

**TRUCK, UTILITY, LIGHTWEIGHT AND TRUCK, UTILITY, LIGHTWEIGHT,
WINCH, MC2 – LAND ROVER 110 4X4**

TECHNICAL DESCRIPTION

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

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INTRODUCTION

1. This EMEI contains the technical description of the Truck, Utility, Lightweight and Truck, Utility, Lightweight with Winch. All relevant weights, dimensions and performance figures are detailed in the Data Summaries EMEI Vehicle G 100 and EMEI Vehicle G 100-1 respectively.

Associated Publications

2. Reference may be necessary to the latest issue of the following documents:
- a. Defence Road Traffic Instructions (DRTI);
 - b. Complete Equipment Schedules (CES):
 - (1) SCES 12035.....Truck, Utility, Lightweight, MC2;
 - (2) SCES 12037..... Truck, Utility, Lightweight, W/Winch, MC2;
 - c. Block Scale 2406/31 – Special Tools for RAEME – B Vehicles – Truck, Utility and Truck, Light, MC2 (Land Rover Model 110);
 - d. [EMEI Vehicle A 029-3](#) – Vehicles – General, Servicing of B Vehicles, Trailers, All Terrain Vehicles (ATV) and Motorcycles – General Instruction;
 - e. [EMEI Vehicle A 291-5](#) – Tyres and Tubes, General Service B Vehicles Tyre Guide – Operator Instructions;
 - f. [EMEI Vehicle G 100](#) – Truck, Utility, Lightweight and Truck, Utility, Lightweight, Winch, MC2 – Land Rover 110 4X4 – Data Summary;
 - g. [EMEI Vehicle G 103](#) – Truck, Utility, Lightweight and Truck, Utility, Lightweight, Winch, MC2 – Land Rover 110 4x4 – Light Grade Repair;
 - h. [EMEI Vehicle G 104-1](#) – Truck, Utility, Lightweight – Land Rover 110 and Truck, Utility, Lightweight, Winch, MC2 – Land Rover 110 4x4 – Medium Grade Repair;
 - i. [EMEI Vehicle G 104-2](#) – Truck, Utility, Lightweight, MC2 – Land Rover 110 and Truck, Utility, Lightweight, Winch, MC2 – Land Rover 110 – Heavy Grade Repair;
 - j. [EMEI Vehicle G 109](#) – Truck, Utility, Lightweight and Truck Utility Lightweight, Winch, MC2 – Land Rover 110 4x4 – Servicing Instruction;
 - k. RPS 02188 (Base Scale); and
 - l. RPS 02189 (Supplement W/Winch).

WARNING

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

WARNING

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

Location of Identification Numbers

3. The locations of identification numbers on components of the vehicle are described in Table 1.

Table 1 Locations of Identification Numbers

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

GENERAL INFORMATION

Engine

4. The vehicle is powered by an Isuzu 4BD1, water-cooled, four-cycle, four-cylinder, in-line, naturally aspirated diesel engine. The engine utilises an open combustion chamber design with direct fuel injection. The cylinders are numbered from the front to the rear of the engine. The crankshaft rotates in a clockwise direction when viewed from the front of the vehicle.

Fuel System

5. The fuel system is comprised of a 68-litre fuel tank, low-pressure fuel pipes/hoses, a chassis-mounted sedimenter, a fuel transfer (supply) pump, a main fuel filter, a fuel injection pump, high-pressure fuel pipes and injectors.

Clutch

6. The pressure plate assembly utilises a single dry plate and diaphragm spring. The clutch (driven) plate has a diameter of 274.1–275.6 mm with the lining material riveted to both sides. The clutch pedal controls the operation of the clutch via a hydraulic system, clutch lever and release bearing.

Transmission

7. The transmission is a LT95A four-speed with helical constant mesh gears. All forward gears are equipped with synchromesh.

8. The transfer case is combined with the transmission and provides high and low gear ratios for on- and off-road driving. The low ratio is used for cross-country (off-road) driving, while the high ratio is used for sealed or formed roads. A differential within the transfer case prevents wind up between the front and rear axles. For extreme driving conditions, where traction is difficult, the differential can be locked by operating a switch located on the dashboard to give the vehicle positive all-wheel drive.

Rear Axle

9. An axle assembly with a design load rating of 1 950 kg is used at the rear of the vehicle. The axle assembly houses a Salisbury 8HA differential with a reduction ratio of 3.54:1, two full floating axles (half shafts) and two hubs.

Front Axle

10. The steerable front drive axle has a design load rating of 1 350 kg and bevel type differential with a ratio of 3.54:1 to transmit drive via the enclosed constant velocity joints to the front wheels.

Brakes

11. The brake system is hydraulically operated, using disc brakes at the front wheels and single cylinder brake drums at the rear wheels. A pedal-actuated tandem master cylinder with pressure differential and servo (vacuum) assistance applies the pressure required to operate the brakes. Brake hydraulic fluid is stored in a reservoir on top of the master cylinder.

Suspension

12. Long travel, single-rate coil springs are utilised on both the front and the rear axles. Double-acting, telescopic shock absorbers are used on the front and rear axles to dampen the spring rebound. The front axle is located by means of a Panhard rod and two radius arms, while the rear axle is located by radius arms (lower links) and an A-frame locating arm (upper link).

Steering

13. A Gemmer worm and roller type steering box is used. The steering box is mounted on the chassis rail and connected to the front wheel steering knuckles by means of a drag link (cross rod) and a track rod. A steering damper, connected between the drag link and the chassis, absorbs road shock feedback transmitted by the front wheels. A three-piece steering column connects the steering wheel to the steering box.

Electrical

14. The vehicle utilises a 12 V electrical system for engine starting and vehicle lighting. A starter motor with gear reduction is used for starting and an alternator is used for battery recharge purposes. The battery is stored in a compartment beneath the passenger seat.

Frame

15. The frame consists of two parallel steel box-section chassis rails, which are held in position by five cross-members. The vehicle's major assemblies, e.g. body, engine, transmission and drive axles, are mounted on or connected to the frame. The frame is hot-dip galvanised to prevent the formation of rust on the chassis rails and/or the cross-members. The cross-member situated below the transmission can be removed to facilitate transmission removal (refer to Figure 1).

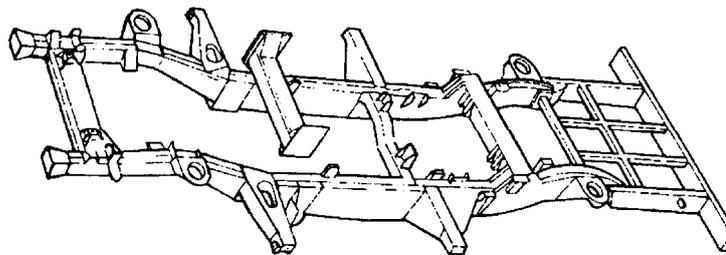


Figure 1 Frame Assembly Body

Body

16. The vehicle's body consists of three box sections, an engine compartment, a two-door open-back cab and a utility (open box) type rear section. A canvas canopy can be fitted over the rear section of the vehicle, effectively closing off the cab and rear section to the elements.

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Wheels

17. The wheel assembly (refer to Figure 2) consists of a ventilated disc wheel rim, tyre and tube. Refer to EMEI Vehicle A 291-5 for the tyre type and the tyre pressure details.

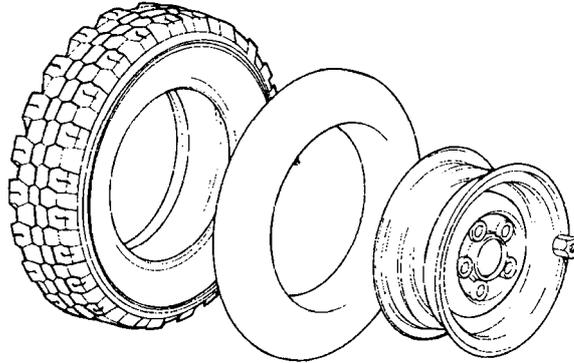


Figure 2 Tyre, Tube and Rim

Winch

18. Where fitted, a Thomas T8000 mechanical winch is used. The winch drive comes from the transmission via a power take-off unit, which is transmitted to the front-mounted winch via a propeller shaft and torque limiter. The winch uses a 45-metre long by 10 mm diameter wire rope with a two-metre chain and hook connected to the free end of the winch rope by a hammerlock.

DETAILED DESCRIPTION

Engine

19. **Construction.** The cylinder block and crankcase are cast in one piece. The engine block carries the camshaft bearings, the crankshaft main bearings and removable dry type cylinder liners. A water jacket incorporated within the engine block, which allows coolant to circulate around each cylinder to assist in keeping the engine at a constant operating temperature.

20. The cylinder head, which is detachable from the engine block, provides both the air inlet and exhaust gas ports and a means of sealing each cylinder. A gasket provides a gas/water tight seal when the cylinder head is bolted to the engine block. The alloy valve seats are pressed into place in the cylinder head and are, along with the valves, cooled when coolant flows up from the engine block and circulates through the passages in the head. The coolant also maintains the cylinder head at a constant temperature.

21. The crankshaft is drop-forged heat-treated steel, counter-weighted, machine ground to close limits, and balanced. The shaft is mounted in five replaceable precision shell-type bearings. Crankshaft end thrust is taken up on the number three bearing.

22. The camshaft is machined from a solid drop forging and mounted in three replaceable bearings located in the engine block. A gear, integral with the camshaft, provides drive to the oil pump.

23. The cam ground pistons are made of aluminium alloy and fitted with two compression rings and one oil control ring. The crown of the piston is recessed for the combustion chamber and machined to allow the inlet and exhaust valves to open (as they protrude below the surface of the cylinder head).

24. The flywheel is machined from a solid drop forging and bolted to the rear flange on the crankshaft. The ring-gear is heat shrunk onto the flywheel.

25. The rotor type oil pump is driven by the camshaft. Oil drawn from the oil pan (sump) is pumped under pressure to the engine lubricating system, via an oil pressure relief valve and a filter. The pressure relief valve prevents the oil pressure from exceeding the required pressure. A removable oil cooler is installed in the engine block and utilises the engine coolant to maintain the engine oil at a constant operating temperature.

26. Figures 3 and 4 illustrate the right- and left-hand views of the engine and show the location of the various components.

Lubrication System

27. The purpose of the lubrication system is to deliver oil under pressure to the various engine components that require lubrication.

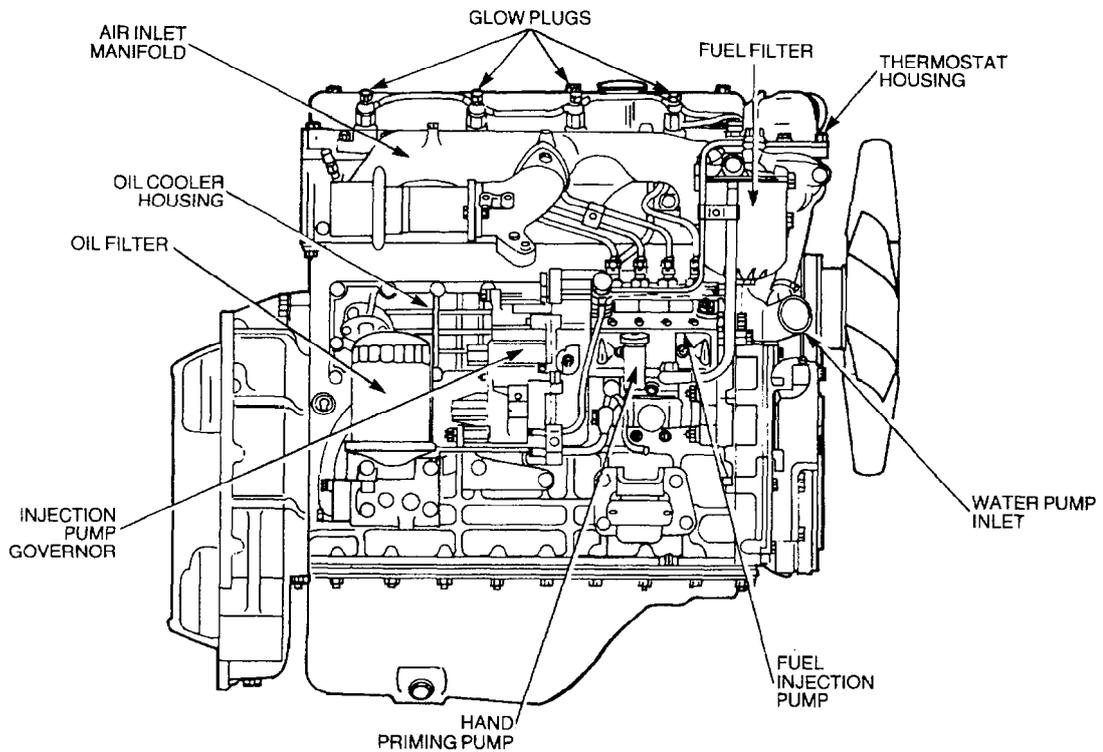


Figure 3 Isuzu Engine 4BD1 – Right-hand Side

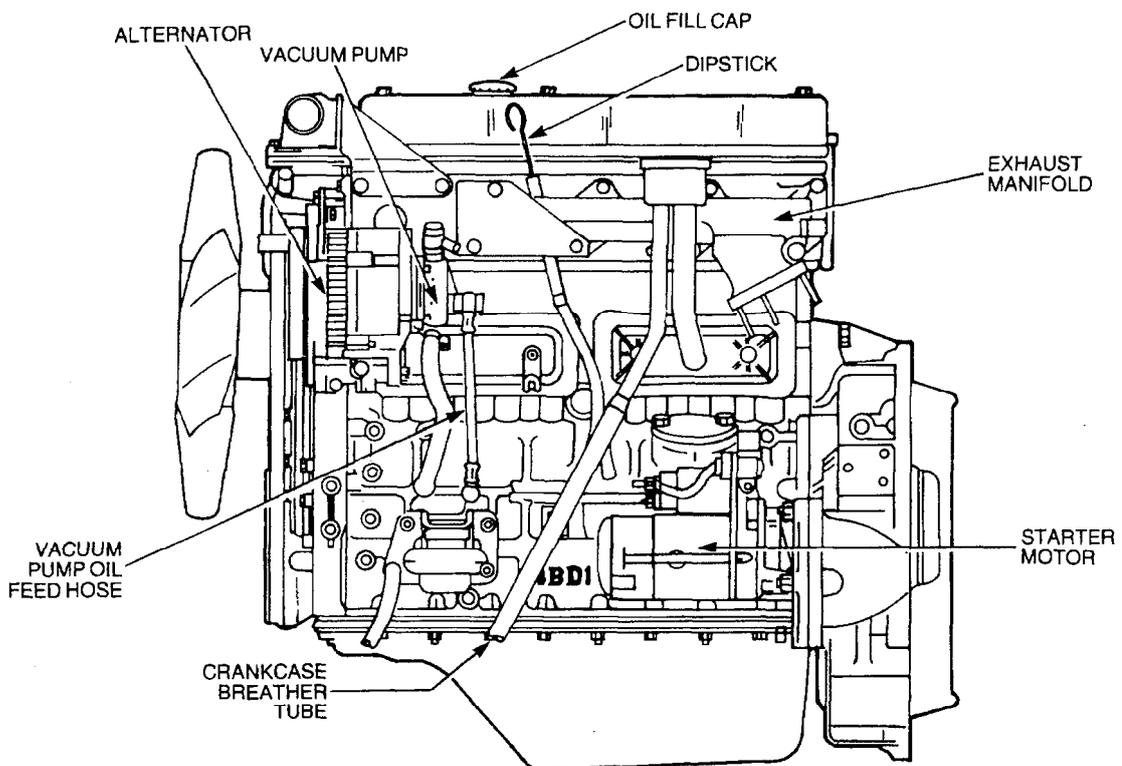


Figure 4 Isuzu Engine 4BD1 – Left-hand Side

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28. The oil pan is constructed from pressed steel and is bolted to the bottom of the engine block. It not only protects the lower, internal components of the engine, e.g. oil pump, crankshaft, con rods, etc, but it is also the storage reservoir for approximately 7.5 L of engine oil. A dipstick, located on the left-hand side of the engine, enables the engine oil to be monitored for both quality and quantity.

29. The oil pump located inside the oil pan, but mounted on the engine block, is a rotor type, i.e. a pair of meshing rotors inside a closed housing. One rotor is attached to the pump drive shaft, which is driven by a gear on the camshaft, while the second rotor is driven by the first (refer to Figure 5). The oil pump is a self-priming type, i.e. when the pump rotors are rotating, a low-pressure area is created in the pump housing, causing atmospheric pressure to force oil through the oil strainer and inlet tube into the pump housing. The meshing of the pump rotors displaces the oil and forces the oil from the pump. A pressure relief valve in the pump housing limits the maximum pump output pressure to 686 kPa (100 psi). Surplus pump output is bypassed to the oil pan.

30. The pressure regulating (relief) valve in the lubrication system operates in the same manner as the oil pump relief valve. The regulating valve maintains a constant pressure in the lubrication system by means of a ball and a spring. When oil pressure in the lubricating system exceeds the desired pressure, the pressurised oil acts on the ball forcing it to compress the spring and open a gallery, which allows oil to drain back to the oil pan and relieve the pressure within the system. The regulating valve limits the oil pressure within the oil galleries to 441 kPa (64 psi).

NOTE

The relief valve may have an electrical lead wire that is not connected electrically. If an oil leak occurs, replace the plug and O-ring with the revised plug and O-ring identified in RPS 02188.

31. The oil filter, mounted vertically on the right-hand side of the engine towards the rear, receives the oil from the oil pump and filters out the finer contaminants, which passed through the oil pump inlet tube strainer. The oil flows through the oil adaptor into the filter housing where it then flows through the filter element, outside-to-inside, trapping the contaminants on the outside of the element. The clean oil then flows downward through the oil adaptor into the oil galleries. If the filter becomes blocked, a bypass relief valve, located in the oil adaptor, allows oil to bypass the filter restricting the oil flow.

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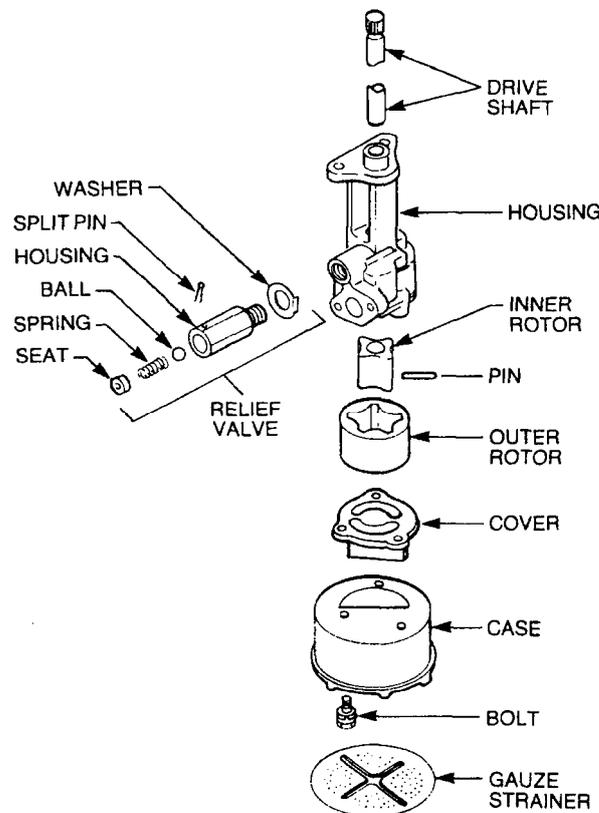


Figure 5 Oil Pump – Exploded View

32. An oil cooler is installed in the lubrication system to prevent the oil from overheating, and causing the breakdown of the chemical composition of the oil and the loss of lubricating qualities. A relief valve, located in the oil cooler housing, allows oil to bypass the cooler should it become blocked. It is installed in the water jacket, behind a cover, on the right-hand side of the engine, where engine coolant can flow over it, dissipating the heat and cooling the oil.

33. Oil galleries direct the flow of oil to the various components requiring lubrication e.g. crankshaft bearings (mains and big ends), camshaft bearings, the rocker arm shaft and the fuel injection pump. Other components are splash lubricated by the oil run off from the pressure-lubricated parts.

Cooling System

34. The cooling system consists of the following:

- a.** coolant, which contains Nalcool corrosion inhibitor in water at a ratio of 1:12;
- b.** water jackets and passages in the engine block and cylinder head;
- c.** a belt-driven centrifugal water pump;
- d.** a thermostat;
- e.** a chassis-mounted radiator, which is connected to the water pump inlet and the thermostat housing outlet by flexible rubber hoses; and
- f.** an expansion tank, which is equipped with a removable pressure cap and connected to the radiator by means of a rubber hose.

35. Although the primary function of the cooling system is to maintain the engine at a constant operating temperature, it also assists the engine to quickly warm up to the normal operating temperature. When the engine/coolant is cold, the thermostat is closed, restricting coolant flow. The water pump circulates the coolant only through the engine block and cylinder head, via the bypass hose, allowing the engine to quickly warm up. When a coolant temperature of 82°C is reached, the thermostat opens, allowing the coolant to flow from the thermostat housing and circulate through the radiator where it is cooled before being drawn back into the engine.

36. The thermostat is a wax pellet, disposable type, designed to open when a coolant temperature of 82°C is reached. At lower temperatures, spring pressure keeps the thermostat closed and the bypass valve at the bottom of the thermostat opens. This allows coolant to circulate from the water pump through the engine and back to the water pump via the bypass hose. As the desired temperature is reached, the wax pellet within the thermostat melts and expands. This exerts pressure on the plunger, which overcomes the spring pressure, opening the thermostat and closing the bypass valve (refer to Figure 6). Heated coolant now flows from the engine to the radiator.

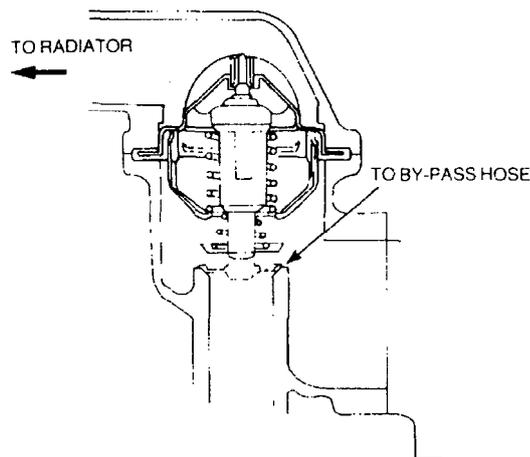


Figure 6 Thermostat Operation

37. The radiator is a cross-flow type, i.e. the tanks are located on the sides of the radiator and the flutes run horizontally across the core. Each flute contains metal fins over its entire length, which by convection, are heated to the temperature of the coolant. Airflow, induced by the forward motion of the vehicle and by the cooling system fan, passes through the radiator core dissipating heat from the fins, thereby reducing the temperature of the flutes and the coolant flowing through the flutes.

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38. The expansion tank allows the heated coolant, which has expanded, to flow from the radiator into the tank via a rubber hose. The removable pressure cap, fitted to the expansion tank, maintains the cooling system under pressure, which effectively raises the boiling point of the coolant enabling the engine to operate at high temperatures. The pressure cap is equipped with a pressure relief valve, rated at 103 kPa (15 psi), and a vacuum valve. Should the pressure exceed the specified limit, the pressure relief valve opens allowing internal pressures to be vented to the atmosphere. After the engine has been shut down, the coolant and the air within the cooling system contract creating a partial vacuum. In this case, the vacuum valve opens allowing outside air to enter. Damage to the radiator and/or hoses may result should either the pressure relief valve or the vacuum valve fail to function properly.

39. The water pump shown in Figure 7 is a belt-driven, mechanical, centrifugal type pump bolted to the front of the engine block. Drive for the water pump comes from the crankshaft pulley, via a V-belt, to the pulley attached to the water pump shaft. The coolant is drawn in through the inlet port and forced out through the port in the cover plate into the engine block water jacket. A six-blade fan attached to the water pump impeller shaft assists with engine cooling by drawing air through the radiator core cooling the contents of the radiator and circulating the air over the engine extremities.

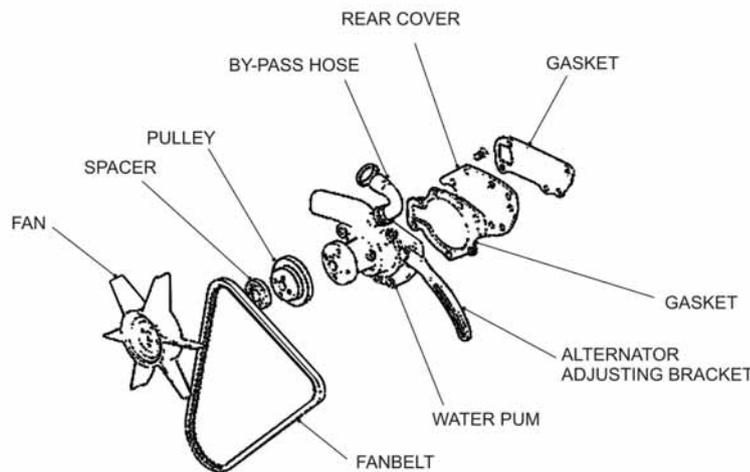


Figure 7 Water Pump Assembly

40. When the coolant in the cooling system reaches 82°C, the thermostat begins to open, permitting coolant to flow through the thermostat housing to the radiator via the radiator hose. The coolant flows from the left-hand radiator tank through the flutes in the radiator core (where it is cooled) to the right-hand tank. The coolant is then drawn from the right-hand tank through the lower radiator hose to the water pump, where it is pumped into the engine block water jacket. The coolant circulates around the cylinders, dissipating the heat from the cylinder walls. It then flows into the cylinder head, where it circulates around the inlet and exhaust ports cooling the valve seats and valves before flowing through the thermostat housing to the radiator to repeat the cooling cycle (refer to Figure 8).

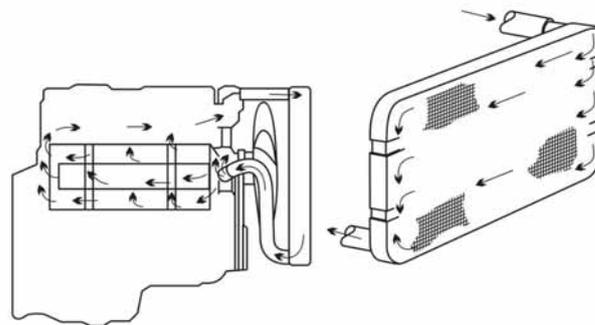


Figure 8 Cooling System – Coolant Flow

Air Cleaner

41. The air cleaner is utilised for the filtering of the air used in the engine's combustion process (refer to Figure 9). The air cleaner assembly is mounted on the rear of the engine and held in position by two metal bands. Incorporated within the air cleaner assembly's housing are the primary element and the safety element. The primary or main element is a dry-type paper element with a perforated metal surround and a plastic fin assembly fitted to one end.

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When the element is installed, the fin assembly is positioned towards the air inlet port in the housing. As air is drawn into the housing, via the air inlet hose, it passes between the fins, which induce a cyclonic twist to the air as it flows through. This action tends to cause the larger or heavier dust particles to be thrown outward eventually falling to the bottom of the housing. The air then passes through the primary filter, which extracts finer dust particles from the air and retains the particles in the element. Clean air then flows to the engine's air inlet manifold via the safety element, which is installed as a precautionary measure should the primary filter become damaged.

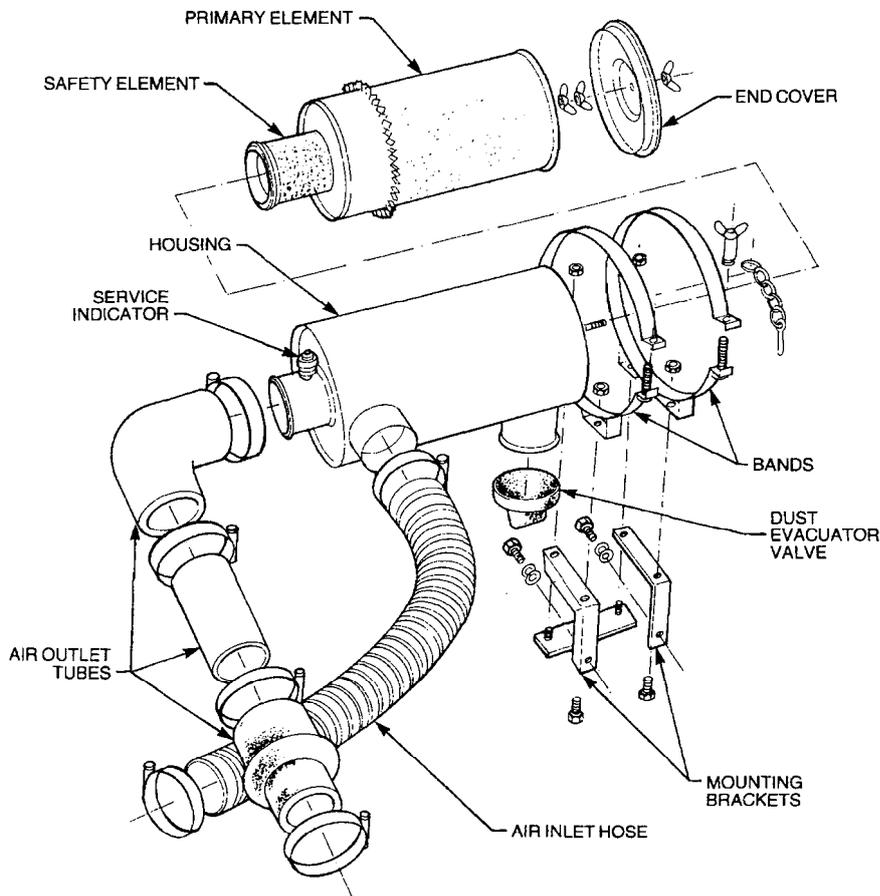


Figure 9 Air Cleaner – Exploded View

42. A service indicator as shown in Figure 10 is incorporated on the air cleaner housing to give a visual indication of air cleaner restriction. When the red float is clearly visible through the window of the indicator, the air cleaner requires servicing. When the air cleaners have been serviced, the service indicator can be reset by pressing the button on the top of the indicator.

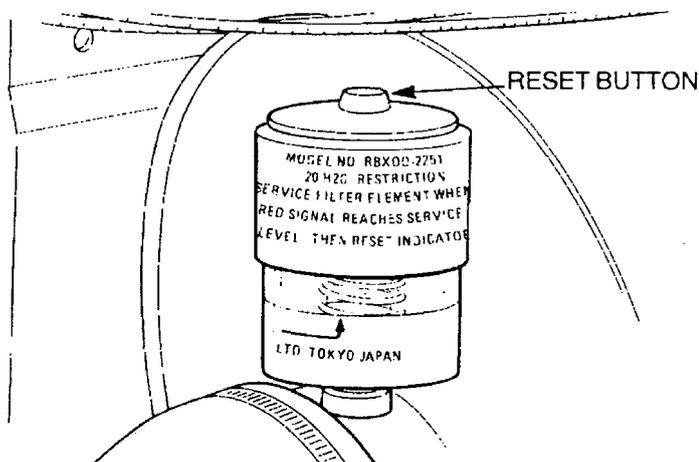


Figure 10 Air Cleaner Assembly Service Indicator

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Fuel System

43. An inlet pipe, fitted to the top of the fuel tank, allows the transfer pump to draw fuel from the tank. When the transfer pump is operating, it draws fuel from the tank via the fuel lines. The fuel passes through a sedimenter (refer to Figure 11) where water and large particles of contaminants are separated from the fuel. It then flows from the sedimenter to the transfer pump, passing through a fine mesh filter (strainer) before entering the pump. The transfer pump provides fuel at a pressure of 176–245 kPa (25.5–35.5 psi) to the fuel filter. The filtered fuel is then supplied to the injection pump, where it is pumped under high pressure, approx 18 000 kPa (2610 psi), to the injectors via the high-pressure fuel lines.

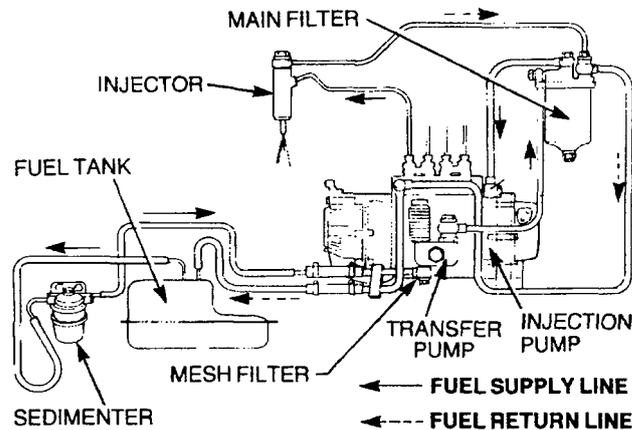


Figure 11 Fuel System

44. The fuel tank is made in two sections from pressed steel then spot welded together. Prior to the joining of the two sections, a baffle plate is welded to the inside of the tank to prevent fuel surge during vehicle operation.

45. The fuel tank is positioned below the driver's seat. The tank has a single-point rubber mounting at the front, bolted to a detachable mounting bracket, which is bolted to the chassis rail. A rigid mounting bracket is welded to the rear of the fuel tank and secured by bolts, nuts and spacers to the body-mounting bracket. Installed in the top of the fuel tank is a fuel gauge sender unit comprising a float mounted on an arm connected to a rheostat (variable resistor). The rheostat is connected by electrical wiring to the fuel gauge. An electric current flows through the fuel gauge to the rheostat and then to earth. The amount of current flow determines the position of the gauge pointer. The current flow is controlled by the amount of resistance created by the position of the float arm on the rheostat. The higher the float, the less the amount of resistance created by the rheostat. More current will flow through the gauge, causing the gauge pointer to react accordingly.

46. Incorporated with the fuel gauge sender unit are a fuel return pipe and a low fuel level sensor. The fuel return pipe allows overflow fuel from the injection pump and injectors to be returned to the fuel tank. The fuel low level sensor, attached to the fuel return pipe, causes a warning light to illuminate when the fuel level in the tank is below approximately nine litres.

47. A fuel sedimenter (refer to Figure 12) is incorporated in the fuel line between the fuel tank and the transfer pump to trap any water or heavy contaminants that may be in the fuel. A drain plug in the bottom of the sedimenter housing allows any water or contaminants to be drained off. The sedimenter is mounted on the chassis rail behind the fuel tank.

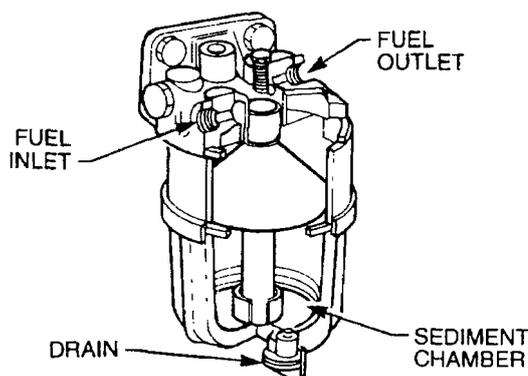


Figure 12 Fuel Sediment

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48. The transfer (supply) pump is a self-regulating mechanical type attached to the side of the fuel injection pump and driven by the injection pump camshaft. The transfer pump supplies fuel at a pressure of 176-245 kPa (25.5-35.5 psi) to the fuel filter and the injection pump. A strainer, incorporated in the transfer pump fuel inlet bolt, filters out coarse particles in the fuel preventing premature wear and damage to the internal components of the transfer pump.

49. **Transfer Pump Sequence.** When the injection pump camshaft is rotating, the transfer pump tappet, forced against the camshaft by the piston return spring via the piston and plunger, tracks the contours of the camshaft lobe causing the following:

- a. **Intake Stroke.** When the tappet is on the back of the camshaft lobe, the piston is on its intake stroke. The inlet check valve opens allowing fuel to flow into the piston spring chamber (refer to Figure 13).

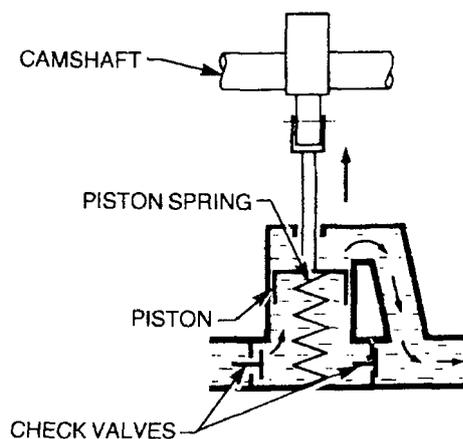


Figure 13 Intake Stroke

- b. **Discharge Stroke.** As the camshaft rotates and forces the piston back into the spring chamber, the inlet check valve closes, causing the fuel pressure to increase and open the outlet valve (refer to Figure 14). The fuel flows through the outlet valve and around to the chamber on the plunger side of the piston. As the camshaft continues to rotate, the spring pressure acting on the piston causes the piston to force the fuel out of the chamber on the plunger side of the piston. The fuel pressure closes the outlet valve causing the fuel to flow through the pump outlet port to the fuel filter.

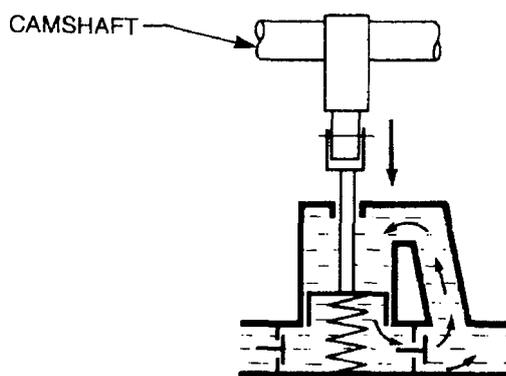


Figure 14 Discharge Stroke

- c. **Pump Pressure Regulation.** When fuel supply exceeds the demand, the fuel pressure acting on the plunger side of the piston becomes equal to the force exerted by the piston spring causing the piston to remain stationary (refer to Figure 15). At this stage, no further pumping action takes place until the fuel pressure in the injection pump fuel gallery drops causing the fuel pressure in the transfer pump to drop.

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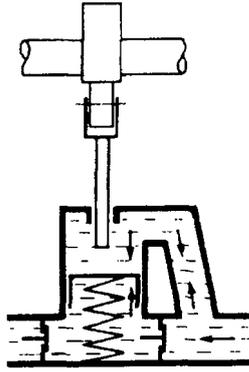


Figure 15 Pump Pressure Regulating

50. The main fuel filter, located at the front right-hand side of the engine, is comprised of a mounting adaptor, a removable housing, and a disposable cartridge and a drain plug (refer to Figure 16). Due to the fine tolerances required for the injection pump components and the injectors, the fuel filter is designed to remove contaminants from the fuel in sizes of 100 microns or larger.

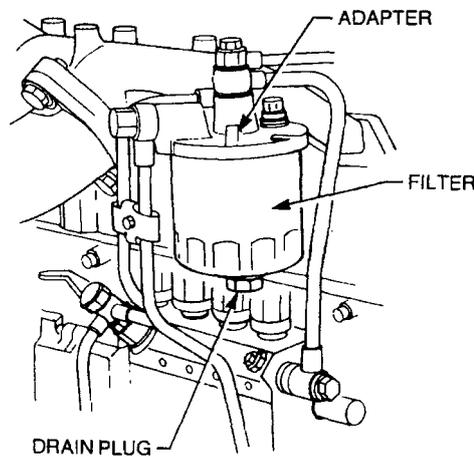


Figure 16 Main Fuel Filter

51. The injection pump is an in-line A-type located on the right-hand side of the engine and driven by the engine camshaft driving gear. Located within the injection pump housing are four plunger and barrel assemblies; one assembly for each of the engine cylinders and a camshaft. The plunger and barrel of each assembly are finely ground and assembled together with extremely fine tolerances forming a matched pair and should never be intermixed with other plungers or barrels.

Fuel Metering

52. The plungers used in the injection pump are 9.5 mm in diameter and have a centre bore drilling, instead of the more common external groove. A lower helix, which rises diagonally to the left giving a left lead, is machined into the side of the plunger (refer to Figure 17).

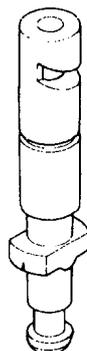


Figure 17 Plunger

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53. The barrels in which the plungers operate have an inlet/spill port, machined through the side into the bore (refer to Figure 18). When the barrel is installed in the injection pump, the port aligns with the fuel gallery in the injection pump. Fuel supply for the plunger flows from the fuel gallery, through the inlet/spill port and into the high-pressure chamber above the plunger.

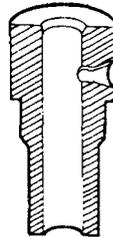


Figure 18 Barrel

54. As the stroke of the plunger is 8 mm, regardless of engine load or speed, the amount of fuel delivered to the injectors is regulated by the position of the helix in regard to the inlet/spill port. With the lowest point of the helix aligned with the inlet/spill port, maximum fuel delivery is achieved. As the plunger is rotated clockwise (when viewed from the bottom of the plunger), the quantity of fuel delivered is reduced with each stroke of the plunger. As the engine operates over varying loads and speeds, the fuel requirements of the engine also vary. To adjust the fuel delivery to suit the engine requirements, a control sleeve with a toothed segment clamped to its upper section and a toothed control rack are utilised. The barrel is installed into the sleeve from the top, while the plunger is installed from the bottom, with the control arms on the plunger stem positioned in the two longitudinal slots machined into the bottom of the control sleeve. When installed in the injection pump, the toothed segment of the sleeve meshes with the toothed control rack, which is mounted longitudinally in a bore within the body of the injection pump and free to move in that bore.

55. Movement of the control rack is regulated by both the accelerator and the injection pump governor. The accelerator is used for the initial or main movement of the rack to enable the engine to reach the required pulling power, while the governor makes finer adjustments to the rack to enable the engine to maintain that power over varying road conditions. As the accelerator pedal is depressed, the rack moves accordingly causing the control sleeve to rotate. The plunger, which is connected to the control sleeve via the control arms, also rotates moving the helix towards the lower point in relation to the barrel inlet/spill port, which is secured in a fixed position within the pump body. Figure 19 illustrates the plunger rotating mechanism showing the plunger helix to barrel inlet/spill port relationship in non-delivery, partial delivery and maximum delivery positions.

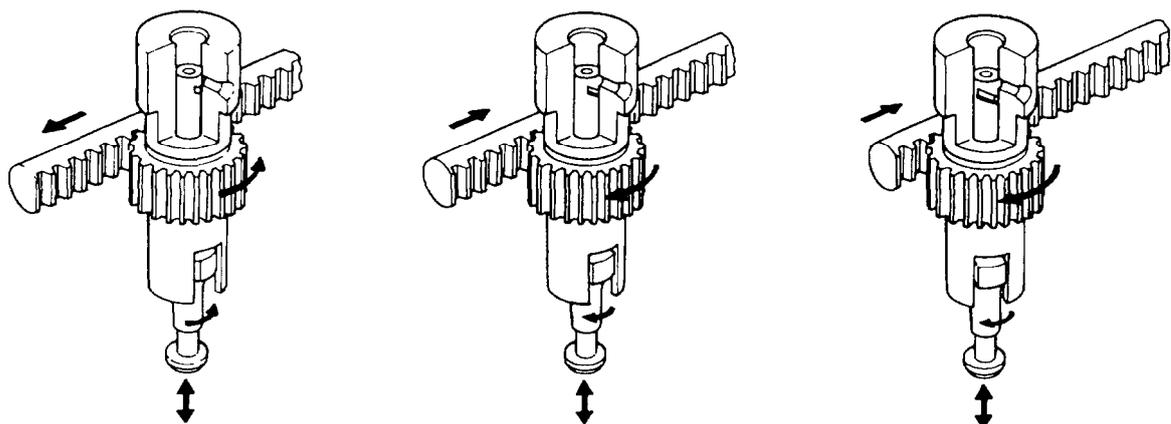


Figure 19 Plunger Rotating Mechanism

56. The injection pump camshaft has four tangential-shaped lobes. When installed in the injection pump body, each camshaft lobe is positioned directly below a plunger and barrel assembly. The camshaft rotates in accordance with the engine's timing gear. The camshaft lobes act on the roller tappets, shims, spring seats and return springs causing the plungers to move up and down within the bore of the barrel (refer to Figure 20). The camshaft drives the pump plunger and also influences the duration of injection, the pump delivery and the rate of delivery by the amount of lift and the profile of the camshaft lobe.

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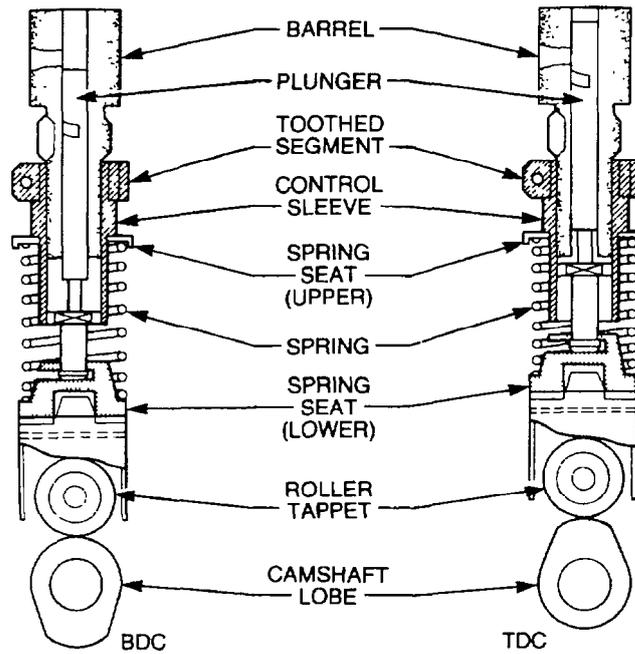


Figure 20 Plunger Drive Assembly

57. A housing is placed over the plunger and barrel assembly to enable the fuel to be pumped under high pressure to the injectors. A delivery valve and return spring are incorporated within the housing. When the housing is installed over the plunger and barrel assembly in the injection pump body, it effectively seals the area above the plunger creating a high-pressure chamber (refer to Figure 21).

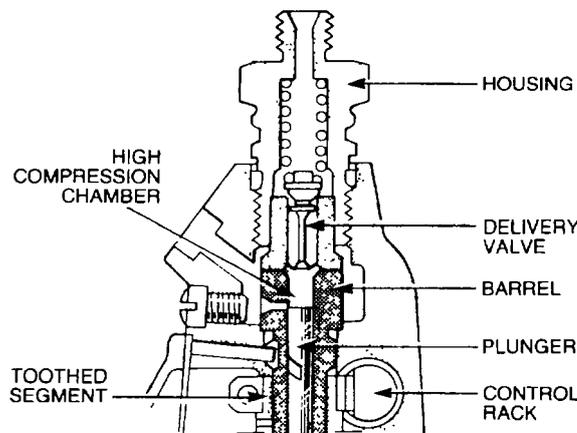


Figure 21 Housing and Delivery Valve Location

58. With the plunger at the bottom of its stroke (BDC), the inlet/spill port is open allowing fuel under low pressure to flow from the injection pump fuel gallery into the high-pressure chamber. As the camshaft rotates, causing the plunger to move towards the top of its stroke (TDC), a series of phases called strokes take place (refer to Figure 22) as follows:

- a. Pre-stroke is the closing-off of the inlet/spill port by the plunger.
- b. Effective stroke occurs when the pressure of the fuel above the plunger has attained the point where the delivery valve is lifted off its seat, against the return spring pressure, allowing the high-pressure fuel to flow to the injectors.
- c. Residual stroke occurs after the plunger helix has uncovered the inlet/spill port allowing the high-pressure fuel above the plunger to spill out into the injection pump fuel gallery via the plunger centre bore and helix.

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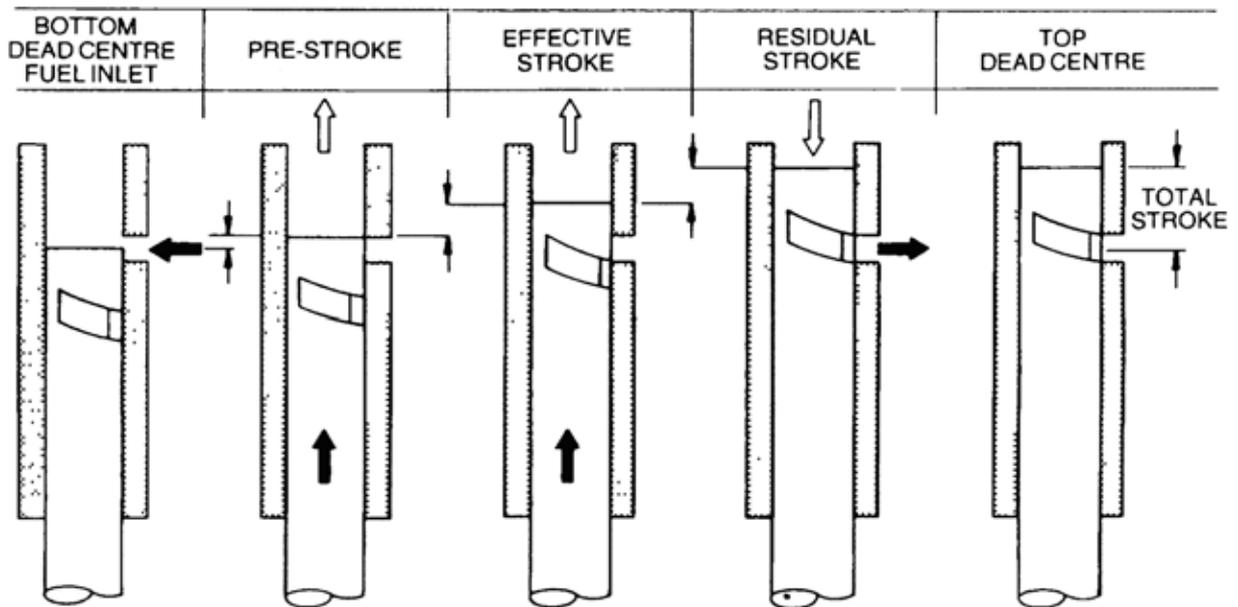


Figure 22 Phases (Strokes) of the Plunger

Fuel Injectors

59. The pressurised fuel from the injection pump passes along high-pressure fuel lines to the four fuel injector nozzle assemblies mounted in the cylinder head with the nozzle of each assembly protruding into the combustion chamber. After the pressurised fuel enters the nozzle holder body, it passes through a high-pressure fuel duct into a pressure chamber and down alongside the nozzle needle in the nozzle body (refer to Figure 23). The high-pressure fuel in the pressure chamber acts against the exposed annular area on the nozzle needle, pushing the nozzle needle and spindle up against spring pressure, opening the needle seat and allowing the fuel to flow out through the orifices, where it is sprayed into the combustion chamber.

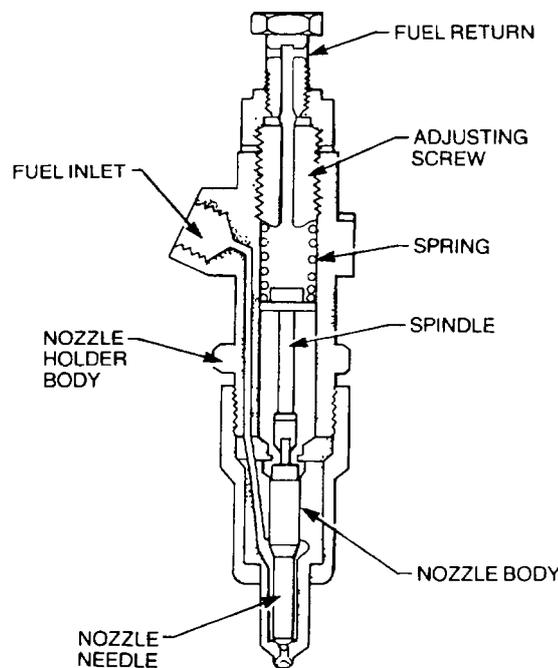


Figure 23 Fuel Injector Assembly

60. A small amount of fuel leakage takes place during fuel injection. The fuel seeps between the nozzle needle and the nozzle body, cooling and lubricating the needle and body as it does so. This fuel is then returned to the fuel tank via the injection pump overflow valve.

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Injection Pump Governor

61. The governor is attached to the back of the injection pump. It is a variable-speed control type, which not only controls the idle and maximum speed of the engine, but also maintains maximum torque output under varying loads and conditions at selected speeds between idle and the maximum no-load speed. Using flyweights, springs, rods and levers, the governor ensures that the engine does not stall when in the idle-speed range and that the maximum engine speed is not exceeded. When the engine is operating between idle and maximum speed, a torque cam and a sensor lever regulate the position of the control rack, which in turn regulates the amount of fuel injected to maintain the engine at the required torque output.

62. Figure 24 illustrates the governor assembly showing the location of the various components.

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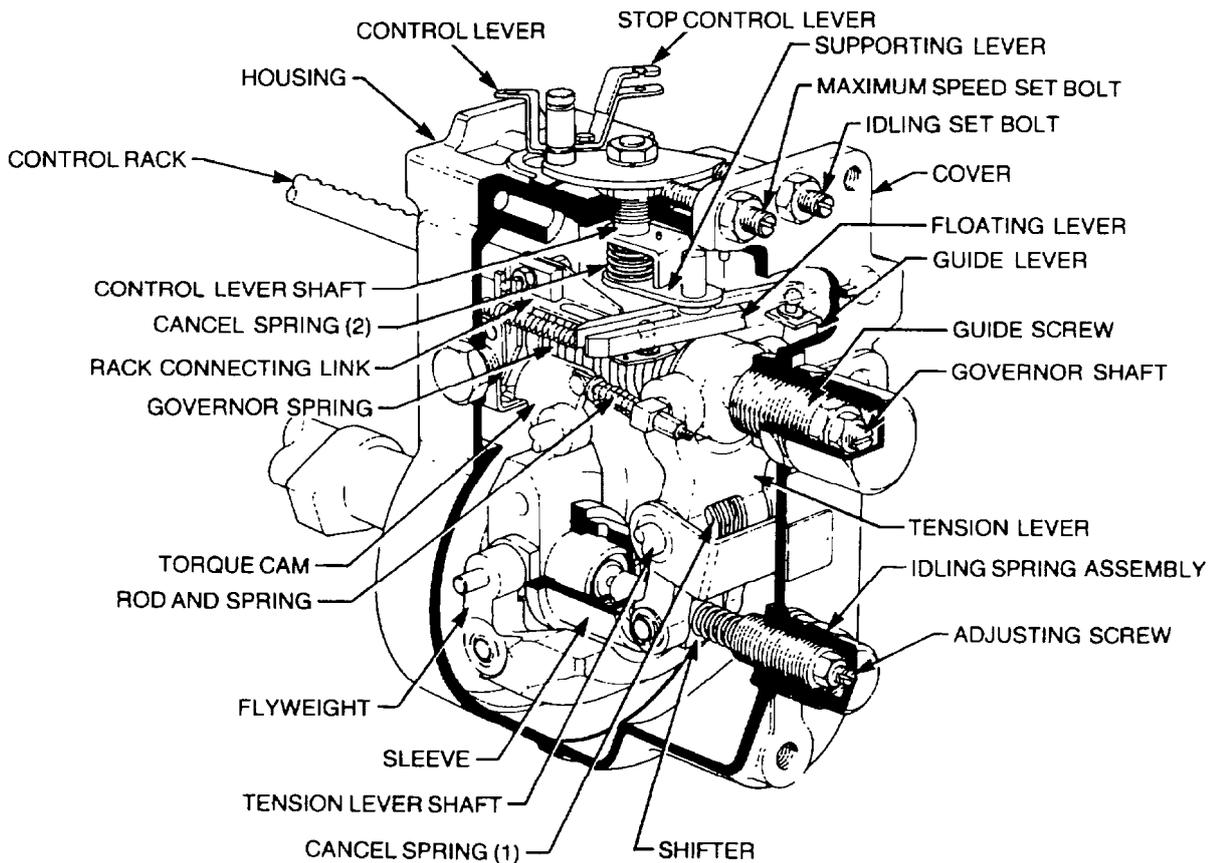


Figure 24 Governor Assembly

63. The flyweight holder (refer to Figure 25) is secured to the rear of the injection pump camshaft by means of a taper, Woodruff key and lock nut. The flyweights are secured to the holder by press-fit pins, around which the flyweights pivot. When the camshaft revolves, the flyweight holder and the flyweights revolve with it. As the camshaft speed increases, the flyweights move outward due to centrifugal force. This action causes the sliders, which are fixed to the arms on the flyweights, to push against a sleeve which causes the sleeve to move in an axial direction (refer to Figure 26).

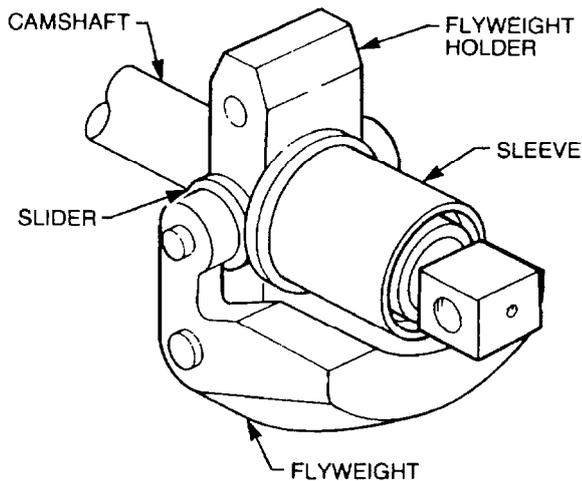


Figure 25 Flyweights Closed

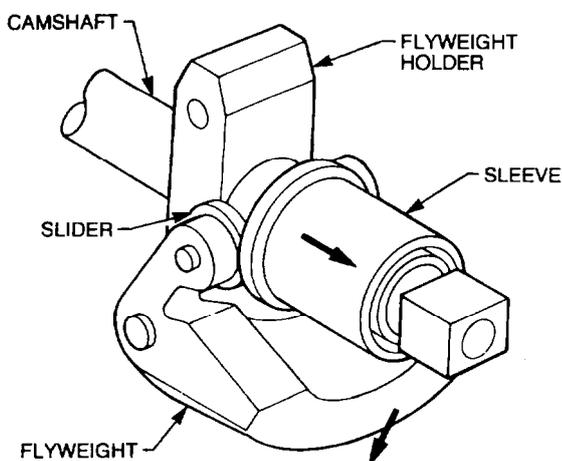


Figure 26 Flyweights Open

64. As the sleeve moves, it pushes against the shifter (which rides in the bearing in the end of the sleeve) causing the shifter to move in an axial direction. The shifter, which is connected to the tension lever by a pivot pin, causes the tension lever (which is shaft mounted to the governor cover) to pivot on the shaft. As the lower section of the tension lever moves away from the pump body, the upper section moves toward the pump body. A spring seat is attached by a pin to the upper section of the tension lever with the governor shaft running through the centre bore of the spring seat. The governor shaft is secured to the governor cover at one end by a guide screw. The other end of the shaft is mounted in a bore in the governor housing (refer to Figure 27).

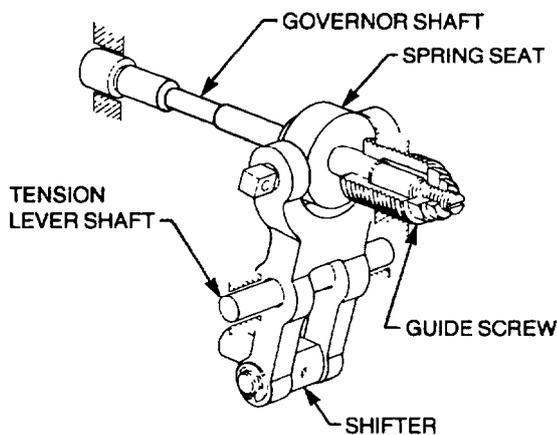


Figure 27 Tension Lever and Governor Shaft

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65. A spring seat is positioned on the governor shaft at the housing end. The governor springs are installed on the governor shaft and held uncompressed between the two seats. An idling spring capsule is positioned toward the bottom of the governor cover. The adjustable capsule houses the idling spring, which butts against the back of the shifter (refer to Figure 28). The combination of the governor springs and the idling spring counter the centrifugal force of the flyweights over the entire engine speed range, ensuring that the setting of the tension lever, in the position appropriate to the amount of flyweight lift, is smooth and progressive.

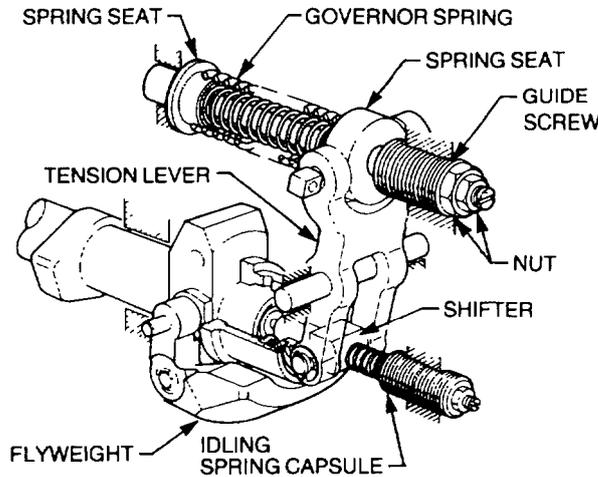


Figure 28 Governor Springs and Idling Spring Locations

66. The guide lever is also mounted on the tension lever shaft and is concentric with the tension lever. Both levers are held together by the force of the cancel spring (1) as shown in Figure 29. A ball joint is welded to the top of the guide lever.

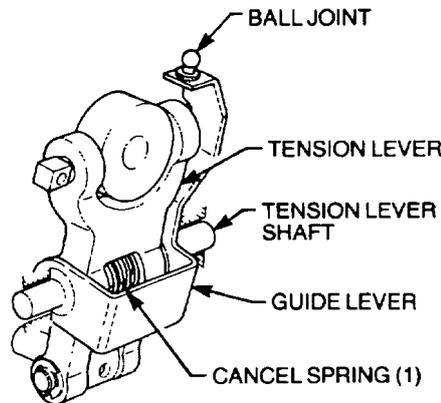


Figure 29 Guide Lever and Cancel Spring (1) Location

67. The connecting link, which has a ball joint welded to it, is secured to the end of the injection pump control rack by a bolt; nut and washer (refer to Figure 30). The start spring is connected to the connecting link and to the spring eye, which is bolted to the governor housing. The spring always works to pull the control rack into the fuel increase direction.

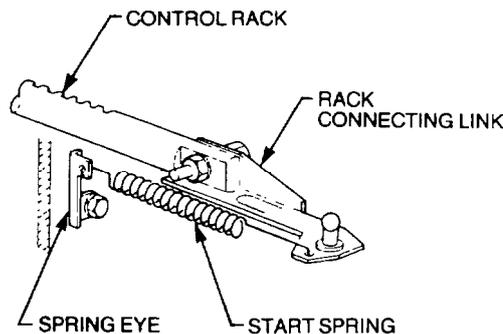


Figure 30 Connecting Link and Start Spring Location

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68. The control lever assembly, which is installed in the governor cover, comprises a floating lever, a supporting lever, a cancel spring, a control lever shaft and a control lever. The centre drilling of the floating lever is positioned on the lower pivot pin on the supporting lever and secured in place by a snap-ring. The supporting lever and the cancel spring (2) as shown in Figure 31 are positioned on the lower end of the control lever shaft and secured by a snap-ring. The force of the cancel spring (2) keeps the elbow on the control lever shaft in contact with the supporting lever. This assembly fits up through the governor cover and the control lever is positioned on the control lever shaft and secured by a nut. The forked ends of the floating lever engage with the tension lever ball joint at one end and the control rack connecting link ball joint at the other. The control lever assembly forms the mechanical linkage between the accelerator cable and the injection pump fuel control rack, and also between the governor assembly and the injection pump fuel control rack.

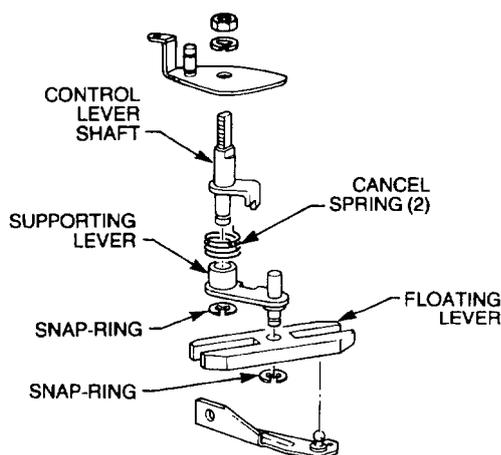


Figure 31 Control Assembly – Exploded View

69. A torque cam is mounted on a pivot pin, which is pressed into the inside of the governor cover on the control rack side. A rod, spring and adjusting nut connects the cam to the spring seat pin on the tension lever. The torque cam pivots on the pin in accordance with the movement of the tension lever or by adjusting the length of the connecting rod (refer to Figure 32).

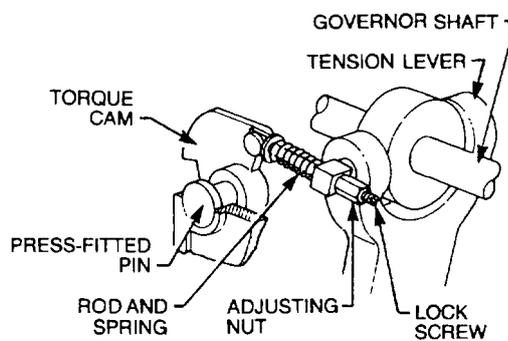


Figure 32 Torque Cam Location

70. The shaft for the full-load-setting lever is installed in the governor housing. As shown in Figure 33, cancel spring (3) is installed over the end of the shaft inside the housing. The U-shaped lever is positioned in the housing with one end located by a guide screw (on the control rack side of the housing). The other end is mounted on the end of the shaft against the cancel spring. The sensor lever is mounted on a pivot pin on the U-shaped lever on the control rack side. The full-load-setting lever, together with a return spring, is secured by a nut and washer to the full-load-setting lever shaft on the outside of the governor housing. The full-load-setting lever (refer to Figure 33) is always forced against the adjustable full-load-setting bolt (also located outside the governor housing) by the return spring (3).

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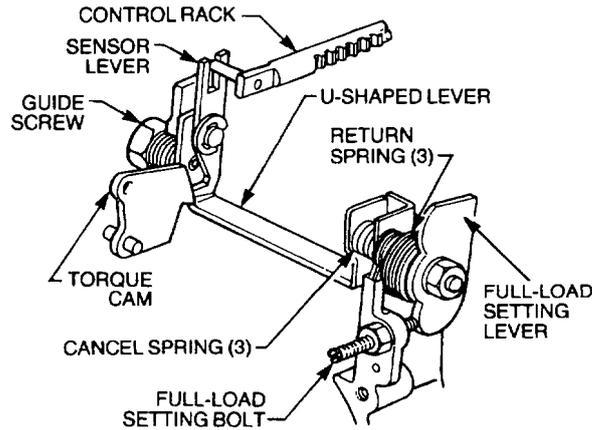


Figure 33 Full-load Setting Lever and Sensor Lever Locations

71. With the engine stationary (the injection pump not operating), depressing the accelerator pedal causes the control lever to move toward the maximum speed position. In so doing, the cancel spring (2) causes the supporting lever and the floating lever to move with the control lever (refer to Figure 34).

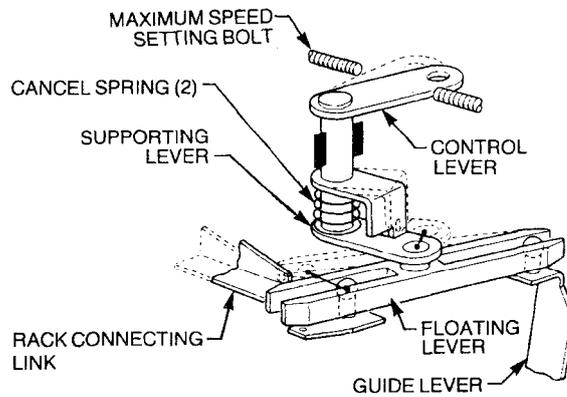


Figure 34 Control Lever Assembly Operation

72. As the guide lever ball joint is held stationary, the floating lever pivots on this ball joint causing the control rack to move in the fuel increase direction (refer to Figure 35). By depressing the accelerator pedal fully, the control lever moves to the maximum speed position causing the elbow on the control lever shaft to move away from the supporting lever. Cancel spring (2) then forces the supporting lever to move toward the elbow causing the floating lever to pivot on the stationary guide lever ball joint and move the control rack to the starting position. In this position, the sensor lever engages with the notch of the torque cam, which controls the engine's starting fuel injection quantity. The governor and the injection pump are now in the engine start position.

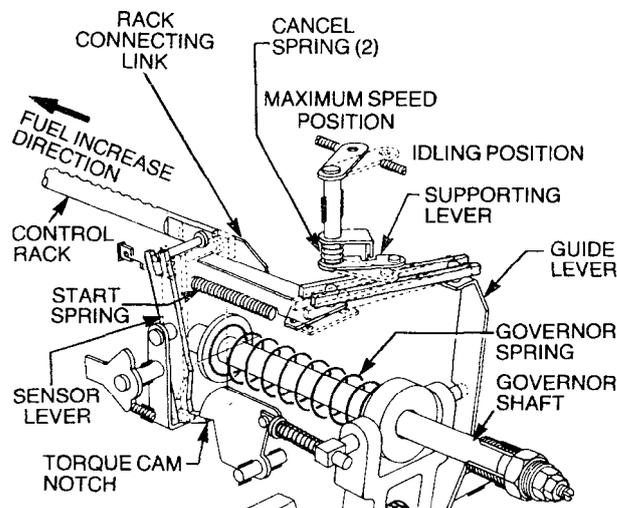


Figure 35 Engine Start Position

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CAUTION

Do not allow the engine to rev up after it starts. This will prevent the sensor lever from disengaging from the notch on the torque cam, dangerously interfering with the governor control of the injection pump.

73. With the engine started and the accelerator pedal released, the control lever returns to contact the idle-speed setting bolt. The control rack moves to decrease the fuel injection quantity and the edge of the sensor lever is released from the torque cam notch (refer to Figure 36).

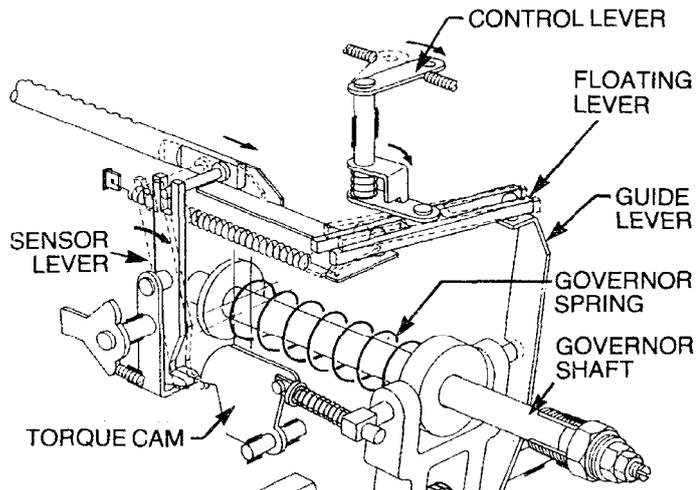


Figure 36 Returning to Idle Position

74. When the control lever returns to the idle position, it causes the supporting lever to return to the idle position creating a central fulcrum for the floating lever. As the engine speed decreases, the flyweight's centrifugal force also decreases to a point where the force of the idling spring causes the flyweight to close. As the flyweight closes, the tension lever moves inward causing the guide lever ball joint to move outward, pivoting the floating lever on the supporting arm pivot and moving the control rack in the increase fuel direction (refer to Figure 37). As the engine speed (and the pump speed) increases, the flyweight's centrifugal force overcomes the idling spring force. The bottom of the tension lever moves outward causing the guide lever ball joint to move inward, pivoting the floating lever on the supporting arm pivot and moving the control rack in the decrease fuel direction. The governor continuously monitors the idle speed in this manner while the engine is at idle.

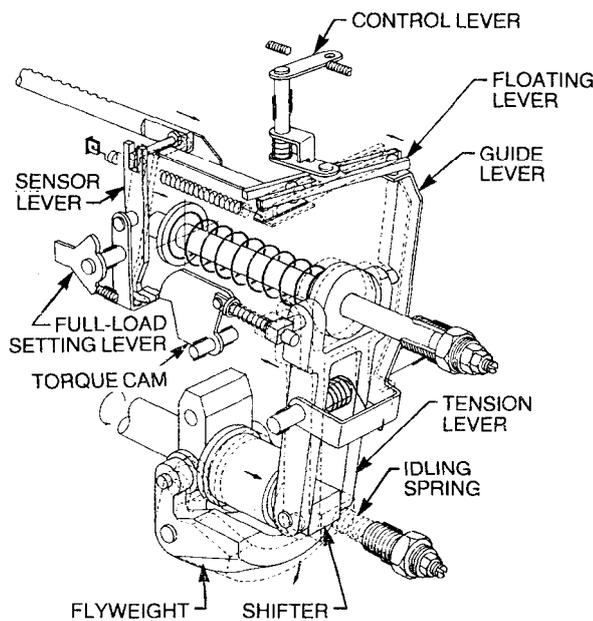


Figure 37 Governing Idle Speed

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75. With the engine running under load, depressing the accelerator until the control lever reaches the maximum-speed-setting bolt will cause the floating lever to pivot on the guide lever ball joint. This moves the control rack to the full-load position, which in turn causes the sensor lever to contact the torque cam. Engine speed fluctuations will cause the flyweight to open and close causing the tension lever to pivot on its shaft, moving the torque cam around its pivot (refer to Figure 38). As the torque cam moves, the sensor lever edge follows the profile of the torque cam, moving the control rack position to control the amount of fuel injected in accordance with the cam profile.

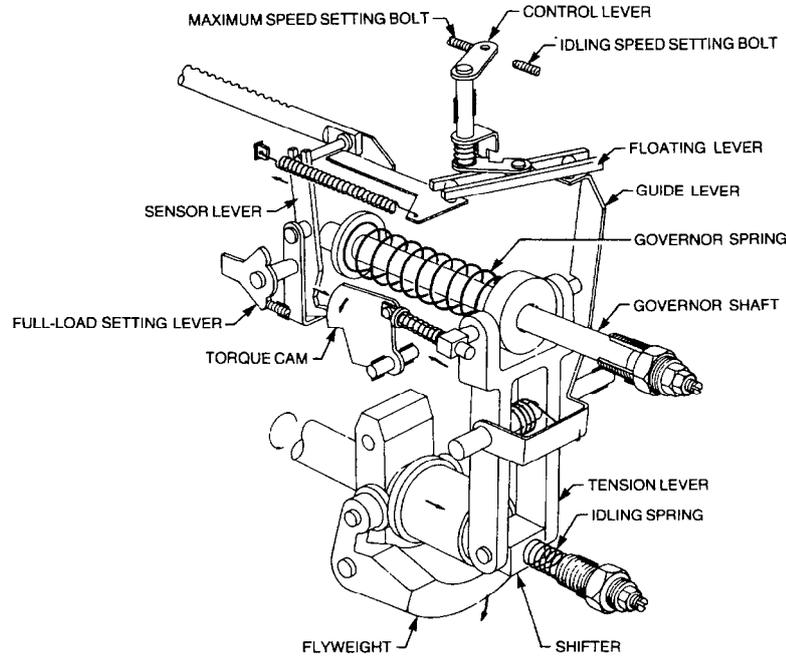


Figure 38 Full-load Operation

76. While the control lever is in contact with the maximum-speed-setting bolt, engine speed can increase while the fuel injection quantity is controlled by the torque cam and the sensor lever. With the supporting lever in contact with the elbow on the control lever shaft, an increase in engine speed causes the guide lever to move toward the fuel injection pump. This pivots the floating lever on the supporting lever pivot and moves the control rack toward the decrease fuel position, decreasing the fuel injection quantity for maximum speed governing. The sensor lever edge disengages from the torque cam for maximum speed governing (refer to Figure 39). The stop control lever moves the rack to the no-fuel position when the ignition is turned off.

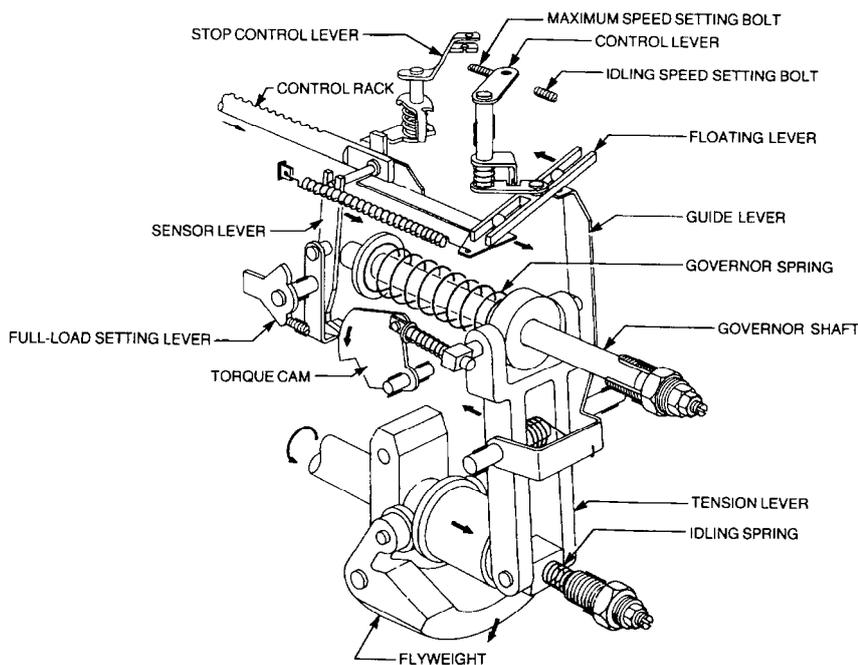


Figure 39 Maximum Speed Control

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Automatic Timer

77. The injection pump is equipped with an automatic timer, which forms the drive connection between the engine's timing gears and the injection pump camshaft. The purpose of the automatic timer is to reduce ignition lag, which, if excessive, causes diesel knock. The automatic timer is designed to advance the injection timing as the engine speed increases, thus allowing additional time for fuel and air in the combustion chamber to form an ignitable mixture, which then ignites at the correct time.

78. The automatic timer achieves this function by means of flyweights and springs. The flyweights and springs are incorporated in the timer and located between the flyweight holder and the injection pump drive gear flange (refer to Figure 40).

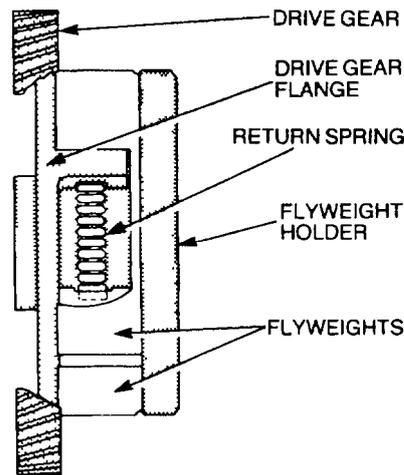


Figure 40 Automatic Timer Assembly

79. The flyweight holder incorporates the flyweight pivot pins, which also act as spring seats, while the drive gear flange incorporates spring seats, which also provide a machined surface against which the flyweights act (refer to Figure 41).

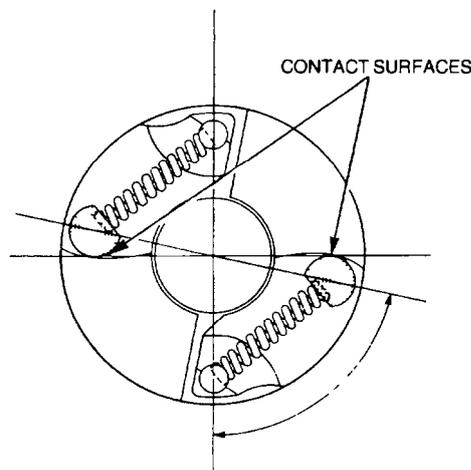


Figure 41 Automatic Timer – Static Position

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80. As the engine speed is increased, the centrifugal force created causes the flyweights to move outward. As the flyweights move, the arc (machined into the flyweight and offset in relation to the flyweight pivot) acts against the drive flange spring seats, drawing the flyweight pivots/spring seats toward the drive flange spring seats. This action causes the flyweight holder (and therefore the injection pump camshaft to which it is attached) to move ahead of the drive gear flange in the direction of rotation, effectively advancing the injection timing (refer to Figure 42).

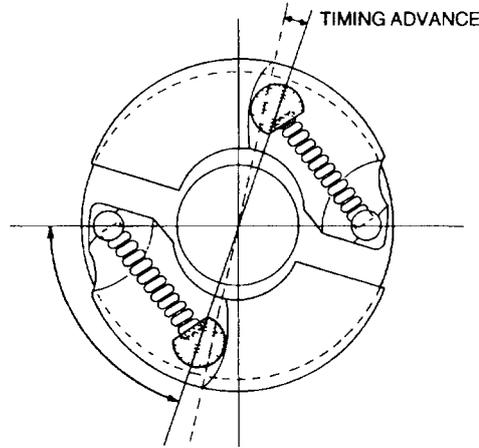


Figure 42 Flyweights in Timing Advance Position

81. When engine speed is decreased, the centrifugal force drops allowing spring pressure to act against the flyweights, causing the flyweights to move inward. In so doing, the spring seats on the flyweight holder begin to move away from the spring seats on the drive gear flange, effectively reducing the timing advance. Figure 43 illustrates the various components of the automatic timer.

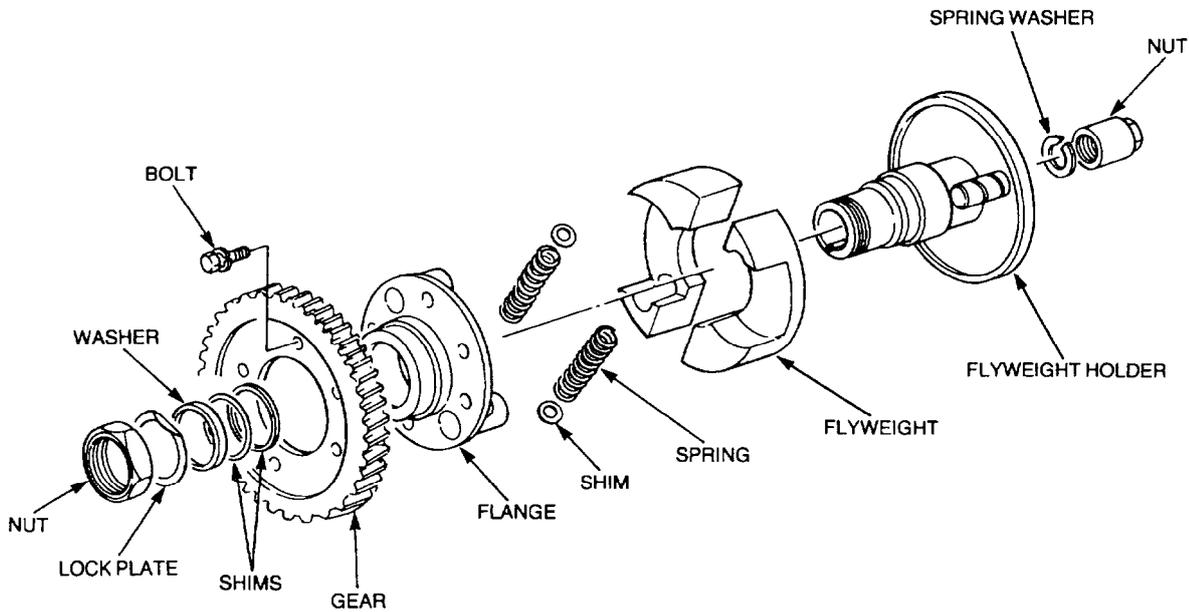


Figure 43 Automatic Timer – Exploded View

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Exhaust System

82. The engine exhaust system consists of a muffler and two exhaust pipes, both of which are constructed from 51 mm diameter, tubular steel. The muffler, with one inlet and one outlet pipe, is connected to both the front (engine) pipe and the rear pipe by flange connections.

83. The engine pipe is connected to the exhaust manifold outlet by means of a flange with a gasket between the flange connections to prevent exhaust gas leakage. The pipe is held in position by a U-bolt clamp and a rigid mounting bracket, while the muffler and the rear pipe are suspended by two U-bolt clamps, connected by bolts and rubber bushes to the chassis cross-members.

84. Figure 44 illustrates the vehicle's exhaust system.

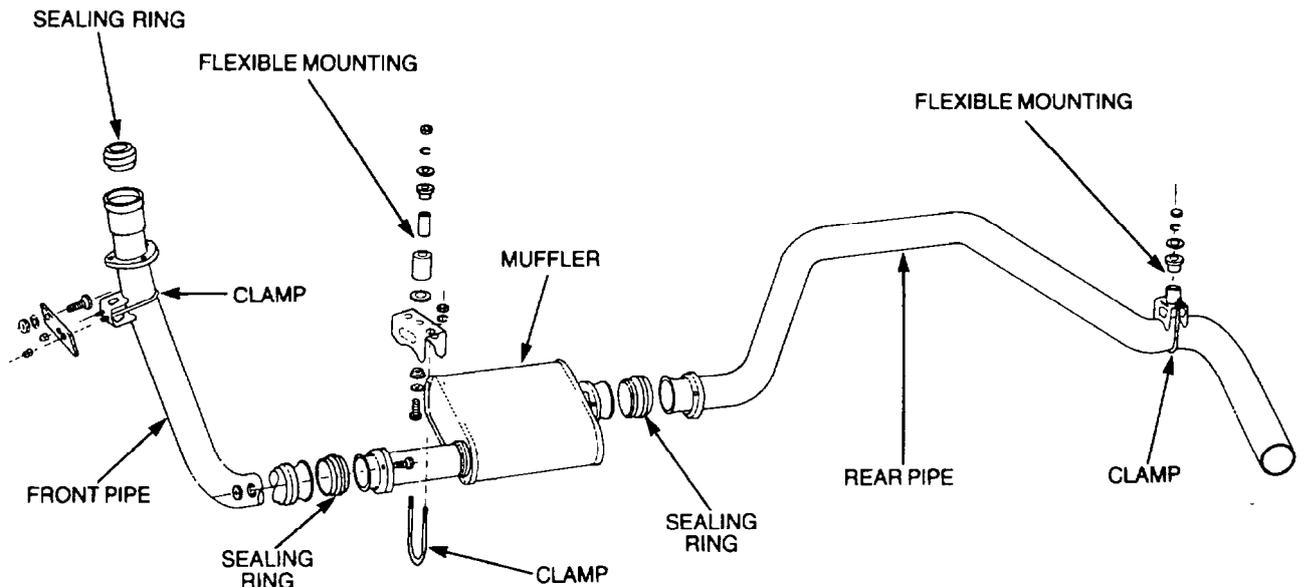


Figure 44 Exhaust System

Clutch

85. The clutch plate used on the vehicle is a spring-dampened single disc with linings riveted to both sides. The pressure plate used is a diaphragm-type, which utilises a Belleville-type spring to apply a load to the pressure plate. Both the clutch plate and the pressure plate are mounted on the flywheel, although only the pressure plate is secured to the flywheel. The clutch plate is held in position by the transmission input shaft (to which the clutch plate is splined) and the pressure plate.

86. The Belleville spring is secured to the pressure plate housing. Ridging on the inside of the pressure plate housing acts as a pivot, causing the Belleville spring to apply a load to the pressure plate when in the released position. This action clamps the clutch plate between the flywheel and pressure plate, causing drive from the flywheel to be transmitted to the transmission input shaft via the clutch plate.

87. To enable gear changes to be made while the vehicle is moving, drive from the flywheel to the transmission input shaft must be interrupted. This is to allow the rotational speeds of the various shafts and gears within the transmission housing to come into close alignment, making gear selection easier and smoother.

88. The break in the drive from the flywheel to the transmission is achieved by means of the clutch pedal, hydraulic circuit, release lever and a release bearing (refer to Figure 45). When the clutch pedal is depressed, a plunger attached to the clutch pedal lever acts on the piston in the clutch master cylinder, displacing hydraulic fluid from the bore of the master cylinder. The hydraulic fluid is forced from the master cylinder to the slave cylinder via pipes and hose. The pressurised hydraulic fluid acts on the piston in the slave cylinder, forcing the piston outward. A plunger attached to the piston pushes against the release lever, which, because of a pivot mounting, pushes against the release bearing, causing the bearing to depress the inner circumference of the Belleville spring. This action causes the outer circumference of the Belleville spring to remove the load it applied to the pressure plate, which in turn relieves the clamping effect applied to the clutch plate, allowing the clutch plate to come away from the flywheel and stop transmitting drive to the transmission.

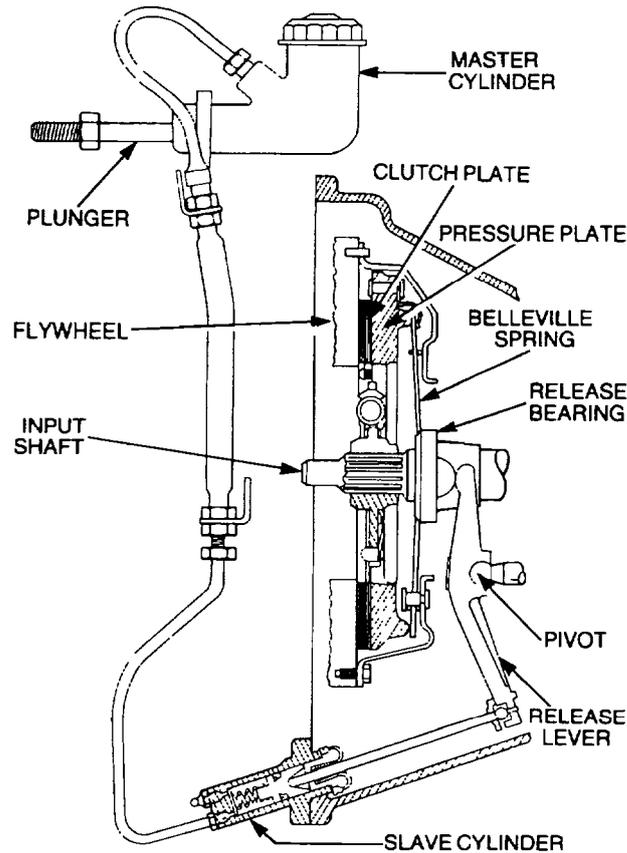


Figure 45 Clutch Assembly – Sectional View

Transmission

89. The transmission consists of two aluminium alloy housings; the bell housing, and the transmission and transfer case housing. The bell housing not only connects the transmission to the engine, but also houses the clutch assembly, the clutch release mechanism and the transmission input (pinion) shaft. A drain plug is located in the bottom of the flywheel housing to provide a means of draining off contaminants, which may have entered the bell housing during fording.

90. The transmission and transfer case housing is actually two separate sections utilising the one casting. The transmission section contains the input shaft, countershaft, reverse idle gear, mainshaft and gear selectors. The transfer case, located at the rear of the casting, contains the mainshaft transfer gear, an intermediate gear assembly and a differential assembly for the transmission output. Both the transmission and the transfer case have their own selector levers as well as individual drain and fill plugs.

91. The transmission input shaft, together with the top gear (fourth), is machined from one solid forging. A counter bore in the gear end of the shaft provides housing for the mainshaft front bearing. The countershaft, with its five gears, is also machined from a solid drop forging and is supported at each end by pre-loaded taper roller bearings. An oil pump, driven by the countershaft, ensures that the mainshaft is constantly supplied with oil. The mainshaft is supported by three bearings: a needle roller bearing at the front, a ball bearing in the centre and a needle roller bearing at the rear. The mainshaft is fitted with four helical cut gears and two synchroniser units. Reverse gear is formed on the outer circumference of the rear synchroniser unit.

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92. When the gears and synchronisers are installed on the mainshaft, they are located from the front (refer to Figure 46): third/fourth gear synchroniser, third gear, second gear, first/second gear synchroniser, first gear and the mainshaft transfer gear, which is located in the transfer case section. The reverse idler gear, which is a spur tooth pinion supported on needle roller bearings and mounted on its own shaft, is also located in the transmission section. Unlike the forward gears that utilise the synchroniser unit to engage the selected gear, the reverse idler gear is moved to mesh with the spur gear on the countershaft and the spur gear on the first/second gear synchroniser. Because the idler gear transmits drive from the countershaft to the mainshaft via the synchroniser, the mainshaft is made to turn in the opposite direction to the normal direction of rotation, thus giving the vehicle a reverse gear.

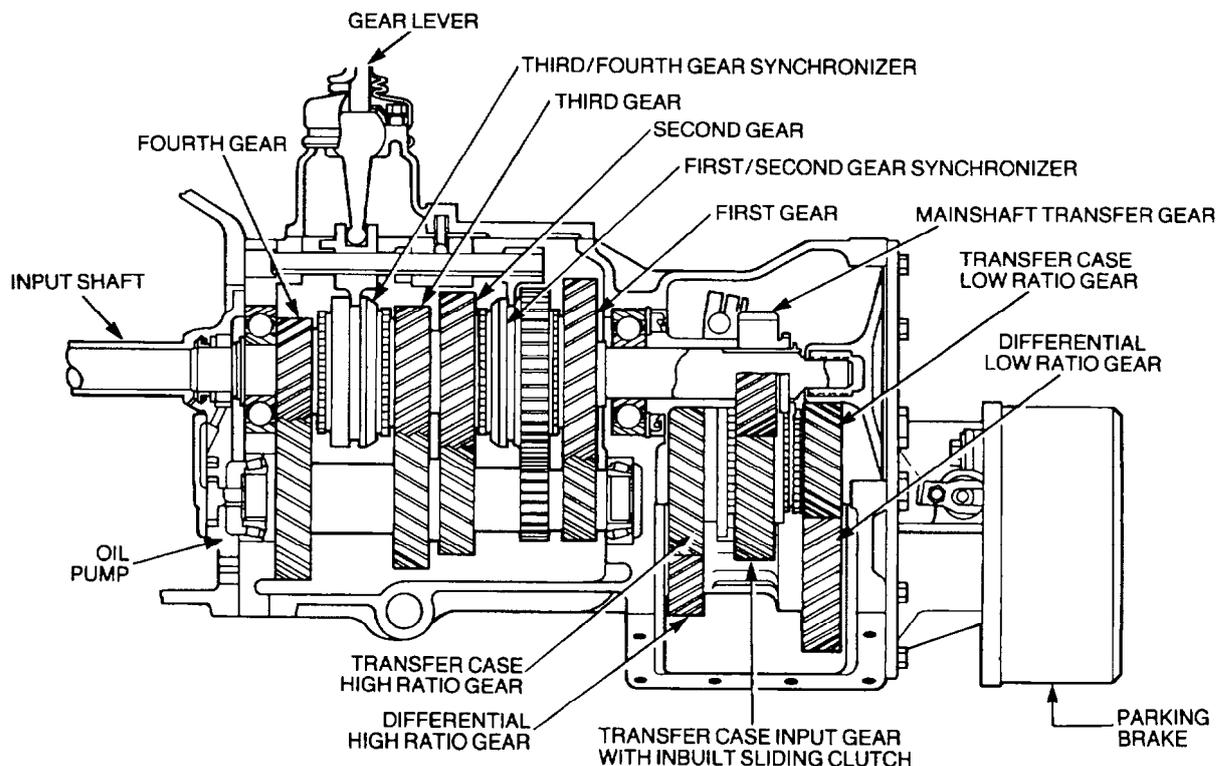


Figure 46 Transmission Assembly – Sectional View

93. Drive is transmitted from the engine via the clutch plate and input shaft to the countershaft, which is in constant mesh with the input shaft gear (fourth gear). When a forward gear is selected (other than fourth), drive is transmitted from the countershaft to the mainshaft via the selected gear and the synchroniser unit. First, second and third gears are also in constant mesh with the countershaft, but as these gears are supported by needle roller bearings on the mainshaft, they cannot transmit drive directly to the mainshaft. Drive is only transmitted to the mainshaft by the synchroniser units, which are splined to the mainshaft, but are able to slide back and forth to engage with the selected gear and transmit drive from that gear to the mainshaft. Drive from fourth (top) gear is transmitted directly to the mainshaft, bypassing the countershaft, but only when the synchroniser unit is engaged with fourth gear. Figure 47 shows drive through the forward gears.

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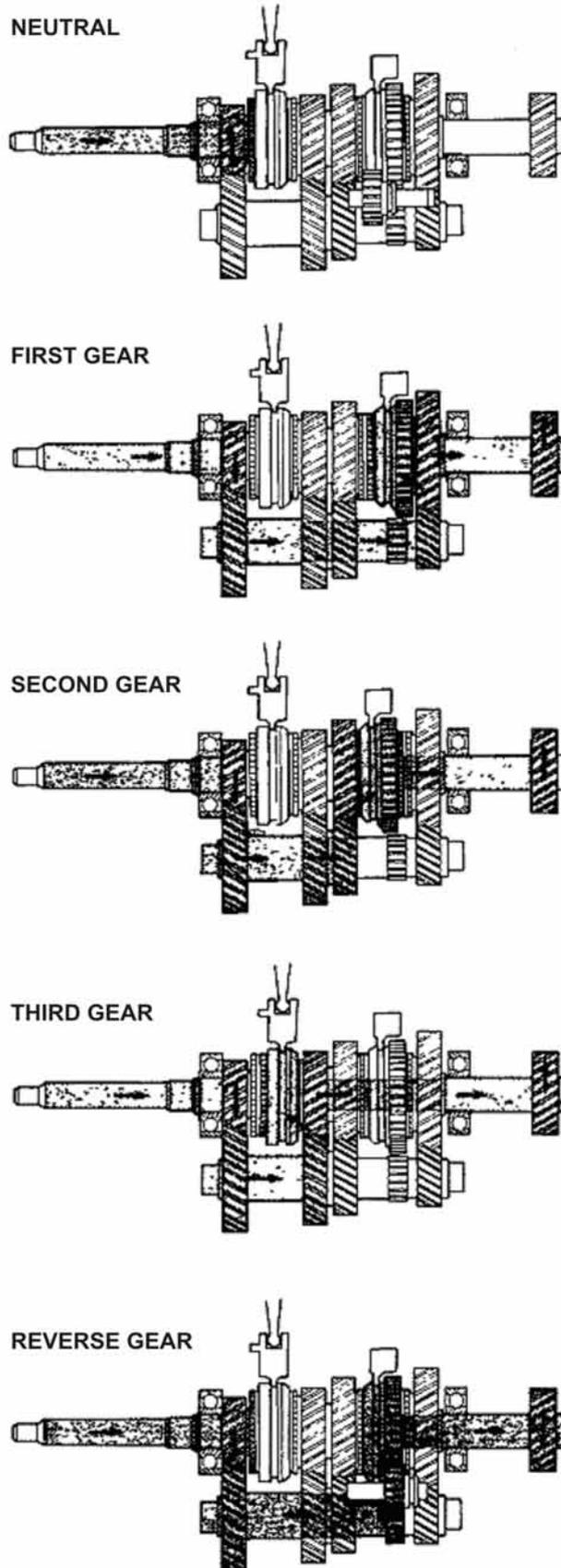


Figure 47 Drive Transmitted through the Gears

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94. Transfer Case. The transfer case enables drive from the transmission to be directed to both the front and rear axles simultaneously, and also provides two extra gear ratios (a low and a high) effectively giving the vehicle a total of eight forward gears and two reverse gears. The low ratio, when selected, is used where low speed and high-torque output is required, while the high ratio is used for normal driving.

95. The mainshaft transfer gear and the intermediate shaft central input gear are in constant mesh with each other, allowing drive from the transfer gear to be transmitted directly to the central input gear. As the central input gear is supported on the intermediate shaft by two tapered roller bearings, drive from the input gear cannot be transmitted to the intermediate shaft. However, a sliding dog clutch, incorporated with the central input gear and moved by a selector lever and fork, enables the drive to be transmitted to either the high or low gear ratios. Although both of these gears are each supported by two tapered roller bearings on the intermediate shaft, they are both in constant mesh with gears on the differential assembly (refer to Figure 48). So, when either the high or low ratio gear is engaged with the central input gear via the sliding dog clutch, drive can be transmitted from the central input gear to the differential then out to the front and rear axles.

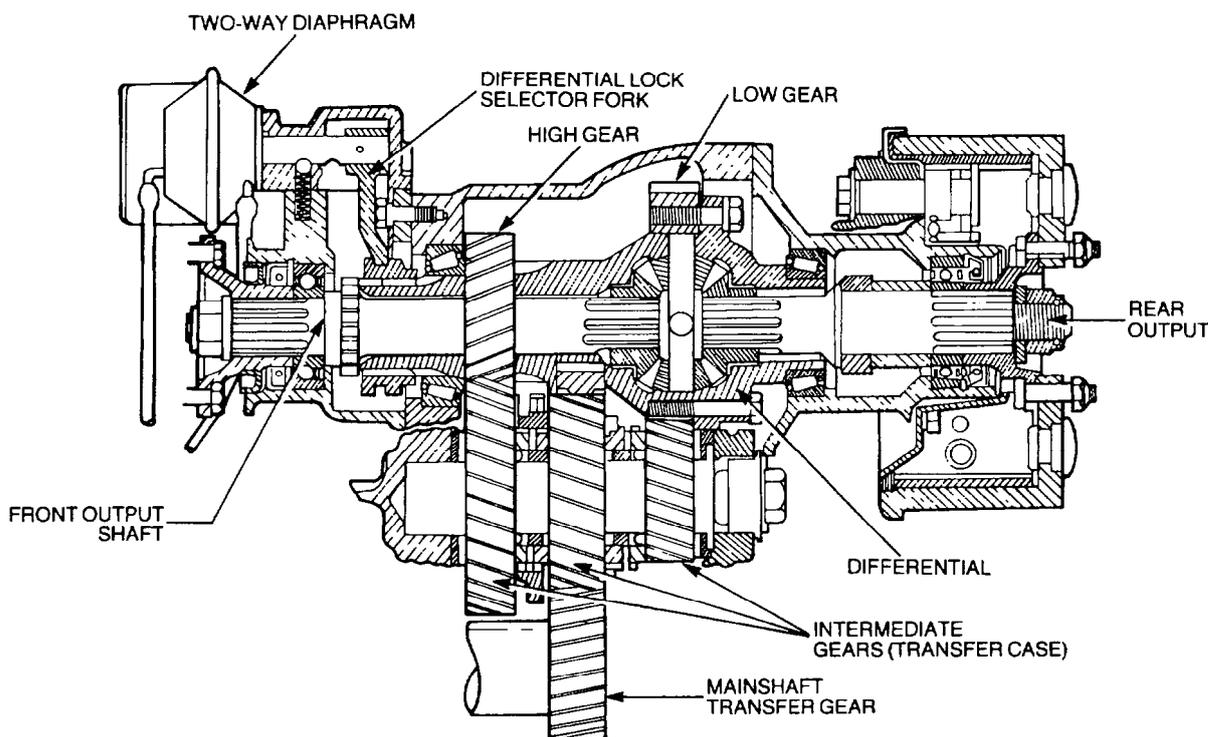


Figure 48 Transfer Case and Differential – Sectional View

96. The two-piece differential case, mounted on two tapered roller bearings in the transfer case, operates in the same manner as a drive axle differential. The differential casing carries two driven gears, the smaller gear being the high ratio and the larger gear, the low ratio. The casing also houses four bevel pinion gears and thrust washers, two side gears and one cross-shaft (see Figure 48). The six gears are installed as a matched set. Front and rear output shafts are installed in the differential and engage with the splines in the side gears. As the differential casing revolves, so do the output shafts, transmitting the drive to the front and rear axles. The rear output shaft carries the speedometer drive gear, while the front output shaft carries a dog clutch. This dog clutch is utilised when positive all-wheel drive is required. By operating the differential lock control switch on the dashboard, vacuum is supplied to the forward side of a two-way diaphragm on the transmission, while the rear side of the diaphragm is vented to the atmosphere via the control switch. The vacuum supply causes deflection of the diaphragm, which moves the selector mechanism, locking the front output shaft (via the dog clutch) to the differential casing. In so doing, the differential action between the front and rear output shafts is now locked out, and positive drive to both output shafts is now provided.

97. When positive drive is no longer necessary and the switch is turned off, the forward side of the vacuum chamber diaphragm is now vented to the atmosphere while a vacuum is applied to the rear side of the diaphragm. The deflection of the diaphragm causes the selector mechanism to move and disengage the dog clutch from the differential casing, unlocking the front output shaft from the differential casing and allowing the differential to resume normal operation.

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98. Power Take-off (PTO). Vehicles equipped with a winch utilise a transmission-driven PTO to provide drive to the winch. The PTO is mounted on the transmission housing below the transfer case (refer to Figure 49). An endless chain transfers drive from the sprocket on the transmission mainshaft to the sprocket on the PTO output shaft. The sprocket on the PTO output shaft is supported on the shaft by two bearings, a ball type and a roller type, and thus revolves freely on the shaft. When the PTO control is moved to the engaged position, the sliding clutch on the torque limiter moves along the splines and engages with the dog clutch on the PTO sprocket.

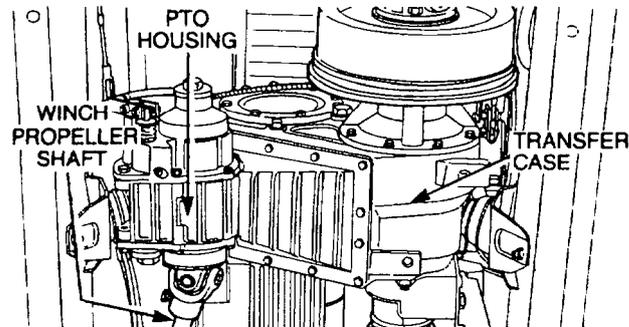


Figure 49 Power Take-off (PTO) Location

99. Drive from the transmission is now transmitted from the PTO sprocket to the torque limiter (refer to Figure 50). If the load applied to the winch is less than the maximum recommended load, the torque limiter will transmit the drive to the PTO output shaft, which transmits the drive to the winch via the propeller shaft. If the load applied to the winch exceeds the maximum recommended load, the torque required to drive the winch will exceed the torque setting of the torque limiter. Should this occur, the torque limiter will slip, preventing the drive being transmitted to the PTO output shaft and, therefore, to the winch. This action prevents the winch from being damaged due to overloading. The torque limiter will automatically reset itself when the excessive load is removed, allowing normal winching operations to proceed.

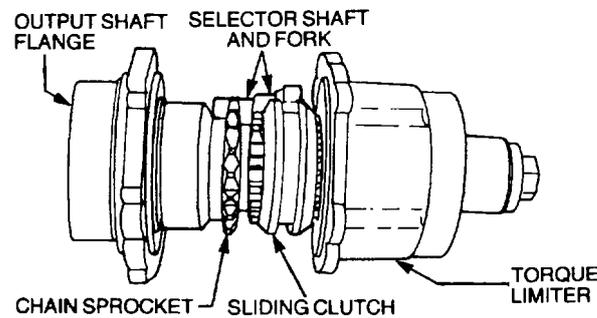


Figure 50 PTO and Torque Limiter Assembly

100. Torque Limiter. The torque limiter, which is incorporated as part of the PTO assembly and used to prevent winch overload, is comprised of a drive hub, a sliding clutch, twelve steel balls and coil springs, a steel spacer, a drive flange, an output shaft and two bearings being a ball type, and a roller type (refer to Figure 51).

101. The drive hub is supported on the output shaft by both the roller and the ball bearings and revolves freely on the shaft. The twelve coil springs and steel balls are installed in four groups of three in the sixteen holes in the drive hub, with the steel balls protruding. When the components are assembled, the steel balls sit in the indents in the drive flange and transmit the drive from the drive hub to the drive flange. When a winch overload occurs, the steel balls are caused to jump from one indent to the next, as the drive flange stalls under load and the drive hub keeps turning. The steel spacer, which is available in varying thicknesses, is used to set the pre-load of the steel balls in the indents by altering the clearance between the drive hub and the drive flange. When the correct clearance is set, a torque of 115 N.m is required to turn the drive hub while the drive flange is held stationary, thus creating a safe working limit for the winch.

102. A cable connects the control lever located on the seat base below the driver's seat to the selector lever on the PTO housing. A selector fork, located in the PTO housing, connects the selector lever to the sliding clutch, which engages with the dog clutch on the PTO sprocket when the control lever is pulled to the engaged position.

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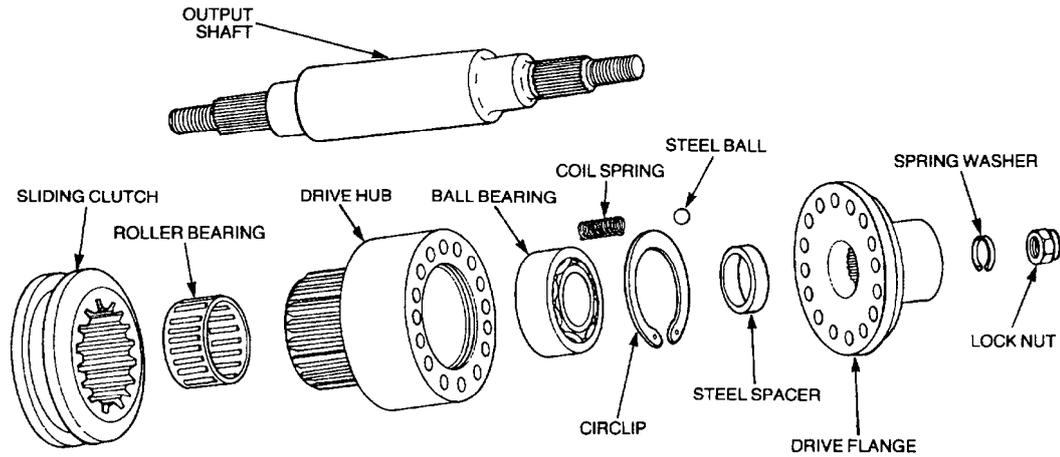


Figure 51 Torque Limiter and Output Shaft

Propeller Shafts

103. Two 1310 series propeller shafts (refer to Figure 52) are used on the vehicle to transmit drive from the transfer case output shafts to both the front and rear axles. Both propeller shafts are constructed with a sliding (slip) joint and two single, needle roller type universal joints. The sliding joint allows the length of the propeller shaft to vary in accordance with the position of the axle as it moves up or down. A grease nipple is fitted to the sliding joint for ease of maintenance. The universal joints allow drive to be transmitted to the axle through varying angles, which are caused by the vertical movement of the axle and suspension. The universal joints are maintenance free and are serviced by replacement.

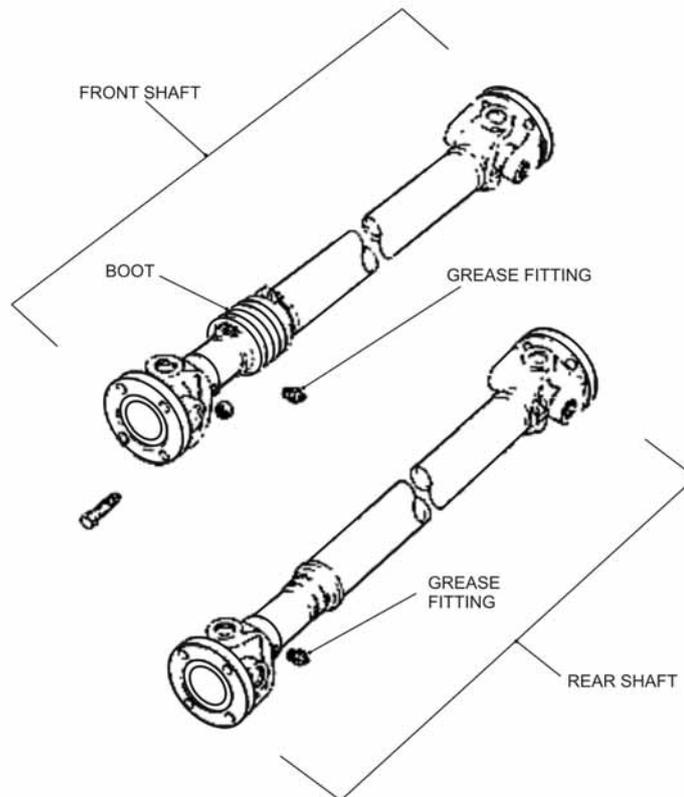


Figure 52 Front and Rear Propeller Shafts

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Rear Axle

104. The rear axle assembly (refer to Figure 53) transmits drive from the propeller shaft to the rear axles, hubs and wheels and a differential is utilised to achieve this. The differential is comprised of a crown wheel and pinion, two side gears, which are spline connected to the axle shafts, four planetary bevel gears, and a cross-shaft, which not only locates the planetary bevel gears, but also forms the axis about which each planetary gear rotates. With the Salisbury differential, the differential carrier is incorporated in the axle housing and cannot be removed. To gain access to the differential, a cover plate must be removed from the rear of the axle housing. The crown wheel and differential case assembly is supported by two tapered roller bearings, as is the pinion. The axles are splined at both ends, with one end installed in the differential side gears and the other end installed in the drive flange, which is bolted to the hubs. The hubs are supported on two tapered roller bearings on the axle housing spindles. A lock nut and an adjusting nut secure the hub to the spindle.

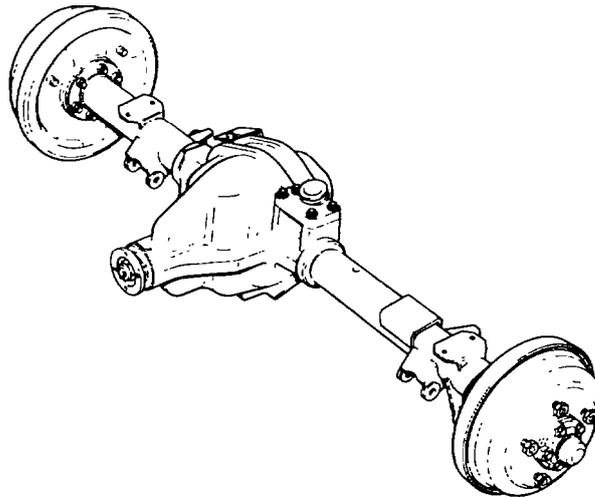


Figure 53 Rear Axle Assembly

105. Drive from the propeller shaft is transmitted by the pinion to the crown wheel. The differential case, to which the crown wheel is bolted, carries the planetary gears, cross-shaft and side gears. When the vehicle is moving in a straight line, without wheel slip, the differential case assembly rotates with the crown wheel causing the axles, hubs and wheels on both sides to rotate simultaneously. When a corner or bend is encountered, the planetary gears and the side gears begin to operate. Because of the different arcs that both drive wheels must take through a corner, the inside wheel, i.e. the one which uses the smaller arc, slows down, while the wheel using the larger arc speeds up. This is accomplished by the planetary gears and side gears. As natural forces impart a greater resistance on the inner wheel, the rotation of that wheel slows down, causing the side gear to resist rotation. Because the planetary gears and side gears are in mesh with each other and because the gear assembly rotates with the differential case, the slowing down of one side gear causes the opposite side gear, and thus the axle shaft, to rotate at a faster speed. This action allows the outside wheel to travel a greater distance in the same time that it takes the inside wheel to travel a lesser distance. This enables the vehicle to negotiate the corner without wheel spin, which would otherwise be the case if a single rigid axle shaft was fitted.

Front Axle

106. The steerable front drive axle is comprised of a differential assembly, two axles (half shafts) and two steerable drive-ends (refer to Figure 54). The differential is housed in a removable carrier and is comprised of a crown wheel and pinion, side gears, two planetary bevel gears and a pinion shaft, which locates the planetary bevel gears and also forms the axis about which the planetary gears rotate. The axle shafts are comprised of an inner shaft splined at both ends with a constant velocity joint and stub axle fitted to one end. Steerable drive-ends are flange-fitted and bolted to the axle housing. These drive-ends enclose the constant velocity joints and provide the fulcrum about which the front hubs and wheels can be turned. A flange, which is spline-fitted to the end of the stub axle and bolted to the wheel hub, transmits the drive from the differential to the hub and wheel. The hub is supported on two tapered roller bearings and held in position on the steerable drive-end yoke spindle by an adjusting nut and a lock nut.

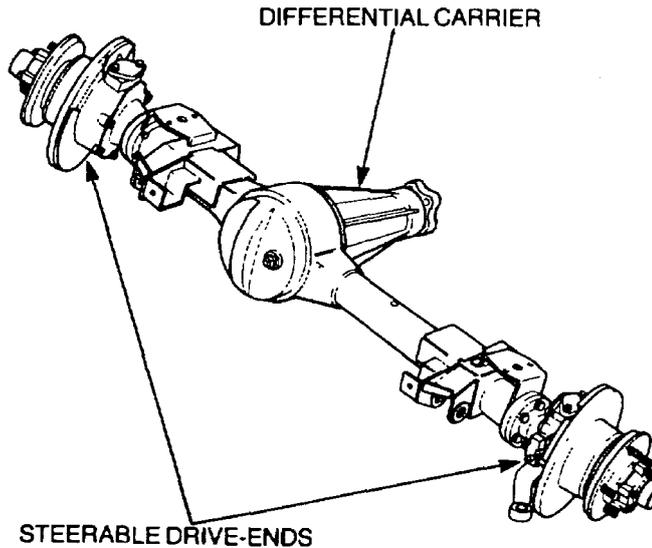


Figure 54 Front Axle Assembly

107. The operation of the front axle differential is the same as that of the rear axle differential. Refer to Paragraph 104 for the operating procedure.

108. Figure 55 illustrates a sectional view of the steerable drive-end.

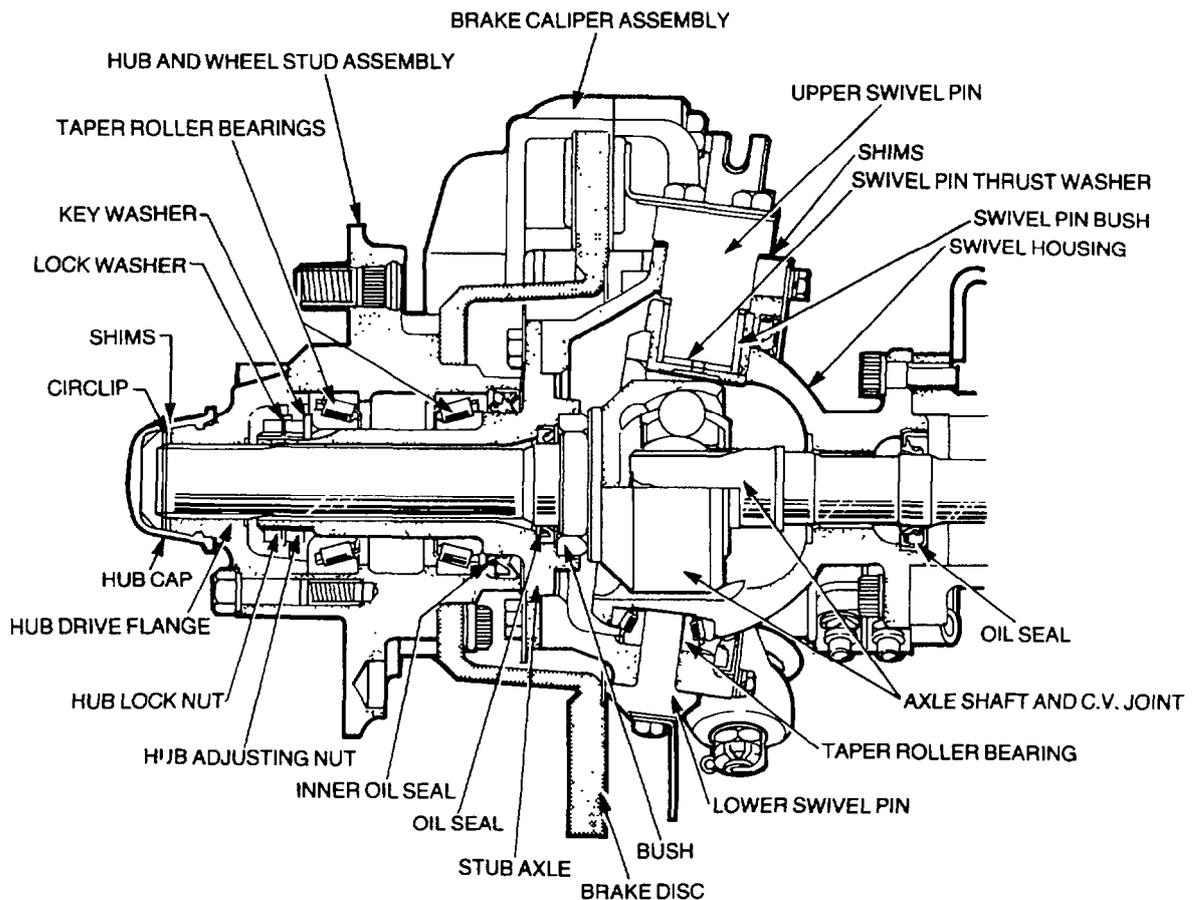


Figure 55 Steerable Drive-end – Sectional View

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Brakes

109. Service Brakes. The service brakes on the vehicle utilise a servo-assisted, dual-circuit hydraulic system. The master cylinder is a dual type, which incorporates two pistons, a proportioning valve, a pressure differential valve assembly, a warning light switch and a brake fluid storage reservoir, which is divided into two compartments, one for the front brakes, and one for the rear brakes.

110. The two pistons (primary and secondary) operate in the one bore (refer to Figure 56), but each has separate circuit outlets. The primary piston (nearest the pedal) operates the rear brake circuit and has one outlet. The secondary piston operates the front brakes and has two outlet pipes, one to each front brake calliper.

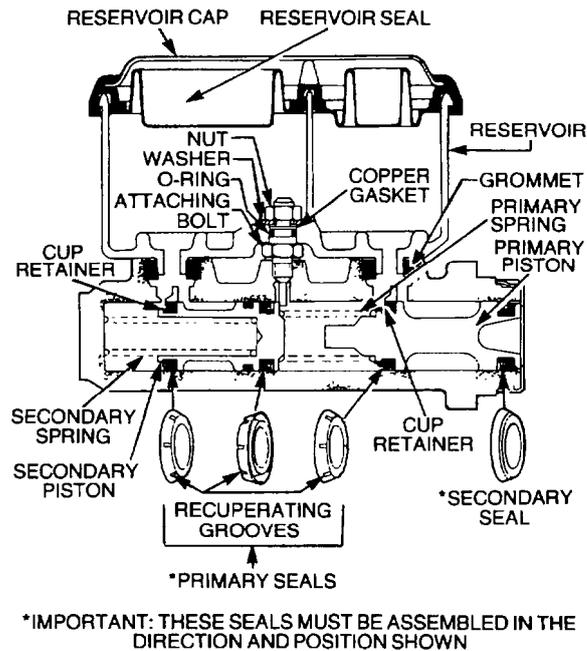


Figure 56 Dual Master Cylinder Sectional View

111. With the brakes in the released position, i.e. the piston return springs hold the primary and secondary pistons against the retainer cap and attaching bolt respectively, both compensating ports are open. This allows brake fluid to flow into the bore of the master cylinder, occupying the space in front of the pistons. As the brake system operates on pressurised hydraulic fluid, air that may have entered the system must be removed. Otherwise, when pressure is applied to operate the brakes, the air compresses to a fraction of the area it originally occupied, absorbing almost all of the hydraulic fluid movement and rendering the brakes inoperable.

112. Once all the air is removed from the brake system, the brake fluid reservoir maintains an air-free supply of brake fluid to the master cylinder. The reservoir contains two compartments. The rear compartment supplies brake fluid to the primary piston (rear brakes), while the front compartment supplies brake fluid to the secondary piston (front brakes).

113. As the brakes are applied, the hydraulic push rod (located in the servo vacuum chamber) pushes against the primary piston, forcing the piston into the bore of the master cylinder. The initial movement of the piston closes the compensating port, trapping the brake fluid in front of the piston and leaving the brake fluid with only one direction to travel, i.e. towards the rear brakes via the proportioning valve and the rear brake circuit. The pressurised fluid starts to act on the wheel cylinders causing the pistons in the wheel cylinders to expand and apply the brakes.

114. The fluid pressure, built up in front of the primary piston, acts on the rear of the secondary piston unseating the secondary piston and closing the compensating port. Although the rear brakes are applied first, the proportioning valve limits the pressure applied to the rear brakes.

115. When the brakes are released, both the brake fluid pressure and the return spring pressure return the pistons to the released positions, opening the compensating ports to allow pressurised fluid to vent into the fluid reservoir.

116. The proportioning valve, located at the master cylinder rear brake outlet (refer to Figure 57), regulates the hydraulic fluid pressure applied to the rear brakes. When the brakes are applied, brake fluid flows past the poppet valve, through the poppet piston and into the rear brake circuit. Due to the progressive application of the brake and the resistances created at the rear wheel cylinders, the fluid pressure increases and the poppet piston is forced to move against the poppet valve.

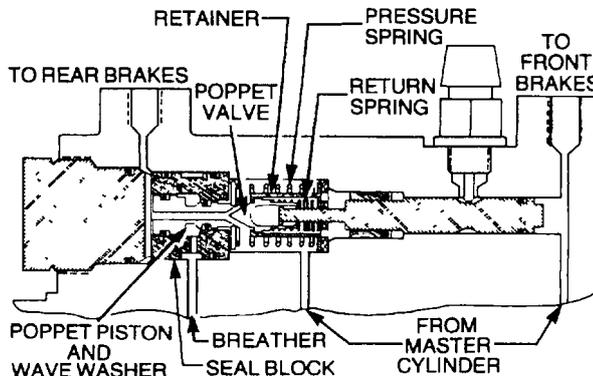


Figure 57 Proportioning Valve Assembly – Location

117. This closes off the fluid flow to the rear wheels (refer to Figure 58). The pressure acts on the large end of the piston, overcoming the pressure on the small end of the piston and the tension exerted by the poppet piston return spring. When the pedal is depressed further, a higher fluid pressure is created. This high fluid pressure acting on the small end of the poppet piston, combined with the tension of the poppet piston return spring, overcomes the lower pressure on the large end of the poppet piston. This forces the piston away from the poppet valve, allowing extra fluid to flow to the rear brakes.

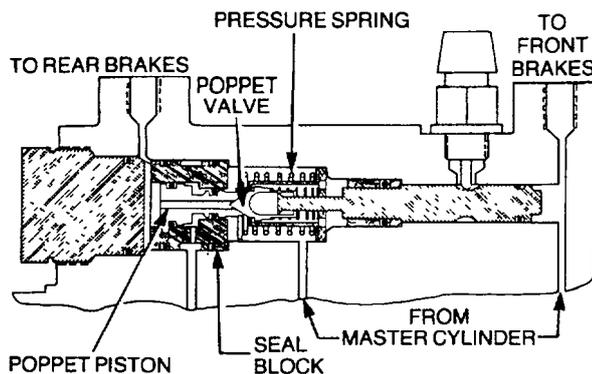


Figure 58 Restricted Fluid Flow to Rear Brakes

118. When the brake pedal is released, the fluid pressure in the rear brake circuit forces the poppet piston against the shoulder of the seal block and momentarily against the poppet valve. The fluid pressure unseats the poppet valve and flows through the poppet piston and master cylinder, through the compensating ports and into the reservoir (refer to Figure 59)

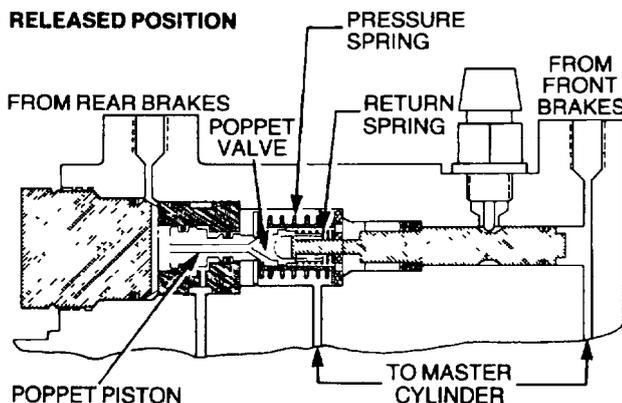


Figure 59 Fluid Return through the Proportioning Valve – Brakes Released

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119. The pressure differential valve assembly is combined with the proportioning valve, but is located between the front and rear brake hydraulic circuits. The pressure differential valve is affected by hydraulic fluid pressures in both the front and rear brake circuits. Should the pressure in one circuit drop off due to a damaged seal or ruptured brake line, the pressure differential valve moves because of the imbalance of pressures at either end of the valve. This action triggers the brake-warning switch positioned over the detent in the pressure differential valve. When the hydraulic system is functioning correctly, the switch plunger sits in the detent and the switch is de-energised. When a fault occurs in one of the circuits (refer to Figure 60) and the pressure differential valve moves, the switch plunger rides up the side of the detent, energising the switch and causing the brake warning light to be illuminated. If the front brake circuit should lose pressure, the movement of the pressure differential valve affects the operation of the proportioning valve by holding the poppet valve clear of the poppet piston. This action prevents the poppet valve from seating on the poppet piston, thus allowing full fluid flow to the rear brakes. Should the rear brakes fail, the pressure differential valve moves towards the rear circuit. In this position, the pressure differential valve does not affect the proportioning valve, but still triggers the brake warning switch and allows full fluid flow to the front brakes.

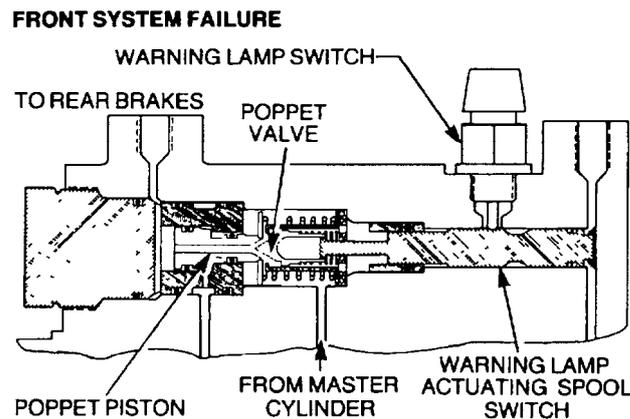


Figure 60 Proportioning Valve Operation Front Brake Failure

120. The servo vacuum chamber is positioned between the brake pedal and the brake master cylinder. The purpose of the vacuum chamber is to assist in the application of the service brakes by relieving the pedal effort required to apply the brakes. Figure 61 shows the various components of the servo vacuum chamber.

121. When the engine is running and the vacuum pump is operating, vacuum from the pump is applied to the servo vacuum chamber via the vacuum hose/pipe and the vacuum check valve. With the service brakes released, the position of the valve rod in the valve body allows air to be drawn out from behind the diaphragms and replaced by a vacuum (refer to Figure 62). This action takes place the instant the brake pedal is released. As a vacuum is constantly applied to the front side of the diaphragms, the vacuum that is now applied to the rear of the diaphragms holds both diaphragms stationary in the released position.

122. When the brakes are applied, the forward movement of the valve rod and plunger assembly closes off the vacuum port to the rear of the diaphragms. At the same time, the valve rod and plunger assembly opens a port that allows air to flow through the air cleaner element and into the chamber at the rear of the diaphragms (refer to Figure 63). With vacuum in front of the diaphragms, the air pressure now acting on the rear of the diaphragms causes the diaphragms and valve body to move forward into the front vacuum chamber. This overcomes the pressure of the return spring and assists the valve rod and plunger assembly to push the hydraulic push rod into the master cylinder.

123. As the brake pedal is released, the brake pedal return spring forces the pedal and the valve rod and plunger assembly to the release position. In so doing, the port that was opened to admit atmospheric pressure to the rear of the diaphragms is closed off and the vacuum port is now open, applying vacuum to the rear of the diaphragms. As there is no imbalance of pressure acting on the diaphragms, the return spring forces the valve body, diaphragms and hydraulic push rod into the release position, removing the force applied to the master cylinder and releasing the brakes.

124. The front wheels are equipped with disc brakes, which utilise hydraulically-operated callipers. Each calliper contains two pairs of opposing pistons with each pair of pistons butting against a brake pad. The brake discs are bolted to the front hubs and are straddled by the brake calliper assemblies, which in turn are securely bolted to the front axle steerable drive-ends.

125. When the brakes are applied, the brake fluid forced into the front brake circuits causes the pistons to expand out from the callipers, pushing the pads towards each other and effectively clamping the brake discs between the pads. This action slows or stops (depending on the amount of brake application) the rotation of the brake discs, effectively slowing or stopping the motion of the vehicle.

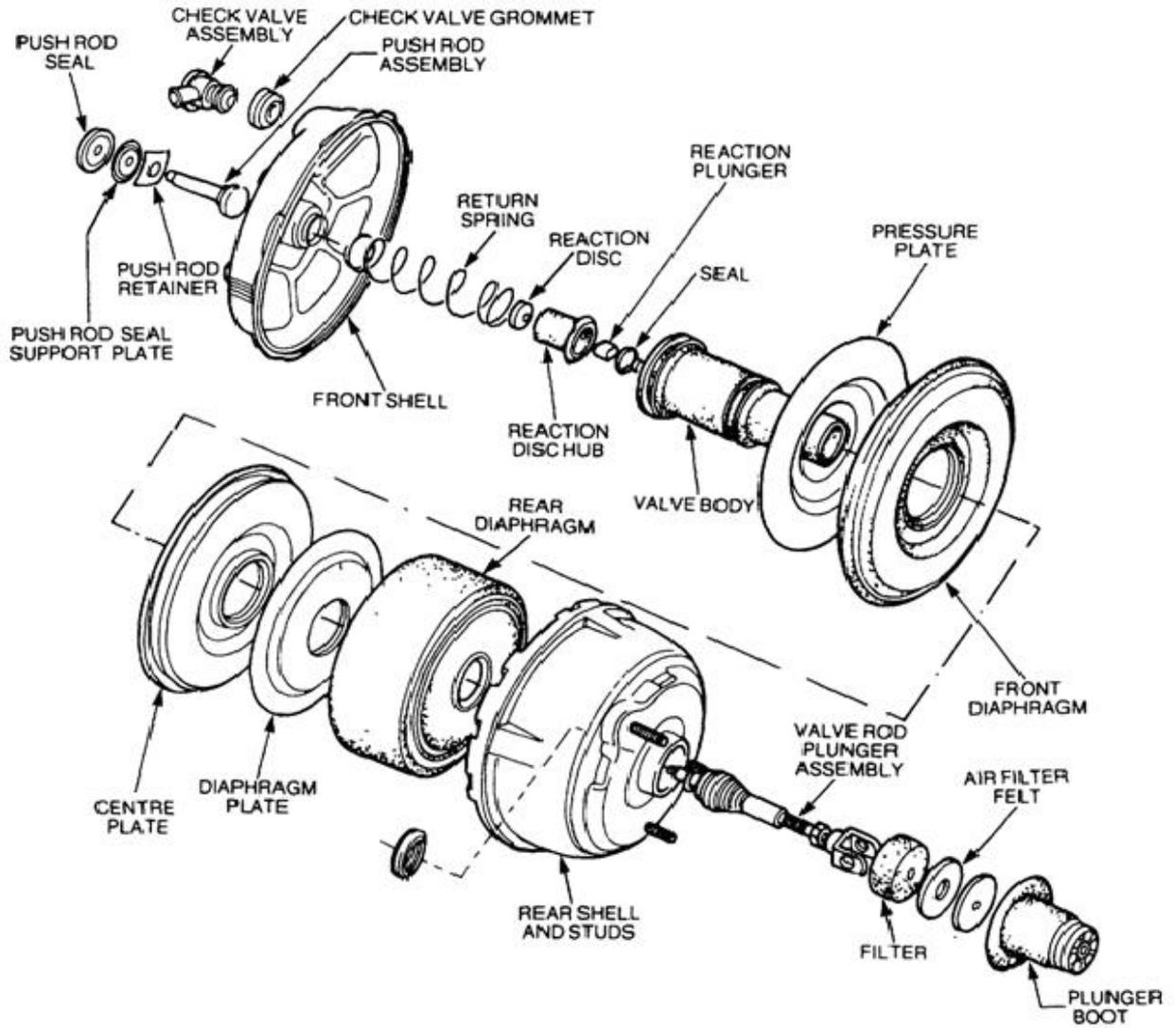


Figure 61 Brake Servo Vacuum Chamber – Exploded View

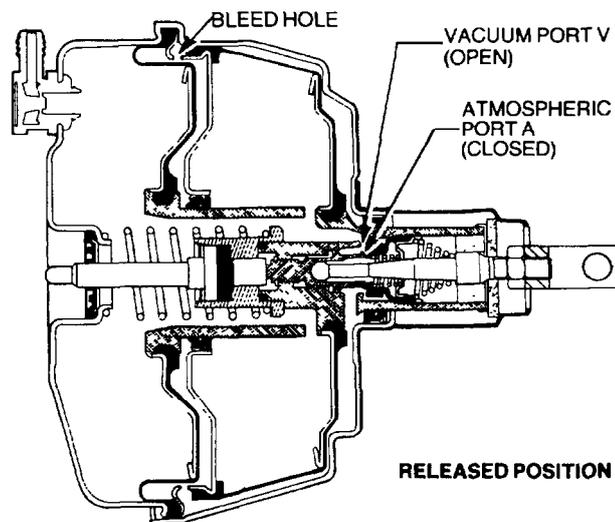


Figure 62 Servo Diaphragms – Stationary Engine Running, Brakes Released

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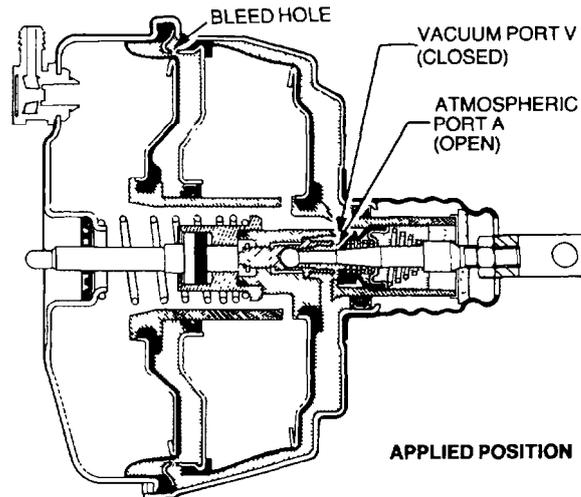


Figure 63 Servo Chamber Operating, Brakes Applied

126. Wear sensors are fitted to the disc pads because the front brakes contribute more to the braking effort than the rear, resulting in a faster wear rate. The sensors inform the driver, via a warning light, that the front pads are worn to their limit (3 mm) and require replacement.

127. Figure 64 illustrates the various components of the disc brake assembly.

128. The service brakes on the rear of the vehicle are shoe and drum type, which utilise a leading shoe and a trailing shoe. The heel of each shoe is attached to the backing plate by means of a fixed anchor. A double-acting single wheel cylinder, mounted at the top of the back plate, actuates both shoes. Brake pedal application produces pressure in the wheel cylinder, which pushes the pistons out and forces the tops of the shoes against the drum. As the leading shoe contacts the revolving brake drum, it wraps into the drum producing an energising action, which causes the leading shoe to provide most of the braking effort. When the vehicle is travelling in reverse, the trailing shoe provides most of the braking effort.

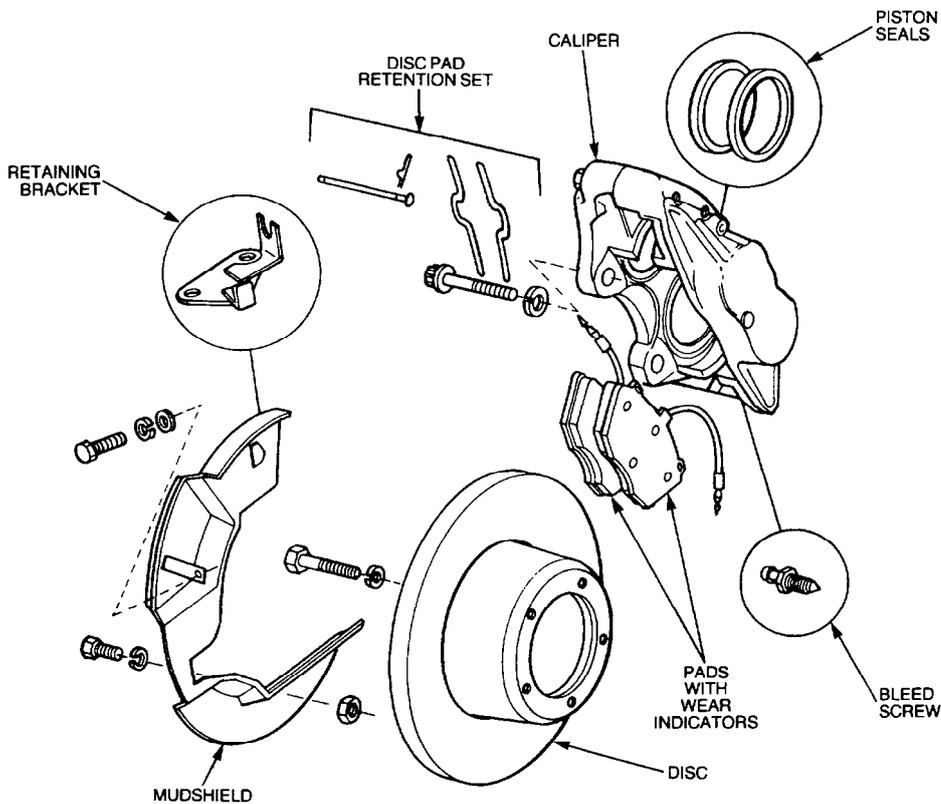


Figure 64 Front Disc Brake Assembly – Exploded View

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129. Figure 65 illustrates the various components of the rear brake assembly.

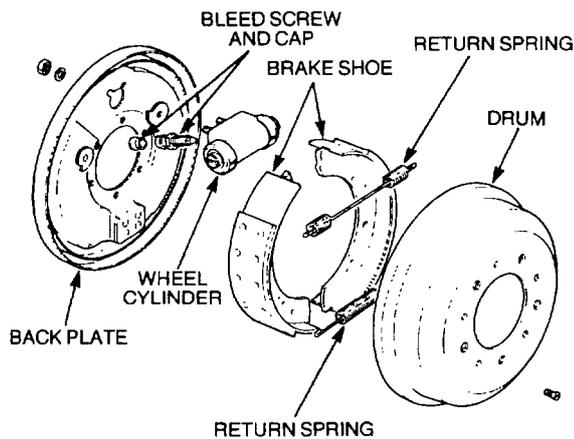


Figure 65 Rear Brake Assembly Exploded View

Parking Brake

130. The parking brake assembly, located on the transfer case rear output shaft, is a shoe and drum type. Unlike the service brakes, the parking brake is mechanically operated by means of a parking brake lever (located in the cabin) and a cable, which connects the lever to the draw link on the brake shoe expander assembly.

131. The expander assembly consists of an expander with two tapered surfaces (machined 180° apart), two rollers, two plungers (each with wedges machined into the base) and a body (refer to Figure 66).

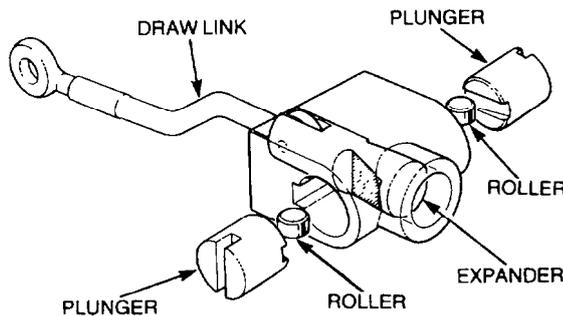


Figure 66 Parking Brake Expander Assembly Exploded View

132. When actuated, the parking brake lever pulls the inner cable of the cable assembly, which pulls the draw link outward from the brake back plate. The draw link, which is fixed to the expander, moves the expander outward. As the expander moves, the two rollers move with it, but also ride up the taper. As the rollers move, they act on the tapers on the base of each plunger causing the plungers to ride up on the rollers, thereby moving the brake shoes against the drum. Figure 67 shows the operation of the expander assembly in the released and the applied positions.

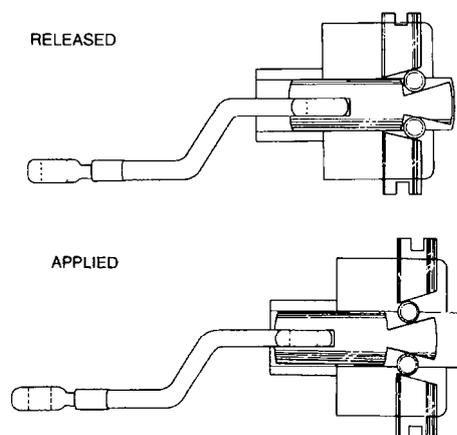


Figure 67 Parking Brake Expander Operation

133. Figure 68 illustrates the various components of the parking brake assembly.

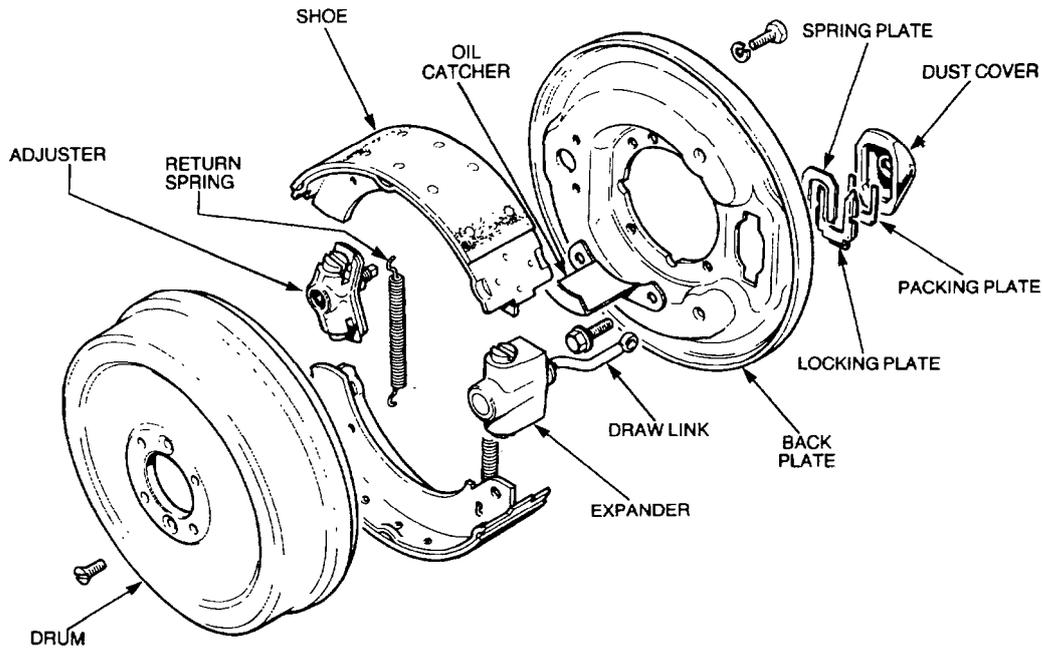


Figure 68 Parking Brake Assembly

Front Suspension

134. The front steerable drive axle is suspended from the chassis by means of two coil springs, two radius rods and a Panhard rod. The radius rods are rubber bushed to both the axle housing and the chassis and are utilised to limit the fore and aft movement of the axle housing. The Panhard rod is also rubber bushed to both the axle housing and a mounting bracket, secured to the chassis. This limits the sideways movement of the axle, but both the Panhard rod and the radius rods permit the axle to move through the vertical plane. The coil springs are positioned between the top of the axle and the chassis to provide a smooth ride and keep the wheels in contact with the ground over various terrains. The two double-acting shock absorbers are positioned in the springs and secured to both the chassis via a mounting bracket, and the axle housing. The shock absorbers are utilised to absorb shock loads, to dampen the spring rebound, and to limit the downward movement of the axle. Rubber bump stops are fitted to the chassis above the axle to prevent the housing from making direct contact with the chassis during maximum vertical lift of the axle. The load rating of the front suspension is 1 350 kg (2 975 lb.).

135. Figure 69 illustrates the various components of the front suspension.

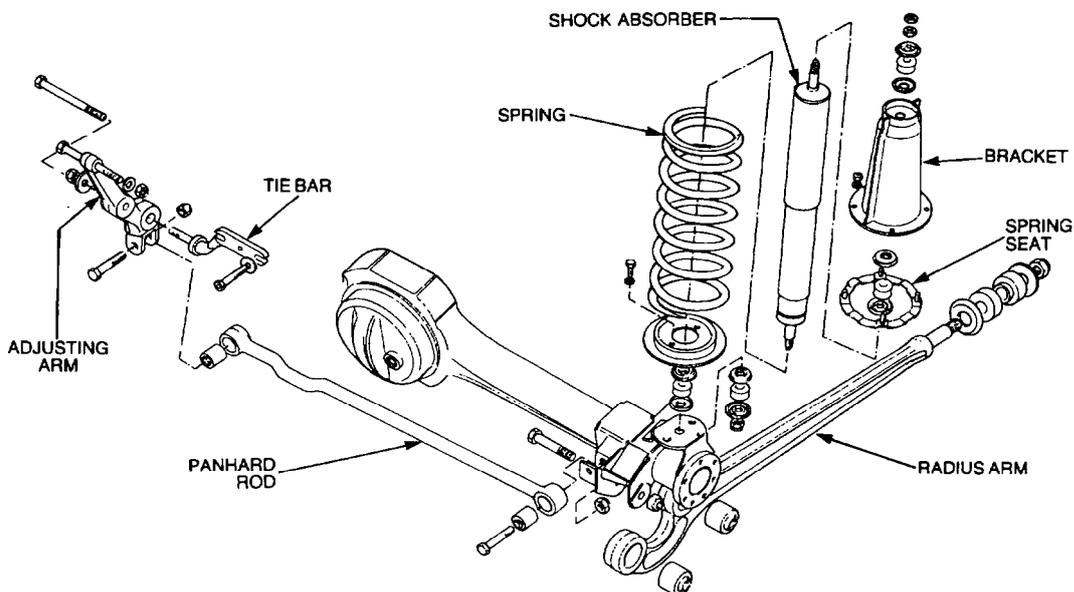


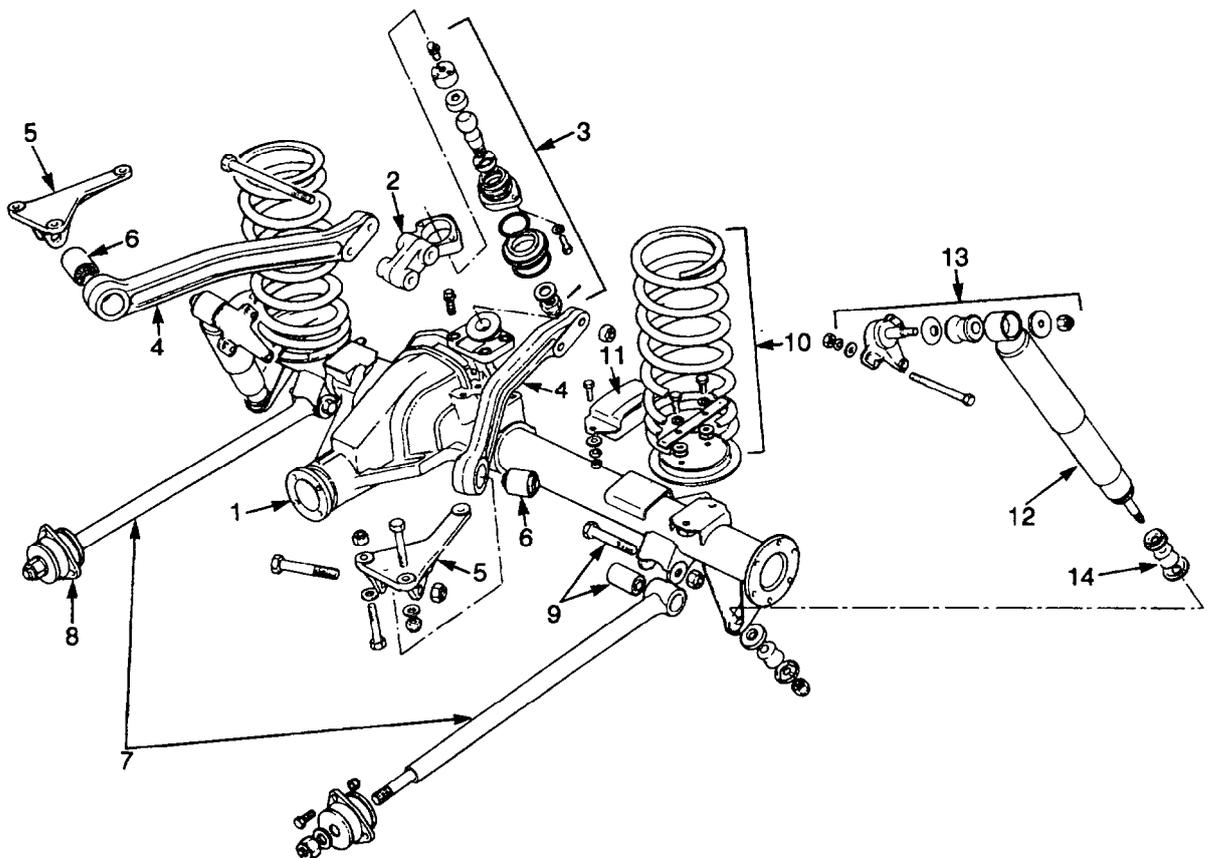
Figure 69 Front Suspension – Left-hand Side

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Rear Suspension

136. The rear suspension is comprised of two lower links, an A-frame upper link, two coil springs and two shock absorbers (refer to Figure 70). The lower links are rubber bushed to both the axle housing and the chassis. The upper A-frame link is mounted at one end of the axle by means of a fulcrum bracket and a ball joint; the other ends are rubber bushed to brackets, which are secured to the chassis. Both the upper and the lower links limit the fore and aft movement of the axle. The upper link also limits the sideways movement of the axle. As with the front suspension, the coil springs are positioned between the axle and the chassis to provide a smooth ride and keep the wheels in contact with the ground over various terrains. The two double-acting shock absorbers are rubber bushed to both the axle housing and the mounting bracket on the chassis and are utilised to absorb shock loads and dampen the spring rebound, and limit the downward movement of the axle. Two rubber bump stops are secured to the chassis above the axle housing to prevent the axle housing making direct contact with the chassis during maximum vertical lift of the axle. The load rating of the rear suspension is 1 950 kg (4 300 lb).

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- | | | |
|--|--------------------------------------|--|
| 1. Salisbury axle casing | 6. Top link bushes | 11. Bump-stop |
| 2. Fulcrum bracket | 7. Lower links | 12. Shock absorber |
| 3. Fulcrum bracket ball joint assembly | 8. Lower link flexible bush assembly | 13. Shock absorber top bush assembly |
| 4. Suspension top links | 9. Lower link bush and bolt assembly | 14. Shock absorber lower bush assembly |
| 5. Top link mounting brackets | 10. Coil spring assembly | |

Figure 70 Rear Suspension

Steering

137. The steering wheel is connected to the steering box by a three-piece shaft. The upper section of the shaft (to which the steering wheel is secured) is housed within the steering column and supported by means of a roller bearing at the top of the column and a ball bearing at the bottom. In turn, the upper end of the steering column is mounted by means of a rod to the bulkhead, while the lower end is secured to a bracket on the firewall by means of a U-shape clamp, which is positioned over the ball bearing (refer to Figure 71).

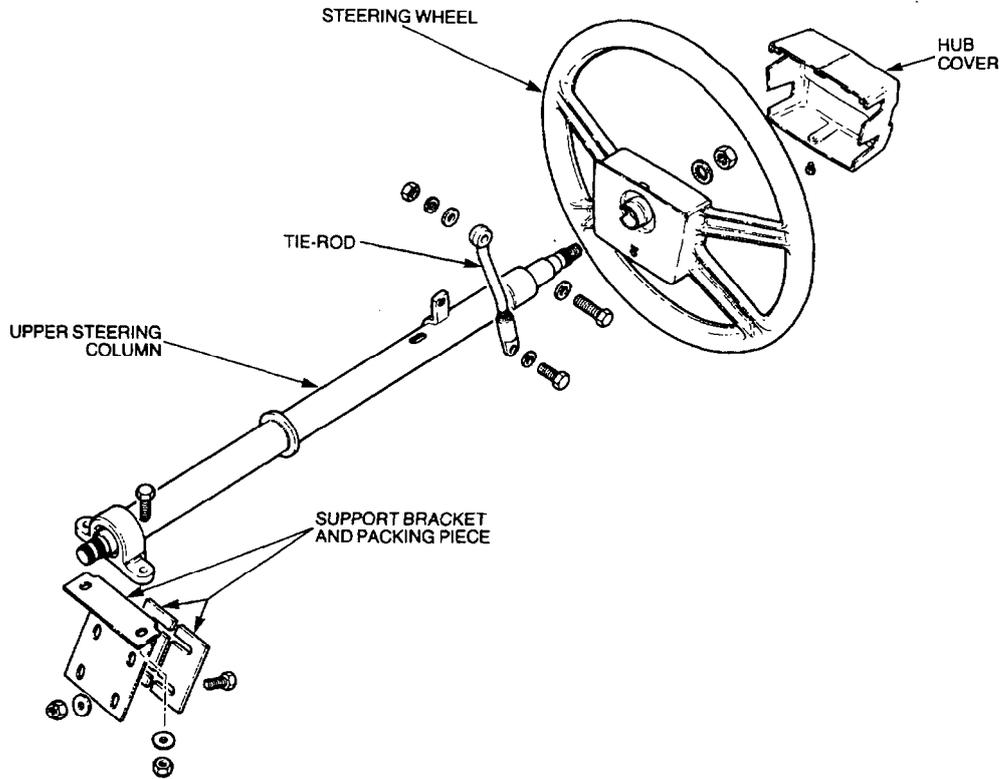


Figure 71 Steering Wheel, Column and Upper Shaft Assembly

138. The lower section of the steering shaft is comprised of two shafts (called coupling shafts), which are held together by a reinforced coupling (refer to Figure 72). The coupling allows the lower section of the steering shaft to collapse in the event of a frontal accident, thus preventing the steering column from being pushed back into the cabin. The lower section is connected to the upper shaft and the steering box by universal joints giving the steering wheel direct control of the steering box.

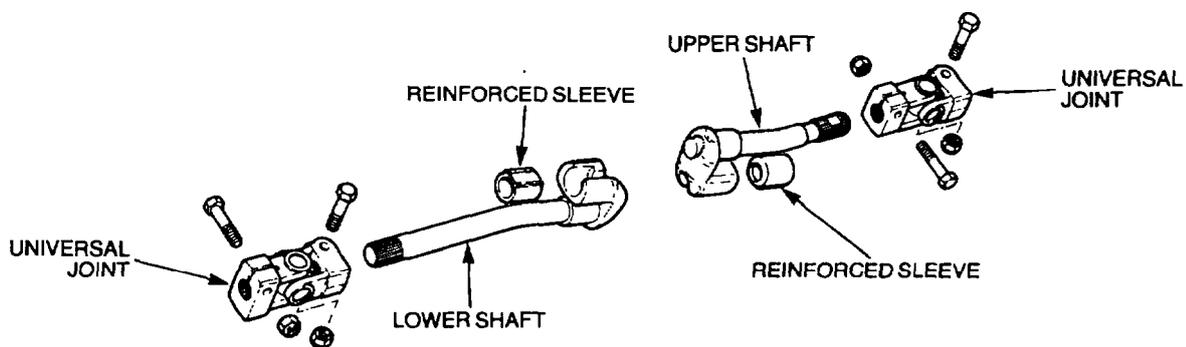
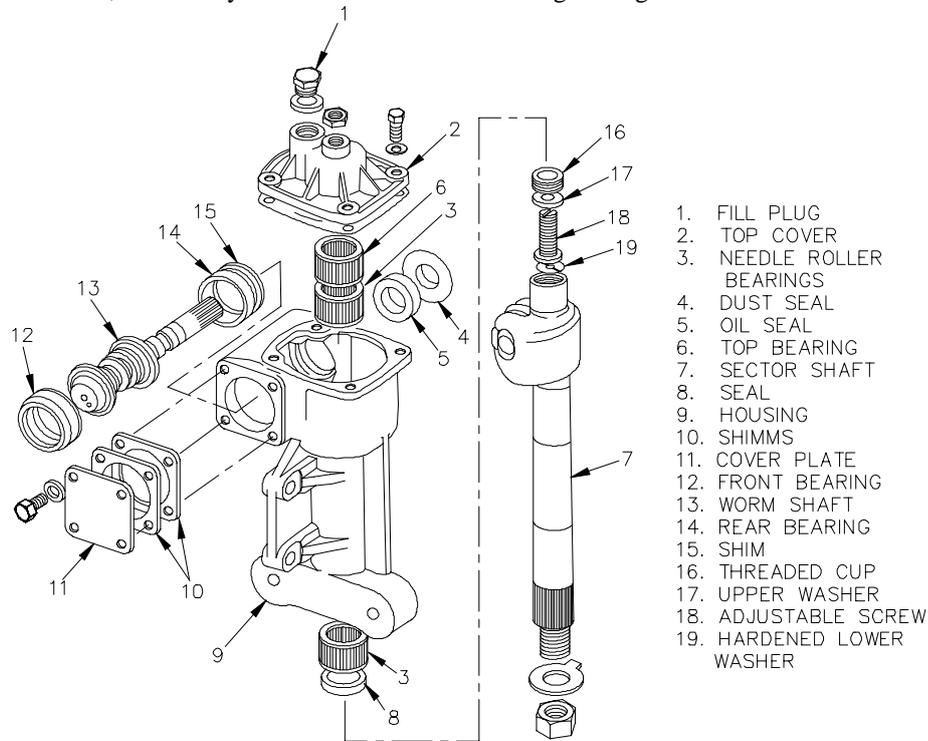


Figure 72 Steering Shaft (Lower Section) and Coupling

139. The steering box is a worm and sector type (refer to Figure 73), which is secured by bolts, nuts and washers to the right-hand chassis rail. Steering wheel movement is transmitted to the worm shaft in the steering box via the steering shafts. As the steering wheel is turned, the worm shaft turns in unison. A coarse spiral-shaped gear is cut on the worm shaft. This gear is in mesh with a similar, but shorter gear mounted on the sector shaft. The sector shaft transfers the rotating action of the steering wheel from the horizontal plane to the vertical plane.

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140. A drop arm is secured to the splined portion of the sector shaft, which protrudes from the bottom of the steering box, and transmits the sector shaft movement to the left-hand front wheel via the drag link. One end of the drag link is connected to the ball joint on the drop arm, while the ball joint end of the drag link is connected to the steering arm on the front of the left-hand steerable drive-end. A track rod, with ball joints at both ends, connects the right-hand steerable drive-end with the left-hand steerable drive-end. This causes the wheel on the right-hand side to turn in unison with the left wheel. A steering damper is installed between the drag link and the chassis to dampen or absorb any shock loads, which may occur while the vehicle is negotiating a turn.



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Figure 73 Steering Box Assembly – Exploded View

141. Figure 74 illustrates the drop arm, steering linkages and the damper.

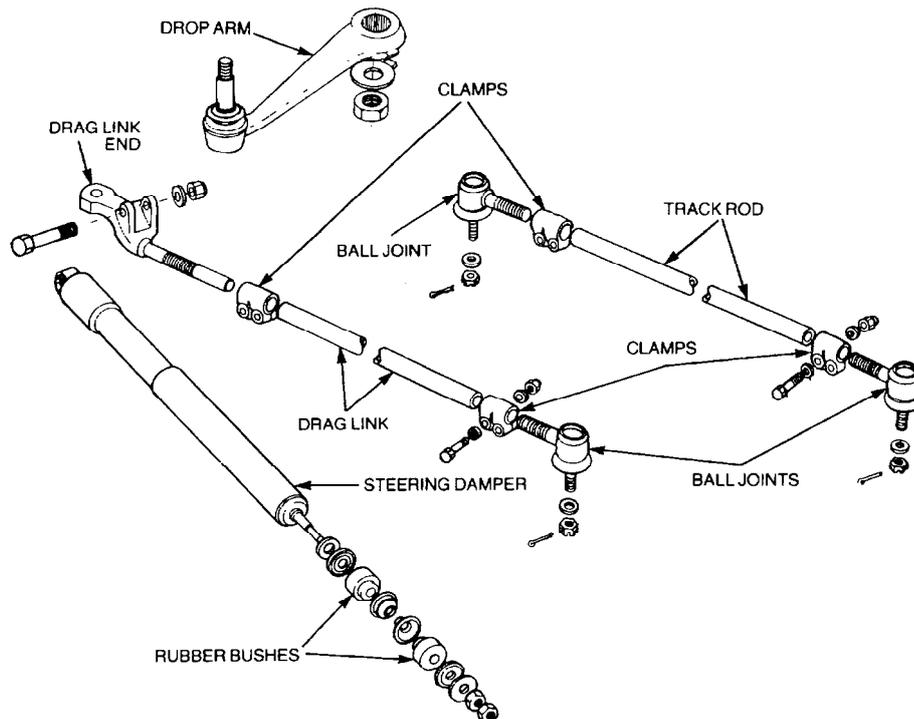


Figure 74 Drop Arm, Steering Linkages and Steering Damper

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Electrical System

142. The vehicle electrical system provides internal and external lighting, fuel supply, engine starting and vehicle performance monitoring through warning lights and instruments.

143. One 12 V battery, located beneath the passenger’s seat, provides the electrical energy to crank the engine at a high enough speed to enable the engine to start. The starting circuit comprises the battery, the ignition switch, the start relay, the engine stop motor, and the starter motor and solenoid. Glow plugs are also part of the starting circuit, but are only utilised in extremely cold conditions if the engine fails to start normally.

144. Turning the ignition switch through the ‘IGNITION’ position (refer to Figure 75) energises the engine stop relay, which controls the engine stop assembly. This moves the injection pump fuel rack to the idle position. With the ignition switch held in the ‘START’ position, the start relay energises applying voltage to the starter motor solenoid. Energising the starter motor solenoid results in the starter motor pinion engaging the engine ring gear, thus cranking the engine. Once the engine has started and the ignition switch returns to the ‘IGNITION’ position, the start relay de-energises. This removes voltage from the starter motor solenoid, which also de-energises, disengaging the starter motor pinion from the engine ring gear. The alternator now supplies the voltage required to operate the vehicle’s electrical systems, as well as recharge the battery.

145. To stop the engine, the ignition switch is turned to the ‘OFF’ position, which reverses the engine stop motor, causing the injection pump fuel rack to move to the no-fuel position. This effectively starves the engine of fuel.

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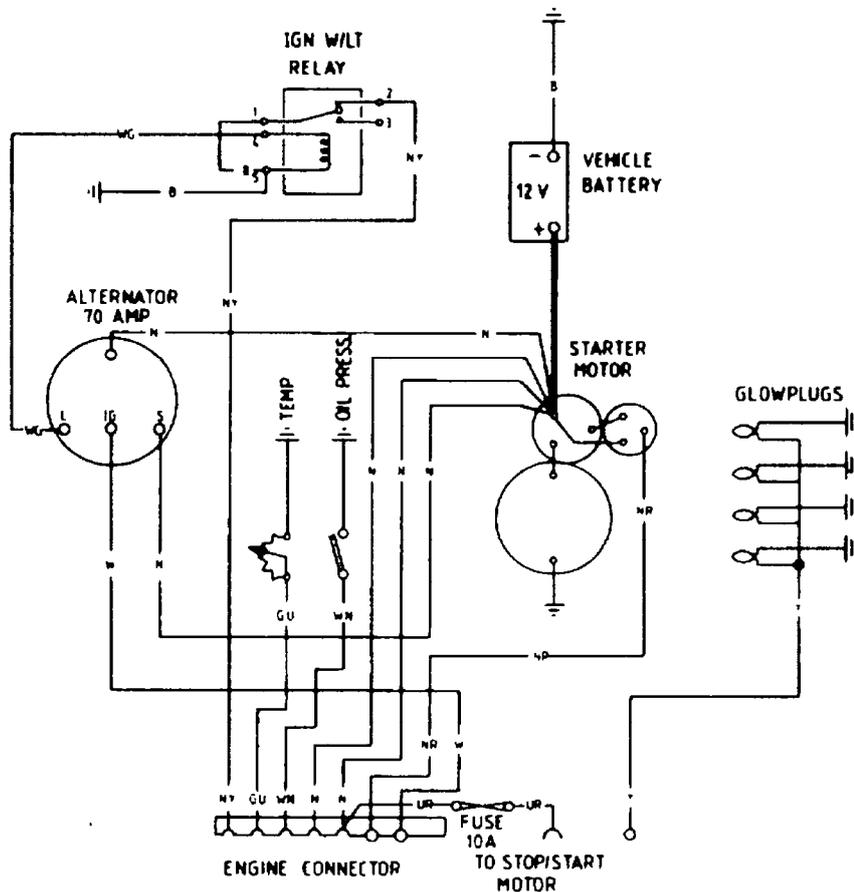


Figure 75 Engine Electrical Circuit

Starter Motor

146. The starter motor is a solenoid-actuated drive type, i.e. the starter solenoid provides a means of engaging the drive pinion with the flywheel ring-gear for cranking the engine. The solenoid comprises a coil, a plunger and a lever. When the ignition switch is turned ‘OFF’ or is in the ‘IGNITION’ position, current does not flow through the windings in the solenoid, and the plunger and lever are held in the released position by spring pressure (refer to Figure 76).

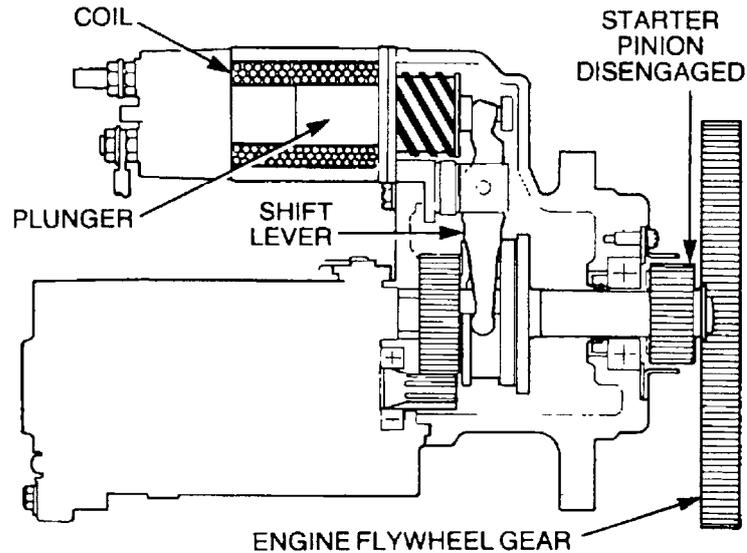


Figure 76 Ignition Switch 'OFF'

147. When the ignition switch is turned to the starting position, current flows to the coil in the solenoid creating a magnetic field, which overcomes spring pressure and draws the plunger through the centre of the coil. As the plunger moves, the lever that is connected to the plunger also moves. The pivoting action of the lever moves the starter motor drive pinion into mesh with the flywheel ring-gear (refer to Figure 77). When the plunger reaches the end of its travel, it closes a set of contacts within the solenoid. These contacts permit full current flow direct from the battery to the starter motor. As the starter motor armature revolves, drive is transferred from the armature to the reduction gear, which is splined to the drive pinion shaft causing the drive pinion and thus the flywheel to revolve.

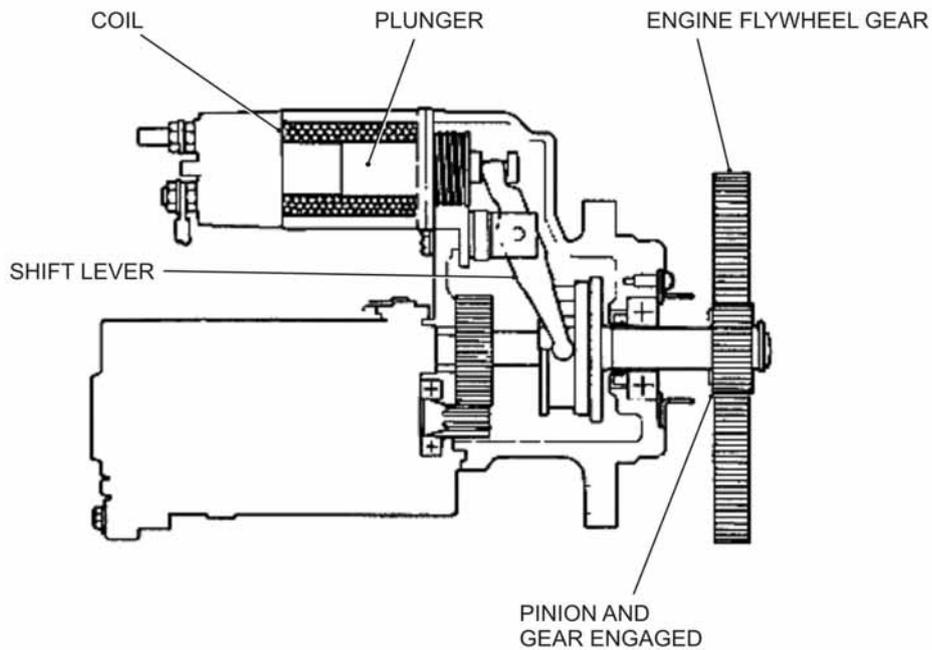
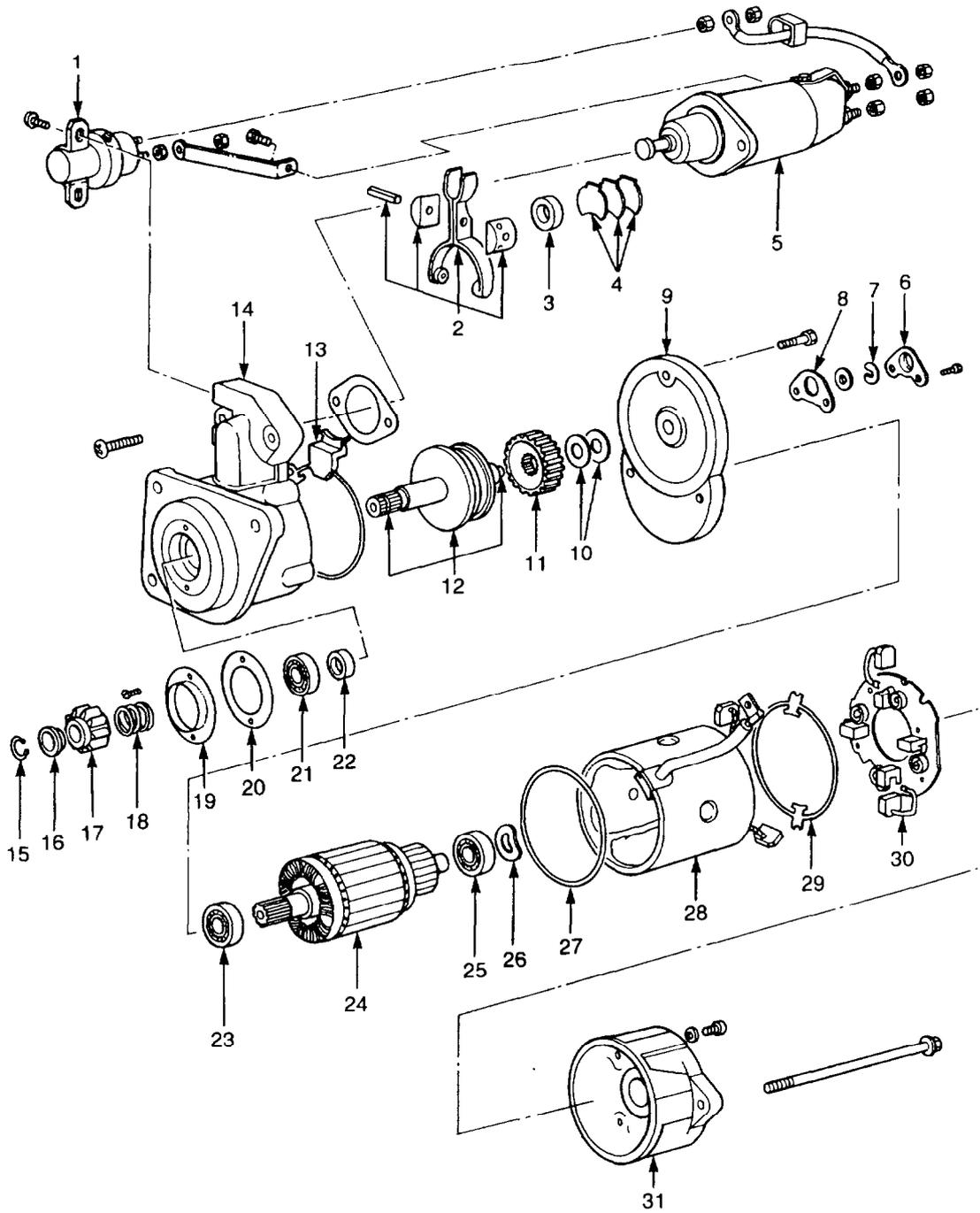


Figure 77 Ignition Switch in 'START'

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148. Figure 78 illustrates the various components of the starter motor.



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- | | | |
|--------------------|---------------------|---------------------------|
| 1. Switch assembly | 11. Reduction gear | 22. Seal |
| 2. Lever assembly | 12. Clutch assembly | 23. Bearing |
| 3. Spacer | 13. Seal | 24. Armature |
| 4. Packing | 14. Clutch housing | 25. Bearing |
| 5. Solenoid | 15. Circlip | 26. Washer |
| 6. Plate cover | 16. Collar | 27. Seal |
| 7. Clip | 17. Pinion | 28. Yoke |
| 8. Plate | 18. Spring | 29. Seal |
| 9. Cover | 19. Bearing cover | 30. Brush holder assembly |
| 10. Shims | 20. Bearing plate | 31. End cover |
| | 21. Pinion bearing | |

Figure 78 Starter Motor – Exploded View

Alternator

149. The alternator utilises an integral regulator. The alternator is a 12 V type with an output capability of 70 amperes. It is mounted on a bracket fitted to the left-hand side of the engine. Drive for the alternator comes from the crankshaft pulley via a V-belt. The alternator is comprised of a stator, a rotor, slip rings, brushes and diode rectifiers. The stator is composed of three windings, which are wound on the inside of a laminated core. The field coil is wound on the rotor, which rotates within the stator (refer to Figure 79). The two brushes each ride on slip rings, which are connected to their particular end of the field coil winding. The diode rectifiers connect the stator windings to the alternator output terminal.

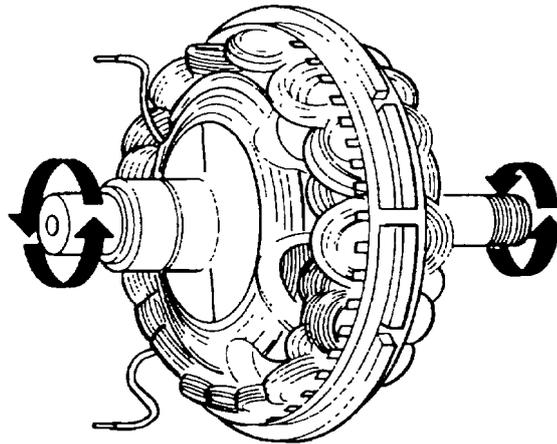


Figure 79 Rotor and Stator Assembly

150. When the ignition is turned 'ON', the ignition warning light illuminates and battery voltage is applied via the ignition switch to the voltage regulator, to the field terminal (B) on the alternator and from the field terminal through the inner carbon brush to the inner slip ring. The current then flows from the inner slip ring through the field coil, where it creates a magnetic field to earth via the outer slip ring and carbon brush (refer to Figure 80). However, a current is not generated while the rotor is stationary. When the engine is started and both the rotor and magnetic field are rotated by the V-belt, the lines of force of the rotating magnetic field cut across the stationary stator windings, causing Alternating Current (AC) to flow in the stator windings and from there to the rectifiers. The current can only flow in one direction through the diodes. Thus the AC, which flows back and forth, is changed to Direct Current (DC), which flows in one direction only, and is used to charge the battery as well as to provide the current for the vehicle's electrical equipment.

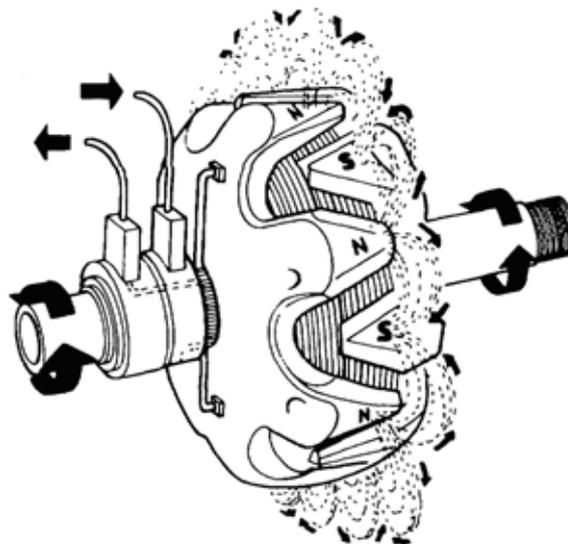


Figure 80 Rotor and Magnetic Field

151. A vacuum pump is fitted to the alternator rear cover and is driven by the alternator's rotor shaft, which is extended to protrude from the alternator rear cover and splined to drive the vacuum pump rotor. The vacuum pump consists of a housing, a rotor and four vanes. It is used to supply vacuum for the brake servo chamber as well as provide the means of actuating the transmission differential lock.

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152. Figure 81 gives an exploded view of the alternator and vacuum pump assembly.

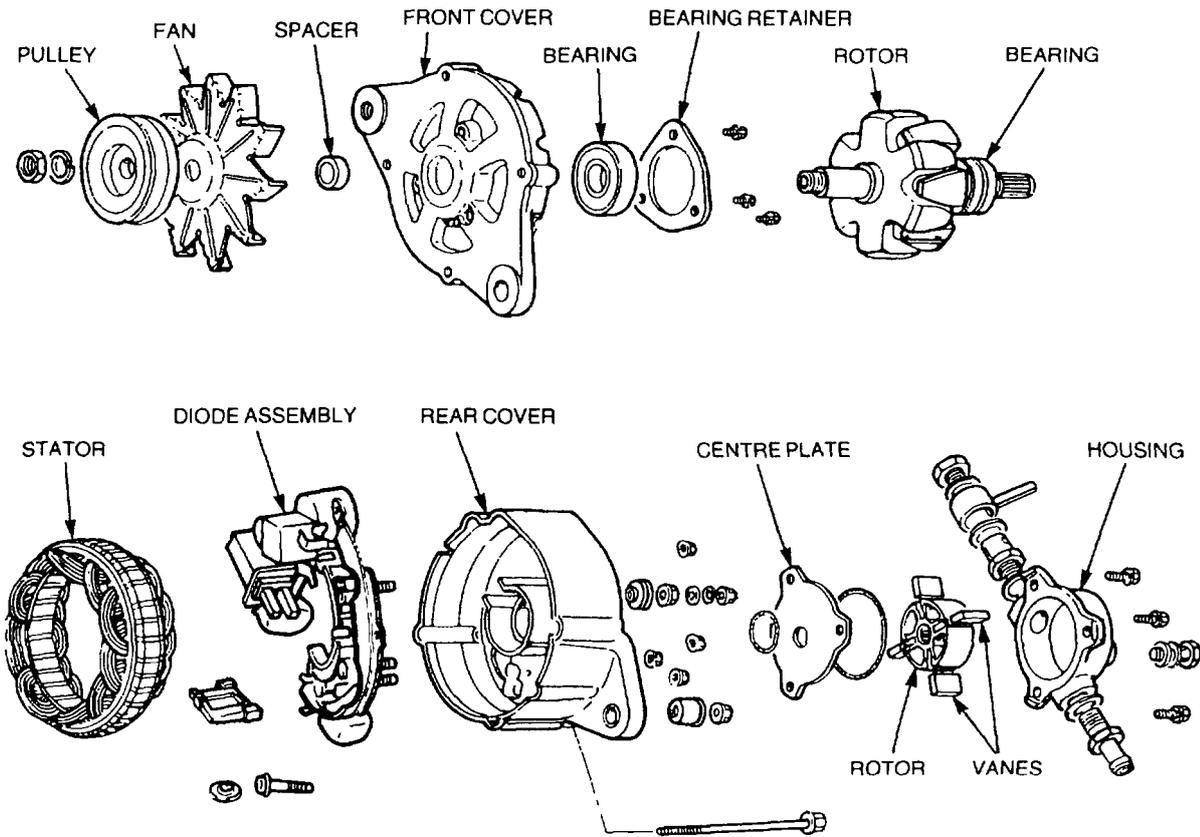


Figure 81 Alternator and Vacuum Pump – Exploded View

Lighting

153. The vehicle lighting is controlled by a three-position switch (refer to Figure 82) that provides the vehicle with normal lighting, blackout lighting and reduced lighting.

- a. In the 'NORMAL' or left position, the head, tail, stop, parking, number plate, turn indicator, dash instrument, map reading and cab courtesy lights can be used.
- b. In the 'BLACKOUT' or mid position, all of the 'NORMAL' lighting (with the exception of dash instrument, warning and map reading lights) is switched off. The blackout stop lights will function when the brakes are applied and the blackout marker lights at the front and rear of the vehicle are illuminated. The convoy light also operates in this mode.

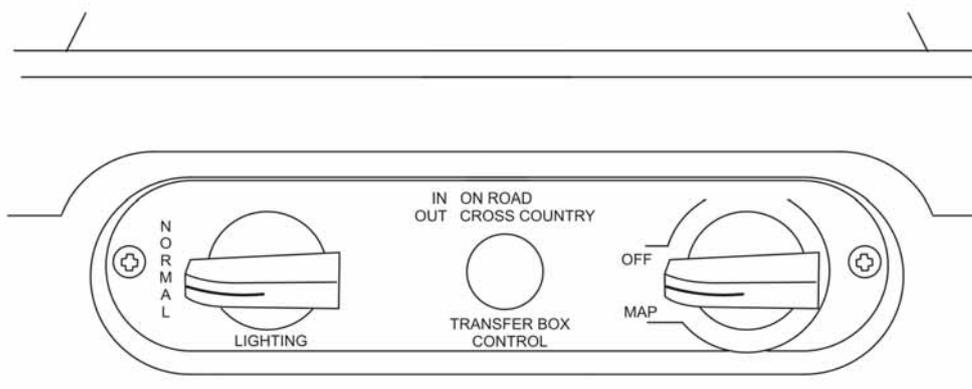


Figure 82 Lighting Control Switch Location

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- c. In the 'REDUCED' or right position, all of the blackout lights are utilised with the addition of the reduced headlights.

NOTE

The instrument lights are provided with a dimming switch, enabling the instrument lights to be dimmed or switched off, irrespective of which of the three modes of lighting is selected.

- 154. The globe wattage for external, internal and military lighting is detailed in Table 2.

Wiring Harnesses

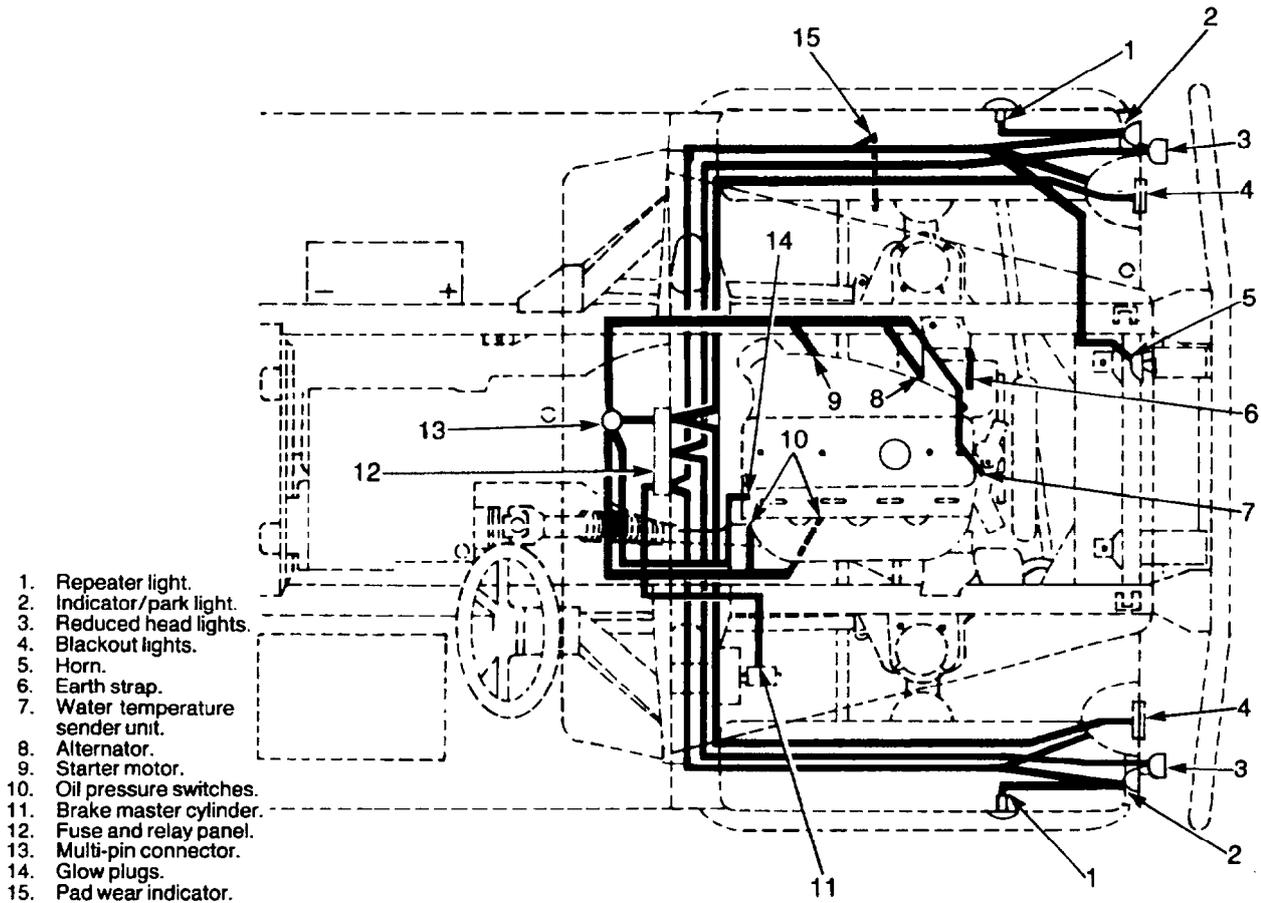
- 155. The vehicle's electrical system is comprised of two main wiring harnesses; the front wiring harness and the rear wiring harness. Figure 83 and Figure 84 show the relative position of the front and rear wiring harnesses, while Figure 85 illustrates the wiring for the dash instruments. Both the front and rear wiring harnesses terminate at the firewall.

Table 2 Globe Wattage

Serial	Position	Light	Quantity	Wattage
1	External	Headlights High/Low	2	60/55 W, Halogen
2		Park Lights	2	6 W
3		Stop and Tail Lights	2	21/6 W
4		Turn Indicator Lights	4	21 W
5		Side Indicator Lights	2	5 W
6		Reverse Lights	2	10 W
7		Number Plate Lights	2	6 W
8	Internal	Dome Light	1	21 W
9		Map Light	1	5 W, Halogen
10		Instrument Lights	2	2 W
11		Speedometer Lights	2	5 W
12		Warning Lights	10	1.2 W
13		Low Fuel Warning Light	1	3 W
14		Hazard Warning Light	1	0.6 W
15	Military	Blackout Lights	4	LED module
16		Convoy Light	1	2 W
17		Reduced Headlights	2	18 W

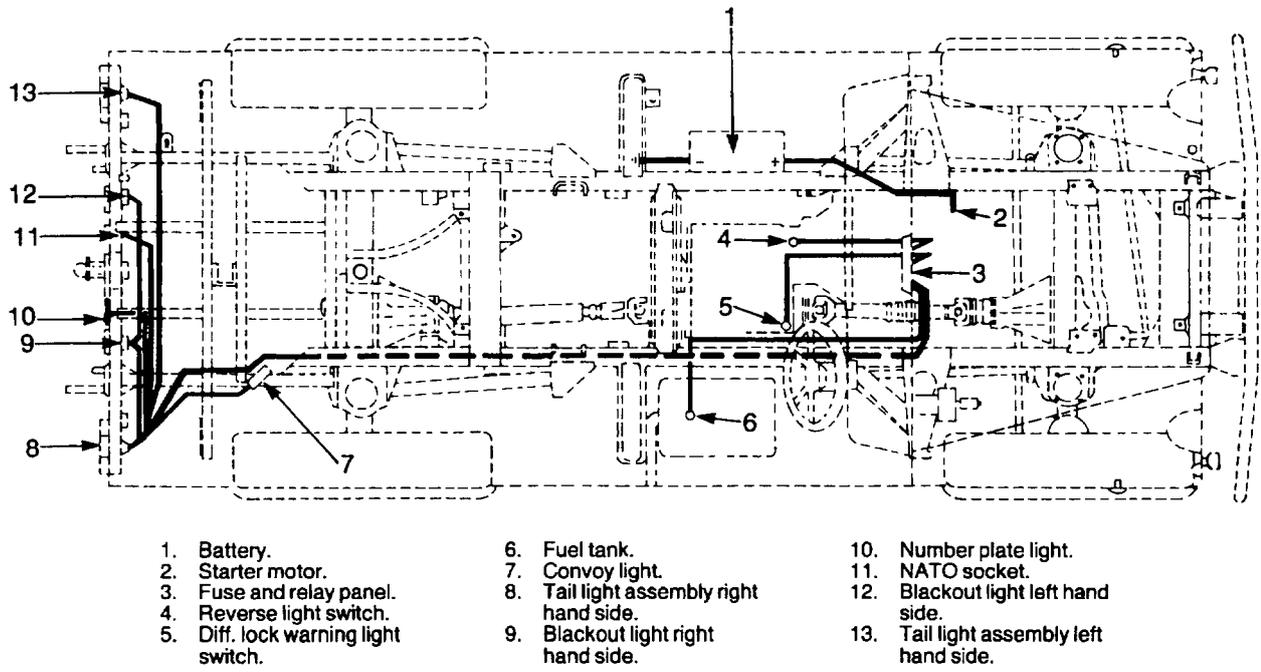
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- 1. Repeater light.
- 2. Indicator/park light.
- 3. Reduced head lights.
- 4. Blackout lights.
- 5. Horn.
- 6. Earth strap.
- 7. Water temperature sender unit.
- 8. Alternator.
- 9. Starter motor.
- 10. Oil pressure switches.
- 11. Brake master cylinder.
- 12. Fuse and relay panel.
- 13. Multi-pin connector.
- 14. Glow plugs.
- 15. Pad wear indicator.

Figure 83 Front Wiring Harness



- 1. Battery.
- 2. Starter motor.
- 3. Fuse and relay panel.
- 4. Reverse light switch.
- 5. Diff. lock warning light switch.
- 6. Fuel tank.
- 7. Convoy light.
- 8. Tail light assembly right hand side.
- 9. Blackout light right hand side.
- 10. Number plate light.
- 11. NATO socket.
- 12. Blackout light left hand side.
- 13. Tail light assembly left hand side.

Figure 84 Rear Wiring Harness

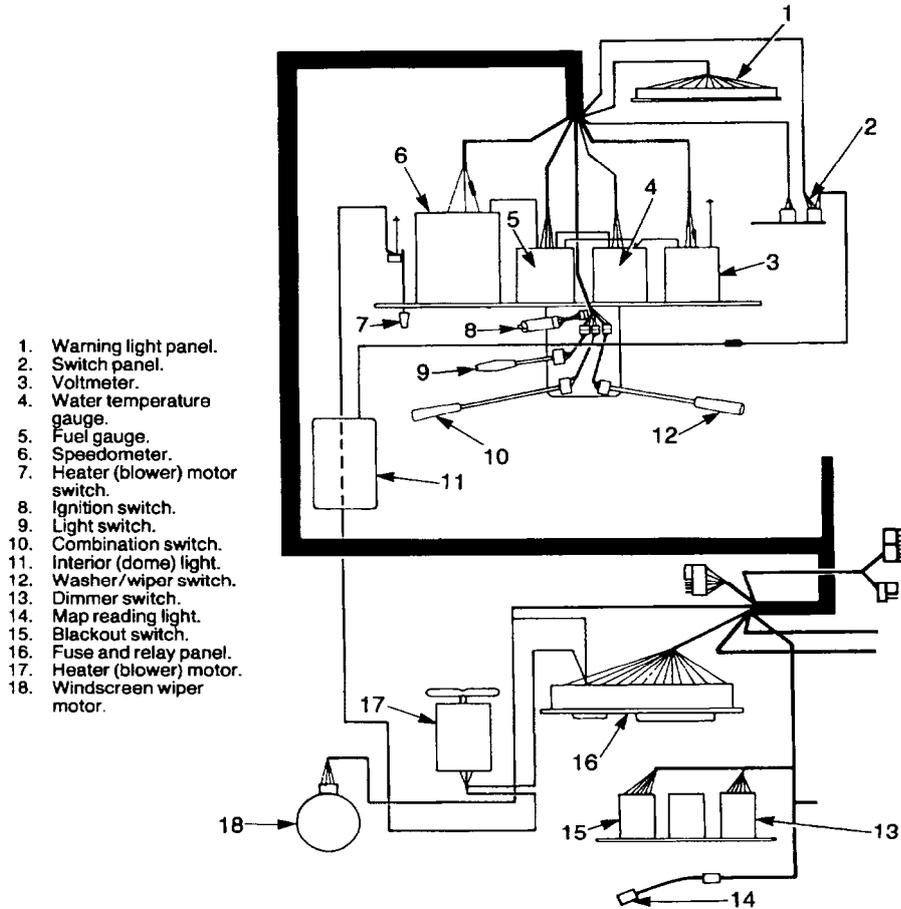
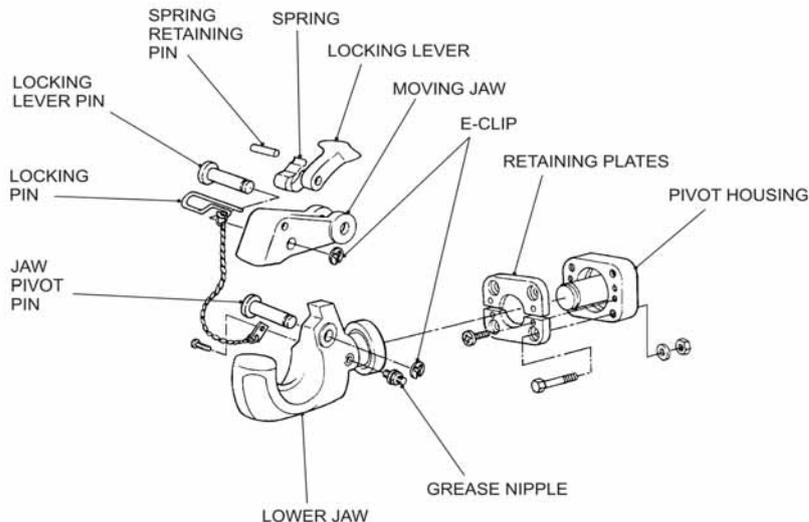


Figure 85 Cabin Wiring

Towing Pintle

156. An approved towing pintle is fitted to the rear of the vehicle. Secured to the chassis rear cross-member by four bolts, nuts and washers, the towing pintle has a recommended towing capacity of 1 200 kg for both highway and cross-country operation. The towing pintle is manually operated and can axially rotate through 360° when a fixed drawbar is attached. Three grease fittings are provided for ease of lubrication.

157. Figure 86 illustrates the various components of the towing pintle.



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Figure 86 Towing Pintle – Exploded View

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Bonnet

158. To protect the engine from the weather and assist with engine cooling, a bonnet is installed over the engine compartment. The bonnet is constructed of pressed aluminium sheeting and braced to prevent the loss of shape. The bonnet ensures that the cooling air drawn through the radiator circulates over the outer extremities of the engine before entering the air stream around the vehicle. In so doing, the cooling air helps to keep the engine at a normal operating temperature. The bonnet can be released by operating the handle located to the left of the steering column. The bonnet opens from the front and pivots on hinges secured to the rear edge of the bonnet and the firewall. The hinges are designed to facilitate easy removal of the bonnet. A folding support strut holds the bonnet in the open position. The de-ditching tool holders and the windscreen fold-down posts are secured by bolts, nuts and washers to the top of the bonnet.

159. Figure 87 illustrates the various components of the bonnet and the de-ditching tool holders.

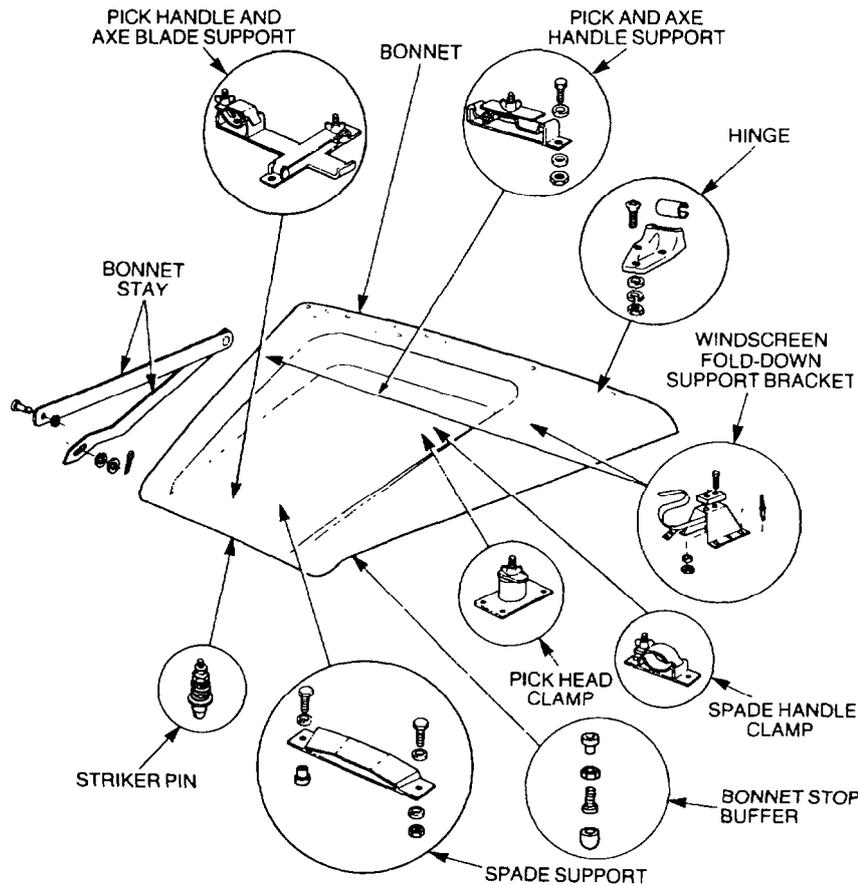


Figure 87 Bonnet and De-ditching Tool Holders – Exploded View

Mudguards

160. Each front mudguard consists of four panels, three of which are made of pressed aluminium sheeting and bolted together to form the outer mudguard. The headlight mounting bracket and the unit sign holder are both pop-riveted to the front panel. The radiator support panel is bolted to the upright on the top panel. Vent grilles are secured by screws to the top panels of the mudguards. The vent in the left-hand mudguard provides a fresh air inlet to the heater, while the vent in the right-hand mudguard helps to provide air to the engine air intake system (although it is not directly linked with the intake system). An aluminium protection plate is fitted to both mudguards to prevent damage to the mudguards during the deployment of camouflage nets.

161. Figure 88 illustrates the various components of the front outer mudguard.

162. The fourth panel, which forms the inner mudguard, is constructed from pressed steel then galvanised to prevent rusting. The inner mudguard is secured to both the chassis and the cabin firewall by bolts. The outer mudguard is positioned over the inner mudguard, and is secured to the inner mudguard by bolts and nuts. When the mudguards are in position, a wheel arch trim (eyebrow) is secured to both the inner and the outer mudguards by plastic rivets.

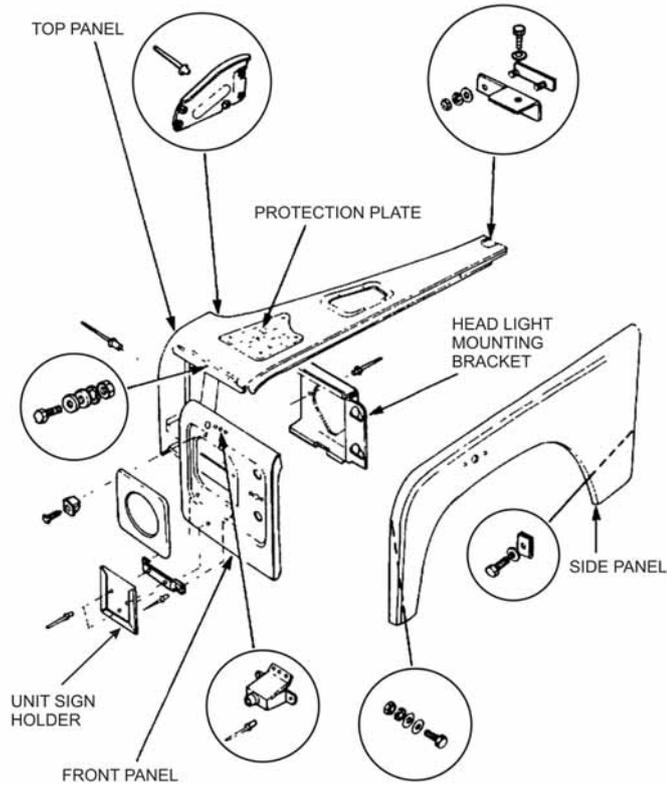


Figure 88 Left-hand Front Outer Mudguard – Exploded View

163. Figure 89 illustrates the various components of the front inner mudguard.

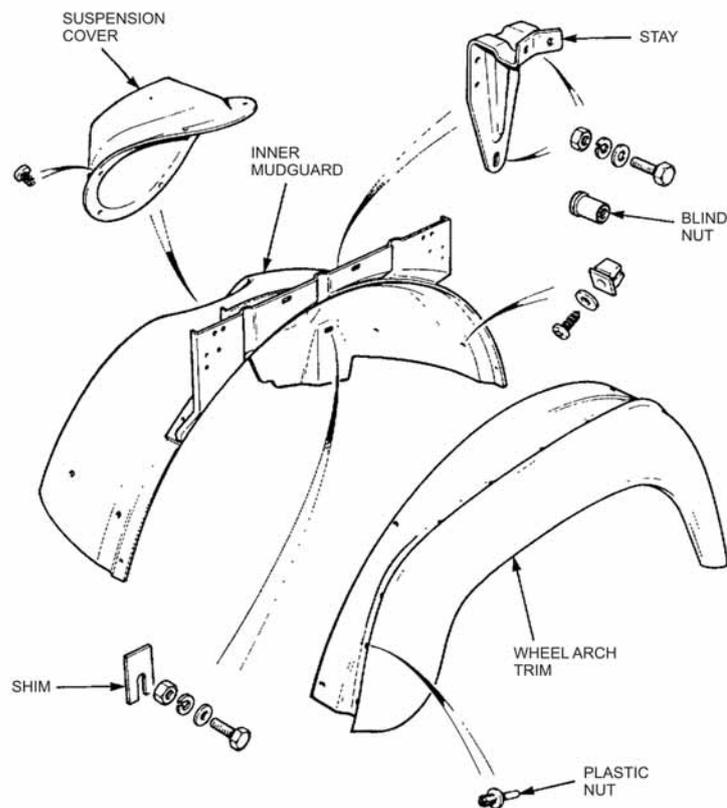


Figure 89 Left-hand Front Inner Mudguard and Wheel Arch Trim

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Cabin Doors

164. The cabin doors are constructed in two sections (upper and lower). The door (lower section) utilises a steel frame with aluminium sheeting, shaped and clinched to the frame. A capping is riveted to the top. Two hinges and a door lock are fitted to the lower section, permitting the door to be opened or retained in the closed position. A check-strap is fitted to the door and to the firewall side brace to prevent the door opening excessively.

165. The upper section (side screen) consists of a steel frame with aluminium sheeting shaped and clinched to the frame. Two sliding windows, the rail in which the windows slide, and various seals are installed onto the frame, forming the side screen. Two studs secured into the bottom of the frame enable the side screen to be positioned on and secured to the lower section forming a full door. A weather strip is installed in the cabin around the door opening. The door, when closed, butts against the weather strip effectively sealing the cab. The door side screens can be removed for air transportability.

166. Figure 90 illustrates the two sections of the front door.

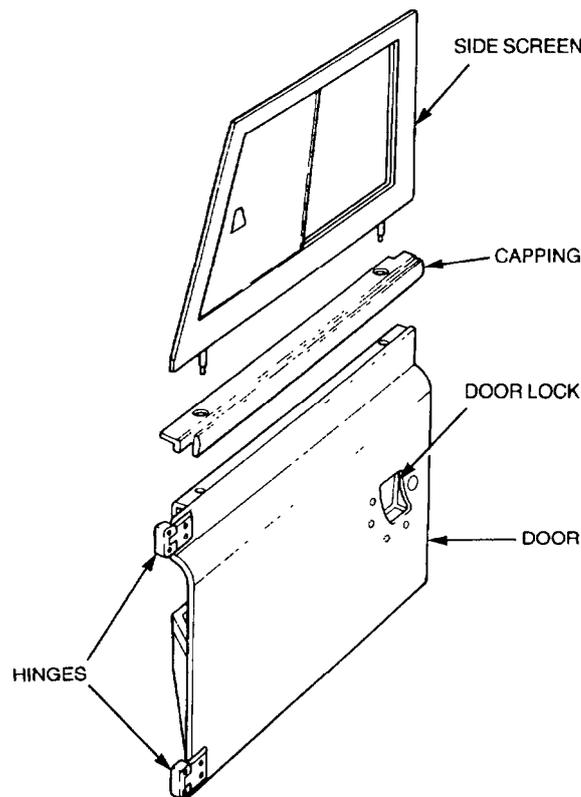


Figure 90 Front Door (Left-hand Side)

Rear Body

167. The rear body consists of eight pressed aluminium panels. The panels are riveted together to form the rear lower body. A galvanised steel capping is riveted to the top of the lower panels, strengthening them and providing mounting positions for the roll cage. A detachable tailgate, located at the rear of the body, is hinged to the chassis rear cross-member. This allows the tailgate to be lowered and permits access to the cargo area of the rear body. Two restraint cables are attached to brackets on the tailgate to hold it in the horizontal position when lowered.

168. Two removable roll bars are provided and, when installed in their respective mountings, help to protect the occupants of the vehicle in the event of vehicle roll over. The roll bars are also utilised as bows for the canvas canopy, which, when installed, protects both the occupants and cargo from the elements. Bolts retain the roll bars in their mountings and facilitate the removal of the roll bars when necessary. When troops are being carried, cushions are provided for seating, which can be removed and stored when the vehicle is required to carry cargo. The rear body is secured to the chassis by four mounting brackets and is also secured by bolts to the rear cross-member.

169. Figure 91 illustrates the various components of the rear body.

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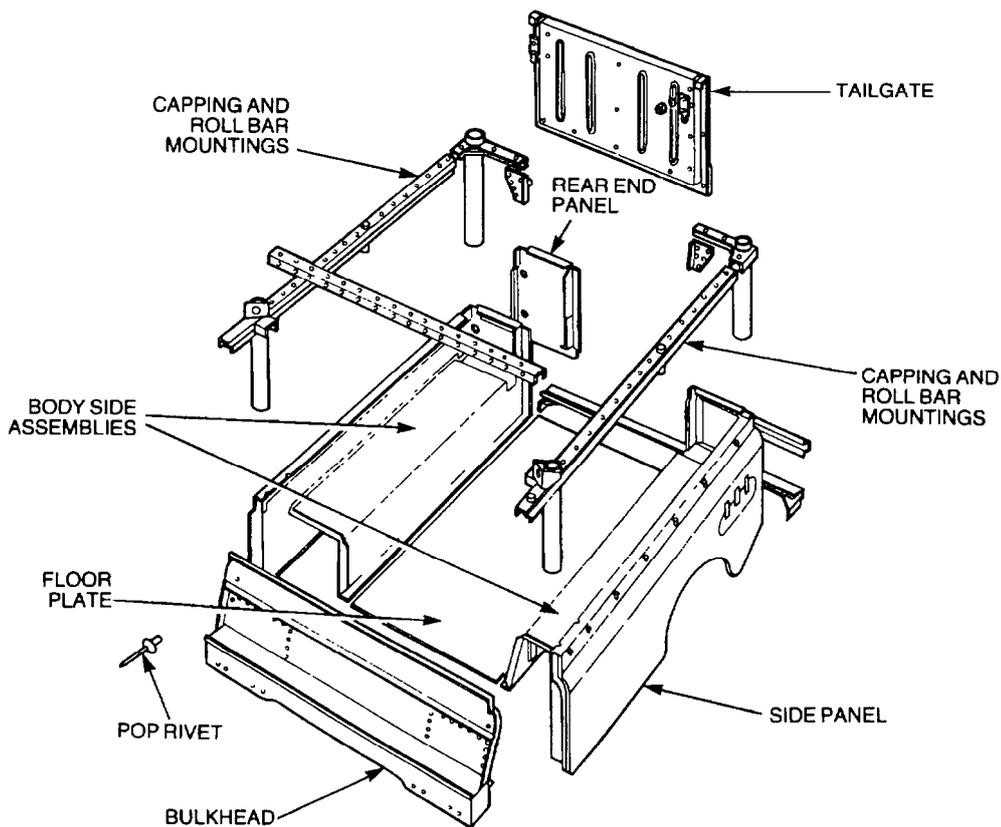


Figure 91 Rear Body – Exploded View

170. A toolbox is incorporated on each side of the rear body and is located to the rear of the wheel arch (refer to Figure 92). Each toolbox is equipped with a hinged lockable lid and provides storage for the hydraulic jack and the vehicle’s tool kit. A wheel arch trim is positioned over each wheel arch and secured to the side panels by plastic rivets.

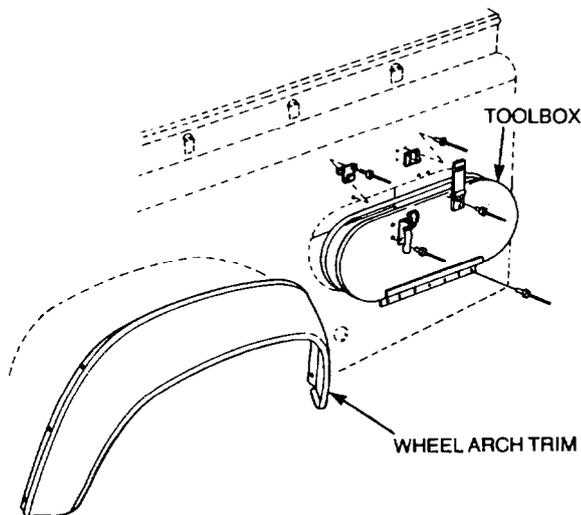


Figure 92 Toolbox and Wheel Arch Trim – Left Side

Winch

171. The Thomas T8000 winch is positioned between the chassis rails, forward of and below the radiator grille. The winch is bolted at the front to the fairlead mounting bracket, while the rear of the winch is secured by bolts to mounting brackets welded to both chassis rails. Drive for the winch comes from a chain-driven PTO located on the transmission via a torque limiter (incorporated in the PTO) and a three-piece propeller shaft (refer to Figure 93).

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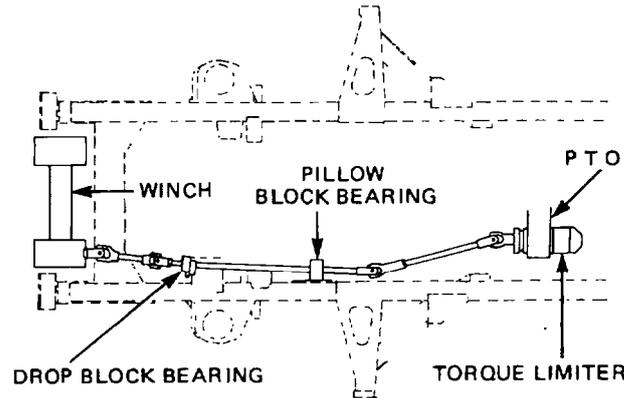


Figure 93 Winch Drive Line

172. Incorporated within the winch housing is a case-hardened, steel, single-ended, right-hand worm and a heavy-duty bronze worm wheel. The worm and worm wheel have a reduction ratio of 50:1. The worm is mounted on angular contact ball races. The drum shaft to which the worm wheel is keyed is supported by three bronze bushes. The winch drum is supported on the drum shaft by two bronze bushes and is free to revolve on the shaft.

173. When the winch worm and worm wheel are revolving (during operation), the drum remains stationary until the dog clutch, which is keyed to the drum shaft at the opposite end to the worm wheel, is engaged with the teeth on the drum. Drive from the propeller shaft is then transferred to the drum via the worm, worm wheel, drum shaft and dog clutch. A lever located on the right-hand side of the winch allows the dog clutch to be manually disengaged (to allow free spool of the winch rope) or engaged for winching.

174. The winch is equipped with a steel wire rope, which is 45 metres long with a diameter of 10 mm. The rope is right-hand, ordinary lay with an independent wire rope core and has a minimum breaking force of 63.1 k.N. (6.31 ton-force). A thimble and a Talurit fitting are attached to the free end of the rope. The winch and rope are capable of a line pull of 3 636 kg (7 999 lb) on the first layer of rope on the winch drum, 3 024 kg (6 653 lb) on the second layer, 2 589 kg (5 696 lb) on the third layer and 2 263 kg (4 979 lb) on the fourth layer. However, if these loads are exceeded, the spring-loaded ball, ratchet type torque limiter is activated, separating the drive line from the winch. Once the excess load is removed, the torque limiter resets itself and winching can continue.

175. The fairlead assembly, to which the winch is bolted, provides a means for guiding the wire rope onto the winch by utilising two horizontal and two vertical rollers (refer to Figure 94). The rollers, made of urethane and mounted on removable steel shafts, provide a smooth feed for the wire rope during winching.

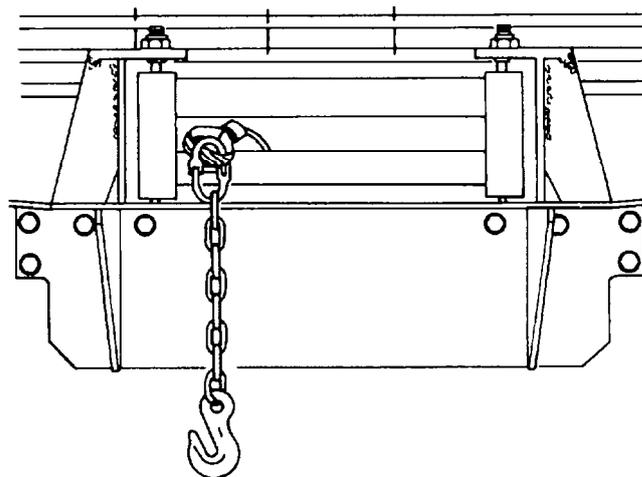


Figure 94 Fairlead Assembly

END

Distribution List: **Vehicle G 16.0 – Code 2** (Maint Level)
(Sponsor: CGSVSPO, Light B Vehicle Section)
(Authority: ECO CGSVSPO 120/10)

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