reading does not match with the data of Table 2, disconnect wiring connector directly from fresh air sensor which is accessible from the evaporator compartment, then measure resistance of the fresh air sensor to determine if sensor or its wiring between sensor and HVAC logic panel is defective.

HVAC UNIT MAINTENANCE

No special maintenance is required on the main and driver's HVAC units, with the exception of cleaning their respective air filter every 10,000 miles (16 000 km) or as required according to operating conditions.

Driver's HVAC unit air filter

The air filter is located under dashboard. To gain access, pull both catches at each end of access panel located over entrance door steps, remove panel then filter. To clean filter, back flush with water, then dry with air.

Main HVAC unit air filter

Two access panels, located in the first and second baggage compartments (L.H. side) allow access to the air filter. Open panels by unscrewing 1/4 of a turn the three screws of either panel, unsnap both fasteners on top of filter, then slide out filter. To clean filter, back flush with water or soapy water, then dry with air.

CAUTION: Do not use high pressure water jet to avoid damaging filter.

EVAPORATOR MOTOR

The evaporator motor is installed in A/C & heating compartment (compartment located between the first and second baggage compartments on L.H. side of vehicle). It is a 27.5 volt, 2 HP (1,5 kW) motor which activates a double blower fan unit. An evaporator motor speed controller may have been installed in HVAC compartment as optional equipment.

Evaporator motor removal

1. Set the 24 volt main battery disconnect switch to the *"Off"* position.

2. Open the second L.H. side baggage compartment door, then pull the black release button located on the L.H. side in order to unlock and open the A/C & heating compartment door.

3. Identify the L.H. side discharge duct inside compartment, remove the three *"Phillips"* head screws retaining the flexible member to duct, then separate the *"velcro"* fasteners located on both sides and at back of duct.

4. Disconnect the discharge air sensor two-pin connector, then remove cable ties securing wires.

5. Repeat step 3 for the R.H. side discharge duct.

6. Disconnect electrical connection on motor plate, then remove cable ties retaining wires at back of duct.

7. From under vehicle, remove the eight bolts retaining the evaporator fan motor support, then remove the complete unit from the A/C & heating compartment.

8. On a work bench, unscrew the fan set screws, the *"Phillips"* head screws retaining cages to support, then slide out the assemblies from the evaporator motor output shaft.

CAUTION: Never support evaporator motor by its output shafts while moving it.

Disassembly

The evaporator motor is one of a conventional design. Defective motor may be disassembled and repaired according to standard procedures.

Installation

Reverse removal procedure. Apply grease on the motor shaft to ease fan installation.

EVAPORATOR MOTOR SPEED CONTROLLER MODULE

Description

The optional evaporator motor speed controller module is mounted on the R.H. side wall inside the A/C & Heating compartment. The purpose of this electronic module is to limit the evaporator motor speed to 70% of its full rated speed throughout the heating mode and during the first stage of the cooling mode; the module will then gradually increase the motor speed as the cooling demand increases.

Troubleshooting

Check that evaporator motor is in good condition, then perform the following test in order to determine if speed controller module is defective, or if HVAC logic panel is sending a bad signal to the module.

1. Locate the HVAC logic panel mounted on the HVAC junction box sliding compartment as illustrated in previous figure 3.

2. Disconnect "WC" wire from HVAC logic panel "WC" terminal.

3. Disconnect "RC" wire (if provided) from HVAC logic panel "RC" terminal.

4. With engine running and *"A/C & Heating"* switch set to the *"ON"* position, connect an ammeter between "WC" and "RC" terminals on HVAC logic panel.

5. The ammeter should indicate 0 mA when *"A/C & Heating temperature"* control is turned to the maximum heating position, and approximately 7 mA when it is turned to the maximum cooling position. If not, replace HVAC logic panel.

6. Connect an ammeter between "WC" terminal on HVAC logic panel and "WC" wire previously disconnected.

7. The ammeter should indicate 0 mA when *"A/C & Heating temperature"* control is turned to the maximum heating position, and approximately 4.85 mA when it is turned to the maximum cooling position. If not, check ground continuity on speed controller module as follows.

8. Set the *"A/C & Heating"* switch to the *"OFF"* position. Connect an ohmmeter between the large and small "--" (ground) terminals on speed controller module.

9. The ohmmeter should indicate less than 5 ohms. If more, the internal ground circuit is defective and can be corrected by installing a jumper wire (18 AWG) between the two "--" (ground) terminals.

10. With the *"A/C & Heating"* switch set to the "ON" position, repeat steps 6 and 7, and if readings still do not check within tolerance, replace speed controller module.

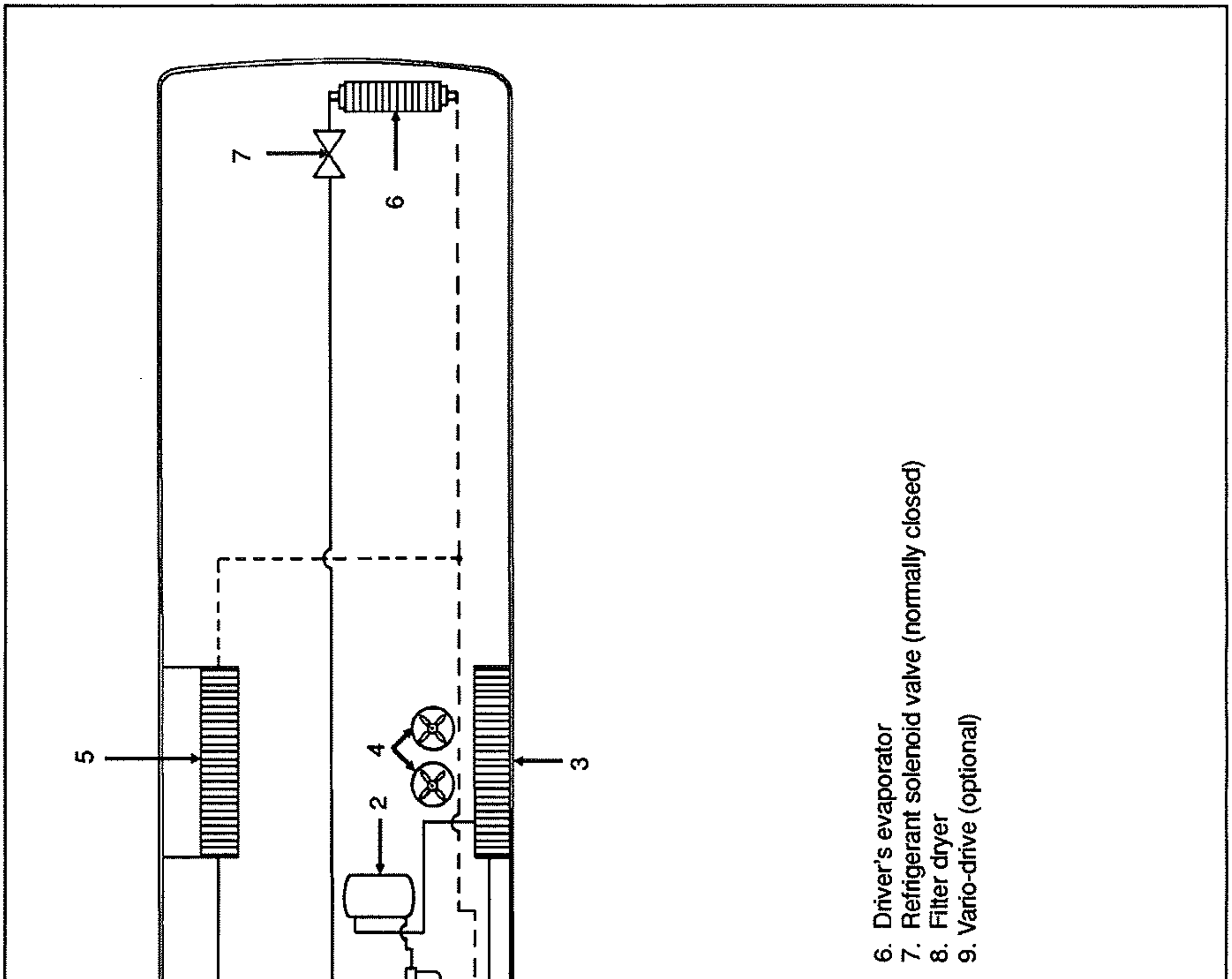
11. Connect a voltmeter between the *"Moteur"* and "--" (ground) large terminals on speed controller module.

12. The voltmeter should indicate approximately 7.5 V when *"A/C & Heating temperature"* control is turned to the maximum heating position, and approximately 0.5 V when it is turned to the maximum cooling position. If not, the speed controller module is defective and must be replaced as a unit.

AIR CONDITIONING SYSTEM

Description

The schematic of figure 10 shows the A/C system and its components. The system is equipped with a 6 cylinder, 05G Carrier compressor and R-12 Freon, thus providing a 9 ton A/C capacity. The receiver and filter dryer are mounted inside the condenser compartment. A small door located at left of condenser compartment door allows viewing of the filter dryer sight glass for an easy day-to-day refrigerant charge verification.



MA3E2210

FIG. 10 - Refrigerant circuit

Refrigerant

The A/C system of this vehicle has been designed to use refrigerant-12 as medium. Regardless of the brand, only refrigerant-12 must be used in this system. The chemical name for refrigerant-12 is Dichlorodifluoromethane.

Refrigerant characteristics

Refrigerant-12 exists as a gas at atmospheric pressure and must be held under pressure to remain liquid. At ordinary temperatures, it will exist as a liquid under a pressure of about 75 psi (516,75 kPa). Refrigerant is colorless in both its liquid and gaseous states, and it has very little odor; however, a distinct odor may be detected in large concentrations.

Refrigerant is nonpoisonous, nonflammable, nonexplosive, as well as being noncorrosive to any of the ordinary metals. Goggles should be worn whenever there is the slightest possibility of refrigerant coming in contact with the face or eyes, because refrigerant evaporates and cools so rapidly that it will cause an injury similar to frosbite.

WARNING: Refrigerant in itself is nonflammable, but if it contacts an open flame, it will decompose in phosgene gas which is toxic.

Procurement

Refrigerant is shipped and stored in metal cylinders. It is serviced in 22 and 100 pound (10 and 45 kg) cylinders. Approximately 25 pounds (11,4 kg) are used in the system.

It will be impossible to draw all the refrigerant out of the cylinder; however, the use of warm water when charging the system will assure the extraction of a maximum amount of refrigerant from the cylinder.

All refrigerant cylinders are shipped with a heavy metal screw cap. The purpose of the cap is to protect the valve and safety plug from damage. It is a good pratice to replace the cap after each use of the cylinder for the same reason. If the cylinder is exposed to the sun radiant heat, the resultant increase in pressure may cause the safety plug to release or the cylinder to burst.

For the same reason, the refrigerant cylinder should never be subjected to excessive temperature when charging a system. The refrigerant cylinder should be heated for charging purposes by placing it in 125 °F (52 °C) water. Never heat above 125 °F (52 °C) or use a blowtorch, radiator, or stove to heat the cylinder.

Welding or steam cleaning on or near any refrigerant line or components of the A/C system could build up dangerous and damaging pressures in the system.

If a small cylinder is ever filled from a large one, never fill the cylinder completely. Space should always be allowed above the liquid for expansion. Weighing cylinders before and during the transfer will determine the fullness of the cylinders.

WARNING: One of the most important precautions when handling refrigerant consist in protecting the eyes. Any liquid refrigerant which may accidentally escape is approximately -40 °F (-40 °C). If refrigerant comes in contact with the eyes, serious injury could result. Always wear goggles to protect the eyes when opening refrigerant connections.

Discharging large quantities of refrigerant into a room can usually be done safely as the vapor would produce no ill effects. However, this should not be done if the area contains a flame-producing device such as a gas heater. While refrigerant normally is nonpoisonous, heavy concentrations of it in contact with a live flame will produce a poisonous gas. The same gas will attack all metal surfaces.

Precautions in handling refrigerant

1. Do not leave a cylinder of refrigerant uncapped.
2. Do not subject the cylinder to high temperatures.
3. Do not weld or steam clean on or near the system.
4. Do not fill a cylinder completely.
5. Do not discharge vapor into an area where a flame is exposed.
6. Do not expose the eyes to liquid refrigerant.

Treatment in case of injury

If liquid refrigerant comes in contact with the skin, treat the injury as if the skin was frost-bitten or frozen.

If liquid refrigerant comes in contact with the eyes, consult an eye specialist or doctor immediately. Give the following first aid treatment:

1. Do not rub the eyes. Splash eyes with cold water to gradually bring the temperature above the freezing point.

2. Apply drops of sterile mineral oil (obtainable at any drugstore) in the eyes to reduce the possibility of infection. The mineral oil will also help in absorbing the refrigerant.

Precautions in handling refrigerant lines

1. All metal tubing lines should be free of kinks, because of the restriction that kinks will offer to the flow of refrigerant. The refrigeration capacity of the entire system can be greatly reduced by a single kink.

2. The flexible hose lines should never be allowed to come within a distance of 2 1/2" (6,3 cm) of the exhaust manifold.

3. Use only sealed lines from parts stock.

4. When disconnecting any fitting in the refrigeration system, the system must first be discharged of all refrigerant. However, proceed very cautiously, regardless of gauge readings. Open very slowly, keeping face and hands away so that no injury can occur, if there happens to be liquid refrigerant in the line. If pressure is noticed when fitting is loosened, allow it to bleed off very slowly.

WARNING: Always wear safety goggles when opening refrigerant lines.

5. In the event any line is opened to atmosphere, it should be immediately capped to prevent entrance of moisture and dirt.

6. The use of the proper wrenches when making connections on O-ring fittings is important. The use of improper wrenches may damage the connection. The opposing fitting should always be backed up with a wrench to prevent distortion of connection lines or components. When connecting the flexible hose connections, it is important that the swaged fitting and the flare nut, as well as the coupling to which it is attached, be held at the same time using three different wrenches to prevent turning the fitting and damaging the ground seat.

7. The O-rings and seats must be in perfect condition. The slightest burr or piece of dirt may cause a leak.

8. O-rings should be coated with refrigeration oil and installed on the line before the line is inserted into the fitting to prevent damaging the O-ring. If leaks are encountered at the couplings or connectors, no attempt should be made to correct the leaks by tightening the connections beyond the recommended torque. The O-rings are designed to seal at the specified torque and overtightening the connection does not result in a satisfactory and permanently sealed connection. The connection must be disassembled and the cause of the leak (damaged O-ring, defective lines, etc.) corrected. Use new O-ring.

Pumping down

Description

This procedure is intended to reduce refrigerant loss by isolating it in the compressor and the receiver tank, as well as in their connecting line, in order to carry out repairs on other sections of the air conditioning system (lines and components).

NOTE: Before attempting any repair between compressor and receiver tank, use a recovery unit to remove refrigerant from the system.

WARNING: When air conditioning system must be opened, refer to previous heading *"PRECAUTIONS IN HANDLING REFRIGERANT"* to prevent any injury.

Procedure

1. Close the outlet valve on the receiver tank by turning it clockwise until the valve is frontseated, backseat the suction valve on the compressor, install an appropriate pressure gauge set, then turn the valve forward 1/4 turn to enable a visual check of the suction pressure.

2. Disconnect the *"Low pressure switch"* connector (mounted near the A/C compressor), then install a jumper wire.

NOTE: This jumper wire will allow the clutch to remain engaged after pressure drops below 15 psi (103,5 kPa).

3. Open the first R.H. side baggage compartment door, unscrew the quarter turn screw and slide open the A/C and heating junction box drawer. Locate the stage *"3 Cool"* on the HVAC logic panel, then install a jumper wire between the central terminal of this stage and its normally-closed contact terminal as illustrated in fig. 11. Locate the stage *"2 Cool"*, then install a jumper wire between the central terminal of this stage and its normally-closed contact terminal as illustrated in fig. 11.

NOTE: No wire has to be disconnected; in fact, wires #31A and 31B will be connected to wire #67A. This temporary connection will restrict compressor operation to two cylinders.

4. Start the engine, turn on the *"Passenger A/C-heating switch"*, then adjust *"A/C-heating temperature"* controls to maximum A/C position.

5. Run the compressor until pressure reaches 1-2 psi (7-14 kPa).

NOTE: During this operation, care must be taken not to fill the receiver tank over the upper sight glass. If so, stop process immediately. Always allow refrigerant piping and units to warm up to the ambient air temperature before opening system or sweating will take place inside the lines.

6. Stop engine, and close compressor outlet valve by turning it clockwise until valve is properly seated.

7. Close compressor suction valve by turning it clockwise until it is properly seated.

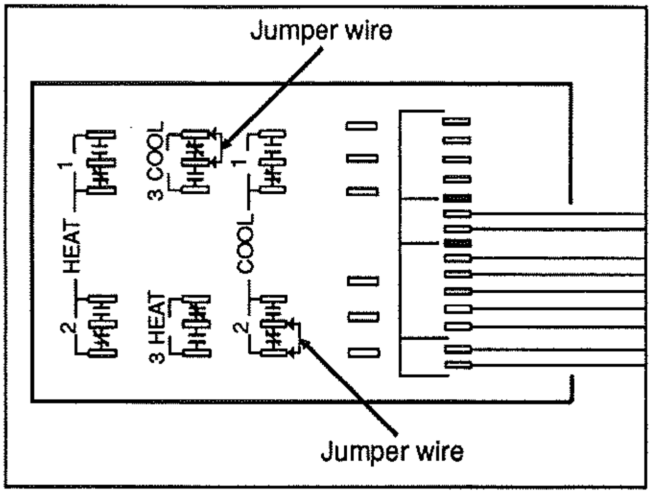


FIG. 11 - HVAC logic panel

Adding refrigerant (vapor state)

Use the suction service valve on the compressor to add refrigerant to the system. Backseat the valve and connect a charging line from the refrigerant cylinder to the valve loosely. Tighten connection at level of refrigerant cylinder and open tank end slightly to purge air from the charging line. Tighten the charging line at the compressor. Screw in the stem of suction valve approximately two turns. Start the engine and run at fast idle. Add sufficient refrigerant to bring the level in lower sight glass of receiver tank to mid-point. Always charge the system with the cylinder upright and the valve on top to avoid drawing liquid out of the cylinder.

When charging an empty system, weigh the amount of refrigerant put into the system. This will eliminate any possibility of overfilling. A full charge requires 25 pounds (11,4 kg).

Fill liquid refrigerant at the receiver tank and complete charge, if necessary, using previous procedure.

A/C SYSTEM COMPONENTS

Compressor

Belt replacement

WARNING: Set the 24 volt main battery disconnect switch to the *"Off"* position, then for greater safety, set the engine starter selector switch in engine compartment to the *"Off"* position.

1. Remove both wing nuts securing belt guard in place, then lift and remove it from engine compartment.

2. Locate the belt tensioner two-way control valve (see fig. 12), then turn handle counterclockwise in order to reverse pressure in belt tensioner air cylinders, thus releasing tension on belts.

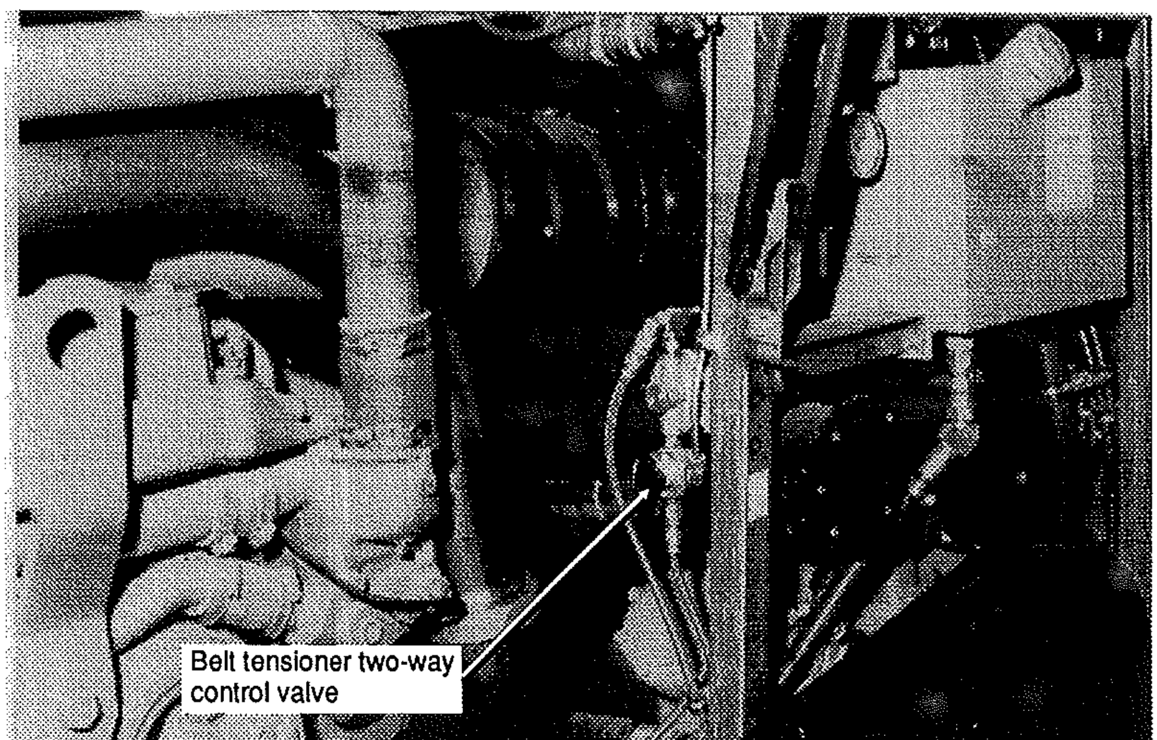


FIG. 12

3. Slip the old belts off and the new ones on.

NOTE: Both belts must always be replaced simultaneously to ensure an equal distribution of load on each of them.

4. Turn clockwise the two-way control valve to its initial position to apply tension on the news belts.

5. For proper operation of the belt tensioner cylinder, adjust the belt tensioner cylinder rod to provide a 1" - 1 1/2" (25 - 38 mm) extension as shown in figure 13.

6. Reinstall the belt guard, then secure in place with the two wing nuts.

NOTE: As new belts stretch with normal wear, check the belt tensioner cylinder rod length and readjust if necessary after a run-in period of 500 miles (800 km).

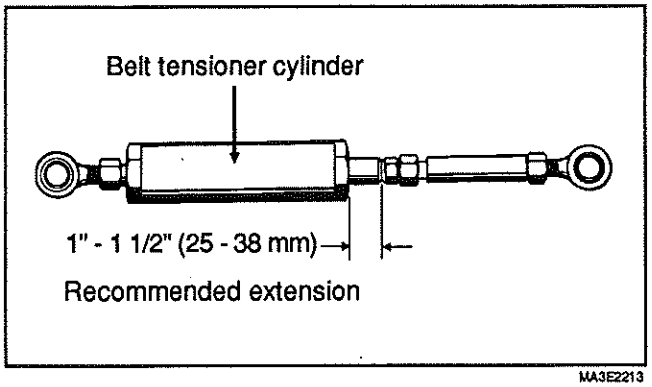


FIG. 13

Troubleshooting guide

A preliminary check may be made by simply feeling the cylinder heads with the unit in operation at ambient temperatures of 35 °F (2 °C) and over. The cylinder heads are internally divided into suction and discharge halves; the lower half of the cylinder head is the suction side, and it should be relatively cool to the touch, as opposed to the hot upper discharge side. If a valve plate or head gasket is blown, or a compressor unloader is stuck open, partially compressed refrigerant vapor will be circulated between the suction and discharge sides of the head. The affected cylinder head will then have a relatively even temperature across its surface and be neither as hot as the normal discharge temperature nor as cool as the normal suction temperature.

Broken suction valves are probably the most difficult item to determine without opening the compressor. Depending on the condition of the cylinder walls and piston rings, a compressor in good condition should be able to pull a vacuum of 20" Hg with the suction service valve frontseated. Failure to reach this value would require disassembly of the compressor to determine actual component conditions.

Blown head gaskets:

Symptom: - Loss of unit capacity at low temperature
- Even cylinder head temperature

Cause: - Improperly torqued cylinder head bolts
- Improperly positioned gasket at assembly
- Warped cylinder head
- Severe liquid refrigerant floodback

Blown valve plate gaskets:

Symptom: - Loss of unit capacity at medium and low temperatures
- Very hot cylinder head surface
- Higher than normal suction pressure

Cause: - Improperly torqued cylinder head bolts
- Severe liquid refrigerant floodback
- Oil slugging caused by an overcharge of oil or flooded starts
- Disharge valves not seating properly (liquid drainback during shutdown)

Broken suction valves:

Symptom: - Loss of unit capacity at all temperatures
- Compressor unable to pull extremely low vacuum with suction service valve frontseated

Cause: - Repeated liquid refrigerant floodback
- Flooded starts
- Overcharge of oil
- Discharge valves not seating properly (liquid drainback during shutdown)
- Expansion valve not controlling properly

Unloader valve stuck open:

Symptom: - Loss of unit capacity at all temperatures
- Higher than normal suction pressure
- Even cylinder head temperature

Cause: - Unloader body stem bent
- Foreign material binding unloader piston or plunger

Maintenance

For the maintenance of A/C compressor, see the *"Carrier Compressor Operation and Service Manual"* included at the end of this section.

Magnetic clutch

Refer to Carrier service information entitled *"Housing-mounted electric clutch"* at the end of this section for the description and maintenance of the magnetic clutch.

A/C compressor vario-drive

Description

An A/C compressor vario-drive may have been installed in engine compartiment as optional equipment. The purpose of this device is to speed up the compressor to have almost its full capacity at fast idle and keep this speed through the rest of the engine speed range (see fig. 14). A V-belt with a variable pitch pulley is used to obtain this result.

Maintenance

For the assembly/disassembly procedures, as well as the belt replacement procedure, refer to the booklet entitled *"Variocomp"* included at the end of this section.

Time delay module

A time delay module integrated in the HVAC logic module is connected in series with the relay coil feeder circuit of the compressor magnetic clutch. This module allows approximately one minute delay following a compressor clutch request and its actual application, to avoid continuous engaging and disengaging (cycling) of clutch.

This time delay will be effective each time A/C system is actuated (Passenger A/C-heating switch), or upon restarting of compressor, when the latter has previously stopped due to an excessive high pressure (over 275 psi (1896 kPa)) or very low pressure (under 15 psi (103,5 kPa)) in the system.

However, time delay will be inoperative and restarting of compressor will be immediate following a regulated interruption by the system, i.e. when temperature inside coach is equal to the selected temperature.

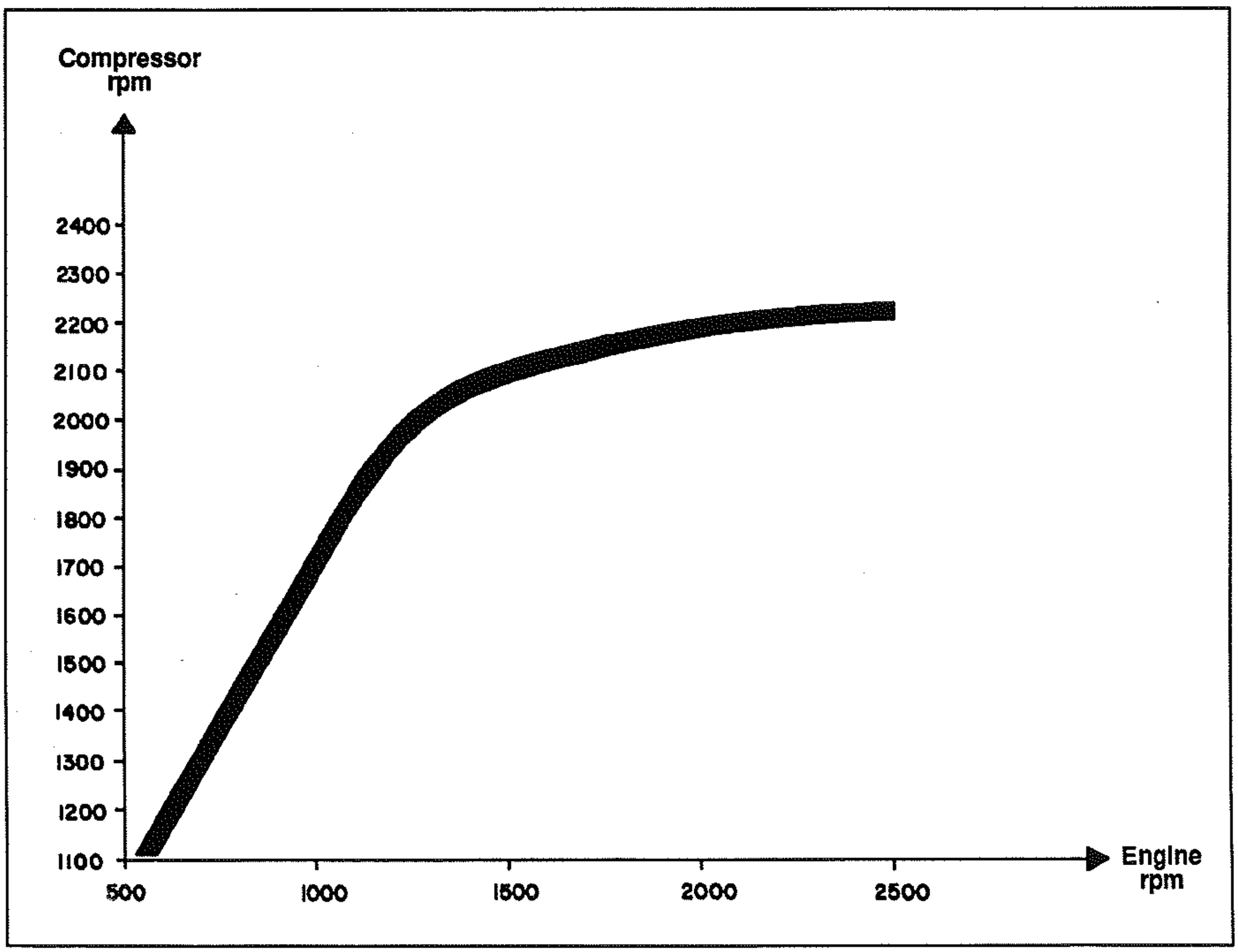


FIG. 14 - Compressor rpm equipped with vario-drive device

Condenser

The condenser coil is hinge mounted on the R.H. side of the vehicle between the first and second baggage compartments. Since the condenser purpose is to dissipate heat from the hot refrigerant, it is important to keep the cooling coils and fins clean. A clogged coil will cause high discharge pressure and insufficient cooling.

Check the external surface of the coil at regular intervals (5000 miles (8 000 km) or more often according to operating conditions) for dirt or any other foreign matter. Flush the condenser coil from inside out, using a water jet or water mixed with air pressure.

CAUTION: Direct the pressure straight through the coil to prevent bending of fins and do not use extremely high pressure. Do not use hot water or steam.

Condenser fan motors

Two axial fan motors are installed in condenser compartment (compartment between the first and second baggage compartments on R.H. side of vehicle) in order to ventilate the condenser coil. The fans pull outside air through the condenser coil and discharge it through opening at bottom of compartment. Depending on pressure in receiver tank (see fig. 15), the fan motors may be operated at full rpm, half rpm or not operated at all. With a low pressure in receiver tank, both fan motors are connected in series and then operate at half rpm, and with a high pressure in receiver tank, both fan motors are connected in parallel and then operate at full rpm. For details about electrical wiring, refer to *"A/C and Heat system"* in the master wiring diagram.

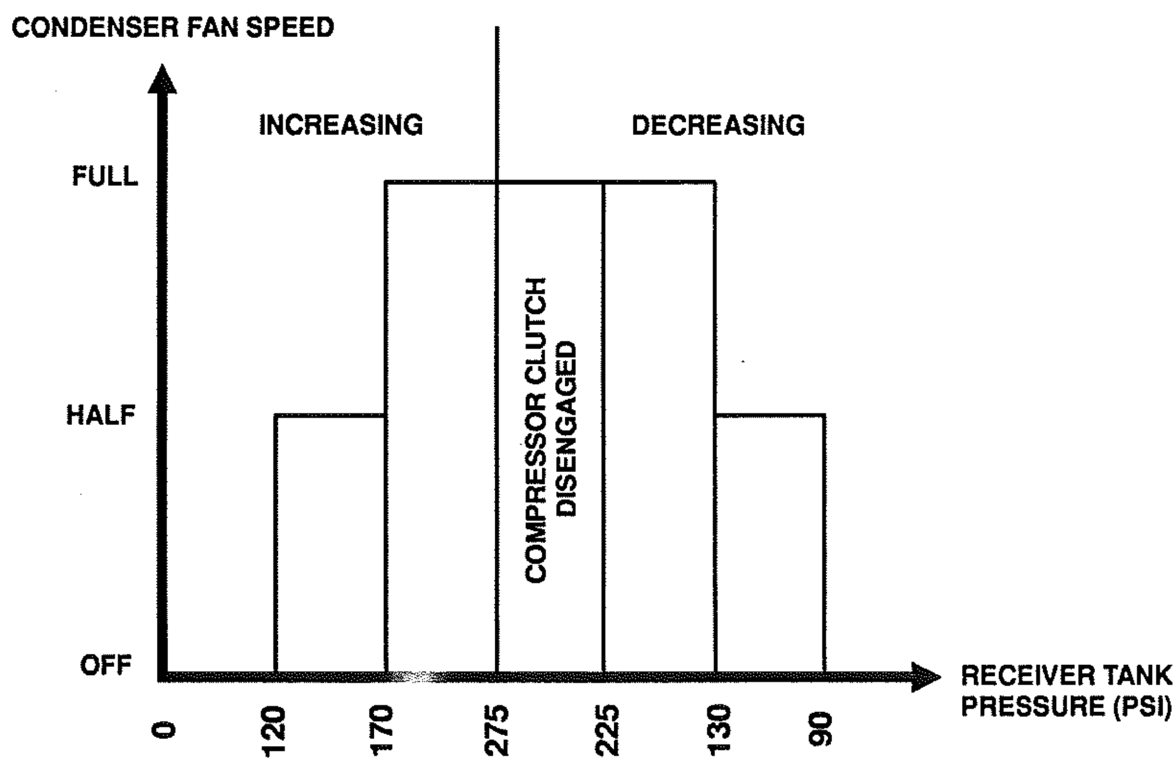


FIG. 15 - Condenser fan speed in relation with receiver tank pressure

Condenser fan motor removal

1. Set the 24 volt main battery disconnect switch to the *"Off"* position.

2. Remove the two *"Phillips"* head screws retaining the fan motor protective cover to the square tubing.

3. Disconnect wiring from terminals on motor. Tag each wire to aid in identification at time of reconnection.

4. Support motor, then remove bolts which attach motor to mounting bracket. Remove the motor.

Disassembly

Preliminary disassembly

1. Remove the brushes.

2. Unscrew the flange retaining screws on the shaft end side (opposite to the commutator end frame), and separate flange from frame (see fig. 16).

3. Remove flange and rotor assembly by pushing bearing shaft toward the commutator end frame.

4. Separate flange from rotor.

Disassembly

1. Perform preliminary disassembly.

2. Note carefully the position of the brush holder ring and the connections on the flange support.

3. Unscrew and remove the flange on the commutator end frame.

4. Remove the brush holder ring.

5. Finally, separate the following parts: brush holders, brush boxes, terminal board, bearings, etc...

Maintenance

Checking operation of brush in holder

Lift brush slightly 1/8" (3 mm) and release it; brush must produce a dry noise.

Checking brush wear

Replace the brushes if less than one third of the initial brush length is left (17/64" (7 mm)). Clean brushes with a clean cloth impregnated with gasoline or alcohol.

WARNING: Cleaning products are flammable and may explode under certain conditions. Always handle in a well ventilated area.

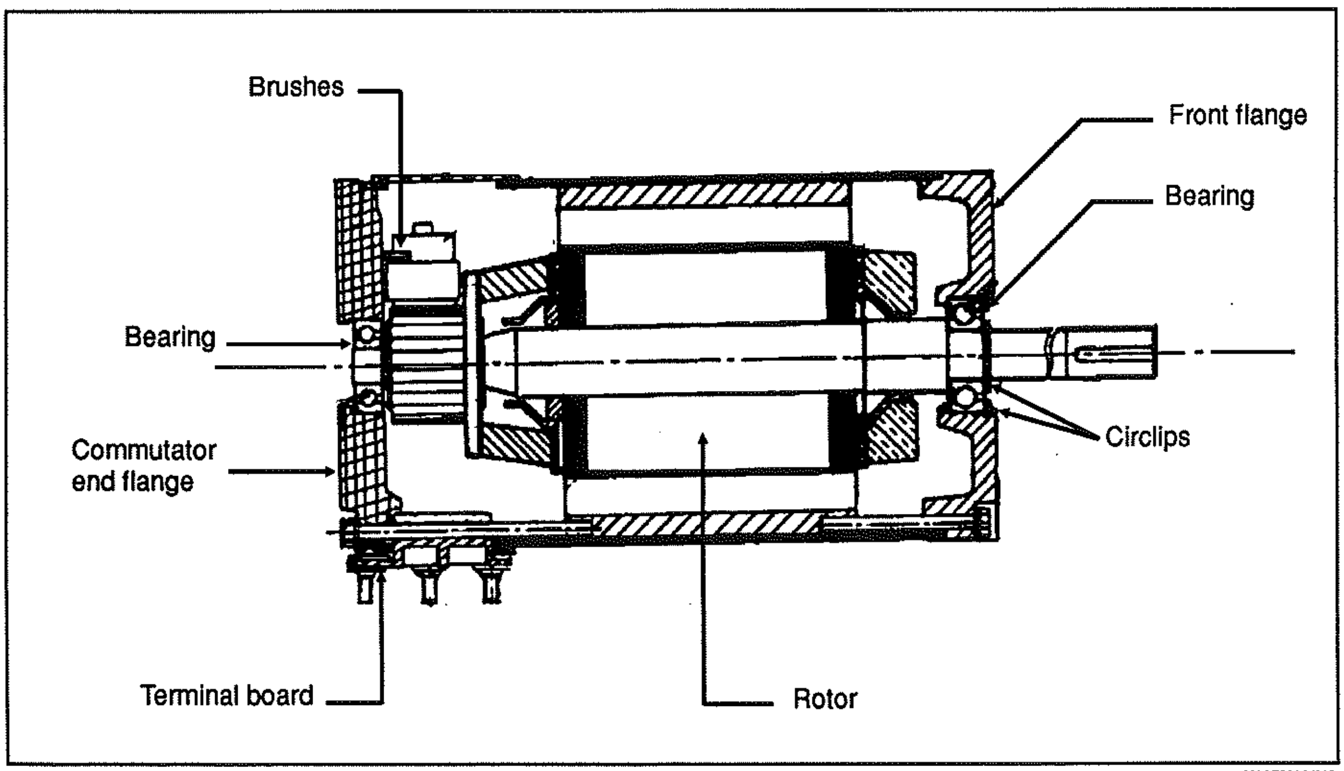


FIG. 16

Checking commutator

The surface must be polished. A brown-black colored surface is normal and indicates a good switching. Ensure there is no evidence of arcing or metal chips.

Lubrication

The motor is provided with two sealed bearings which require no maintenance.

Reassembly

Reverse disassembly procedure.

Installation

Reverse removal procedure.

Receiver tank

The receiver tank is located in the condenser compartment. The function of the receiver tank is to store the liquid refrigerant. During normal operation, the level of the refrigerant should be approximately at the bottom of the lower sight glass.

In case of extreme pressure rise in the liquid receiver tank, a pressure relief valve will break at 350 psi (2 413 kPa) and relieve the receiver tank pressure.

The receiver tank incorporates an inlet valve on the inlet side (upper section) which allows the tank to be isolated or serviced. An outlet valve on the outlet side (lower section) permits complete isolation from the rest of the system.

Filter dryer

Description

A filter dryer, also located in the condenser compartment, is installed on the liquid refrigerant line after the receiver tank. It is used to absorb moisture and foreign matter from refrigerant before it reaches the expansion valves. The filter should be replaced if the system has been opened to prolonged exposure as shown by the moisture indicator sight glass.

Replacement

The filter is of the disposable type. When replacement is required, remove and discard the complete unit and replace with a new unit of the same type according to this procedure:

1. Isolate the refrigerant in the receiver tank by following the *"Pumping down"* procedure stated previously.
2. Change the filter dryer as a unit.
3. Admit a small quantity of refrigerant (R-12) to the low side of the system. Check for leaks. Return the system to normal operation.

CAUTION: Do not use carbon tetrachloride or similar solvent to clean parts. Do not use steam guns. Use mineral spirits or naphta. All parts should be thoroughly cleaned. Use a stiff brush to wash dirt from grooves, holes, etc.

WARNING: Cleaning products are flammable and may explode under certain conditions. Always handle in a well ventilated area.

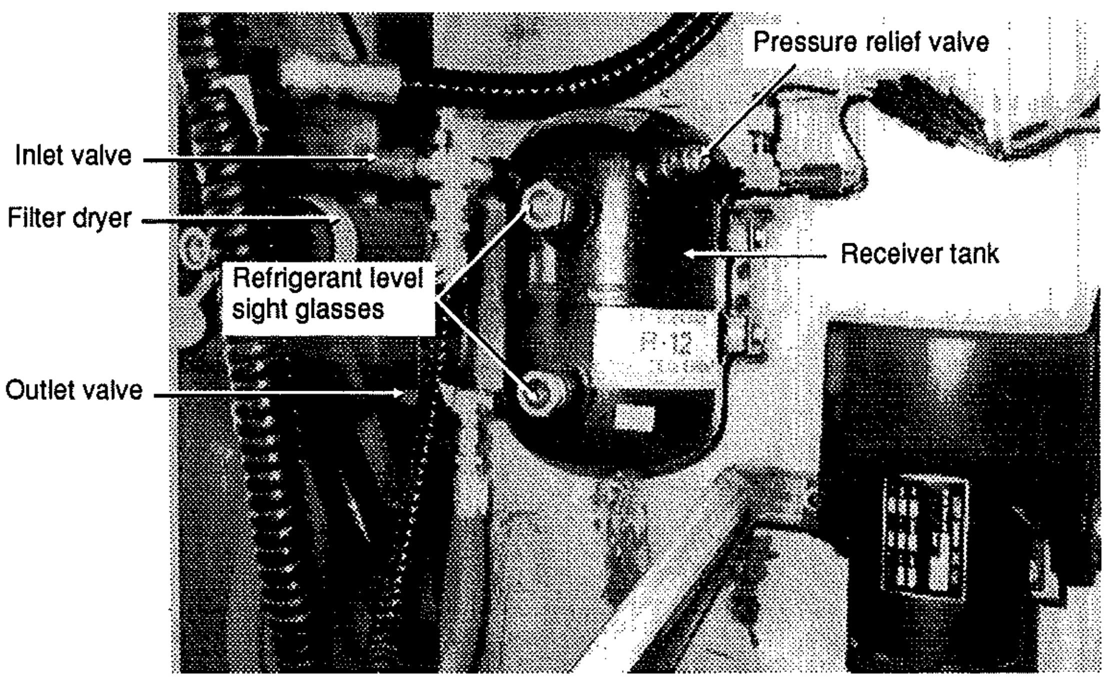


FIG. 17

Moisture indicator

The moisture sensitive element consists of a color changing ring which is reversible from pink to blue and vice versa as the moisture content in the refrigerant changes. Pink indicates a wet refrigerant, light violet (caution) and blue indicates a dry refrigerant.

Since temperature changes affect the solubility, the color change will also vary with the refrigerant temperature. The following table shows the color change for R-12 at various moisture levels and liquid line refrigerant temperatures.

REFRIGERANT R-12			
INDICATOR COLOR			
TEMPERATURE	BLUE	LIGHT VIOLET	PINK
	(p.p.m.)	(p.p.m.)	(p.p.m)
75 °F (24 °C)	Below 5	5-15	Above 15
100 °F (38 °C)	Below 10	10-30	Above 30
125 °F (52 °C)	Below 15	15-45	Above 45
p.p.m. = parts per million (moisture content)			

A moisture level of 15 p.p.m. for refrigerant 12 indicated in the blue color range of the above table is generally considered dry and safe. A color indication of light blue to light violet indicates the caution range of moisture level. For positive protection, the drying of the system should be continued until the color of the element turns deep blue.

Moisture is one of the main causes of chemical instability or contamination in air conditioning systems. If moisture is present, it can corrode the valves, condenser and evaporator coils, compressor and other components causing a malfunction and eventual failure of the system. Uncontrolled moisture in the system can result in very expensive multiple component replacements if not corrected at an early stage. The moisture indicator permits an early detection of moisture in the system and when corrected by a dessicant charge, system contamination is greatly minimized.

Liquid refrigerant solenoid valve

Description

The flow of liquid refrigerant to the driver's evaporator is controlled by a normally-closed solenoid valve located at ceiling of spare wheel and tire compartment and is accessible through the reclining bumper.

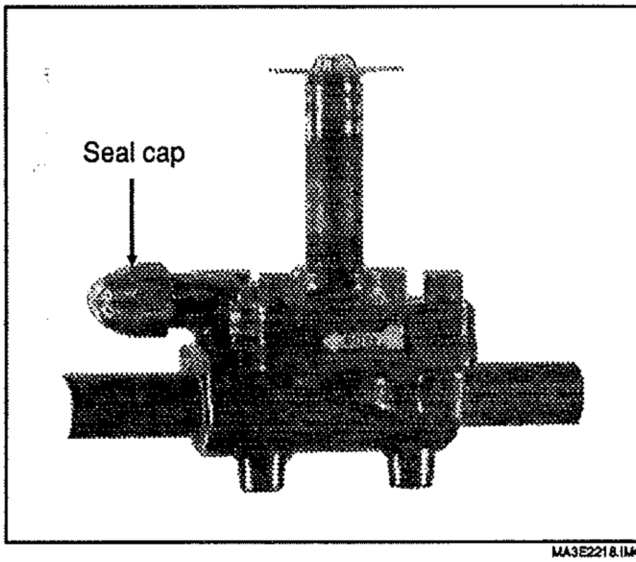


FIG. 18 - Refrigerant solenoid valve (without coil)

Manual bypass

This type of solenoid valve is equipped with a manual operating stem. The 3/16" square stem located on the bonnet is exposed when seal cap is removed. To manually open valve, turn stem 1/2 turn counterclockwise. To manually close valve, turn stem clockwise until tight against seat. Manual stem must be in closed position for automatic electric operation.

Coil replacement

1. Disconnect connector from the coil connector.
2. Take out the retaining screw at the top of the coil housing. The entire coil assembly can then be lifted off the enclosing tube.
3. Place the new coil and yoke assembly on the enclosing tube; lay data identification plate in place.
4. Insert the coil retaining screw, rotate housing to proper position and tighten screw securely.
5. Connect connector from coil connector.

Valve disassembly

1. Remove the coil as stated previously.
2. Pump down the system as stated earlier in this section.
3. Remove the four socket head screws which hold the body and bonnet together (see fig. 19).
4. Carefully lift off the bonnet assembly (upper part of the valve) so that plunger will not fall out. The diaphragm can now be lifted out.

NOTE: The above procedure must be followed before brazing solder-type bodies into the line.

CAUTION: Be careful not to damage the machined faces while the valve is apart.

Valve reassembly

1. Place the diaphragm in the body with the pilot port extension up.
2. Hold the plunger with the synthetic seat against the pilot port.
3. Make sure the bonnet O-rings are in place, then lower the bonnet assembly over the plunger, making sure that the locating sleeve in the bonnet enters the mating hole in the body.
4. Insert the four socket head screws and tighten evenly.
5. Replace the coil as stated previously.
6. Admit a small quantity of refrigerant (R-12) to the low side of the system. Check for leaks. Return the system to normal operation.

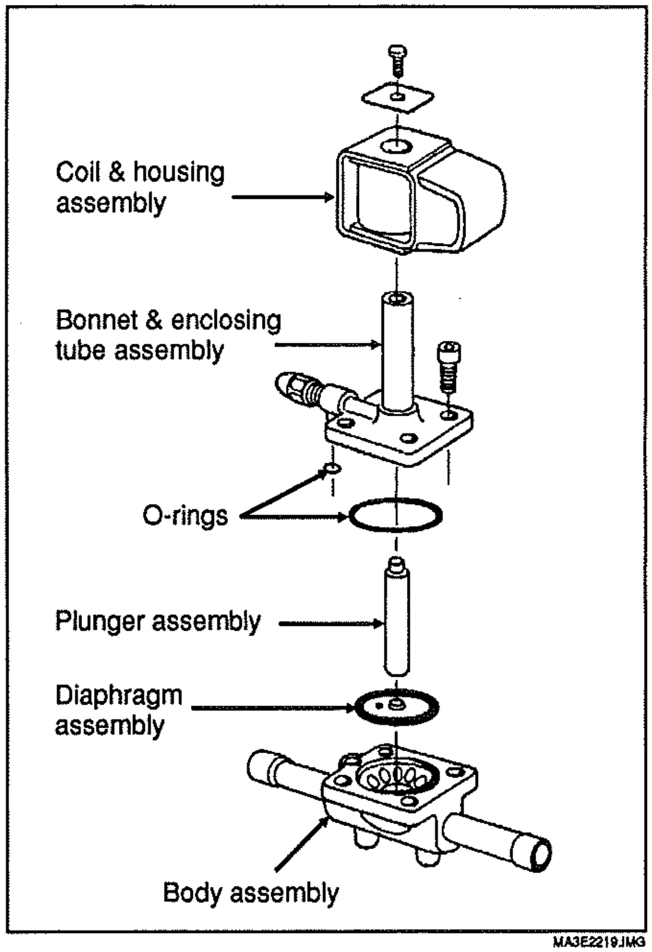


FIG. 19 - Refrigerant solenoid valve disassembly

HUMIDISTAT

Description

This control, which is frequently used in houses, activates a humidifier in cases where the humidity rate of ambient air in house is lower than the rate selected manually on the humidistat. The same control is used on this vehicle, with the exception that inside ambient air of vehicle must be dried when the humidity rate is too high. To do so, the signal transmitted by the humidistat is reversed by the use of the HVAC control module.

Air is dried by activating the stage *"Cool 1"* on the HVAC logic panel. Thus, the humidistat is a control which enables the bypass of the A/C system control to activate the A/C compressor. In practice, this means that when the heating system is operating, the A/C system can also operate simultaneously. A yellow LED mounted on the HVAC control module will be turned on to indicate a dehumidifying request (for location, refer to previous heading *"Humidistat yellow LED"*). The humidistat is located in the HVAC compartment in centre of the rear wall.

NOTE: Even if the dehumidifying function is requested, the stage *"Cool 1"* on the HVAC logic panel will not turn on as long as the ambient temperature inside vehicle will not be less than 4 °F (2 °C) from the selected temperature with *"Passenger A/C - Heating temperature"* control.

Setting

Set humidistat control to provide a humidity rate of 30%.

Checkout

1. Turn counterclockwise the control knob of the humidistat to the *"Off"* position;

2. Start engine, then switch on the *"Passenger A/C-heating"* switch.

3. Turn clockwise the *"Passenger A/C - Heating temperature"* control to its maximum heating position; the red LED located on the center console should illuminate to indicate operation of the heating system.

4. Then, turn **slowly** counterclockwise the *"Passenger A/C - Heating temperature"* control until the green LED located on the center console also illuminates (red LED should remain illuminated) to indicate the dehumidifying request.

5. Turn the control knob of the humidistat to its maximum clockwise position; the green LED on the center console should turn off.

6. Reset humidistat control in order to provide a humidity rate of 30 %.

Maintenance

Do not apply oil to any part of the humidistat. To insure trouble-free performance, the nylon element should be inspected periodically. Dirt and grease will not damage the element, but may reduce its sensitivity. If necessary, remove accumulated dust and dirt with a soft bristled brush.

HEATING SYSTEM

Description

The schematic of figure 20 shows the heating system and its components.

In addition to the normal heating provided by the engine, an optional 41,000 Btu/hr preheating system may have been installed in the engine compartment.

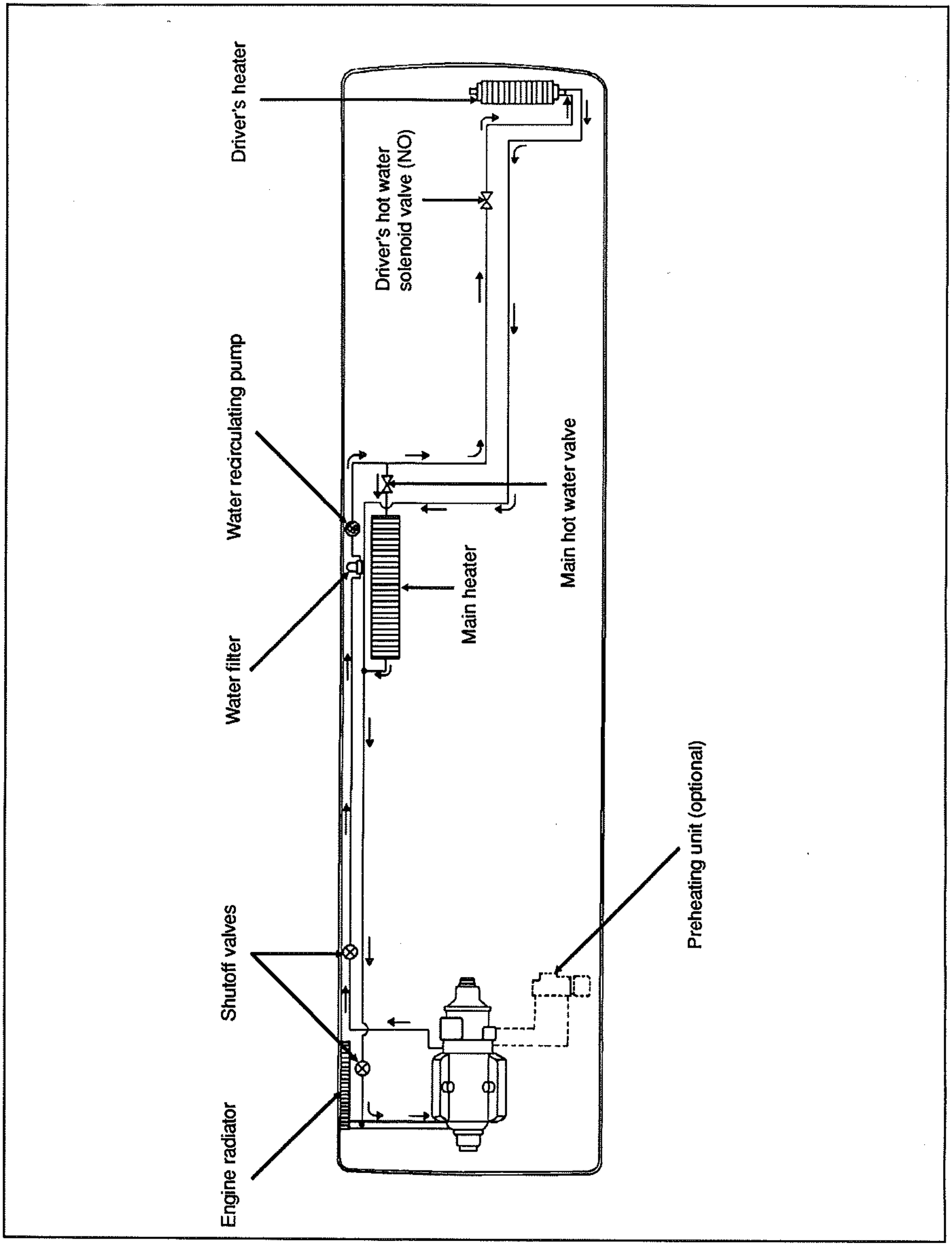


FIG. 20 - Heating system components

Draining heating system

To drain the entire system, refer to section 05 *"Cooling"*. If only the driver's or main heater core must be drained, refer to the following instructions.

Driver's heater core

1. Stop engine and allow engine coolant to cool.

2. Locate the normally-open water solenoid valve on the ceiling of the spare wheel compartment (see fig. 21), disconnect its wiring connector, then connect a 24 volt external power source, using jumper cables, to close valve.

WARNING: Before proceeding with the following step, check that coolant has cooled down.

3. Loosen hose clamp, install an appropriate container to recover coolant, then disconnect silicone hose from water solenoid valve.

4. From inside of vehicle, open the manual vent on the coolant inlet line near the driver's unit (see fig. 22) to ensure an efficient draining.

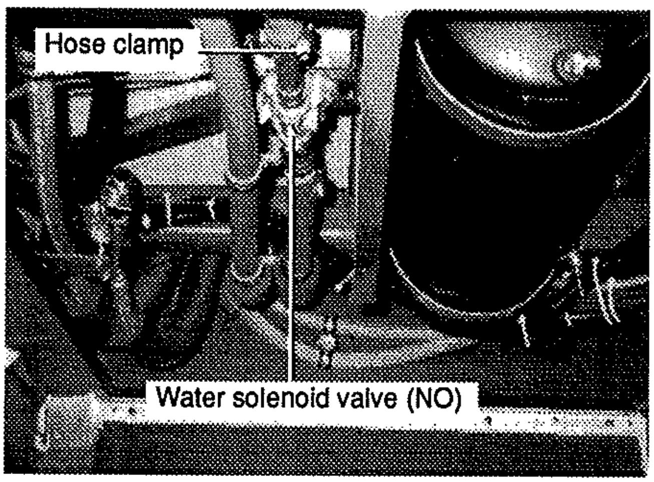


FIG. 21

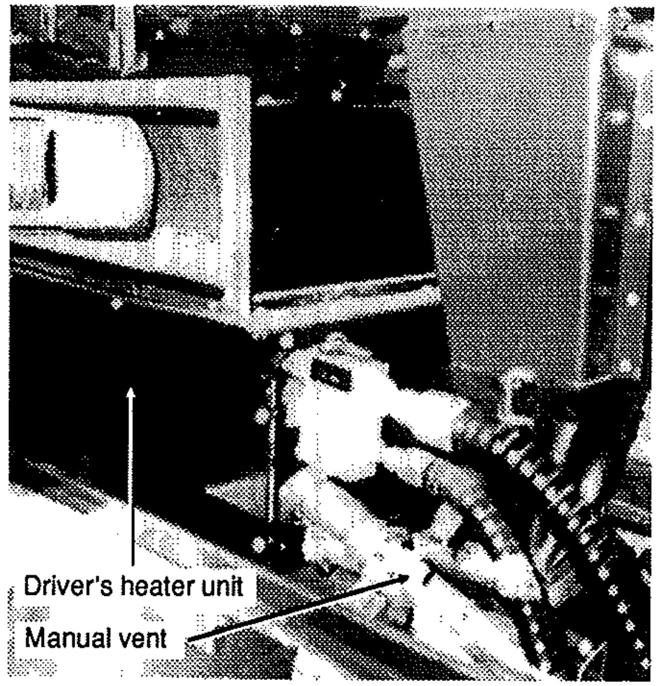


FIG. 22

Main heater core

1. Stop engine and allow engine coolant to cool.

2. Close both water shutoff valves. One is located in engine compartment under the radiator fan gearbox, while the other one is located in the L.H. ski compartment (small compartment between the last baggage compartment and rear electric compartment).

3. Open the second L.H. side baggage compartment door, then pull the black release button located on the L.H. side in order to unlock and open the A/C & heating compartment door.

WARNING: Before proceeding with the following step, check that coolant has cooled down.

4. Open drain cock in bottom of heater core, then open manual vent located on top of heater core (see fig. 23) in order to allow air to enter while draining.

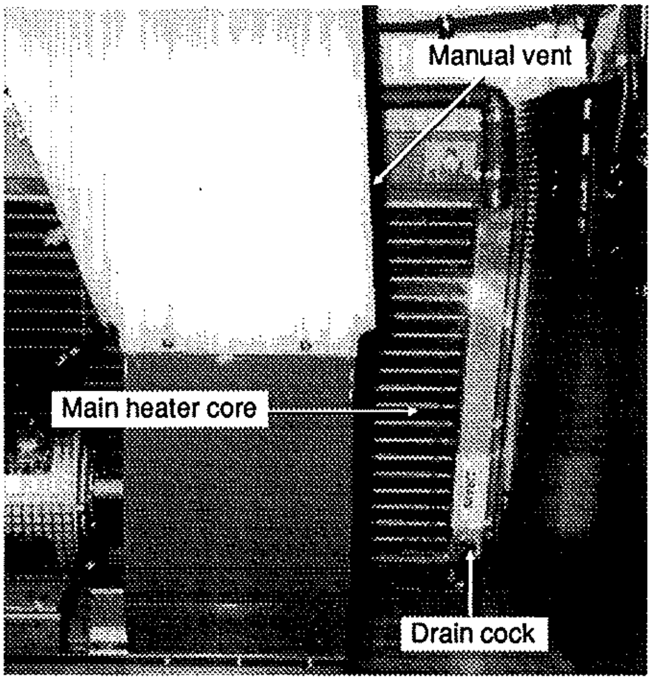


FIG. 23

Filling heating system

1. Ensure that the drain hose is reconnected and the manual vents and drain cock closed.

2. Open the surge tank filler cap and slowly fill the system to level of filler neck.

3. After initial filling, the water valves should be opened and water recirculating pump should be energized to assist in circulating coolant through the heating system. To perform this operation, start the engine, switch on the *"Passenger A/C-heating"* switch, then turn clockwise to their maximum position the *"Passenger and Driver's A/C-heating temperature"* controls in order to request the heating mode in each of these sections.

4. When coolant level drops below the surge tank filler neck, slowly fill the system to level of filler neck.

5. Once level has been stabilized, replace surge tank filler cap.

Bleeding heating system

Whenever the heating system has been drained and refilled, or the system has run low of coolant and coolant has been added, it is necessary to bleed air from heating system. Locate the manual vents illustrated in figures 22 and 23, then open them momentarily until no air escapes from the lines.

HEATING SYSTEM COMPONENTS

Driver's water solenoid valve

Description

A two-way normally open, internal pilot-operated solenoid valve designed for smooth closing is used to control the coolant flow through the driver's heating unit. The valve is made of forged brass with internal brass or stainless steel parts. It is mounted on the coolant inlet line of the driver's heating unit, and is accessible through the spare wheel compartment. The valve cannot be manually bypassed.

Improper operation

1. Faulty control circuit: Check the electric system by energizing the solenoid. A metallic clicking noise indicates that solenoid is operating; absence of clicking indicates a loss of power or a defective solenoid. Check for open breaker, open-circuited or grounded coil, broken lead wires.

2. Burned-out coil: Check for open-circuited coil. Replace coil if necessary.

3. Low voltage: Check voltage across the coil leads. Voltage must be at least 21 volts.

4. Excessive leakage: Disassemble valve and clean all parts. Replace worn or damaged parts with a complete spare part kit for best results.

Coil replacement

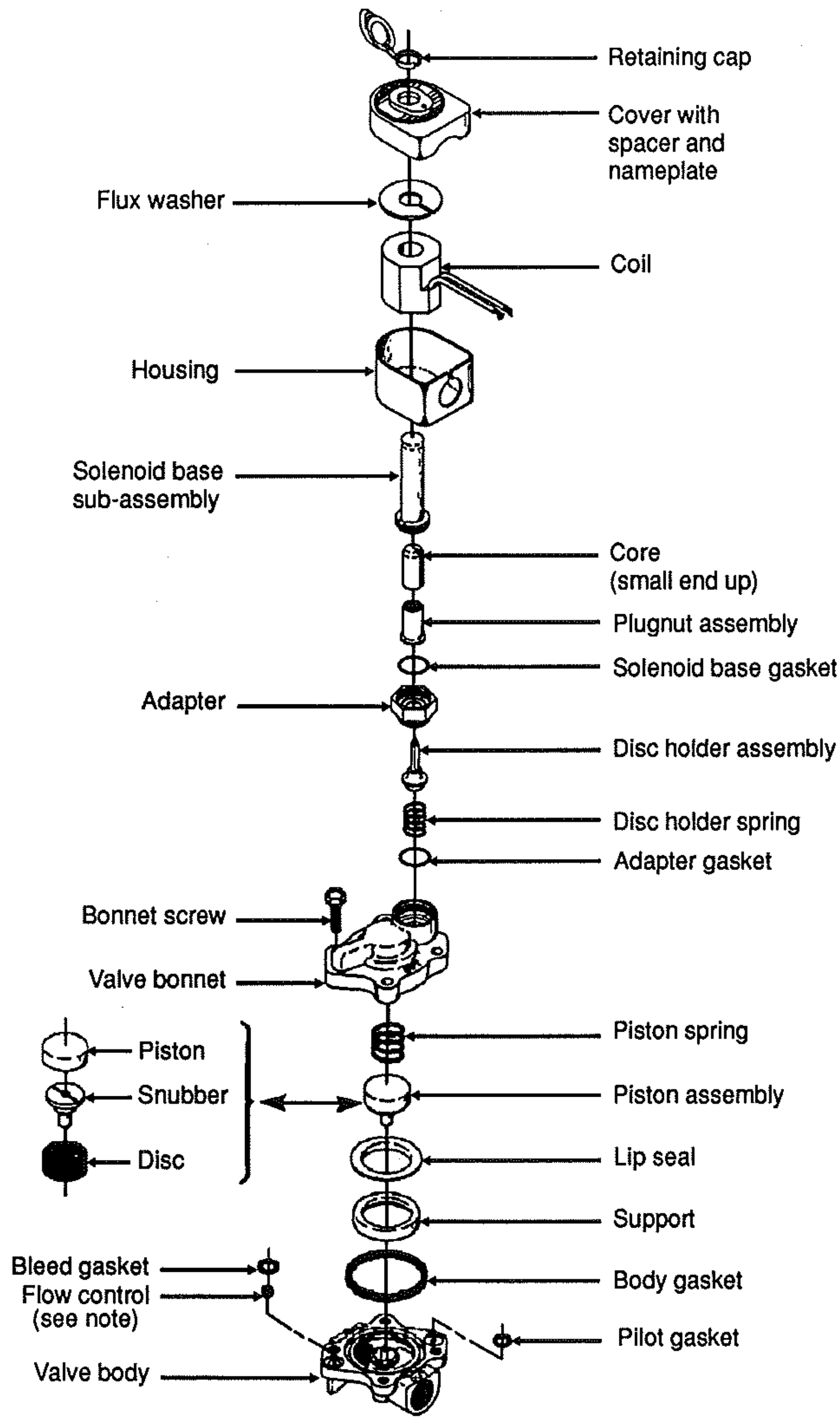
1. Disconnect connector from coil connector.

2. Remove retaining cap, cover with spacer and nameplate (see fig. 24).

3. Slip flux washer and coil off the solenoid base subassembly.

4. Coil is now accessible for replacement. Reassemble by reversing sequence of disassembly. Refer to exploded view for identification and location of parts.

NOTE: Solenoid must be completely reassembled, as the housing and internal parts complete the magnetic circuit.



NOTE: Concave end of flow control to face valve bonnet.

MA3E2224

FIG. 24 - Driver's water solenoid valve

Valve disassembly

1. Drain driver's heating unit as previously explained in this section under heading *"Draining heating system"*.

2. Disconnect connector from coil connector.

3. Disassemble valve in an orderly fashion paying careful attention to exploded view (fig. 24) provided for identification of parts.

4. Remove retaining cap and slip the entire solenoid enclosure off the solenoid base subassembly.

5. Unscrew solenoid base subassembly with the special wrench adapter supplied in rebuild kit (for wrench adapter only, order ASCO wrench kit # K218-950). Remove core, plug nut assembly, and solenoid base gasket.

6. Unscrew adapter and remove disc holder assembly, disc holder spring, and adapter gasket.

7. Remove the four bonnet screws and valve bonnet from valve body. Remove the following parts: piston spring, piston assembly, lip seal, support, body gasket, bleed gasket, flow control, pilot gasket.

8. All parts are now accessible for cleaning or replacement. Replace worn or damaged parts with a complete spare part kit for best results.

CAUTION: Do not damage valve seat in any manner, as its sealing feature will be affected, thus resulting in continuous leakage.

Valve reassembly

1. Reassemble by reversing sequence of disassembly paying careful attention to exploded views (fig. 24) provided for identification and location of parts.

2. Lubricate the disc and all gaskets with *"Dow corning 111"* compound lubricant or an equivalent high-grade silicone grease.

3. Position the flow control in valve body with concave end outward, i.e. facing valve bonnet.

4. Position bleed gasket, pilot gasket and body gasket in valve body.

5. Preassemble snubber, disc, and piston to form piston assembly. Install snubber into recessed side of disc and press this assembly into position.

6. Position lip seal, flanged end up, onto piston. Position support in valve body and install piston with snubber, disc, and lip seal into support.

CAUTION: When assembling valve bonnet to valve body, be sure that either the letters "MB" (if present) on the valve bonnet line up with "In" on the valve body, or that the word "Out" (where applicable) lines up with "Out" on the valve body. Note that both "MB" and the word "Out" may be present on the same valve bonnet.

7. Replace piston spring, valve bonnet, and bonnet screws. Torque bonnet screws in a crisscross sequence to 95 ± 10 lbf•in. (11 ± 1 N•m).

8. Replace adapter gasket, disc holder spring, disc holder assembly, and adapter. Torque adapter to 175 ± 25 lbf•in. (20 ± 3 N•m).

9. Position solenoid base gasket and plugnut assembly in adapter. Install core (small end up) into solenoid base subassembly and install into adapter. Torque solenoid base subassembly to 175 ± 25 lbf•in. (20 ± 3 N•m).

10. Replace solenoid enclosure and retaining cap, then reconnect the coil connector.

11. Refill heating system as previously stated under heading *"Filling heating system"*, then bleed air from the driver's heating unit as stated previously under heading *"Bleeding heating system"*.

12. After maintenance is completed, operate the valve a few times to be sure of proper operation. A metallic clicking noise indicates that the solenoid is operating.

Water recirculating pump

Description

This vehicle is provided with a water recirculating pump, which is located in the A/C and heating compartment. The water recirculating pump consists in a centrifugal pump and an electric motor, which are mounted on a common shaft in a compact assembly. A pilot between the pump end and motor cover ensures proper alignment of the complete assembly.

The motor is equipped with prelubricated sealed ball bearings which require no maintenance. A self-adjusting mechanical shaft seal is incorporated in this assembly to prevent coolant leakage between the pump cavity and armature shaft. This seal derives its lubrication from the liquid pumped, and **it will be destroyed if permitted to operate dry.**

This pump requires no periodic maintenance other than replacement of motor brushes. Replacement of motor brushes can be performed without removing the pump assembly. Visual inspection of the pump should be made while the pump is in operation to determine if the shaft seal is intact. If there is evidence of coolant leakage, the unit must be disassembled for corrective measures. Disassembly of the pump will be necessary only in the case of a seal leak, bearing failure, or motor failure.

Removal

1. Stop engine and allow engine coolant to cool.

2. Close shuttoff valve on the line located in the L.H. ski compartment (small compartment between the last baggage compartment and rear electric compartment).

3. Disconnect the electrical wiring from the motor.

WARNING: Before proceeding with the following step, check that coolant has cooled down.

4. Remove the drain plug at the bottom of pump and place a container to recover the residual coolant in the line.

5. Disconnect water lines from the pump at the flange connections.

6. Remove the two clamps holding the pump motor to its mounting bracket. Remove the pump with the motor as an assembly.

Disassembly (refer to fig. 25)

1. Remove two brush caps (3) and two brush and spring assemblies (4). When removing brushes, note the position of the brush in the tube. Brush life is significantly decreased if brushes are not replaced properly.

2. Remove the pump cover (12) by removing eight fillister head screws. Remove cover carefully to prevent damage to gasket (10).

3. Remove gasket (10).

4. Remove two hex nuts and lock washers which hold pump assembly to the motor.

5. Remove the pump from the motor as follows:

a. Install puller tool assembly (MP Co. Part No. 24702 or equivalent) to pump body (8) using four screws removed from the pump cover (12).

b. Tighten the puller screw to press the motor shaft out of the impeller hub. The pump is now free of the motor.

6. Remove the puller tool.

7. Remove impeller (11) and components of the pump seal assembly (15) and seal seat assembly (16).

CAUTION: Do not scratch or mar the sealing surface of this seat, as it sealing feature will be affected, thus resulting in continuous leakage.

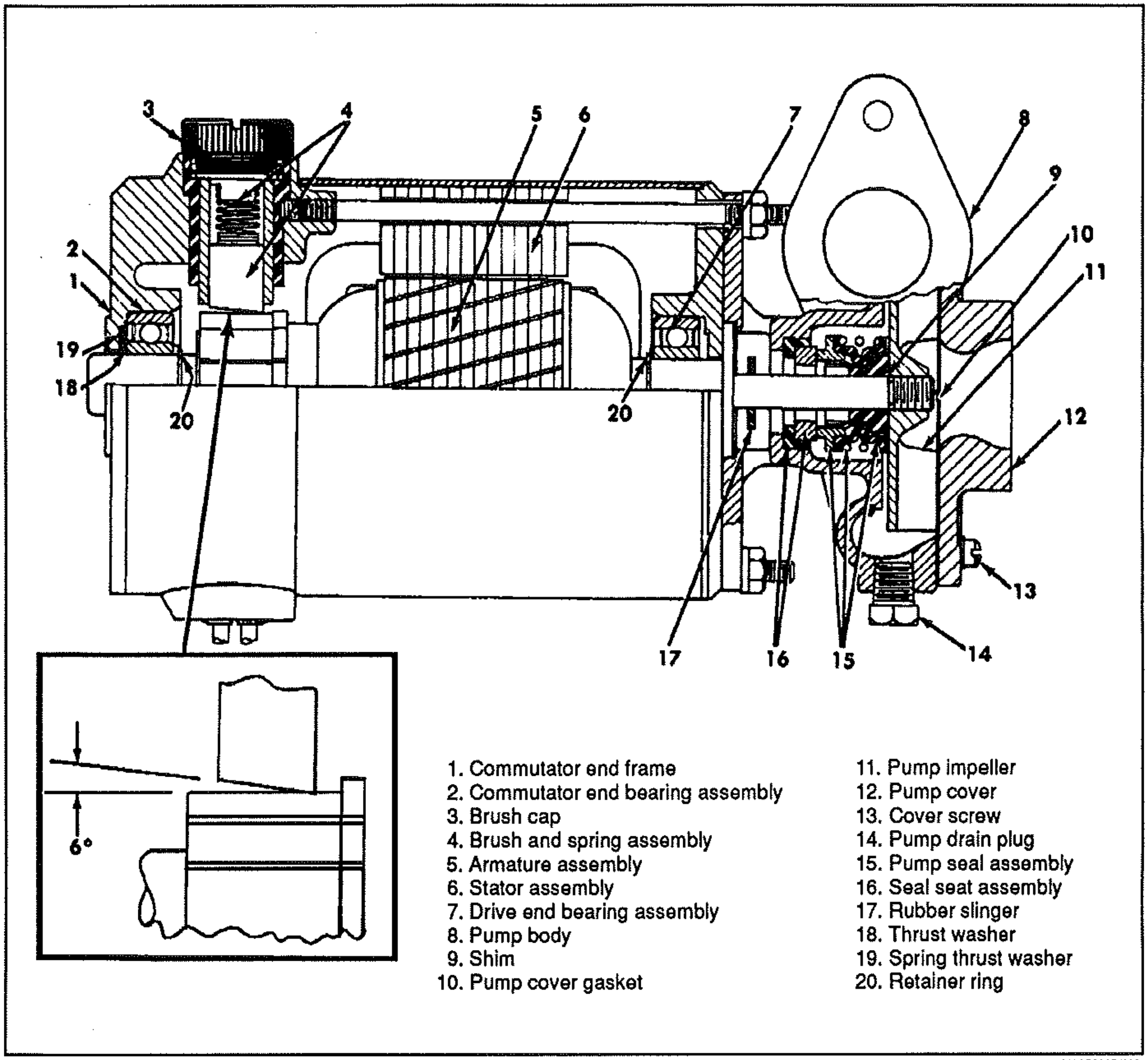


FIG. 25 - Water recirculating pump and motor

Inspection

Components removed from the recirculating pump and motor assembly should be compared with new parts to determine the degree of wear.

Brushes

1. When removing brushes, note the position of the brush in the tube. Brush life is shortened if the brushes are not replaced properly.

2. Examine brushes for the following:

a. Wear.

Replace the brushes if less than 25% of the usable brush is left (less than 0.300" (8 mm)).

b. Chipped edges.

Chips can be caused by improper handling or installation. Badly chipped brushes should be replaced regardless of their length.

c. Annealed brush spring.

This can be detected by noting the resiliency of the spring. Annealing is caused by failing to tighten the brush caps properly, thus not providing a good low resistance contact between the terminal and the brush tube. Replace brushes showing evidence of annealed springs.

d. Frayed or broken pigtail.

An improperly installed brush may have the pigtail (shunt) pinched under the terminal or between the coils of the spring. If the pigtail is badly frayed or broken, replace the brush.

3. Observe the following factors when replacing brushes:

a. The face of a new brush is carefully cut to cause proper seating during the *"wear-in"* period.

b. Improper installation can harm both the brush and the commutator.

c. Replacement brushes should be of the proper grade.

d. New brushes have a 6 degree angle on the brush face. The brush should always be inserted so that the angle is open away from the pump end of the assembly (see inset, fig. 25).

e. Brush performance will be affected if the spring and terminal are not properly placed in the brush tube. The spring should be free over its entire length and the terminal should make good contact with the metal brush tube insert.

Bearings (fig. 25)

1. Rotate the motor shaft. If the ball bearings show evidence of wear, they should be replaced.

2. When removing the armature from the motor, the number of washers and their arrangement should be noted. Improper number or installation of washers can cause improper tracking of brushes, which will result in excessive preloading of bearings and noisy operation. Position spacer (19) and retainer ring (20) as shown.

3. The use of a bearing puller is recommended when removing the bearings to help prevent damaging the armature winding or the commutator.

4. Replacement bearings should be pressed in to the same exact location as the original bearings.

5. It is recommended that a suitable sealant (such as Loctite or equivalent) be used between the shaft and the bearing, if the fit is not tight enough to prevent the shaft from spinning inside the inner race.

6. After replacing the bearings, check the position of the commutator in the motor by looking down into the brush tube. Neither the riser nor the edge of the commutator should be visible.

Commutator

1. The commutator is a precise assembly. Although it is solidly built of a fairly tough material, it can be easily ruined by careless handling.

2. The commutator should be refinished only on equipment which will provide good concentricity and the proper finish.

3. The commutator should be refinished if a micrometer reading shows a difference between *"in track"* and *"off track"* diameter of 0.187" (4,7 mm) or more.

4. The commutator should be carefully undercut with a 0.025" (0,6 mm) or less slot width.

5. A 25 to 50 micromesh finish is desirable on a new or refinished commutator.

6. The commutator should not be touched with the fingers since sweat and body oils will rapidly discolor and oxidize the surface.

Miscellaneous

1. Check the rubber shaft slinger (17) to make sure it is tight on the motor shaft. If the slinger slips on the shaft, it should be replaced.

2. Inspect seal assemblies (15) and (16) to determine wear. If the seal has leaked, or is badly worn, it is recommended that a complete new seal assembly be installed.

3. The impeller (11) is a press fit on the armature shaft. This press fit must be maintained to prevent the impeller from slipping. Install a new impeller if necessary.

Assembly

1. Install floating seal seat (16) in pump body (8) in the following manner:

a. Clean the seal seat in a suitable cleaning solvent to remove dust or dirt.

b. Insert the seat in the proper recess in the pump body. This is a snug fit, but a drop of machine oil or a small amount of clean grease applied only to the neoprene ring and to the body cavity will ensure easy installation. Be sure the seat bottoms in the pump body around its entire circumference.

2. Install slinger (17) on the motor shaft.

3. Assemble body (8) to the motor.

4. Lubricate the pump shaft with a small amount of light oil, then slip the seal bellows and washer assembly (15) onto the shaft, so that the seal washer contacts the seal seat (16) in the pump body (18).

5. Install impeller (11) in the following manner:

a. Place the impeller on a flat surface with the vanes against the flat surface.

b. Invert the motor and pump body assembly, then pilot the pump shaft into the impeller bore. **DO NOT HAMMER** on the motor shaft extension at rear of the motor.

c. Press on motor and pump body until the machined face of the pump body is flush with the face of the flat surface on which the impeller is resting. The face of the impeller vanes must now be flush with the machined face of the pump body.

6. Install gasket (10). This gasket is 0.010" (0,25 mm) thick and serves both to seal the cover and to establish the proper clearance between the face of the impeller and the pump cover.

7. Attach cover (12) to the pump body using eight (8) fillister head screws (13).

8. Install motor brushes (4) and brush caps (3), observing the precautions mentioned previously under step 3 in *"Inspection"* procedure.

Installation

1. Apply gasket cement to the pump body line adapter and to the line flanges, put in place the two gaskets, then connect water lines from the pump at the flange connections. Position the pump and motor assembly on the mounting bracket, position the mounting clamps over the motor and secure with mounting bolts.

2. Apply pipe sealant on threads of drain plug, then screw it in place.

3. Connect electrical wiring to the pump motor.

4. Open shuttoff valve located in the L.H. ski compartment (small compartment between the last baggage compartment and rear electric compartment).

5. Fill the cooling system as previously instructed in this section under *"Filling heating system"*, then bleed the system as previously instructed in this section under *"Bleeding heating system"*.

Water filter

Description

This vehicle is provided with a cleanable water filter, which is located in the A/C and heating compartment. The filter element uses the micronic principle of filtration which utilizes a resin-impregnated cellulose and an accordion-pleated design for a maximum filtering area. A relief valve integrated to the filter element allows bypass of the filter in case it would be seriously restricted (see fig. 26).

Maintenance

The filter maintenance consists in an initial cleaning after the first 3000 miles (4 800 km), and subsequently every 100,000 miles (160 000 km).

NOTE: Each time soldering is performed on any water pipe of the heating system, operate heating system a few minutes so that any foreign matter will be routed to the filters. Clean filters.

Cleaning procedure

1. Stop engine and allow engine coolant to cool.
2. Close shuttoff valve on the line located in the L.H. ski compartment (small compartment between the last baggage compartment and rear electric compartment).

WARNING: Before proceeding with the following step, check that coolant has cooled down.

3. Unscrew the filter casing with a 1 1/4" open end wrench.
4. Remove filter element, then clean inside of casing.
5. Using water under pressure, flush the element from inside towards the outside.
6. Replace element in casing, ensure that gasket and o-ring are still in place, then tighten casing on its cover.
7. Correct coolant level in surge tank as instructed previously in this section under *"Filling heating system"*.

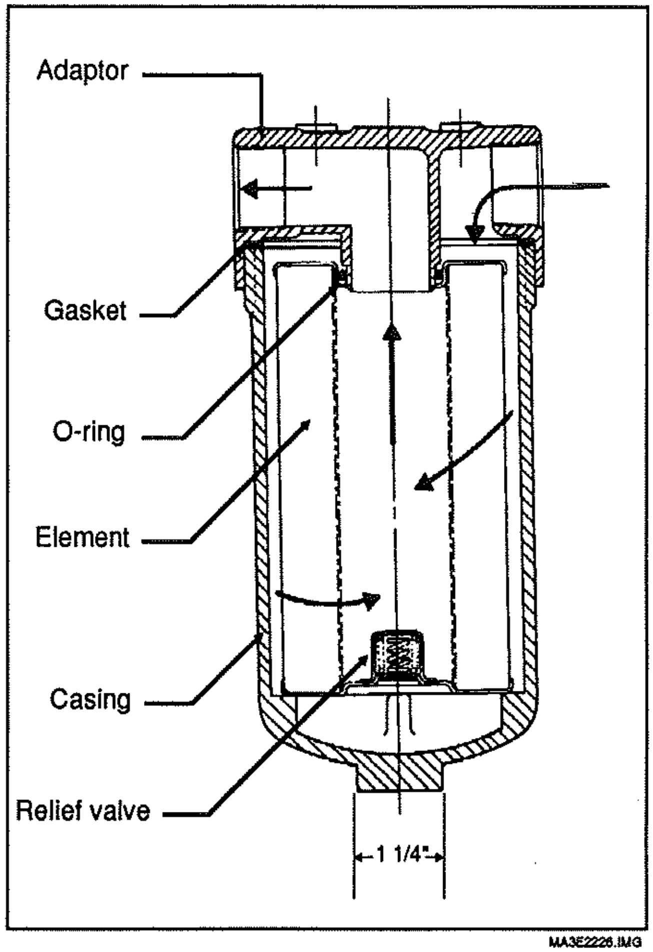


FIG. 26 - Water filter

Preheating system

Description

An optional preheating system may have been installed in vehicle to preheat and maintain the heat in the engine coolant. The preheater works in conjunction with the heating system of the vehicle, which heats the interior of the coach.

The preheater operates independently of the vehicle engine. It is connected to the heating circuits, the fuel supply system and the vehicle electrical system.

The burner connection to the preheater heat exchanger is so designed that the burner can be completely removed. When the protective hood is removed, the entire electrical equipment is made easily accessible for any checking and maintenance work required.

When the cable duct attached lengthways is removed, glow-ignition plug, flame sensor, final control switch and safety thermal cutout switch are made accessible.

Switching on the preheater

The pilot lamp comes on when the preheater is switched on. Combustion air flows in to flush out the combustion chamber, and the water recirculating pump is put in operation.

The fuel metering pump conveys fuel in precise doses to the combustion chamber, where fuel and combustion air form a combustible mixture which is ignited by the glow plug. Once the flame sensor has signalled to the control unit that combustion has taken correctly, the glow-spark plug and ignition coil is switched off.

The hot combustion gases are diverted at the end of the flame pipe, then pass through the indirect heating surfaces of the heat exchanger and transmit their heat to the water (coolant) passing through the heat exchanger.

The preheater is thermostatically controlled and operates intermittently, i.e. the switched-on times of the burner vary depending on the coolant temperature which in turn depends on the setting of the built-in coolant thermostat.

The water recirculating pump remains in operation as long as the heater is operating, even in the regulation intervals and during the delayed cutout of the switched-off preheater.

The preheater can be switched on at any time, i.e. during the delayed cutout period too. Ignition takes place once this delay time is over.

Switching off the preheater

When the preheater is switched off, the fuel supply is interrupted. The flame goes out, and at the same time a delayed cutout of some 2.5 minutes begins. The combustion air still flowing flushes the remaining combustion gas out of the chamber and cools off the hot parts on the exhaust side of the heat exchanger, while the water recirculating pump still running transmits the heat present in the heat exchanger, thus preventing local overheats. Once the delayed cutout time is over, both the combustion air blower and the water recirculating pump switch off automatically.

Safety equipment

Flame monitoring:

The flame is monitored by the flame sensor. This switch acts on the safety switch in the control unit, which switch shuts down the preheater in the event of a malfunction.

Automatic shutdown in the event of non-ignition or flame going out

If the preheater does not ignite, it switches off automatically not more than 3 minutes after being switched on.

If the flame goes out by itself during operation, the fuel supply stops automatically after no more than 4 minutes.

If there is a fault caused by the blower motor, the motor current fuse built into the control unit switches off the preheater.

Overheating and peak temperature

If the preheater overheats (e.g. due to lack of coolant), the safety thermal cutout switch stops the fuel supply. The preheater switches off automatically at the end of the delayed cutout time (approx. 2.5 minutes).

If the coolant temperature reaches the desired peak value, the coolant thermostat keeps this temperature approximately constant by alternately switching the preheater on and off.

Maintenance

For the maintenance, repair and troubleshooting of this device, refer to the *"Eberspächer Manual"* at the end of this section.

NOTE: Switch on the preheating system briefly about once a month, even during the warm season.

CAUTION: During welding procedure on vehicle, disconnect the preheater module connector in order to protect this system from voltage surges.

SPECIFICATIONS

HVAC LOGIC PANEL

Make . . . . Honeywell
Model W973B
Voltage rating . . . . .24 volts
Switching (on-off stages) . . . . .Pilot duty spdt relays
Input signal (from electronic transmitter) . . . . 1 to 16 V DC
Supplier number W973B1016
Prevost number 56-1805

ELECTRONIC TRANSMITTER

Make . . . . Honeywell
Model . . . . .T7067B (modified for Prevost)
Voltage rating . . . . 20 volts (from HVAC logic panel)
Current draw . . . . 20 milliamperes
Output signals . . . . Two 1-16 volt signals (one each for cooling and heating) to HVAC logic panel
Output signal rate of change (upon deviation from set point) . . . . 2.5 V DC/1 °F (0,5 °C)
Supplier number T7067B1006
Prevost number 38-0877

FRESH AIR INLET SENSOR

Make . . . . Honeywell
Model C7046A
Sensing element . . . . Carbon type, thermistor-resistor element
Nominal resistance . . . . 3000 ohms at 77 °F (25 °C)
Nominal sensitivity . . . . .70 ohms/°F (124 ohms/°C) at midrange
Supplier number C7046A1004
Prevost number 95-0082

RETURN AIR SENSOR

Make . . . . Honeywell
Model T7047C
Supplier number T7047C1025
Prevost number 95-0088

DISCHARGE AIR SENSOR

Make	Honeywell
Type	Non-adjustable thermistor sensor
Nominal resistance	1420 ohms at 75 °F (24 °C)
Nominal sensitivity	15 ohms/°F (25 ohms/°C) resistance increases as temperature falls
Supplier number	T7022A1010
Prevost number	56-1806

MAIN EVAPORATOR MOTOR

Make	Prevost
Type	T-19
Voltage	27.5 V DC
Current draw	69 amps
Horsepower	2
Revolution	1750 rpm
Insulation	Class F
Brush life	10 000 hours
Supplier number	T-19
Prevost number	56-1939
Brush supplier number	1197
Brush Prevost number	56-1202

CONDENSER MOTORS

Make	LeRoy-Somer
Type	TAP-12
Voltage	27.5 V DC
Current draw	23 amps
Horsepower	0.57
Revolution	1950 rpm
Insulation	Class F
Brush life	10 000 hours
Supplier number	TAP-12
Prevost number	56-1558
Brush supplier number	2.100.330
Brush Prevost number	56-1914

MAIN EVAPORATOR AIR FILTER

Make	AAA filters
Type	Permanent self-charging electrostatic
Supplier number	N/A
Prevost number	87-0961

DRIVER'S UNIT EVAPORATOR MOTORS

Make . . . . Aurora
Type RG500EF
Voltage . . . . 24 V DC
Quantity 2
Supplier number 001.58.04
Prevost number 56-1194

DRIVER'S UNIT EVAPORATOR AIR FILTER

Make . . . . Spall-Bowman
Type . . . . Permanent washable aluminum filter
Supplier number . . . . N/A
Prevost number 87-0840

REFRIGERANT

Type . . . . Freon 12 (Dichlorodifluoromethane)
Quantity . . . . 25 lbs (11,4 kg)

COMPRESSOR

Make . . . . Carrier Transicold
Model 05G
No. of cylinders 6
Bore . . . . 2" (50,8 mm)
Stroke . . . . 1-15/16" (49,2 mm)
Operating speed . . . . 400 to 2200 rpm (1750 rpm, nominal)
Minimum speed (for lubrification) . . . . 400 rpm
Nominal horsepower 15
Oil pressure at 1750 rpm . . . . 15 to 30 psi (103-207 kPa)
Oil capacity . . . . 1.13 U.S. gal (4,3 liters)
Weight . . . . 142 lbs (64,5 kg)
Approved oils
- Calumet Refining Co. R030
- Texaco WF68
- Witco Chemical Corp. . . . . Suniso 4GS

Supplier number 05GC037310
Prevost number 95-0097

COMPRESSOR UNLOADER VALVE

Make	Carrier Transicold
Type	Electric (AMC)
Voltage	24 V DC
Watts	15
Supplier number (without coil)	17-40407
Prevost number (without coil)	95-0095
Coil supplier number	22-50030
Coil Prevost number	95-0096

MAGNETIC CLUTCH

Make	Carrier Transicold
Type	housing mounted 9" dia., 2-C grooves
Voltage	24 V DC
Coil resistance at 68 °F (20 °C)	5.15 - 5.69 ohms
Supplier number	50-01122-01
Prevost number	95-0094

COMPRESSOR V BELTS

Without A/C compressor vario-drive

Make	Gates
Model	CX 96
Prevost number	50-6321
Quantity	2

With A/C compressor vario-drive

Between compressor and vario-drive

Make	Linnig
Model	LR1-BG7
Prevost number	95-0159
Qty	1

Between vario-drive and engine crankshaft

Make	Gates
Model	CX 75
Prevost number	50-6601
Qty	2

CONDENSER COIL

Make . . . . Carrier Transicold
Tubing . . . . .3/8" copper
Rows . . . . 5 rows, 5 circuits
. . . . 2 rows for subcooling
Fins . . . . .008 aluminum (or .006 copper optional)
. . . . 9 per inch
. . . . Corrugated with straight edge
Supplier number . . . . N/A
Prevost number . . . . 45-9042 (aluminum type)
. . . . 45-1465 (copper type)

RECEIVER TANK

Make . . . . Standard refrigeration
Prevost number 87-1002

FILTER DRYER ASSEMBLY

Make . . . . Henry
Supplier number 815030
Prevost number 87-0647

DRIVER'S LIQUID REFRIGERANT SOLENOID VALVE

Make . . . . Parker
Type . . . . Normally-closed with manual bypass
Nominal capacity with R-12 . . . . 9 Tons
Voltage . . . . 24 V DC
Amperage draw . . . . 0.67 amps
Watts 16
Supplier number (without coil) RB9MP3-MM
Prevost number (without coil) 95-0054
Coil supplier number . . . . .R23MM-CB 24 V DC
Coil Prevost number 95-0055
Repair kit Prevost number 95-0056

HUMIDISTAT

Make . . . . Honeywell
Model H402A
Scale range . . . . 15 to 60 % relative humidity with OFF and ON position
Setting recommended 30%
Sensing element . . . . A thin (1 mil) moisture sensitive nylon ribbon
Supplier number H402A1023
Prevost number 56-1803

DRIVER'S HOT WATER SOLENOID VALVE

Make . . . . Asco
Type . . . . Normally-open (without manual bypass)
Voltage . . . . .24 V DC
Current draw . . . . 0.47 amp.
Watts 11.2
Supplier number (with coil) 106-269-1
Prevost number (with coil) 87-0812
Coil Prevost number 87-0960
Repair kit Prevost number 87-0872

WATER RECIRCULATING PUMP

Make . . . . M.P. pumps
Model 12300
Voltage . . . . .24 V DC
Current draw . . . . 5.3 amps
Revolution . . . . 3000 rpm
Supplier number 22023
Prevost number 87-0871

HOT WATER VALVE (OPERATED BY AIR CYLINDERS)

Make . . . . Aurora
Model . . . . AH 28
Prevost number 87-0964

WATER FILTER ASSEMBLY

Make . . . . Purolator
Type . . . . 0F-15F ("T" type)
Relief valve setting . . . . 17-19 psi (117-131 kPa)
Filter size . . . . 10 microns
Filtering area . . . . 430 sq.in. (2 774,188 cm2)
Supplier number (with element) 0F-12-10
Prevost number (with element) 87-0834
Element supplier number 0F-2-10
Element Prevost number 87-0835

PREHEATING SYSTEM

Make	Eberspächer (Espar)
Model	D 12 W
Capacity	41,000 Btu (12 kWh)
Heating medium	Coolant
Rated voltage	24 V DC
Operating voltage	20-28 V DC
Power consumption (without water recirc. pump)	55 watts
Fuel consumption	0,4 U.S. gallons/hr (1,65 liters/hr)
Supplier number	25 1656 05 00 00
Prevost number	87-0969

SERVICE BULLETINS AND SERVICE INFORMATION LETTERS

Service Bulletins and Service Information Letters will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of publications pertaining to this section should be noted below as soon as received. These should then be filed for future reference.

NUMBER	DATE	SUBJECT

Trouble Shooting Checklist

Form must be typed

TRW Ross Gear Division
800 Heath Street
Lafayette, IN 47902
317 423-5377

Evaluation Performed By: Co.	City	State	Phone #	Date	Mileage	Chassis No.

Owner	City	State	OEM Mfg.	Truck Model	Date of Delivery

Type of Service

_____ General Freight _____ Log _____ Tanker _____ Compactor

_____ Dump _____ Mixer _____ Waste Hauler _____ Off Highway Only Other _____

Front Axle Model & Capacity

Part Number of Steering Gear	Code Date	Mfg & Part Number of Pump	Part Number of Assist Cylinder

Reservoir Location & Capacity	Type of Fluid used	

Detailed Description of Complaint

Hydraulic Tests

Test Temp Of Oil At Reservoir	Pressure At Idle No Load	Flow At Idle	Flow At Gov. RPM	Pressure At Idle Load Valve Closed	Pressure At Gov. Load Valve Closed
_____ °F	_____ PSI	_____ GPM	_____ GPM	_____ PSI	_____ PSI

Steering Pressure on Dry Concrete   Highest Reading

Center To Full Right Turn _____ PSI   Center To Full Left Turn _____ PSI   Is Vehicle Loaded? Yes _____ No _____

Internal Leakage — Gear Relief Valve Removed If Present

Right Turn _____ GPM _____ PSI   Left Turn _____ GPM _____ PSI

Poppet Setting

Right Turn _____ GPM _____ PSI   Left Turn _____ GPM _____ PSI

Internal Leakage With Assist Cylinder Isolated

Right Turn _____ GPM _____ PSI   Left Turn _____ GPM _____ PSI

Poppet Setting

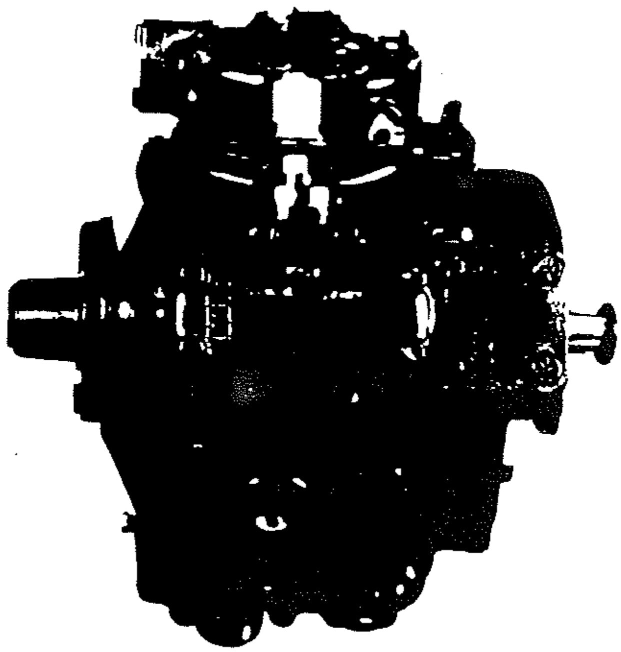
Right Turn _____ GPM _____ PSI   Left Turn _____ GPM _____ PSI

If problem is not solved install Flow Meter in a location that it can be observed during a test drive. If problem occurs during test drive observe Flow, Pressure, and Reservoir Temp

Flow _____ GPM _____ PSI   TEMP _____ °F

MODEL 05G
BUS COMPRESSOR

OPERATION AND SERVICE MANUAL
05G BUS COMPRESSOR



UNITED TECHNOLOGIES CARRIER TRANSICOLD

Carrier Transicold Division, Carrier Corporation, P O Box 4805, Syracuse, NY 13221 • Printed in U. S. A. 0387

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SECTION 1
DESCRIPTION

1.1 INTRODUCTION

This operation and service manual covers the Model 05G bus compressors listed in the model chart below. These compressors are designed for air conditioning in bus and rail applications. They can easily be distinguished from the Model 05G compressors used in trailer refrigeration applications by the shape of the oil pump and bearing head and by the absence of mounting flanges on the seal end cover. (See figure 1-1.)

MODEL	PART NO.	DESCRIPTION
05GA	05GA037110/120	New aluminum compressor, without unloaders
05GB	05GB037110/120	New aluminum compressor, with one electric unloader
05GC	05GC037110/120	New aluminum compressor, with two electric unloaders
05GD	05GD037110/120	New aluminum compressor, with one pressure unloader
05GE	05GE037110/120	New aluminum compressor, with two pressure unloaders
05GX	05GX037110	Service replacement compressor-with plugged heads for use with or without unloaders, and without service valves, unloaders, clutch, coupling, switches, or other accessories attached.

1.2 GENERAL DESCRIPTION

The Model 05G bus compressors are of the open reciprocating type, that is, of positive displacement. Compressor wear is minimized by splash lubrication and by force feed lubrication, which is accomplished by a low speed oil pump driven directly from the end of the compressor crankshaft. See figure 1-1.

CAUTION

THE OIL PUMP MUST BE SET TO ROTATE IN THE SAME DIRECTION AS THE CRANKSHAFT. (REFER TO PARAGRAPH 3.2.2.)

The tapered end of the crankshaft, which extends outside the crankcase, is adaptable to a variety of belt driven clutch mechanisms. A mechanical seal prevents refrigerant leakage where the rotating shaft passes through the crankcase. See figure 1-1.

The compressor is equipped with flanges for connecting suction and discharge service valves. Connections are also provided for pressure gauges and safety cutout switches. Sight glasses installed on both sides of the crankcase, provide a means for checking oil level in the compressor crankcase. A drain plug facilitates draining of oil from the crankcase and an oil fill plug enables addition of oil when necessary. A bottom plate provides access through the bottom of the crankcase for maintenance.

Capacity of the Model 05G bus compressor is determined by piston displacement and clearance, suction and discharge valve size, compressor speed, suction and discharge pressure, type of refrigerant, and unloader solenoid valves.

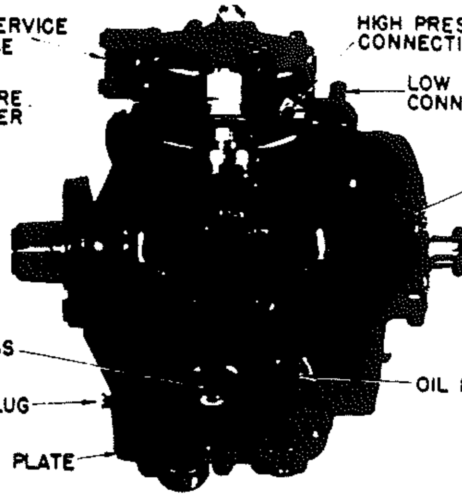


Figure 1-1. Model 05G Bus Compressor, with Pressure Unloaders

1.3 COMPRESSOR REFERENCE DATA

Model No.	05G Bus Compressor
No. of Cylinders	6
Bore	2" (50.8 mm)
Stroke	1-15/16" (49.2 mm)
Operating Speed	400 to 2200 rpm (1750 rpm, nominal)
Minimum Speed (for lubrication)	400 rpm
Oil Charge	9 pints (4.3 litres)
Weight	142 lb (64.5 kg)
Approved Oils*	
Calumet Refining Co.	R030
Texaco	WF68
Witco Chemical Corp.	Suniso 4GS

*NOTE: The above oils are suitable for use with reciprocating compressors using R-12 or R-22 and with evaporator temperatures above -40°F (-40°C).

1.4 DETAILED DESCRIPTION

1.4.1 SUCTION AND DISCHARGE VALVES

The compressor uses reed type suction and discharge valves made of highest quality steel for long life. The valves operate against hardened integral seats in the valve plate.

The pistons move in a straight line, but alternately in divergent directions. The downstroke of the piston admits refrigerant gas through the suction valve, and then compresses this gas on the upstroke, thereby raising its temperature and pressure. The compressed gas is prevented from re-entering the cylinder on its next downstroke by the compressor discharge valve. See figure 1-2 for a diagram of the gas flow through a compressor without capacity control unloaders. For compressors equipped with unloaders, refer to paragraph 1.4.2 and figures 1-3 through 1-6.

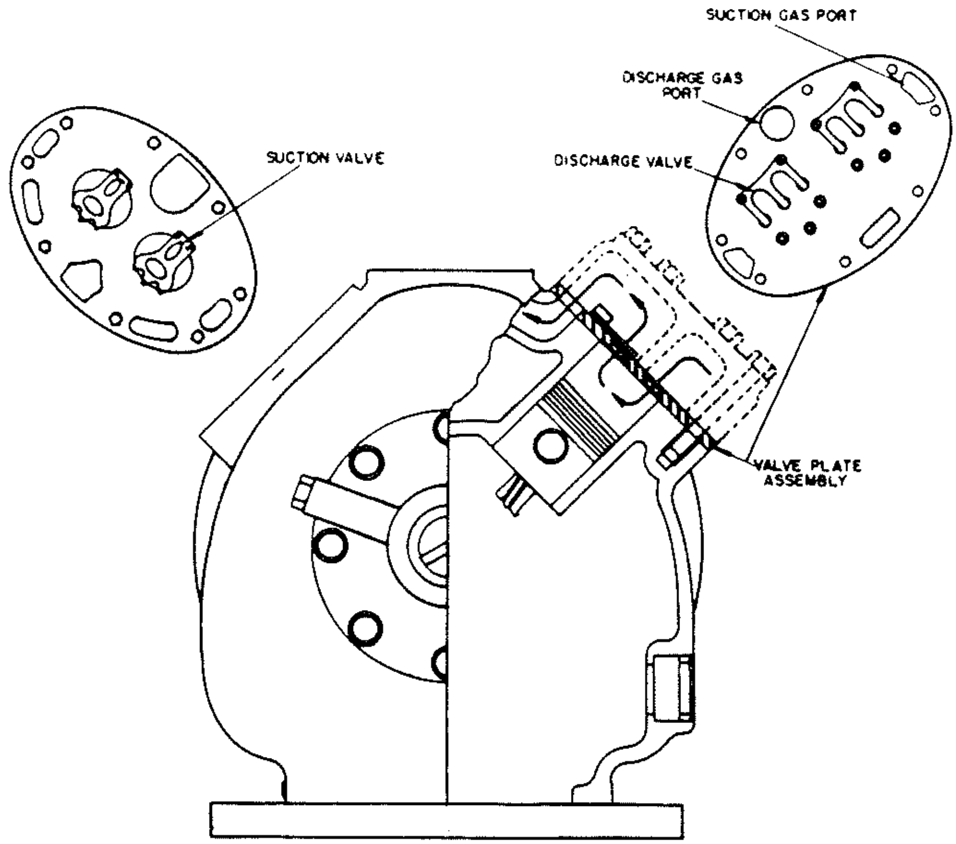


Figure 1-2. Gas Flow Through Compressor Without Capacity Control

1.4.2 CAPACITY CONTROL UNLOADERS

There are two types of optional capacity control unloaders used with the 05G Bus Compressors: electric solenoid-operated and pressure-operated unloaders. Both of these unloaders are of the snap-action, cylinder head bypass type, using a piston type control valve to control discharge gas flow. They differ primarily in the method of controlling the bypass control valve. The two types of unloaders can be easily identified by their shape. See figures 1-3 through 1-6.

1.4.2.1 <u>Electric Solenoid-Operated Unloaders</u>

The unloader solenoid is controlled by either a pressure switch or temperature switch (thermostat). When demand for refrigeration decreases, the pressure or temperature switch energizes the solenoid which unloads the cylinder and allows discharge gas to circulate as shown in figure 1-3. The unloaded cylinders operate with little or no pressure differential, consuming very little power. When the solenoid is de-energized, cylinders reload allowing discharge gas to circulate as shown in figure 1-4.

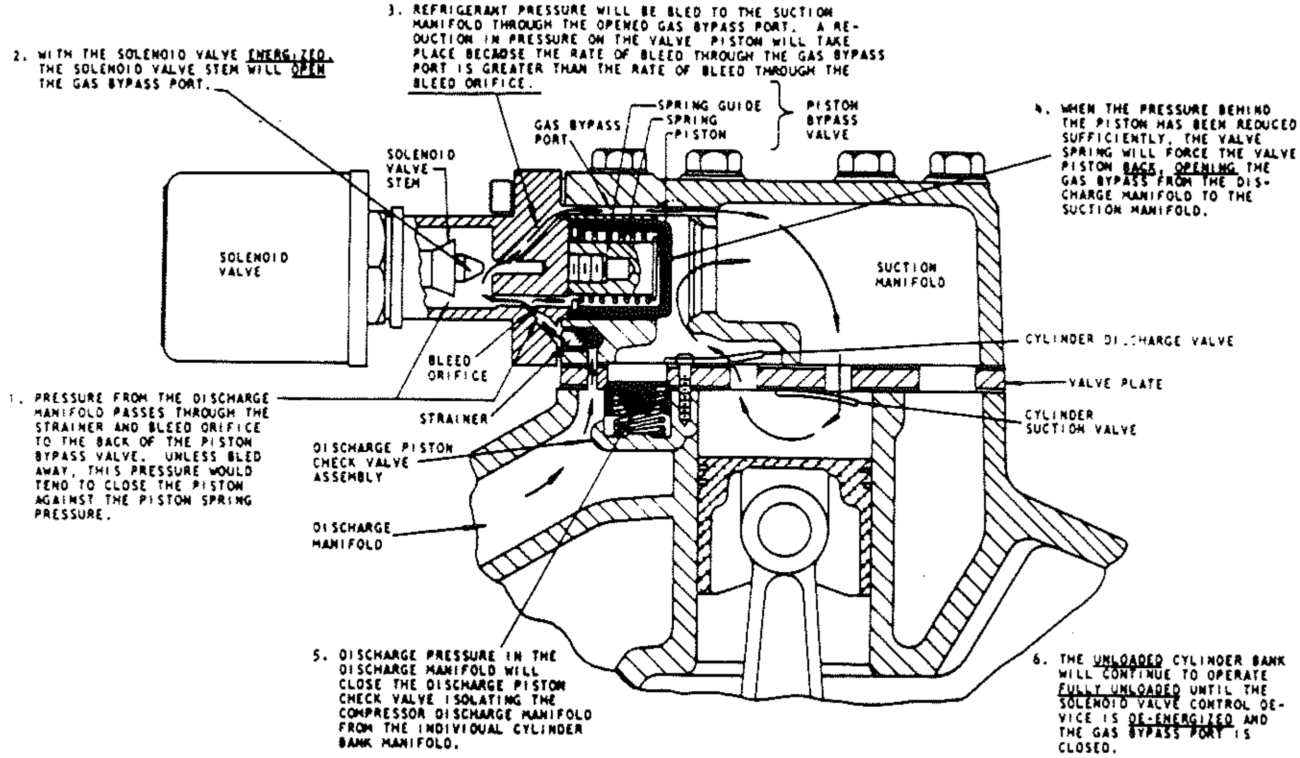


Figure 1-3. Solenoid-Operated Unloader, Unloaded Operation

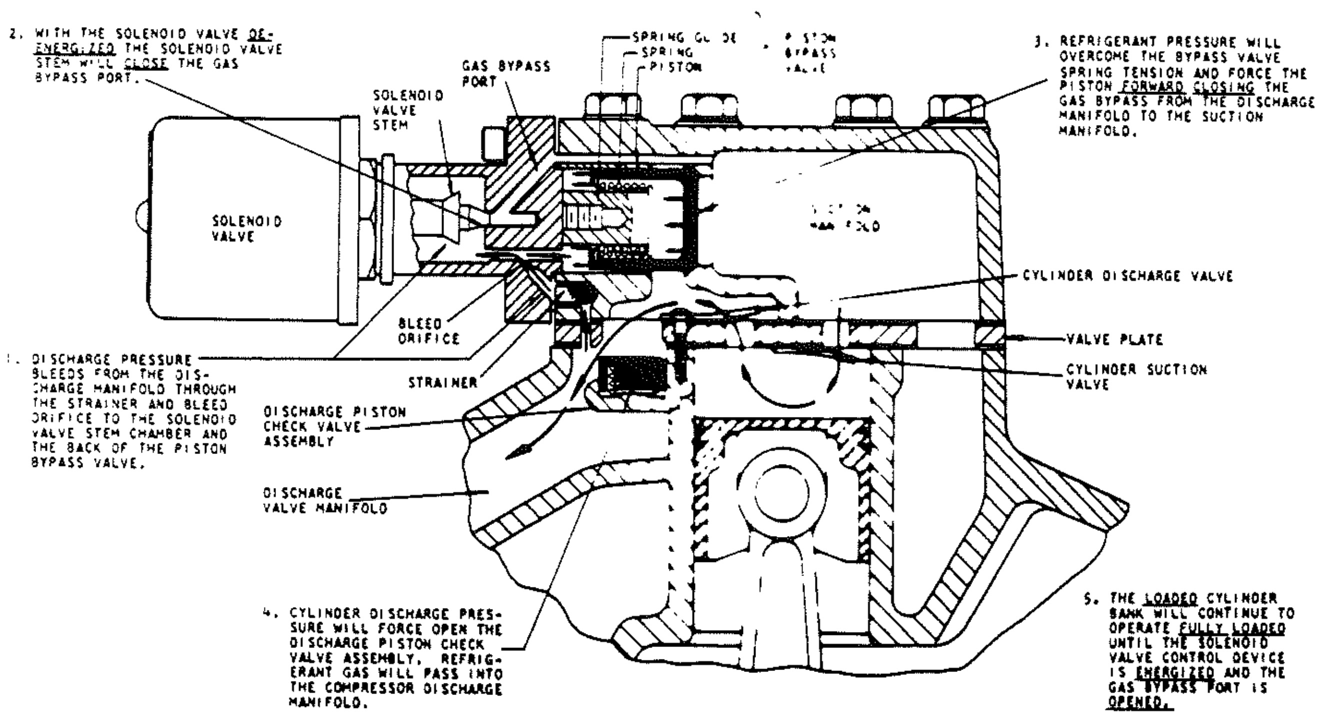


Figure 1-4. Solenoid-Operated Unloader, Loaded Operation

1.4.2.2 Pressure-Operated Unloaders

The pressure-operated unloaders are controlled by suction pressure and actuated by discharge pressure. Each unloader valve controls two cylinders. On startup, controlled cylinders do not load up until differential between suction and discharge pressure is 10 psi (1.7 kg/cm^2)

During loaded operation, when suction pressure is above the valve control point, the poppet valve will close. Discharge gas bleeds into the valve chamber; the pressure closes the bypass piston; and the cylinder bank loads up. Discharge gas pressure forces the check valve open, permitting gas to enter the discharge manifold. See figure 1-5.

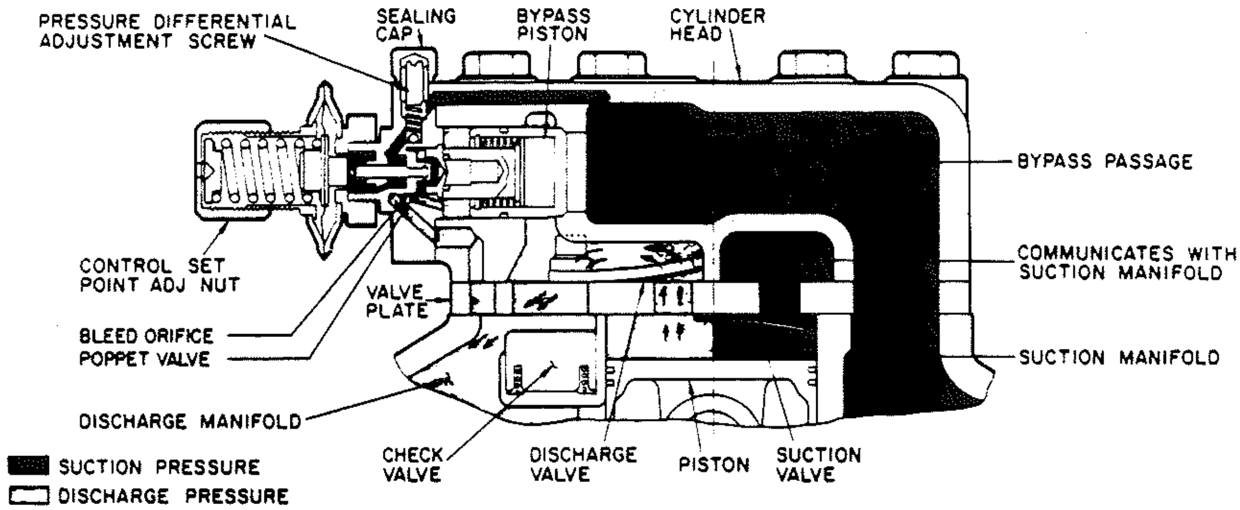


Figure 1-5. Pressure-Operated Unloader, Loaded Operation

During unloaded operation, when suction pressure drops below the valve control point, the poppet valve will open. Discharge gas bleeds from behind the bypass piston to the suction manifold. The bypass piston opens, discharge gas is recirculated back to the suction manifold and the cylinder bank is unloaded. Reduction in discharge pressure causes the check valve to close, isolating the cylinder bank from the discharge manifold. See figure 1-6.

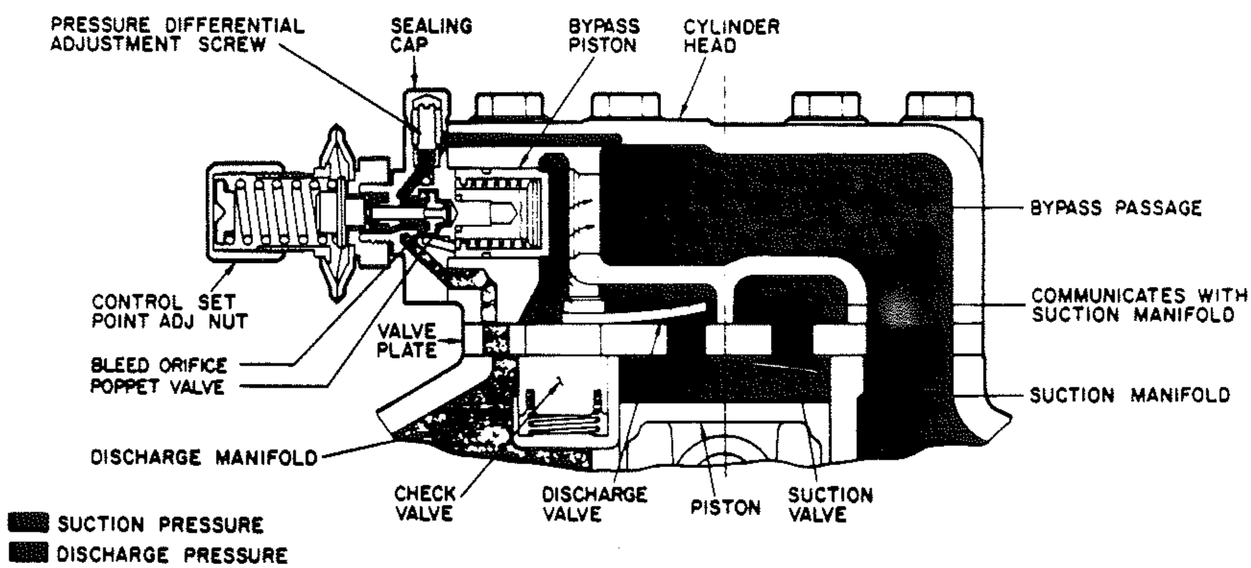


Figure 1-6. Pressure-Operated Unloader, Unloaded Operation

1.4.3 LUBRICATION SYSTEM

CAUTION

THE OIL PUMP MUST BE SET TO ROTATE IN THE SAME DIRECTION AS THE CRANKSHAFT. (REFER TO PARAGRAPH 3.2.2.)

Force-feed lubrication of the compressor is accomplished by a low speed oil pump driven directly from the compressor crankshaft. Refrigeration oil is drawn from the compressor crankcase through the oil filter screen and pick up tube to the oil pump located in the bearing head assembly. The crankshaft is drilled to enable the pump to supply oil to the main bearings, connecting rod bearings, and the shaft seal. (See figure 1-7.) The lubricating oil is pumped, under pressure, through the lube system by a loved-rotor type oil pump.

The oil flows to the pump end main bearings, connecting rod bearings and seal end main bearings, where the oil path is divided into two directions. The largest quantity flows to the oil relief valve, which regulates oil pressure at 15 to 18 psi (2.09 to 2.30 kg/cm^2) above suction pressure. When the oil pressure reaches 15 to 18 psi above suction pressure, the relief valve spring is moved forward allowing oil to return to the crankcase. The remaining oil flows through an orifice and into the shaft seal cavity to provide shaft seal lubrication and cooling. This oil is then returned to the crankcase through an overflow passage.

An additional oil pressure relief valve, built into the oil pump, is open at speeds above 400 rpm to relieve a portion of the oil pressure to the crankcase in order to maintain oil pressure below an acceptable maximum. At low speeds, the valve is closed to ensure adequate oil pressure at 400 rpm. At speeds above 1900 rpm, the oil pressure will be 25 to 30 psi (2.8 to 3.1 kg/cm^2) above suction pressure.

The oil pressure equalization system consists of two oil return check valves and a 1/8-inch pressure equalization port between the suction manifold and crankcase. Under normal conditions, check valves are open and allow for oil return to the crankcase. Under flooded start conditions, pressure rises in the crankcase and closes the check valves, preventing excess oil loss. The equalization port allows for release of excessive pressure, that has built up int the crankcase, to the suction manifold; this ensures that the oil loss is kept to a minimum.

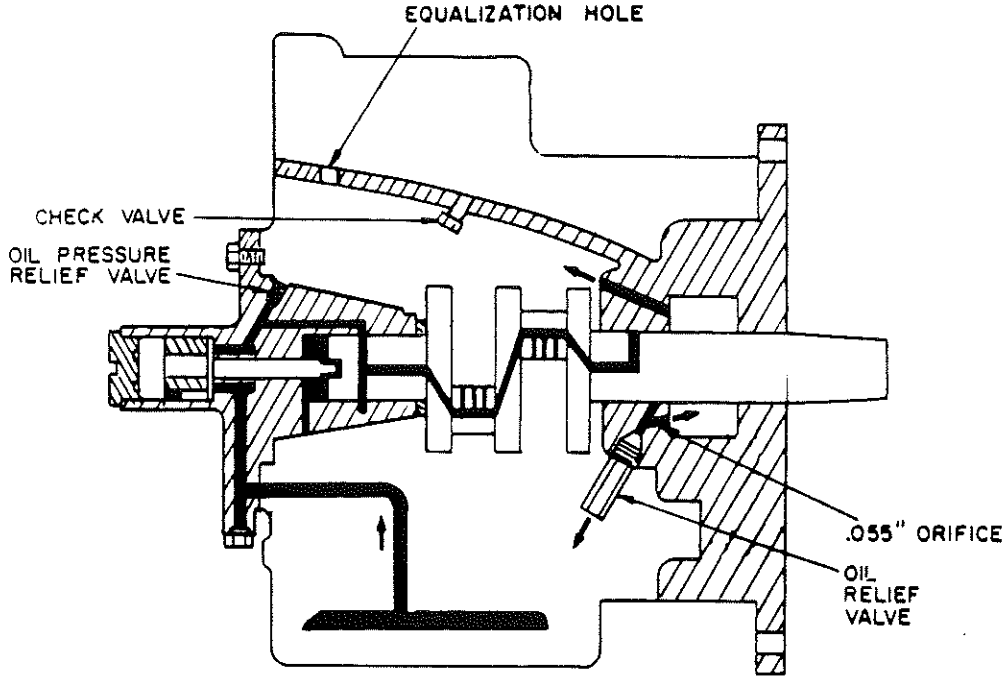


Figure 1-7. Lubrication System

1.4.4 SUCTION AND DISCHARGE SERVICE VALVES

The suction and discharge service valves furnished for use on the compressors are equipped with mating flanges for connecting to flanges on the compressor. See figure 1-1. These valves are provided with a double seat and a gauge connection, which enable servicing of the compressor and refrigerant lines.

Turning the valve stem clockwise (all the way forward) frontseats the valve, closing off the suction and discharge lines and opening up the gauge connection to the compressor. See figure 1-8. Turning the valve stem counterclockwise (all the way out) backseats the valve, opening up the suction or discharge line to the compressor and closing off the gauge connection.

With the valve stem midway between frontseated and backseated positions, suction or discharge line is open to both the compressor and the gauge connection.

For example, when connecting manifold gauge to measure suction or discharge pressure, ensure valve stem is fully backseated. Then, to measure suction or discharge pressure, partially frontseat (about two turns) the valve stem.

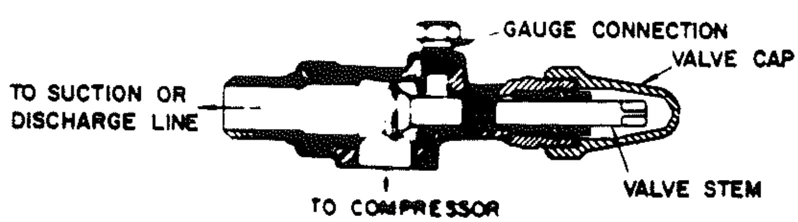


Figure 1-8. Suction or Discharge Service Valve

SECTION 2

COMPRESSOR REPLACEMENT

2.1 COMPRESSOR REMOVAL

Refer to the operation and service manual covering the equipment in which the compressor is installed for specific removal instructions. A general removal procedure is given below.

a. If compressor is completely inoperative, frontseat the suction and discharge service valves to trap the refrigerant in the unit. If the compressor will operate, pump down the unit; then, frontseat the suction and discharge service valves.

b. Slowly loosen plug in gauge connection on suction and discharge service valve and bleed refrigerant pressure to atmosphere.

c. Disconnect refrigerant lines at service valve flange connections on the compressor; retain hardware.

d. Ensure power source is removed from any controls installed on the compressor.

e. Remove any components necessary to gain access to the compressor or to enable removal.

f. Disconnect the drive mechanism at the compressor.

g. Remove mounting hardware and remove compressor from unit.

h. If compressor is to be repaired, refer to section 3 for repair procedures. if a replacement compressor is to be installed, refer to paragraph 2.2 for replacement procedures.

2.2 COMPRESSOR REPLACEMENT

Consult the unit service parts list for the correct replacement.

Service replacement compressors are furnished without suction and discharge service valves and unloader valves. The service valves are normally retained on the unit to isolate the refrigerant lines during compressor replacement. Blank-off pads are installed on the service replacement compressor valve flanges. These pads must be removed prior to installing the compressor. If the defective compressor is to be returned for overhaul or repair, install the pads on the compressor for sealing purposes during shipment.

Service replacement compressors are normally furnished with cylinder head bypass piston plugs installed on the unloader flanges in lieu of the unloader valves. The unloaders (if used) must be removed from the defective compressor and transferred to the replacement compressor prior to installation. Refer to paragraph 2.2.1.

If the defective compressor is to be returned for overhaul or repair, install the plugs on the compressor for sealing purposes during shipment.

2.2.1 INSTALLING COMPRESSOR UNLOADERS

a. Remove the three socket head capscrews holding piston plug to cylinder head of the replacement compressor. See figure 2-1.

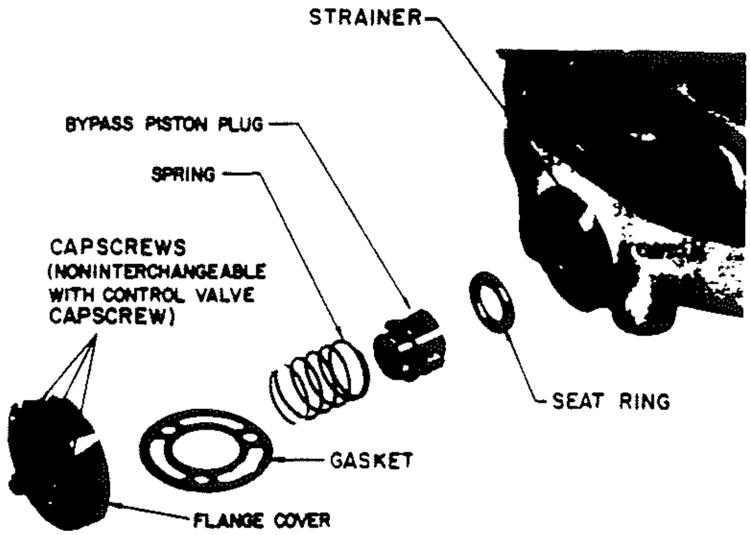


Figure 2-1. Removal of Bypass Piston Plug

b. Remove flange cover, gasket, spring, bypass piston plug, and seat ring. A tapped hole is provided in piston plug for use with a jackscrew to enable removal of the plug. One of the socket head capscrews may be used as a jackscrew.

c. Remove the three socket head capscrews holding unloader in the cylinder head of the defective compressor; remove the unloader and retain the capscrews.

NOTE

Capscrews removed from the bypass piston plug flange cover are not interchangeable with capacity control unloader valve capscrews. When installing the unloaders, be sure to use the unloader capscrews.

d. Using a new gasket, install the unloaders in the cylinder heads of the replacement compressor. See figure 2-1. Refer to table 3-1, page 3-16, for required torque values.

e. If the defective compressor is to be returned for overhaul or repair, install the bypass piston plug, spring, seat ring and flange cover onto the cylinder heads.

2.2.2 INSTALLING COMPRESSOR

WARNING

PARTIALLY FRONTSEAT SERVICE VALVES OR BY OTHER MEANS RELIEVE PRESSURE IN REPLACEMENT COMPRESSOR BEFORE REMOVING PLUGS.

CAUTION

THE OIL PUMP MUST BE SET TO ROTATE IN THE SAME DIRECTION AS THE CRANKSHAFT. (REFER TO PARAGRAPH 3.2.2.)

a. Install the compressor by reversing the procedure of paragraph 2.1, steps b. through g. Install new locknuts on compressor mounting bolts and new gaskets on suction and discharge service valves.

b. Check oil level sight glass. Oil level should be between bottom 1/8 and 1/2 of sight glass. If necessary, add or remove oil.

c. Leak test, evacuate, and dehydrate the compressor.

d. Fully backseat suction and discharge service valves.

e. Run the compressor and check for leaks and noncondensibles in the refrigerant system.

f. Check refrigerant level.

g. Recheck compressor oil level.

h. Check operation of compressor unloaders (if installed).

SECTION 3

COMPRESSOR MAINTENANCE

3.1 COMPRESSOR DISASSEMBLY

Prior to disassembly of the compressor, oil must first be drained from the crankcase. Place the compressor in a position where it will be convenient to drain the oil. Remove the oil fill plug to vent the crankcase. Loosen the drain plug in the bottom plate and allow the oil to drain out slowly.

If dismantled parts are to be left overnight or longer, dip them in clean compressor oil (to prevent rusting) and store in protected area.

If a defective part in the compressor is to be replaced, it may be necessary to remove other parts first. Therefore, the disassembly instructions that follow are arranged in the order for complete disassembly. See figure 3-22 for an exploded view of the compressor. Refer to table 3-2 for permissible wear limits and table 3-1 for torque values for tightening bolts.

3.1.1 CYLINDER HEAD AND VALVE PLATE ASSEMBLY

WARNING

DO NOT UNSCREW CAPSCREWS ALL THE WAY BEFORE BREAKING SEAL. ENTRAPPED PRESSURE COULD RESULT IN INJURY.

a. Loosen cylinder head capscrews. If the head is stuck, tap it lightly with a wooden or lead mallet to free it. Be careful not to drop the head or damage the gasket sealing surface. Remove cylinder head capscrews and gasket. See figure 3-1.

b. Remove the discharge valve capscrews, lock washers, stops, and valves. (See figure 3-2.)

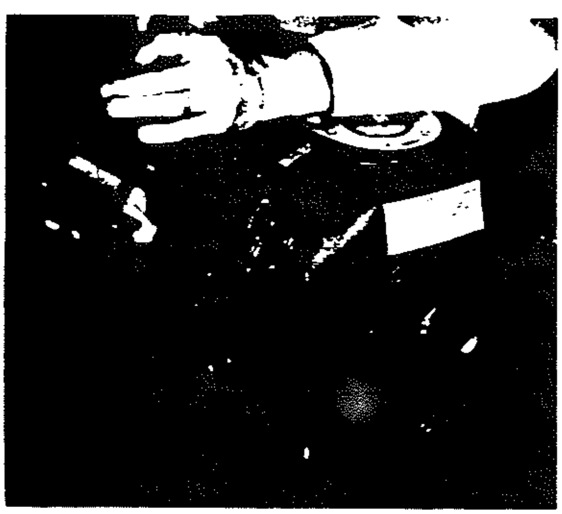


Figure 3-1. Cylinder Head Removal

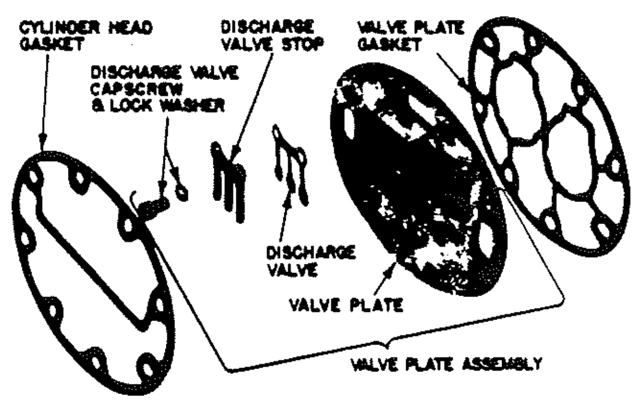


Figure 3-2. Exploded View of Valve Plate Assembly

c. Free the valve plates from the cylinder deck by using the discharge valve capscrews, without washers, as jackscrews through the outermost tapped holes in the valve plate after the valve stops and valves have been removed. (See figure 3-3.) Remove the valve plate gasket.

Figure 3-3. Valve Plate Removal

d. Discard valves and gaskets. Use only new valves and gaskets when reassembling cylinder head and valve plate assemblies.

3.1.2 BOTTOM PLATE, STRAINER, AND CONNECTING ROD CAPS

a. Turn the compressor over, bottom side up, and remove the bottom plate. (See figure 3-4.) Scrape off gasket.

b. Remove the oil strainer.

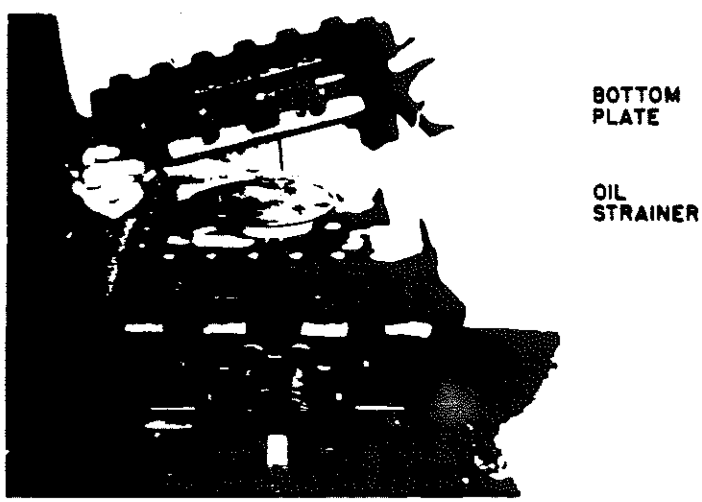


Figure 3-4. Bottom Plate Removal

c. Match mark each connecting rod cap and connecting rod for correct reassembly. Remove the capscrews, flat washers and connecting rod caps. It is recommended that the capscrews and flat washers be discarded and new capscrews (special) and flat washers be installed during compressor reassembly. (See figure 3-5.)

d. Push the piston rods down so that the piston rings extend below the cylinders. Remove and discard piston rings. Use only new rings when reassembling the compressor. (See figure 3-6.)

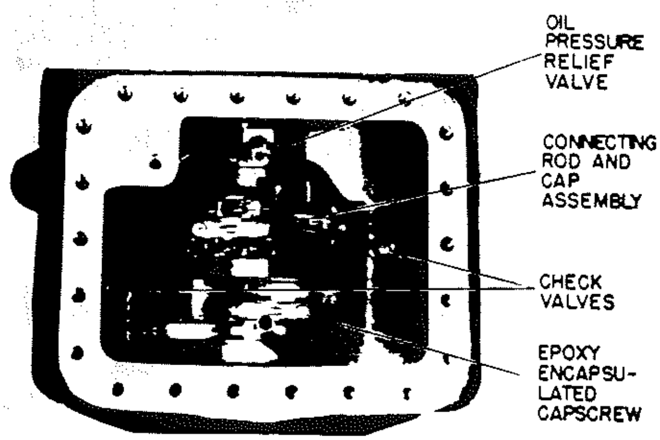


Figure 3-5. Bottom Plate and Oil Strainer Removed

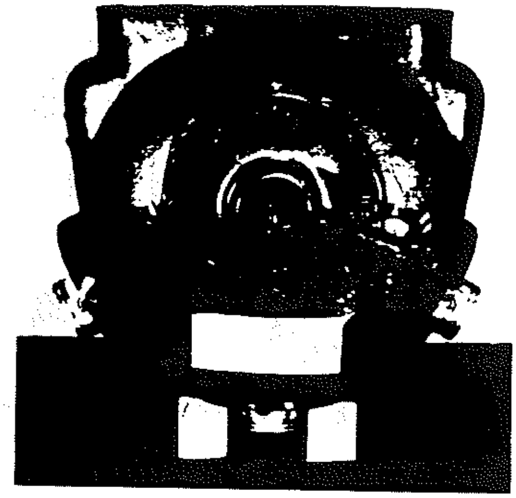


Figure 3-6. Piston Rings Removed

3.1.3 OIL PUMP AND BEARING HEAD ASSEMBLY

Remove eight capscrews and remove oil pump bearing head assembly, gasket and thrust washer. (See figure 3-7.) Disassembly and cleaning of the pump and bearing head assembly will be accomplished during inspection and before reassembly.

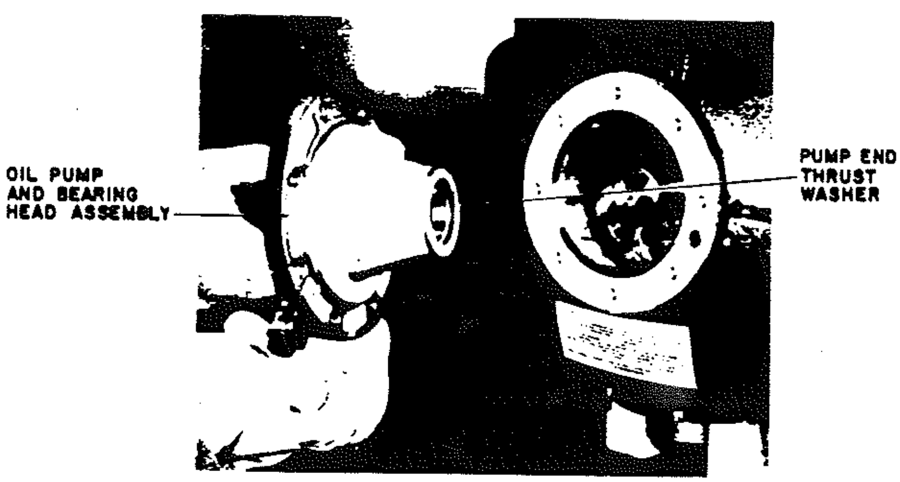


Figure 3-7. Oil Pump and Bearing Head Assembly and Thrust Washer Removal

3.1.4 SHAFT SEAL AND CRANKSHAFT

a. Remove six capscrews and remove shaft seal cover and carbon washer. (See figure 3-8.)

b. Tap seal end of crankshaft to loosen seal grip on shaft. Using two long screwdrivers, pry out the shaft seal. (See figure 3-9.)

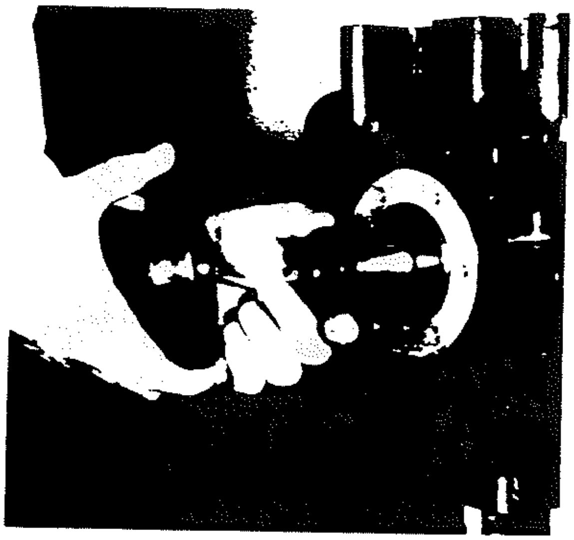


Figure 3-8. Shaft Seal Cover and Carbon Washer Removal

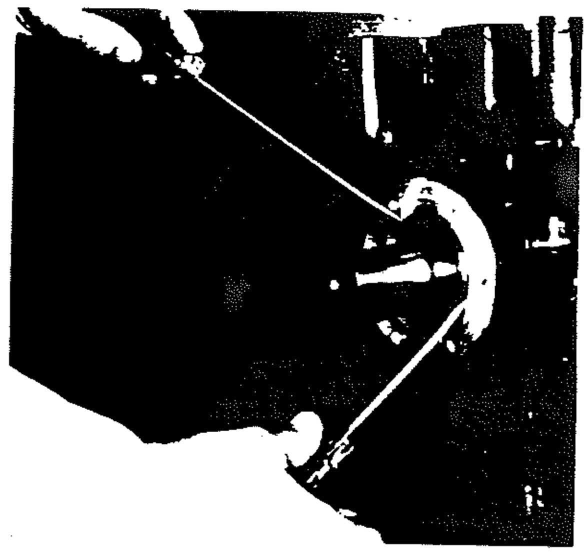


Figure 3-9. Shaft Seal Removal

CAUTION

DO NOT ALLOW CRANKSHAFT TO DROP ON CONNECTING RODS INSIDE THE CRANKCASE WHEN REMOVING THE CRANKSHAFT.

c. Push piston rod assemblies out of the way and remove the crankshaft and seal end thrust washer.

d. Remove and check operation of the oil return check valves. (See figure 3-5, page 3-3.) The check valves are free-floating devices and can easily be checked visually.

e. Remove and check oil pressure relief valve. The oil pressure relief valve is a spring-loaded device which can be checked by using a small piece of stiff wire to ensure that the spring mechanism can be depressed.

f. Remove the piston rod assemblies.

g. Remove the suction strainer. (See figure 3-18, page 3-12.) Clean the strainer screen with a solvent. Inspect the strainer; if damaged, replace it.

3.2 INSPECTION AND PREPARATION FOR REASSEMBLY

3.2.1 GENERAL

a. Clean all parts with an approved solvent. Use a stiff bristle brush to remove dirt from grooves and crevices.

b. Inspect all parts for wear and overall condition. Replace any defective or excessively worn parts. Refer to table 3-2 for a list of minimum and maximum wear limit dimensions.

c. Inspect suction and discharge valve seats (on valve plate).

d. If unloaders are installed, inspect operation of unloader bypass piston.

e. After cleaning, ensure all moving parts are coated with compressor oil before reassembly.

f. Use only new gaskets during reassembly. Ensure all metal gaskets (includes cylinder head, valve plate, and unloader or bypass plug gaskets) are installed dry. All fiber gaskets should be finger wiped with compressor oil before installing.

3.2.2 OIL PUMP AND BEARING HEAD ASSEMBLY

If it was determined that the oil pump was not operating properly, the entire oil pump and bearing head assembly must be replaced. Replacement parts for the pump are not available. However, in the event the pump requires inspection or cleaning, disassembly and reassembly instructions are provided below.

a. Remove pump cover and O-ring. (See figure 3-10.)

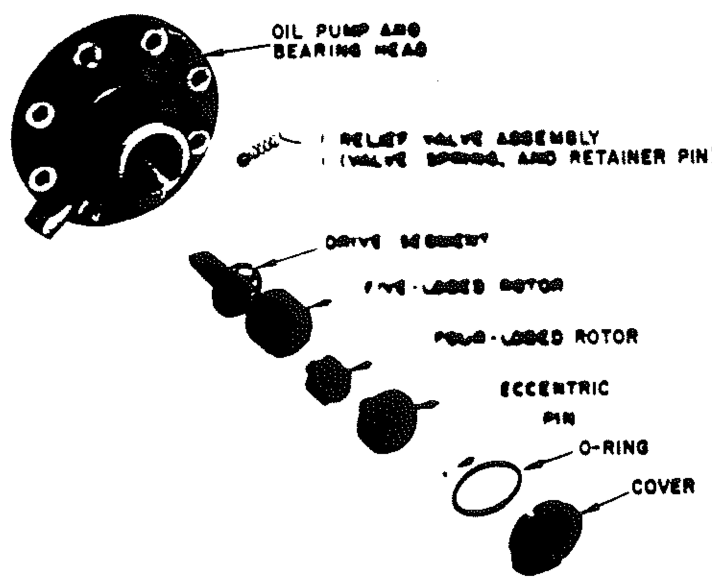


Figure 3-10. Oil Pump and Bearing Head Assembly Exploded View

b. Note direction of pump by location of pin in eccentric.

c. If direction of oil pump is not the same rotation as the crankshaft, remove pin. Pin can be removed by holding eccentric in, tipping top of pin slightly outward, and turning pump bottom side up; pin should fall out.

d. The remainder of the pump components can now be removed, if so desired, by pushing out the drive segment from the crankshaft end of the bearing head.

e. Remove the relief valve assembly by removing the retainer pin.

f. Clean all parts; coat all moving parts with compressor oil before proceeding with reassembly. Mark outside of pump at the short groove for ease of installing pin at a later time.

g. Insert drive segment and five lobed rotor, ensuring that the pins on the rotor are inserted into the appropriate holes in the drive segment drive wheel.

h. Reinstall the four-lobed rotor inside the five-lobed rotor, ensuring that the end with the counter bore is installed toward the drive segment.

i. Reinstall the eccentric in direction indicated (CW or CCW) as so desired so oil pump rotates in the same direction as the crankshaft.

j. Reinstall the pin in the shortest of the two grooves inside the bearing head.

k. Reinstall the O-ring and pump cover.

l. Reinstall the relief valve assembly.

3.2.3 PISTONS, PINS AND CONNECTING RODS

a. Piston and pin, and connecting rod and rod cap are matched sets and must not be interchanged. That is, if either the piston or piston pin is to be replaced, you must replace both of them. Likewise, if a connecting rod or rod cap must be replaced, both must be replaced.

b. Match mark and disassemble pistons, pins, connecting rods, and caps. (See figure 3-11.)

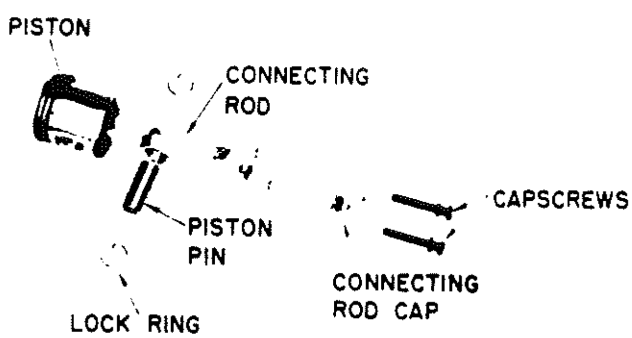


Figure 3-11. Connecting Rod, Piston, and Pin

c. Check wear dimensions of disassembled parts to determine if they are worn beyond limits given in table 3-2, page 3-15.

d. If parts are worn beyond limits, replace them in matched sets as specified above.

e. Coat piston pins with compressor oil and reassemble pistons, pins, and connecting rods in matched sets.

3.3 COMPRESSOR REASSEMBLY

3.3.1 GENERAL

a. Ensure compressor and component parts are ready for reassembly. Refer to paragraph 3.2.

b. Prior to installing new piston rings, it is necessary to break the hard glazed surface of the cylinder in order to reduce the wearing-in period of the new rings. Break the glaze by rehoning lightly in an up and down rotating motion. Clean thoroughly after breaking glaze.

c. The instructions that follow are arranged in the normal order for reassembly of a completely disassembled compressor.

3.3.2 PISTONS, RODS, AND RINGS

a. The gap between the ends of the piston rings can be checked with a feeler gauge by inserting the ring into the piston bore about one inch below the top of the bore. Align the ring in the bore by pushing it slightly with a piston. The maximum and minimum allowable ring gaps are 0.013 and 0.005 inches (0.33 and 0.127 mm).

b. Install the piston and rod assemblies up through the bottom of the crankcase and into the cylinders. Allow pistons to extend beyond the top of the cylinder to enable installation of piston rings. Pistons should be installed so that the chamfer, on the connecting rod, faces toward the crankshaft journals. Center rods on each crankshaft throw may be installed in either direction. (See figure 3-12.)

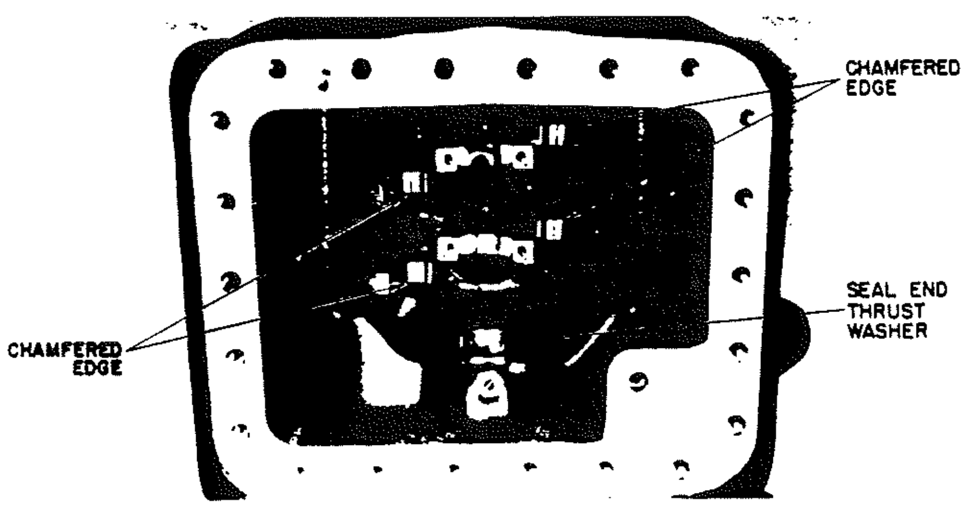


Figure 3-12. Installing Piston Rod Assemblies and Seal End Thrust Washer

c. Depending on date of manufacture, the compressor may be fitted with double or single ring pistons. This variation may also exist with replacement piston and oil rings must be fitted. Also, double ring and single ring pistons may be installed in the compressor.

d. If using double ring pistons, the oil ring is installed in the groove nearest the bottom and the compression ring in the groove nearest the top. The oil ring is notched on the outside circumference. This notch must be installed towards the bottom. (See figure 3-13.)

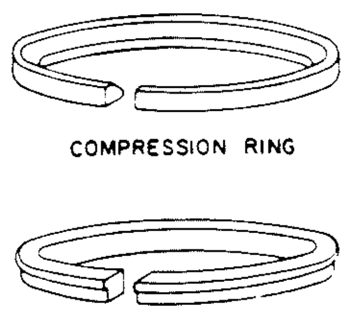


Figure 3-13. Piston Rings

e. The compression ring is chamfered on the inside circumference. This ring is installed with the chamfer towards the top. If using a double ring piston, stagger the ring end gaps so they are not aligned.

f. Measure side clearance between ring and ring groove in piston. Maximum dimensions are provided in table 3-2.

3.3.3 CRANKSHAFT AND SEAL END THRUST WASHER

a. Two brass thrust washers are used. The pump end thrust washer is positioned on two dowel pins located on the bearing head and is installed with the oil pump and bearing head assembly. The seal end thrust washer is positioned just ahead of the seal end main bearing on two dowel pins installed in the crankcase. Both thrust washers should be inspected for wear and scoring before reassembly.

CAUTION

DO NOT ALLOW CRANKSHAFT TO DROP ON CONNECTING RODS INSIDE THE CRANKCASE WHEN INSTALLING THE CRANKSHAFT.

b. Install the seal end thrust washer on the two dowel pins. (See figure 3-12.) Ensure piston rods are pushed out of the way and install the crankshaft.

3.3.4 OIL PUMP AND BEARING HEAD ASSEMBLY AND THRUST WASHER

a. Reinstall the pump end thrust washer on the two dowel pins located on the bearing head. (See figure 3-14.)

CAUTION

ENSURE THAT THRUST WASHER DOES NOT FALL OFF DOWEL PINS WHILE INSTALLING OIL PUMP.

b. Reinstall the bearing head assembly on the compressor crankshaft with a new gasket. Carefully push oil pump on by hand ensuring that the thrust washer remains on the dowel pins, the tang on the end of the drive segment engages the slot in the crankshaft, and the oil inlet port on the pump is aligned with the oil pickup tube in the crankcase. The pump should mount flush with the crankcase and should be oriented as shown in figure 3-1.

c. Align the gasket and install the eight capscrews in the mounting flange. Refer to table 3-1, page 3-15, for applicable torque values.

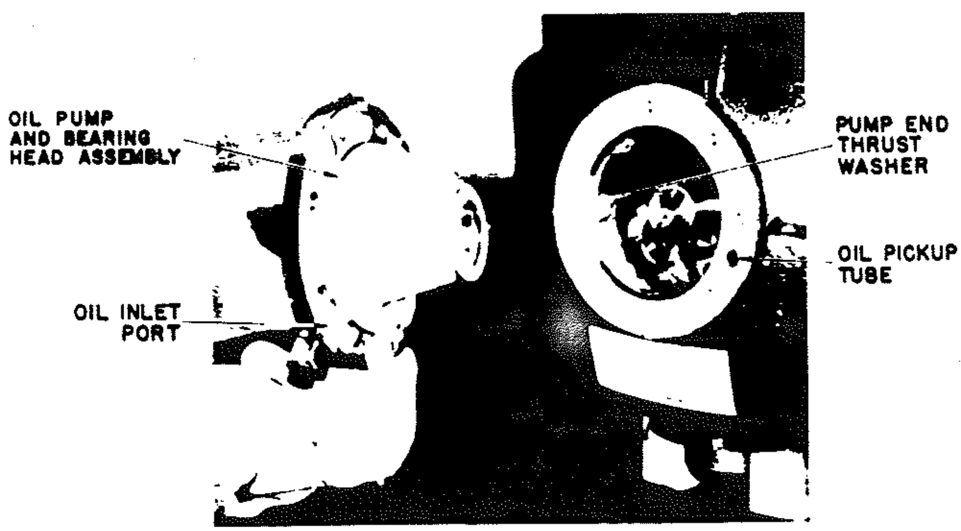


Figure 3-14. Installing Oil Pump and Bearing Head Assembly and Pump End Thrust Washer

3.3.5 CONNECTING ROD CAPS

a. Do not tap piston with hammer if rings are caught at entrance to the cylinder. Using a ring compressor, squeeze rings sufficiently to allow piston to be pushed down into the cylinder. Ensure that ring ends are staggered so that the gaps are not aligned, and lightly tap piston down into the cylinder. (See figure 3-15.) The ring compressor can be easily fabricated from a piece of sheet metal.

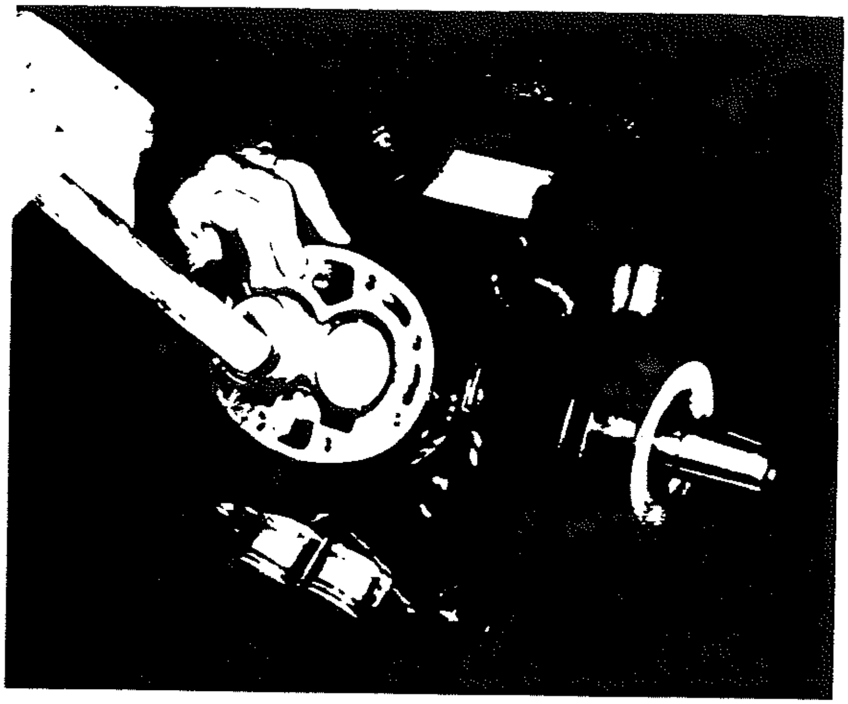


Figure 3-15. Installing Pistons

b. Install connecting rod caps on connecting rods using new capscrews (special) and flat washers. Reuse of the old capscrews is not recommended. Ensure that the caps are installed on the dowel pins. Torque capscrews to torque value shown in table 3-1. Ensure freedom of movement of crankshaft after capscrews are torqued on each rod cap.

3.3.6 CHECK VALVES,RELIEF VALVE,STRAINER,AND BOTTOM COVER PLATE

a. Check operation and reinstall check valves and relief valve. (See figure 3-5). The check valves are free-floating devices and can easily be checked visually. The relief valve is a spring-loaded device which can be checked by using a small piece of stiff wire to ensure that the spring mechanism can be depressed.

b. Clean and reinstall the oil strainer.

c. Using a new gasket, install the bottom cover plate. See figure 1-1 for relative location of compressor mounting flanges. Torque cover capscrews, in a diagonal pattern, to the torque value shown in table 3-1.

3.3.7 SHAFT SEAL

a. Install new shaft seal assembly, cover gasket, and cover plate only. Never reinstall a used seal assembly and gasket. A new carbon washer should never be installed in a used cover plate. When installing the seal assembly, use care not to damage carbon washer or seal seat. If the new carbon washer is damaged during installation, replace it with a new one. (See figure 3-16.)

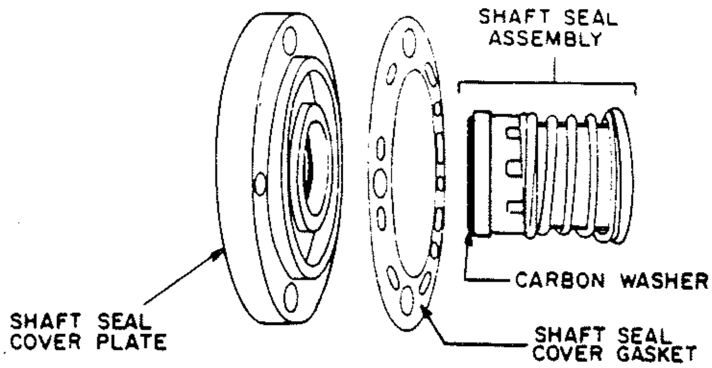


Figure 3-16. Shaft Seal Exploded View

b. Remove new carbon washer from new seal assembly. Lubricate shaft and neoprene seal bellows where it contacts the shaft. Slide seal assembly onto shaft until neoprene bellows starts to grip the shaft. (See figure 3-17.)

c. Install the old carbon washer in the new seal seat. Install two capscrews in opposite sides of the old cover plate. (See figure 3-17.) Draw up capscrews evenly to properly position new seal assembly against shoulder on shaft. Remove capscrews and old carbon washer and cover plate.

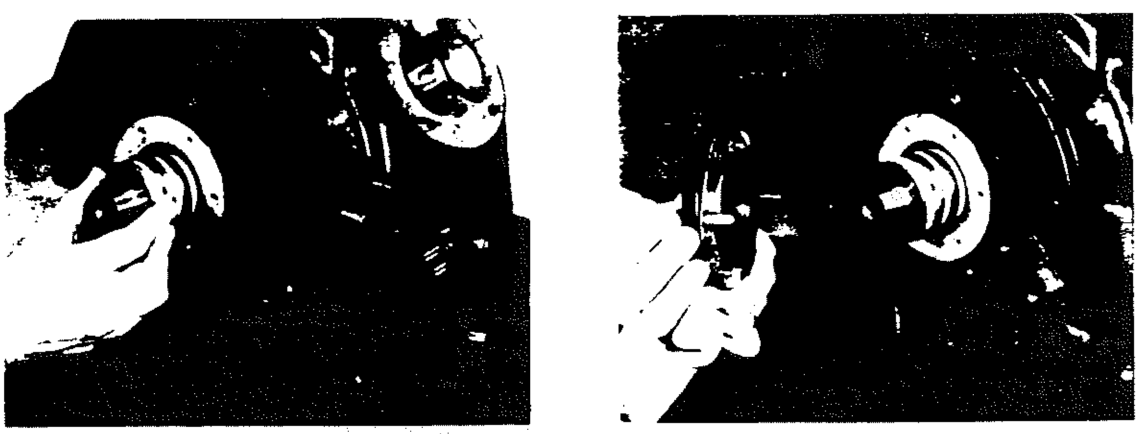


Figure 3-17. Installing Shaft Seal

d. Lubricate new carbon washer and carbon washer seal seat with refrigerant oil. Install new carbon washer in seal seat, taking care not to damage the carbon washer or the seat. Ensure that notches in carbon washer are aligned with two small knurls inside the seal seat. Install the new cover plate and gasket. Draw capscrews down evenly to prevent damage to carbon washer.

3.3.8 SUCTION AND DISCHARGE VALVE PLATE ASSEMBLY AND CYLINDER HEAD

a. Install only new valves and gaskets, and do not interchange valves.

b. Install suction valve positioning springs on dowel pins. Assemble positioning springs with spring ends bearing against cylinder deck. The spring will bow outward in the middle. (See figure 3-18.)

c. Place suction valves on dowel pins, over the positioning springs.

d. Place valve plate and new valve plate gasket on cylinder deck, ensuring that the valve plate is properly positioned on the four dowel pins (the top head has five dowel pins). (See figure 3-19.)

e. Using a small screwdriver, operate the suction valves to ensure that the valve tips are not being held by the valve plate gasket. (See figure 3-20.)

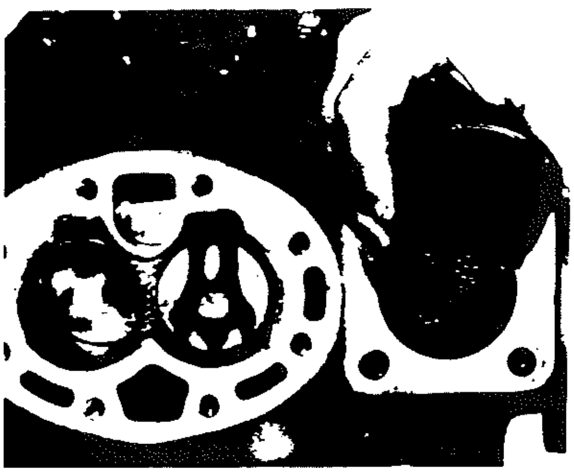


Figure 3-18. Installing Suction Valves and Strainer

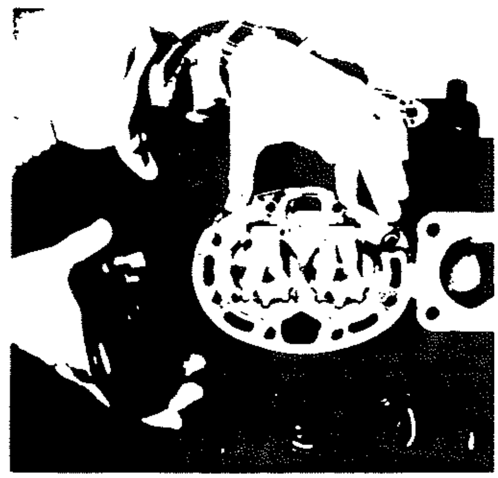


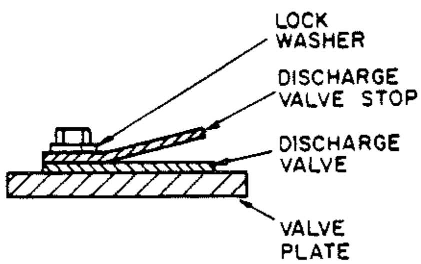
Figure 3-19. Installing Valve Plate and Gasket

Figure 3-20. Checking Suction Valve

f. Install discharge valve and discharge valve stop with capscrews and lock washers. (See figure 3-21.) Torque capscrews to value shown in table 3-1, page 3-15.

g. If capacity control unloaders are used, they are installed in the right and left cylinder heads. The center bank has a flange connection for the discharge service valve. Install cylinder head and new cylinder head gasket with capscrews, ensuring that the gasket and cylinder head are properly positioned on the valve plate. Torque the capscrews, in a diagonal pattern, to value shown in table 3-1.

h. Repeat the above procedure for the other two cylinder banks.



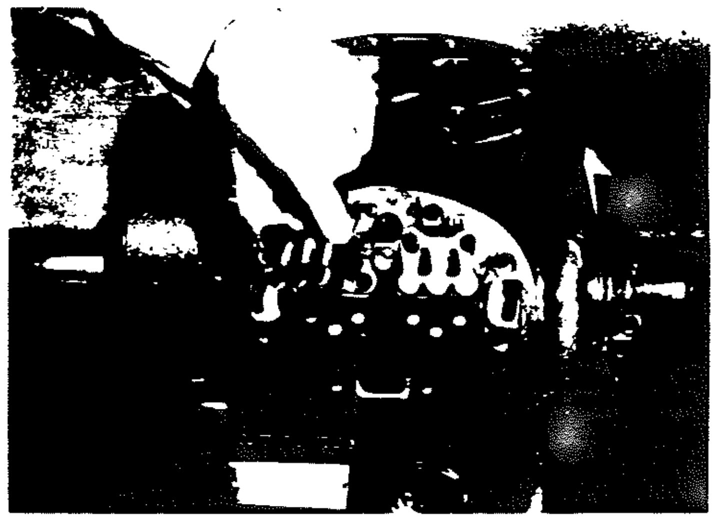


Figure 3-21. Installing Discharge Valve and Valve Stop

3.3.9 SUCTION STRAINER

NOTE

Suction strainer has been preformed to fit into suction cavity.

Remove and clean the suction strainer. (See figure 3-18.) Check it for damage. If it is damaged, replace it. Reinstall the suction strainer and valve blank-off pad using a new gasket.

3.3.10 ADDING OIL

Add the proper oil charge to the compressor through the oil fill plug or suction service valve cavity. (See figure 1-1.) Refer to paragraph 1.2 for the required oil charge.

3.4 REINSTALLING COMPRESSOR

Refer to paragraph 2.2.2 to reinstall the compressor. Allow compressor to run for 4 to 5 hours before checking new seal assembly for leaks.

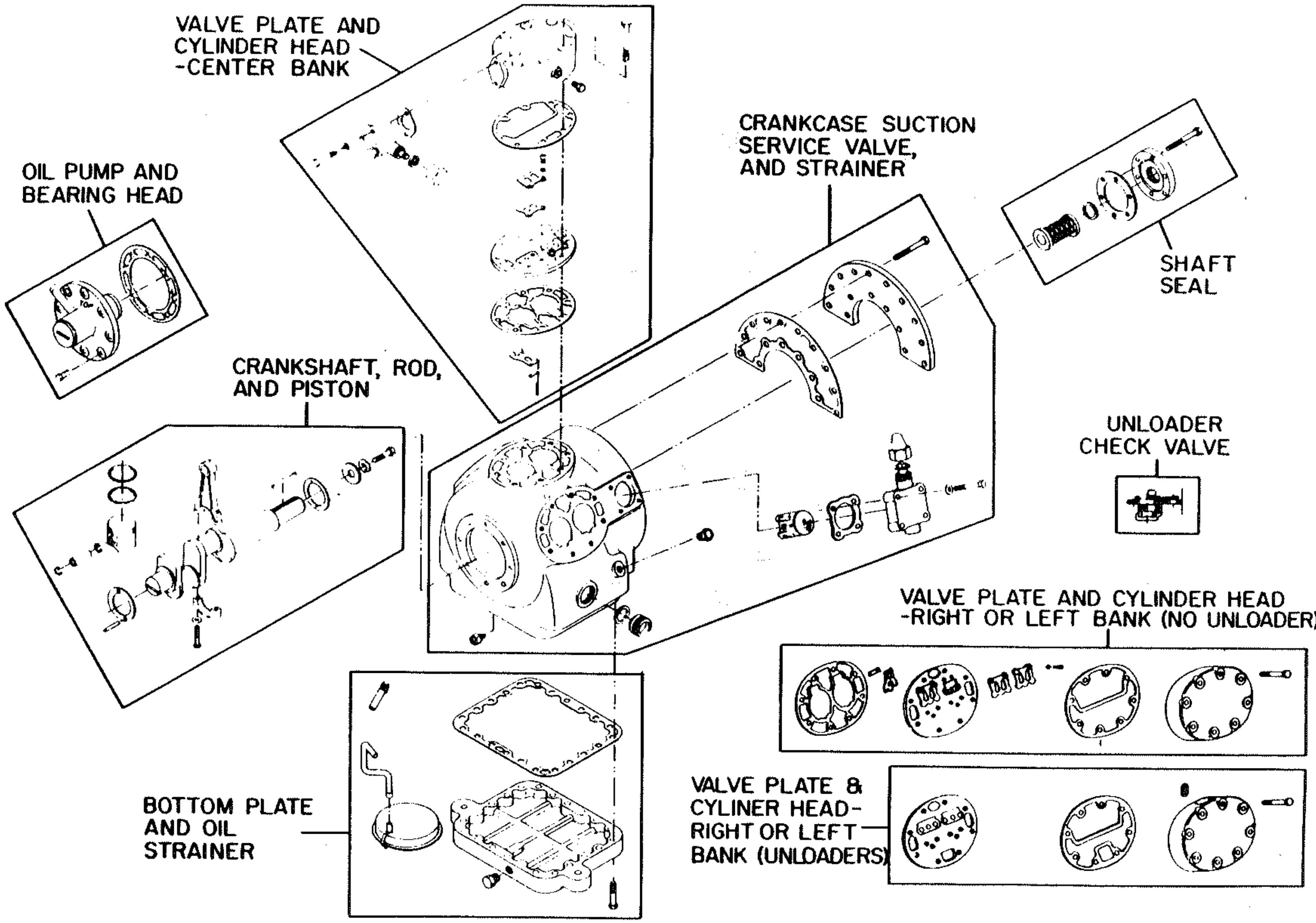


Figure 3-22. Model 05G Bus Compressor Exploded View

Table 3-1. Torque Values

SIZE DIAM(in.)	THREADS PER IN.	TORQUE RANGE FT-LB	TORQUE RANGE MKG	USAGE
1/16	27 (pipe)	8-12	1.11 - 1.66	Pipe Plug - Crankshaft
1/8	27 (pipe)	15-20	2.07 - 2.77	Oil Return Check Valve - Crankcase
	20 (pipe)	20-25	2.77 - 3.45	Pipe Plug - Press. Gauge Connection
1/4	20	8-12	1.11 - 1.66	Connecting Rod Capscrew
	28	12-16	1.66 - 2.21	Unloader Valve
	28	6-10	0.83 - 1.38	Oil Pump Drive Segment
No. 10	32	4-6	0.55 - 0.83	Oil Pump Drive Segment
5/16	18	16-20	2.21 - 2.77	Cover Plate - Pump End Bearing Head Discharge Valve
3/8	16	25-30	3.46 - 4.15	Pump End Bearing Head Bottom Plate - Crankcase Compressor Foot Seal Cover
3/8	16	30-35	4.15 - 4.84	Cylinder Head
7/16	14	55-60	7.61 - 8.30	End Cover - Crankcase
1/2	13	55-80	7.61 - 11.06	Suction Valve - Crankcase
1-1/2	18 NEF	35-50	4.84 - 6.91	Oil Level Sight Glass

NEF - National Extra Fine

Table 3-2. Wear Limits

PART NAME	FACTORY MAXIMUM INCHES	FACTORY MAXIMUM MM	FACTORY MINIMUM INCHES	FACTORY MINIMUM MM	MAXIMUM WEAR BEFORE REPAIR INCHES	MAXIMUM WEAR BEFORE REPAIR MM
SEAL END						
Main Bearing Dia	1.8760	47.6504			0.002	0.051
Main Bearing Journal Dia			1.8725	47.5615	0.002	0.051
PUMP END						
Main Bearing Dia	1.3760	34.9504			0.002	0.051
Main Bearing Journal Dia			1.3735	34.8869	0.002	0.051
CONNECTING ROD DIA	1.3768	34.9707			0.002	0.051
Piston Pin Bearing	0.6883	17.4752			0.001	0.025
CRANKPIN DIAMETER			1.3735	34.8869	0.0025	0.0635
Throw (Height)	0.9690	24.6329	0.9678	24.5821		
THRUST WASHER (Thickness)						
Pump End	0.145	3.683	0.144	3.658	0.040*	1.016
Seal End	0.157	3.987	0.155	3.937	0.040*	1.016
CYLINDERS AND PISTONS						
Bore	2.0010	50.8254			0.002	0.051
Piston (Dia)			See figure 3-23		0.002	0.051
Piston Pin (Dia)			0.6873	17.4574	0.001	0.025
Piston Pin Bearing			Thumbfit			
Piston Ring Gap	0.013	0.330	0.005	0.127	0.025	0.635
Piston Ring Side Clearance	0.002	0.051	0.001	0.0254	0.002	0.051
SUCTION VALVE RECESS (Depth)	0.082	2.083	0.078	1.981	0.090	2.286

*Maximum end clearance between thrust washer and shaft.

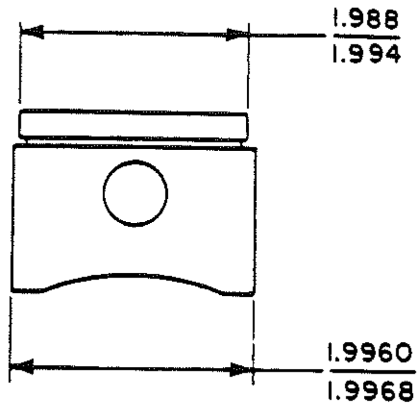


Figure 3-23. Piston Dimension (Wear Limits)

Carrier TRANSICOLD

Service Information

Number BAR-SER85-1

Date 6-14-85

Subject HOUSING-MOUNTED ELECTRIC CLUTCH

The procedure on the attached pages should be followed carefully when servicing the Carrier Transicold housing-mounted clutch. The following tools are recommended when removing and replacing this clutch:

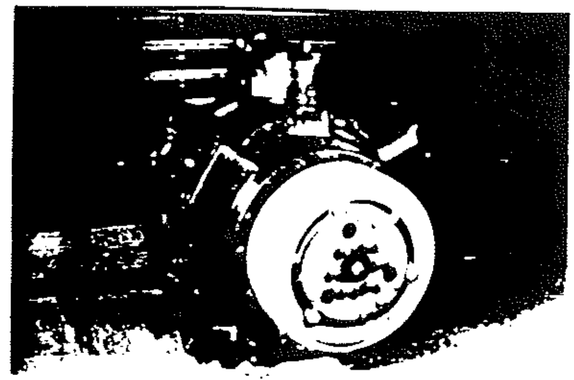
TOOL LIST

DESCRIPTION	CTC PART NO. (WHERE APPLICABLE)
Spanner Wrench	07-00240
Rotor Installation Tool	07-00241
Socket Bearing Retaining Nut - Large	07-00242-01
3/8" Socket Set	
Torque Wrench	
3 Leg Puller w/3 1/4-20 UNC Cap Screws	
1 - Bolt 7/8-14 UNC x 2" Long	
Feeler Gauge .020 .030 .060	
Grease Gun, Manual, 0.1 Oz Per Stroke	
Depth Gauge 0-1/2"	
Ohmmeter	

Andrew Widay
Manager
CTC Service Engineering

05G COMPRESSOR HOUSING MOUNTED CLUTCH

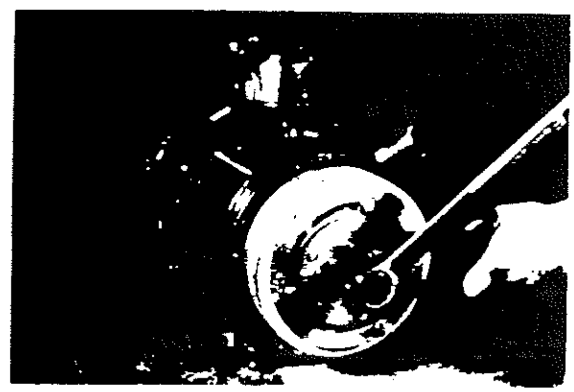
The new housing-mounted electric clutch, HMC, eliminates drive belt loading on the 05G crankshaft, and applies this load directly to the crankcase of the compressor. The following procedure should be followed carefully whenever it becomes necessary to remove and replace the HMC.



Housing-Mounted Clutch Removal

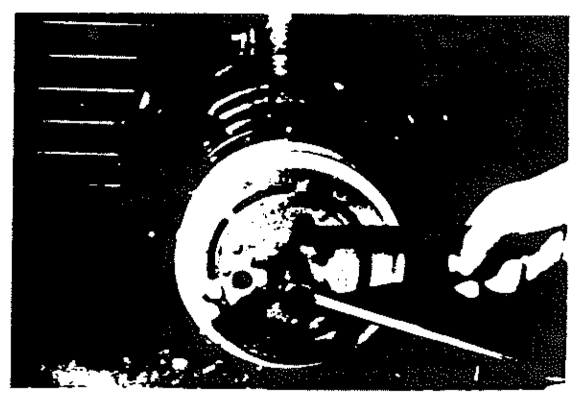
CAUTION: Remove drive belt before attempting to remove clutch.

1. Remove armature as a complete assembly by removing retaining capscrew (3/8-24 x 1-1/4" Lg), lockwasher, and special 3/8 washer from compressor crankshaft. Use special CTC tool P/N 07-00240 to prevent crankshaft rotation, as shown.



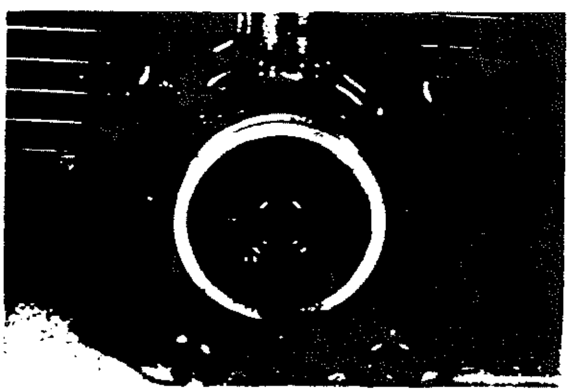
2. Install a 7/8-14 x 2" capscrew into the center hole of the armature assembly. Use this capscrew as a jacking bolt to remove the armature assembly. Use tool 07-00240 as in Step 1 to prevent crankshaft rotation.

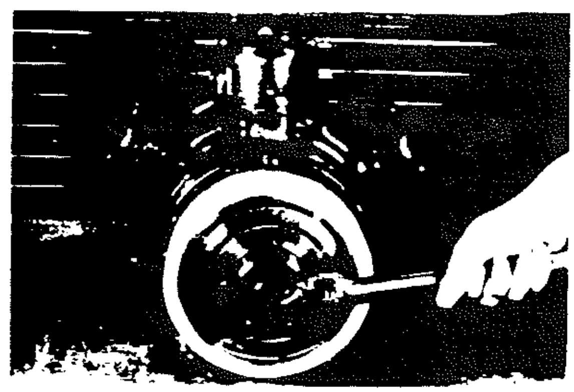
   NOTE: Do not use a puller or pry against the armature hub or bumper plate, as this could cause damage to these parts.



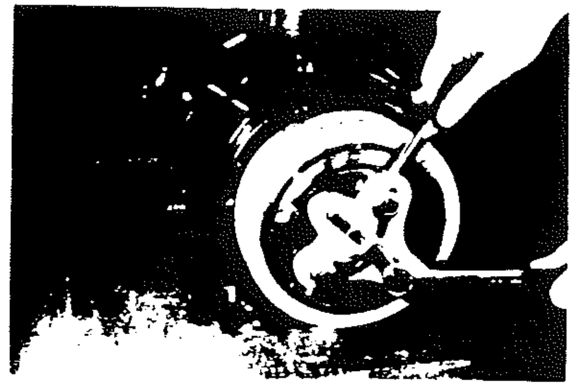
3. Remove the clutch armature assembly from the compressor crankshaft as a complete assembly, as shown.

4. Remove the rotor retaining nut with special CTC tool P/N 07-00242-01.



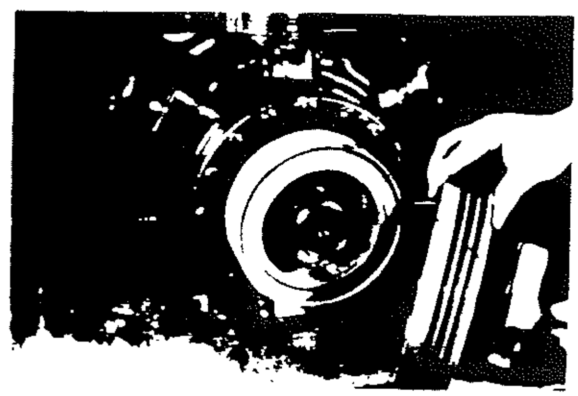


5. Install a flange-type gear puller into the three 5/16-18 tapped holes in the clutch rotor assembly, as shown.

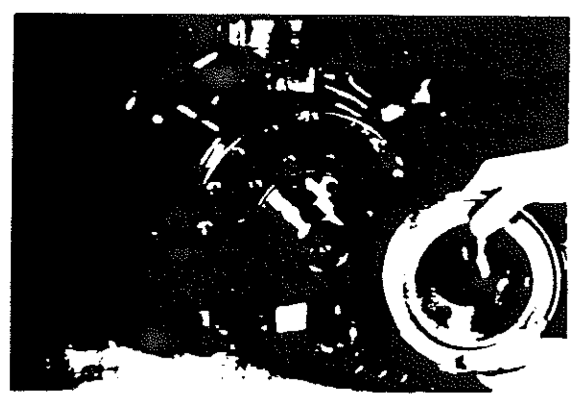


CAUTION: Use a washer or other protective device to prevent damage to crankshaft and threaded hole in the crankshaft by the puller. Never use a puller in the belt grooves, as damage to the rotor may result. Use a pry bar as shown to prevent rotation of the clutch rotor.

6. Once the rotor has been pulled from the clutch bearing mounting hub, carefully lift the rotor assembly away from the compressor, as shown.



7. To remove the clutch coil, disconnect the coil's electrical cable from the wiring harness. Then remove only the three 3/8-16 capscrews holding the coil to the flange of the clutch bearing mounting hub, and carefully remove the coil, pulling straight out from the flange. Do not pry coil off, as it may bend the mounting plate.



Housing-Mounted Clutch Installation

1. Prior to installing the HMC, inspect for dents, nicks, or burrs on the clutch bearing mounting hub and clutch assembly. Correct if any are found, and clean clutch mounting hub and ID of clutch bearing with a chlorinated base or naphtha type solvent.

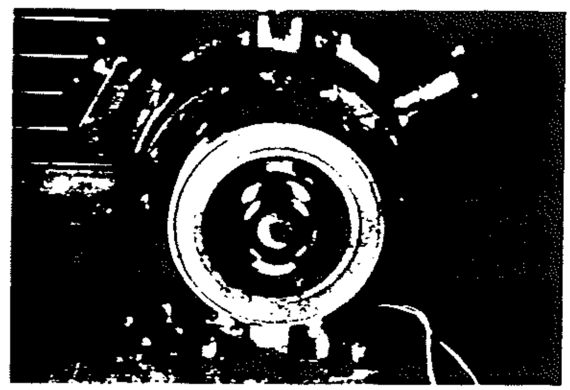
2. Inspect coil for damaged power leads, bent or cracked mounting plate, or burned or cracked potting material.

3. Check coil for electrical continuity, resistance, and shorts to ground.

Resistance at 68°F:	Lead to Lead	24 VDC coil	5.15-5.69 ohms
		12 VDC coil	1.92-2.12 ohms
	Lead to Ground	12/24 VDC coil	INF or open

   Replace coil if above conditions are not met.

4. Slide the coil onto the clutch bearing mounting hub so that the lead wires exit between the 3 and 5 o'clock position, as shown.



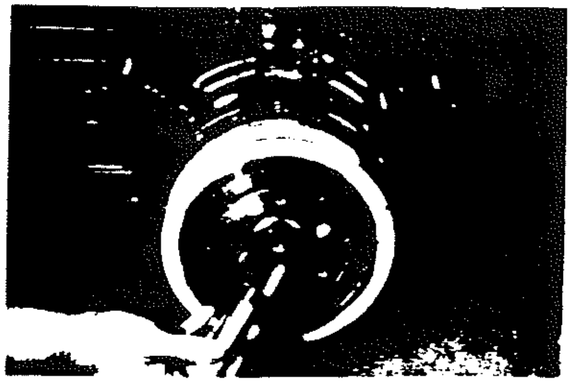
5. Secure the coil to the bearing mounting hub flange with the three 3/8-16 capscrews removed in Step 7 of Clutch Removal. Torque capscrews to 25-30 ft-lb (3.46-4.15 MKG).

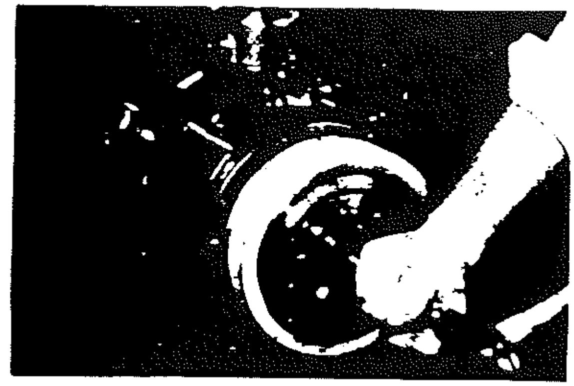
   CAUTION: Do not draw coil onto the clutch bearing mounting hub flange with the capscrews, as this may distort the coil.

6. To ease the installation of the rotor onto the clutch bearing mounting hub, preheat the inner race of the rotor bearing by placing an electric heater inside the bearing bore (a 75-100 watt outdoor post lamp style bult applied for 15-30 minutes may be used).

   CAUTION: Do not heat bearing with an open flame or heat bearing above 175°F.

7. After preheating bearing, slide rotor assembly onto clutch bearing mounting hub. To facilitate seating of the bearing on the hub, place CTC tool P/N 07-00241 against the inner race of the bearing and tap gently with a hammer, as shown.

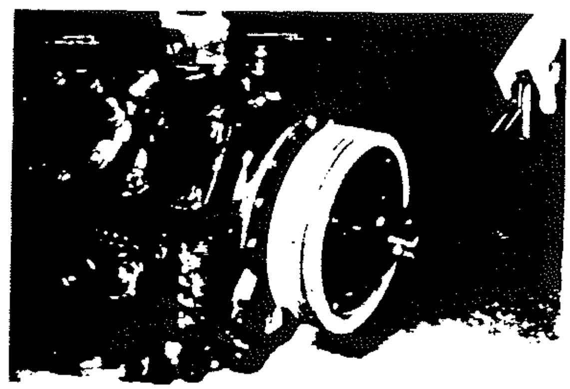




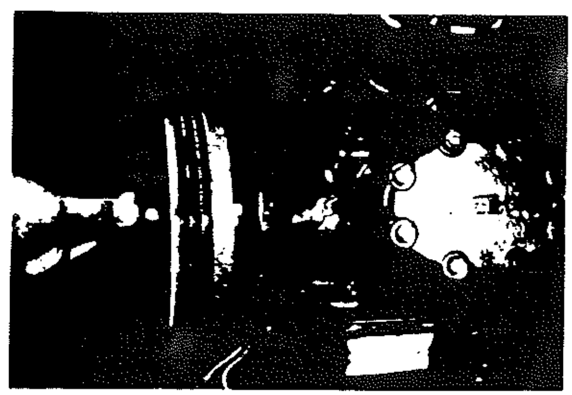
8. Install bearing retaining nut on clutch mounting hub and use torque wrench to tighten.

   If the smaller nut without the grease fitting is used, torque nut to 50 ft-lb with CTC tool P/N 06-00242-02 The taper on the nut faces the bearing.

   If the larger nut with the grease fitting is used, torque the nut with CTC tool P/N 07-00242-01. Due to the self-locking feature of the nut, the installation torque may vary. When installing the nut, observe the torque required to turn the nut onto the hub. After the nut seats the bearing against the hub, apply a torque 50 ft-lb greater than the installation torque.

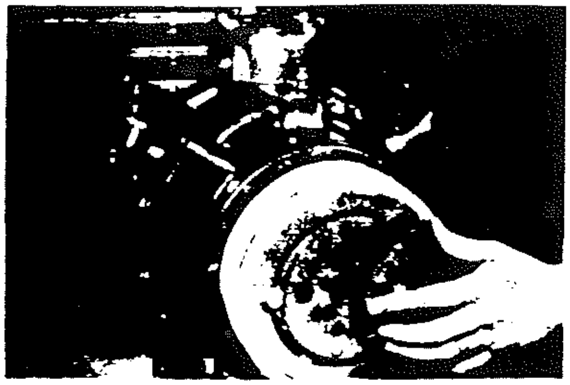


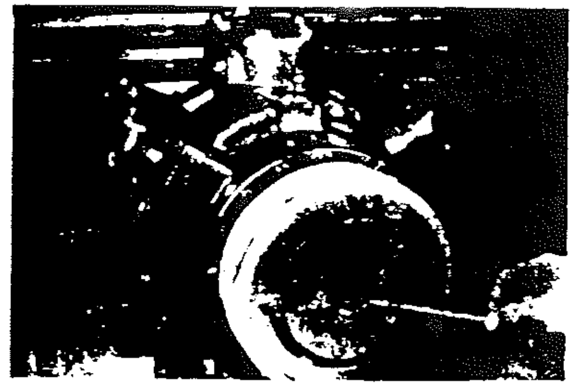
9. Check coil to rotor clearance by inserting .020 thick by .156 wide (max.) feeler gauge through an outer slot in rotor, as shown. Insert the feeler gauge so it extends beyond the rear face of the rotor and rotate the rotor one full turn. There should be no rubbing or binding.



10. Place armature and hub assembly onto the compressor crankshaft and insure the hub seats on the crankshaft properly.

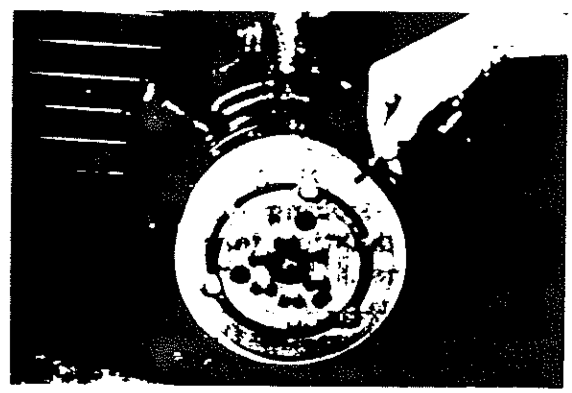
11. Insert the special key CTC P/N 68G2-9072 (1.75 x .250 x .199) in the keyway until outer end of key is flush with the hub's counter bore, as shown.





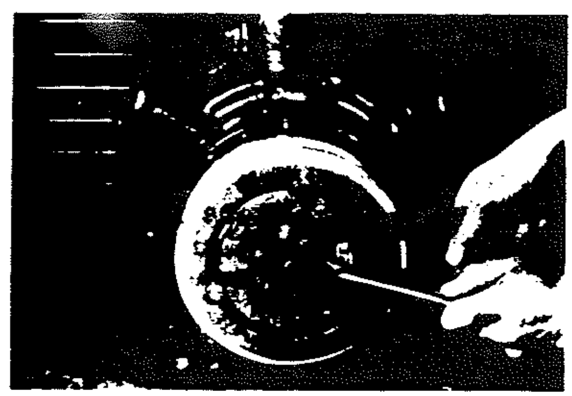
12. Secure armature assembly to crankshaft with the 3/8 special flat washer, lock washer, and 3/8-24 x 1-1/4" lg capscrew removed in Step 1 of Clutch Removal. Torque capscrew to 16-20 ft-lb using CTC tool P/N 07-00240 to prevent crankshaft rotation.

Steps 13-19 are for new clutch installation only. After the initial adjustment, shim stack should not be changed.



13. Measure the air gap between the armature and rotor surfaces, as shown.

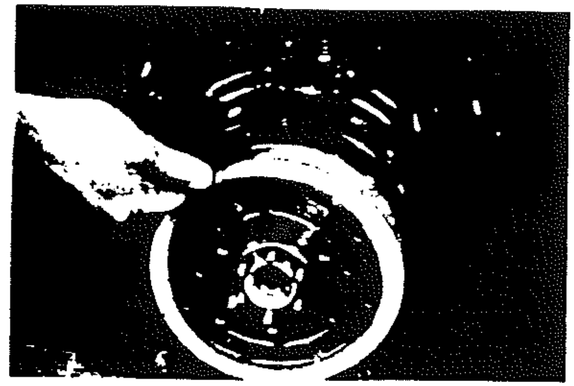
14. Record this measurement and determine the amount of shims that must be removed to obtain a .030/.060 air gap. The shims consist of 1-.010 and 6-.020 shims.



15. Remove the six armature plate to armature hub retaining nuts and washers. Use CTC tool P/N 07-00240 to prevent armature rotation, as shown.

16. Remove the required number of shims to obtain an air gap of .030/.060.

17. Insert a .020 feeler gauge between the outside edge of the clutch bearing mounting hub and the inside edge of the armature mounting hub, as shown. The clearance should be .020 or greater.



18. Reinstall armature plate, washers, and retaining nuts and torque to 7 ft-lb using CTC tool P/N 06-00240 to prevent crankshaft rotation.

19. Recheck air gap to confirm that you have obtained the .030/.060 clearance.

FIELD SERVICE PROCEDURES

1. Greasing of Clutch Bearing

The clutch bearings are pre-greased by the bearing manufacturer with the proper operating charge. Do not add grease to the bearing for at least 5000 hours of bus operation.

CAUTION: Overgreasing of the bearing will cause the bearing to operate at higher temperatures that may result in:

1. Blowing grease through the bearing seals onto the clutch friction faces, causing clutch slippage. A slipping clutch tends to run extremely hot, resulting in forcing more grease from the bearing, thereby increasing slippage and burning the magnetic coil.
2. Reduction in torque transmission capacity.

This is a situation where "more" is not better.

Recommended frequency for adding grease:

Up to 5000 hours bus operation	None
After initial 5000 hours	Add 0.1 oz SR1-2 grease during preseason A/C system checkout (i.e., once per year during a Spring month)

Grease required must be "Chevron SR1-2" or CTC Engineering approved equal.

Procedure for Adding Grease to the Clutch Bearing

The grease fitting is located in the clutch bearing retaining nut. Access to the grease fitting is accomplished by removing the armature assembly as in Steps 1, 2, and 3 of HMC Removal.

NOTE: The removal of the armature in order to add grease to the bearing is deliberate to insure that all grease spillage can be cleaned from the clutch, reducing the potential for clutch slippage and the resulting loss of clutch torque transmission capacity.

Any unauthorized modification of the clutch armature to facilitate greasing of the bearing will void the clutch and compressor warranties.

It is recommended that a hand operated grease gun with approximately 0.1 oz delivery per stroke be used to add grease to the bearing. Grease gun must contain "Chevron SR1-2" grease.

Wipe the grease fitting clean of all dirt and foreign materials.

Attach grease gun to grease fitting. Insert 0.1 oz grease into bearing (1 to 2 strokes of the gun).

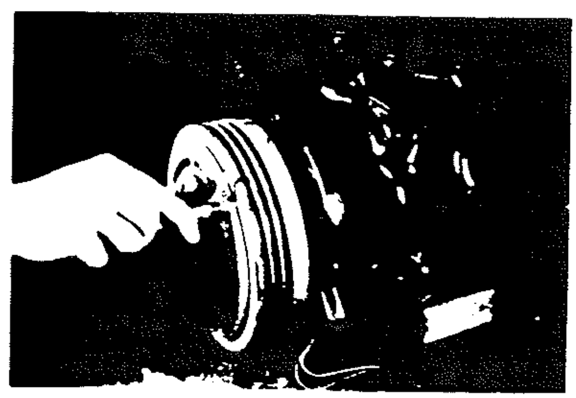
CAUTION: Do not give extra strokes "for good measure" as premature clutch performance degradation may result.

After adding grease to the bearing, wipe all grease spillage from clutch faces, retaining nut, and hubs. If you can see it, wipe it up.

Reinstall armature assembly and torque retaining nut to 16-20 ft-lb torque, as in Steps 10, 11, and 12 of HMC Assembly.

2. Inspection for Wear

CAUTION: Insure bus or compressor drive engine is not operating. Take extra precautions to prevent inadvertant engine starting while clutch is being serviced.



A) With clutch coil de-energized, measure distance from face of armature to face of rotor, as shown. Feeler gauges inserted between the rotor and armature friction faces is not recommended due to the uneven wear on the friction surfaces.

Energize the clutch coil and repeat the measurement. If the difference between the first and second measurements exceeds .110 inches, the clutch rotor and armature are to be replaced.

NOTE: Do not attempt to readjust the armature travel by removing shims. A catastrophic clutch failure may result. After initial (new) air gap adjustment the shim stack should never be changed.

B) Never mix rotor and armature assemblies between used assemblies or new and used assemblies.

CAUTION: If either the armature or rotor assemblies are defective, both assemblies must be replaced.

C) If raised ribs on friction face are worn flat or nearly flat, replace armature and rotor assemblies.

variocomp®

der Antrieb für konstante Leistungen von Klimaanlagen in Omnibussen

Montageanleitung und
Ersatzteile

Typ LRF18 für Carrier-Kompressor 05G

Centrifugal variocomp

Allgemeines

Bei Demontage und Montage des variocomp ist auf Sauberkeit und fachmännisches Arbeiten zu achten. Ein Zerlegen kommt nur zum Zwecke des Auswechselns von Teilen, welche erneuert werden mussen, in Frage. Vor dem Zerlegen des variocomp ist dieser erst sauber mit einem geeigneten Waschmittel zu reinigen.

Die Montage ist an einem sauberen Arbeitsplatz vorzunehmen. Die wieder zur Verwendung kommenden Teile mussen vor der Montage mit einem geeigneten Waschmittel gereinigt werden.

Beschadigte Teile und solche, die durch starken Verschleiß abgenutzt sind, werden durch neue ersetzt. Demontierte Walzlager sind nicht wieder zu verwenden, sondern sind bei Montage durch neue zu ersetzen.

Anziehmomente für Schrauben sind in den Beschreibungstexten angegeben.

Achtung: Umgebungstemperatur max. 100°C.

General information

Please take great care in disassembly and assembly. No dirt! Disassembly is only allowed for changing parts which must be replaced. Clean variocomp with suitable detergent before disassembly.

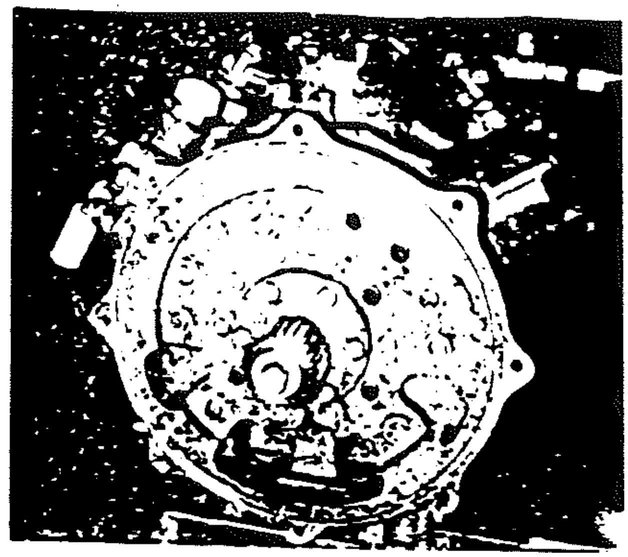
Assemble in a clean place. The parts which will be reinstalled must be cleaned with a suitable detergent before reassembly.

Damaged and worn parts must be replaced by new parts. Do not reuse disassembled antifriction bearings but replace them by new ones.

Thigthening torques are listed.

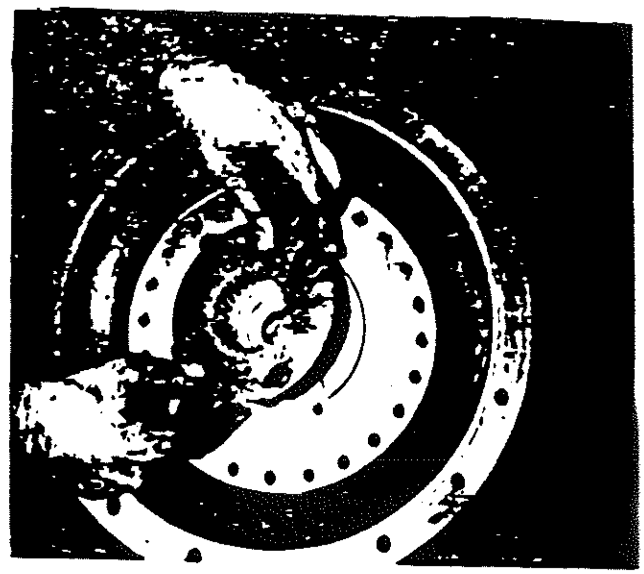
Attention: max. ambient temperature is 100°C.

[illegible]
Asse[illegible] [illegible]cedure



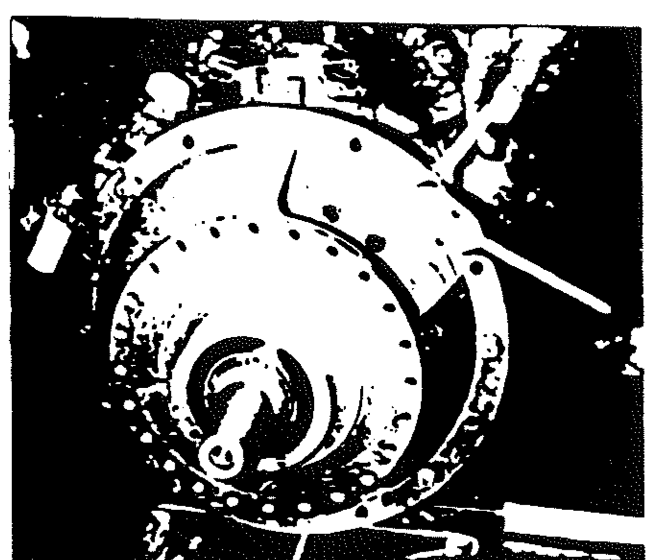
1.
[illegible] der elastischen Kupplung auf
[illegible] ressorwelle befestigen.

1.
[illegible] s[illegible] seat which is a part of
the flexible coupling to the
compressor shaft.



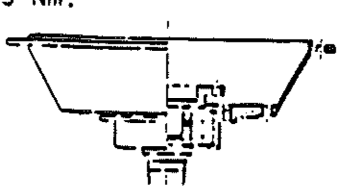
2.
Elastischen Kupplungsring montieren.
Schrauben locker einschrauben.
(Sh. 4.)

2.
Attach flexible coupling with bolts
but do not tighten securely.
(see 4.)

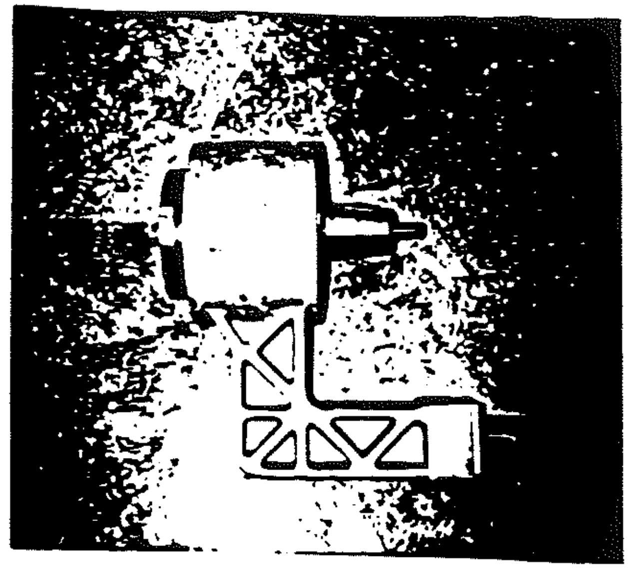


3.
Glocke an Kompressorflansch mit
8 Sechskantschrauben M 8 x 40 DIN
931 - 8.8, SW 13, 8 Sechskantmuttern
M 8 DIN 934-8 und beidseitig je 1
Scheibe A 8.4 DIN 125 anschrauben.
Anzugsmoment 25 Nm.

3.
Mount bell housing on compressor
flange with 8 hexagon bolts - M 8 x 40
DIN 931 - 8.8, SW 13, 8 hexagon nuts
M 8 DIN 934 - 8 and apply flat washers
to both sides (8.4 DIN 125). Tightening
torque 25 Nm.

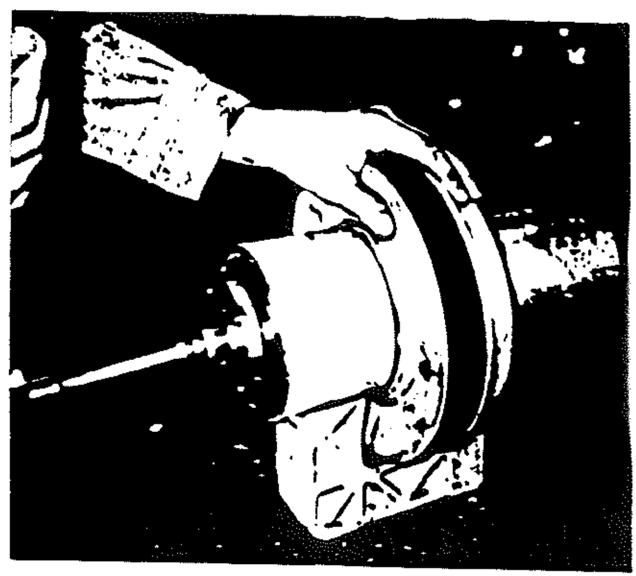


Vormontage
partial mounting beforeassembly
procedure



1.
Antriebsscheibe am Haltearm
montieren. Spannschraube M 12,
SW 17, einschrauben.
Anzugsmoment 110 Nm.

1.
Mount input disc on holding arm.
Bolt on with clamping bolt M 12,
SW 17.
Tightening torque 110 Nm.

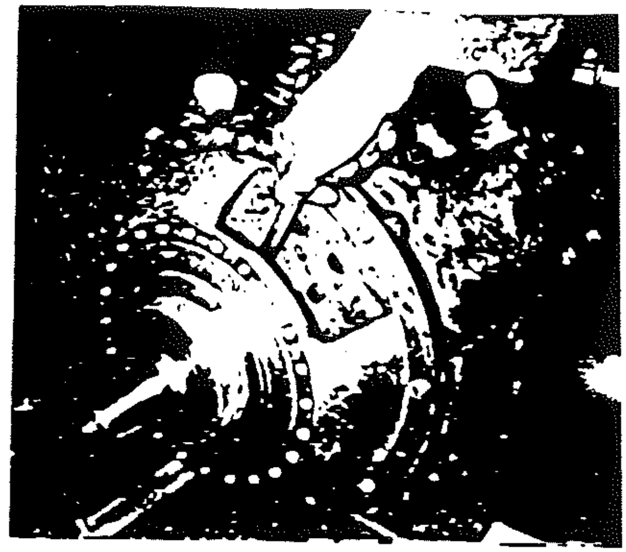


2.
Vom Haltearm und vom Halter die
Sechskantmuttern M 12 DIN 934-8,
SW 19 und die Unterlegscheiben
entfernen und damit den Haltearm am
Halter befestigen.
Anzugsmoment 86 Nm.

2.
Remove the hexagon nuts M 12 DIN 934-8,
SW 19 and washers from holding arm and
tighten bracket. Mount holding arm to
the tighten bracket.
Tightening torque 86 Nm.

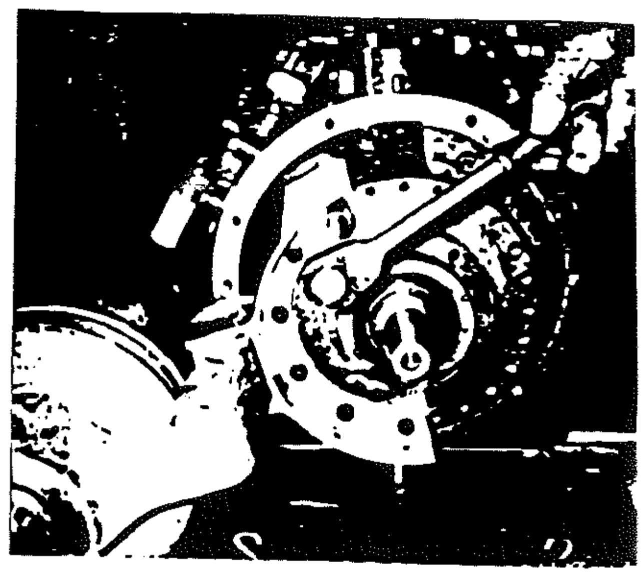
4.
[illegible]

4.
[illegible] Flexible Flange [illegible]



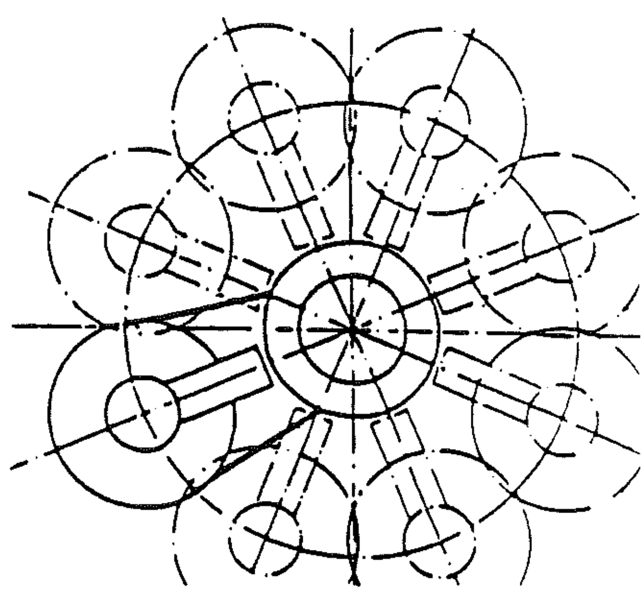
5.
Halter planaufliegend an Glocke anschrauben mit 6 Zylinderschrauben
M 10 x 16 DIN 7984 - 8.8, SW 7.
Anzugsmoment 49 Nm.

5.
Secure tighten bracket flat to the bell housing with 6 cheese head screws
M 10 x 16 DIN 7984 - 8.8, SW 7.
Tightening torque 49 Nm.



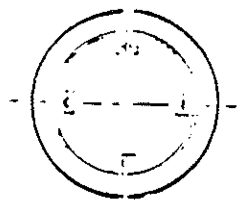
5.1
Der Halter kann in 48 Stellungen, jeweils 7,5° versetzt, angeschraubt werden.

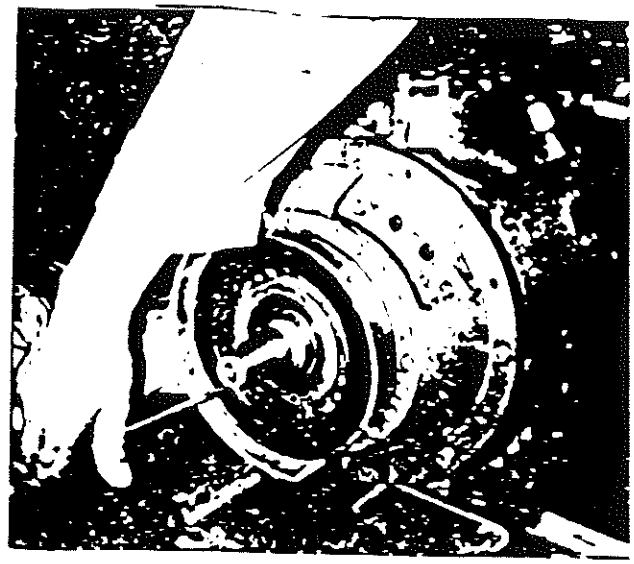
5.1
The tighten bracket can be attached in 48 positions which are equally spaced at 7,5°.



6.
[illegible] Zylinderschrauben [illegible] 8.8, SW 6.
[illegible]

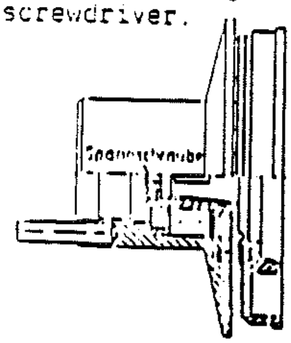
6.
[illegible] flat to the bell [illegible] 2 cheese head screws M 8 x [illegible] SW 6.
[illegible] value [illegible]

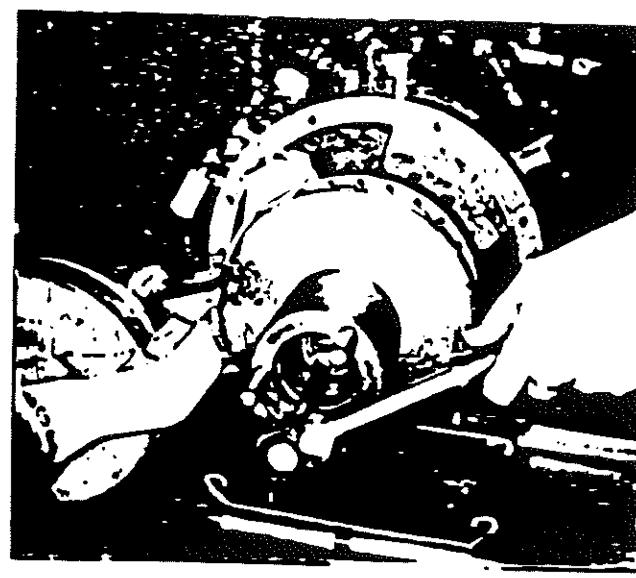




7.
Regelscheibe auf Welle schieben, dabei auf Paßfeder in Nabennut achten und mit Spannschraube M 12, SW 19, anschrauben. Anzugsmoment 110 Nm. Gegenhalten mit Schraubendreher.

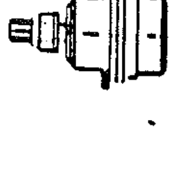
7.
Slide variable disc onto shaft making sure the key is in position with keyway and mount with tightening screws M 12, SW 19. Tightening torque 110 Nm while holding in to position with screwdriver.



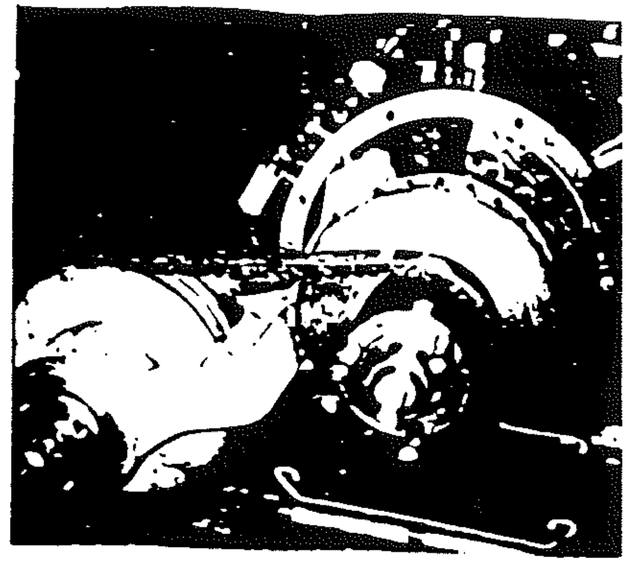


8.
Nabe von Regelscheibe einsetzen und mit Sicherungsring 72 x 2,5 DIN 472 sichern.

8.
Mount hub to variable disc and secure with internal snap ring 72 x 2,5 DIN 472.

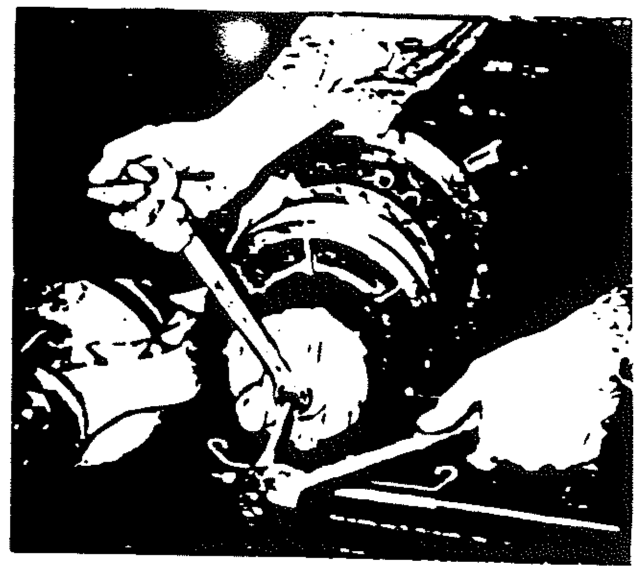


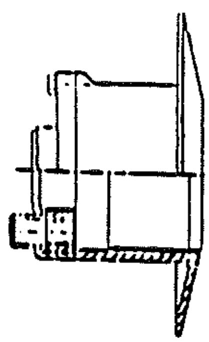
8.
[illegible] aufsetzen,
[illegible] Kompressorseite,
[illegible] Antriebsseite
9.
[illegible] compressor
side [illegible] on belt drive side.

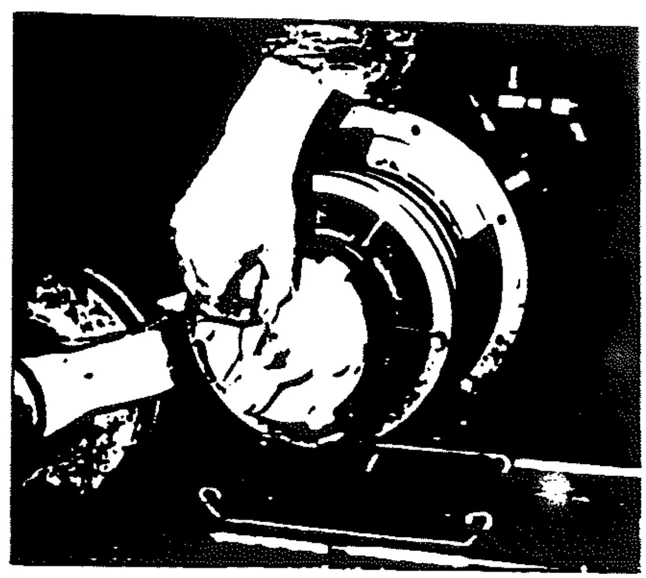


10.
2. Hälfte Regelscheibe auf Nabe von Regelscheibe aufschieben. Dann solange verdrehen, bis die 3 Bolzen reinpassen. Mit Sechskantmutter M 16 x 1,5 DIN 985-8, SW 24, und Unterlegscheibe festschrauben. Anzugsmoment 50 Nm. Gegenhalten mit Sechskantschlüssel, SW 8, im Innensechskant der Schraube. Zur Kontrolle der Stellung der Sechskantmutter Splint einsetzen.

10.
Slide 2nd half of variable disc onto 1st half of variable disc and turn until three bolts will fit into the variable disc. Mount with hexagon nut M 16 x 1,5 DIN 985 - 8, SW 24 and flat washer. Use allen wrench SW 8 in allen head bolt to maintain 50 Nm torque. Use key in order to control the position of the hexagon nut.







11.
Zum Riemenwechsel umgekehrt vorgehen.

11.
To change the V-belt, reverse the procedure.

LINNIG Antriebstechnik GmbH
Riedheimerstraße 8
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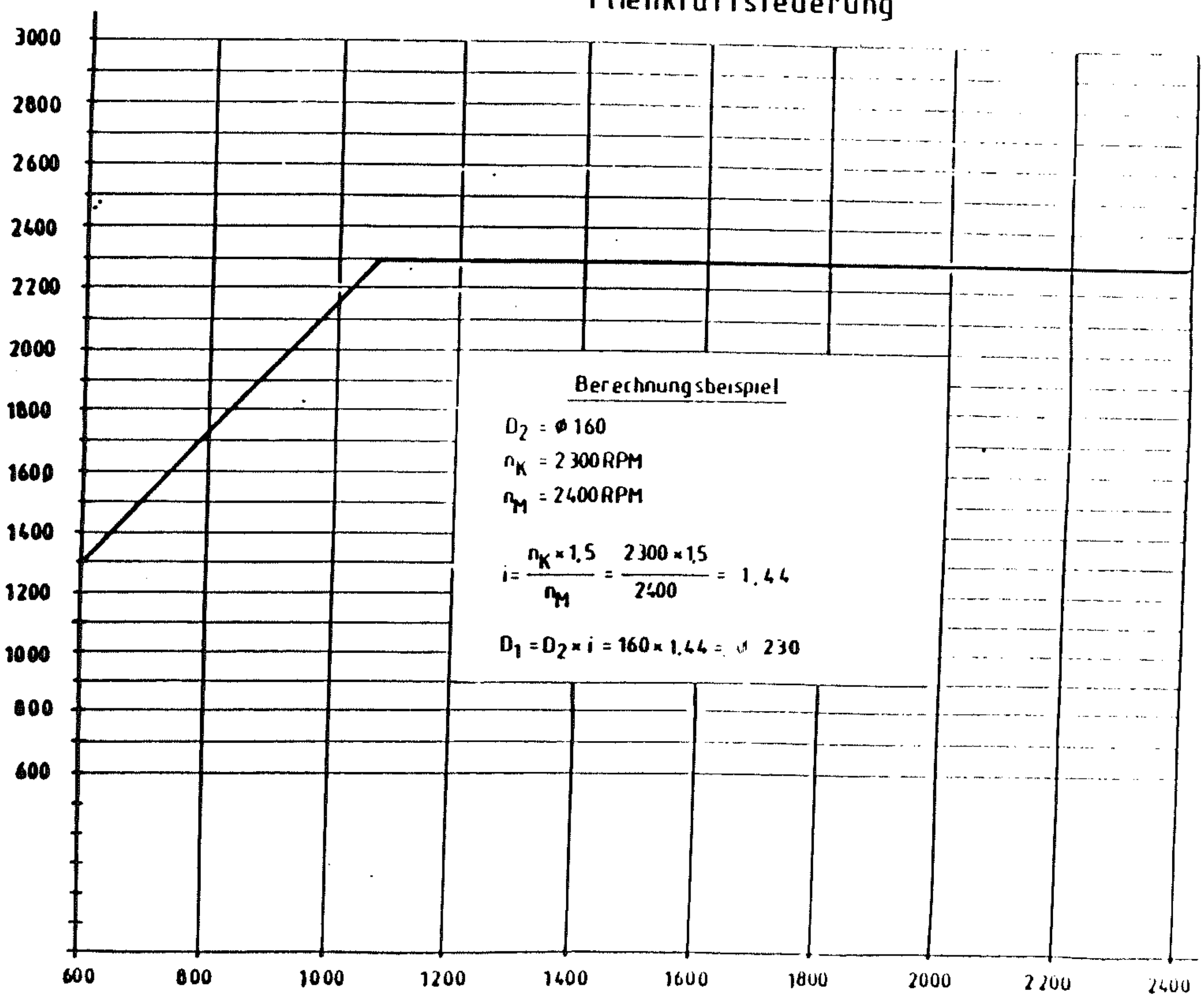
Drehzahldiagramm Variocomp LRF 18
Fliehkraftsteuerung



Berechnungsbeispiel

$D_2 = \phi\, 160$

$n_K = 2300\,RPM$

$n_M = 2400\,RPM$

$$i = \frac{n_K \times 1{,}5}{n_M} = \frac{2300 \times 1{,}5}{2400} = 1{,}44$$

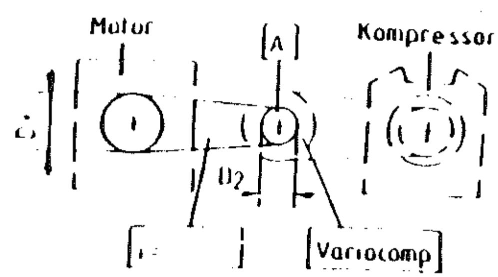
$$D_1 = D_2 \times i = 160 \times 1{,}44 = \phi\ 230$$

n_K = n Kompressor max RPM

n_M = n Motor max RPM

$$\boxed{i = \frac{n_K \times 1{,}5}{n_M} = \frac{D_1}{D_2}}$$

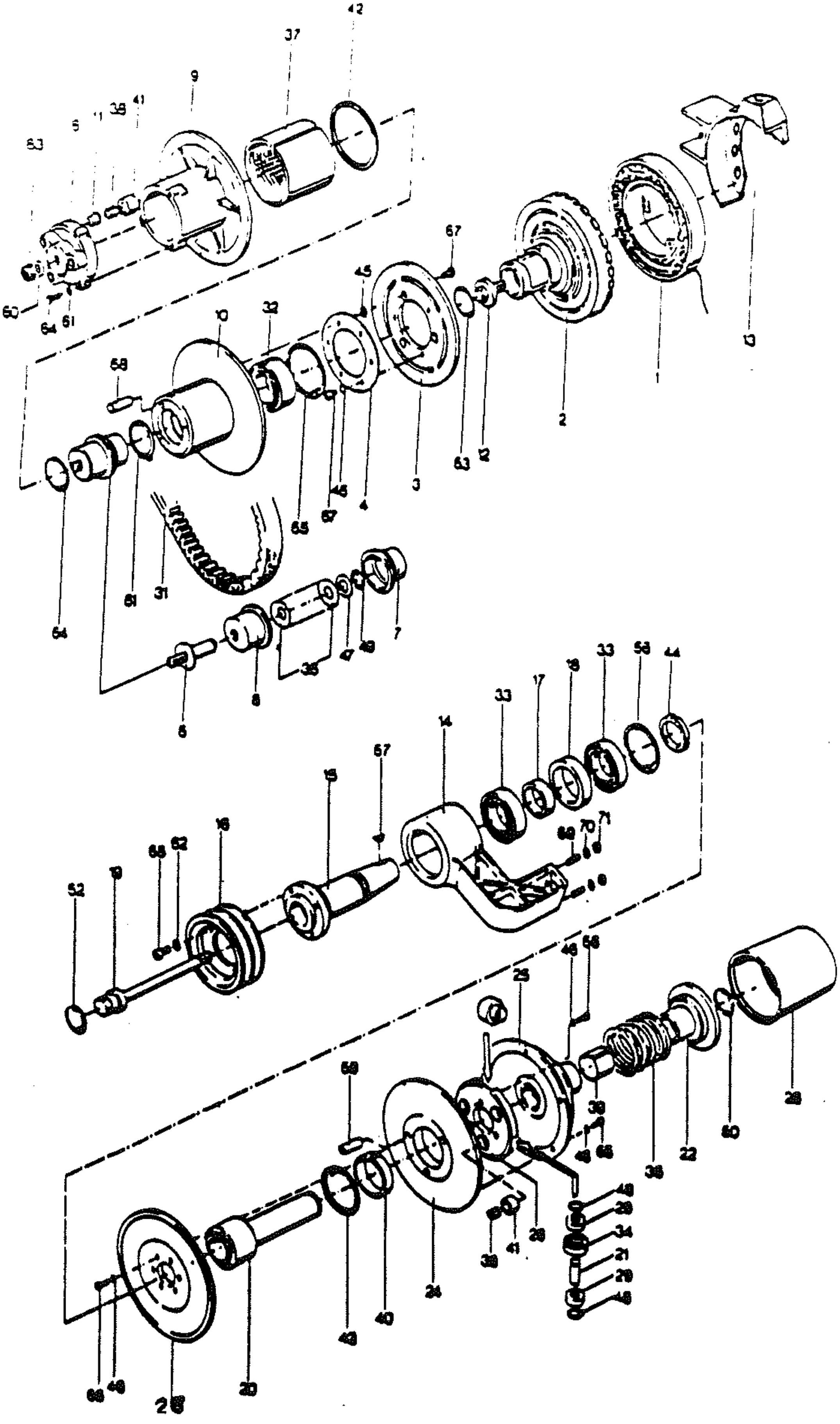
$$\boxed{D_1 = D_2 \times i}$$



Änderung vorbehalten

Datum 15.11.1986

Ersatzteile
Stand: 1.4.1988

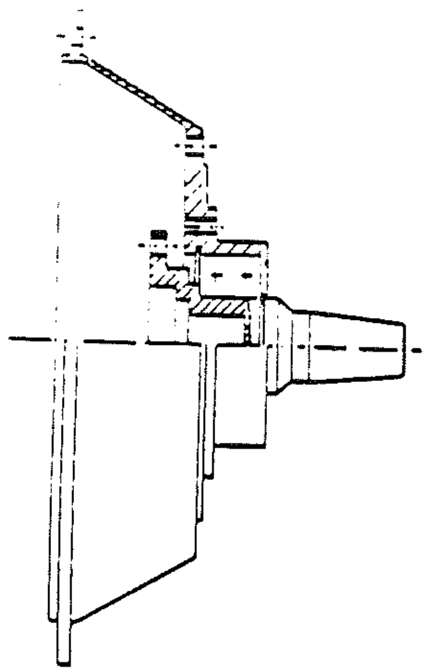


[illegible]

Stand: [illegible] 4. 988

Bezeichnung		Teil	Anzahl
Magnet	o1.o21	1	1
Rotor	o2.112	2	1
Ankerscheibe	o3.olo	3	1
Ringfeder	o4.o16	4	1
Welle	o5.o77	5	1
Abschlußdeckel	o6.2o6	6	1
Nabe	o8.264	7	1
Nabe	o8.265	8	1
Regelscheibe	o9.242	9	1
Regelscheibe	o9.243	1o	1
Buchse	o9.247	11	3
Spannschraube	11.o62	12	1
Halter	LRF 8 BG2	13	1
Halter	11.o81	14	1
Welle	o5.o76	15	1
Riemenscheibe	o7.168	16	1
Distanzbuchse	o9.245	17	1
Distanzbuchse	o9.244	18	1
Spannschraube	11.1o4	19	1
Welle	o5.142	2o	1
Bolzen	o5.143	21	3
Flansch	o6.21o	22	1
Regelscheibe	o9.233	23	1
Regelscheibe	o9.238	24	1
Kurvenscheibe	o9.236	25	1
Scheibe	o9.237	26	1
		27	
Schutzhaube	11.1o6	28	1
Laufrolle	11.1o8	29	6
		3o	
Keilriemen	LR1-8G7	31	1
Kulle		32	1
Kulle		33	2
Laufrolle		34	3
Tellerfeder		35	23
Druckfeder		36	1
DU-Buchse		37	1
DU-Buchse		38	6
DU-Buchse		39	1
DU-Buchse		4o	1
Ultrabuchse		41	6

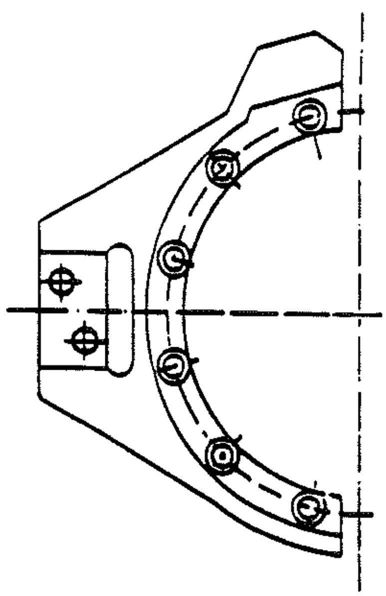
Bezeichnung	Teil	
Abstreifer	42	
Abstreifer	43	
Nutmutter	44	
Schnorring	45	
Schnorring	46	
Stützscheibe	47	
Seegerring	48	
Seegerring	49	
Seegerring	5o	
Seegerring	51	
Seegerring	52	
Seegerring	53	
Seegerring	54	
Seegerring	55	
Seegerring	56	
Scheibenfeder	57	
Zylinderstift	58	
Zylinderstift	59	
Scheibe	6o	
Scheibe	61	
Federring	62	
Skt.-Mutter	63	
Skt.-Schraube	64	
Zyl.-Schraube	65	
Zyl.-Schraube	66	
Zyl.-Schraube	67	1
Zyl.-Schraube	68	4
Stiftschraube	69	2
Scheibe	7o	2
Skt.-Mutter	71	2



LR 1.8 BG 1

Glocke

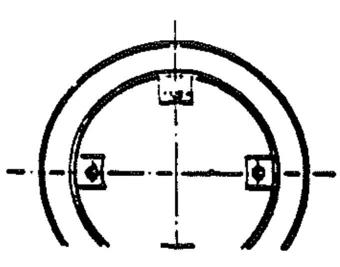
BELL



LRF 1.8 BG 2

Halter

TIGHTEN - BRACKET



LR 1 BG 3

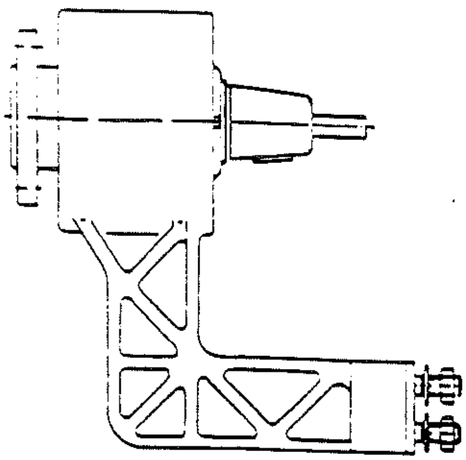
Magnet

MAGNETIC COIL

variocomp LRF 1.8

Ersatzteil-Baugruppen

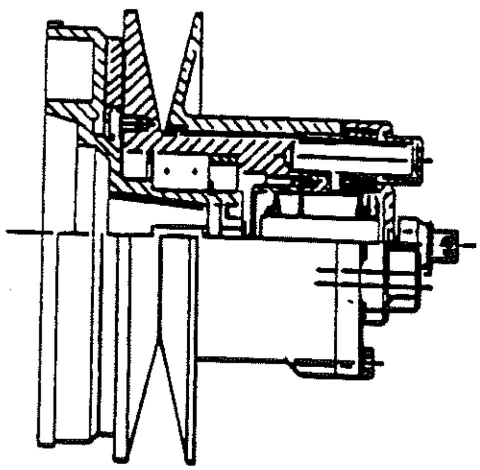
1.8.1988



LRF 1 BG 4.1

Haltearm

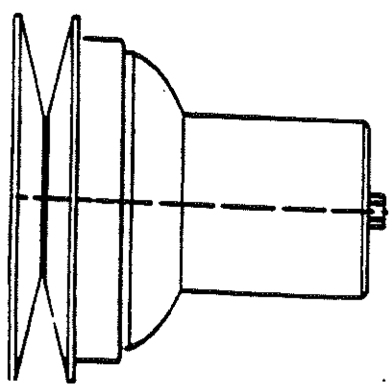
HOLDING ARM



LR 1 BG 10

Abtriebsscheibe

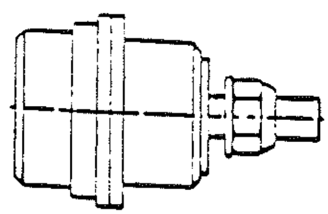
OUT PUT DISC



LRF 1 BG 4.2

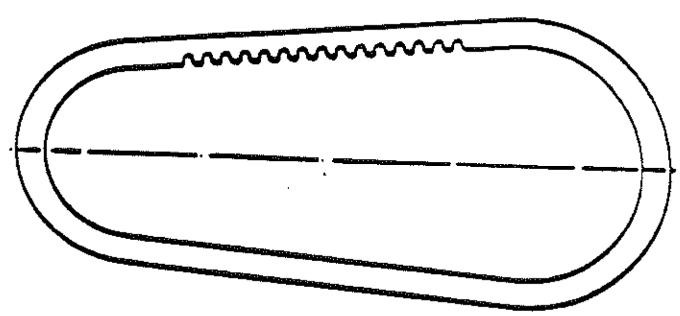
Antriebsscheibe

INPUT DISC



LR 1 - BG 6.1

Nabe
HUB



LR 1 - BG 7

Keilriemen
Y-BELT

Troubleshooting D 12 W

Troubleshooting and repair manual

Eberspächer

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Valid for heater designs

25 1570 01 00 00 12 V[1)]
25 1571 01 00 00 24 V[1)]

25 1655 01 00 00 12 V[2)]
25 1656 01 00 00 24 V[2)]

1) Version with temperature switch

2) Version with flame sensor

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Description of operation
Construction and operating principle:

The burner connection to the heat exchanger is so designed that the burner can be completely removed.

When the protective hood is removed, the entire electrical equipment is made easily accessible for any checking and maintenance work required.

When the cable duct attached lengthways is removed, glow-ignition plug, flame sensor, final control switch and safety thermal cutout switch are made accessible.

Switching on the heater:

The pilot lamp comes on when the heater is switched on. Combustion air flows in to flush out the combustion chamber, and the water circulation pump is put into operation.

The fuel metering pump conveys fuel in precise doses to the combustion chamber, where fuel and combustion air form a combustible mixture which is ignited by the glow plug.

Once the flame sensor has signalled to the control unit that combustion has taken place correctly, the glow-spark plug and ignition coil is switched off.

The hot combustion gases are diverted at the end of the flame pipe, then pass through the indirect heating surfaces of the heat exchanger and transmit their heat to the water passing through the heat exchanger.

The heater is thermostatically controlled, and operates intermittently, i. e. the switched-on times of the burner vary depending on the heat requirement. The water temperature depends on the setting of the built-in water thermostat.

The water circulation pump remains in operation as long as the heater is operating – even in the regulation intervals and during the delayed cutout of the switched-off heater. The pump can also be operated independently of the heater by means of an appropriate circuit.

The heater can be switched on at any time, i.e. during the delayed cutout period too. Ignition takes place once this delay time is over.

Switching off the heater:

When the heater is switched off, the fuel supply is interrupted. The flame goes out, and at the same time e delayed cutout of some 2.5 minutes begins. The combustion air still flowing flushes the remaining combustion gas out of the chamber and cools off the hot parts on the exhaust side of the heat exchanger, while the water circulation pump still running transmits the heat present in the heat exchanger, thus preventing local overheats. Once the delayed cutout time is over, both the combustion air blower and the water circulation pump switch off automatically.

Safety equipment:

Flame monitoring:
The flame is monitored by the flame sensor. This switch acts on the safety switch in the control unit, which switch shuts down the heater in the event of a malfunction.

Automatic shutdown in the event of non-ignition or flame going out:

If the heater does not ignite, it switches off automatically not nore than 3 minutes after being switched on.

If the flame goes out by itself during operation, the fuel supply stops automatically after no more than 4 minutes.

If there is a fault – caused by the blower motor – the motor current fuse built into the control unit switches off the heater.

Overheating and peak temperature:

If the heater overheats (e.g. due to lack of water), the safety thermal cutout switch stops the fuel supply. The heater switches off automatically at the end of the delayed cutout time (approx. 2.5 minutes).

If the fluid temperature reaches the desired peak value, the water thermostat keeps this temperature approximately constant by alternately switching the heater on and off.

In the event of faults, first check the following points

The troubleshooting chart does not cover the following fault causes, so please check these points as a genearal principle.

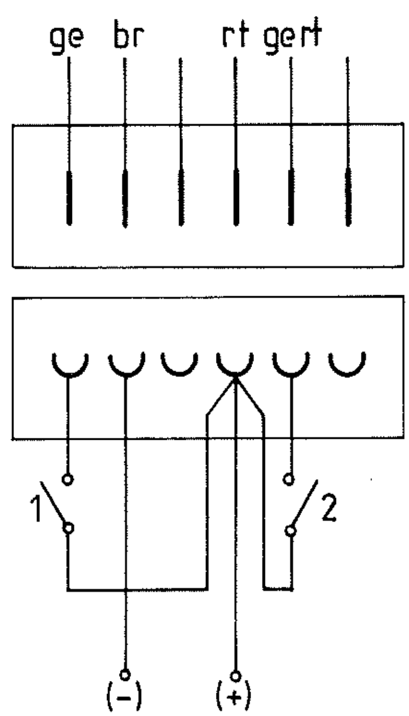
1. Faulty wiring, short-circuiting, breaks
2. Corroded contacts
3. Battery voltage less than 10.5 or 21 V respectively measured at the 6-pin plug between terminals 4 and 2 when the heater is started
4. Mechanical damage to components
5. Fuel tank empty

Making a test cable

If the fault has not yet been eliminated, we recommend that a test cable be made for further systematic searching for the fault. Using the test cable, it can quickly be determined whether the cause of a fault lies in the heater or its control unit and fuel supply system, or in the operating and control elements.
After removing the hood, connect the test cable to the 6-pin plug instead of the operating unit. Check for correct functioning of the heater using the troubleshooting chart, and remove the test cable and attach the operating unit when functioning is correct.

Continue searching for the fault manually using the troubleshooting chart.

D 12 W test cable



1 On/off switch
2 Water pump switch

Troubleshooting

Fault → / Cause ↓	No blower noise approx. 5 secs. after switch-on	Blower runs, approx. 5 secs. after switch-on, for about 5 secs., then cuts automatically	Blower runs about 5 secs. after switch-on, pump ticks, automatic cutout after 3 minutes	Blower runs about 5 secs. after switch-on, pump does not tick, then automatic cutout after 3 minutes	Heater cuts out permanently during heating operation	Heating capacity insufficient or heater goes off by itself	Heater smokes and soots	Blower continues to run after switch-off longer than the usual delayed cutoff time (3 - 4 minutes)
Main 16A fuse defective	O							
Glow ignition plug (GZE 201) coked/defective			O					
Motor current fuse in control unit defective	O							
Safety thermal cutout switch has responded					O			
Ignition spark generator defective			O					
Glow plug series resistor defective			O					
Undervoltage		O						
Overvoltage		O			O			
Control unit not supplying pulses for the fuel metering pump				O				
Reed relay in control unit has no contact		O						
On/off switch, timer, control switch defective	O							
Plug relay sticking in D12W (25 1570/71) with temperature switch			O					
Electronic delayed shutoff unit defective in D12W (25 1655/56) with flame sensor								O

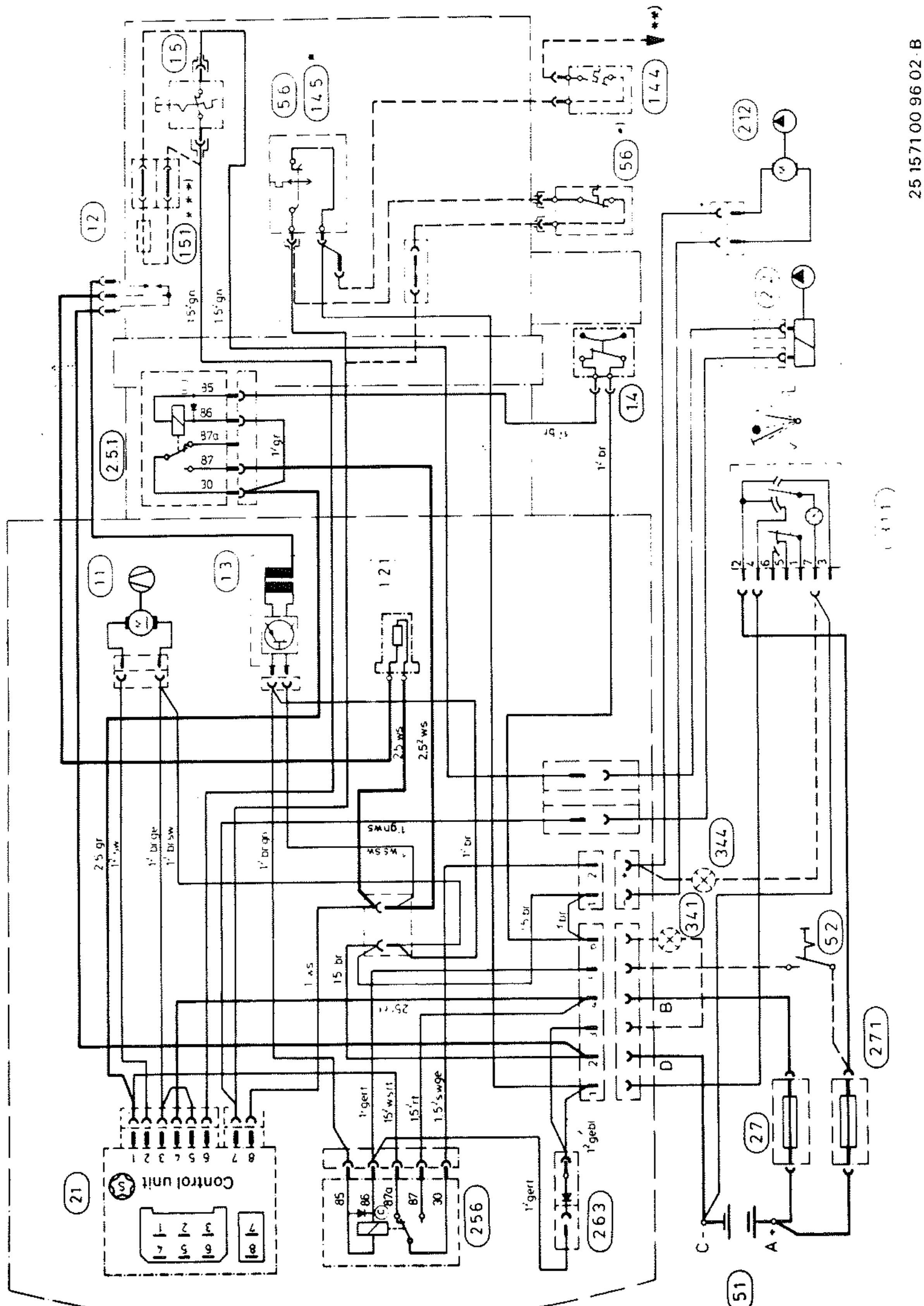
Check	Remedy
Visual/continuity check	Remove short-circuit in the wiring or coke from the heating coil of the glow ignition plug, replace the glow ignition plug if necessary
Visual/continuity check	If necessary, change glow ignition plug
Visual/continuity check	Remove damage in combustion air system, motor or blower, change the motor current fuse
Switch off the heater Check water flow (min. 1000 l/h)	Remove air from water circuit, operate the safety thermal cutout switch
Hold high-tension cable approx. 5 mm away from earth	If necessary, change the ignition spark generator
Visual/continuity check	If necessary, change the glow plug series resistor
Measure voltage at 6-pin plug, terminals 4 and 2, min. voltage 10.5 or 21 V	Charge battery Check wiring for voltage drops
Measure voltage at 6-pin plug, terminals 4 and 2, max. voltage 14.5 or 29 V	Check dynamo regulator, change if necessary
Connect pilot light to the contacts of the fuel metering pump or terminal 6 on the control unit, if no pulses are available	Change the control unit
See Fault	Change the control unit
Visual/continuity check	If necessary, change the operating element
Check relay functioning	If necessary, change the plug relay
See Fault	Change the optical flame sensor

Troubleshooting

Fault → Cause ↓	No blower noise approx. 5 secs. after switch-on	Blower runs, approx. 5 secs. after switch-on, for about 5 secs., then cuts automatically	Blower runs about 5 secs. after switch-on, pump ticks, automatic cutout after 3 minutes	Blower runs about 5 secs. after switch-on, pump does not tick, then automatic cutout after 3 minutes	Heater cuts out permanently during heating operation	Heating capacity insufficient or heater goes off by itself	Heater smokes and soots	Blower continues to run after switch-off longer than the usual delayed cutoff time (3-4 minutes)
Fuel metering pump not pumping				O				
Fuel metering pump pumping too much							O	
Fuel metering pump pumping too little			O			O		
Fuel line leak Filter clogged Air in the fuel line			O			O		
Combustion and/or exhaust line clogged							O	
Combustion air blower speed too low							O	
Electric motor defective	O							
Blower damage (Combustion air blower damage)	O							
Temperature switch does not respond in D12W 25 1570/71			O					
Optical flame sensor defective in D12W 25 1655/56			O					

Check	Remedy
Connect test lamp to the fuel metering pump when pulses are present	Replace fuel metering pump
Measure fuel quantity; if the quantity is outside the permissible tolerance	Replace fuel metering pump
Measure fuel quantity; if the quantity is outside the permissible tolerance	Replace fuel metering pump
Visual check	Seal and bleed fuel line, change filter
Visual check	Remove blockage
Measure speed at motor shaft	Change electric motor
If the shaft of the electric motor does not turn	Replace burner
If the shaft of the electric motor turns	Change electric motor
Defect is present when there is still minus at terminal 85 (glow plug relay) after max. 120 secs. after switch-on	Change temperature switch
Clean quartz rod on flame sensor with a soft cloth: if no function:	Change the optical flame sensor

Wiring diagram D 12 W – 12 V and 24 V / Design 25 1570/71 with temperature switch



Parts list to wiring diagram

1.1 Burner motor
1.2 Glow ignition plug
1.2.1 Series resistor for glow plug
1.3 Ignition spark generator
1.4 Temperature switch
1.4.4 Blower switch (on request)
1.4.5 Water thermostat, internal
1.5 Safety thermal cutout switch
1.5.1 Safety thermal cutout fuse

2.1 Control unit
2.2 Fuel metering pump
2.5.1 Glow plug relay
2.5.6 Water pump relay
2.6.3 Water pump diode
2.7 Main fuse, 16A
2.7.1 Control unit element fuse, 8A
2.12 Water pump

3.1.1 Universal switch
3.4.1 Operating pilot light
3.4.4 Water pump operating pilot light

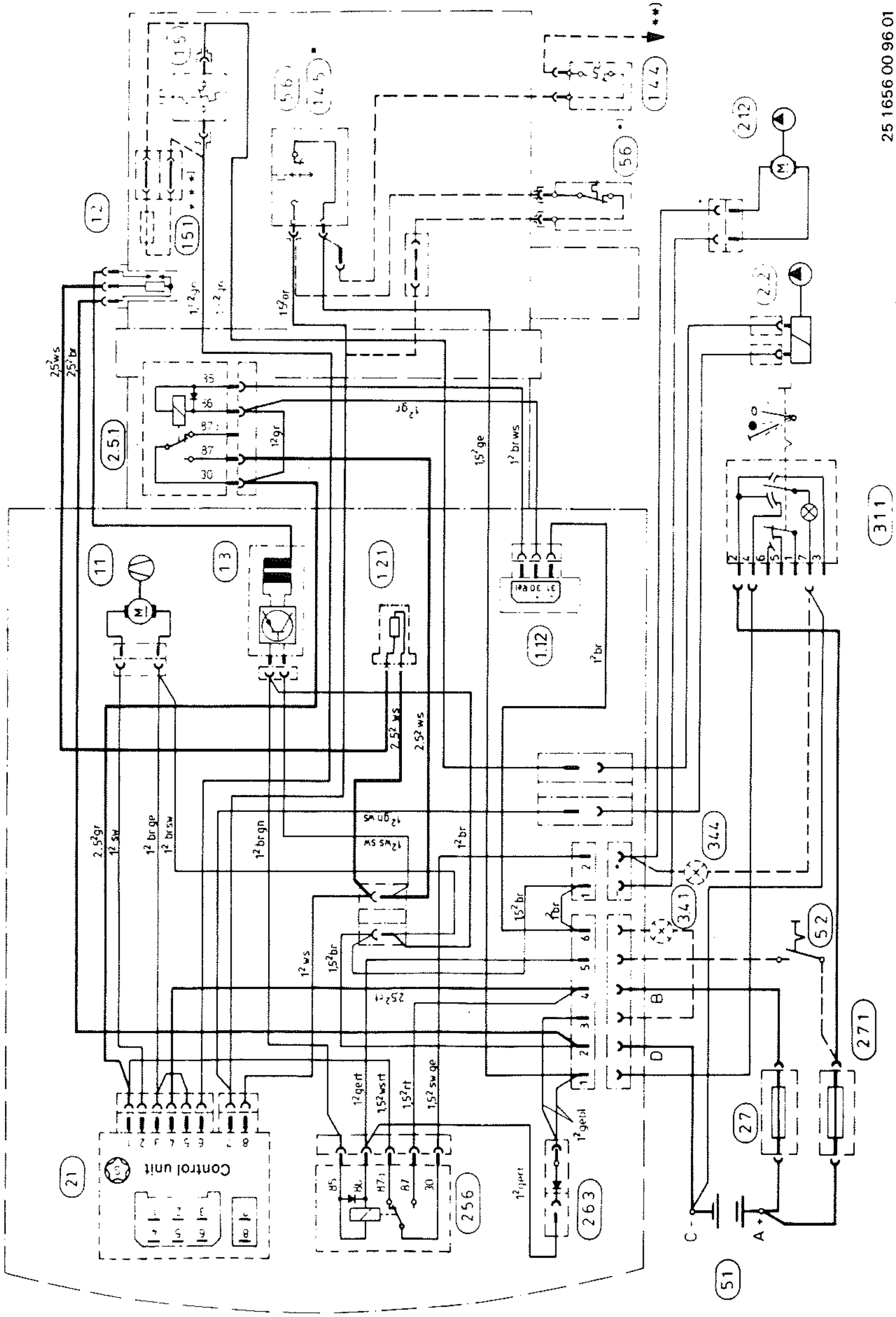
5.1 Battery
5.2 Switch for separate water pump operation
5.6 Water thermostat, external (on request)

* on request 5.6 external
1.4.5 on heater
** to relay of vehicle blower
*** 1.5.1 or 1.5 optional

A . . . B = L Plus
C . . . D = L Minus
L Plus + L Minus = L Total

rt = red
br = brown
ws = white
sw = black
gn = green
ge = yellow
vi = violet

Wiring diagram D 12 W – 12 V and 24 V / Design 25 1655/56 with flame sensor



Parts list with wiring diagram

1.1	Burner motor
1.2	Glow ignition plug
1.2.1	Series resistor for glow plug
1.3	Ignition spark generator
1.4.4	Temperature switch for vehicle blower (on request)
1.4.5	Final control switch
1.5	Safety thermal cutout switch
1.5.1	Safety thermal cutout fuse
1.12	Flame sensor
2.1	Control unit
2.2	Fuel metering pump
2.5.1	Glow plug relay
2.5.6	Water pump relay
2.6.3	Water pump diode
2.7	Main fuse, 16A
2.7.1	Actuating element fuse, 8A
2.12	Water pump
3.1.1	Universal switch
3.4.1	Operating pilot light
3.4.4	Water pump operating pilot light
5.1	Battery
5.2	Switch for separate water pump operation
5.6	Control switch for water temperature (on request)

* on request 5.6 external
1.4.5 on heater

** to relay of vehicle blower

*** 1.5.1 or 1.5 optional

A . . . B = L Plus
C . . . D = L Minus
L Plus + L Minus = L Total

rt = red
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sw = black
gn = green
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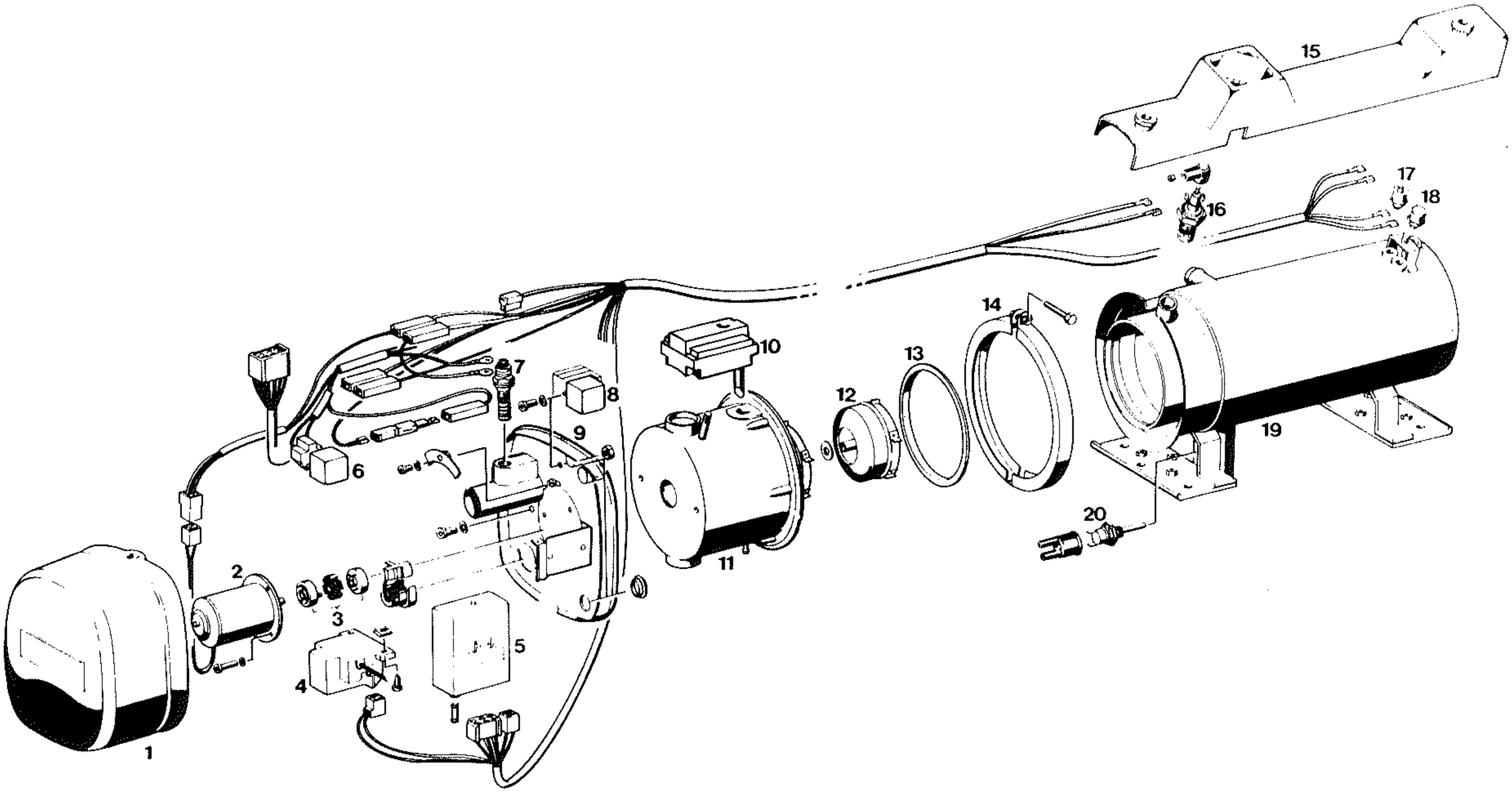


1 Hood
2 Electric motor
3 Coupling
4 Ignition spark generator
5 Control unit
6 Glow ignition plug relay
7 Series resistor
8 Water pump relay
9 Support plate
10 Flame sensor in D12W 25 1655/56
11 Burner
12 Atomizer
13 Sealing ring
14 Profile clip
15 Cable duct
16 Glow ignition plug
17 Safety thermal cutout switch
18 Control switch
19 Heat exchanger
20 Temperature switch in D12W 25 1570/71

Repair steps

1. Removing and installing the glow ignition plug
2. Removing and installing the safety thermal cutout switch
3. Removing and installing the control switch
4. Removing and installing the temperature switch
5. Removing and installing the ignition spark generator
6. Removing and installing the control unit
7. Removing and installing the series resistor
8. Removing and installing the electric motor
9. Removing and installing the water pump diode
10. Removing and installing the glow ignition plug and water pump relays
11. Removing and installing the burner head
12. Removing and installing the flame sensor

1. Removing and installing the glow ignition plug

Undo the knurled nuts and remove the cable duct.
Detach plug connector and cable plug from the glow ignition plug.
Unscrew the glow ignition plug (WAF 22).
Screw the glow ignition plug back in, or replace it if necessary, following visual and continuity test.

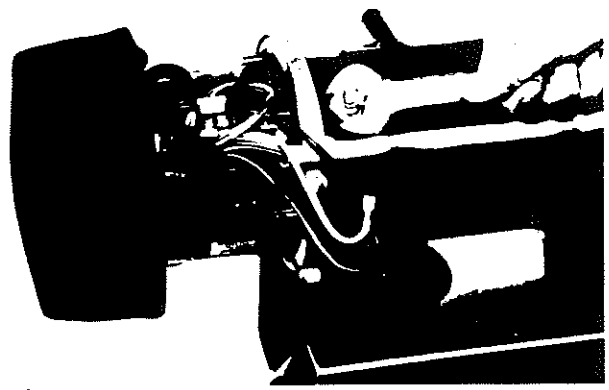


Fig. 1

2. Removing and installing the safety thermal cutout switch

Undo the knurled nuts and remove the cable duct.
Detach the cable plug.
Unscrew the safety thermal cutout switch (WAF 16).
Replace the safety thermal cutout switch.

Fig. 2

3. Removing and installing the control switch

Undo the knurled nuts and remove the cable duct.
Detach the cable plug.
Unscrew the control switch (WAF 16).
Replace the control switch.

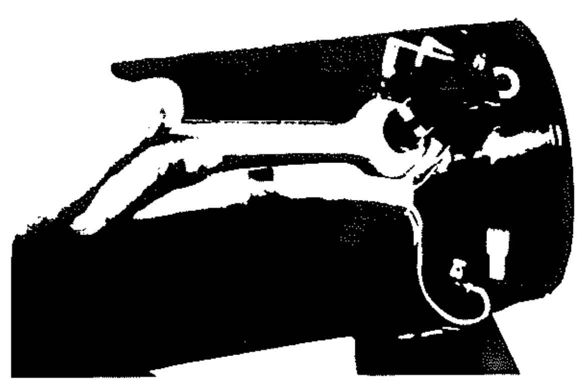


Fig. 3

4. Removing and installing the temperature switch (heater design 25 1570/71)

Remove the protective rubber cap.
Detach the cable plug.
Unscrew the temperature switch (WAF 16).
Replace the temperature switch.

Fig. 4

5. Removing and installing the ignition spark generator

Remove the hood.
Undo the knurled nuts and remove the cable duct.
Detach plug connector and cable plug from the glow ignition plug.
Unscrew the plug connector from the high-tension cable.
Pull the high-tension cable out through the rubber grommet.
Remove the plug housing from the ignition spark generator.
Undo the screws from the ignition spark generator.
Replace the ignition spark generator.
Pass the high-tension cable back through the rubber grommet and screw on the plug connector.
Reattach the plug housing to the ignition spark generator.
Reattach the plug connector and the cable plug to the glow ignition plug.

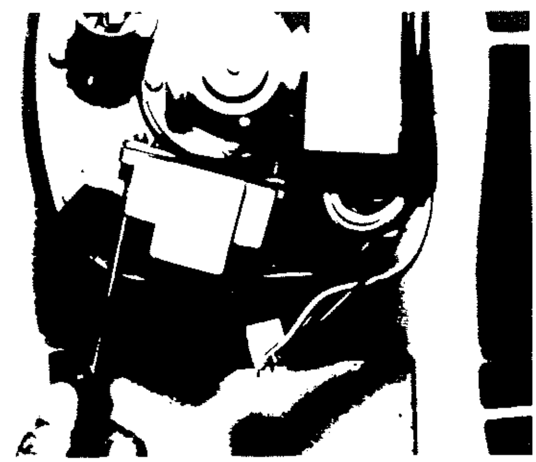


Fig. 5

6. Removing and installing the control unit

Remove the hood.
Detach both plugs from the control unit.
Remove the control unit off the holding bracket.
Replace the control unit.

Please note:
When installing a new control unit, a motor current fuse must be placed in it.

Cat. No. for motor current fuse
12 V 25 1570 05 01 00
24 V 25 1531 05 02 00

Fig. 6

7. Removing and installing the series resistor

Remove the hood.
Undo the connecting cable from the series resistor (WAF 7).
Unscrew the series resistor (WAF 19).
After visual and continuity test, screw the series resistor, or if necessary a new one, back in.

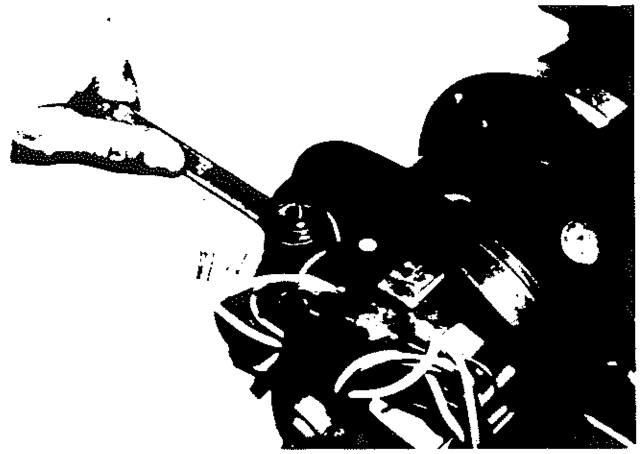


Fig. 7

8. Removing and installing the electric motor

Check the motor current fuse in the control unit and replace it if necessary.

Remove the hood.
Detach the plug housing from the electric motor at the cable harness.
Remove the control unit (see repair step 6).
Undo the 3 cross-head screws on the flange of the electric motor.
Remove the electric motor.
Install the new electric motor.

Please note:
When the motor is replaced, the driver pins of the two coupling halves must be seated in the recesses of the driver disc.

Fig. 8

9. Removing and installing the water pump diode

Remove the hood.
Detach the cable plug from the diode housing.
Install a new diode (diode connections cannot be mixed up).

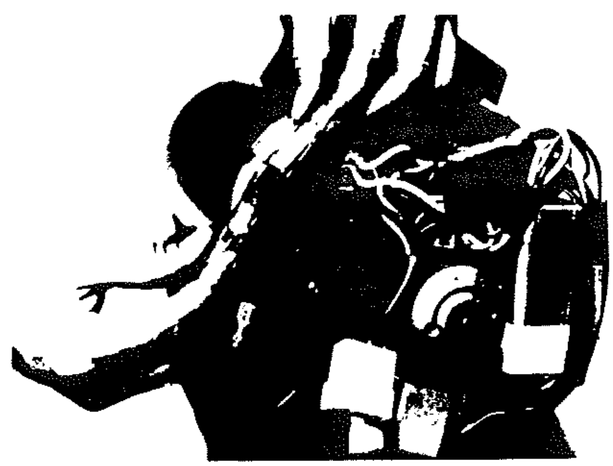


Fig. 9

10. Removing and installing the glow ignition plug and water pump relays

Detach the relay from the connection base.
Replace the relay.

Fig. 10

11. Removing and installing the burner head

Undo the knurled nuts and remove the cable duct.
Remove the hood.
Detach the cable plugs from the safety thermal cutout, control and temperature switches.
Detach plug connector and cable plug from the glow ignition plug.
Undo the fuel connection and detach it.
Detach the plug connections for current supply (6-pin plug), for the water pump (2-pin plug) and the fuel metering pump (2-pin flat connector housing).
Pull cable with plug out of the penetration hole.
Open the Vee-profile clamp (WAF 10) and remove the burner head.

Please note:
The seal should as a rule be changed when the burner head is changed.

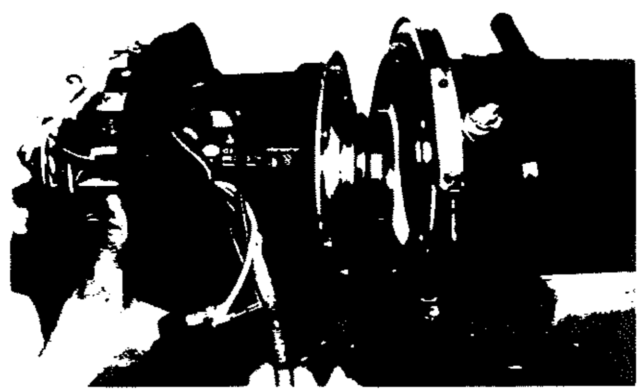


Fig. 11

12. Removing and installing the flame sensor (heater design 25 1655/56)

Undo the knurled nuts and remove the cable duct.
Detach the plug from the flame sensor.
Undo the cross-head screw in the middle of the flame sensor housing.
Pull the flame sensor out of the hole.
Replace the flame sensor.

Tightening torque of cross-head screw 1 + 0.2 Nm

Fig. 12

Measuring the fuel quantity

IMPORTANT: Only measure the fuel quantity when the battery is sufficiently charged. At least 11/22 V and at most 13/26 V must be applied at the control unit during measurement.

1. Preparation

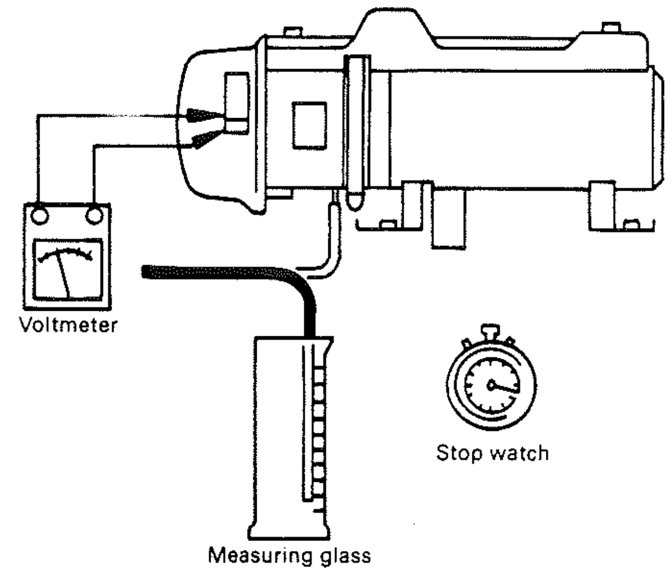
Detach the fuel line from the heater and introduce it into a measuring glass (50 ml). Connect voltmeter to terminal 3 (–) and 4 (+) of the 6-pin plug. Have a stop watch ready.
Switch on the heater until fuel is being pumped evenly. The fuel line is now filled and bled.
Switch off the heater, and empty the measuring glass.

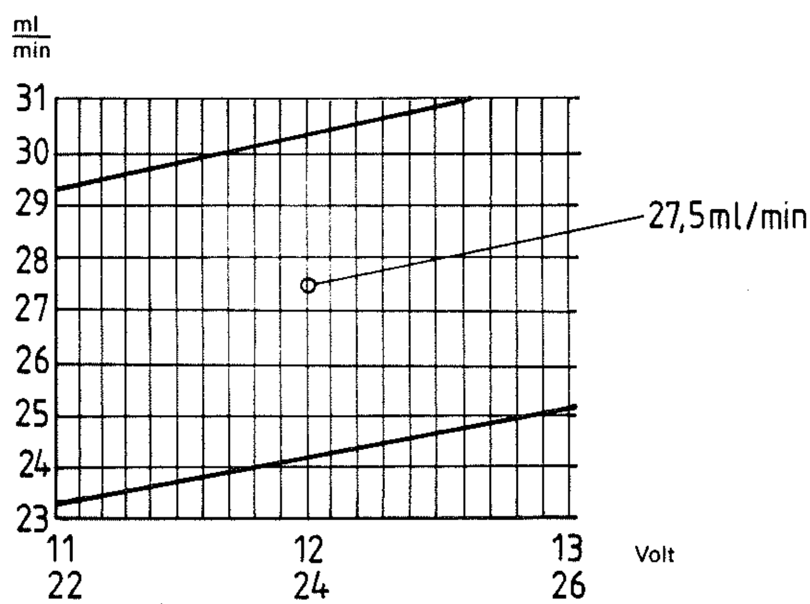
2. Measurement

Switch on the heater.
As soon as fuel is being pumped, switch on the stop watch, read off the voltage on the meter, switch the heater back off after one minute, and read off the fuel quantity.

3. Evaluation

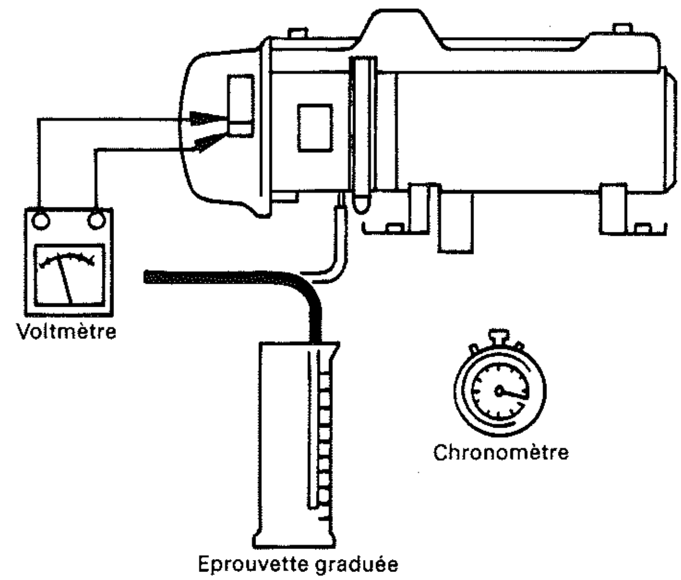
Using the diagram, read upwards from the measured voltage and horizontally from the fuel quantity measured during one minute.
The intersection of the two lines must be within the two limit curves. If not, replace the metering pump.





Mesure du débit de carburant

ATTENTION: Ne procéder à la mesure du débit de carburant qu'avec une batterie suffisamment chargée! Durant la mesure, une tension entre 11 et 13 ou 22 et 26 V doit être présente au coffret de commande.



1°) Préparatifs

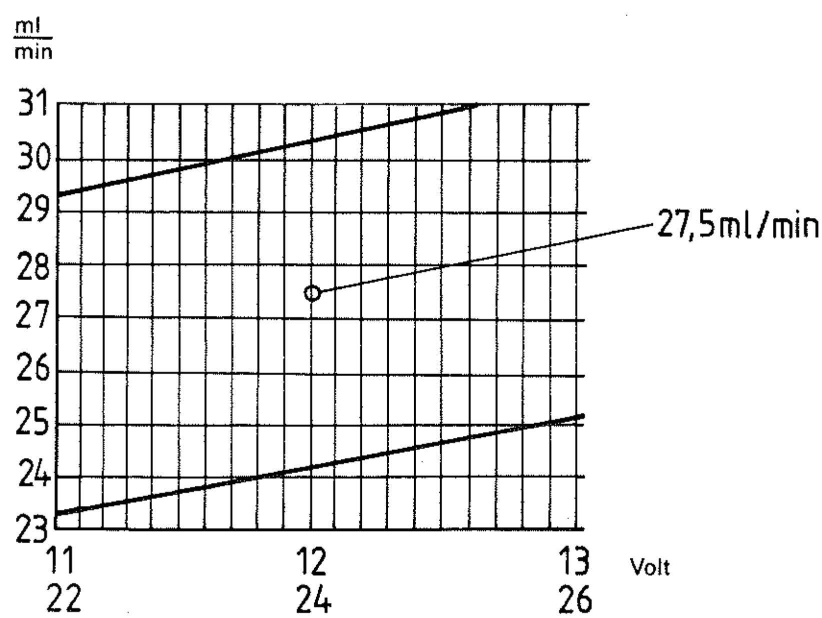
Retirer la conduite de carburant de l'appareil de chauffage et l'introduire dans une éprouvette graduée (d'au moins 50 ml). Raccorder un voltmètre aux bornes 3 (–) et 4 (+) du connecteur à 6 broches et tenir un chronomètre à portée de la main. Mettre l'appareil de chauffage en marche et attendre qu'un débit régulier de carburant soit visible. A ce moment, le circuit d'alimentation est rempli et débarrassé de tout air gênant.
Eteindre l'appareil et vider l'éprouvette.

2°) Mesure

Remettre l'appareil en marche.
Dès que du carburant est amené, enclencher le chronomètre et lire la tension mesurée au voltmètre. Eteindre l'appareil au bout d'une minute, très exactement, et déterminer la quantité de carburant remplissant l'éprouvette graduée.

3°) Evaluation

Examiner le diagramme ci-dessous, la tension étant sur l'axe des coordonnées et la quantité de carburant débitée pendant une minute sur l'axe des abscisses. Le point de mesure doit se situer à l'intérieur des deux pentes limites. Est-il en dehors de ces limites, remplacer la pompe de dosage.



10. Removing and installing the glow ignition plug and water pump relays

Detach the relay from the connection base.
Replace the relay.


Fig. 10

11. Removing and installing the burner head

Undo the knurled nuts and remove the cable duct.
Remove the hood.
Detach the cable plugs from the safety thermal cutout, control and temperature switches.
Detach plug connector and cable plug from the glow ignition plug.
Undo the fuel connection and detach it.
Detach the plug connections for current supply (6-pin plug), for the water pump (2-pin plug) and the fuel metering pump (2-pin flat connector housing).
Pull cable with plug out of the penetration hole.
Open the Vee-profile clamp (WAF 10) and remove the burner head.

Please note:
The seal should as a rule be changed when the burner head is changed.

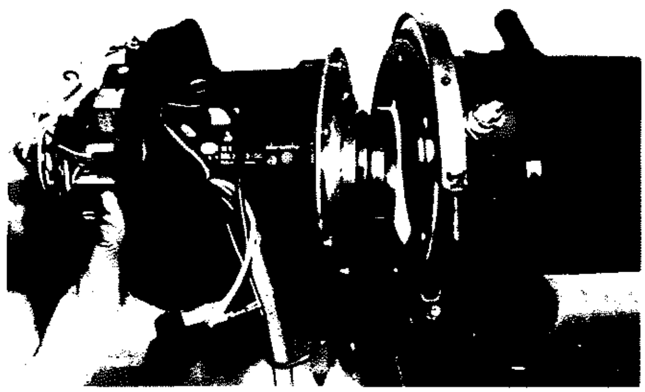


Fig. 11

12. Removing and installing the flame sensor (heater design 25 1655/56)

Undo the knurled nuts and remove the cable duct.
Detach the plug from the flame sensor.
Undo the cross-head screw in the middle of the flame sensor housing.
Pull the flame sensor out of the hole.
Replace the flame sensor.

Tightening torque of cross-head screw 1 + 0.2 Nm

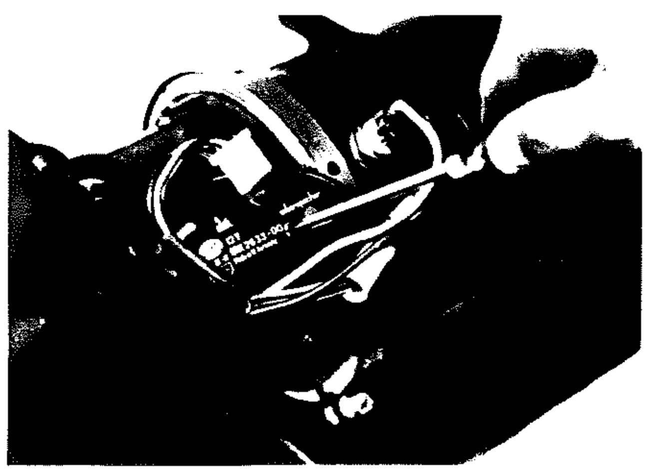


Fig. 12

7. Removing and installing the series resistor

Remove the hood.
Undo the connecting cable from the series resistor (WAF 7).
Unscrew the series resistor (WAF 19).
After visual and continuity test, screw the series resistor, or if necessary a new one, back in.

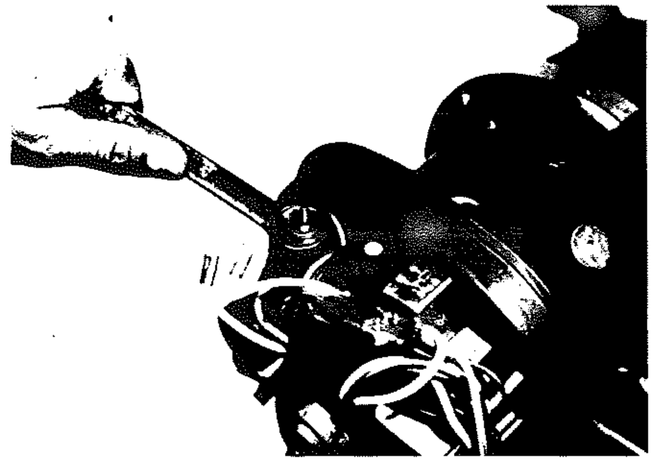


Fig. 7

8. Removing and installing the electric motor

Check the motor current fuse in the control unit and replace it if necessary.

Remove the hood.
Detach the plug housing from the electric motor at the cable harness.
Remove the control unit (see repair step 6).
Undo the 3 cross-head screws on the flange of the electric motor.
Remove the electric motor.
Install the new electric motor.

Please note:
When the motor is replaced, the driver pins of the two coupling halves must be seated in the recesses of the driver disc.

Fig. 8

9. Removing and installing the water pump diode

Remove the hood.
Detach the cable plug from the diode housing.
Install a new diode (diode connections cannot be mixed up).

Fig. 9

4°) Dépose/Repose du thermostat (Modeles D12W 25 1570/71)

Oter le capuchon caoutchouté de protection et débrancher le câble.
Dévisser le thermostat (Cle de 16), puis le remplacer.

Figure 4

5°) Dépose/Repose du générateur d'étincelles

Retirer le couvercle.
Desserrer l'écrou moleté et retirer le puits de câbles.
Débrancher le câble de bougie, puis retirer le connecteur du câble de haute tension. Sortir le câble du passe-câbles caoutchouté. Enlever le connecteur du générateur d'étincelles, desserrer les vis de fixation de celui-ci et le remplacer. Réintroduire le câble de haute tension au travers du passe-câbles et y visser la cosse de bougie.
Remettre le connecteur en place sur le nouveau générateur d'étincelles, rebrancher la bougie.

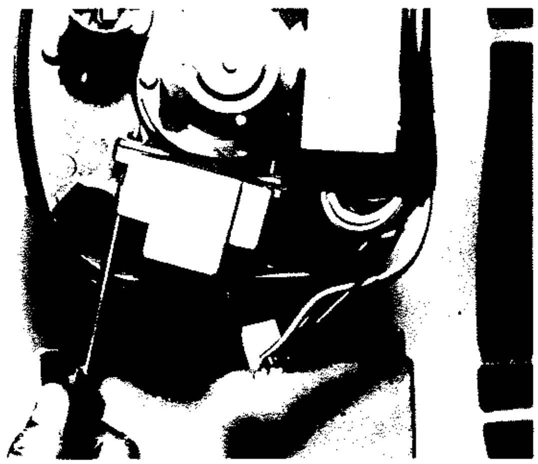


Figure 5

6°) Dépose/Repose du coffret de commande

Retirer le couvercle.
Oter les deux connecteurs présents sur le coffret.
Enlever celui-ci de son équerre de fixation et le remplacer par un coffret neuf.

Attention:
A la repose d'un coffret de commande neuf, munir celui-ci d'un fusible moteur (à commander séparément).

N° de commande du fusible moteur:
12 V = 25 1570 05 01 00
24 V = 25 1531 05 02 00

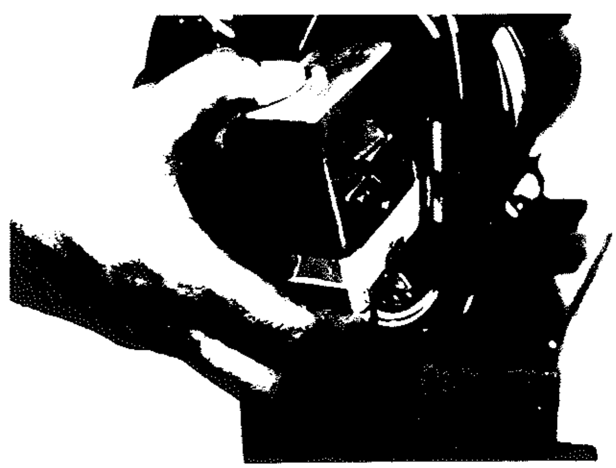


Figure 6

Procédures de réparations

1°) Dépose/Repose de la bougie
2°) Dépose/Repose du commutateur de surchauffe
3°) Dépose/Repose du régulateur
4°) Dépose/Repose du thermostat
5°) Dépose/Repose du générateur d'etincelles
6°) Dépose/Repose du coffret de commande
7°) Dépose/Repose de la résistance série
8°) Dépose/Repose du moteur électrique
9°) Dépose/Repose des diodes de la pompe à eau
10°) Dépose/Repose des relais de bougie et de pompe à eau
11°) Dépose/Repose de la tête de brûleur
12°) Dépose/Repose du détecteur de flamme

1°) Dépose/Repose de la bougie

Desserrer l'écrou moleté et retirer le puits de câbles.
Oter le capuchon de bougie et débrancher le câble d'allumage.
Dévisser la bougie (Clé de 22).
Après avoir examiné visuellement la bougie ou après l'avoir contrôlée à l'aide d'un ohmmètre, la remettre en place ou, le cas échéant, la remplacer par une bougie neuve.

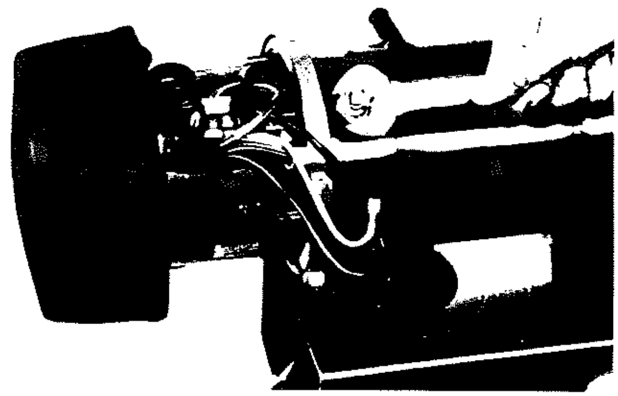


Figure 1

2°) Dépose/Repose du commutateur de surchauffe

Desserrer l'écrou moleté et retirer le puits de câbles.
Débrancher le câble du connecteur.
Dévisser le commutateur de surchauffe (Cle de 16) et le remplacer.

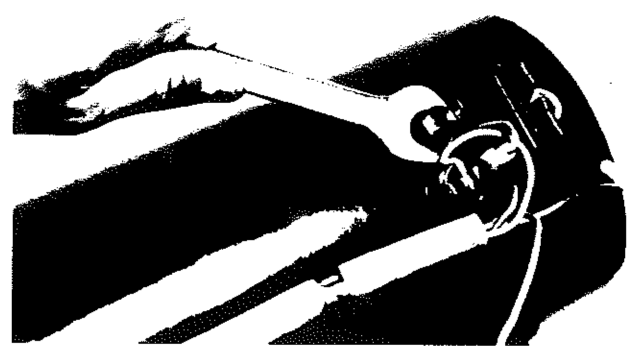


Figure 2

3°) Dépose/Repose du régulateur

Desserrer l'écrou moleté et retirer le puits de câbles.
Débrancher le câble du connecteur.
Dévisser le régulateur (Cle de 16) et le remplacer.

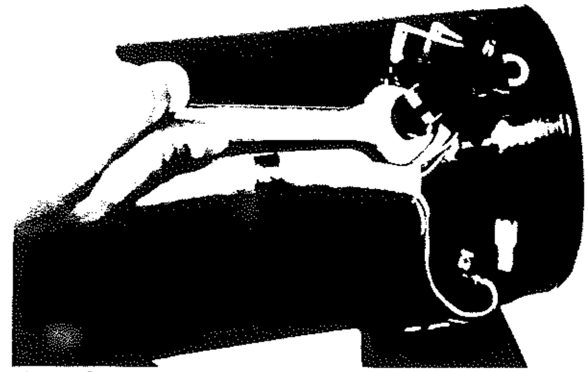


Figure 3

Dépistage de pannes D 12 W

Dépistage et élimination de pannes

Eberspächer

J. Eberspächer
Eberspächerstr. 24
D-7300 Esslingen
Telefon (zentral)
(07 11) 3109-0
Telefax
(07 11) 3109-5 00

Valable pour les modèles d'appareils:

25 1570 01 00 00 12 V[1]
25 1571 01 00 00 24 V[1]

25 1655 01 00 00 12 V[2]
25 1656 01 00 00 24 V[2]

1) Version avec thermostat

2) Version avec détecteur de flamme

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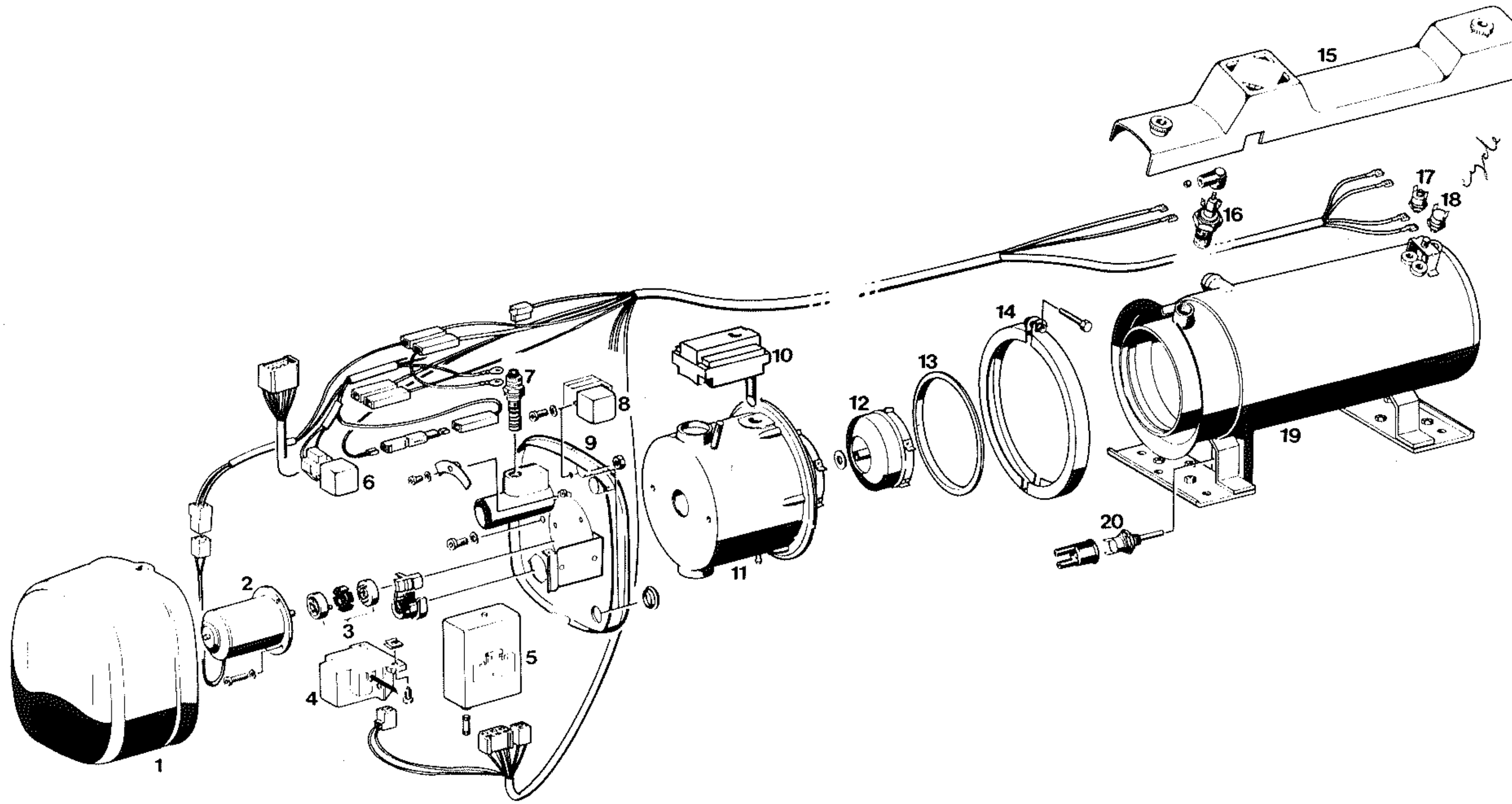
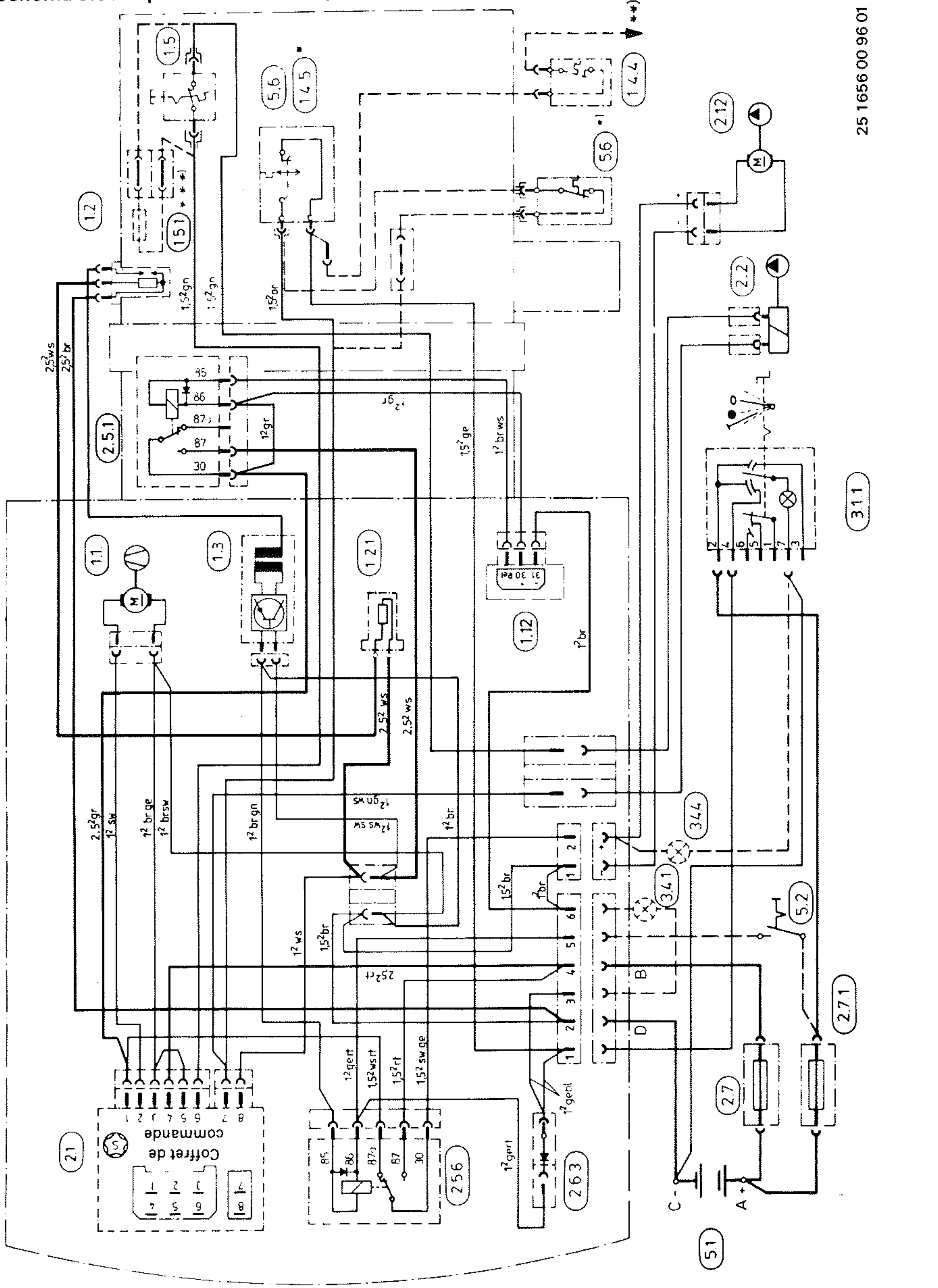


1 Couvercle
2 Moteur électrique
3 Couplage
4 Générateur d'etincelles
5 Coffret de commande
6 Relais de bougie
7 Résistance série
8 Relais de la pompe à eau
9 Plaque-support
10 Détecteur de flamme (modèles D12W 25 1655/56)

11 Brûleur
12 Gicleur
13 Joint d'étanchéité
14 Collier profilé
15 Puits de câbles
16 Bougie
17 Commutateur de surchauffe
18 Commutateur du régulateur
19 Echangeur de chaleur
20 Thermostat (modèles D12W 25 1570/71)

Schéma électrique D 12 W 12/24 V (Modèle 25 1655/56 avec détecteur de flamme)



Nomenclature des pièces (voir schéma)

1.1	Moteur du brûleur
1.2	Bougie
1.2.1	Résistance série de la bougie
1.3	Générateur d'etincelles
1.4.4	Thermostat de soufflerie du véhicule (optionnel)
1.4.5	Commutateur du régulateur
1.5	Commutateur de surchauffe
1.5.1	Fusible de surchauffe
1.12	Détecteur de flamme
2.1	Coffret de commande
2.2	Pompe de dosage de carburant
2.5.1	Relais de bougie
2.5.6	Relais de la pompe à eau
2.6.3	Diode de la pompe à eau
2.7	Fusible principal 16A
2.7.1	Fusible du dispositif d'opération 8A
2.12	Pompe à eau
3.1.1	Commutateur universel
3.4.1	Indicateur de service
3.4.4	Indicateur de service de la pompe à eau
5.1	Batterie
5.2	Commutateur de commande distincte de la pompe à eau
5.6	Régulateur de la température d'eau (optionnel)

* externe, pos. 5.6 (option)
intégré, pos. 1.4.5 (option)
** vers le relais de la soufflerie du véhicule
*** pos. 1.5.1 ou 1.5, au choix

A...B = L +
C...D = L –
(L+) + (L–) = L total

rt = rouge
br = marron
ws = blanc
sw = noir
gn = vert
ge = jaune
vi = violet

Fonctionnement de l'installation
Constitution et fonctionnement:

La pompe de circulation d'eau fonctionne tant que l'appareil est en service, même pendant les périodes où le brûleur est arrêté du fait du thermostat e celles où l'appareil continue de tourner après avoir été arrêté. Il est également possible de faire tourner la pompe indépendamment de l'appareil, à l'aide de la commande spéciale prévue à cet effet.

L'appareil peut être mis ou remis en marche à tout moment (par conséquent même s'il n'a pas fini de tourner aprés un premier arrêt, mais l'allumage ne reprendra alors qu'après la fin de cette phase de post-fonctionnement).

Mise sous tension de l'appareil:
A la mise sous tension, le voyant de contrôle s'allume. De l'air comburant vient balayer la chambre de combustion du brûleur, tandis que la pompe de circulation d'eau se met en route. La pompe de dosage de carburant encoie dans la chambre de combustion une quentité de carburant exactement dosée. Le carburant et l'air comburant forment alors un mélange inflammable que la bougie met à feu.

Dés que le détecteur de flamme a informé le coffret de commande qu'il à perçu une flamme, c'est-à-dire que la combustion est en cours, la bougie de réchauffage et d'allumage et excitateur d'allumage se ra désactivée.

A l'extrêmité du tube à feu, les gaz brûles chauds sont déviés; ils viennent balayer les faces de chauffage indirect de l'échangeur de chaleur, par l'intermédiaire duquel ils transmettent leur chaleur à l'eau qui le parcourt.

L'appareil est thermostaté et fonctionne en régime intermittent; plus précisément, le brûleur fonctionne pendant les laps de temps plus ou moins longs suivant les besoins en chaleur. La température de l'eau dépend du réglage thermostatiqe choisi.

La liaison entre brûleur et échangeur de chaleur est conçue de manière à pouvoir déposer complètement le brûleur.

Il suffit de déposer le capot de protection pour accéder facilement à l'ensemble de l'installation électrique (vérifications et opérations d'entretien).

En déposant la gaine électrique placée longitudinalement, on accède à la bougie, detecteur de flamme, à la thermostat et au coupe-circuit anti-surchauffe.

Arrêt du chauffage:
L'arrêt de l'appareil a pour effet de stopper l'arrivée de carburant. La flamme s'éteint, mais l'appareil continue de tourner pendant environ 2,5 minutes (phase de post-fonctionnement). Pendant ce temps, l'air comburant aspiré de l'extérieur purge la chambre de combustion des résidus de gaz brûlés tout en refroidissant les perties chaudes du côté "gaz brûlés" de l'échangeur de chaleur; de son côté, la pompe de circulation d'eau, qui continue de tourner, se charge d'évacuer la chaleur subsistant dans l'échangeur, ce qui exclut tout risque de suréchauffement localisé.

A la fin de la phase de post-fonctionnement, la turbine d'air comburant et la pompe de circulation d'eau s'arrêtent automatiquement.

Dispositifs de sécurité:

Contrôle de présence de la flamme:
La présence de la flamme est contrôléen en permanence par le détecteur de flamme, dont dépent le coupe-circuit de sécurité qui procoque l'arrêt de l'appareil en cas d'incident.

Arrêt automatique en cas d'absence d'étincelle ou d'extinction de la flamme:
Si l'appareil n'allume pas, il est mis automatiquement hors tension au bout de 3 minutes au maximum.

Si pendant le fonctionnement de l'appareil la flamme vient à s'éteindre spontanément, l'arrivée de carburant est coupée automatiquement au bout de 4 minutes au maximum.

En cas d'incident imputable au moteur de turbine, le coupe-circuit "courant moteur" incorporé au coffret de commande automatique met l'appareil hors tension.

Surchauffe et température correspondant à la commande de réglage final:
En cas de surchauffe de l'appareil (due par exemple à une insuffisance d'eau), le coupe-circuit anti-surchauffe coupe l'arrivée de carburant, et l'appareil s'arrête automatiquement à la fin de la phase de post-fonctionnement (environ 2,5 minutes).

Lorsque la température de l'eau atteint la température commandée à l'aide du réglage final, le thermostat coupe et tétablit alternativement l'appareil, de manière à maintenir cette température à peu près constante.

En cas de panne, d'abord vérifier:

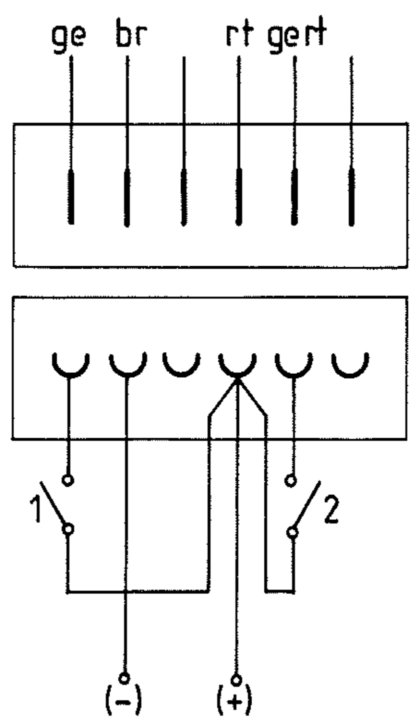
(Il n'est pas tenu compte des points suivants dans les instructions de dépannage, d'où il s'avère utile de procéder, par principe, à leur vérification).

1°) Mauvais branchement, court-circuit, faux-contact
2°) Bornes oxydées
3°) Tension de batterie insuffisante (inférieure à 10,5 ou 21 V, mesurée au connecteur à 6 broches entre les bornes 4 et 2)
4°) Détérioration mécanique d'éléments
5°) Révervoir de carburant vide

Réalisation d'un câble de contrôle

Au cas où l'origine de la panne ne proviendrait pas de l'un des points ci-dessus, il faut alors procéder au dépistage systématique, auquel cas il est alors recommandé de se bricoler un câble de contrôle. A l'aide de celui-ci, il est alors aisé de déceler, du moins grossièrement, l'élément défaillant: appareil de chauffage lui-même, y compris le coffret de commande, alimentation en carburant ou éléments de régulation et d'opération.
Aprés avoir enlevé le boîtier du connecteur à 6 broches, raccorder le câble de contrôle sur ce dernier, à la place du dispositif d'opération. Au vu du schéma de dépistage de panne, contrôler alors le bon fonctionnement de l'appareil. Ceci une fois établi, retirer le câble de contrôle, rebrancher le dispositif d'opération et poursuivre la procedure de dépistage en fonction du schéma.

Câble de contrôle D12W



1 Allumeur
2 Commutateur de la pompe à eau

Dépistage de panne

Dérangement constaté →

Cause probable ↓

Cause probable	Soufflerie toujours pas audible, 5 secondes environ après la mise en marche	La soufflerie se met en marche env. 5 secondes après son enclenchement, puis s'arrête automatiquement au bout de 5 nouvelles secondes	La soufflerie se met normalement en marche, et la pompe cliquète. Extinction automatique au bout de 3 minutes	La soufflerie se met normalement en marche, sans que la pompe ne cliquète. Extinction automatique au bout de 3 minutes	L'appareil fonctionne, mais sans chauffer	Flux thermique insuffisant ou extinction automatique de l'appareil de chauffage	Le chauffage fume et encrasse	Après avoir éteint l'appareil, la soufflerie continue de fonctionner au-delà de son temps normal (3 à 4 minutes) inertiel
Fusible principal (16A) grillé	○							
Bougie (GZE 201) encrassée/défectueuse			○					
Fusible du moteur grillé, dans le coffret de commande	○							
Commutateur de surchauffe a réagi					○			
Générateur d'étincelles défectueux			○					
Résistance série (bougie) défectueuse			○					
Sous-tension		○						
Surtension		○			○			
Le coffret de commande n'émet d'impulsions de commande de la pompe de dosage				○				
Pas de contact au relais Reed du coffret de commande		○						
Allumeur, minuterie ou commutateur de régulation défectueux	○							
Le relais de bougie colle (D 12 W 25 1570/71 avec thermostat)			○					
Electronique défectueuse (D 12 W 1655/56 avec détecteur de flamme)								○

Examiner/Vérifier	Remède
Contrôle visuel ou avec un ohmmètre	Eliminer un court-circuit éventuel, nettoyer l'encrassement du filament de la bougie, ou remplacer éventuellement celle-ci
Contrôle visuel ou avec un ohmmètre	Remplacer éventuellement la bougie
Contrôle visuel ou avec un ohmmètre	Eliminer les dégats éventuellement causés par l'air de combustion, par le moteur ou par la soufflerie, remplacer le fusible du moteur
Eteindre l'appareil de chauffage, contrôler le débit de l'eau (au moins 1000 l/h)	Purger l'air présent dans le circuit d'eau de refroidissement. Déclencher le commutateur de surchauffe
Maintenir le câble de haute tension à env. 5 mm de la masse	Remplacer éventuellement le générateur d'etincelles
Contrôle visuel ou avec un ohmmètre	Remplacer éventuellement la résistance série
Mesurer la tension au connecteur à 6 broches, entre les bornes 4 et 2. Tension minimum: 10,5 ou 21 V	Recharger la batterie. S'assurer que tous les branchements n'occasionnent pas de pertes de tension
Mesurer la tension au connecteur à 6 broches, entre les bornes 4 et 2. Tension maximum: 14,5 ou 29 V	Vérifier le régulateur de la génératrice, remplacer éventuellement
Raccorder une lampe-témoin aux contacts de la pompe de dosage et à la borne 6 du coffret de commande. En cas d'absence d'impulsions ...	... remplacer le coffret de commande
Déterminer la panne	Remplacer le coffret de commande
Contrôle visuel ou avec un ohmmètre	Remplacer éventuellement le dispositif d'opération
Contrôler le fonctionnement du relais	Remplacer éventuellement le relais de bougie
Déterminer la panne	Remplacer le détecteur optique de flamme

Dépistage de panne

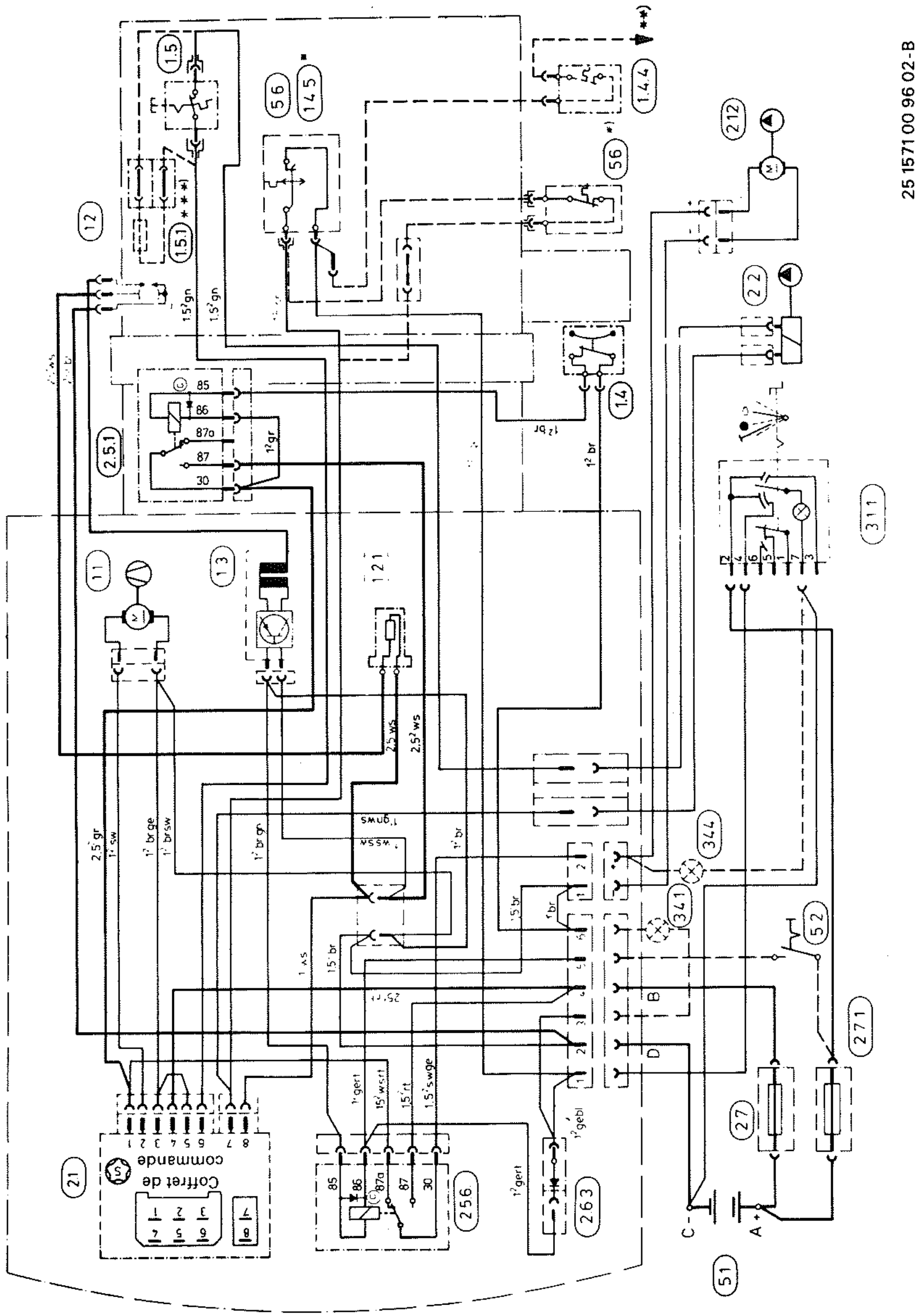
Dérangement constaté →

Cause probable ↓

Cause probable	Soufflerie toujours pas audible, 5 secondes environ après la mise en marche	La soufflerie se met en marche env. 5 secondes après son enclenchement, puis s'arrête automatiquement au bout de 5 nouvelles secondes	La soufflerie se met normalement en marche, et la pompe cliquète. Extinction automatique au bout de 3 minutes	La soufflerie se met normalement en marche, sans que la pompe ne cliquète. Extinction automatique au bout de 3 minutes	L'appareil fonctionne, mais sans chauffer	Flux thermique insuffisant ou extinction automatique de l'appareil de chauffage	Le chauffage fume et encrasse	Après avoir éteint l'appareil, la soufflerie continue de fonctionner au-delà de son temps normal (3 à 4 minutes) inertiel
La pompe de dosage du carburant n'alimente pas				○				
La pompe de dosage débite trop de carburant							○	
La pompe de dosage ne débite pas assez de carburant			○			○		
Fuite dans le circuit d'alimentation en carburant. Filtre colmaté. Présence d'air dans le circuit			○			○		
Amenée d'air de combustion ou évacuation des gaz brûlés bouchée							○	
Vitesse de rotation trop faible de la soufflerie d'air de combustion							○	
Moteur électrique défectueux	○							
Dégâts de la soufflerie (d'air de combustion)	○							
Le thermostat ne fonctionne pas (D12W 25 1570/71)			○					
Le détecteur de flamme ne fonctionne pas (D12W 25 1655/56)			○					

Examiner/Vérifier	Remède
Raccorder une lampe-témoin aux contacts de la pompe de dosage. En cas de présence d' impulsions ...	... remplacer la pompe de dosage de carburant
Mesurer le débit de carburant. Si celui-ci est en dehors des tolérances mini/maxi prescrites ...	... remplacer la pompe de dosage de carburant
Mesurer le débit de carburant. Si celui-ci est en dehors des tolérances mini/maxi prescrites ...	... remplacer la pompe de dosage de carburant
Contrôle visuel	Etanchéifier et/ou purger le circuit d'alimentation en carburant. Remplacer le filtre
Contrôle visuel	Eliminer le ›bouchon‹
Mesurer les révolutions de l'arbre moteur	Remplacer le moteur électrique
Si l'arbre principal du moteur électrique <u>ne</u> peut être tourné ...	... remplacer le brûleur
Si l'arbre principal du moteur électrique peut être tourné ...	... remplacer le moteur électrique
Le thermostat est défectueux si, au bout de 120 secondes après la mise en marche de l'appareil, une tension négative est toujours présente sur la borne 85 (relais de bougie)	Remplacer le thermostat
Nettoyer avec un chiffon doux le bâton de quartz du détecteur de flamme. Si celui-ci ne fonctionne toujours pas ...	Remplacer le détecteur optique de flamme

Schéma électrique D 12 W 12/24 V (Modèle 25 1570/71 avec thermostat)



Nomenclature des pièces (voir schéma)

1.1 Moteur du brûleur
1.2 Bougie
1.2.1 Résistance série de la bougie
1.3 Générateur d'etincelles
1.4 Thermostat
1.4.4 Commutateur de soufflerie (optionnel)
1.4.5 Thermostat interne de température d'eau
1.5 Commutateur de surchauffe
1.5.1 Fusible de surchauffe

2.1 Coffret de commande
2.2 Pompe de dosage de carburant
2.5.1 Relais de bougie
2.5.6 Relais de la pompe à eau
2.6.3 Diode de la pompe à eau
2.7 Fusible principal 16A
2.7.1 Fusible du dispositif d'opération 8A
2.12 Pompe à eau

3.1.1 Commutateur universel
3.4.1 Indicateur de service
3.4.4 Indicateur de service de la pompe à eau

5.1 Batterie
5.2 Commutateur de commande distincte de la pompe à eau
5.6 Thermostat externe de température d'eau (optionnel)

* externe, pos. 5.6 (option)
intégré, pos. 1.4.5 (option)
** vers le relais de la soufflerie du véhicule
*** pos. 1.5.1 ou 1.5, au choix

A . . . B = L +
C . . . D = L –
(L+) + (L–) = L total

rt = rouge
br = marron
ws = blanc
sw = noir
gn = vert
ge = jaune
vi = violet

23

ACCESSORIES

CONTENTS OF THIS SECTION

HUBODOMETER . . . . 23 - 1
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INVERTER . . . . 23 - 3
KEYLESS DOOR ENTRY SYSTEM (V.I.P. model only) . . . . 23 - 3
BACK-UP CAMERA . . . . 23 - 3
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MONITOR . . . . 23 - 5
TACHOGRAPH . . . . 23 - 5
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LAVATORY . . . . 23 - 9
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HUBODOMETER

Description

An optional wheel hubodometer (see fig. 1) may have been installed on the R.H. side of the drive axle. It indicates the total distance in miles or kilometers covered by the coach since it has left the factory, including road testing.

Operation

The hubodometer is calibrated for a specific wheel size (diameter). Wheel rotation causes a mechanism inside the hubodometer to record distance after a predetermined number of rotations. The unit should be serviced at a competent speedometer repair facility.

Hubodometer removal

To remove the unit, remove the two nuts and lock washers securing it to the wheel hub, then pull the unit off the studs.

Hubodometer installation

Place the hubodometer unit over the wheel hub studs. Replace the lock washers and nuts. Torque stud nuts to 110-165 lbf•ft (150-225 N•m).

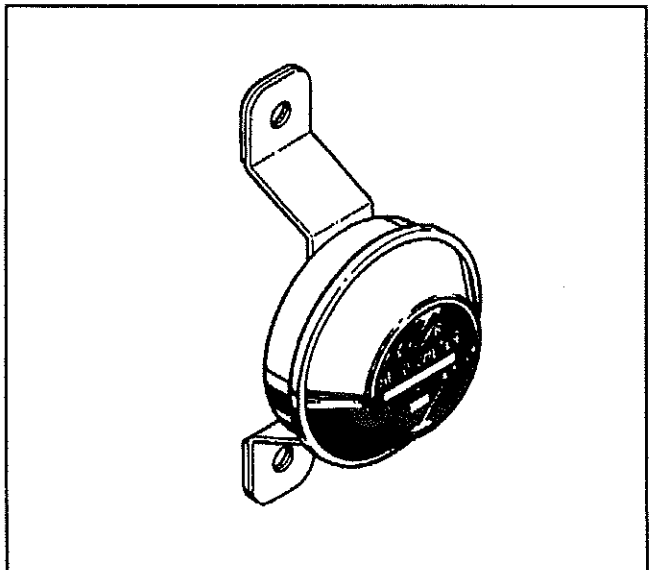


Fig. 1 - Hubodometer MA3E2301

SOUND SYSTEM

Twelve Hi-Fi speakers in passenger section, a PA system with volume control and one microphone oultet mounted in driver's area are provided as standard equipment. A *"Blaupunkt"* AM/FM radio cassette player, two additional Hi-Fi speakers in driver's area, as well as different microphone outlets may have been installed as optional equipment.

NOTE: Before attempting to solve an electrical problem on the sound system, refer to diagram #21/25 of the master wiring diagrams and to the *"Sound system troubleshooting"* later in this section.

AM/FM radio cassette player

Instructions for proper use of the radio are included in the *"Blaupunkt Owner's Manual"* which is provided in the technical publications box delivered with the vehicle. The radio is a serviceable component and should only be serviced by a qualified electronics technician. Refer to *"Blaupunkt Service Centers"* guide included in the technical publications box. Before requesting any service from a qualified technician, check that the 5 amp radio protection fuse mounted in back of the radio and accessible only when radio is slid out from its support, is in good condition.

To remove the radio from its location, proceed as follows:

1. Remove the four Phillips-head screws retaining the R.H. lower control panel to the dashboard.
2. Carefully pull out panel slightly from dashboard, then unscrew wing nut retaining radio to its support (refer to fig. 2).
3. Hold panel firmly while pulling on the handle to slide radio out.

To reinstall, reverse removal procedure.

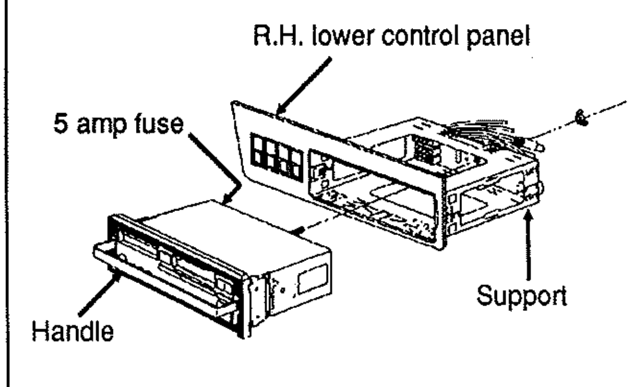


Fig. 2 - AM/FM radio cassette player MA3E2302

AM/FM radio cassette player protection code

The radio protection code has not been programmed in factory. However, operator may, at his convenience, program the antitheft protection code following instructions given in the *"Blaupunkt Owner's Manual"* under heading *"Reinstalling your code"*.

Amplifier

A 80 watt amplifier is provided for the sound system. It is located over the driver's compartment and on front of the left parcel rack (see fig. 3). Remove the amplifier as follows:

1. Set the battery main disconnect switches to the *"OFF"* position.
2. From the driver's compartment, locate the driver's dome light panel (see fig. 3).
3. Remove the four snap caps and retaining screws from the driver's dome light panel, remove panel from its location and let it hang by the wires.
4. Remove the four screws retaining the amplifier to its mounting bracket, disconnect wiring connectors from both sides of amplifier, then remove amplifier from its location.
5. Reverse the above procedure to install the amplifier.

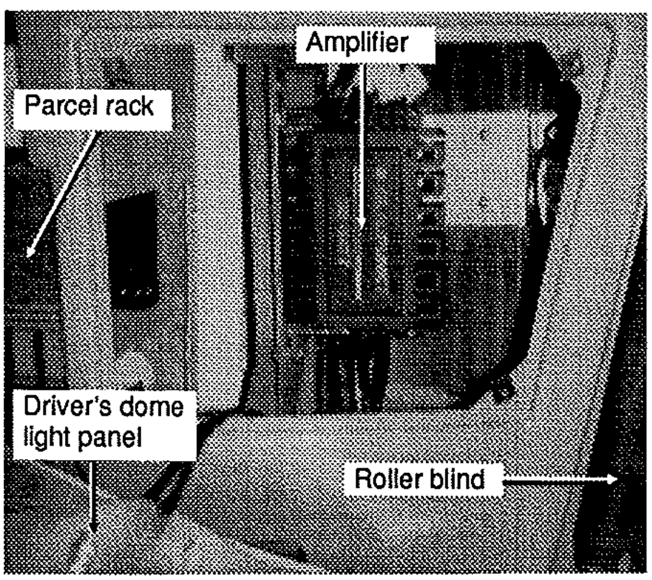


Fig. 3 - (View from under) MA3E2303

Public address system control box (PA)

The public address system control box is located in the left corner at driver's feet. A one ampere cartridge-type fuse is mounted in an external holder of the box and may be checked without removing the box from its location (see fig. 4). To remove the fuse, unscrew the fuse cap, then remove the fuse from its holder with the cap as the cap is removed. The fuse may then be pulled out from the cap. Always replace a fuse with a fuse of the same type and rating.

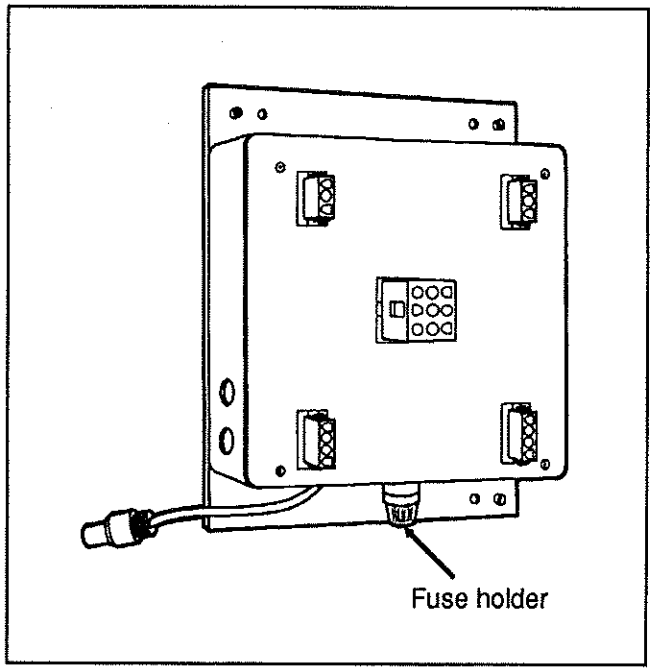


Fig. 4 - PA system control box MA3E2304

SOUND SYSTEM TROUBLESHOOTING

MALFUNCTION	POSSIBLE CAUSE	CORRECTIVE MEASURE
High-frequency continuous noise	Speaker circuit grounded to the structure	Locate and insulate wire grounded to the structure
Extensive difference between driver's and passenger's speakers when speaker selection switch is activated	*"Fader"* incorrectly set	Push radio *"Fader"* control and turn to set required balance
Malfunction of additional microphone outlet(s)	May be incorrect wiring between microphone outlet(s)	Check interconnection between microphone outlet(s)

INVERTER

The vehicles equipped with the optional video system and TV monitors are provided with an inverter which is recessed in the upper R.H. wall of the first R.H. baggage compartment. The inverter is used to convert the 12 V DC into 120 V AC. Two 20 ampere cartridge-type fuses, easily replaceable, are mounted in the front panel external holders, while a 4 ampere fuse, located inside the inverter, is accessible once the rear panel has been removed. A troubleshooting guide and an internal component wiring diagram of the inverter are included in the leaflets entitled *"Powerverter Operating and Installation Instructions"*, which are included in the technical publications box delivered with the vehicle.

WARNING: Some earlier models of inverter may be provided with a large capacitor mounted on the back of the unit. Never short-circuit its two terminals as it will result in personal injuries.

KEYLESS DOOR ENTRY SYSTEM (V.I.P. model only)

The keyless entry system has two main components:

1. A five-button keypad on the outside panel of the entrance door.

2. An electronic microprocessor/relay module mounted on top of the defroster unit.

The factory-programmed code is permanently recorded on a plastic card (credit card size) which is supplied to the owner, and on a decal which is affixed on the electronic microprocessor/relay module mounted on defroster unit. Owner can also select and program its own personal code (e.g. a birthday or part of a social security number) by pressing a specified sequence of keypad buttons. Refer to *"Owner's Manual"* for instructions on how to program a new code and for any operation information relating to the keyless door entry system.

CAUTION: Never press on the keypad buttons with a key, a pencil or any sharp object. Such objects could damage the buttons. Although each button is provided with two digits separated by a vertical line, there is only one contact per button. Press in center of button, i.e. between the two digits where there is the vertical line.

Before attempting to solve an electrical problem on the keyless door entry system, refer to diagram #19/22 of the master wiring diagrams (V.I.P. model).

CAUTION: Do not tamper the electronic microprocessor/relay module seal during the vehicle warranty period as it will void its warranty.

BACK-UP CAMERA

General description

A back-up camera and monitor may have been installed as optional equipment. When the driver selects the reverse range, the camera and monitor will automatically switch on, thus allowing driver to view behind the vehicle, and they will automatically switch off after the reverse range has been released. On V.I.P. model, the camera and monitor may also be switched on using the rocker switch provided on L.H. side control panel in driver's area.

The camera is retractable and is visible from the outside only when it is functioning. A switch mounted on the R.H. side of rear junction box enables the extension of the camera for maintenance or cleaning purpose. The camera enclosure is insulated with a thick foam, and a heating strip (52 watts) is wound around the camera and is controlled by a thermal switch. The camera is fed from the 12 volt circuit; for specific wiring information, refer to diagram #19/25 of the master wiring diagrams.

Maintenance

Instructions for proper use of the camera are included in the *"Operating Instructions"* manual provided in the technical publications box delivered with the vehicle. The adjustments or repairs of the camera should only be done by qualified video service personnel. Remove the camera from its location as follows:

1. Set battery main disconnect switches to the *"ON"* position.

WARNING: Set the remote control switch in engine compartment to the *"OFF"* position to prevent accidental move of the vehicle by another person.

2. Set the camera service switch (mounted on the R.H. side of rear junction box) to the *"ON"* position in order to extend the back-up camera.
3. Working from outside of vehicle, remove the wave pin from the clevis pin of the camera air cylinder extension rod, then slide out clevis pin.
4. Open and block the camera hinged panel assembly to its maximum position.
5. Using a 7 mm wrench, remove the four bolts securing the camera hinged panel assembly to the rear cap, while retaining panel to prevent it from falling off vehicle. Carefully lower the camera hinged panel to disconnect the coaxial cable and wire connectors from rear cap.
6. Lay the camera hinged panel assembly on a clean work bench.
7. Remove the four bolts retaining the camera mounting plate to its enclosure (see fig. 5).
8. Remove the two center bolts to separate camera from its mounting plate.
9. Disconnect coaxial cable from camera, then disconnect wires from camera and thermal switch.
10. Send the camera to a qualified video service center.

Reverse the above procedure to reinstall the camera.

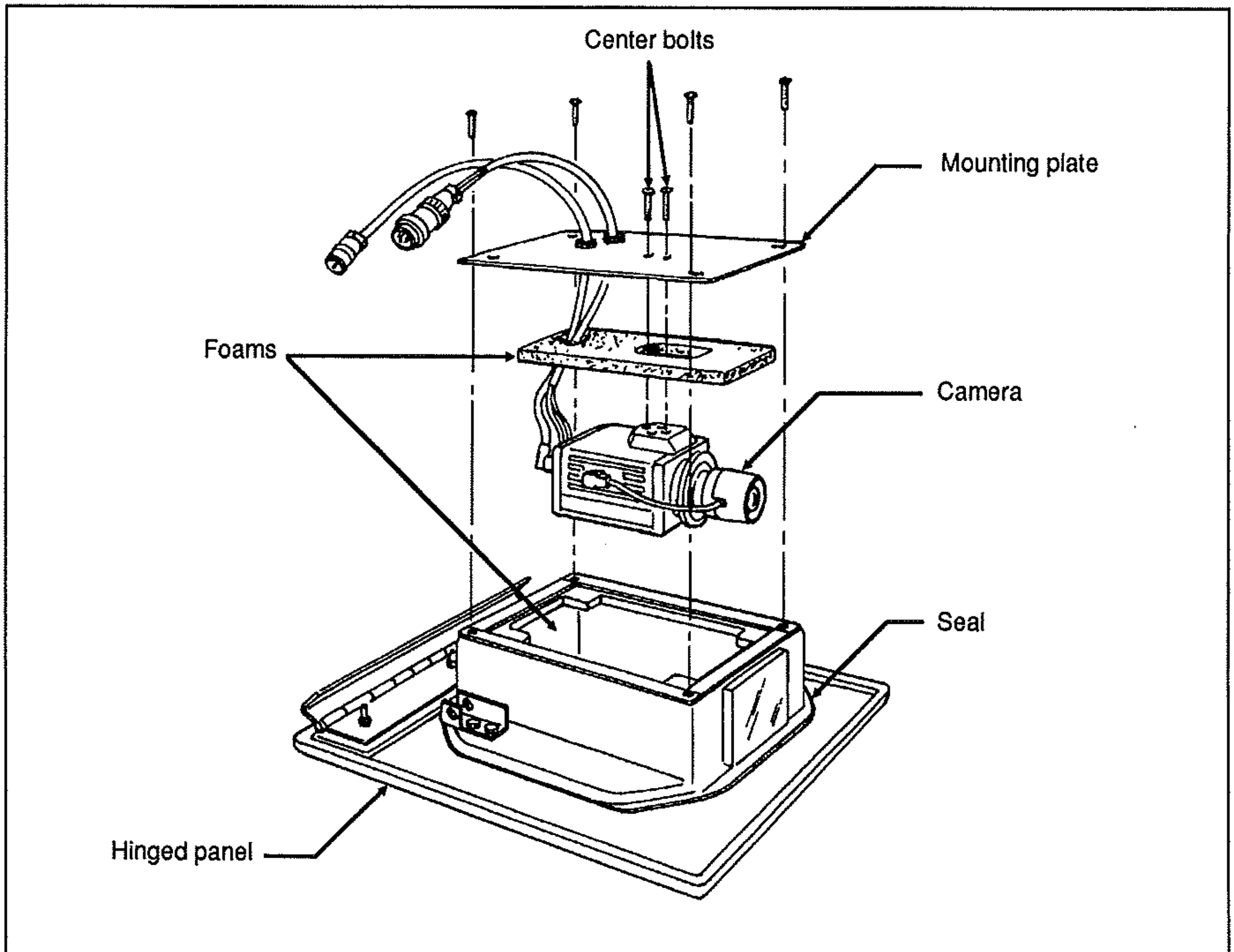


Fig. 5 - Back-up camera disassembly

MAE32305

MONITOR

General description

On vehicles equipped with the optional back-up camera, a monitor is mounted on the R.H. dashboard control panel; brightness and contrast controls located over the monitor enable the adjustment of the monitor as required. The monitor operates on a 5 volt tension, and is connected to a 12-5 volt transformer which is located in the *"Alarm junction box"*. For specific wiring information, refer to diagram #19/25 of the master wiring diagrams.

Maintenance

Repair of the monitor should only be done by a qualified service center. Remove the monitor from its location as follows:

1. Set battery main disconnect switches to the *"OFF"* position.
2. From driver's compartment, remove both snap caps and retaining screws, one on each side of dash cover, then remove the dash cover.
3. Disconnect the black connector from the top of monitor (see fig. 6).
4. Disconnect the 6 pin connector located behind the monitor.
5. Remove both screws on top of monitor bracket, then remove both screws, one on each side of monitor (see fig. 6).
6. Remove carefully the monitor from its location.

Reverse the above procedure to reinstall the monitor.

TACHOGRAPH

General description

The multi-purpose tachograph, which is available as optional equipment, includes the following items:

Speedometer

Indicates driving speed in mph and km/h.

Odometer

Indicates the accumulated vehicle distance in miles or kilometers.

Tachometer

Indicates engine speed in hundreds of revolutions per minute (rpm).

Clock

Operates even if the battery main disconnect switches are set to the *"OFF"* position.

Speed indicator light

Lights when speed specified by the owner has been reached.

Paper recording

The paper recording of speedometer and tachometer data is available in a 24 hour or seven day period format.

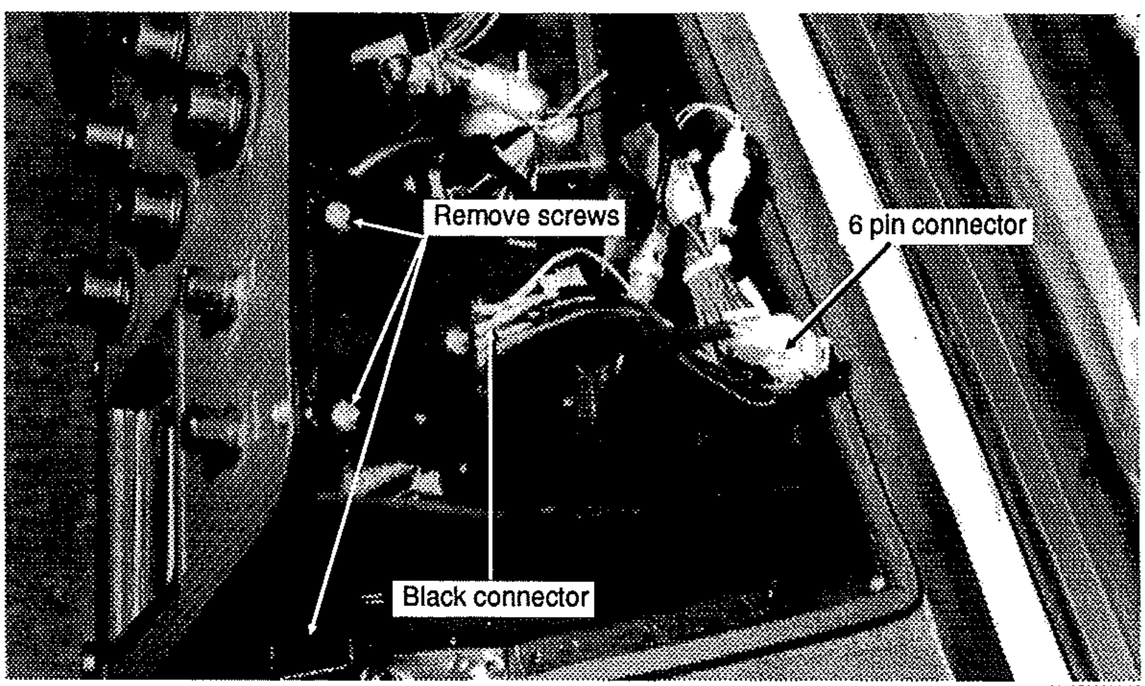


Fig. 6

Maintenance

To change card inside tachograph, open the tachograph cover using the key provided; lift the card retaining tab, and replace card with the mph or km/h side facing the tab, then replace retaining tab and close cover.

CAUTION: Do not run engine without card or with damaged card in tachograph as it may damage tachograph mechanism. Install a dummy plastic card (Prevost part #59-0251) when vehicle has to be operated without a regular tachograph card.

To reset the clock, open the tachograph cover using the key provided, and turn the adjustment roller on L.H. side of tachograph.

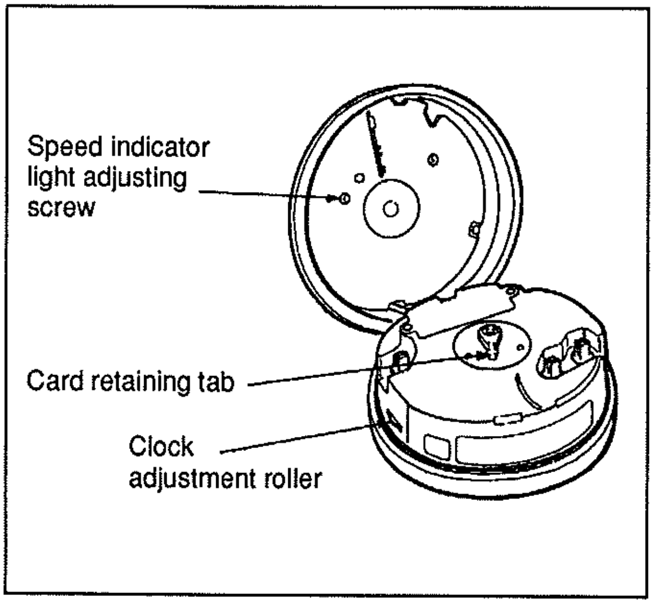


Fig. 7 - Tachograph

COLD STARTING AID (ETHER)

The vehicle is equipped with an ether cold starting aid designed to ease engine starting when temperature is below 35 °F (2 °C). A manually-operated type is installed as standard equipment, while an electrically-operated type is available as optional equipment.

Manually-operated type

On vehicles equipped with a manually-operated cold starting aid, the system consists simply of a starting fluid cup which is located on top of the air intake duct. To use cold weather starting fluid, lift cover of the starting fluid cup, insert one 7 cc capsule, shut cover tightly, and then start engine from engine compartment. Be sure to remove empty capsule before inserting a new one.

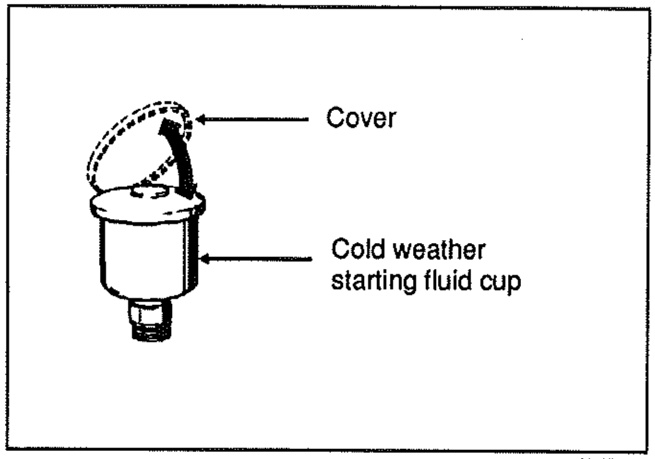


Fig. 8

CAUTION: This practice should be performed only when absolutely necessary. If required, we recommend that the starting fluid be used only in 7 cc capsule form, one at the time. Excessive use of fluid could result in serious engine damage.

WARNING: FIRE HAZARD - Starting fluid used in the capsules is highly flammable, toxic, and possesses sleep-inducing properties. Do not smoke while using or handling capsules, and keep away from flame or high temperatures. Avoid inhaling fumes produced by starting fluid.

Electrically-operated type

On vehicles equipped with an electrically-operated cold starting aid, the system consists of the main following parts:

- Ether starting aid switch
- Ether cylinder
- Solenoid valve (24 V)
- Thermal cutout valve
- Atomizer

The control rocker switch is located near the ignition switch on the L.H. lower switch panel. This switch is provided with a locking mechanism to avoid accidental use when engine is running. To activate the ether starting aid, proceed as follows:

1. Prior to cranking engine, slide down lock tab while pressing rocker switch for three seconds to fill solenoid valve.
2. Release switch to discharge shot.
3. Allow three seconds for shot to discharge.
4. Start engine, use additional shots if necessary to keep engine running.

CAUTION: This pratice should be performed only when absolutely necessary. Excessive use of fluid could result in serious engine damage.

The ether cylinder and solenoid valve assembly are mounted on the engine compartment wall (under booster block) and are accessible from the engine compartment R.H. side door.

The thermal cutout valve is mounted on the engine L.H. thermostat housing (air filter side); its function is to prevent discharge of ether when engine is warm (over 90 °F (32 °C)). An atomizer is installed on top of air intake duct (refer to fig. 9).

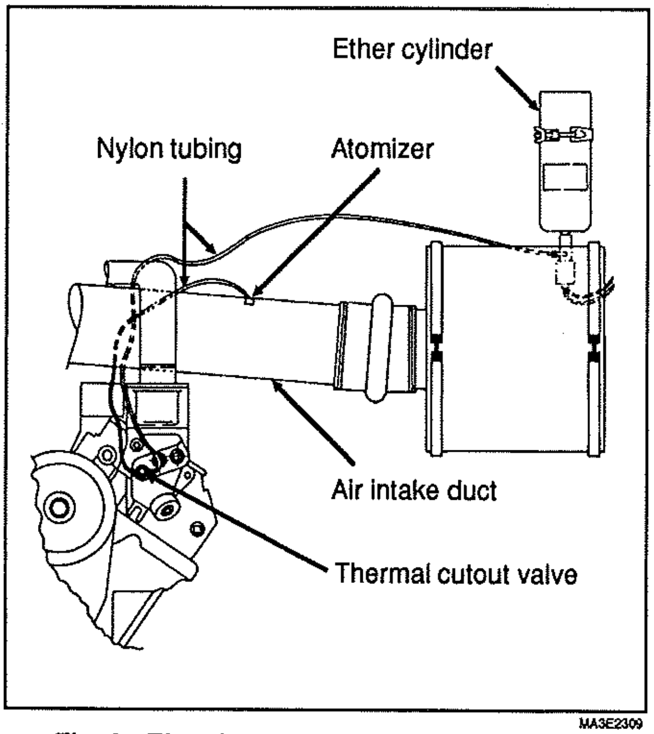


Fig. 9 - Electric cold starting aid installation

Preventive maintenance

During the summer months, remove cylinder to avoid high temperature actuation of the cylinder safety relief device. Always screw valve cap into solenoid valve opening to prevent entrance of road dirt. When removing cylinder, be careful to prevent dirt from entering the valve.

Troubleshooting (if system is non-functioning)

WARNING: During the following test, direct free end of tube away from personnel and all sources of ignition as this fuel is extremely flammable. Avoid breathing vapors and contacting fuel with skin. Never smoke during test.

1. Check cylinder for hand tightness and fuel supply. Empty cylinder weight is approximately 17 oz (480 g); full cylinder weight is approximately 35 oz (990 g). If cylinder is empty, replace it. Before replacing cylinder, install new valve gasket in solenoid valve.

2. If still not functioning, disconnect tubing at solenoid valve fitting. Actuate solenoid valve. (Ask an assistant to actuate solenoid valve by means of the rocker switch on the dashboard.)

- If solenoid valve is non-functioning, check electric circuit, (refer to diagram #4/25 of the master wiring diagrams); if sound, remove and replace the solenoid valve; if not, repair electric circuit.

- If valve is functioning, reassemble valve fitting and connect tube. Disconnect tube at thermal cutout valve from port "Tube from valve".

3. Actuate the solenoid valve.

- If fuel is not discharged from tube, remove tube and blow out or replace.

- If fuel is discharged, connect tube to thermal cutout valve, then disconnect other tube.

4. Actuate the solenoid valve.

- If fuel is not discharged, replace the cutout valve.

NOTE: If engine coolant temperature is 90 °F (32 °C) or over, it is normal that fuel is not discharged as the valve is in closed position.

- If fuel is discharged, connect tube to thermal cutout valve, then disconnect tube from atomizer.

5. Actuate the solenoid valve.

- If fuel is not discharged from tube, fuel line is clogged. Remove tube and blow out or replace.

- If fuel is discharged, replace the atomizer.

Thermal cutout valve quick test

1. Engine coolant temperature must be below 90 °F (32 °C).

2. Temporarily disconnect tube at thermal cutout valve from port *"Tube to atomizer"*.

3. Actuate solenoid valve. (Ask an assistant to actuate solenoid valve by means of the rocker switch on the dashboard.) Fuel should be discharged through the thermal cutout valve.

WARNING: Avoid breathing vapors and contacting fuel with skin. Never smoke during test.

4. Reconnect tube to thermal cutout valve.

5. Start engine, using cold starting aid if necessary, then stop engine when it reaches operating temperature.

6. Disconnect tube at thermal cutout valve as in step 2, then repeat step 3. No fuel should be discharged.

DESTINATION SIGN

Description

The destination sign is located at upper front of the vehicle. The lighting is provided with a fluorescent tube which is activated by means of a rocker switch located on the L.H. side control panel. The destination sign is electrically operated; its motor is controlled by two rocker switches mounted side by side on the destination sign. The small one determines the rolling speed without actuating it. The larger switch (momentary type) controls and actuates the rolling direction (forward or backward).

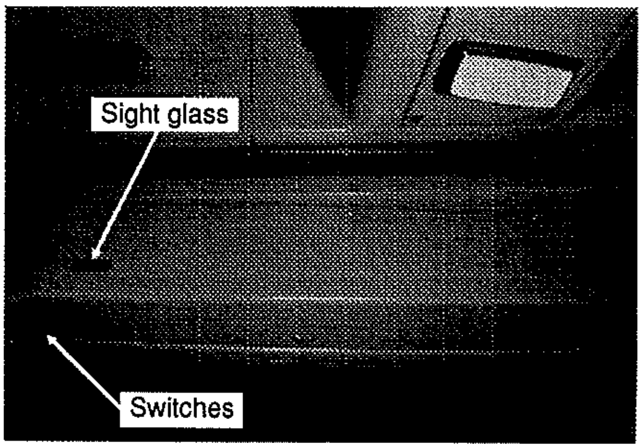


Fig. 10 - Destination sign

Maintenance

Inspect regularly the following items:

1. Check for free and easy mechanism movement.
2. Check for loose items on the sign mechanism, such as wire, loose clips, hanging tape, etc.
3. Check tension and condition of the two drive belts; replace as required.
4. Periodic lubrication is **NOT** recommended.

Fluorescent replacement

1. Remove the six Phillips-head screws and washers retaining the destination sign cover, then carefully remove the cover from its location.
2. Remove both Phillips-head screws, one on each fluorescent assembly hinged bracket (see fig. 11), then lower assembly.
3. Push on tab located on each fluorescent pin receptacle while removing fluorescent.
4. Install new fluorescent, then reinstall the assembly by reversing the above procedure.

Electric motor removal and installation

To remove the electric motor, repeat previous step 1, plus the following:

1. Disconnect wires from electrical motor.
2. Remove both screws retaining motor to destination sign frame (see fig. 11).
3. Slide motor upwards, then remove the drive belt.
4. Remove motor through the provided opening.
5. Install the motor by reversing the above procedure.

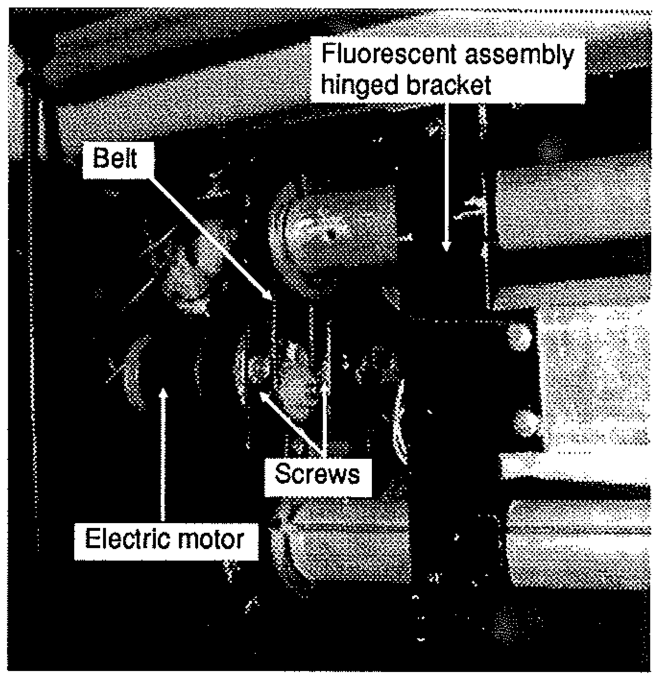


Fig. 11

Sign curtain repair

In the event a destination sign curtain is torn, it can be repaired with 3M polyester tape or any equivalent cellophane tape. When repairing a tear, the tape should be used on both sides of the curtain.

LAVATORY

Description

The lavatory is located in the rear R.H. corner of coach and is equipped with the following standard items: chemical flush toilet, towel and toilet tissue dispensers, waste container, washbasin, fresh water reservoir, low temperature water safety valve, mirror, fluorescent lighting, cleaning cabinet; then, it may be equipped with liquid soap and wet-type towel dispensers, an ashtray and a heating element for the fresh water reservoir as optional equipment.

Locking the door from inside will illuminate the ceiling fluorescent plus outside signs which are mounted on the outer wall of lavatory, over the windshield and an indicator light on the L.H. dashboard. A night-light is always illuminated when ignition switch is in the *"ON"* position.

Maintenance

The servicing procedure for the lavatory is described in the *"Operator's Manual"* included in the technical publications box delivered with the vehicle.

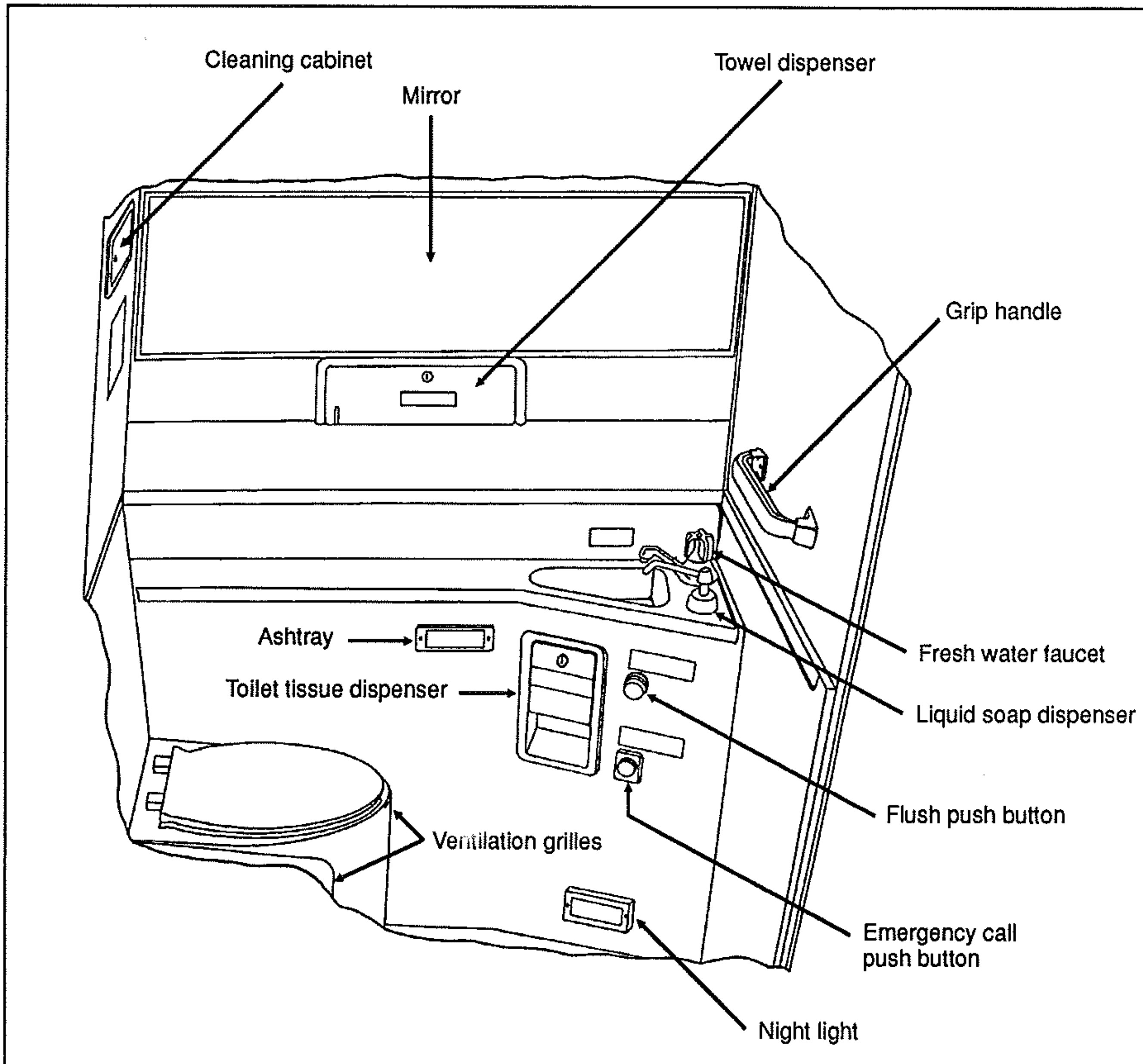


Fig. 12 - Lavatory

Ventilation fan

Description

The lavatory ventilation fan, mounted in engine compartment over the oil reserve tank, serves two purposes. It exhausts objectionable odors and provides a constant air circulation in the lavatory compartment by heating or cooling the lavatory with the vehicle ambient air. Air flows in the lavatory compartment through a vent grille located in the upper section of the lavatory door and exhausts through grilles located on both sides of toilet. A series-mounted resistor (2 ohms) located in the fan outlet opening is provided to reduce noise by limiting the motor rpm.

NOTE: This fan runs constantly whenever the ignition switch on the L.H. lower control panel is in the *"ON"* position.

Maintenance

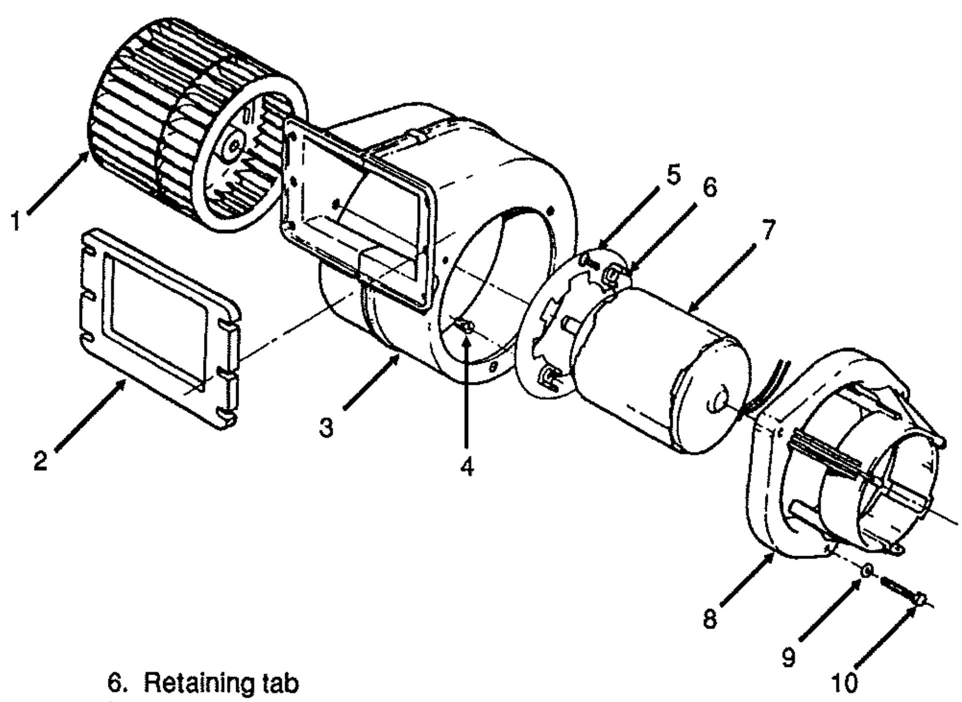
The frequency of preventive maintenance should be determined according to vehicle mileage and operating conditions. However, it is recommended to check this item approximately every 50,000 miles (80 000 km).

Remove fan and motor assembly. Check for fan housing wheel and motor free operation. When defective motor occurs, new motor must be installed.

NOTE: This motor is similar to those used on the driver's defroster and upper windshield defroster units.

Removal and installation

1. With the engine compartment rear door opened, remove hose clamp securing duct to ventilator inlet, then disconnect duct.
2. Disconnect the ventilator motor wiring connector.
3. Remove the two nuts retaining the ventilator fan housing support to the square tube, then remove the ventilator assembly from its location.
4. The unit can now be disassembled and motor replaced referring to fig. 13 as a guide.
5. Reverse previous steps to reinstall ventilator assembly on vehicle.



1. Fan wheel
2. Gasket
3. Housing
4. "Allen" screw
5. Motor ring
6. Retaining tab
7. Motor
8. Motor bracket
9. Washer
10. Motor retaining screw

MA3E2313

Fig. 13 - Lavatory ventilation fan disassembly

Door lock

Lavatory door lock has inside and outside handles, as well as an inside latch to lock door from inside the compartment. If the lock fails to release, the door can be opened from the outside using a special key which is supplied to the driver. Lock assembly can be removed from the door, then readily disassembled and parts replaced, if necessary (see fig. 14). A thin coat of lubricant on all moving parts will ensure trouble-free operation.

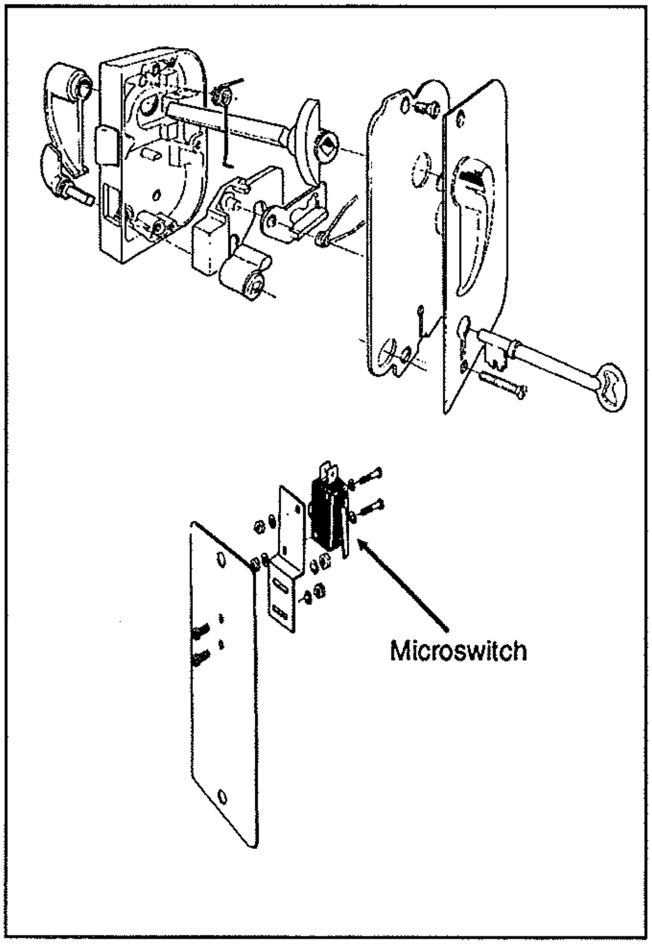


Fig. 14 - Lavatory door lock installation

Lavatory light

The lavatory light is installed on ceiling and is provided with two fluorescent tubes. A microswitch, which is mounted in the door exterior frame, is activated by the door lock mechanism upon locking to energize the circuit. This switch is readily serviced by removing the two Phillips-head screws securing the mounting plate to the door exterior frame.

Proceed as follows to replace a fluorescent:

1. Press in side of lens (mirror side), free lens from its retaining groove, slide out other side, then remove lens.

2. Unsnap defective fluorescent tube by pushing its both extremities simultaneously against felt discs (see fig. 15).

3. Holding the fluorescent with one hand, push inwards one of the pin receptacle steel plates to free tube extremity, then remove tube from its fixture.

4. Reverse above procedure to install new fluorescent tube.

If ballast is defective or a wire feed voltage check is required, ballast cover may be removed by performing the previous first three steps and the following:

WARNING: Be careful when checking the ballast feed voltage as its output voltage is 600 volts.

a. Grasp and press inwards both cover extremities to free its edges from the four rivets.

b. Reverse previous steps to install cover, fluorescent tubes and lens.

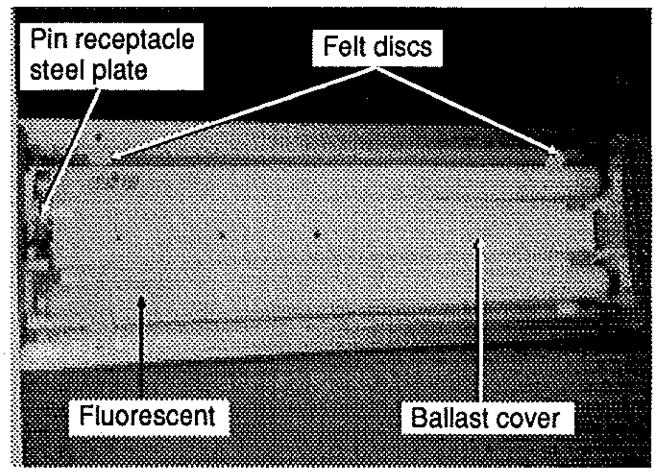


Fig. 15 - Lavatory fluorescent lamp assembly

Lavatory night-light

The lavatory night-light is illuminated as soon as the ignition switch is set to the *"ON"* position. Proceed as follows to replace defective bulb:

1. Unscrew the two Phillips-head screws retaining the lens to the lavatory wall, then remove it.

2. Push and turn the bulb counterclockwise, then pull it out of the socket.

3. Place the new bulb into the socket, then push and turn clockwise to lock in position.

4. Place the light lens and fix in place.

Emergency buzzer

The lavatory emergency buzzer is mounted on the alarm junction box in front service compartment, and sounds when the emergency call push button switch in the lavatory compartment is activated. For specific wiring information, refer to diagram #18/25 of the master wiring diagrams. To remove the emergency call push button switch, proceed as follows:

1. Remove both Phillips-head screws retaining push button switch plate to wall.
2. Using the appropriate key, unlock and open the toilet tissue dispenser flap.
3. Remove all toilet tissues.
4. Unscrew the Phillips-head screw retaining the toilet tissue dispenser assembly, then remove it from its location.
5. Remove switch through this opening, taking care to disconnect electric wires.

Fresh water tank

The fresh water tank located at rear of lavatory wall (under cleaning cabinet), supplies water to the washbasin by gravity. Two tubes are connected in the upper section of tank (see fig. 16). One serves as overflow as well as vent tube and runs along the wall to the underside of the lavatory close to the engine air filter housing, while the other tube is connected to the fresh water fill valve which is mounted over the engine oil reserve tank. A third tube connected in the lower section of fresh water tank is provided with a TEE-connector and allows fresh water to flow to the washbasin faucet and to the low temperature water safety valve for an automatic or manual drainage. An access panel, located at rear of last R.H. side row of seats and secured in place with a Phillips-head screw, allows access to the cleaning cabinet and fresh water tank tubings, fresh water tank heater and different wiring connectors.

Fresh water tank heater

A 75 watt, 110 volt AC immersion-type water heater is installed in the bottom of the fresh water tank. The heated portion of element must at all times be immersed to insure proper heater life. The heater is controlled by a toggle switch mounted on the alarm junction box in front service compartment. Its power source is provided by the 110 volt in-station connector also mounted on the alarm junction box.

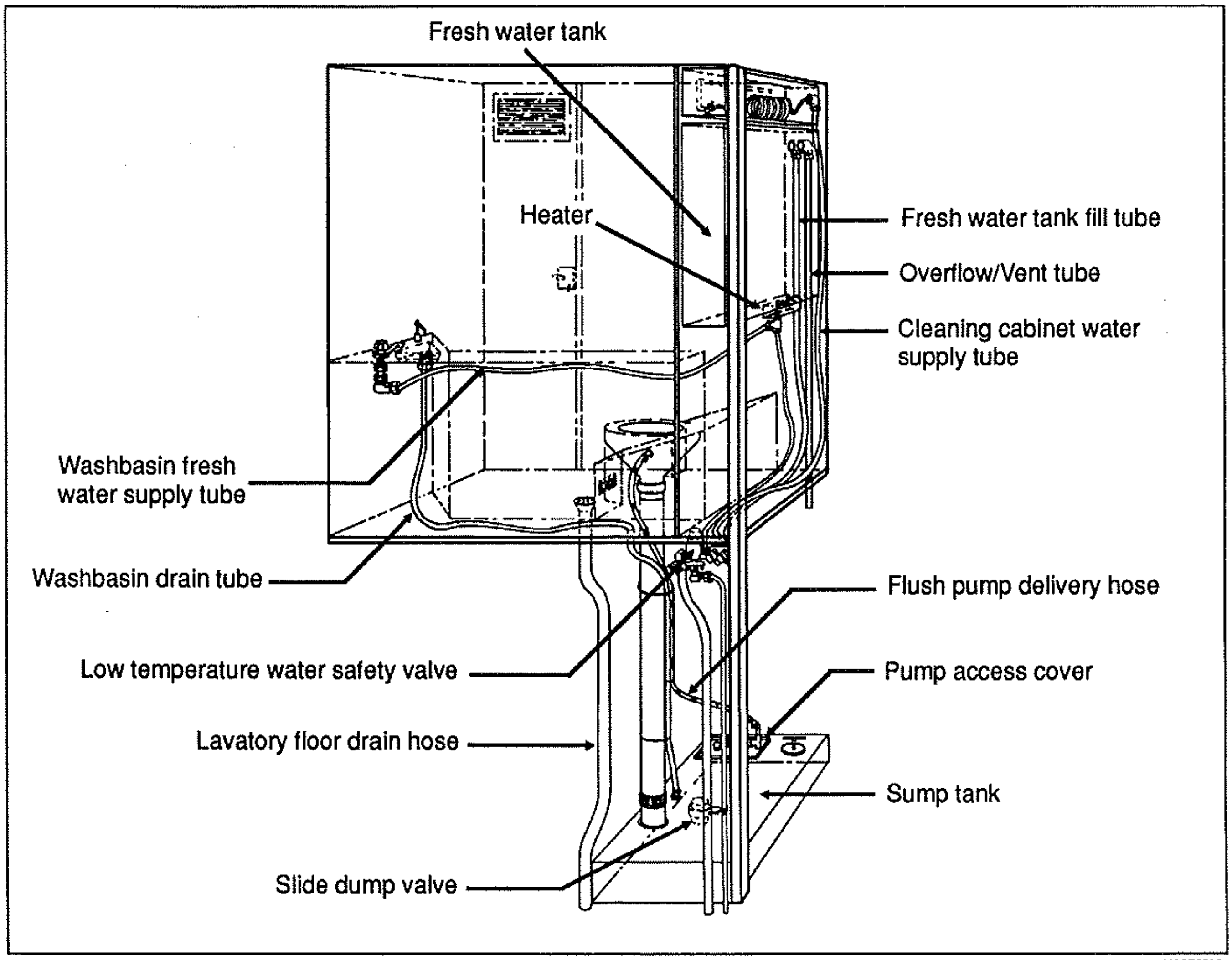


Fig. 16 - Lavatory tubing installation (view from rear of vehicle)

Liquid soap dispenser

A liquid soap dispenser may have been installed as optional equipment. To refill dispenser, proceed as follows:

1. Turn cover slightly clockwise until it stops.
2. Insert projection at end of *"BOBRICK"* key into rectangular hole in cover (see fig. 17). Push straight in. While holding *"BOBRICK"* key in, turn cover counterclockwise about 1/8 turn.

CAUTION: Do not use *"BOBRICK"* key to turn cover.

3. Lift out piston and spout, cover and supply tube.
4. Fill dispenser with soap. This model can dispense vegetable oil soaps, synthetic detergents, and lotion soaps.

CAUTION: Never use abrasive cleaners.

5. Replace supply tube, piston, and spout mechanism reversing the steps above.
6. Secure the cover by turning clockwise until lock snaps into position.

NOTE: The dispenser requires priming when extremely viscous lotion soaps are used. Remove piston and spout, cover and supply tube assembly. Pump water into assembly, then replace into dispenser.

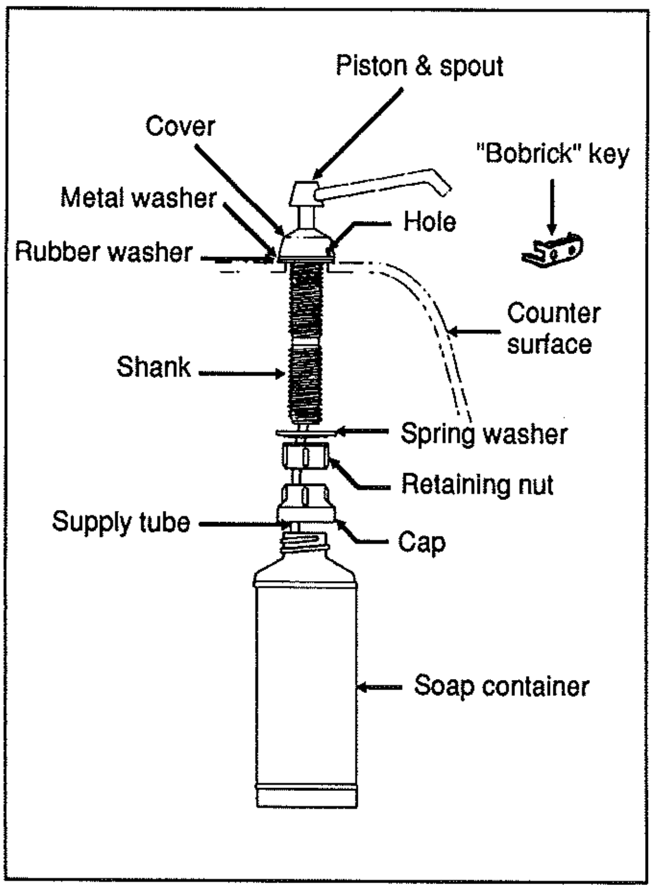


Fig. 17 - Liquid soap dispenser

Flush push button

The green flush push button is located near the toilet tissue dispenser. Press on push button to actuate a pneumatic timer located on the other side of wall; this timer allows an electric current flow during a preset time to a pump into the sump tank.

Pneumatic timer removal and installation

1. Unscrew and remove the flush push button lock nut.
2. Using the appropriate key, unlock and open the toilet tissue dispenser flap.
3. Remove all toilet tissues.
4. Unscrew the Phillips-head screw retaining the toilet tissue dispenser assembly, then remove it from its location.
5. Remove pneumatic timer through this opening, taking care to disconnect electric wires.

NOTE: Care must be taken to avoid loosing the spacers installed on the mounting sleeve.

6. Reverse the above procedure to reinstall timer. The recommended torque for the lock nut is 15 lbf•ft (21 N•m).

Timer adjustment

Timer can be adjusted from 0.2 second to 3 minutes by turning the time adjustment screw clockwise to increase time, and counterclockwise to decrease time. To gain access to the time adjustment screw, repeat previous steps 2, 3, and 4.

Flush pump

The submersible-type flush pump is mounted inside an enclosure in the sump tank. The enclosure is provided with a screened side which serves as a strainer to prevent solid matters from entering the pump. The pump requires no periodic maintenance other than cleaning of the strainer side using a water jet introduced through the circular cap opening, once the sump tank is completely drained. The pump can run dry periodically without damage. However, for maximum seal life, the run dry periods should be kept to a minimum.

CAUTION: If vehicle is stored for an extended period of time, make sure to clean the strainer as solid matter will tend to pack, and will require replacement of strainer.

Flush pump pressure adjustment

The flush pump is provided with a manually-adjustable control valve mounted on the flush pump cover and serves to limit flush pump output pressure. To adjust, ask an assistant who will activate the flush push button and check the liquid projection while you manually adjust the control valve.

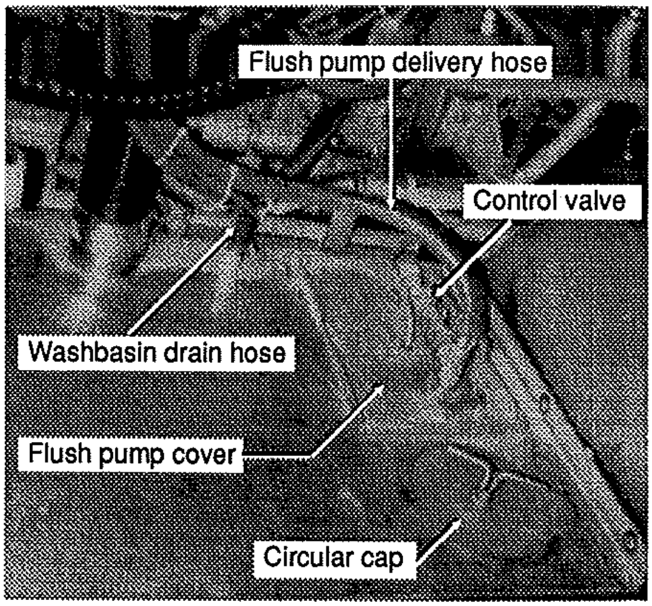


Fig. 18 - Sump tank installation MA3E2318

SPECIFICATIONS

HUBODOMETER (US model: miles)

Make	Stemco
Supplier number	650-0593
Prevost number	65-0002

HUBODOMETER (Canada model: km)

Make	Stemco
Supplier number	650-0025
Prevost number	65-0117

AM/FM RADIO CASSETTE PLAYER

Make	Blaupunkt
Model	Phoenix SQR 29
Power source	12 volts
Maximum output power	15 watts
Supplier number	7 649 580 517
Prevost number	90-0644

AMPLIFIER

Make	Blaupunkt
Model	BPA 420
Power source	12 volts
Total output power	80 watts (RMS)
Supplier number	9 404 230 194
Prevost number	90-0542

INVERTER

Make	Tripp-Lite
Model	PV-500FC
Power source	12 V DC
Output power	500 watts/115 V AC, 60 Hz
Prevost number	56-1935

TACHOGRAPH (US model)

Make	VDO
Scale	0 - 80 mph
	0 - 3300 rpm
	24 hours
Supplier number	140508
Prevost number	59-0259
Repair kit (Prevost number)	09-0208
Paper chart (Prevost number)	59-0122
Dummy plastic card (Prevost number)	59-0251

TACHOGRAPH (Canada model)

Make	VDO
Scale	0 - 125 km/h
	0 - 3300 rpm
	24 hours
Supplier number	140509
Prevost number	59-0258
Repair kit (Prevost number)	09-0207
Paper chart (Prevost number)	59-0179
Dummy plastic card (Prevost number)	59-0251

ETHER START CYLINDER

Make	Quick start
Volume net	22 US fl. oz
Supplier number	LP-535
Prevost number	51-0173

DESTINATION SIGN FLUORESCENT TUBE

Make . . . . . General Electric
Length . . . . . .30" (76 cm)
Outside diameter . . . . . 1" (25 mm)
Wattage 20
Color . . . . . Cool white
Quantity 1
Supplier number F30T8 CW4
Prevost number 83-0120

LAVATORY VENTILATION FAN MOTOR

Make . . . . . Aurora
Type RG500EF
Voltage . . . . . 24 V DC
Rotation . . . . . Right hand
Supplier number 001.58.04
Prevost number 56-1194

LAVATORY FLUORESCENT TUBES

Model . . . . . F15T8 CW
Length . . . . . .18" (45 cm)
Wattage 15
Quantity 2
Prevost number 83-0102

EMERGENCY BUZZER

Make . . . . . Mallory
Frequency . . . . . 2900 Hz
Supplier number . . . . . SC 628 W
Prevost number 56-1957

FRESH WATER TANK

Make . . . . . Prevost
Capacity . . . . . 18 US gal (68 liters)
Prevost number 40-3030

FRESH WATER TANK HEATER

Make . . . . . Hot Watt
Wattage . . . . . 75 W
Voltage . . . . . 115 V AC
Supplier number . . . . . EM 37-5
Prevost number 56-2018

FLUSH PUSH BUTTON PNEUMATIC TIMER

Make . . . . Furnas
Type . . . . Resettable
Time . . . . 0,2 to 180 seconds
Supplier number 55-AA
Prevost number 90-0348

FLUSH PUMP

Make . . . . Jabsco
Model number 30240-0024
Power source . . . . 24 volts
Capacity . . . . 1750 GPH
Prevost number 90-0496

SERVICE BULLETINS AND SERVICE INFORMATION LETTERS

Service Bulletins and Service Information Letters will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of publications pertaining to this section should be noted below as soon as received. These should then be filed for future reference.

NUMBER	DATE	SUBJECT

24

LUBRICATION

CONTENTS OF THIS SECTION

DESCRIPTION . . . . 24 - 1
FIRST SERVICE ON NEW VEHICLE . . . . 24 - 1
DIFFERENTIAL OIL . . . . 24 - 1
COOLANT STRAINER . . . . 24 - 1
MANUAL TRANSMISSION OIL . . . . 24 - 1
AUTOMATIC TRANSMISSION OIL FILTER . . . . 24 - 1
ENGINE OIL . . . . 24 - 1
ENGINE OIL CHANGE INTERVALS . . . . 24 - 1
ENGINE OIL RESERVE TANK . . . . 24 - 1
COLD WEATHER OPERATION . . . . 24 - 2
FLEXIBLE HOSE MAINTENANCE . . . . 24 - 2
PRE-STARTING INSPECTION . . . . 24 - 2
LEAKS . . . . 24 - 2
SERVICE LIFE . . . . 24 - 2
LUBRICATION AND SERVICING SCHEDULE . . . . 24 - 4

DESCRIPTION

A lubrication schedule is included in this section to give the location of key service points on the vehicle. Where cleaning, removal or disassembly are required for lubrication purposes, these procedures are covered in the applicable sections of this manual.

Lubrication intervals are based on recommendations for normal operating conditions. Where more severe service is encountered, more frequent attention will be required.

FIRST SERVICE ON NEW VEHICLE

Differential oil

Factory-filled oil in differential on new vehicle should be drained and refilled after 1,000 miles (1 600 km) and no more than 3,000 miles (4 800 km) of initial operation, then according to the lubrication and servicing schedule.

Coolant strainer

The coolant strainer is designed to recover the soldering residues trapped inside the coolant lines during their initial assembly; perform initial cleaning once vehicle has run approximately 3,000 miles (4 800 km), then according to the lubrication and servicing schedule.

NOTE: If additional soldering has been performed on any point of coolant piping, clean coolant system strainer as outlined for a new vehicle (3,000 miles (4 800 km)).

Manual transmission oil

Factory-filled oil in manual transmission on new vehicle should be drained, flushed and refilled after 3,000 miles (4 800 km) and no more than 5,000 miles (8 000 km) of initial operation, then according to the lubrication and servicing schedule.

Automatic transmission oil filter

Change cartridge after first 5,000 miles (8 000 km), then after each 25,000 miles (40 000 km) as specified in the lubrication and servicing schedule.

Engine oil

Since engine break-in has been done in factory, there is no special break-in, so oil should be changed according to the lubrication and servicing schedule intervals. Furthermore, the engine oil filter should be replaced each time the engine oil is changed.

ENGINE OIL CHANGE INTERVALS

The engine oil change intervals are related to the operating conditions, such as vehicle load, speed, etc., and may vary. It is recommended however, that the oil change be performed after every 10,000 miles (16 000 km).

The drain intervals may then be gradually increased or decreased with experience on a specific lubricant, considering the recommendations of the oil supplier (analysis of drained oil can be helpful), until the most practical service condition has been established.

Solvents should not be used as flushing oils. Dilution of the fresh refill oil supply can occur, which may be detrimental for the engine.

Engine oil temperature should be checked every 25,000 miles (40 000 km) to determine oil cooler efficiency. This check should be made by inserting a steel jacketed thermometer in the dipstick opening, immediately after stopping a hot, loaded engine. If the oil temperature exceeds the coolant temperature by more than 60 °F (33 °C), the oil cooler may be clogged.

For detailed oil specifications, refer to *"Detroit Diesel Series 92 Service Manual"* under heading *"Lubricating oil for Detroit Diesel engines"*.

ENGINE OIL RESERVE TANK

An oil reserve tank with a capacity of 2.2 US gallons (8,3 liters) is connected to the crankcase by a hose with a shutoff valve, allowing oil to be added to crankcase by opening valve. Comparison of oil levels in sight gauge, before and after adding oil to crankcase, shows approximately how much oil has been added.

Filling of this tank can be made by opening the rear engine door. The tank is mounted on R.H. side of engine compartment, over the A/C compressor.

COLD WEATHER OPERATION

The proper selection of the engine oil grade will ease cold weather starting (refer to the lubrication and servicing schedule for the engine oil grade recommendation). Other practical considerations, such as the use of batteries, cables and connectors of adequate size, proper setting of voltage regulator, ether starting aid, oil and coolant heater systems, and proper fuel selection will ease cold weather starting.

FLEXIBLE HOSE MAINTENANCE

The performance of engine and equipment are greatly related to the ability of flexible hoses to supply lubricating oil, air, coolant, and fuel oil. Maintenance of hoses is an important step to ensure efficient, economical, and safe operation of the engine and related equipment.

Pre-starting inspection

Check hoses daily as part of the pre-starting inspection. Examine hose for leaks, and check all fittings, clamps, and ties carefully. Ensure that hoses are not resting on or touching shafts, couplings, heated surfaces including exhaust manifolds, any sharp edges, or other obviously damaging areas. Since all machinery vibrates and moves to a certain extent, clamps and ties can fatigue with time. To ensure proper support, inspect fasteners frequently and tighten or replace them as necessary.

Leaks

Investigate leaks immediately to determine if fittings have loosened or cracked, and also if hoses have ruptured or worn through. Take corrective action immediately. Leaks are not only potentially detrimental to machine operation, but can also result in added expenses caused by the need to replace lost fluids.

CAUTION: Personal injury and/or property damage may result from fire due to the leakage of flammable fluids, such as fuel or lube oil.

Service life

The limited service life of a hose is determined by the temperature and pressure of the gas or fluid within it, the time in service, its installation, the ambient temperatures, amount of flexing, and the vibration it is subjected to. With this in mind, it is recommended that all hoses be thoroughly inspected at least every 500 operating hours or after 15,000 miles (24 000 km). Look for surface damages or indications of damaged, twisted, worn, crimped, brittled, cracked, or leaking lines. Hoses having the outer surface worn through or a damaged metal reinforcement should be considered unfit for further service.

It is also recommended that all hoses in this vehicle be replaced during major overhaul and/or after a maximum of five service years. Quality of replacement hose assemblies should always be equal to or superior to the Original Equipment Manufacturer.

LUBRICANT CODE

(see Lubrication and Servicing Schedule on the following pages)

B-1 Brake fluid, Heavy Duty DOT 3

G-1 General purpose gear lubricant SAE 90 (A.P.I. spec. GL-5)

L-1 High melting point, water resistant, lithium base grease

L-2 Molybdenum disulphide grease

L-3 NLGI grade #1 (National Lubricating Grease Institute)

Grease tube Prevost part #68-0500

Grease tube Rockwell part #A-1779-W283

Other recommended greases:

- Shell Darina EP-1
- Texaco Thermotex EP-1
- Amoco Super Permalube #2
- Citco Premium Lithium EP-2
- Exxon Ronex MP-2
- Kendall L-427 Super Blu #2
- Mobilith AW-1
- Sohio Factran EP-2

L-4 NLGI grade #2 (National Lubricating Grease Institute)

Approved greases:

- Kendall L-424 Grease
- Amoco Super Chassis
- Amalie All-Purpose Grease with Moly, Li-2M
- Exxon 5160
- Shell Super Duty Special FF
- Maralube Moly Code 529
- Philube MWEP2 Grease
- PN-C1AZ 19590 or a grease meeting Ford Motor Company Specification M1C-75B

L-5 Lubriplate #1242

L-6 Special high temperature silicone grease (Prevost part #68-0460)

O-2 Dexron or Dexron II automatic transmission oil

O-3 Approved oils:

- Calumet Refining Co. R030
- Texaco WF68
- Witco Chemical Corp. Suniso 4GS

O-4 Hypoid gear oil GL-5

- SAE 85W-140 (above 10 °F (-12 °C))
- SAE 75W-90 (below 10 °F (-12 °C))

S-1 Special *"KYSOR"* shutterstat fluid.

W-1 Windshield washer fluid

W-2 Ethylene glycol permanent-type antifreeze solution (absolutely must be low silicate type). No less than 30% antifreeze and no more than 67% antifreeze should be used.

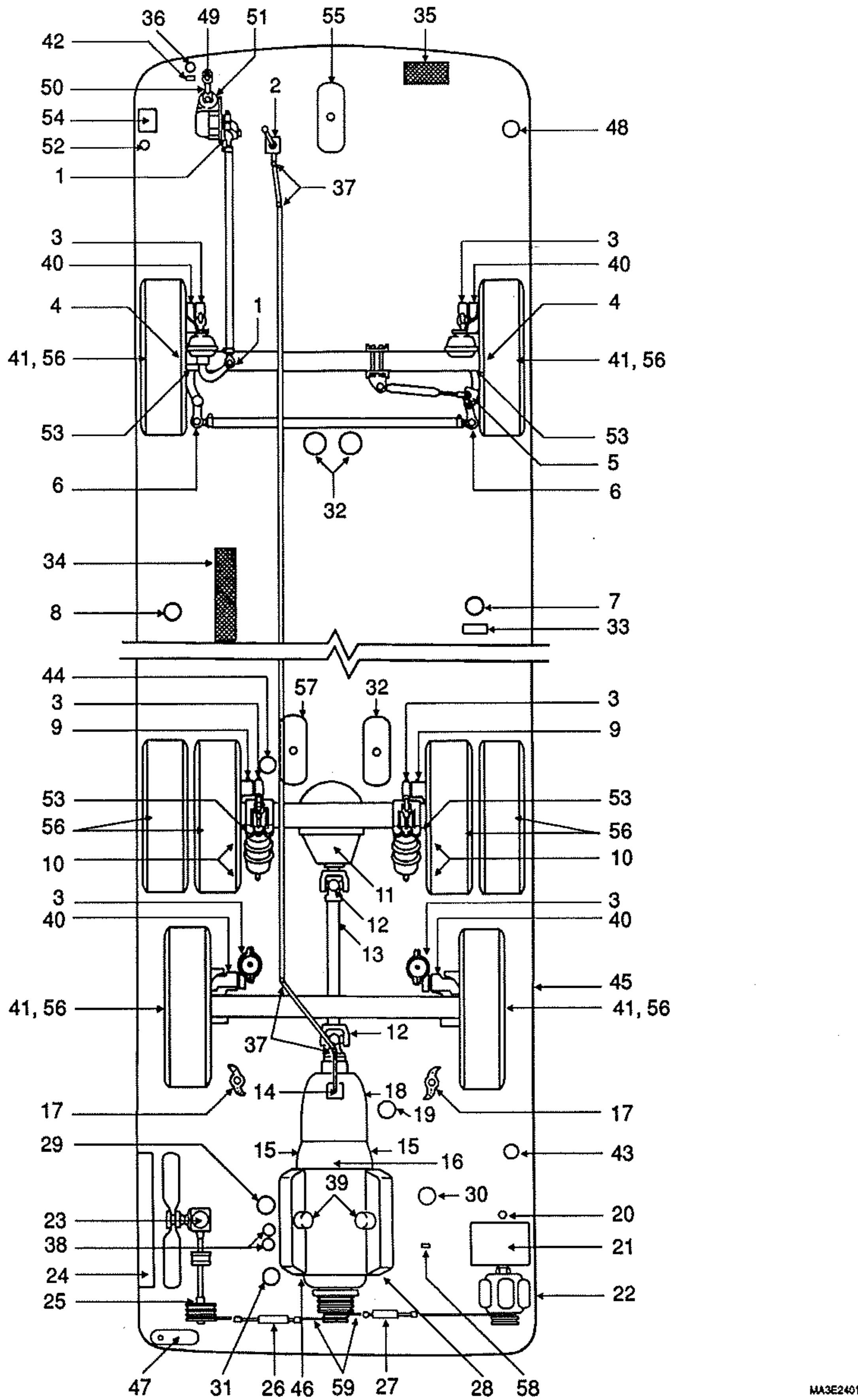
NOTES

1. Heavy-duty engine oil SAE-40 meeting MIL-L-2104D specification. Certain engine operating conditions may require exceptions to this recommendation. They are as follows:

   A. For continuous high temperature operation (over 100 °F (38 °C) ambient or 200 °F (93 °C) coolant out), the use of a SAE grade 50 lubricant is recommended.

   B. At ambient temperatures below freezing where starting aids are not available or at very cold temperatures (0 °F (-18 °C) to -25 °F (-32 °C), the use of multiviscosity grade 15W-40 or monograde SAE 30 lubricants will improve startablility.
2. Same as engine crankcase oil (refer to note 1).
3. For vehicles equipped with the optional *"RACOR"* primary fuel filter/water separator, change cartridge element every 25,000 miles (40 000 km).
4. Replace element whenever differential pressure exceeds 15 psi (100 kPa) between the inlet and outlet of air filter.
5. The level is acceptable when the oil is visible in the sight glass on R.H. side of compressor. For an accurate reading, release air on belt tensioner, then level compressor. The oil level should be in center of sight glass.
6. For detailed information about the moisture indicator, refer to section 22 *"Heating and Air Conditioning"* in this manual, under heading *"A/C system components"*.
7. For proper oil level, refer to section 13 *"Wheels, Hubs and Tires"* in this manual, under heading *"Front and tag axle wheel hubs"*.
8. For proper maintenance of the air tanks, refer to section 12 *"Brakes and Air System"* in this manual, under heading *"Air reservoirs"*.

LUBRICATION AND SERVICING SCHEDULE



PERFORM THE FIRST SERVICE ITEMS ON NEW VEHICLE AS OUTLINED PREVIOUSLY.

NOTE THAT THE ITEMS UNDER HEADING *"MISCELLANEOUS"* ARE SCHEDULED ACCORDING TO A TIME PERIOD INSTEAD OF MILEAGE.

1) CHECK DAILY BEFORE OPERATING VEHICLE, SERVICE IF REQUIRED

Item	Description	Remarks	Lubricant
*18	Transmission (manual)	Fill	See note 2
18	Transmission (automatic)	Fill	O-2
28	Engine Crankcase	Fill	See note 1
**30	Primary Fuel Filter/Water Separator	Drain accumulated water	-----
41	Wheel Bearings (front and tag axles)	Check level in sight glass (see note 7)	G-1
43	Power Steering Reservoir	Fill	O-2
47	Coolant Surge Tank	Fill	W-2
54	Windshield Washer Reservoir	Fill	W-1
55	Accessory Air Tank	Drain accumulated water (see note 8)	-----
56	Wheels and Tires	Check for proper tire pressure and missing wheel stud nuts	-----
57	Wet Air Tank	Drain accumulated water (see note 8)	-----
58	Air Cleaner Restriction Indicator	Replace air cleaner element when red signal locks in full view	-----
59	V-belts	Check condition	-----

2) SERVICE EVERY 5,000 MILES (8 000 km) OR TWICE A YEAR, WHICHEVER OCCURS FIRST

Item	Description	Remarks	Lubricant
1	Steering Drag Link Ends	1 fitting on each end	L-2
*2	Shifter Housing	1 fitting (steering compt.)	L-2
3	Slack Adjusters (all wheels)	1 fitting/adjuster	L-3
4	Steering Knuckle Pins	2 fittings/knuckle	L-2
5	Steering Damper End	1 fitting	L-2
6	Steering Tie Rod Ends	1 fitting on each end	L-2
7	Receiver Tank	Check refrigerant level at receiver tank lower sight glass	-----
8	Coolant Filter (strainer)	Clean strainer after first 3,000 miles (4 800 km), then after each 50,000 miles (80 000 km)	-----
9	Brake Camshafts (drive axle)	1 fitting/camshaft	L-2
10	Brake Shoe Anchor Pins (drive axle)	2 fittings/brake	L-2
11	Differential Oil	Drain and refill differential; break-in period between 1,000 and 3,000 miles (1 600 and 4 800 km), then after each 25,000 miles (40 000 km) To level of filler plug 5,000 miles (8 000 km)	O-4

* For vehicles equipped with manual transmission only
** Optional equipment

2) SERVICE EVERY 5,000 MILES (8 000 km) OR TWICE A YEAR, WHICHEVER OCCURS FIRST (CONTD)

Item	Description	Remarks	Lubricant
12	Propeller Shaft U-joints	2 fittings/U-joint	L-4
13	Propeller Shaft Slip Joint	1 fitting	L-4
*14	Shift Lever Pivot	1 fitting	L-2
*15	Clutch Control Cross Shaft	3 fittings	L-2
*16	Clutch Release Bearing	1 fitting	L-1
**17	Tag Axle Lever Pivot	1 fitting/pivot	L-2
*18	Manual Transmission Oil	Drain, flush and refill; break-in period between 3,000 and 5,000 miles (4 800 and 8 000 km), then after each 50,000 miles (80 000 km)	See note 2
19	Automatic Transmission Oil Filter	Change cartridge after first 5,000 miles (8 000 km), then after each 25,000 miles (40 000 km)	-----
20	Pre-cleaner	Check discharge tube	-----
21	Air Cleaner (dry type)	Inspect and clean, replace element if required	-----
22	A/C Compressor	Check oil level (see note 5)	O-3
23	Fan Gearbox Oil Level	Maintain level between the two marks on the dipstick	G-1
24	Radiator Shutter Rods and Cranks	Apply	O-2
25	Fan Drive Shaft Pillow Block	1 fitting	L-1
26	Belt Tensioner Cylinder Rod Ends (fan)	1 fitting on each end	L-2
27	Belt Tensioner Cylinder Rod Ends (A/C compressor)	1 fitting on each end	L-2

3) SERVICE EVERY 10,000 MILES (16 000 km) OR ONCE A YEAR, WHICHEVER OCCURS FIRST

Item	Description	Remarks	Lubricant
28	Engine Oil	Drain and refill	See note 1
29	Engine Oil Filter	Change cartridge	Fill with engine oil
30	Primary Fuel Filter	Change cartridge (see note 3)	Fill with clean fuel
31	Secondary Fuel Filter	Change cartridge	Fill with clean fuel
32	Air Tanks	Drain accumulated water (see note 8)	-----
33	Refrigerant Moisture Indicator	Replace filter dryer unit according to moisture indicator (see note 6)	-----
34	Central A/C and Heating Unit Air Filter	Clean or replace	-----
35	Driver's A/C and Heating Unit Air Filter	Clean or replace	-----
*36	Clutch Master Cylinder	Check oil level	B-1

* For vehicles equipped with manual transmission only
** Optional equipment

4) SERVICE EVERY 25,000 MILES (40 000 km)

Item	Description	Remarks	Lubricant
11	Differential Oil	Drain and refill differential	O-4
19	Automatic Transmission Oil Filter	Change cartridge	-----
**30	Primary Fuel Filter/Water Separator	Change cartridge element	Fill with clean fuel
*37	Shift Control Rod U-joints	4 fittings	L-2
**38	Spin-on Type Coolant Filters (Perry)	Change both cartridges	-----
39	Engine Crankcase Breathers	Inspect and replace if necessary	-----
40	Disc Brake Calipers (front & tag axles)	One fitting on each caliper	L-3
41	Wheel Bearing Oil (front and tag axles)	Drain and refill (see note 7)	G-1
*42	Clutch Pedal Free Play	Check and adjust if required	-----

5) SERVICE EVERY 50,000 MILES (80 000 km)

Item	Description	Remarks	Lubricant
8	Coolant Filter (strainer)	Clean strainer	-----
18	Automatic Transmission Oil	Drain and refill	0-2
*18	Manual Transmission Oil	Drain, flush and refill	See note 2
43	Power Steering Oil Filter	Change cartridge element	-----
44	Air Dryer (AD-4)	Replace dessicant cartridge	-----

6) MISCELLANEOUS

Item	Description	Remarks	Lubricant
*36	Hydraulic Clutch Oil (each 2 years)	Replace	B-1
45	Battery Terminals (yearly)	Clean and coat terminals	Battery terminal coating
46	Shutterstat (half-yearly)	Disconnect air supply line - inject a few drops of oil	S-1
47	Coolant Surge Tank (yearly)	Test coolant solution	W-2
---	Cooling System (each 2 years)	Drain, flush and refill	W-2
48	Front Door Rotating Column (air-operated model only) (half-yearly)	1 needle fitting in center of rotating column	L-5
49	Upper Steering Column U-joint (yearly)	1 fitting	L-2
50	Steering Column Slip Joint (yearly)	1 fitting	L-2
51	Lower Steering Column U-joint (yearly)	1 fitting	L-2
52	Accessory Air Filter	See note 4	-----
**53	ABS Sensors	Apply at sensor reinstallation	L-6

* For vehicles equipped with manual transmission only
** Optional equipment

SERVICE BULLETINS AND SERVICE INFORMATION LETTERS

Service Bulletins and Service Information Letters will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of publications pertaining to this section should be noted below as soon as received. These should then be filed for future reference.

NUMBER	DATE	SUBJECT