TRUCK, CARGO, HEAVY, MC3 – MACK

TRUCK, CARGO, HEAVY, MC3 WITH WINCH

TECHNICAL DESCRIPTION

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INTRODUCTION

1. This manual contains the technical description of the cargo-carrying vehicle with and without a winch. The vehicle in its basic form is capable of carrying a 10-tonne payload on formed roads or an 8-tonne payload cross country. In addition, a maximum gross trailer mass of 17 tonnes may be towed on formed roads and a mass of 10 tonnes may be towed cross country.

2. For dimensions, weights, fuels, lubricants and other technical reference data, refer to EMEI Vehicle G 700, Data Summary.

ENGINE

Description

3. The Mack engine model EM6-285, as shown in Figures 1 and 2, is a 4-cycle, 6 cylinder in-line, inter-cooled, turbocharged diesel engine, with a direct fuel injection system and an open combustion chamber design. The engine utilises a full-pressure wet sump lubrication system with spin-on full flow filters to cleanse the lubricating oil. The cylinders number from the front to the back, for the purpose of firing order, valve timing and piston numbering. Crankshaft rotation is clockwise when viewed from the front.

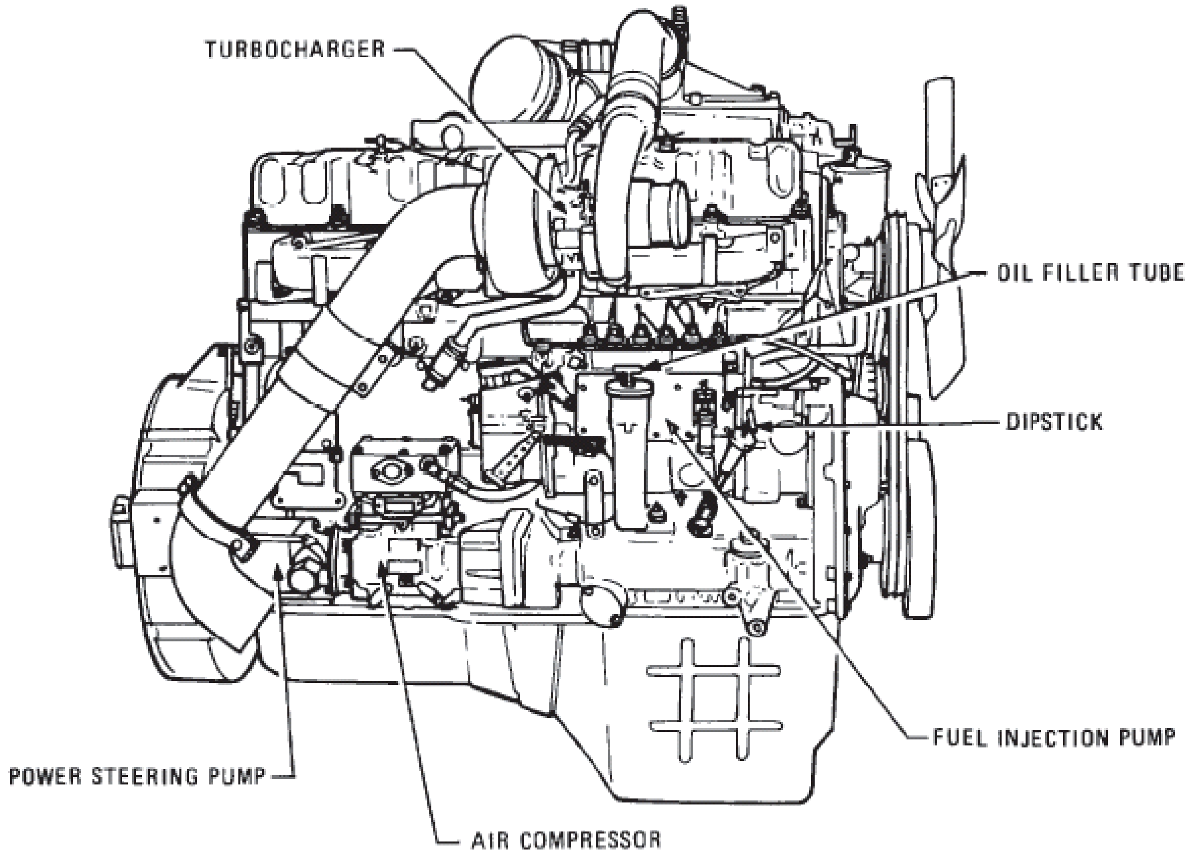


Figure 1 Engine EM6-285 Mack, Right-hand Side View

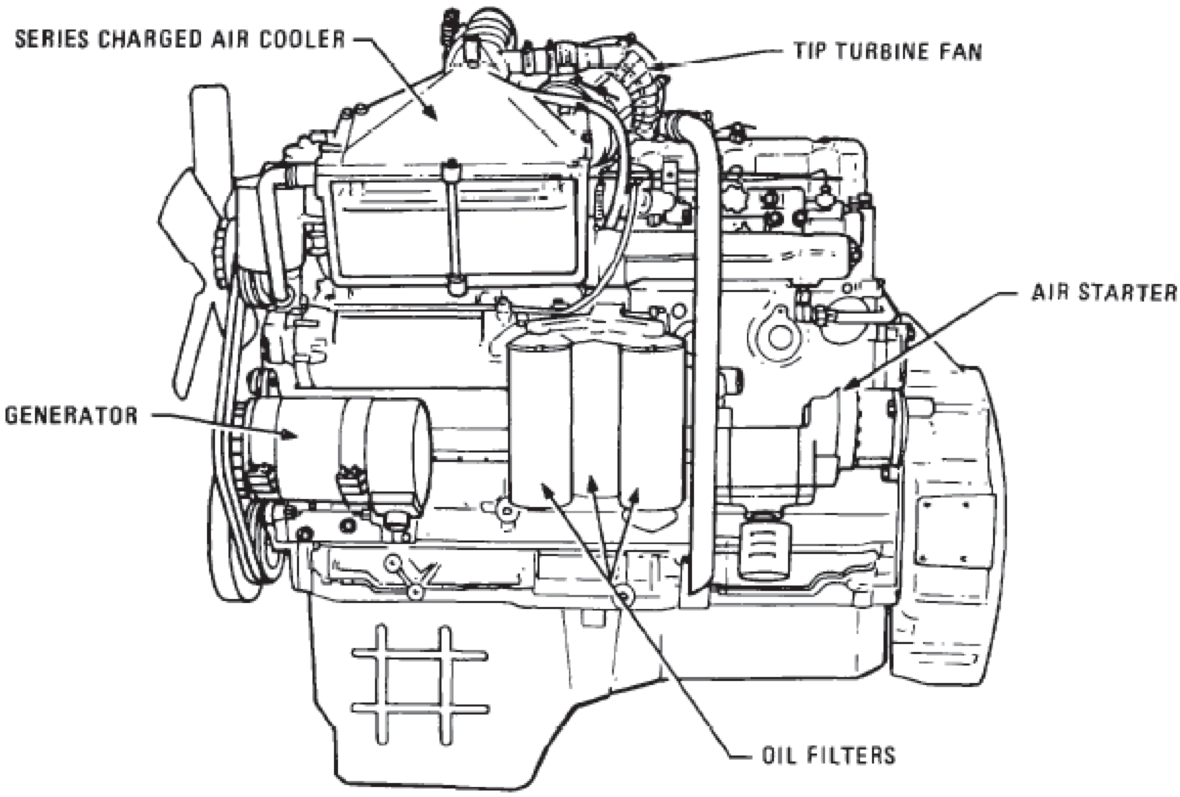


Figure 2 Engine EM6-285 Mack, Left-hand Side View

Engine Number

4. This is stamped on the top edge of the timing gear housing located on the front right-hand side viewed from the rear.

NOTE

Unless otherwise stated, references to left or right-hand side are to be taken as viewed from the rear of the vehicle.

Construction

5. The crankcase dipstick and the oil filler tube (Figure 1) are mounted on the right-hand side of the engine as is the injection pump, which is mounted on the timing gear housing, and is gear driven by the camshaft drive gear.

6. The air-compressor is mounted midway along the engine (Figure 1) and is driven by the auxiliary shaft, which in turn is driven by the camshaft drive gear.

7. The power steering pump is coupled to the rear of the compressor (Figure 1) and is driven by the compressor crankshaft.

8. The turbocharger mounted on the exhaust manifold (Figure 1) utilises the exhaust gases to drive a turbine, which is connected directly to the impeller. The impeller draws air into the compressor, which in turn forces air towards the inlet manifold.

9. The generator (Figure 2), fan and water pump are driven by two V-type belts from a driving pulley mounted on the front end of the crankshaft.

10. The series charged air cooling system (Figure 2) is located between the turbocharger and the inlet manifold. Its purpose is to cool the pressurised air as it travels from the turbocharger to the inlet manifold. This is done by means of a heat exchanger and a tip turbine fan. The fan is driven by pressurised air taken from a bleed off point on the turbocharger to inlet manifold crossover tube.

11. The air starter is located between the oil filters and the flywheel housing (Figure 2). It is driven by compressed air stored in a tank located on the right-hand side of the vehicle.

12. The crankcase and cylinder block are cast in one piece and carry the crankshaft main bearings and removable dry type cylinder liners. Water jackets surrounding each cylinder allow coolant to circulate and keep the engine at a constant operating temperature.

13. The oil pump draws oil from the oil pan and supplies the oil under pressure to the engine lubrication system. An oil pressure relief valve directs oil flow to spray nozzles, which spray oil up into the piston to keep piston temperatures down.

14. Two detachable cylinder heads are bolted to the engine block and a gastight and watertight seal is maintained by means of gaskets and fire-rings. The valve seats are of alloy and are pressed into place. The exhaust valve seat is especially hardened to resist the high exhaust gas temperatures. The valves and valve seats are continually cooled by continuous circulation of coolant, which flows up from the cylinder block and through the passages in the heads.

15. The crankshaft is a drop forging of heat-treated steel. It is counterweighted, balanced both statically and dynamically, and ground to close limits. The shaft is mounted in seven precision-type replaceable shell bearings, with number four bearing taking up the thrust.

16. The pistons, made of an aluminium alloy, are cam ground and fitted with three compression and one oil control ring. The piston crown has been recessed for the combustion chamber. The semi-floating type piston pins have an interference fit into the piston; circlips are used to retain the pin within the piston.

17. The camshaft is machined from a solid drop forging and mounted in seven replaceable bearings. Special contours are ground into the back of the cam lobes for Dynatard braking operation.

18. The flywheel is bolted to the crankshaft flange. The ring gear is heat shrunk onto the flywheel.

Engine Specification

19. Table 1 lists the engine specifications.

Table 1 Engine Specification

Item	Detail
Number of cylinders	6
Bore	123.8 mm (4.874 in)
Stroke	152.4 mm (6 in)
Displacement	11 L (672 in^3)
Output (maximum)	212 kW (285 bhp) @ 1 800 rpm
Torque (maximum)	1 464 N.m (1080 ft.lbf) @ 1 200 rpm
Maximum recommended speed:	
Full load	2 100 rpm
No load (maximum)	2 280 rpm
Recommended low idle speed	525 to 575 rpm
Compression ratio	15:1
Firing order	1-5-3-6-2-4
Engine oil capacity (including filters)	55 L (12 gal)
Crankshaft:	
Main journal diameter	101.549 to 101.574 mm (3.9980 to 3.9990 in)
Number of main bearing	7
Crank pin diameter	76.123 to 76.149 mm (2.9970 to 2.9980 in)
Bearing clearance (main journals)	0.050 to 0.127 mm (0.002 to 0.005 in)
Crank shaft – end play	0.101 to 0.279 mm (0.004 to 0.011 in)
Thrust taken by	Number 4
Bearing tunnel	107.975 to 108.00 mm (4.251 to 4.252 in)

Table 1 Engine Specification (Continued)

Item	Detail
Camshaft:	
Journal Diameter:	
1 through 6	61.950 to 61.976 mm (2.439 to 2.440 in)
7	57.175 to 57.200 mm (2.251 to 2.252 in)
Bearing clearance:	
1 through 6	0.05 to 0.101 mm(0.002 to 0.004 in)
7	0.038 to 0.076 mm (0.0015 to 0.003 in)
Camshaft end play	0.203 to 0.355 mm (0.008 to 0.014 in)
Thrust taken by	thrust washer
Timing gear backlash	0.033 to 0.274 mm (0.0013 to 0.0108 in)
Connecting rods:	
Bearing end clearance	0.177 to 0.304 mm (0.007 to 0.012 in)
Running clearance	0.027 to 0.099 mm (0.0011 to 0.0039 in)
Weight variation inset of six	7.075 g (0.25 oz)
Length between centres	271.424 to 271.50 mm (10.686 to 10.689 in)
Twist within 305 mm (12 in)	0.254 mm (0.010 in)
Bend within 305 mm (12 in)	0.101 mm (0.004 in)
Pistons:	
Top, extension above cylinder block at TDC	0.508 mm (0.020 in)
Recommended piston clearance across major axis	
(90° from pin) bottom of skirt	0.121 to 0.185 mm (0.0048 to 0.0073 in)
Pistons pins:	
Length	105.918 to 106.045 mm (4.170 to 4.175 in)
Diameter	50.769 to 50.772 mm (1.9988 to 1.9989 in)
Recommended clearance in rod	0.030 to 0.040 mm (0.0012 to 0.0016 in)
Recommended clearance in piston	heat piston to 93.3°C (200°F) in oil and hand press pin
Piston rings:	
Compression rings on each piston	3 (wedge shape)
Size:	
First and second	2.895 to 2.908 mm (0.114 to 0.1145 in) out edge only
Third	3.022 to 3.035 mm (0.119 to 0.1195 in) outer edge only
Oil ring on each piston	1
Size	4.762 mm (0.1875 in)
Ring gap:	
Compression rings	0.330 to 0.635 mm (0.013 to 0.025 in)
Oil ring-side rail	0.330 to 0.635 mm (0.013 to 0.025 in)
Fit in groove – side clearance:	
First (comp)	Keystone rings (wedge shape) Should not exceed 0.152 mm (0.006 in) when measured 1.587 mm (0.062 in) in from face of land
Second (comp)	
Third (comp)	
Oil	0.025 to 0.088 mm (0.001 to 0.0035 in)

Table 1 Engine Specification (Continued)

Item	Detail
Valve seats:	
Angle of face	29° 30’ to 30° 00’ (30° +0° and -30’)
Width of seat (inlet)	1.587 to 2.381 mm (0.0625 to 0.0937 in)
Width of seat (exhaust)	1.587 to 2.381 mm (0.0625 to 0.0937 in)
Inlet valves:	
Stem diameter	12.611 to 12.636 mm (0.4965 to 0.4975 in)
Angle of face	29°30’ to 30° 00’ (30° +0° and -30’)
Tappet clearance (cold)	0.406 mm (0.016 in)
Stem clearance	0.050 to 0.101 mm (0.002 to 0.004 in)
Exhaust valves:	
Stem diameter	12.585 to 12.611 mm (0.4955 to 0.4965 in)
Angle of face	29°30’ to 30° 00’ (30° + 0° and -30’)
Tappet clearance (cold)	0.609 mm (0.024 in)
Stem clearance in guide	0.076 to 0.127 mm (0.003 to 0.005 in)
Valve guides:	
Distance above head measured from valve spring seat face:	
Inlet	39.290 mm (1.5469 in)
Exhaust	39.290 mm (1.5469 in)
Cam follower:	
Clearance in block	0.012 to 0.050 mm (0.0005 to 0.002 in)
Shank diameter	17.411 to 17.424 mm (0.6855 to 0.686 in)
Head diameter	35.052 to 35.179 mm (1.380 to 1.385 in)
Push rods overall length:	
Inlet	394.766 to 396.341 mm (15.542 to 15.604 in)
Exhaust	397.154 to 397.916 mm (15.636 to 15.666 in)
Valve springs:	
Inner:	
Free length	76.993 mm (3.0312 in)
Load at 51.593 mm (2.03122 in)	43.544 to 48.080 kg (96 to 106 lb)
Service limit	40.913 kg (90.2 lb)
Outer:	
Free length	90.090 mm (3.5469 in)
Load at 54.768 mm (2.1562 in)	58.195 to 64.319 kg (128.3 to 141.8 lb)
Service limit	54.975 kg (121.2 lb)
Valve rocker arms:	
Ratio	1.8:1
Hole ID	28.691 to 28.704 mm (1.1296 to 1.1301 in)
Clearance on shaft	0.012 to 0.038 mm (0.0005 to 0.0015 in)
Shaft diameter	28.666 to 28.679 mm (1.1286 to 1.1291 in)

Table 1 Engine Specification (Continued)

Item	Detail
Oil pump:	
Gear end clearance	0.063 to 0.127 mm (0.0025 to 0.005 in)
Running clearance – gear to body	0.088 to 0.152 mm (0.0035 to 0.066 in)
Backlash – body gears	0.596 to 0.749 mm (0.0235 to 0.0295 in)
Backlash – drive gears	0.182 to 0.350 mm (0.0072 to 0.0138 in)
Oil pressure at 600 rpm engine (hot oil)	175 kPa (25 psi)
Oil pressure at 2 100 rpm engine (hot oil)	275 to 660 kPa (40 to 95 psi)
Tip turbine fan:	
Fan portion:	
Number of blades	10
Blades OD	4.6 in
Overall wheel OD	6.125 in
Turbine wheel:	
Number of blades	66
Turbocharger:	
Shaft end play	0.0762 to 0.2032 mm (0.003 to 0.008 in)
Bearing radial check	0.0762 to 0.1524 mm (0.003 to 0.006 in)
Auxiliary driveshaft:	
Bearing, pre-sized ID (in place):	
Front	52.415 to 52.491 mm (2.0636 to 2.0666 in)
Rear	50.810 to 50.886 mm (2.0004 to 2.0034 in)
Bearing, pre-sized OD:	
Front	58.775 to 58.801 mm (2.314 to 2.315 in)
Rear	57.200 to 57.226 mm (2.252 to 2.253 in)
Bearing bore in block:	
Front	58.699 to 58.724 mm (2.311 to 2.312 in)
Rear	57.124 to 57.150 mm (2.249 to 2.250 in)
Bearing interference fit in bore (front and rear)	0.050 to 0.101 mm (0.002 to 0.004 in)
Shaft end play	0.203 to 0.355 mm (0.008 to 0.014 in)
Bearing clearance	
Front	0.040 to 0.142 mm (0.0016 to 0.0056 in)
Rear	0.035 to 0.137 mm (0.0014 to 0.0054 in)
Journal diameter:	
Front	52.349 to 52.374 mm (2.061 to 2.962 in)
Rear	50.749 to 50.774 mm (1.998 to 1.999 in)

Lubrication System

20. The lubrication system, as shown in Figure 3, comprises of the following six components:

- **a.** oil pan,
- **b.** oil pump,
- **c.** oil pressure relief valve,
- **d.** oil cooler,
- **e.** oil filters, and
- **f.** oil galleries.

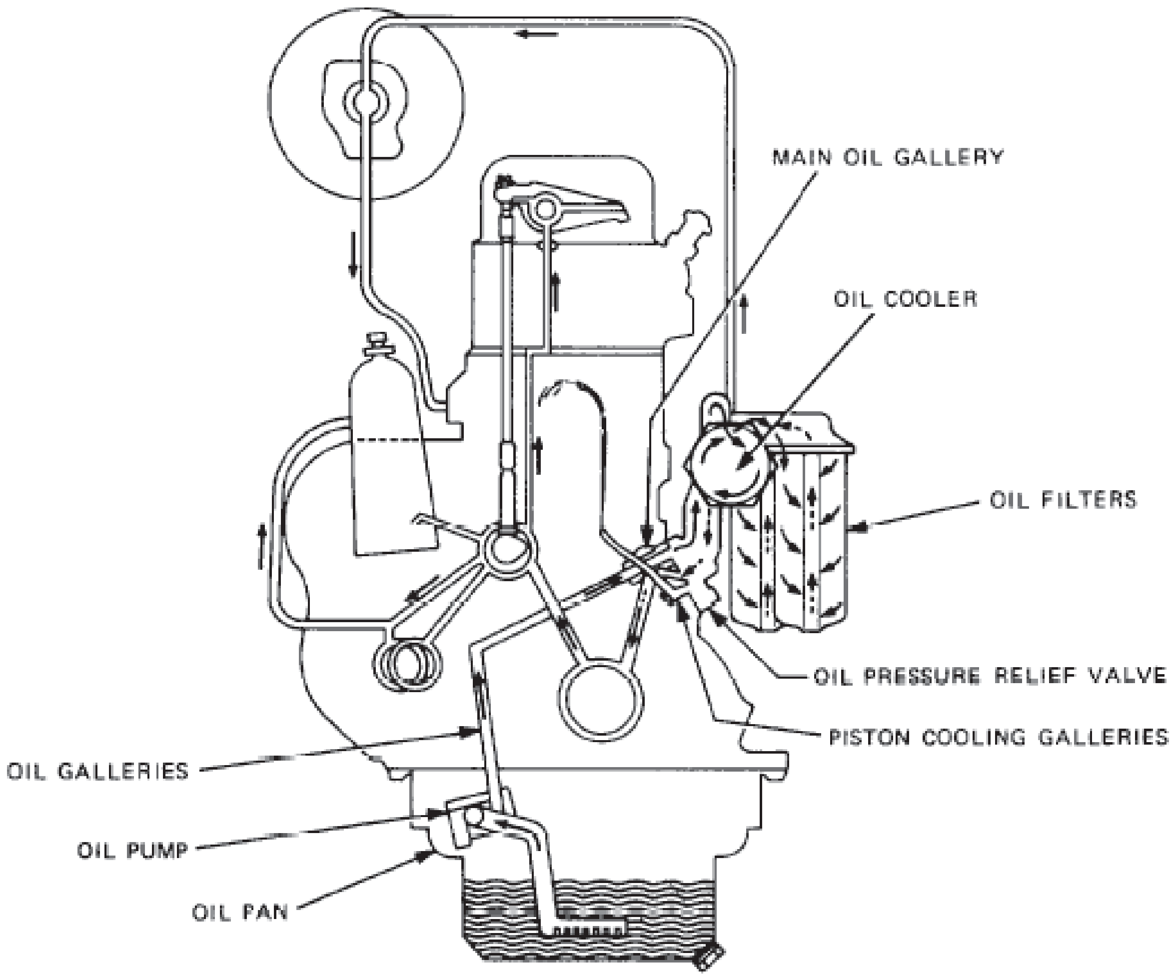


Figure 3 Engine Lubrication System

21. This system is designed to deliver oil under pressure to the various engine components requiring lubrication to enable them to function smoothly. It also provides a jet of oil to the underside of the pistons where the oil acts as a coolant, keeping the piston operating temperature down. The system also filters and cools the oil, preventing oil breakdown or loss of lubricating qualities due to dirt build-up or over heating. A large capacity oil pan stores the oil for the lubrication system.

22. The oil pump is mounted in the base of the crankcase and driven by a gear on the auxiliary shaft; it draws oil from the oil pan and pumps it to the pressure relief valve housing (Figure 4). The housing is a machined casting mounted on the left-hand side of the engine containing the pressure relief valve. This valve controls the oil for piston cooling. At engine speeds above idle, the piston cooling plunger is moved permitting oil from the oil pump to be directed into the piston cooling gallery (Figure 5).

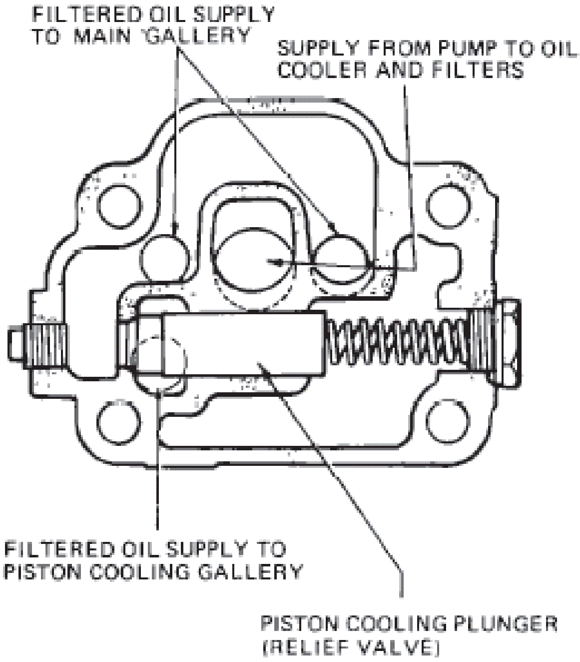


Figure 4   Oil Pressure Relief Valve

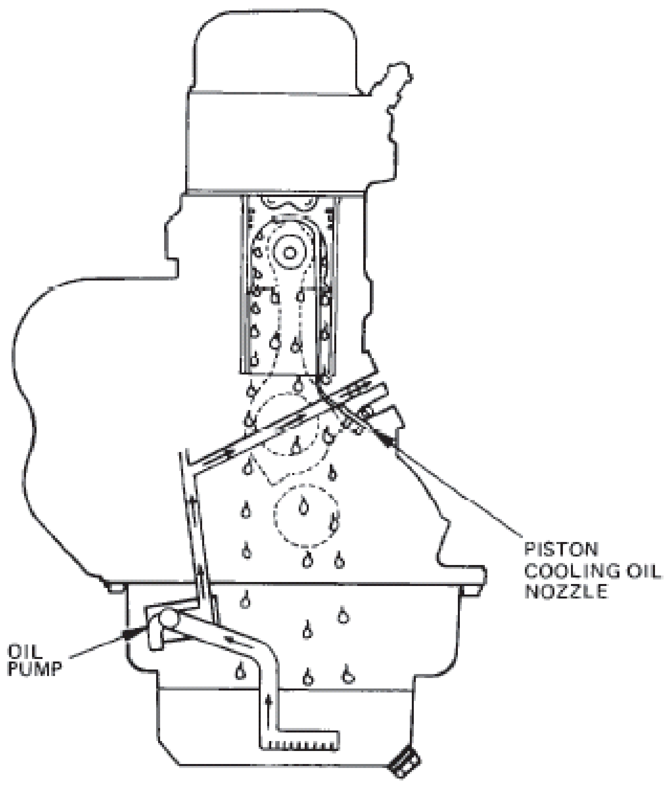


Figure 5   Front Schematic View – Oil Cooling System

23. The pressure relief valve housing directs oil flow through an adapter to the oil cooler; from there to the oil filter mounting adapter assembly and into the oil filters. The filters are mounted to function in parallel. In addition, the adapter assembly houses the oil filter bypass relief valve assembly. This valve is pre-set to retain 260 to 360 kPa (38 to 52 psi) oil pressure before opening when the filters become restricted. After the oil has been filtered, it returns to the pressure relief valve where it is then directed into the engine oil galleries (Figures 6 and 7).

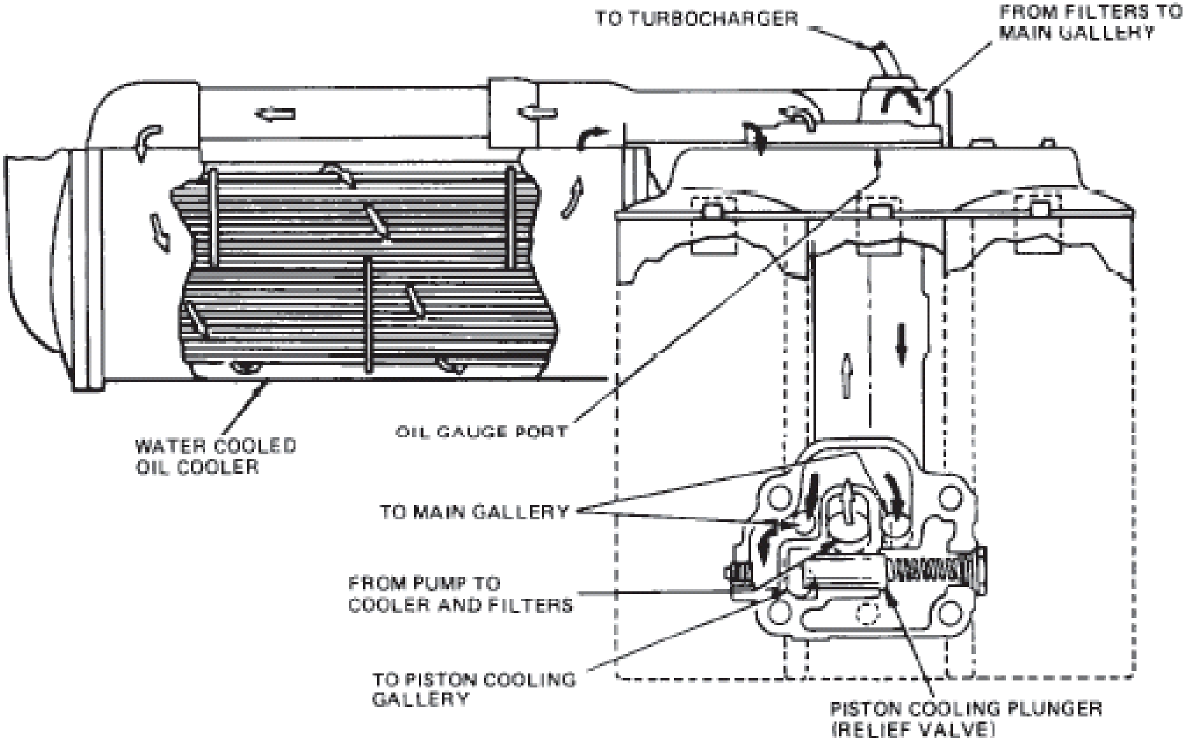


Figure 6 Oil Flow Diagram (Side View)

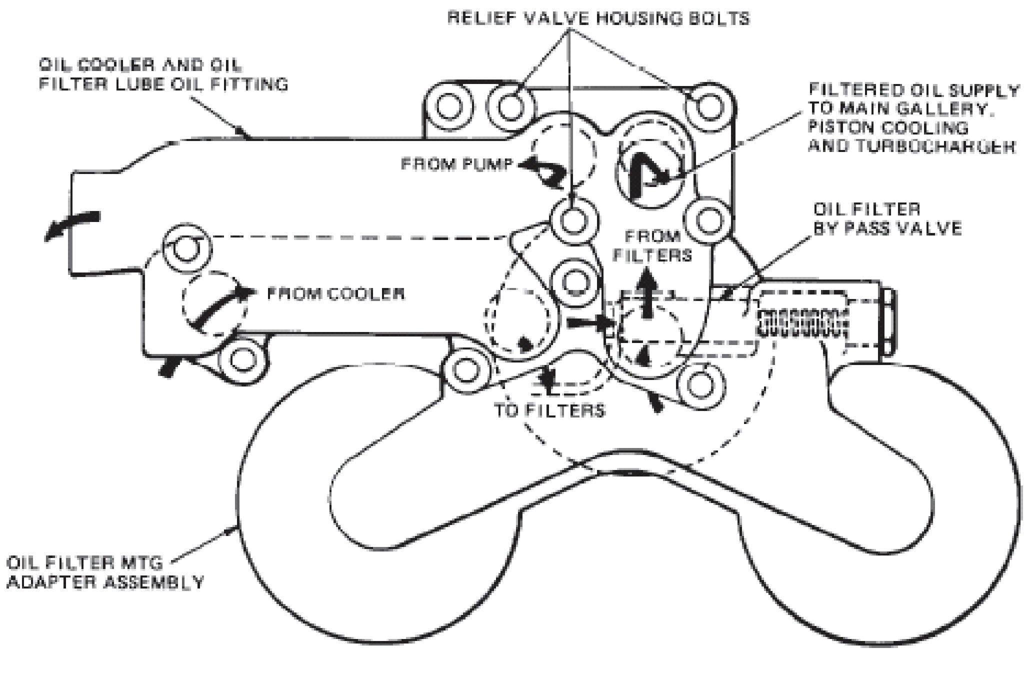


Figure 7 Oil Flow Diagram (Plan View)

24. The oil flows from the main oil gallery to the crankshaft main bearings; from there to the con-rod big end bearings, the camshaft bearings and also the valve rocker arm shafts. Oil from numbers one and four camshaft bearings is directed to the auxiliary shaft bearing; from there oil is fed by an external line to the injection pump and by internal drillings to the compressor crankshaft (Figure 8).

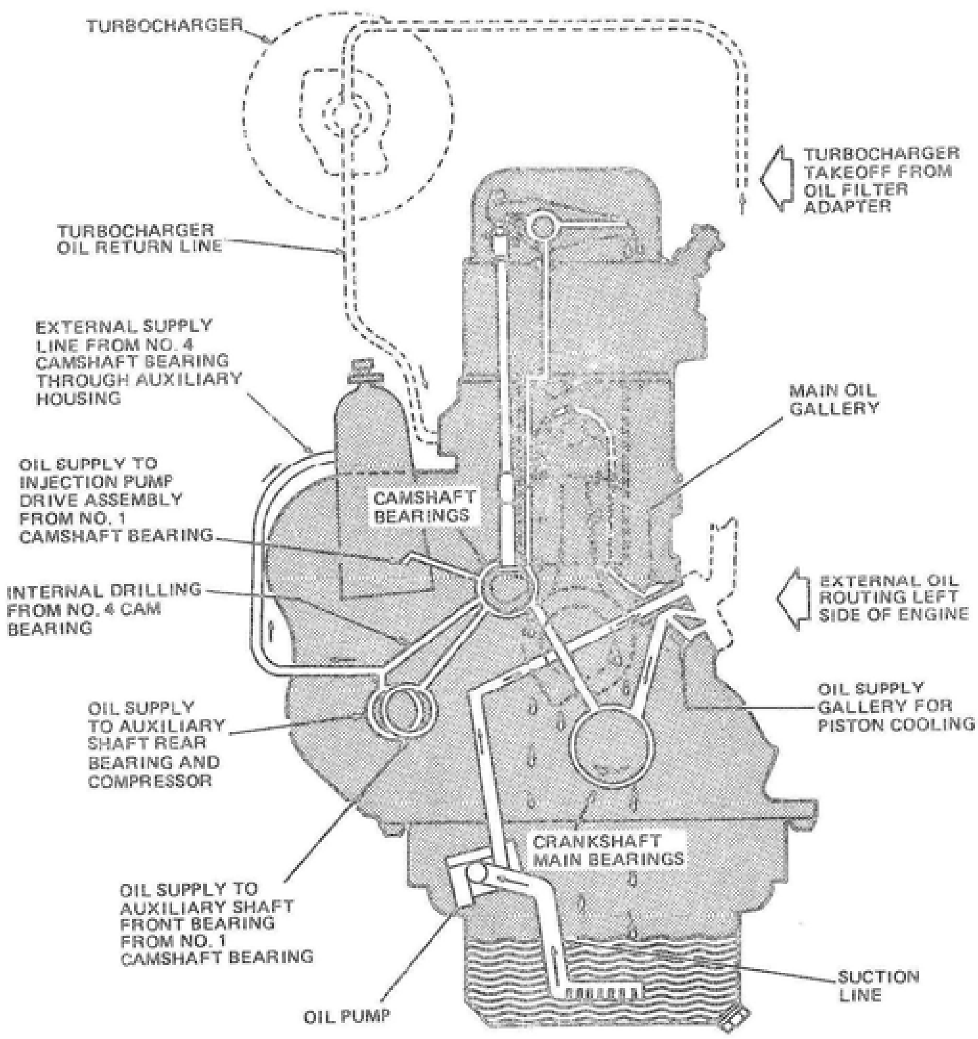


Figure 8 Front Schematic View – Engine Oil System

Air Cleaners

25. The vehicle is equipped with two externally mounted Donaldson Donaclone air cleaners. The air cleaners on the right-hand side filters the turbocharger air supply, while the air cleaner on the left-hand side filters the air supply for the intercooler tip turbine fan. A restriction gauge is fitted to the right-hand air cleaner allowing the driver to see at a glance when the air cleaners require servicing. The air cleaners are comprised of five major components:

a. top cover,

b. filter elements,

c. upper body,

d. lower body, and

e. dust cap.

26. The dust cup, lower body and upper body are held together by clamps (Figure 9). Rubber O-rings are placed between these components to ensure non-filtered air cannot enter and bypass the cleaning process. The filter element is positioned in the upper body with a rubber O-ring installed at the base of the element. The top of the filter element is sealed by means of a plastic cover, with a wing nut securing both the plastic cover and element in position. The top cover is installed with an O-ring on the upper body and is locked in position by spring clips, effectively sealing the air cleaner body so that air passing through the filter must flow via the designed route.

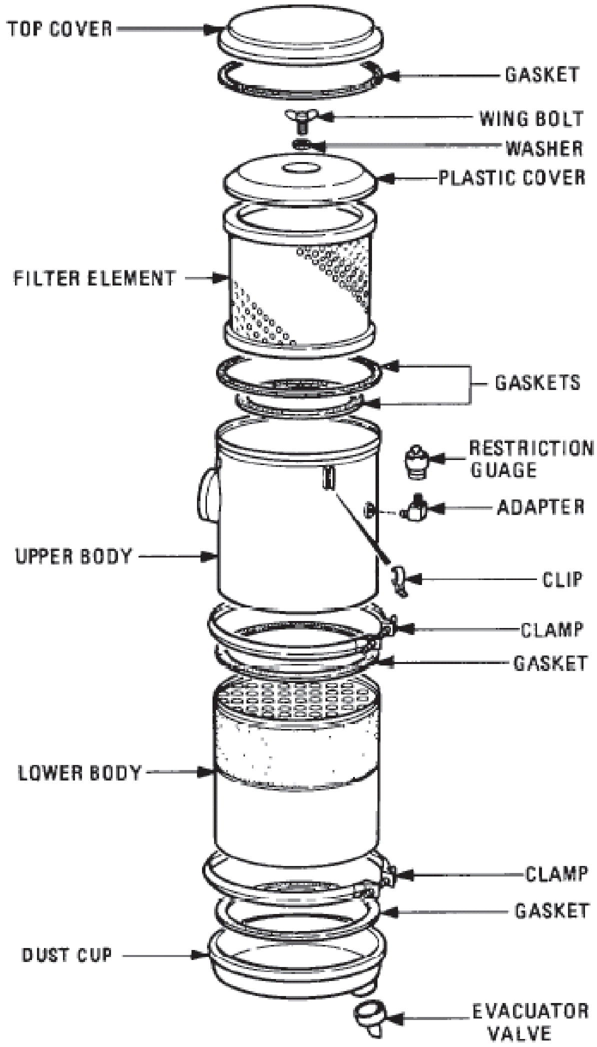


Figure 9 Air Cleaner (Exploded View)

27. Air is drawn through the perforations in the lower body (Figure 10) through the specially designed polypropylene tubes, which have vanes moulded into the top to induce a cyclonic twist to the air as it passes through. This causes the dust particles to be thrown outward, allowing clean air to be drawn up through the aluminium tubes to the filter element. The dust particles then fall through the bottom of the tubes and collect in the dust cup. The clean air then passes through the filter element, which extracts any dust particles that may have escaped the first stage of the cleaning process, before it flows on to the turbocharger or tip turbine fan.

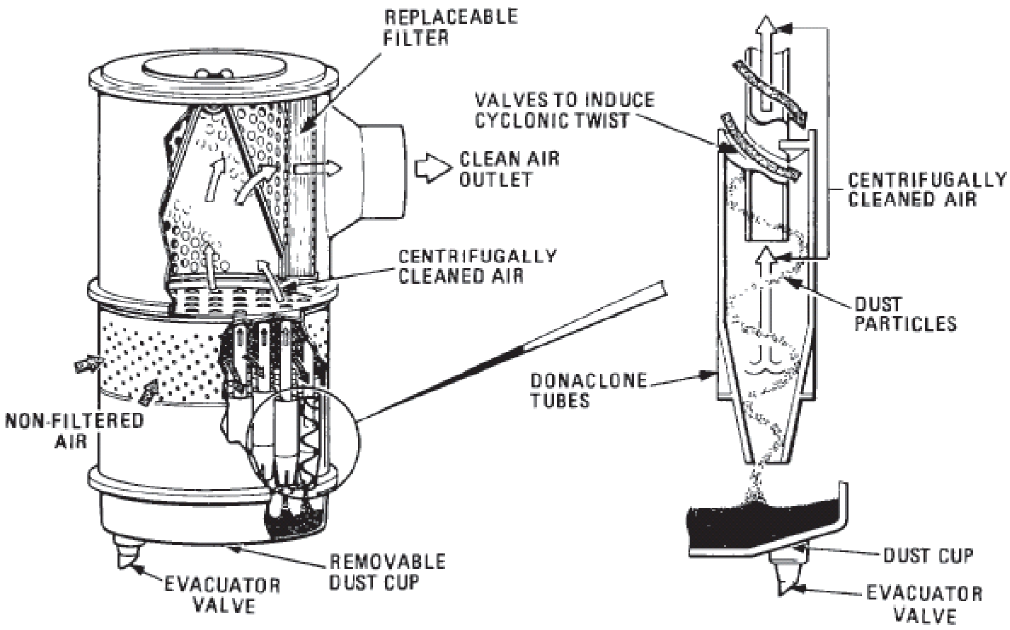


Figure 10 Air Flow Through Air Cleaner

Fuel System

28. The fuel injection system is comprised of eight major components:

- **a.** fuel tank;
- **b.** primary fuel filter;
- **c.** fuel supply pump;
- **d.** secondary filter;
- **e.** injection pump;
- **f.** high-pressure fuel lines;
- **g.** injection nozzles; and
- **h.** governor.

29. This system must filter the fuel, meter the amount of atomised fuel injected into the combustion chamber and inject it at the proper time in order to obtain optimum performance.

30. The fuel tank is the fuel system supply reservoir with a capacity of 265 L (59 gal) and is mounted on the right-hand side of the vehicle to the rear of the axle bogie. Fuel drawn from the tank passes through the primary filter, where large particles of dirt and sediment are removed from the fuel and retained in the filter. This filter is a spin-on type with a 13/16 – 18 UNF thread.

31. Fuel is then drawn into and pumped out of the supply pump into the secondary filter, where very fine particles are removed from the fuel preventing unnecessary damage of the close fitting parts of the injection pump and nozzles. This filter is a spin-on type with a 7/8 – 16 UNF thread.

32. The fuel is then fed into the injection pump where it is then pumped out under high pressure to the injection nozzles and in turn injected as an atomised spray into the combustion chambers. Pressure within the fuel system is maintained at a specified level by the use of a vented overflow valve, which is located at the front of the injection pump fuel gallery. All excess fuel in the injection pump is allowed to pass from the overflow valve to the fuel tank via the return line. A small amount of fuel used for cooling and lubrication of the injectors is carried via the injector leak-off line to join the return line at the overflow valve. Fuel is also delivered from the return line to the starter motor lubricator valve for starter motor lubrication (Figure 11).

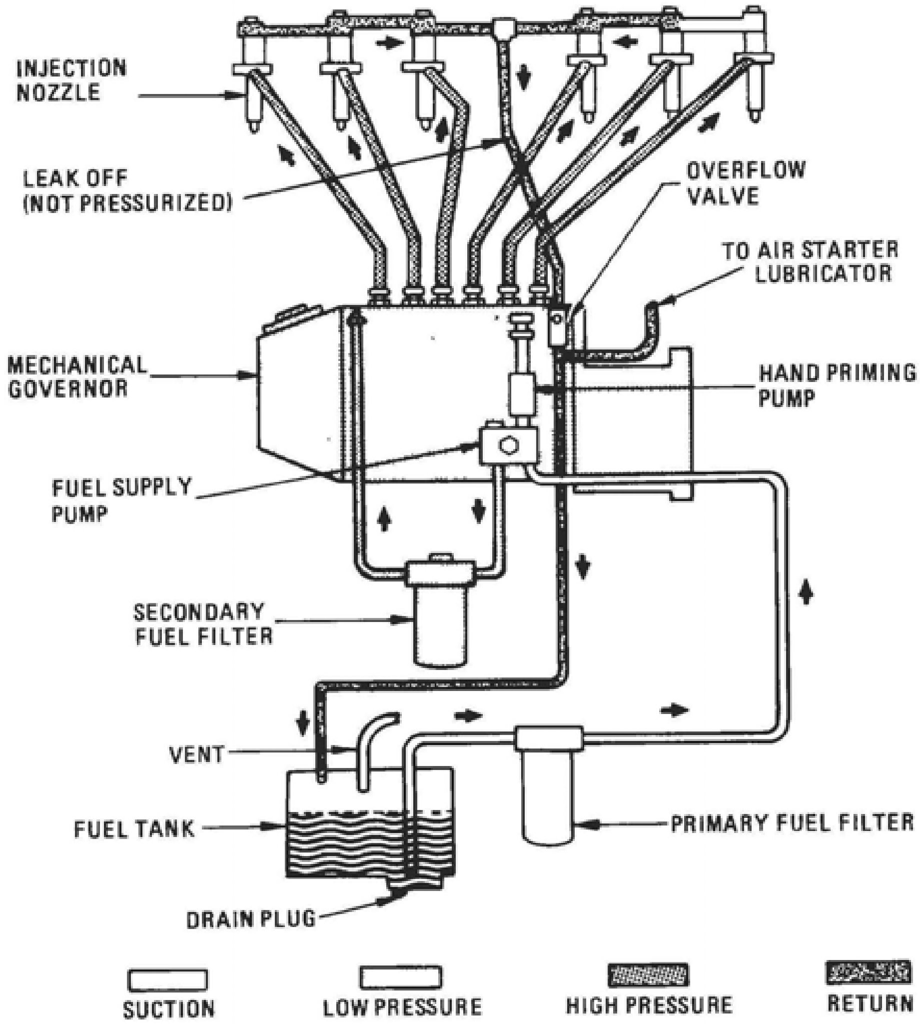


Figure 11 Schematic View of Fuel System

33. The fuel supply pump is mounted directly on the injection pump housing and is driven by a lobe on the injection pump camshaft. The pump is plunger actuated and self regulating, and will build up pressure only to a predetermined point. As the camshaft lobe allows the plunger to be forced by its spring towards the camshaft, the suction created by the plunger movement opens the inlet valve and permits fuel to enter the plunger spring chamber (Figure 12). Then, as the cam lobe drives the plunger against its spring, the fuel in the plunger spring chamber is forced by the plunger through the outlet valve around to the chamber in back of the plunger created by its forward movement. As the camshaft continues to rotate, it allows the plunger spring, which is now under compression, to press the plunger backward again, thus forcing the fuel at the back of the plunger out into the fuel line through the secondary filter to the injection pump (Figure 13). At the same time, the plunger is again creating a suction effect, which allows additional fuel to flow through the inlet valve into the plunger spring chamber. When pressure at the back of the plunger is equal to the force exerted by the plunger spring, the plunger remains stationary and no further pumping action takes place until the pressure drops (Figure 14).

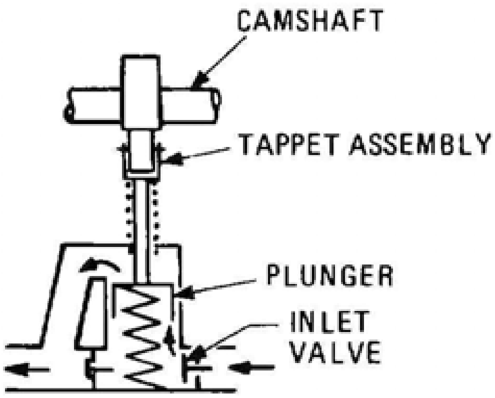


Figure 12 Pumping and Filling

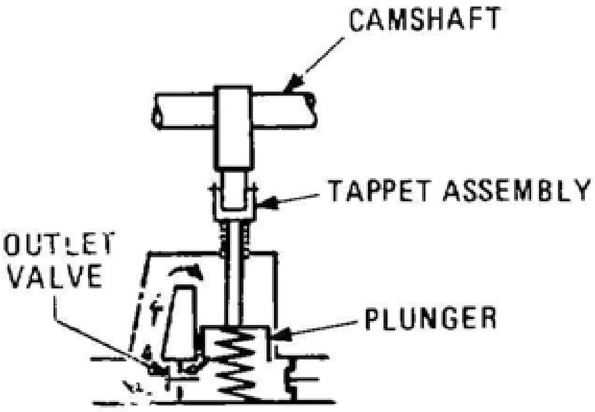


Figure 13 Fuel Flows from Below the Plunger to Above the Plunger

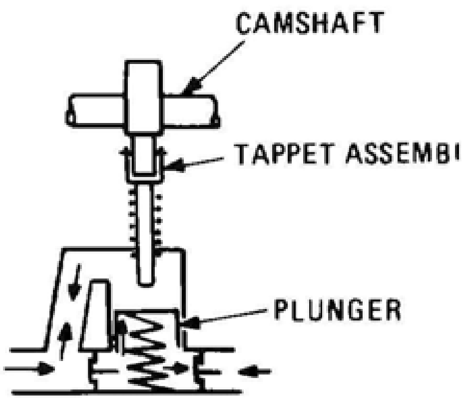


Figure 14 Pumping Action Stopped

34. The fuel injection pump, which is mounted on the right-hand side of the timing gear housing and is gear driven by the engine camshaft driving gear, contains six plunger and barrel assemblies within its housing – one assembly for each cylinder of the engine. Each barrel has two ports 180 degrees apart, the inlet-port and the spill-port, and also a delivery valve assembly, which is mounted directly above the barrel. Machined into the sides of the plunger are two vertical slots 180 degrees apart and a slow turning spiral, called a helix, leading to each vertical slot. The double helix design provides balanced pressure around the plunger and cushions the spill after the end of fuel delivery (Figure 15).

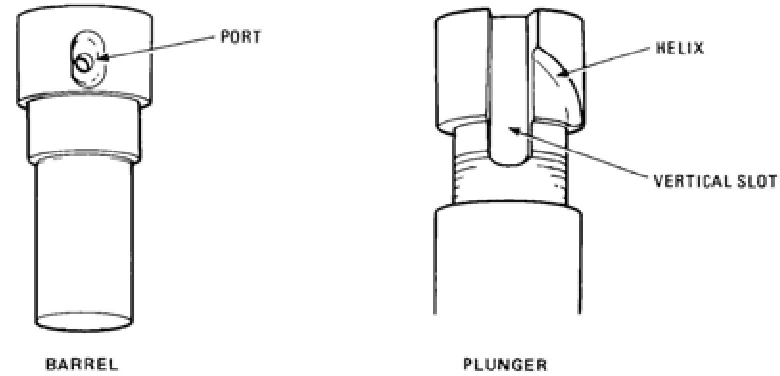


Figure 15 Barrel and Plunger

35. The plunger is ground to fit the barrel with extremely close tolerances forming a matched pair that should never be intermixed. The rotation of the camshaft, located in the lower section of the injection pump housing, lifts the plungers. The plungers are returned to their lower position by the spring assemblies. As the plunger moves to the bottom of its stroke, the inlet and spill ports are uncovered allowing low-pressure fuel, which is surrounding the head of the barrel, to fill the space above the plunger, the vertical grooves and the helical recesses. As the plunger starts upwards, it closes the ports and traps fuel in the upper part of the barrel. This is called the 'Port Closing' position (Figure 16). The continued upward thrust of the plunger immediately builds up pressure of the trapped fuel, causing the delivery valve above the barrel to open and allow the fuel to be delivered through the high-pressure line to the nozzle (Figure 17). As the plunger moves up the barrel, the cut-away of the helix uncovers the spill-port in the barrel releasing the fuel trapped above the plunger through the helical recess and spill-port to the gallery (Figure 18). The pressure above the plunger drops immediately and the delivery valve snaps shut. The rapid closing of the delivery valve greatly reduces pressure in the high-pressure line, thus eliminating secondary injection at the nozzle.

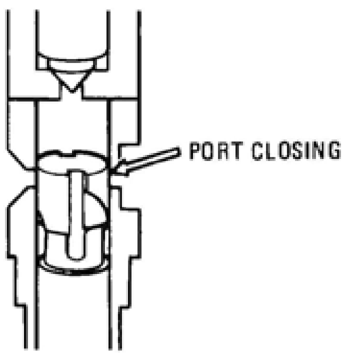


Figure 16 Port Closing

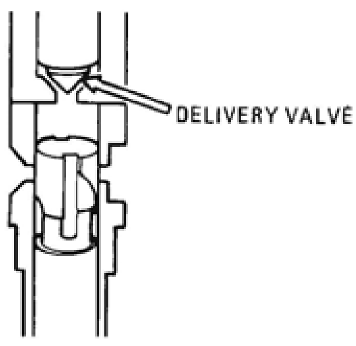


Figure 17 Fuel Pressure Above Plunger Opens Delivery Valve

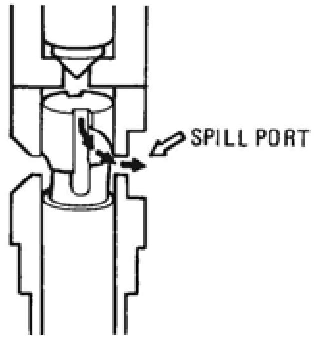


Figure 18 Fuel Pressure Above Plunger Drops, Delivery Valve Shuts

36. A snubber valve assembly is installed into the fuel system. It is located between the injection pump outlet fitting and the upper delivery valve spring seat. The valve is designed to reduce cavitation erosion by acting as a one-way damper snubbing out the high-pressure pulsations in the high-pressure line (Figure 19).

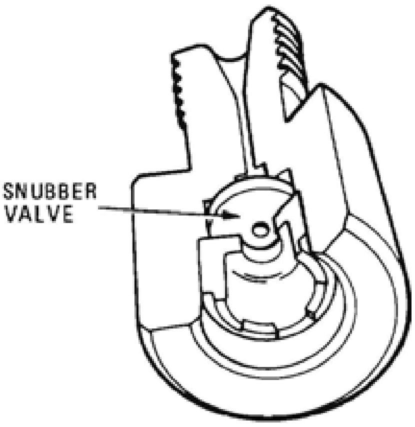


Figure 19 One-piece Snubber Valve Assembly

37. Since the total plunger stroke is constant, metering is accomplished by varying the length of the ‘effective’ part of the plunger’s helix (Figure 20). The amount of fuel injected depends on the effective stroke of the plunger. This effective stroke is varied by rotating the plunger within its barrel (Figure 21). When the plunger’s two vertical slots are lined up with the barrel ports, fuel pressure won’t build as the plunger reciprocates. This is the zero fuel delivery position. As the plunger is rotated, it travels further up the barrel before uncovering the spill-port and, therefore, delivers a greater amount of fuel. In the full throttle position, the helix covers the spill-port for its greatest distance and maximum fuel is injected (Figure 22).

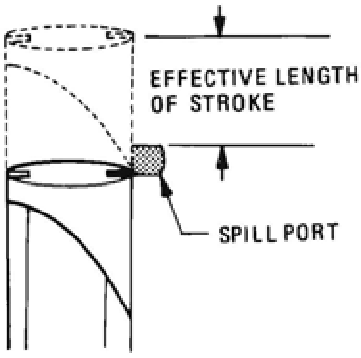


Figure 20 Plunger Stroke

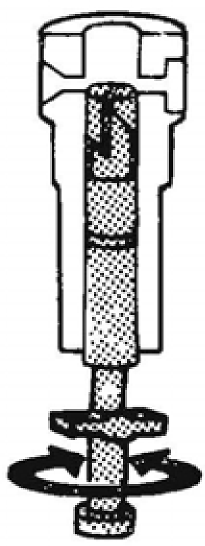


Figure 21 Vary the Effective Plunger Stroke

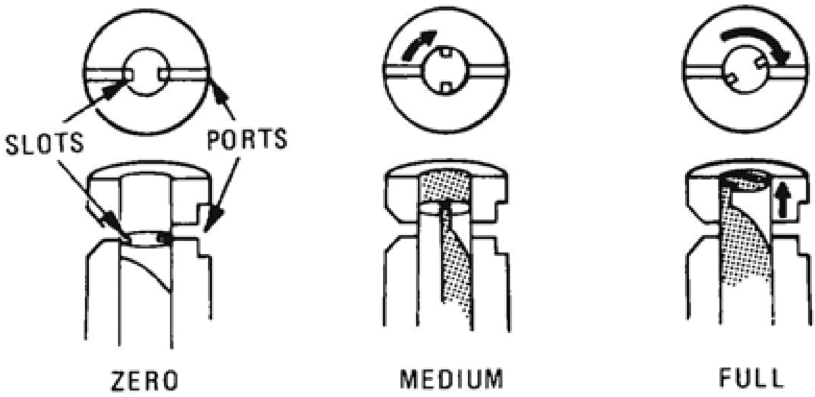


Figure 22 Fuel Metering

38. The plunger is rotated by a control rack that runs the length of the injection pump (Figure 23). It meshes with control gear segments mounted on control sleeves fitted over each barrel. These sleeves fit over flanges on the bottom of the plungers. With this arrangement, all of the plungers are rotated simultaneously.

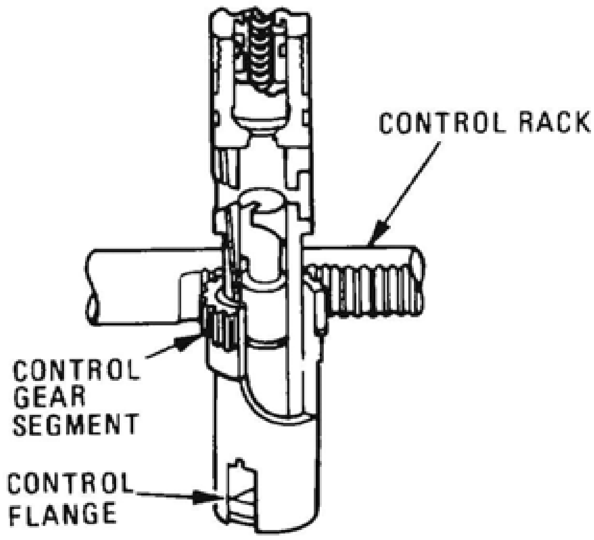


Figure 23 Fuel Meting Control

39. The fuel under high pressure travels from the injection pump, through the high-pressure lines to the injection nozzle mounted at the top of each cylinder. The high-pressure lines are all the same length and bore size, and are isolated from each other to prevent them from rupturing. The nozzle assembly contains a spindle and spring as well as a high-pressure fuel duct. The spindle bore and the spring chamber are utilised as a passage for the leak-off fuel that cools and lubricates the nozzle valve. This nozzle valve is spring loaded by the spindle and spring assembly located in the nozzle holder. The spring is set to provide the specified nozzle opening pressure. High-pressure fuel lifts the nozzle valve off its seat allowing the fuel to be injected into the cylinder through equally sized holes in the nozzle tip in the form of a fine spray (Figure 24).

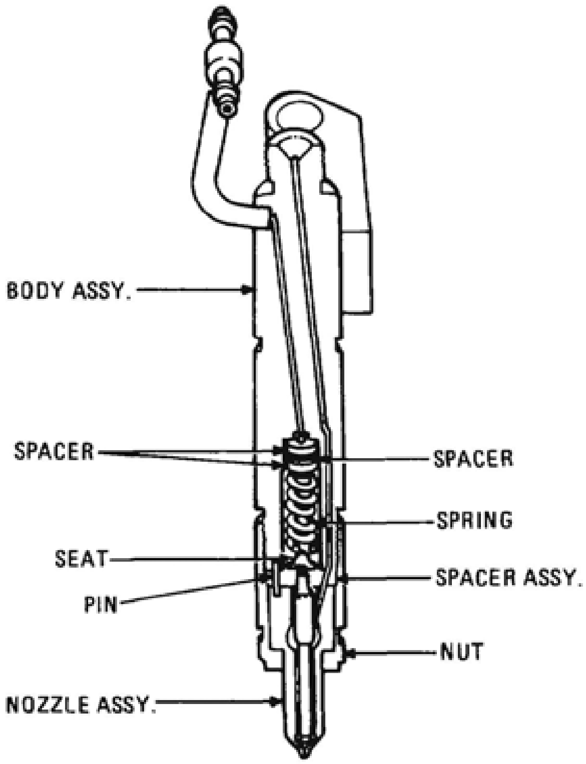


Figure 24 Fuel Injector Nozzle Assembly

40. At the point in the plunger stroke where the lower edge of the helix uncovers the spill-port, the delivery valve closes quickly. As the delivery valve closes, the delivery valve relief piston causes a controlled rapid lowering and maintaining of residual high pressure in the high-pressure line. The consequent reduction in line pressure enables the spring in the nozzle holder to quickly seat the valve. At this point, injection is completed.

Governor

41. A mechanical governor mounted on the end of the pump housing, opposite the drive end, controls the injection pump rack. It provides a coupling between the accelerator linkage and the injection pump rack, regulating fuel delivery in response to pedal position, load and engine speed. The functions of the governor are to maintain desired engine rev/min under varying engine loads, control idling rev/min and maximum rev/min. The governor is gear driven through a slip clutch arrangement on the injection pump camshaft, which protects the governor components from torsional vibrations.

42. The governor shaft assembly contains the governor flyweights, sliding sleeve assembly, and the inner and outer governor springs (Figure 25). As the flyweights revolve, centrifugal force tends to move them outward. This movement is opposed by the governor springs acting through the sliding sleeve assembly. As engine rev/min increases, centrifugal force finally causes the flyweights to move the sliding sleeve rearward. When the rev/min decreases, the spring force overcomes the centrifugal force of the flyweights and moves the sliding sleeve forward toward the injection pump.

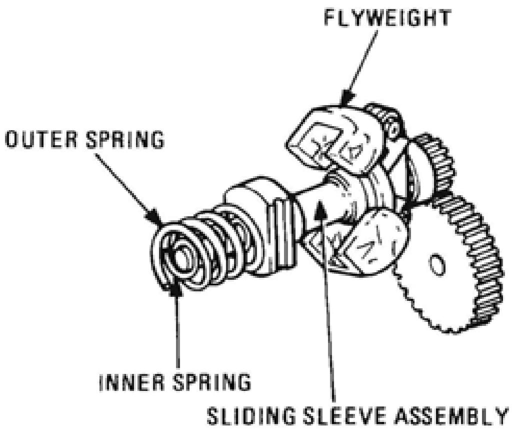


Figure 25 Fuel Injector Pump Governor

43. The fulcrum lever is connected at its lower end to the fulcrum lever bracket by means of a pin. The fulcrum lever bracket extends around the operating lever shaft, but is not rigidly connected to it (Figure 26). The spring hub is firmly secured to the operating lever shaft and connected through a double torsional spring to the fulcrum lever bracket (Figure 27), which allows relative movement between the operating lever shaft and fulcrum lever bracket.

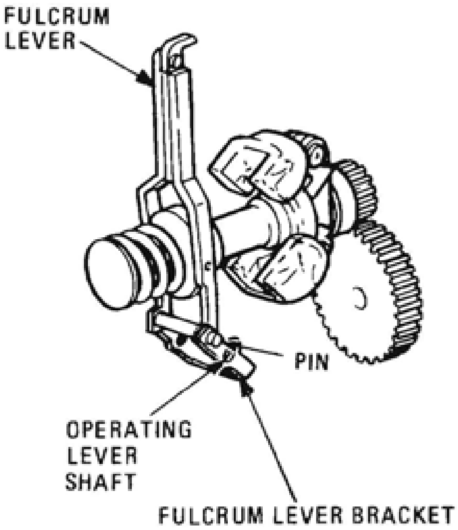


Figure 26 Governor and Fulcrum Lever

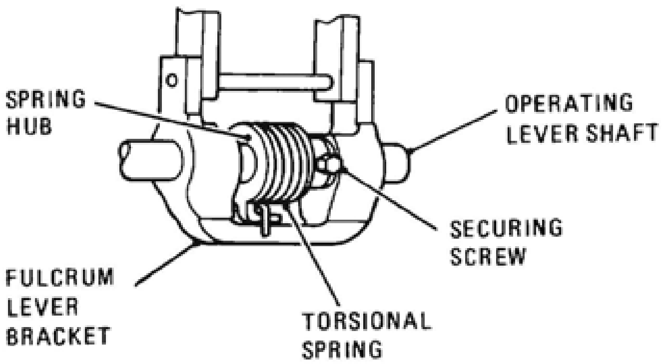


Figure 27 Fulcrum Lever Bracket

44. Movement of the operating lever will rotate the spring hub and the fulcrum lever bracket, thereby causing the fulcrum lever to rotate on its pivot. The upper end of the fulcrum lever is connected through a linkage to the control rack. This, in turn, rotates the plungers to vary the amount of fuel delivered. If the accelerator is held in the maximum rev/min position, the engine speed will continue to increase until the governor weights move outward enough to force the sliding sleeve and fulcrum lever rearward, away from the injection pump (Figure 28). The engine is then at governed maximum rev/min under no load.

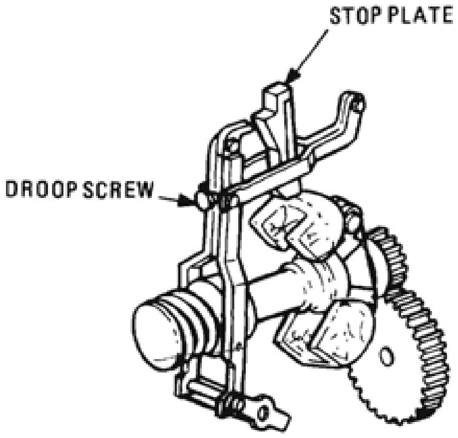


Figure 28 Governor, Fulcrum Lever and Stop Plate

45. A Maxidyne Fuelling Concept is incorporated with the governor assembly; it provides increased engine torque in the lower rev/min ranges. To do this, a special type of maximum fuel stop plate is used. It is adjustable both horizontally and vertically. An extension or torque cam at the upper end of the fulcrum lever contacts the stop plate, and under load, follows the stop plate profile (Figure 29). As engine speed decreases, the sliding sleeve assembly moves forward, pushing the fulcrum lever and control rack towards increased fuel delivery. The torque cam is simultaneously moving over the stop plate. As engine speed continues to drop, the lower end of the fulcrum lever moves still further towards the pump. This movement causes the droop screw to contact the lower end of the stop plate (Figure 30). The purpose of the droop screw is to limit fuel delivery in order to match turbocharger output at low engine rev/min. As engine speed decreases still further, the lower end of the fulcrum lever moves towards the pump. It then pivots about the droop screw, thereby moving the top end of the fulcrum lever away from the pump, decreasing fuel.

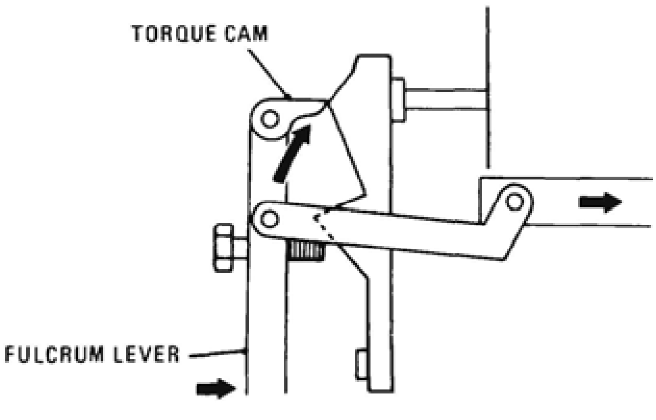


Figure 29 Increased Fuel Delivery

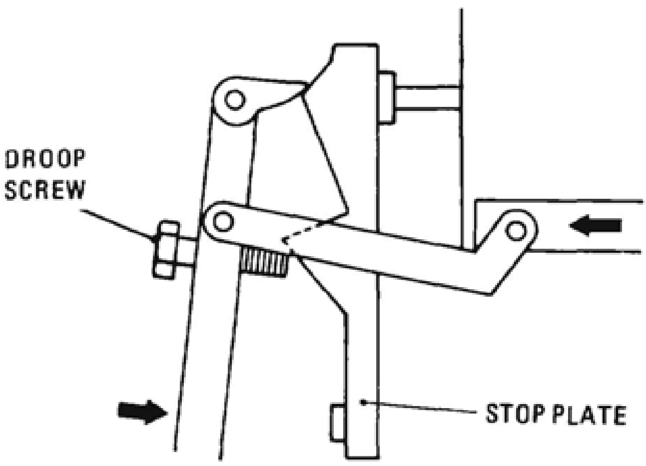


Figure 30 Fuel Delivery Limited

Fuel Tank

46. The fuel tank is constructed from steel with the bottom, rear wall and ends of the tank made from 2 mm sheet steel and the top and front wall made from 3 mm tread plate. Each joint is overlapped and fillet welded, giving the fuel tank strength and rigidity, preventing buckling or distortion caused by the heavy mass of fuel it contains. A baffle plate is welded to the inside of the tank to prevent fuel surging from one end of the tank to the other.

47. The fuel tank sits on two ‘J’ brackets that are bolted to two angle iron brackets, which in turn are bolted to the chassis rail (Figure 31). Two stainless steel straps connected to the ‘J’ brackets hold the fuel tank securely in position. A fusible vented brass cap and a cork and rubber compound gasket are used to seal the fuel tank filler neck. A security chain and retainer prevent the cap falling in dirt or being lost when removed from the tank. A fuel gauge sender unit is installed in the fuel tank. The sender unit comprises a float mounted on an arm, which is connected to a rheostat (variable resistor) (Figure 32). An electric current flows through the fuel gauge to the rheostat and from there to earth on the chassis. The amount of current flowing through the gauge regulates the position of the gauge pointer. Current flow through the gauge is governed by the amount of resistance created by the rheostat, which is controlled by the position of the float and arm. The more fuel in the tank the higher the float and arm will sit causing the rheostat to turn to the position of least resistance and allowing more current to flow through the gauge. This causes the gauge pointer to indicate a full fuel tank.

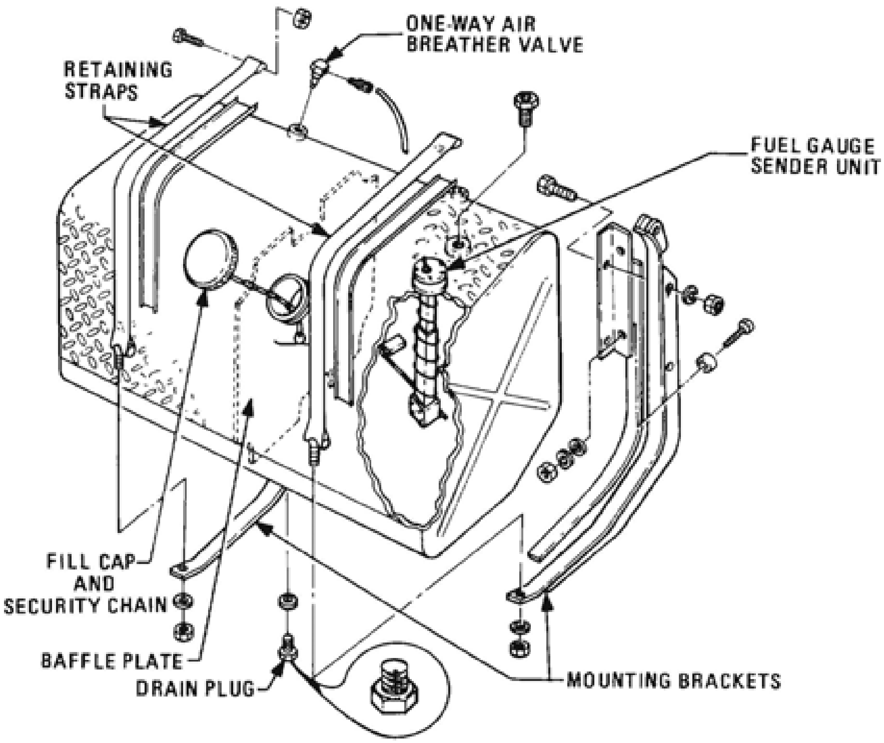


Figure 31 Fuel Tank and Mounting Brackets

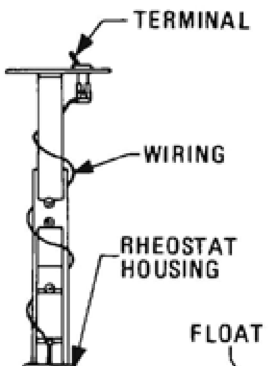


Figure 32 Fuel Gauge Sender Unit

48. A breather valve is fitted to the top of the fuel tank. This valve allows air to be drawn into the tank to take the place of fuel drawn out by the engine preventing a vacuum build up in the tank, which would otherwise restrict or stop the flow of fuel to the engine. The breather valve incorporates a spring-loaded ball (Figure 33), which acts as a one-way valve, allowing air to flow into the tank, but preventing fuel flowing out. A hex head drain plug is located in the bottom of the fuel tank, allowing water and other impurities to be drained from the tank without having to remove the tank (Figure 31).

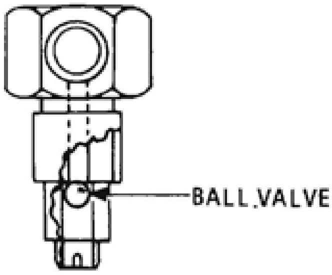


Figure 33 One-way Breather Valve (Fuel Tank)

Exhaust System

49. The exhaust system on the vehicle consists of a muffler, a flexible steel and asbestos pipe and five pipes made from tubular steel, all joined together by steel broad band clamps (Figure 34). The upper section of the exhaust system is connected by a clamp to the turbocharger exhaust outlet and held in position by a rigid mounting bracket attached to the flywheel housing. The lower section of the exhaust system is rigidly mounted to the radiator support crossmember by three brackets, one on the crossover pipe and two on the muffler. The flexible pipe joining the upper section to the lower section acts as an insulator, absorbing engine vibrations that would otherwise be transmitted along the rigidly mounted exhaust system to the chassis. It also takes up opposing movements of the chassis and engine, preventing the exhaust system from fracturing and thus eliminating the need for the exhaust system to be rubber mounted.

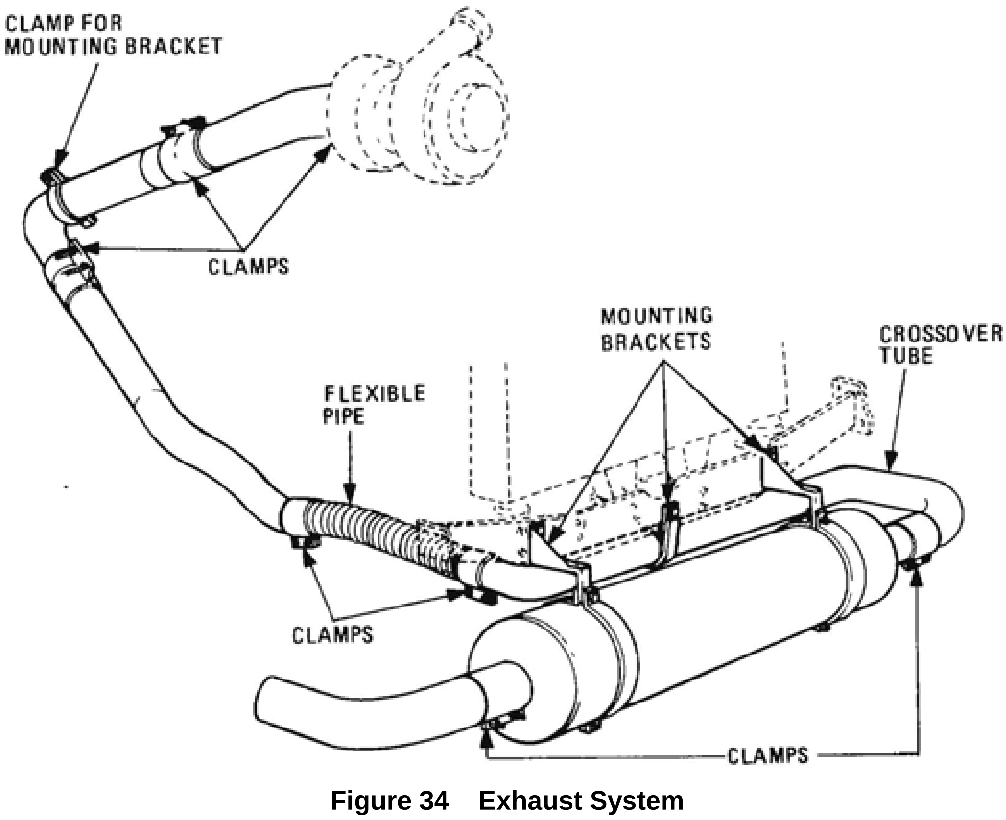


Figure 34 Exhaust System

Turbocharger

50. A Garret AiResearch TV63 series turbocharger is fitted to the vehicle. It is made up of three main components: the turbine, the bearing housing and the compressor. The turbocharger is mounted on the exhaust manifold and uses exhaust gas energy, which is normally discharged to the atmosphere. The exhaust gas enters the turbine housing and flows around and radially inward causing the turbine wheel to rotate. The exhaust gas is then discharged through the centre of the turbine housing into the exhaust system (Figure 35).

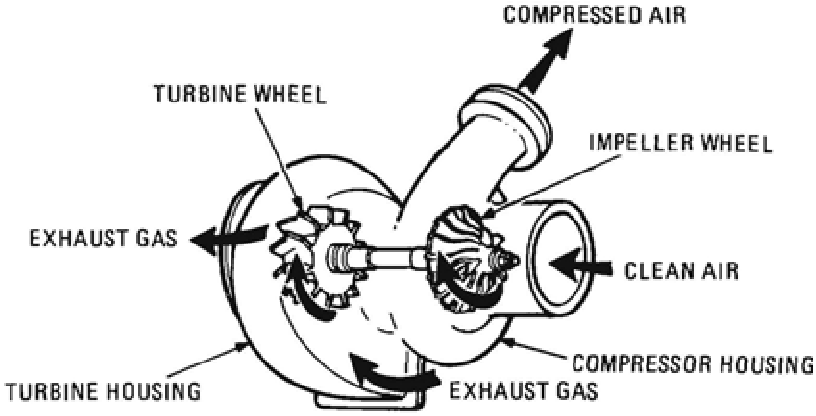


Figure 35 Turbocharger Operation

51. The turbine wheel and shaft are manufactured in one piece with the shaft mounted in sleeve type bearings located in the bearing housing. These bearings are pressure lubricated and cooled by oil from the engine lubricating system. Piston ring type seals are used at each end of the shaft to effectively contain the oil to the bearing housing (Figure 36).

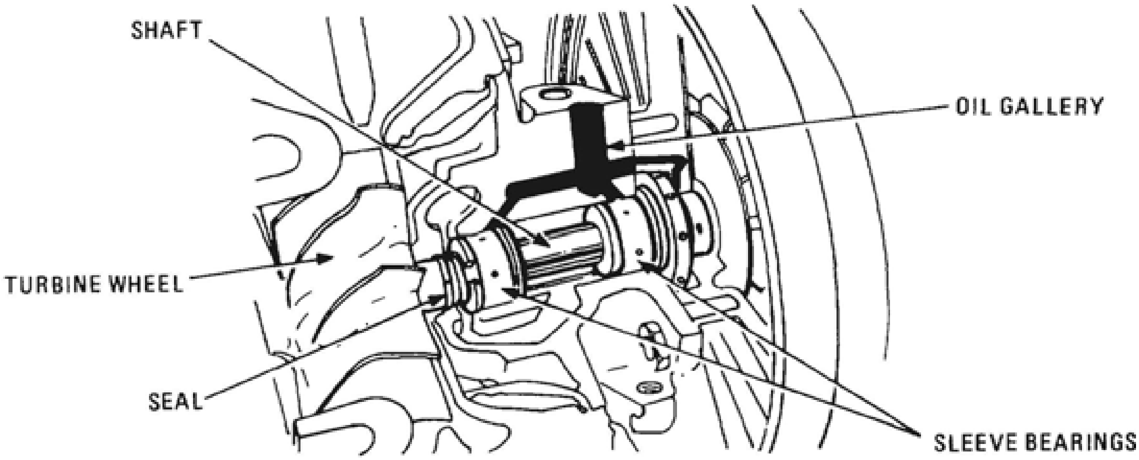


Figure 36 Sectional View of Bearing Housing

52. The impeller in the compressor housing is mounted on the shaft, so that the turbine wheel and impeller rotate as one. Air is drawn into the centre of the impeller; it then flows radially outward through a diffuser section into the compressor housing. The air leaves through a tangential outlet on the outside of the compressor housing and is ducted through the crossover tube and intercooler to the inlet manifold.

53. The turbocharger is a delicately balanced, precision machine, which operates at speeds up to 85 000 rpm and requires good lubrication of the bearings that support the shaft. However, damage to these bearings can occur during a period called ‘oil lag’. This is the tune taken between engine start-up and the point where oil under pressure is available at the turbocharger bearings. During the ‘oil lag’ period the engine should not be accelerated. Allow several seconds for oil pressure to build up and lubricate the turbocharger bearings. It is when these bearings are run dry (at the high revolutions at which the turbocharger operates) that damage occurs.

54. The same applies when shutting down the engine. The turbocharger is rotating at a high speed and continues to do so after the engine is shutdown and the oil flow ceases. The heat of the turbocharger and the lack of lubricant could easily damage a turbocharger if the engine is shutdown immediately after operating at top rpm for an extended period. To avoid damaging the turbocharger, it is desirable to have the turbocharger rotating slowly. To do this, allow the engine to idle for three minutes before shut down. This idle period also helps to dissipate the heat build-up.

Charge Air Cooling

55. A two stage, or series, charge air cooling arrangement, combining a water-to-air heat exchanger with an air-to-air heat exchanger, is fitted to the vehicle. This combination heat exchanger lowers the temperature of the air coming from the turbocharger to the inlet manifolds by about 100 °C (180 °F). The coolant for the water-to-air heat exchanger is drawn off the top of the water pump, circulated through the core and returned to the cooling system via the oil cooler end cap (Figure 37).

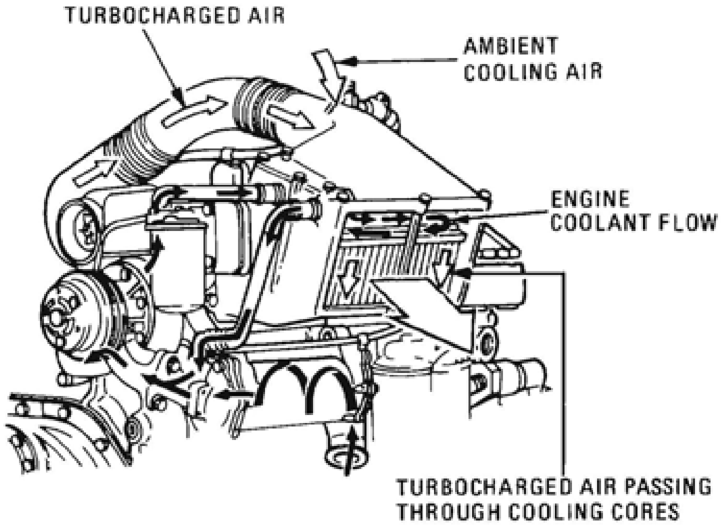


Figure 37 Series Charged Air Cooling Flow Diagram

56. The tip turbine fan draws the cooling air for the air-to-air heat exchanger through the air cleaner mounted on the left-hand side of the cabin. The shaft, on which the fan revolves, is mounted on two bearings located in the discharge housing. These bearings are lubricated by grease, which is packed into the hub during the assembly of the fan. Pressurised air taken from a bleed-off point on the turbocharger to inlet manifold crossover tube drives the turbine fan, which in turn forces cooling air to pass through the heat exchanger (Figure 38). A small directional flow valve is placed in the tip turbine fan operating air inlet line. This valve prevents reverse air flow, which could contaminate the turbocharged air in the crossover tube (Figure 39).

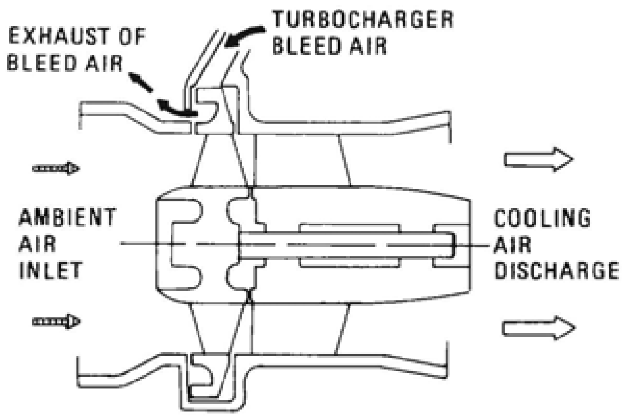


Figure 38 Operation of the Tip Turbine Fan

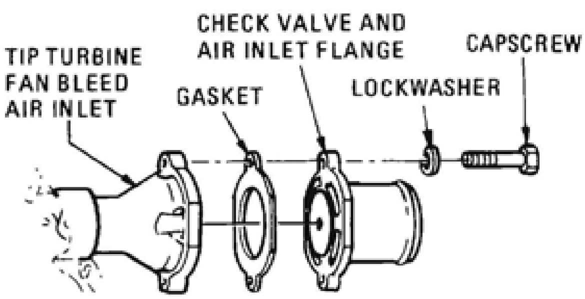


Figure 39 Air Valve Assembly

Engine Brake

57. This vehicle is fitted with a Dynatard engine brake system, which when activated assists the vehicle's service wedge brakes, providing increased vehicle safety from better braking. This is done by converting the engine to an air compressor. To accomplish this, the exhaust valve must open towards the completion of the compression stroke, to allow compressed air without fuel to expand into the exhaust manifold, instead of acting against the piston on the downstroke. The early opening of the exhaust valve during the compression stroke when the Dynatard is operating increases the turbocharger speed, thus increasing charging pressure slightly above that for normal operation. The increased airflow through the engine results in greater negative or retarding horsepower, thus enhancing braking effort.

58. To operate the Dynatard engine brake system, the exhaust valve must assume two different timings: one for normal engine operation where the exhaust valve opens during the exhaust stroke only and one for Dynatard operation where the exhaust valve opens on both the compression and exhaust strokes. To accomplish this, a special contour is ground into a portion of the exhaust cam lobe base circle to provide a small lift profile (Figure 40). This lift profile is timed to open the exhaust valve near the completion of the compression stroke.

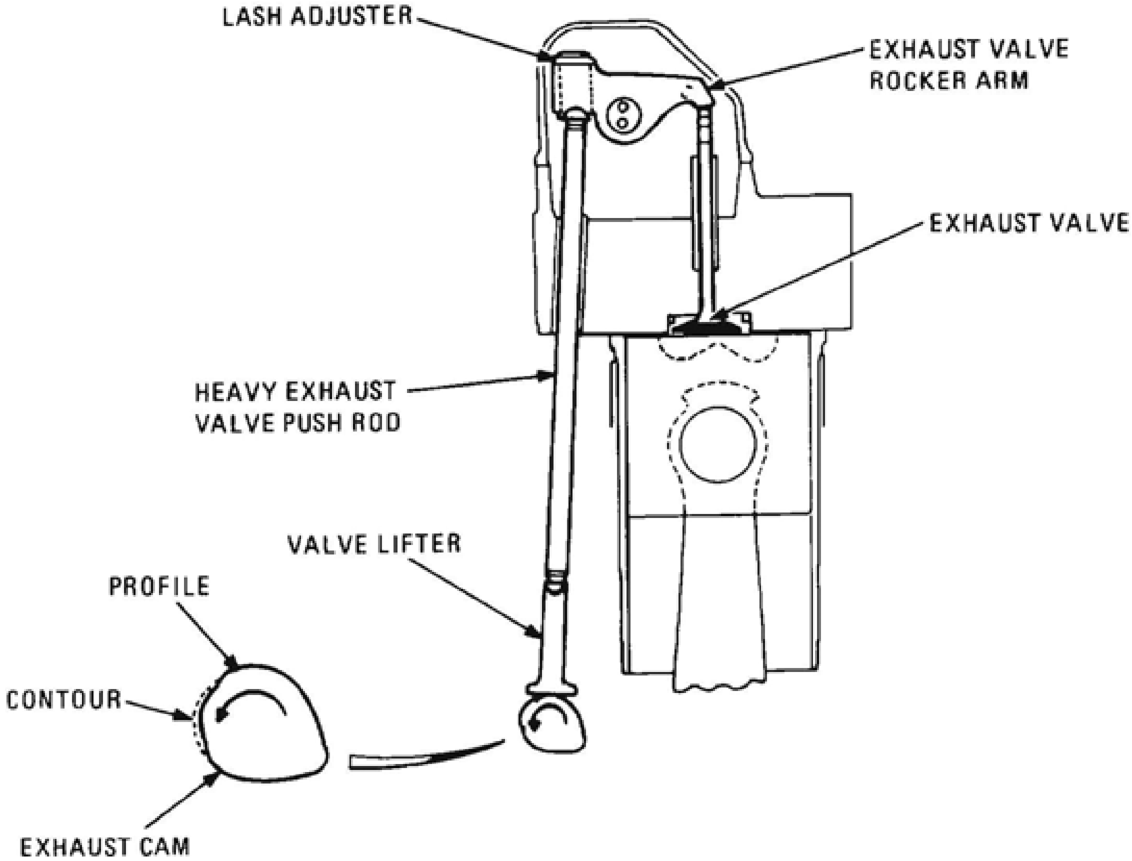


Figure 40 Dynatard Engine Brake Valve Mechanism

59. To prevent the exhaust valve from opening on every compression stroke causing the engine to act as a retarder at all tunes, a special hydraulic lash adjuster has been installed in the exhaust rocker arms. Under normal driving conditions the lash adjuster allows enough clearance for the cam follower to override the small lift profile on the exhaust cam lobe base circle, keeping the exhaust valve closed on the compression stroke. When the Dynatard is activated, the lash adjuster expands and causes the cam follower to follow the special contours on the exhaust cam lobe base, making the exhaust valve open near the end of the compression stroke.

60. The hydraulic lash adjuster is composed of two hydraulic pistons operated by lubricating oil. The control piston is on the top and the socket piston, which houses the push rod, is on the bottom (Figure 41). When the Dynatard is disengaged, oil flows into the hydraulic lash adjuster through two passages (Figure 42) in the rocker arm. This allows equal oil pressure to be applied to both sides of the control piston. With equal oil pressure on both sides of the piston, the spring is strong enough to hold the control piston down, unseating the ball valve. The unseated ball valve allows oil to flow in and out of the socket piston chamber, thus allowing the socket piston to move up and down freely within its bore. This free movement of the socket piston provides the clearance required for normal operation of the exhaust valve.

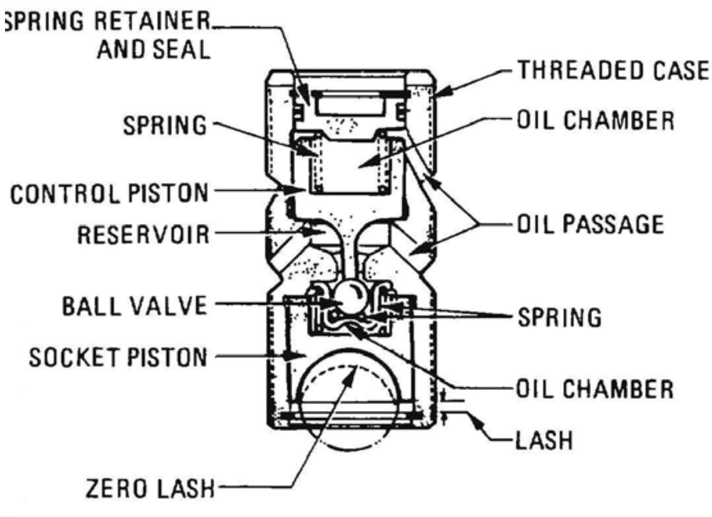


Figure 41 Hydraulic Lash Adjuster

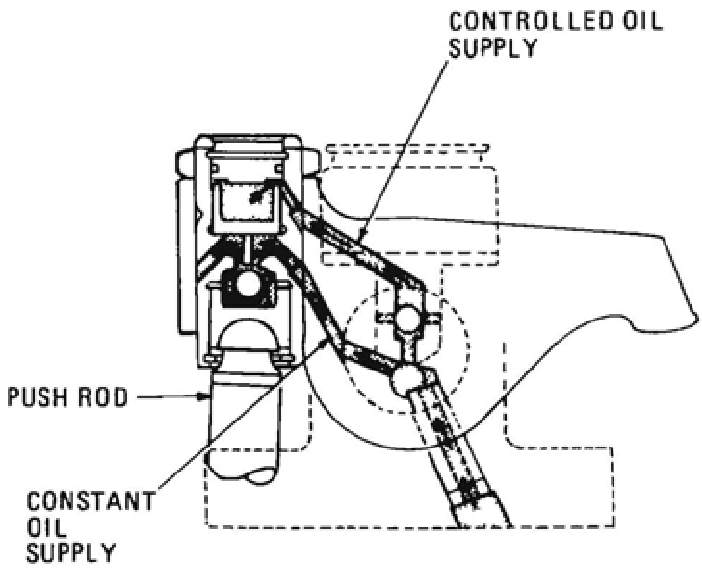


Figure 42 Oil Flow Through Lash Adjuster, Brake ‘Off’

61. When the Dynatard is activated, the oil to the upper chamber is cut off and redirected back through the rocker arm passage into the engine. The oil pressure below the control piston now overcomes the upper spring, forcing the control piston to lift and allowing the ball valve to seat (Figure 43). However, just before the ball valve seats, the socket piston is forced down by its spring and oil fills the socket piston chamber forming a hydraulic lock that keeps the lash adjuster expanded, eliminating the normal operating clearance.

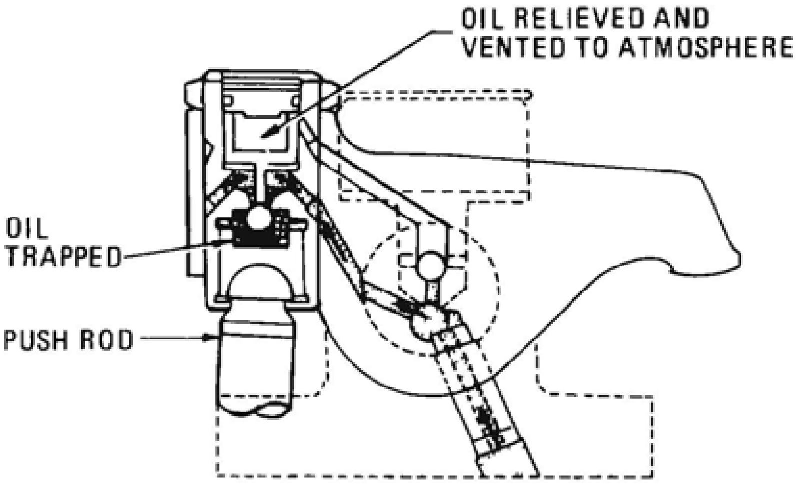


Figure 43 Oil Flow Through Lash Adjuster, Brake 'On'

62. Two oil passages in the rocker arm shaft supply the oil needed to operate the lash adjuster (Figure 44). The lower passage carries a constant supply of oil for the socket piston of the hydraulic lash adjuster and for the lubrication of the rocker arm. The upper passage is the on-off control gallery. Oil is supplied through this passage to the upper chamber of the control piston.

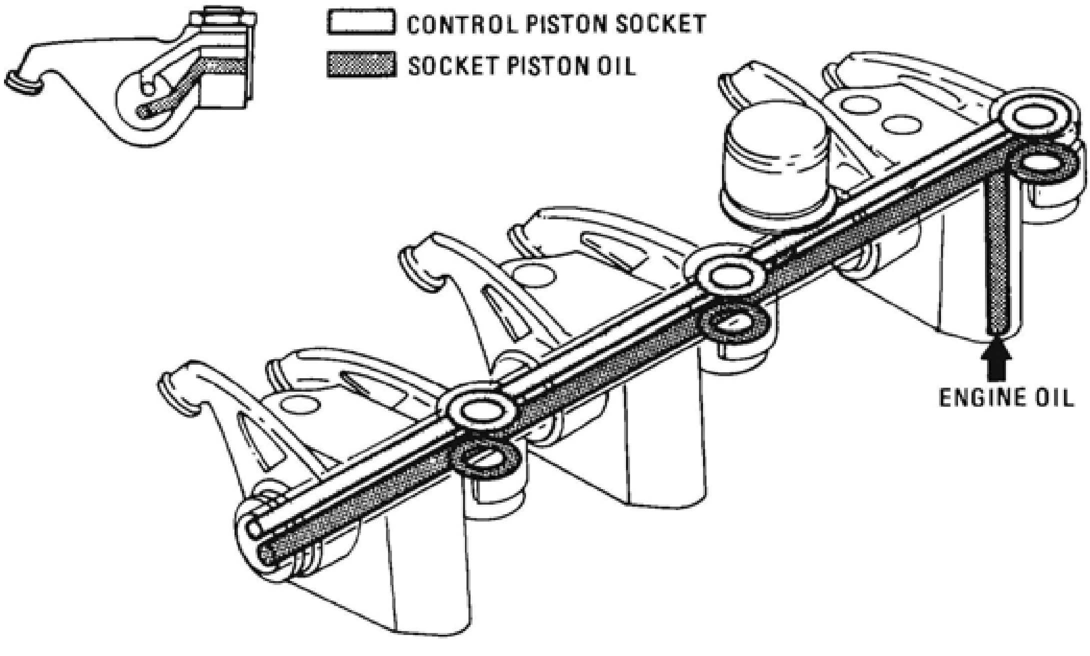


Figure 44 Valve Rocker Assembly Oil Circuit

63. To control the oil supply to the upper chamber of the control piston, a solenoid and ball valve assembly has been used. The assembly is installed on the rocker arm shaft where the upper and lower oil passages are connected (Figure 45). One solenoid is used on each rocker arm shaft. In the Dynatard off position, oil flows from the constant supply gallery past the solenoid control valve ball, which is on its upper seat, into the on-off gallery and into the upper chamber of the control piston, resulting in normal engine operation.

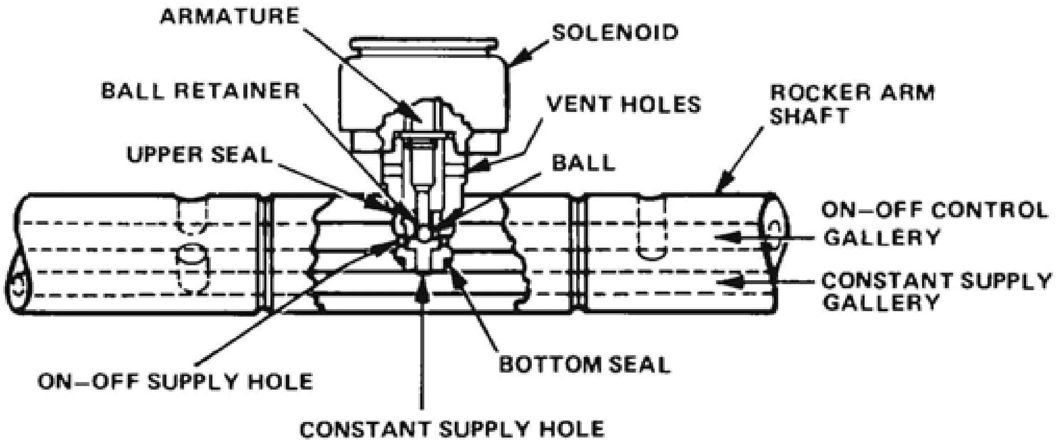


Figure 45 Dynatard Control Valve and Solenoid

64. Dynatard braking occurs when the solenoid control valve is energised. When energised, the ball valve is forced onto its lower seat, shutting off the constant oil supply to the on-off gallery. Oil is then vented from the upper chamber of the control piston through the on-off gallery by way of vent holes in the upper section of the solenoid valve stem back to the engine. The venting action causes the hydraulic lash adjuster to assume a zero clearance condition, thus actuating the engine braking system.

65. Electrical controls energise the solenoids, which turn the Dynatard brake on and off. They include the cab switch, treadle valve brake switch, relay(s), fuel injection pump switch and the solenoids (Figure 46). The fuel injector switch closes only when the fuel injector rack is in the ‘no-fuel’ position. This ensures that the brake can only be energised when fuel is not being injected into the engine. The purpose of the relay is to eliminate the need for the heavy solenoid current to pass through the fuel injection pump switch.

66. The Dynatard can be activated by two methods; either by depressing the brake treadle valve or by operating a control switch on the instrument panel. With either method, the accelerator pedal must be released to allow the injector pump rack to move into the zero fuel position. This action closes the injector pump switch allowing the electrical current to energise the solenoid control valve to bring the Dynatard into action. However, should the engine reach idle speed, the injection pump governor will automatically advance the rack from the no-fuel to a fuel delivery position, opening the injection pump switch and disengaging the Dynatard system.

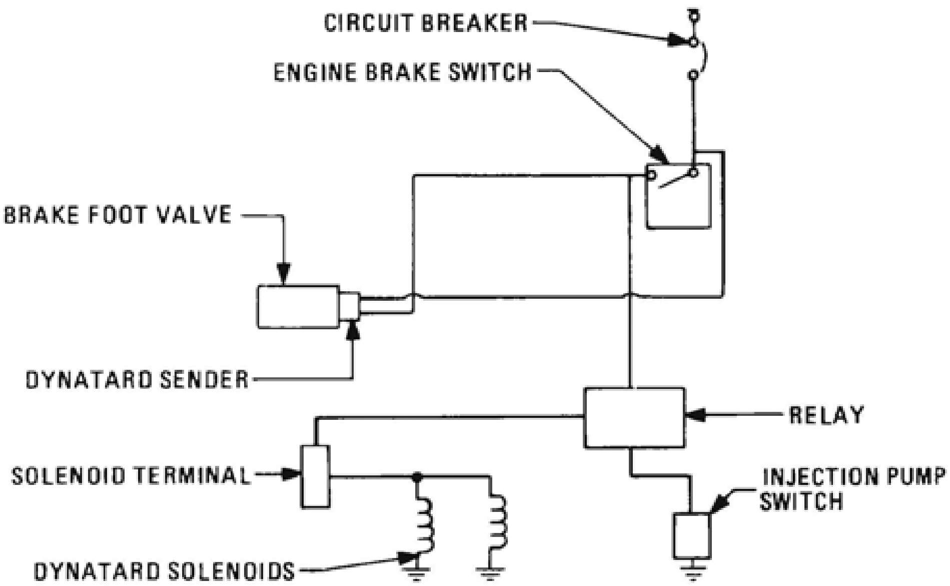


Figure 46 Dynatard Brake Wiring Circuit

COOLING SYSTEM

Description

67. The radiator with top and bottom mounted storage tanks is mounted in front of the engine and acts as a heat exchanger for the cooling system. A pressure cap located in the top radiator tank seals the system and is designed to hold a pressure of 69 kPa (10 psi) within the system. Also located in the top tank is the water inlet, through which heated water from the engine flows into the radiator to be cooled. To circulate the water, a centrifugal pump is used. The pump is mounted on the front of the engine block and driven by twin V-belts from the crankshaft pulley. Attached to the water pump impeller shaft is a six-blade fan, which assists the cooling by drawing air through the radiator core cooling the water within the radiator, and also by circulating the air over the engine extremities. A thermostat, which regulates the flow of water through the system in order to maintain a stable operating temperature, is incorporated in the system, as is a coolant conditioner that helps prevent corrosion and rust build-up within the cooling system. A drain cock is fitted to the outlet pipe between the radiator bottom tank and the engine oil cooler (Figures 47 and 48).

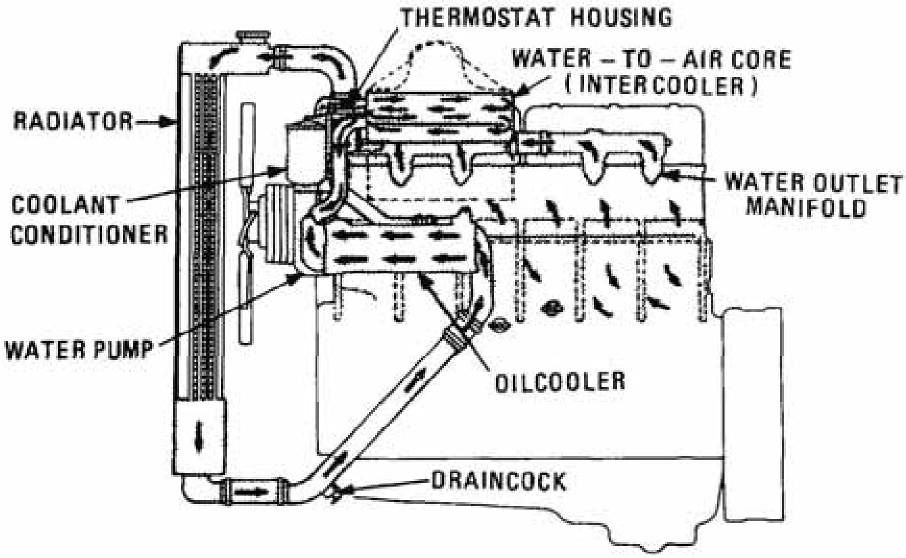


Figure 47 Coolant Flow Diagram

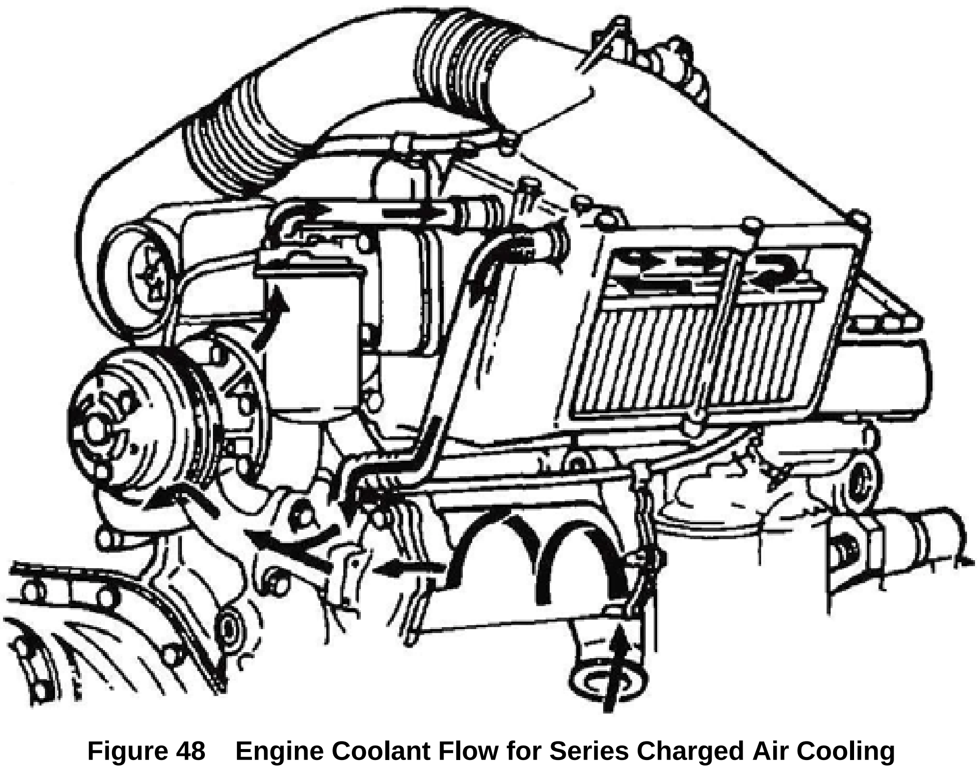


Figure 48 Engine Coolant Flow for Series Charged Air Cooling

68. Water is drawn from the lower radiator tank by the centrifugal pump, through the oil cooler and into the pump. From there it is pumped into the cylinder block where it circulates in and around the cylinder walls before moving up into the cylinder heads. From the cylinder heads, the water flows along the coolant outlet manifold to the thermostat housing, through the thermostat and back to the radiator.

69. The thermostat is a heat sensitive valve, which controls the flow of coolant in the cooling system. When the engine is cold, the thermostat is closed thus restricting the flow of coolant to the radiator. The coolant now flows through a short bypass hose directly back to the water pump and then to the cylinder block. This circulation of coolant within the engine allows the engine to warm up quickly, and prevents any undue pressure build up at the water pump. When the coolant temperature reaches 81 °C to 83 °C (177 °F to 182 °F), the thermostat starts to open and should be fully open – 9.5 mm (3/8 in.) – at 94 °C to 96 °C (202 °F to 207 °F) allowing the water to circulate through the engine and radiator without restriction as shown in Figure 49.

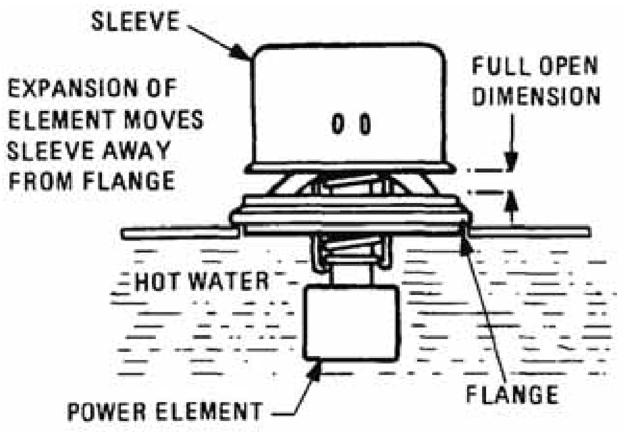


Figure 49 Wax Pellet Type Thermostat

70. The water flowing into the top radiator tank is drawn to the bottom tank by the water pump. It flows through a number of vertical flutes to the bottom tank. These flutes are interconnected by thin copper vanes. Together the flutes and vanes make up the radiator core. Air drawn over these vanes by the fan helps to dissipate the heat and cool the water flowing within the flutes. This cooled water is then recirculated through the engine helping to maintain the engine at an operating temperature of 80 °C to 85 °C (176 °F to 185 °F).

71. The cooling system operates with a pressure of up to 69 kPa (10 psi). This pressure in the system raises the boiling point of the water, enabling the engine to operate at high temperatures. When the pressure limits of the cooling system are exceeded, due to expansion, a relief valve built into the radiator filler cap (Figure 50) allows excess pressure to bleed off. The relief valve opens at 69 kPa (10 psi), allowing the steam or water to flow through an overflow tube to be vented to the atmosphere.

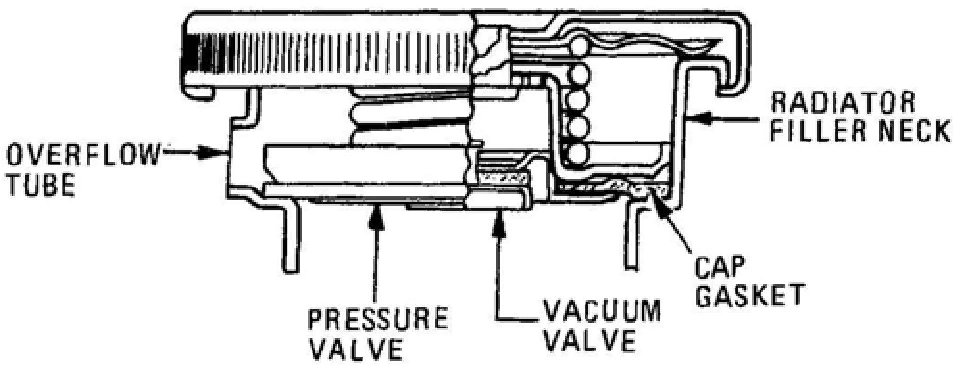


Figure 50 Radiator Filler Cap

72. After the engine is shut down, the water and air within the cooling system contract and tend to cause a partial vacuum. In this case, the vacuum valve opens (Figure 50) allowing outside air to enter the system. If either the pressure relief valve or the vacuum valve fail to function properly, all the benefits of a pressurised system are lost and collapsing or rupturing of the hoses and radiator may result from excessive vacuum or pressure respectively.

73. To prevent corrosion or rust build-up in the cooling system, a coolant conditioner contained in a spin-on cartridge (Figure 51) has been installed on the thermostat housing. The conditioner acts as a water softener, a corrosion inhibitor, a filter to remove solid contaminants and assists in tracing water leaks by leaving a brightly coloured dye in the water leak tracks.

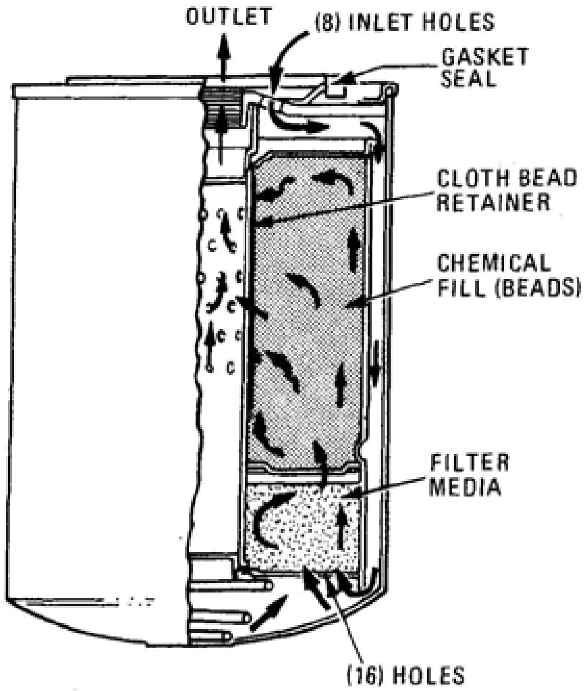


Figure 51 Coolant Conditioner Cartridge

74. A pipe mounted on the water pump housing feeds water to the cartridge. The water flows through the pipe to the conditioner adapter housing, through a check valve located in the housing and into the cartridge (Figure 52). The water circulates through the cartridge then returns to the main system via another check valve in the adapter housing, and a small port in the thermostat housing. Although the cartridge is similar in design to those used in lubrication and fuel systems, it has a different thread pattern to prevent mistaken installation.

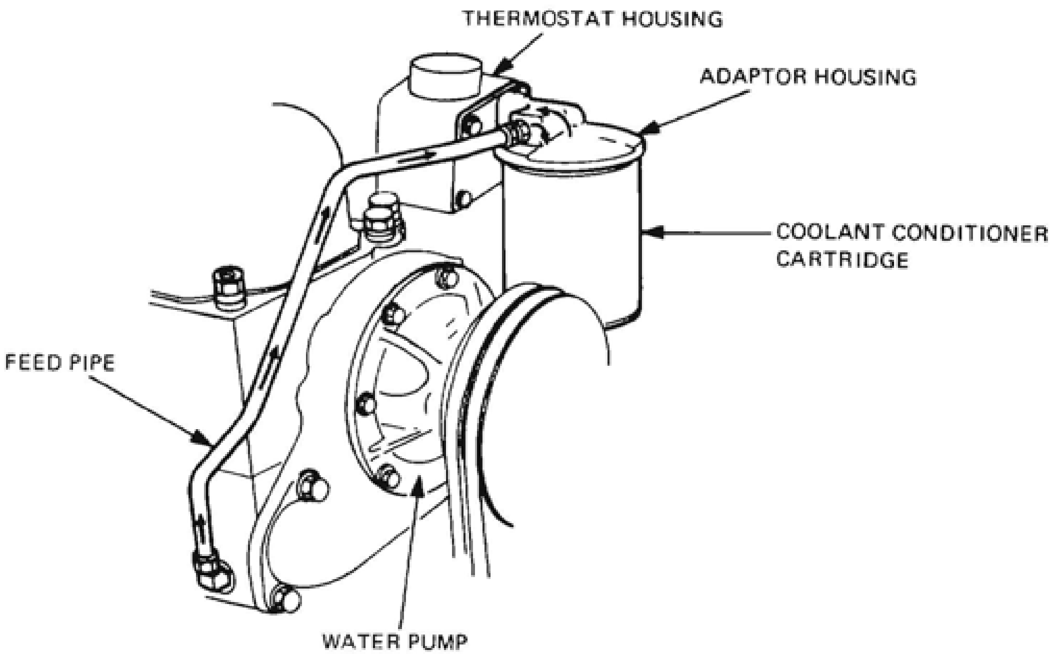
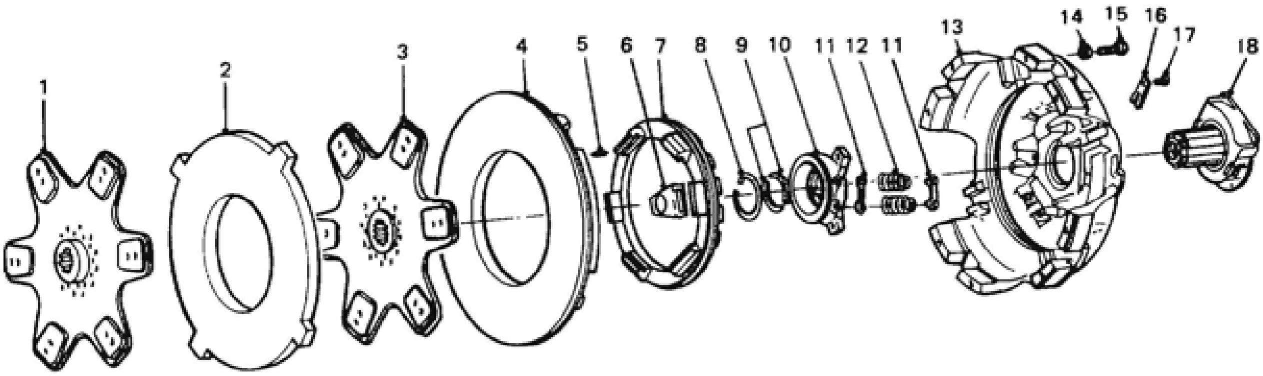


Figure 52 Coolant Conditioner Circuit

Clutch

75. The vehicle is fitted with a Spicer model AS 1552 (CL79) angle spring, two-plate clutch. The angle spring clutch uses six angle springs and is a dry disc, internally adjustable, pull-type design. The centrally located springs are entirely isolated from the heat of the pressure plate. The pressure plate is driven by drive lugs, which mate with drive slots in the clutch (flywheel ring). Two ceramic type driven plates are used; these have ceramic trapezoidal buttons riveted to the rigid hub steel discs (Figure 53).



1	Front clutch disc	7	Adjusting ring	13	Flywheel ring
2	Intermediate plate	8	Snap ring	14	Spring washer
3	Rear clutch disc	9	Release sleeve half ring locks	15	Flywheel ring retaining bolt
4	Pressure plate	10	Release sleeve retainer	16	Adjusting ring lock
5	Return spring	11	Pressure spring pivot	17	Bolt and lock washer assembly
6	Release lever	12	Pressure spring assembly	18	Release bearing and sleeve

Figure 53 Exploded View of Clutch Assembly

76. Adjustment for lining wear on these clutches MUST be made internally in the clutch cover at the threaded adjusting ring. If wear adjustments are made on the external adjusting lever, early clutch failure can be expected. External adjustment is for clutch brake and is used to set the clearance between the release bearing and the clutch brake.

77. The clutch is cable actuated with the cable assemblies consisting of an outer plastic lined sheath with threaded terminal ends, clamping nuts, a stranded inner steel cable, and rubber boots for end sealing. When the firewall mounted pendant pedal is depressed, movement of the clutch lever pulls the inner cable and actuates the clutch release lever pulling the release bearing away from the pressure plate, disengaging the clutch. Clutch spring pressure and retractor springs return the clutch pedal when foot pressure is released, re-engaging the clutch (Figure 54).

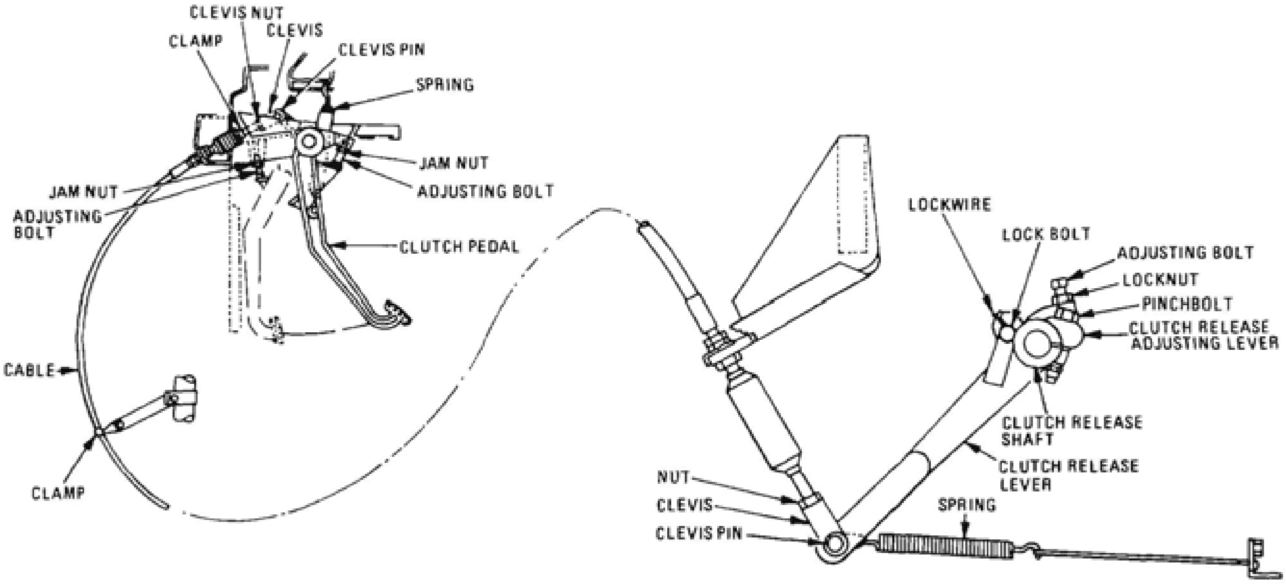


Figure 54 Clutch Control Arrangement

Clutch Brake

78. A Spicer torque limiting clutch brake is fitted to the vehicle (Figure 55). This brake assists in preventing severe gear clash when initially selecting first or reverse gears. The brake comes into effect only when the clutch pedal is depressed through the last 25 mm of travel, causing the clutch release bearing to come into contact with the clutch brake disc, sandwiching the disc against the transmission input shaft bearing cover. This action creates a braking effect and either slows down or stops the rotation of the clutch brake disc. Because the disc is splined to the transmission main input shaft, the shaft rotation is slowed down or stopped allowing first or reverse gear to be selected without clashing or putting undue strain on the gears.

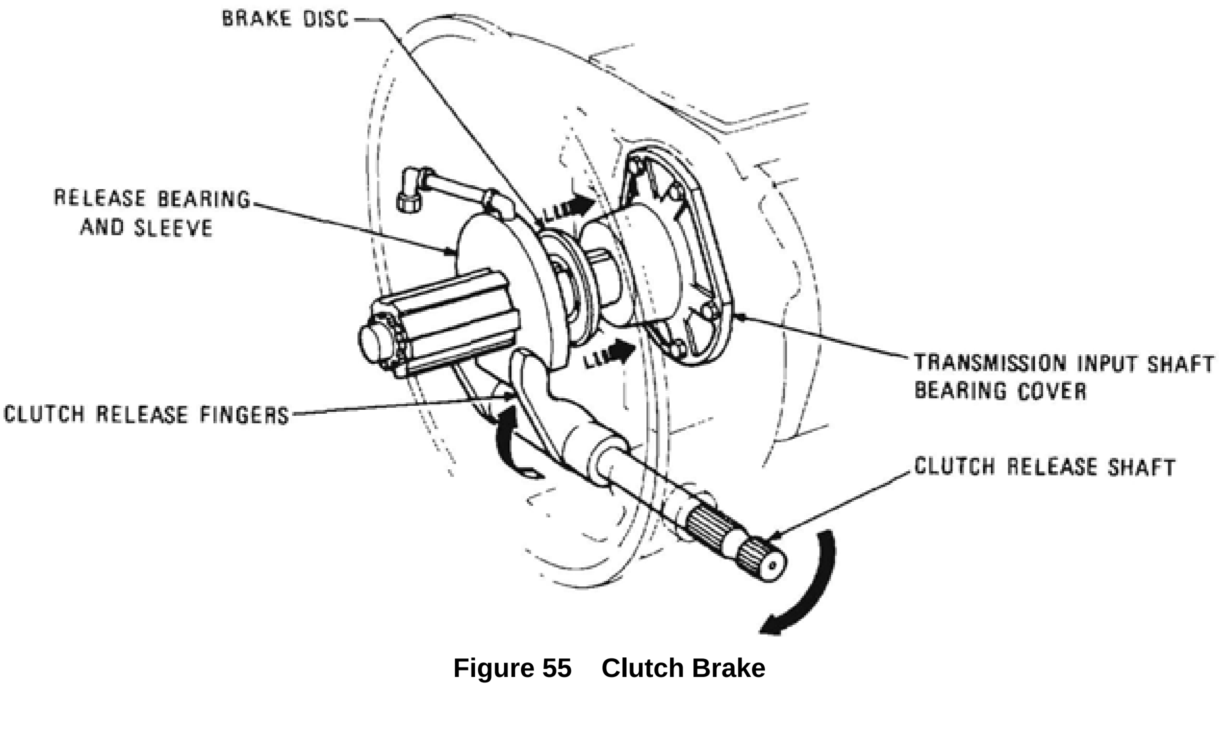


Figure 55 Clutch Brake

GEARBOX (TRANSMISSION)

Description

79. A Mack Maxitorque TRL1078 Transmission as shown in Figure 56 is fitted to the vehicle. This is a triple countershaft transmission providing five forward speeds and one reverse speed. The gearbox case is a two-piece high strength aluminium construction with cast iron liners at all shaft bearing locations.

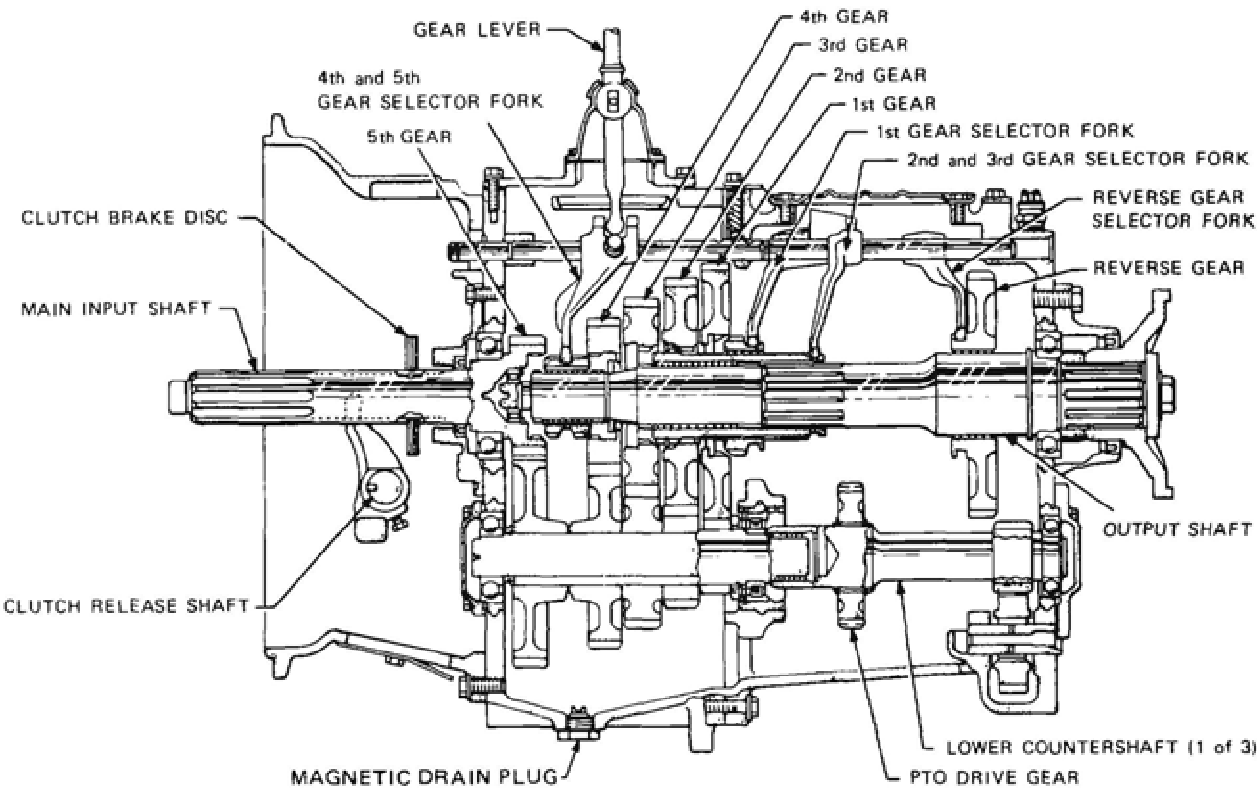


Figure 56 Sectional View of Transmission

80. The short overall length and the extremely high capacity of this transmission are brought about by the use of three countershafts. The countershafts, being equally spaced around the input shaft, share the load equally and reduce the amount of shaft flexing to a minimum (Figure 57). The five forward gears are engaged by means of sliding clutches. Reverse gear is engaged by engaging the reverse sliding spur gear with the three individually mounted idler gears.

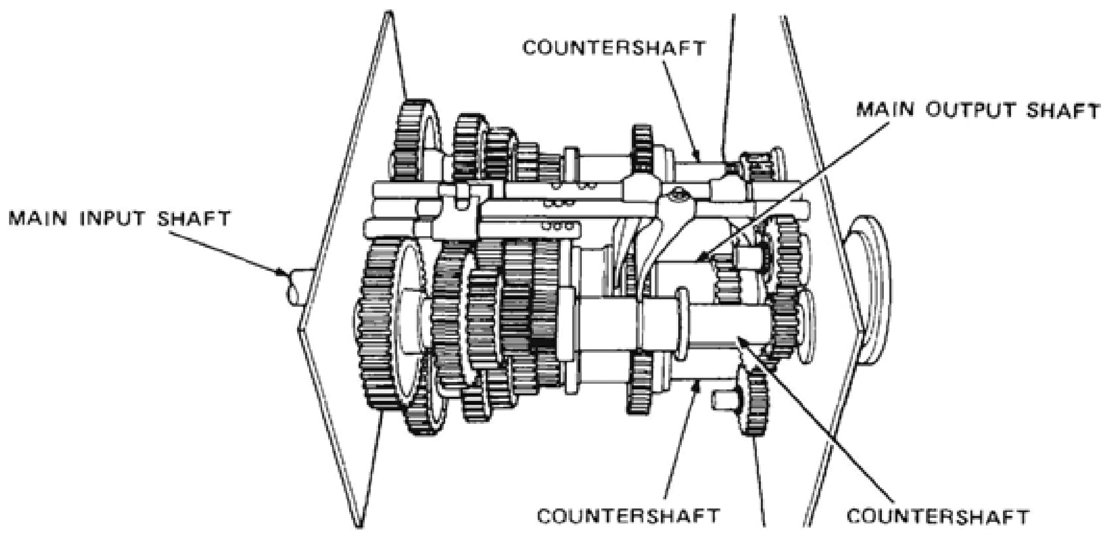


Figure 57 Gears and Countershafts

81. All rotating and sliding parts are lubricated by oil from gear throw-off when the engine is operating. A magnetic filter plug is located on the right-hand side of the transmission case and a magnetic drain is provided at the bottom of the case. These are used to pull out ferrous metallic particles from the passing oil and hold them.

82. The gears of the gear set are of the spur type design and, with the exception of reverse gear, are in constant mesh with the countershaft gears. Ratios for the gears are:

- **a.** 1st 8.59
- **b.** 2nd 4.99
- **c.** 3rd 2.84
- **d.** 4th 1.66
- **e.** 5th 1.00
- **f.** Reverse 8.81

TRANSFER CASE

Description

83. The Mack TC-150 two-speed manual change transfer case, as shown in Figure 58 is fitted to the vehicle. Incorporated in the transfer case is a planetary gear type centre differential for front-wheel drive availability at all times without requiring driver attention. However, for extreme traction conditions, a driver-controlled, air actuated, differential lockout is provided.

84. All gears are of the helical type and are in constant mesh. The Hi-Lo engagement is effected by means of a sliding clutch. Lubrication of all rotating and sliding parts is by means of gear throw-off when in operation. Additional oil is provided for the countershaft Hi-Lo range gear needle bearings and clutch by means of an oil line from the main shaft rear bearing cover to the countershaft rear bearing cover. The oil flows through rifle drilled holes in the countershaft to the needle bearings and sliding clutch. Ratios are:

- **a.** High range 0.768:1
- **b.** Low range 1.992: 1
- **c.** Front output shaft 0.966: 1

85. The planetary differential directs torque to the front and rear axles with a bias of the torque (approx. 3:1) going to the rear axles. Although it provides the vehicle with all-wheel drive, its main function is to prevent wind-up between the front and rear propeller shafts. When slippery conditions are encountered, a driver-controlled, air actuated, differential lockout is provided. When activated, the differential action of the planetary gears is locked out giving equal torque to both front and rear axles.

NOTE

When either the Power Divider Lock switch on the dash panel is operated or the Lo-range in the transfer case is selected, both the differential lockout in the transfer case and the power divider lockout on the intermediate axle carrier are activated, giving the vehicle positive all-wheel drive.

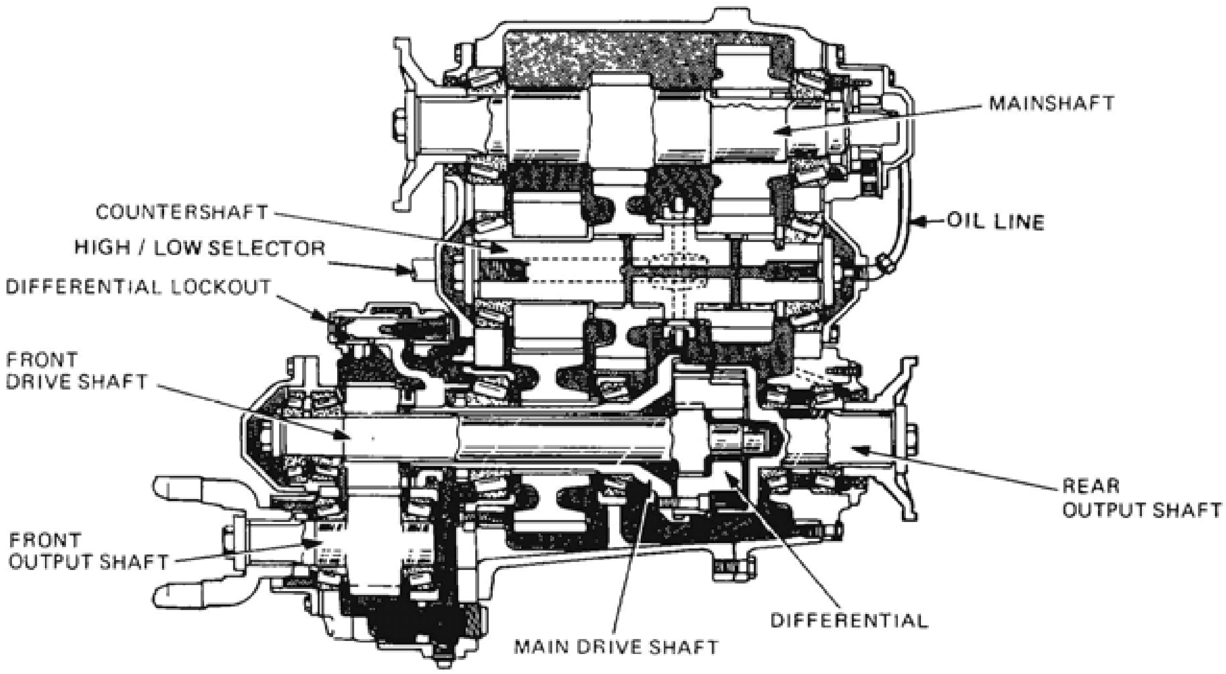


Figure 58 Sectional View of Transfer Case

Propeller Shaft

86. Spicer 1610 and 1810 series propeller shafts are used on the vehicle. The main transmission to transfer case shaft is of the 1810 series and has a slip-joint with two universal joints. The shaft between the transfer case to the front axle is a 1610 series two-piece shaft with a centre bearing and three universal joints. An 1810 series shaft is used to transmit the drive from the transfer case to the intermediate carrier axle. This shaft has a slip-joint and two universal joints. Drive from the intermediate carrier is transmitted to the rear carrier by an 1810 series shaft, which has a slip joint and two universal joints. On winch models, drive is transmitted from the Power Take Off (PTO) to the winch via a 1510 series, two-piece propeller shaft fitted with universal joints and a chassis supported centre bearing. All universal joints and slip joints are fitted with grease nipples for ease of lubrication (Figure 59).

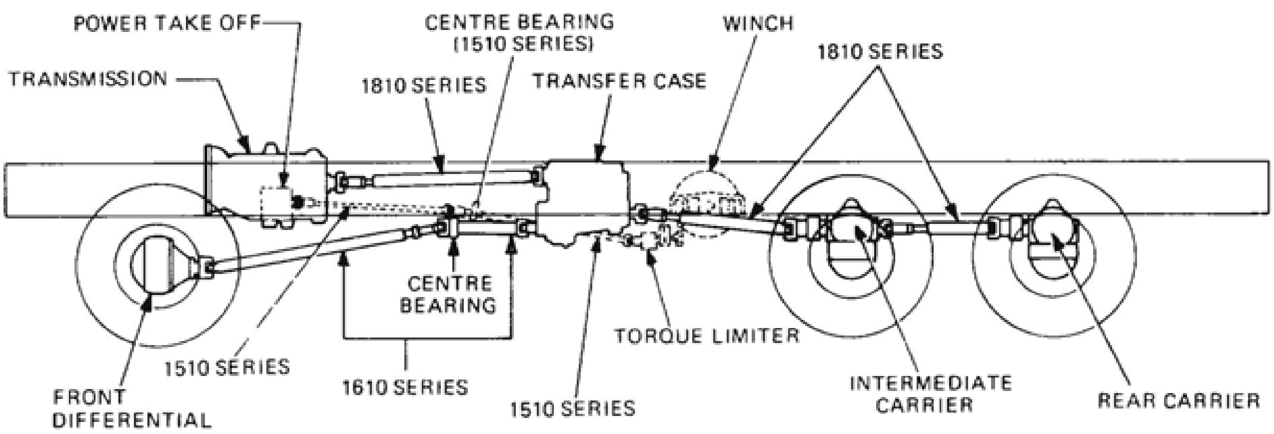


Figure 59 Propeller Shaft Locations

Transfer Case Oil Cooler (if fitted)

87. The transfer case oil cooler system consists of the following major components:

a. heat exchanger,

b. circulation pump assembly,

c. suction case assembly,

d. power steering pump,

e. priority valve, and

f. electrical components.

88. A diagrammatic representation is shown at Figure 60.

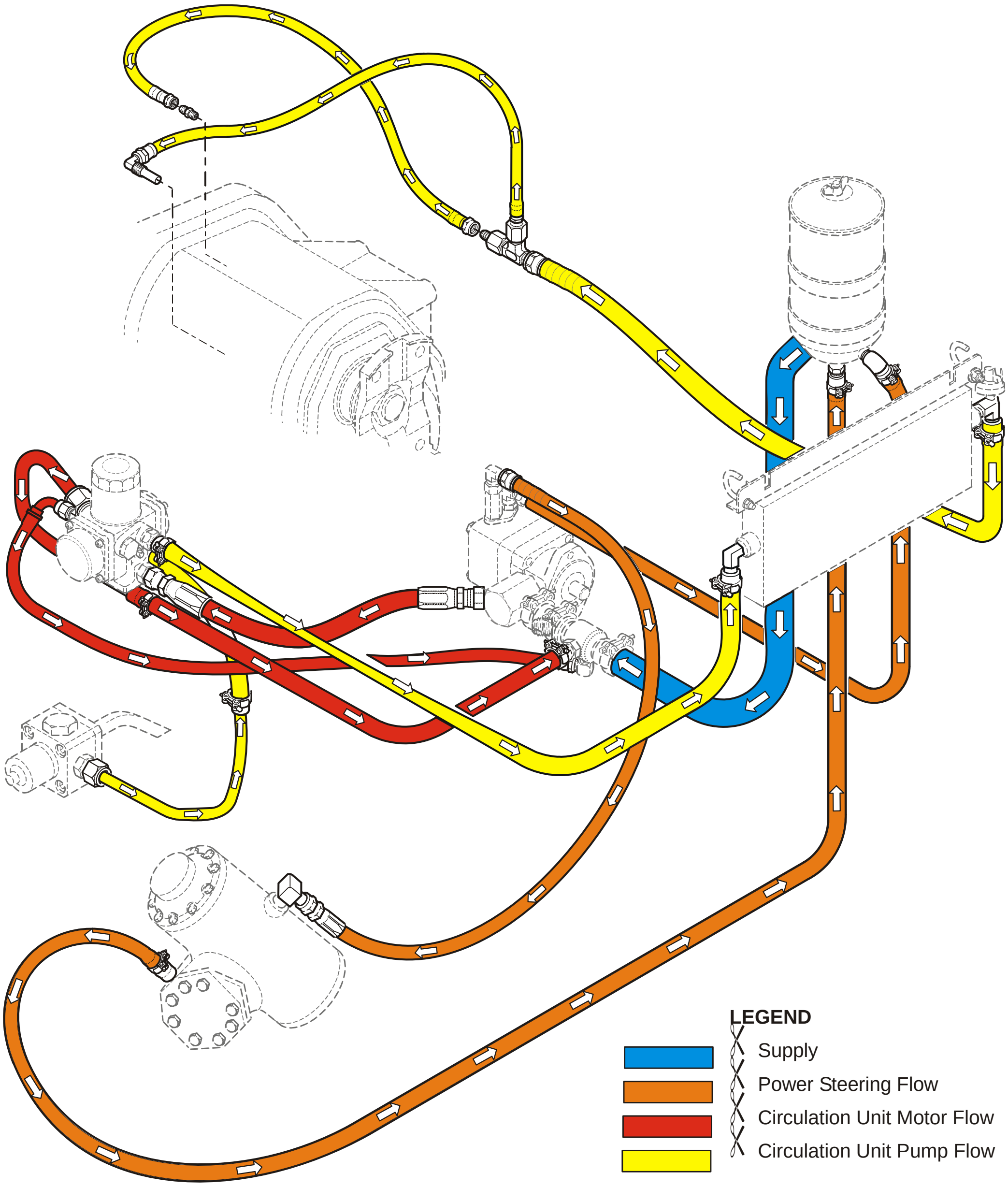


Figure 60 Transfer Case Oil Cooler System

Heat Exchanger

89. An oil cooler heat exchanger is mounted in front of the engine radiator, below the air conditioning system condenser.

90. The coil and fins of the heat exchanger act as a heat transfer surface, channelling heat from the transfer case oil to the atmosphere thus cooling the oil. The radiator and heat exchanger arrangement is shown in Figure 61.

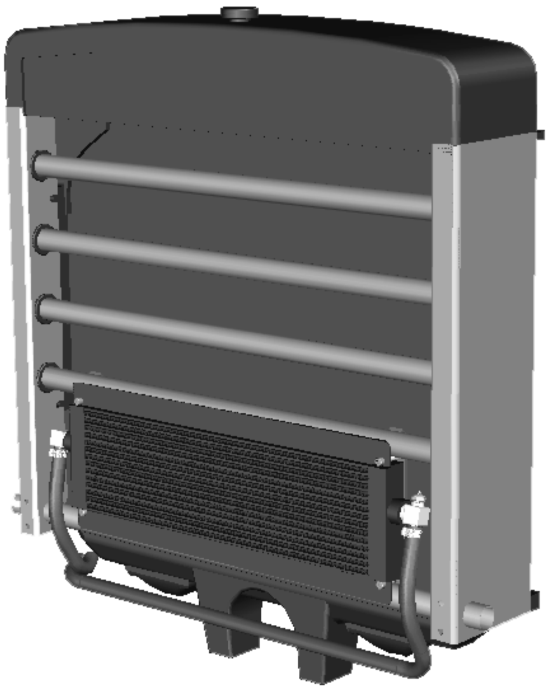


Figure 61 Radiator and Heat Exchanger

Circulation Pump Assembly

91. The circulation pump assembly (Figure 62) consists of a motor Geroter element and a pump Geroter element sharing a common drive shaft supported by two long life lubricated bearings. The motor is driven by oil flow from the truck power steering pump and, in turn, drives the oil cooler circulation pump.

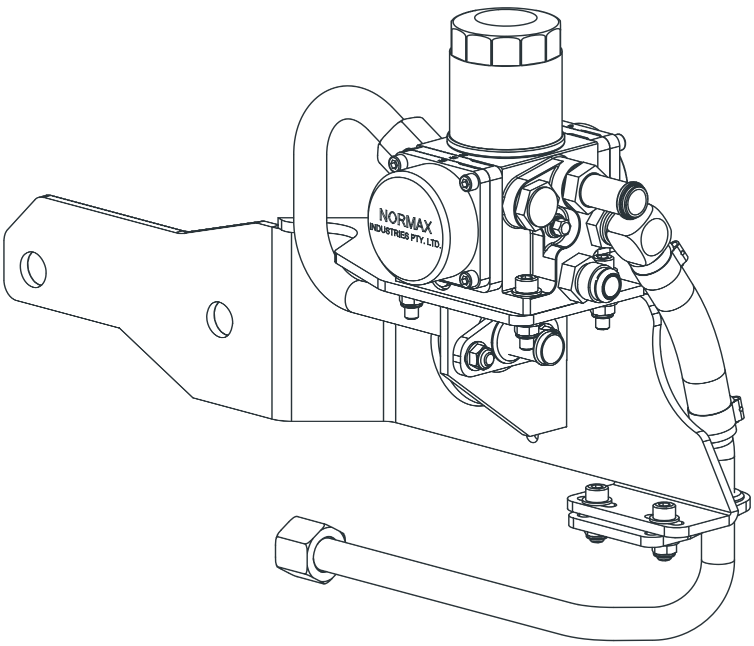


Figure 62 Circulation Pump Assembly

92. The self priming pump draws oil through the suction case assembly, passing it through the spin-on filter. The filtered oil then flows to the heat exchanger where it is cooled by the air flow. Cooled oil is then returned to the transfer case via the rear bearing housing.

93. Two high temperature long life Teflon seals act on hardened and ground seal journals of the drive shaft. These individual seals protect against cross contamination of the motor drive and circulation pump oil. Slippage oil from the pump is internally drained to the pump inlet. Slippage oil from the motor is externally drained and is connected back to the power steering pump inlet.

94. The Geroter are keyed to the heavy duty drive shaft and run on pressure balanced thrust plates against the main housing. Timing grooves ensure quiet, smooth and pulse free operation on both the pump and motor.

95. A spin-on type filter is fitted to the circulation pump assembly. The filter is fitted with an inbuilt bypass check valve to allow the oil to bypass the filter element when it is clogged or when the oil viscosity is high.

96. The housing incorporates all cross connections and the following:

- **a.** motor relief valve,
- **b.** pump relief valve,
- **c.** auto start valve,
- **d.** pump filter, and
- **e.** pump and motor connections.

97. A 10.30 kPa reverse sealed check valve is fitted to the housing to protect the shaft from environmental attack. The shaft area is packed with grease as an additional protection against environmental attack.

Suction Case Assembly

98. The suction case assembly (Figure 63) is mounted to the right-hand side of the transfer case and consists of a pickup tube, oil strainer, filler plug and dipstick assembly.

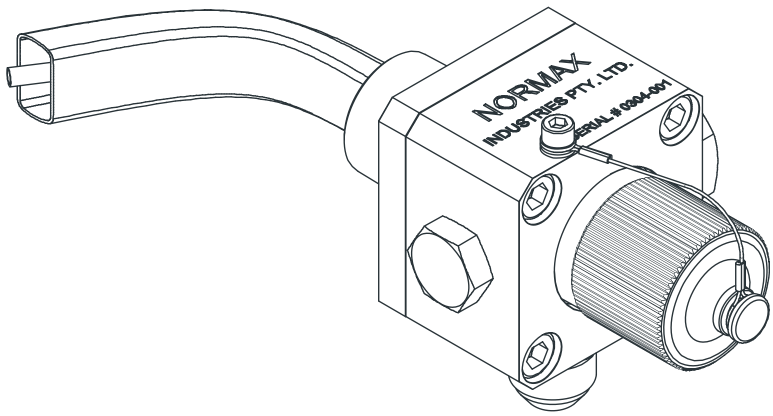


Figure 63 Suction Case Assembly

Power Steering Pump

99. The power steering pump (Figure 64) is coupled to the rear of the compressor and is driven by the compressor crankshaft.

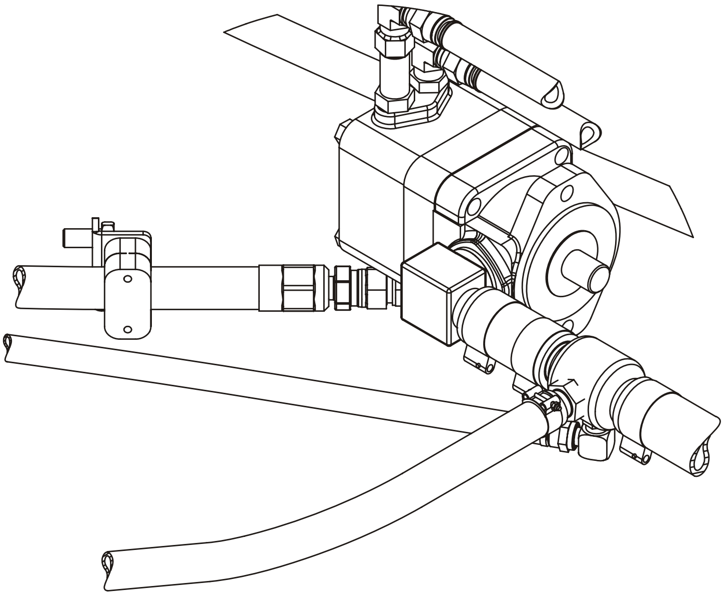


Figure 64 Power Steering Pump

100. The power steering pump is fitted with a priority valve, which enables two hydraulic circuits to be fed by the pump. The first circuit supplies oil pressure to the power steering system and the other supplies oil pressure to the transfer case oil cooler system. Flow to the transfer case oil cooler system is determined by pump delivery.

101. The priority valve maintains a constant flow to the power steering circuit and diverts the remaining flow to the transfer case oil cooler circuit to drive the circulation unit motor.

102. The power steering circuit is protected by an integral relief valve in the power steering pump, and the transfer case oil cooler circuit is protected by a relief valve fitted to the circulation unit.

Priority Valve Operation

103. The priority valve is shown in Figure 65. Pressure is sensed in cavities ‘A’, ‘B’ and ‘C’. Primary flow into cavity ‘A’ is restricted by the controlled flow orifice. Secondary flow will be zero until the pump flow rate through the controlled flow orifice develops a pressure differential across the control spool.

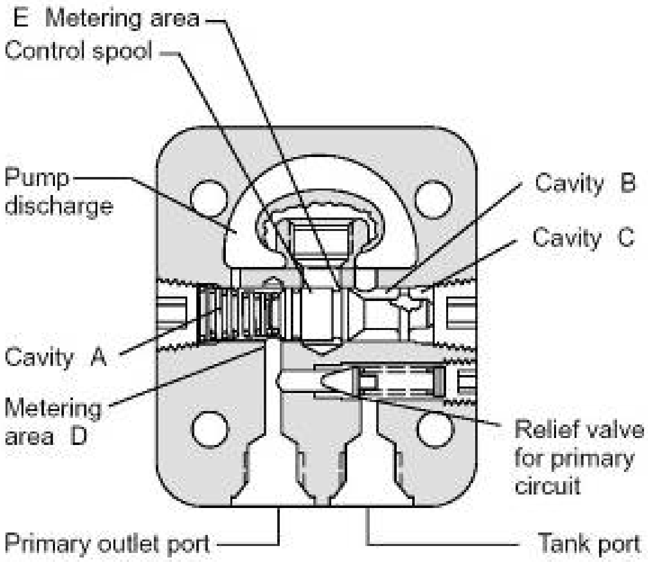


Figure 65 Priority Valve Operation

104. When pump delivery is increased, pressure builds up in cavities ‘B’ and ‘C’ because of the resistance to flow through the controlled flow orifice. This causes the spool to shift toward cavity ‘A’ against the spring. The amount of spool shift is proportional to the pressure differential between cavities ‘A’ and ‘C’.

105. Flow from the primary port is held to an almost constant volume, as determined by the controlled flow orifice and the metering action of the control spool at area ‘D’. Flow to the secondary port varies with pump delivery. Metering at ‘E’ diverts excess flow to the secondary port.

106. This single spool design cannot give precisely controlled flow to the primary circuit because of the effects of varying conditions of flow and pressure. For example, if the primary circuit is operating at 1000 lb/in² and the secondary at 100 lb/in², the spool must be metering at ‘E’. However, if primary pressure is 100 lb/in² and secondary is 1 000 lb/in², the spool must be metering at ‘D’. As the two systems approach the same pressure, the probability of flow fluctuation increases because the spool may shift between these two metering points.

Electrical Components

107. The transfer case oil cooler system (Figure 66) is a hydraulically controlled system, which uses few electrical components. A low oil pressure warning sensor is fitted to the outlet of the heat exchanger to sense system pressure. A dash mounted lamp, controlled by the sensor, indicates low system oil pressure.

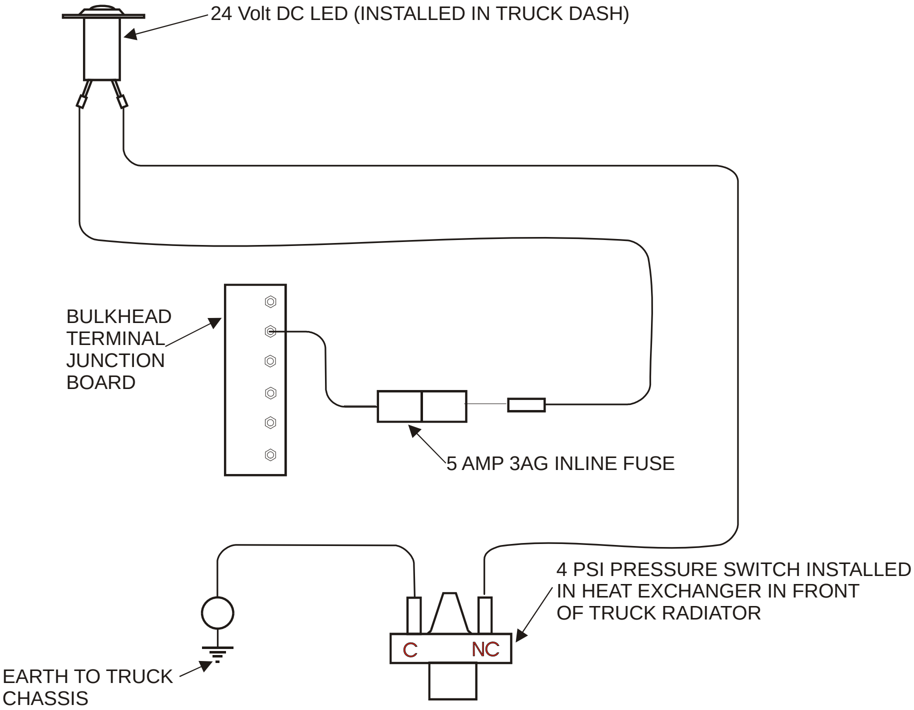


Figure 66 Transfer Case Oil Cooler Wiring Diagram

REAR TANDEM AXLE (BOGIE)

Description

108. A Mack SS441W Spring Bogie with a load carrying capacity of 20 000 kg (44 000 lbs) is fitted to the vehicle. The bogie comprises an intermediate and rear axle assembly each with a final drive ratio of 6.34: 1 with top mounted, dual reduction carriers for straight line through drive. Each differential assembly incorporates an inter-wheel power divider. In addition, an inter-axle power divider is mounted in front of the intermediate carrier. Drive between the intermediate and rear axle assemblies is by means of a short propeller shaft, fitted with Spicer universal joints. Mack full-floating axles transmit the drive from the carrier assembly to the wheels (Figure 67).

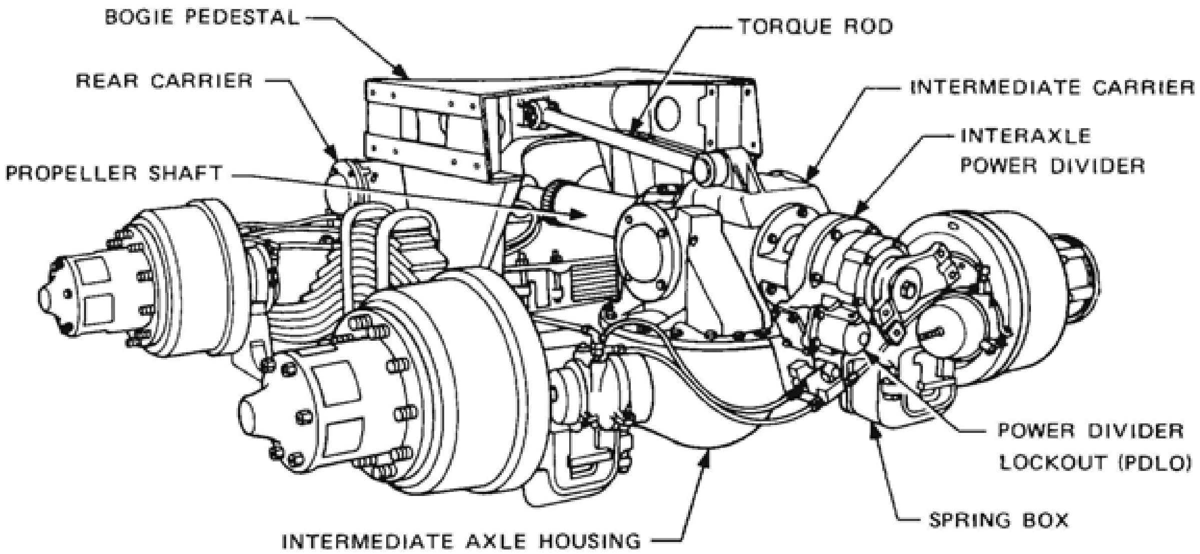


Figure 67 Rear Bogie Axle Assembly

109. The straight line through drive for the top mounted driveheads minimises driveline angularity, vibration and universal joint wear. Each pair of matched bogie carriers are identical, except for the input drive and through-shaft arrangement of the intermediate carrier, which differs from the input pinion mounting of the rear unit. Affixed to the intermediate carrier is a power divider, which houses a hollow bevel pinion, carried in an overhung arrangement by a pair of tapered roller bearings. A through shaft passes through the centre of the hollow bevel pinion and transmits drive to the rear axle (Figure 68).

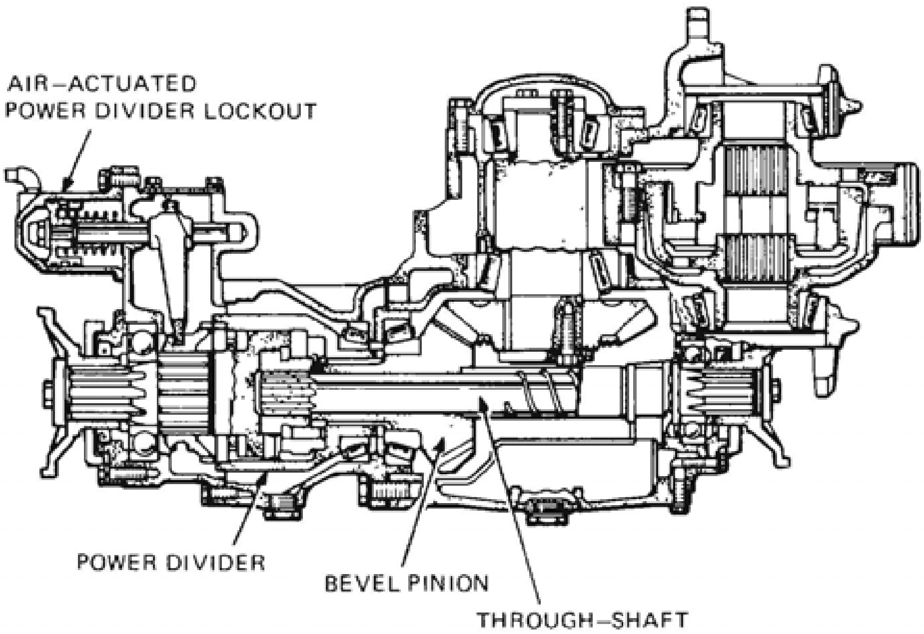


Figure 68 Intermediate Axle Carrier

110. The main drive pinion in the rear carrier has a solid shank and is also carried in an overhung arrangement by a pair of tapered roller bearings mounted in a separable housing. The pinion shaft in each carrier is mounted at right angles to the main drive pinion shaft and is straddle mounted by a pair of tapered roller bearings. The bearing at the gear end is mounted in the carrier housing bulkhead and the other end in a separable bearing retainer (Figure 69). Proper mesh of the bevel gears is obtained by varying the thickness of the shim packs between the pinion and gear housings and the carrier housing.

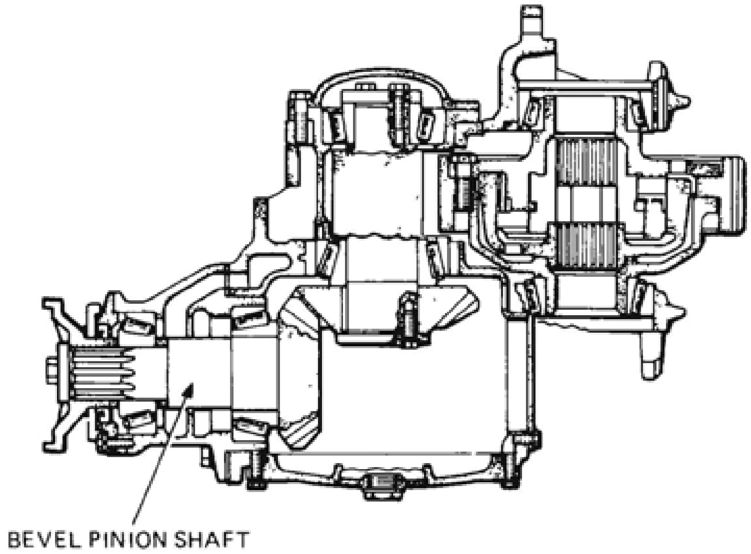


Figure 69 Rear Axle Carrier

111. Drive from the inter-axle power divider, under normal driving conditions, is distributed equally to the intermediate and rear axle carriers. The drive for the first reduction is transferred from the main drive pinion shaft via the bevel gear set to the pinion shaft. The second reduction is from the helical pinion to the bull gear. An inter-wheel power divider is mounted on the bull gear in place of the conventional spider and side gears; this transmits the drive from the bull gear to the axle shafts, which in turn drive the wheels (Figure 70).

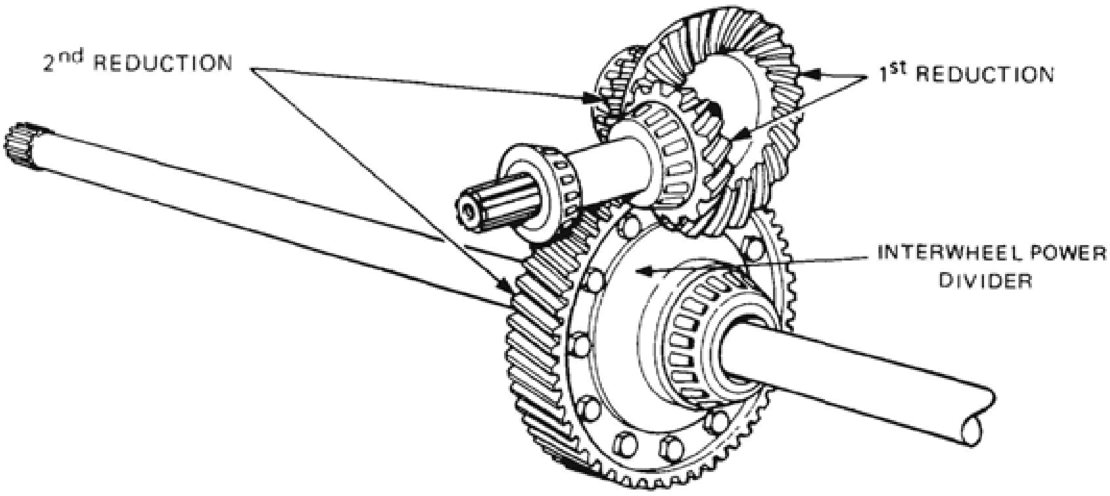


Figure 70 Duel Reduction Axle Carrier Gear Train

112. The bull gear and power divider assembly is straddle mounted by a pair of tapered roller bearings. These bearings are mounted in the carrier bearing pedestals. Preloading of the bearings is provided for by a slotted adjusting nut threaded to the inboard side of the right-hand bearing cap (Figure 71).

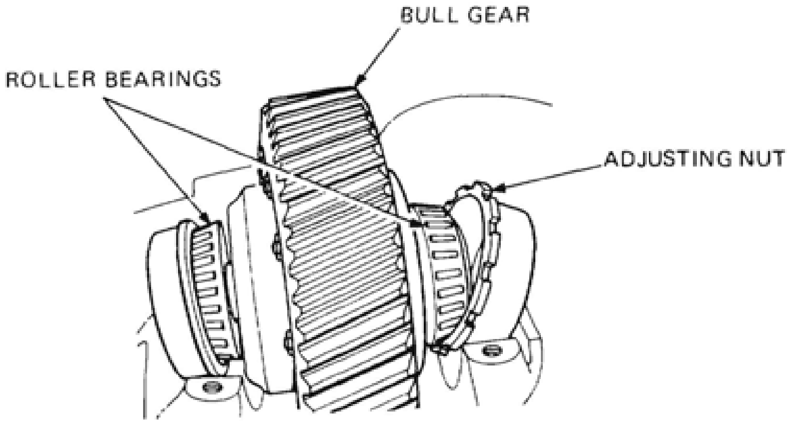


Figure 71 Bull Gear and Power Divider Assembly

Lubrication

113. While the vehicle is in motion, all moving parts in both bogie carriers are constantly bathed in oil, due to the various pumping actions of the moving parts. Oil is pumped under pressure to the inter-axle power divider by a pump which is formed of tightly wound helical coil wire fixed to the rear half of the inter-axle through shaft. It is enclosed over its entire length by a close fitting tube anchored to the rear bearing retainer and oil trough assembly. The oil trough is integral with the bevel gear compartment cover and collects lubricant thrown off from the bevel gears to feed the intake port of the pump (Figure 72).

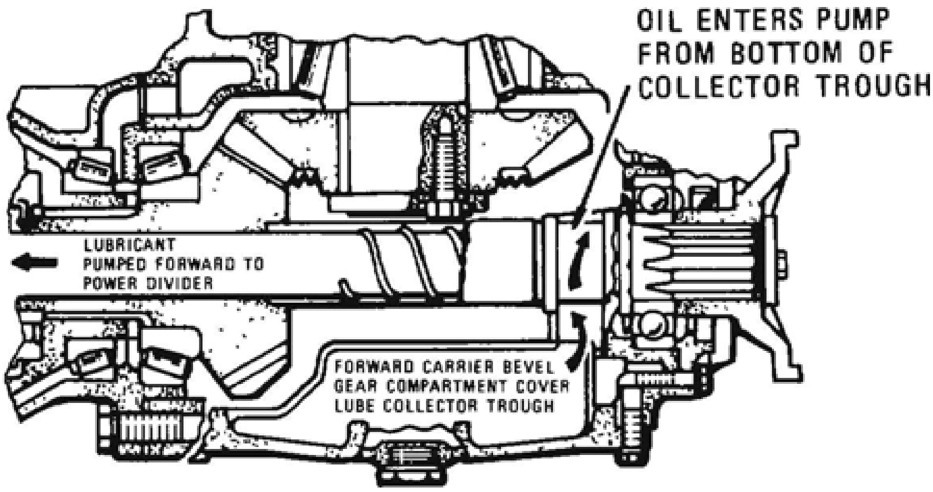


Figure 72 Inter-axle Power Divider Oil Supply Pump

114. Another trough integral with the carrier housing directs throw-off oil from the bevel gears directly to the drive pinion tapered roller bearings through drilled and cast-in oil passages. All other gears and bearings are lubricated by their own pumping action created when running in oil.

Power Dividers

115. The power divider is a torque proportioning differential. Although it performs as a true differential, the power divider is also capable of distributing torque unequally. In slippery conditions, such as mud or sand, a bias of torque is automatically directed to the axle with better traction. A bias of 3:1 is produced. This means that, with one axle slipping, the torque delivered to the other axle is equal to three times the resistance remaining on the slipping axle. As the resistance on the low resistance axle decreases, the torque impressed on the other axle will correspondingly fall off, so that zero resistance on one axle, three times zero or zero torque will be transmitted on the other axle. To overcome this stalled condition, a light application of the footbrake will increase resistance thus offered to the spinning wheel, multiplied by three and delivered to the tractive axle, which will aid vehicle recovery.

116. The power divider is comprised of three main elements; a driving member and two driven members. The driving member is a cage carrying 24 short radial plungers in two rows. Each plunger is free to slide a short distance inward and outward when interposed with the inner and outer cam driven members. The inner cam, which is splined to the through-shaft interconnected to the rear differential carrier pinion gear, is placed within the ring of plungers. The outer cam, which is splined to the hollow drive pinion of the intermediate differential carrier, surrounds the plungers. These three elements are in concentric relation, with the plungers bearing on both the inner and outer cams (Figure 73).

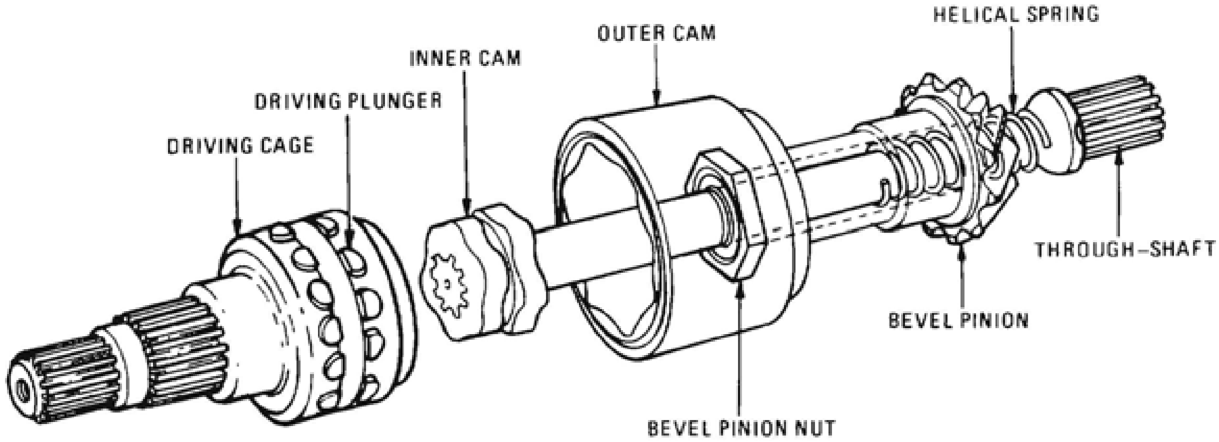


Figure 73 Inter-axle Power Divider Illustrated

117. Relative motion between the driving cage and either of the cams will cause the plungers to move in and out as they ride over the surfaces of the cams. Because the two cams are opposed, inward motion of a plunger as it rides over a cam lobe causes outward motion on its other end, forcing the other cam to turn in the opposite direction. This action is exactly the same as with a conventional differential, except that it is accomplished with cams and plungers instead of by spider and side gears.

118. The two rows of plungers are stagger-indexed while the outer cam has a single row of uniformly spaced lobes. The plungers ride on the two staggered rows of cam lobes on the inner cam, and it is this staggered relationship of the cams and the angularity of the plunger ends that provides the positive drive. In operation, when the driveshaft turns, the cage carrying the radial plungers turns with it. The plungers, which are in contact with the cams at all times and because of the angle of contact, cause the cams to turn with the cage. So for normal straight driving, the whole power divider revolves as a unit, driving both intermediate and rear axles at the same speed.

119. When differential action is required, such as negotiating a deeply rutted or potholed road, one cam will tend to overrun the speed of the cage while the other lags behind. The overrunning cam moves ahead of the plungers, either forcing them inward or allowing them to move outward as they travel over the cam surfaces. The opposite ends of the plungers work against the inclined surfaces of the lagging cam, forcing it to turn at a slower speed than the cage. A true differential action is effected regardless of the speed of the two cams. The average speed of the cams is always equal to that of the cage.

Power Divider Lockout

120. A driver controlled, air actuated, power divider lockout is fitted to the vehicle. This lockout is only used when maximum traction is required and only for short periods. When the driver actuates the control valve lever in the cabin, air pressure forces a piston in the air shift cylinder, which is mounted in a separable housing on the power divider, to actuate a gear-type sliding clutch lockout (Figure 74). The sliding clutch lockout engages with the mating teeth of the power divider outer cam, locking together both axles in positive through-drive for maximum traction with no differential action taking place between the intermediate and rear axle. The sliding clutch lockout is normally held out of action by a compression spring, which acts against the piston in the air shift cylinder. When the lockout is engaged, an electric buzzer in the driver’s compartment sounds continuously. This is done to remind the driver to release the lock as soon as normal traction is regained.

NOTE

> The power divider lockout is used in conjunction with the transfer case differential lockout. Both are controlled by the ‘Power Divider Lock’ switch on the dash panel or by the selection of Lo-range in the transfer case.

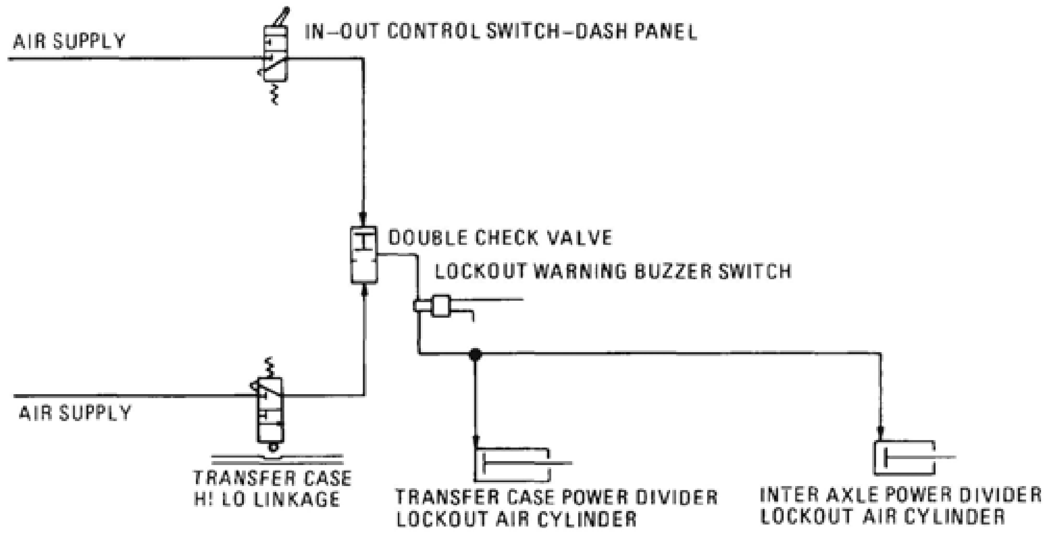


Figure 74 Power Divider Lockout System

Inter-wheel Power Divider

121. An inter-wheel power divider is fitted to the intermediate and rear carriers of the bogie. It replaces the conventional spider and side gear differential arrangement and operates in the same manner as the inter-axle power divider, except that it directs power from the carrier to the wheels. Like the inter-axle power divider, the inter-wheel power divider operates like a true differential, but is also capable of directing the torque unequally to the wheels. If one wheel loses traction, the power divider directs up to 75 per cent of the torque available at the carrier to the wheel with the greater traction. Like the inter-axle power divider, the inter-wheel power divider consists of a driving cage, 24 blunt-nosed, radial plungers, and inner and outer cams. But unlike the inter-axle power divider. it is not equipped with the power divider lockout.

POWER STEERING

122. The power steering system, (Figure 75) fitted to the vehicle is a Sheppard SGP49 (Model 592). The steering gear features an integral assembly, wherein the booster cylinder, control valve and mechanical steering gear are incorporated into a single unit. A Vickers V20 series pump, which is mounted directly on and driven by the air compressor output shaft, pumps oil from the oil reservoir to the steering gear unit.

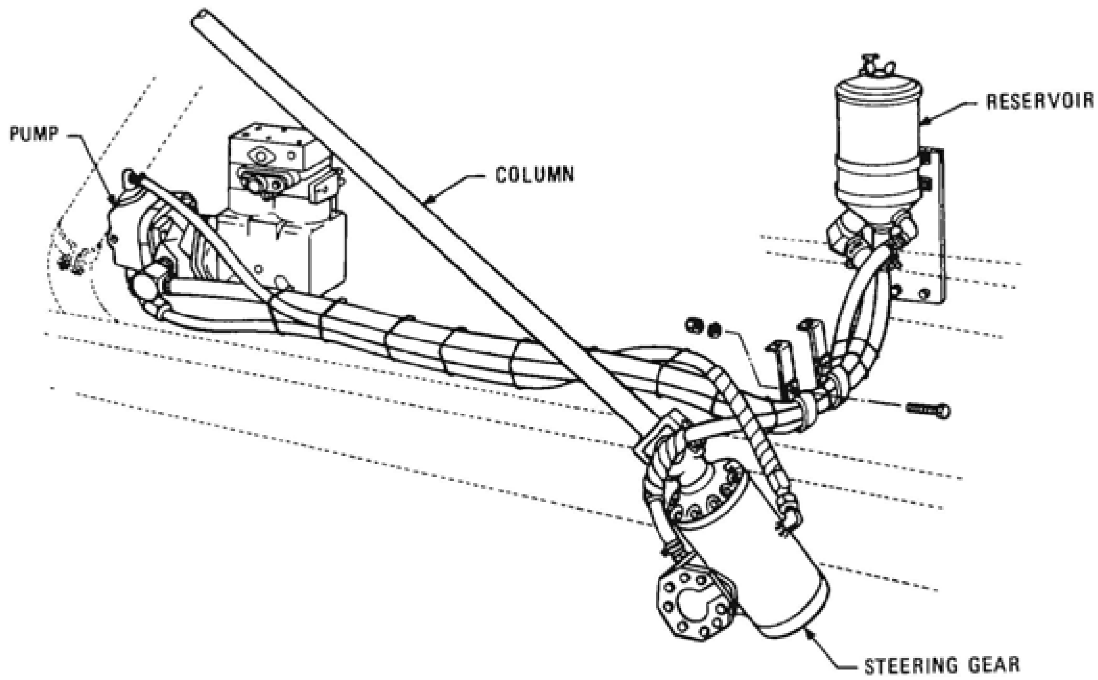


Figure 75 Power Steering System

123. These pumps are of vane type, consisting of a body, cover, drive shaft assembly, pressure plate and pumping cartridge. The pumping cartridge is comprised of the vanes, a slotted rotor and a ring with an elliptical bore. The vanes fit slots in the rotor and these parts are assembled into the ring. The inner rotor is splined to the drive shaft. When the pump is started, centrifugal force causes the vanes to follow the contour of the ring. After hydraulic pressure is developed in the system, the vanes are held in contact with the ring by pressurised oil introduced behind the vanes. The oval contour of the ring forms two opposed pumping chambers. Oil from the reservoir is inducted into the low pressure areas formed at the point where chamber volume is greatest. This fluid is carried around by the vanes and is discharged at the outlet port, which is located at the point of minimum chamber volume.

124. There are two inlet and two outlet ports located at 180 degree intervals. This balances out hydraulic forces within the pump, eliminating radial loads on the shaft bearings. The pressure plate is used to seal the chambers; this is held against the cartridge by a light spring until hydraulic pressure is built up. The hydraulic pressure takes over from the light spring and holds the pressure plate against the cartridge. An integral flow control valve is incorporated in the pump to control delivery volume and pressure (Figure 76). An orifice installed in the cover outlet port limits the maximum flow of the oil from the pump to the gear. When pressure in the system builds up, a pilot operated relief valve, located within the flow control valve, diverts excess fluid to the reservoir, thus limiting the pressure to a maximum of 12 066 kPa (1 750 psi).

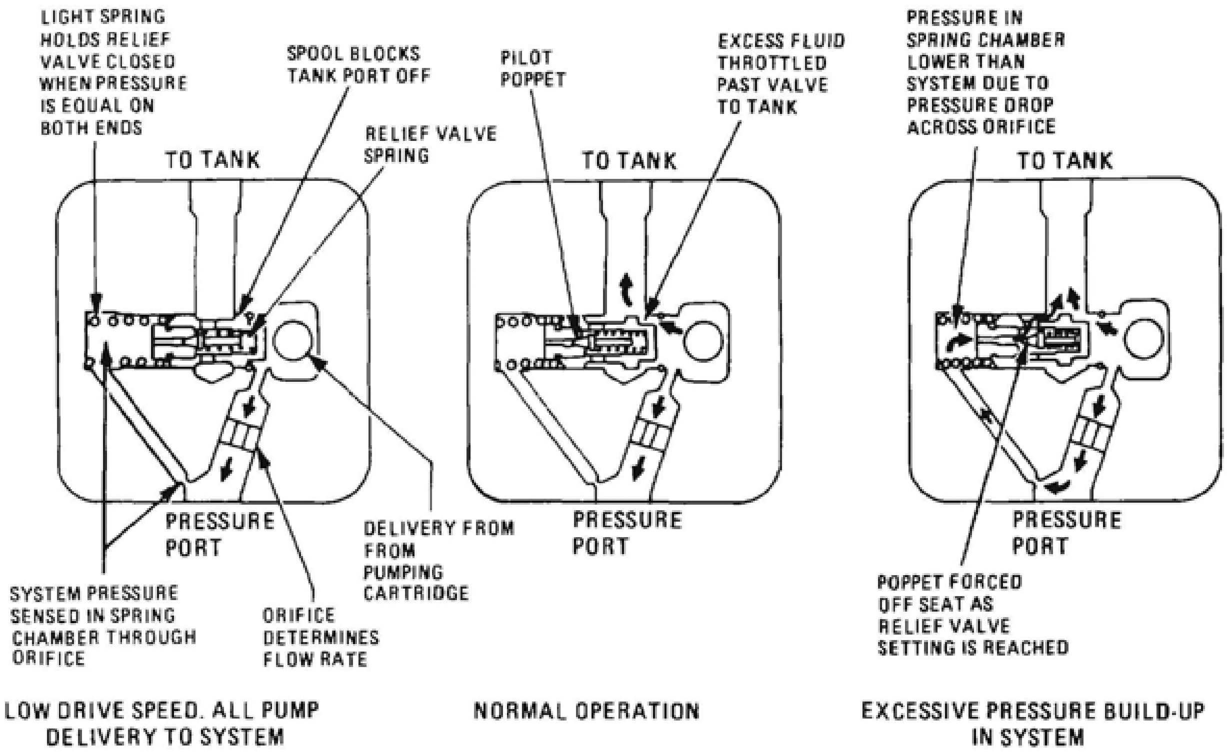


Figure 76 Operation of Integral Flow Control Valve

125. The steering gear assemblies consist of four basic parts: the actuating shaft, the actuating valve, the actuating piston and the output shaft (Figure 77). The actuating shaft has an Acme type, multiple start thread, which engages a similar type thread in the actuating valve. The actuating shaft is connected to the steering column and, therefore, is caused to rotate whenever the steering wheel is turned. When the actuating shaft is rotated, it causes the actuating valve to travel along the shaft due to the action of the threads. Direction of valve travel is determined by direction of steering wheel rotation. The valve is fitted in a bore in the piston and has approximately 0.8 mm (1/32 in) linear travel within this bore, relative to the piston.

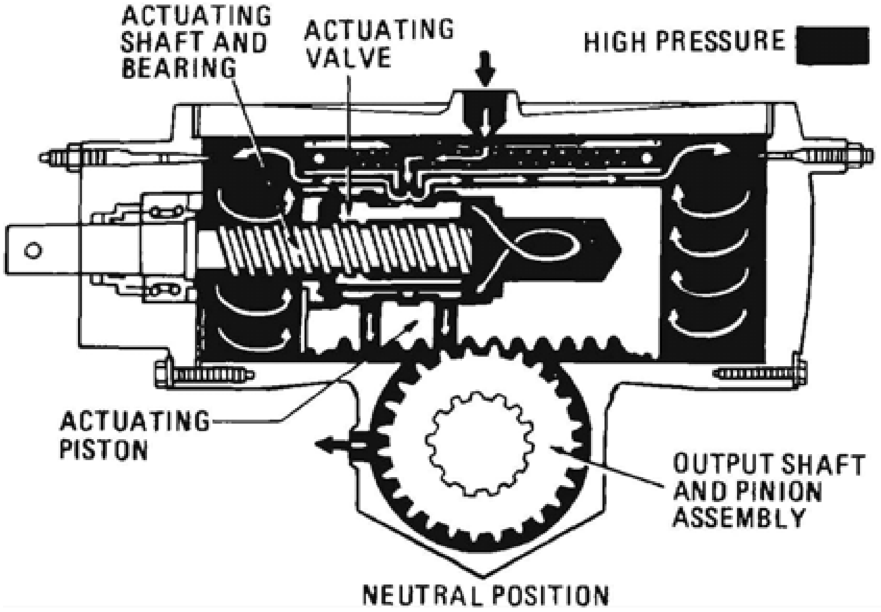


Figure 77 Power Steering Gear in Neutral Position

126. As the valve moves back and forth in response to steering wheel movement, lands and grooves on its outer diameter alternately cover or uncover ports in the piston. As these ports are covered or uncovered, fluid pressurised by the pump is directed to the correct end of the piston for the direction of turn desired. At the same time, passages are opened so that fluid at the opposite end of the piston can return to the reservoir. When power-assisted steering is no longer required, the reversing springs centre the valve and thereby neutralise the system. Fluid flow when steering gear is in neutral and in operation is shown in Figures 77and 78.

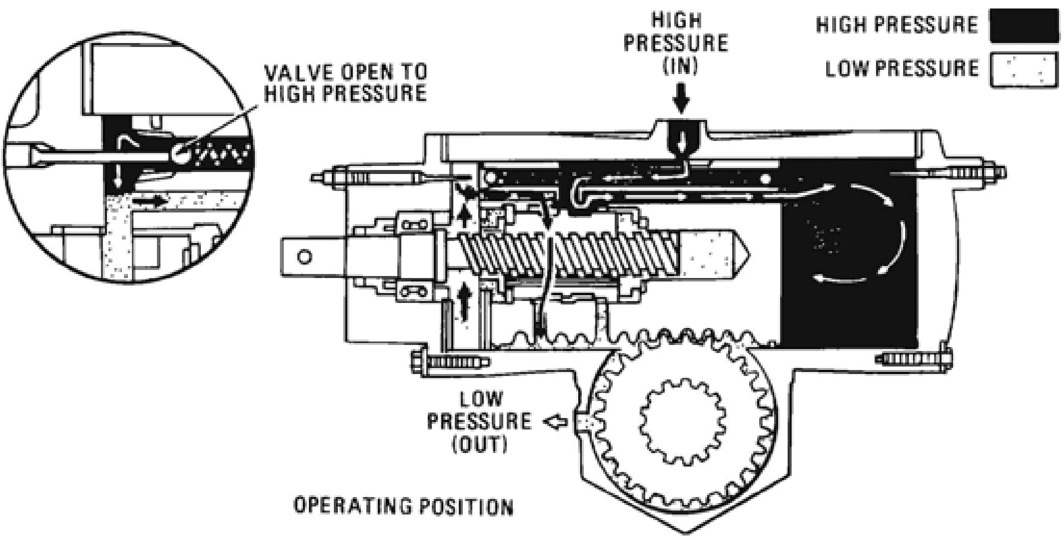


Figure 78 Power Steering Gear in Operating Position

127. The piston, in addition to having passages for conducting oil, has a rack machined on one side. The rack meshes with a gear that is splined to the output shaft. As the piston moves back and forth, the output shaft is forced to rotate, thus providing the motion to operate the drag link and turn the front wheels. Relief valves are located in the piston; these are activated by two adjustable plungers, one mounted in the cylinder head and the other in the bearing cap. In operation, these plungers serve to relieve hydraulic pressure as the piston approaches the end of the housing. This is accomplished when the valve ball is unseated by that portion of the plunger that extends into the cylinder. When the valve ball is unseated, pressure cannot build up, thus preventing overloading of the hydraulic system and mechanical components (Figure 78 inset).

STEERABLE DRIVE AXLE

128. The Fabco SDA-18B steerable drive axle fitted to the vehicle is a fabricated cast steel Banjo type with steel axle housing tubes and flanges (Figure 79). The maximum load carrying capacity of the axle is rated at 8 181 kg (18 000 lb). Each inner axle shaft has a single universal joint connecting it to the outer axle shaft. The Eaton differential carrier is a conventional spiral bevel gear type with a spider and side gear arrangement and a ratio of 6.5:1.

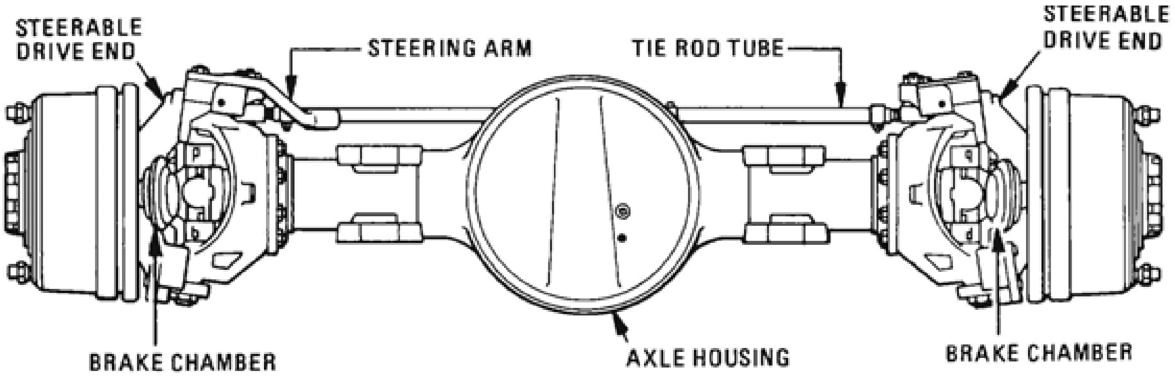


Figure 79 Front, Steerable Drive Axle

129. The axle is a constant drive type with drive from the carrier being transmitted to the wheels via Eaton axles, Spicer Mechanics universal joints and Fabco drive ends (Figure 80). Brakes fitted to the axle are air operated wedge type with shoes and drums. The axle is mounted to the chassis by two semi-elliptic leaf springs and spring rate is dampened by two double-acting shock absorbers.

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1 Stud, right hand wheel
2 Nut, right hand wheel
3 Nut, wheel stud lock
4 Drum
5 Lining, brake
6 Bolt, backing plate retaining
7 Plate, brake backing
8 Vent
9 Bolt, upper kingpin steering stop
10 Bolt, upper kingpin bracket mounting (3½" long)
11 Nut, upper kingpin bracket mounting
12 Yoke, spindle
13 Stud, steering arm (2 1/16" long) short
14 Nut, steering arm mounting lock
15 Stud, steering arm (2 9/16" long) long
16 End, right tie rod
17 Nut, tie rod end
18 Ball stud, upper kingpin
19 Bearing, upper kingpin
20 Bracket, upper kingpin
21 Tube, tie rod
22 Steering arm
23 O-ring, upper kingpin
24 Washer, upper kingpin ball stud
25 Stud, suspension yoke
26 Nut, upper kingpin ball stud lock
27 Seal, inner drive yoke
28 Shaft, inner axle
29 Yoke, inner drive with ring
30 Yoke, suspension
31 Washer, drive yoke retaining
32 Washer, drive yoke sealing
33 Bolt, axle shaft
34 Cross and bearing assembly
35 Bolt, cross and bearing
36 Fitting, grease
37 Bracket, lower kingpin (plain)
38 Nut, lower kingpin
39 Ball stud, lower kingpin
40 O-ring, lower kingpin
41 Bearing, lower kingpin
42 Disc, lower kingpin bearing
43 Stud, lower kingpin bracket
44 Yoke, outer drive with ring and bearing race
45 Seal, outer axle shaft
46 Bearing, outer axle shaft
47 Bolt, wheel spindle
48 Seal, hub
49 Bearing, inner hub
50 Hub assembly
51 Bearing, outer hub
52 Stud, outer axle
53 Dowel, drive stud
54 Nut, drive stud
55 Plug, axle flange
56 Shaft, outer
57 Nut, wheel bearing lock
58 Washer, wheel bearing lock
59 Nut, wheel bearing lock (with dowel)
60 Gasket, outer axle shaft
61 Spindle
62 Spring, brake shoe return

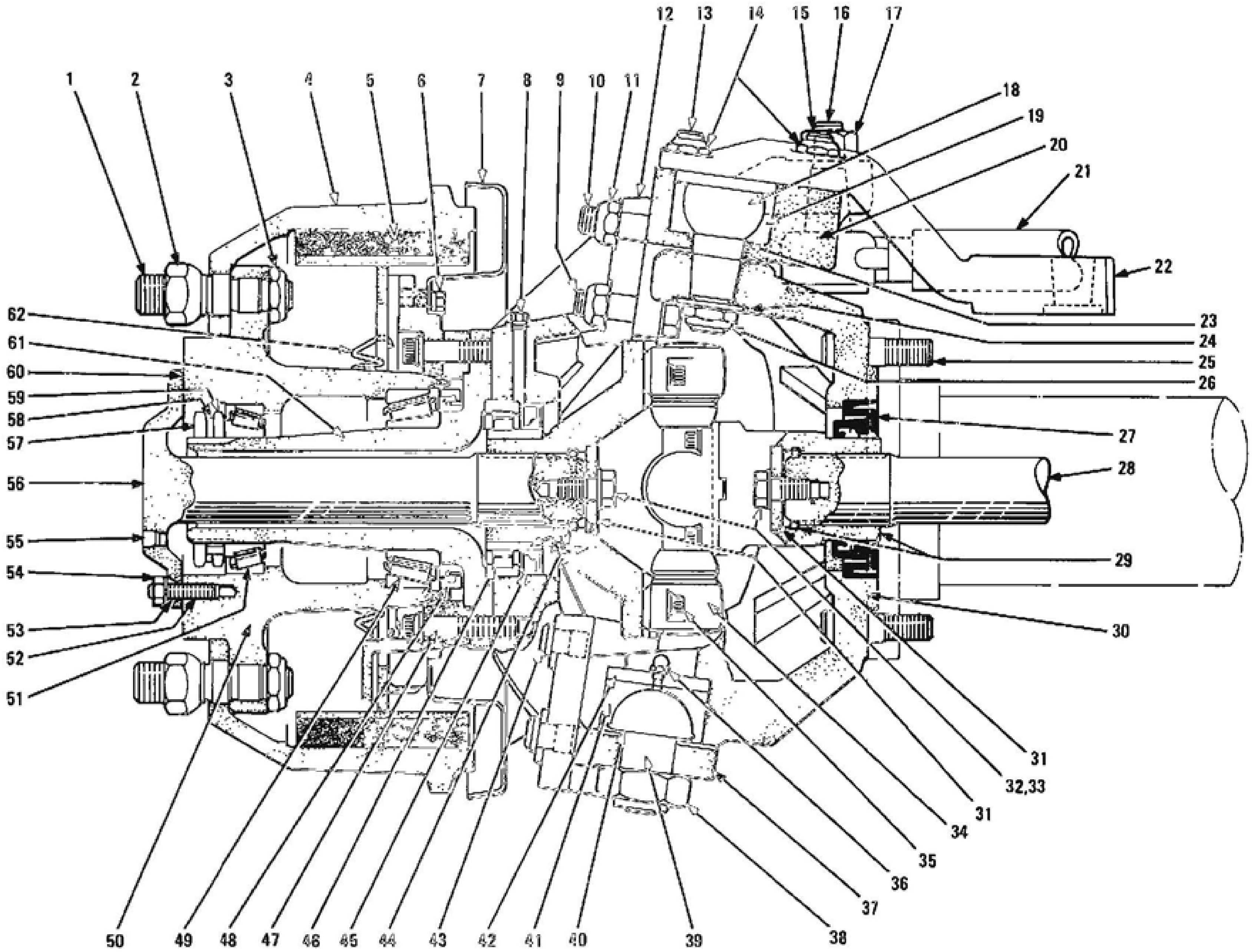

Figure 80   Sectional Drawing of Steerable Drive End

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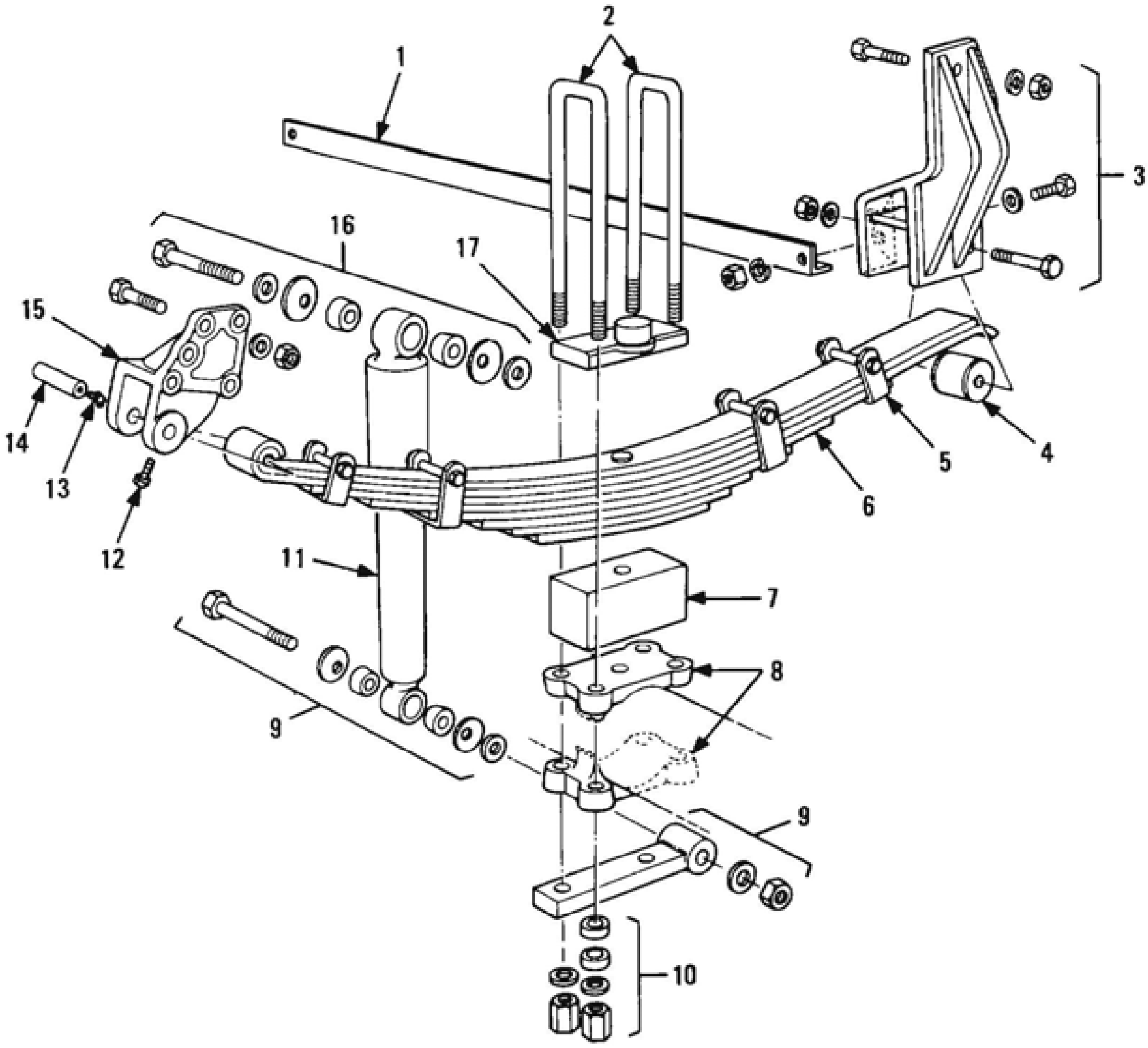
FRONT SUSPENSION

130. The front steerable drive axle is mounted on two semi-elliptic springs made up of eight leaves and held together by means of a centre bolt. The spring is mounted to the chassis by a fixed shackle pin at the front and a slipper joint at the rear, i.e. the spring sits on a skid plate and is free to move back and forth. The axle is slung under the springs and is secured by U-bolts. Double action shock absorbers are utilised to absorb shock loads and dampen the spring rate (Figure 81). The front suspension is rated at 5 400 kg (11 900 lb) plus 10%.

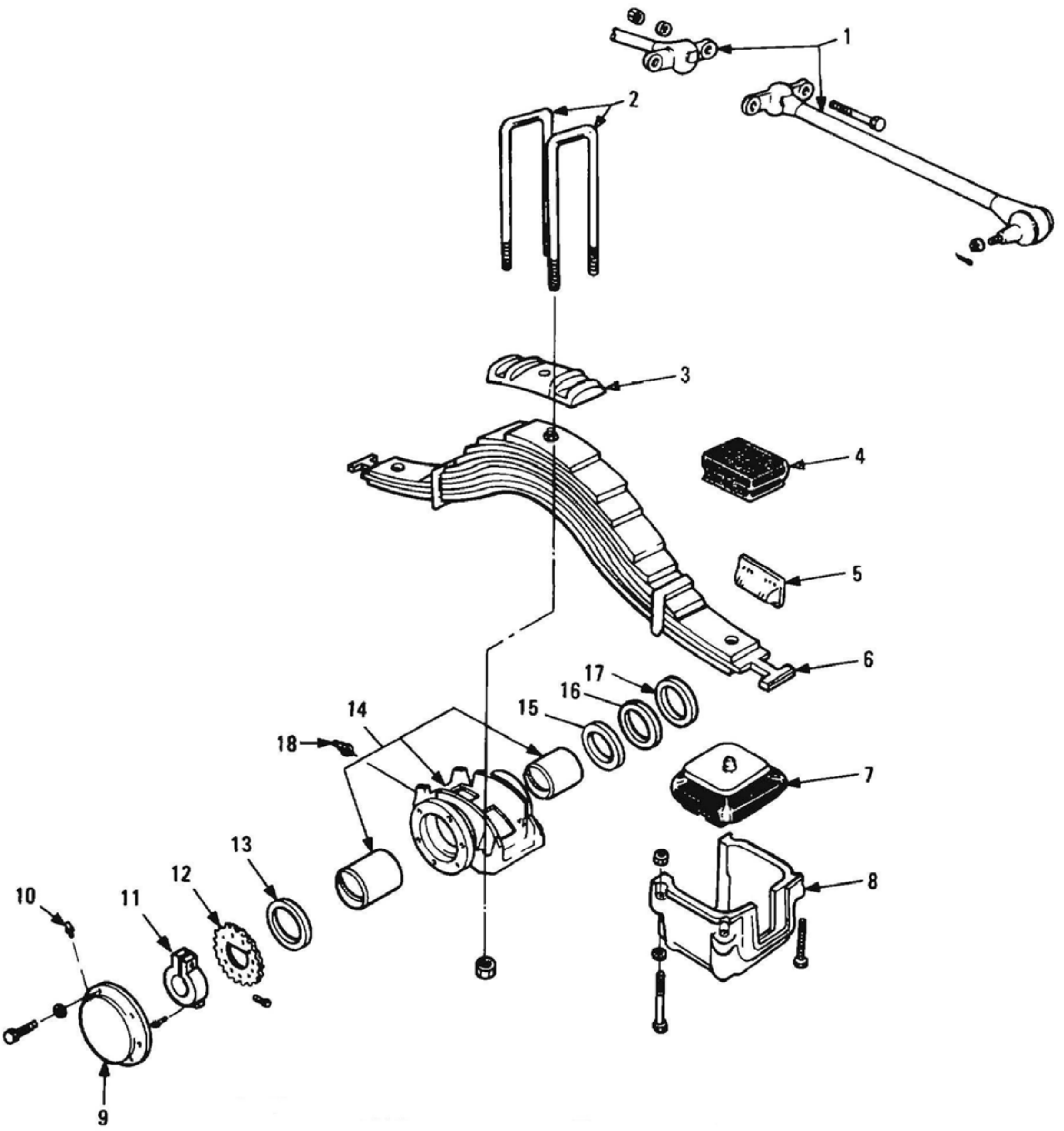


1	Cross brace	7	Spacer block	13	Grease fitting
2	U-bolts	8	Mounting flanges (axle housing)	14	Shackle pin
3	Rear spring mounting	9	Lower mounting (shock absorber)	15	Front shackle mounting
4	Rubber insulator	10	Nuts, U-bolt	16	Upper mounting (shock absorber)
5	Alignment clips	11	Shock absorber	17	Bump stop plate
6	Spring assembly	12	Locating screw (shackle pin)		

Figure 81 Exploded View of Front Suspension (Left Side)

REAR SUSPENSION

131. The rear bogie is suspended by camel back springs, the ends of which are secured to the axle housings through rubber shock insulators slung below the axles. The centre of the spring is anchored by means of U-bolts to the trunnion bracket assembly. The trunnion bracket is mounted on the trunnion shaft and forms a pivot about which the spring assembly oscillates. Integral T-ends of the main spring leaves engage with slotted webs in the spring boxes and serve as anchors against pullout in the event of excessive loading (Figure 82).



1	Torque rods	7	Lower rubber insulator	13	Seal
2	U-bolts	8	Spring box cap	14	Trunnion and bushing assembly
3	Clamping plate	9	Trunnion cap	15	Trunnion bearing thrust washer
4	Upper rubber insulator	10	Breather	16	Inner thrust washer
5	Spacer	11	Adjusting nut	17	Seal
6	Spring assembly	12	‘D’ washer	18	Grease nipple

Figure 82 Exploded View of Rear Suspension

132. To brace the bogie axle housings against rotation resulting from driving and torques, the suspension was designed in the form of a parallelogram, in which the two camel back springs form the lower member and two horizontal torque rods form the upper member (Figure 83). The torque rods are fastened by rubber bushed pins to a lug on the top-mounted bogie carrier casting and to the frame crossmember centred between the bogie axles. This arrangement of ball-jointed torque rods permits maximum flexibility of the bogie and absorbs all resultant oscillating movement with a minimum of friction. Therefore, all torque reactions of the axles are resolved into horizontal forces, which are transferred directly to the frame with no vertical component.

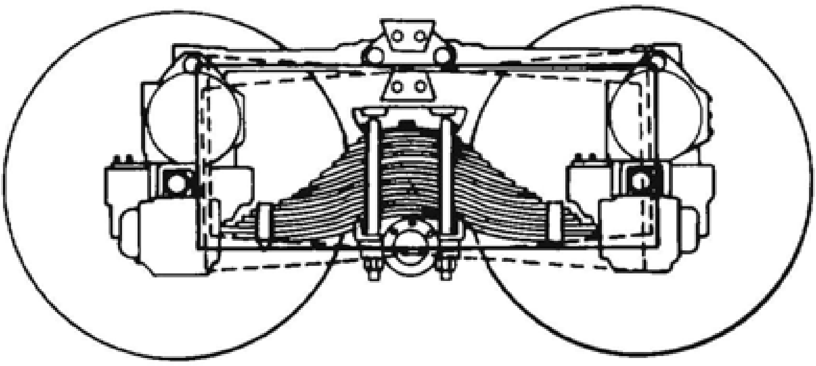


Figure 83 Illustration of Parallelogram Design Suspension

133. A one-piece fabricated steel trunnion bracket is used to support the frame. It also functions as combination bracket and crossmember. It was designed to provide a four-point bolting pattern to eliminate the concentration of stresses at any one point on the frame. The trunnion centre, being below the axle centres, causes the vehicle to be suspended pendulum like from the axle housing, thus improving the overall stability of the bogie and preserving uniform loading on all bogie drive wheels under all conditions. The trunnion bracket serves as a spring seat and also a pivot point for the spring type suspension where bronze bushes are used on the spindle ends. U-bolts are used to clamp the springs and U-bolt spacer to the trunnion bracket.

BRAKES

Service Brakes

134. The service brakes on the vehicle are dual circuit, air actuated, self adjusting, wedge type with spring actuated emergency/parking brakes. Figures 84 and 85 illustrate the front and rear brake assemblies (right-hand side) showing the position of the self adjusting plungers, shoes, return springs and stabilizer springs (front wheels only).

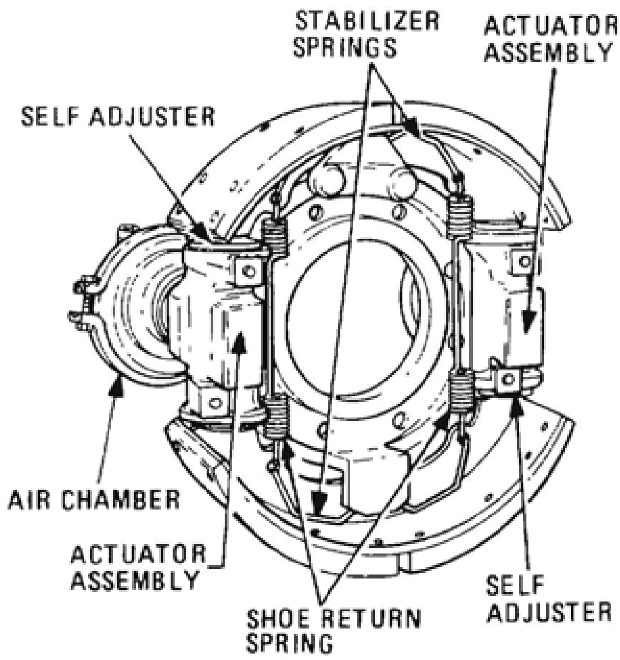


Figure 84 Front Brake Assembly (Right-hand Side)

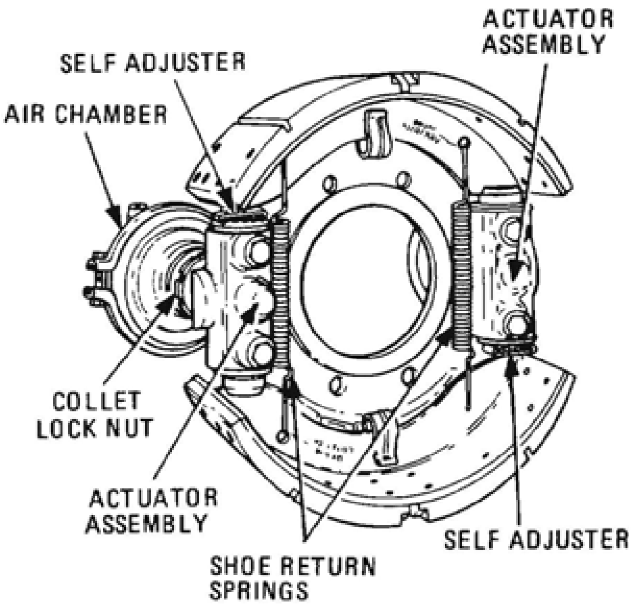


Figure 85 Rear Brake Assembly (Right-hand Side)

135. When the brake is applied, air pressure in the air chamber causes the diaphragm to push the wedge head between the rollers, spreading the rollers and plungers apart, and pushing the brake shoes outward (Figure 86). Initially, all the plungers are lifted off the plunger abutments and momentarily suspended. As the linings contact the drum, the drum tends to drag the shoes and plungers around with it. This causes the solid plungers at the trailing end of the shoe to reseat on its abutment and thus absorb and transfer the brake torque to the brake support. When the brake is released, air is evacuated from the air chamber allowing the wedge spring to return the wedge and diaphragm to the off position. At the same time, the shoe return springs push the raised plungers back to their abutments.

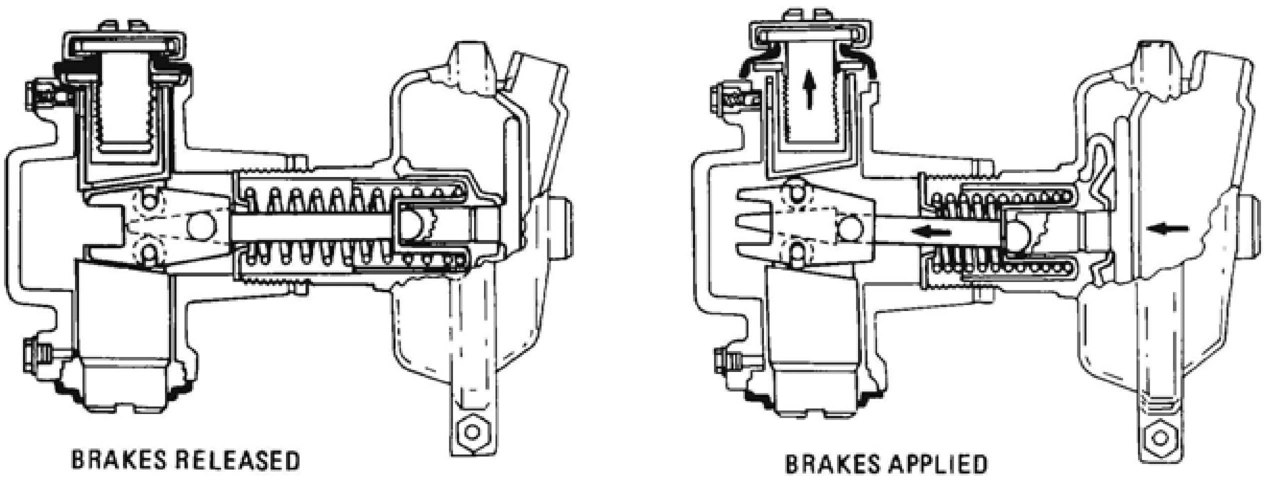


Figure 86 Wedge Brake Operation

136. The adjusting plunger assembly on the front brakes incorporate an adjusting plunger, adjusting nut, adjusting screw and clip assembly, adjusting cap, adjusting lever, pin and spring, and an overload spring (Figure 87).

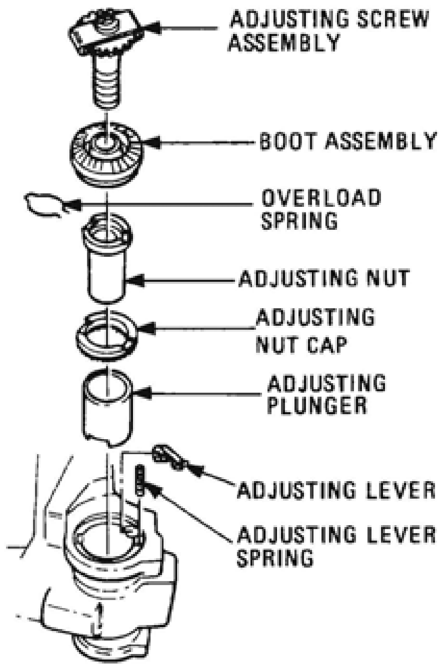


Figure 87 Exploded View of Adjusting Plunger (Front Brakes)

137. Adjustment of the front brakes takes place when the adjusting plunger moves out of the plunger housing. If the linings have worn enough to require adjustment, the plunger will move out far enough to allow the adjusting lever to pick up the next tooth on the adjusting cap (Figure 88). When the brake is released, the shoe return springs cause the plunger to reseat. The inward movement of the plunger causes the adjusting lever to turn the adjusting cap and nut one tooth position (Figure 89). The adjusting screw clip, which is fitted on the end of the adjusting screw and mates with the brake shoe, prevents the adjusting screw turning during automatic adjuster operation. In the event of a hard brake stop, the vehicle may rock back slightly in the opposite direction while the brakes are applied. This rock back places a load on the adjusting nut cap, which in turn can damage the adjusting lever, especially if the adjusting lever has picked up a new tooth prior to rock back. To prevent the adjusting lever being damaged, an overload spring is incorporated in the plunger. The overload spring allows the adjusting nut cap to turn slightly taking load away from the adjusting lever preventing damage to the lever occurring. After the brakes are released, the tension of the overload spring causes the adjusting nut to turn, providing normal automatic adjustment.

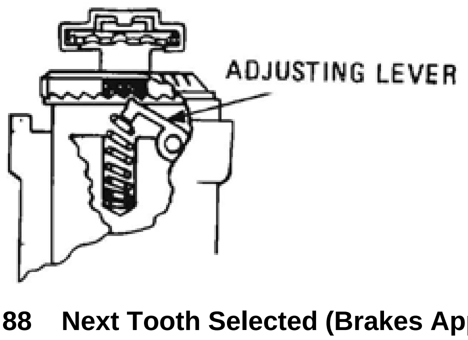


Figure 88 Next Tooth Selected (Brakes Applied)

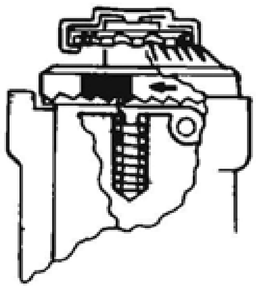


Figure 89 Brake Adjustment (Brake Released)

138. The adjusting plunger assembly on the rear brakes incorporates an adjusting plunger, adjusting screw, adjusting sleeve, hollow cap screw, spring and adjusting pawl (Figure 90).

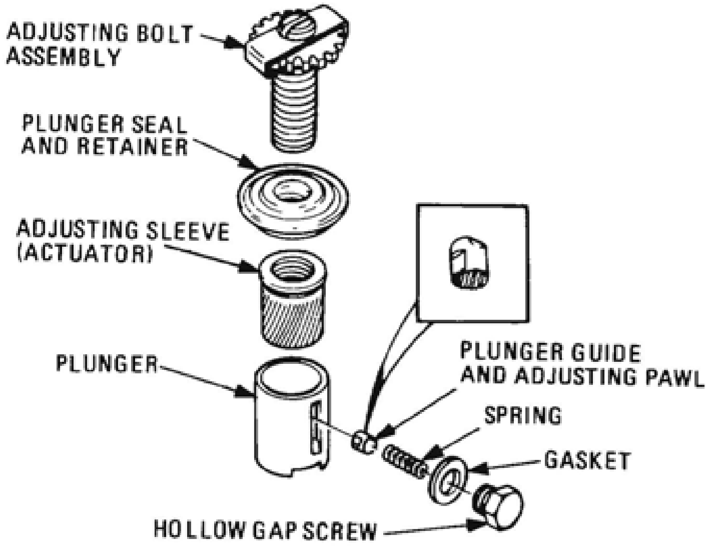


Figure 90 Exploded View of Adjusting Plunger

139. The automatic adjustment of the rear brakes takes place as the brakes are actuated. The adjusting plunger moves outward taking with it the adjusting sleeve and screw. The sloping face of the helical teeth on the adjusting sleeve act against the sloping face on the teeth of the pawl, causing it to lift against spring tension. The more the linings wear, the further the outward movement of the plunger and the more the resulting lift of the pawl until it climbs over and drops into the next tooth space on the adjusting sleeve. As the brake is released and the shoe return spring forces the plunger to reseat on its abutment, the upright face on the teeth of the adjusting pawl lock against the teeth on the adjusting sleeve, causing the sleeve to rotate and advance the adjusting screw, reducing the lining clearance as it does so (Figure 91).

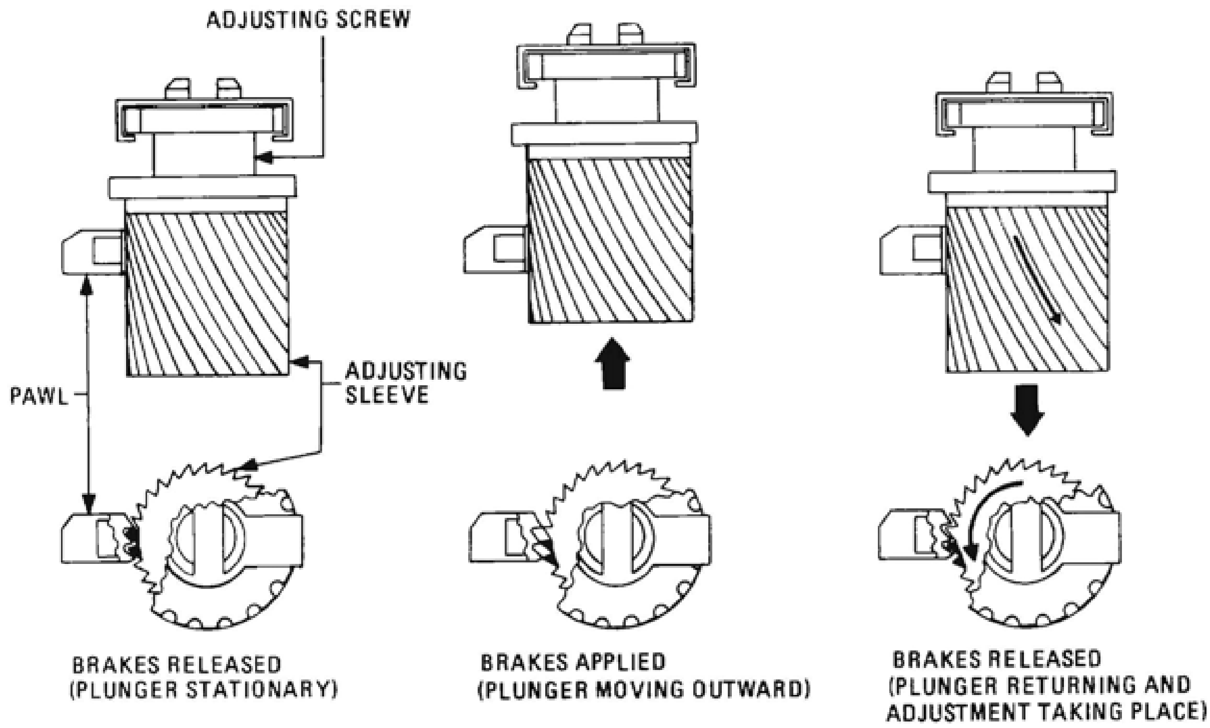


Figure 91 Adjusting Plunger Operation (Rear Brakes)

NOTE

The brakes will self adjust only when the brakes are applied while the vehicle is travelling in a forward direction and if the linings have worn enough to require adjustment. This is because when the vehicle is travelling in a rearward direction, the adjusting plungers remain stationary while the solid plungers move outward to apply the shoes. Adjustment can only take place when the adjusting plungers move outward.

140. To operate the braking system, compressed air is required. The compressor supplies the compressed air, which is stored in four separate tanks: two primaries, a secondary and a reserve. The primary tanks supply air to the rear service brakes, while air supply for the front brakes comes from the secondary tank. Both circuits operate with an air pressure of 827 kPa (120 psi) maximum. The reserve tank supplies air for the emergency releasing of the spring brakes if they have been applied due to low pressure in both the primary and secondary circuits. The reserve tank stores enough air to enable the brakes to be released approximately two times. If the air pressure of the primary or secondary system drops below 480 kPa (70 psi), a red warning light located on the instrument panel is illuminated and an audible warning buzzer is activated.

141. The compressor (Figure 92, Item 1) is connected by steel and flexible air line to the wet tank (Figure 92, Item 2). Heated air from the compressor passes through the air line to the wet tank. As the air cools, the moisture in the air condenses and is retained in this wet tank. Dry air from the wet tank is then fed into the primary and secondary storage tanks (Figure 92, Item 3 and Item 4 respectively) passing through one-way check valves (Figure 92, Item 6 and Item 7) as it enters these tanks. The check valves prevent loss of pressure should the supply line rupture or the compressor fail. Air from the wet tank is fed to the governor (Figure 92, Item 5), which operates the compressor unloading mechanism when the reservoir air pressure reaches 827 kPa (120 psi).

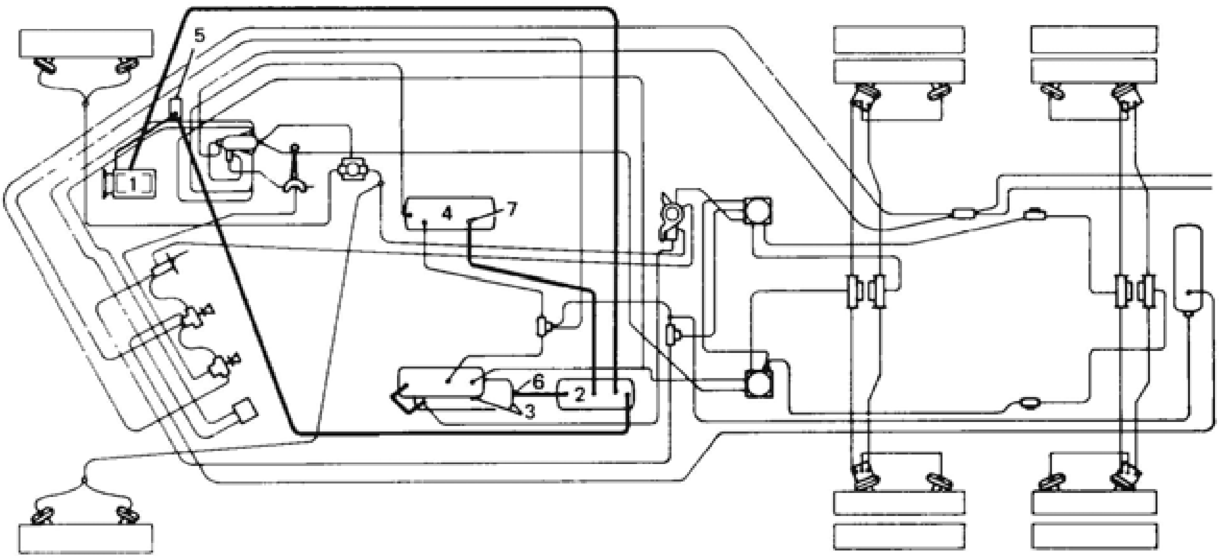


Figure 92 Brake System – Air Supply Circuit

142. The primary storage tank (Figure 93, Item 3) supplies air to the top section of the treadle valve (Figure 93, Item 8), double check valve (Figure 93, Item 9), the spring brake control valve where it acts as a sensor line (Figure 93, Item 10), and the service brake relay (Figure 93, Item 11). When the treadle valve is depressed, air flows from the treadle valve (Figure 93, Item 8) to the service brake relay (Figure 93, Item 11). This air acts as a signal or trigger opening the service brake relay (Figure 93, Item 11) allowing the air, sourced from the supply tanks (Figure 93, Item 3), to flow through the relay and into the rear service brake chambers (Figure 93, Item 13). The pressurised air acts on a diaphragm in the service brake chamber, which forces the push rod out, driving the wedge between the brake shoes and expanding them against the drum.

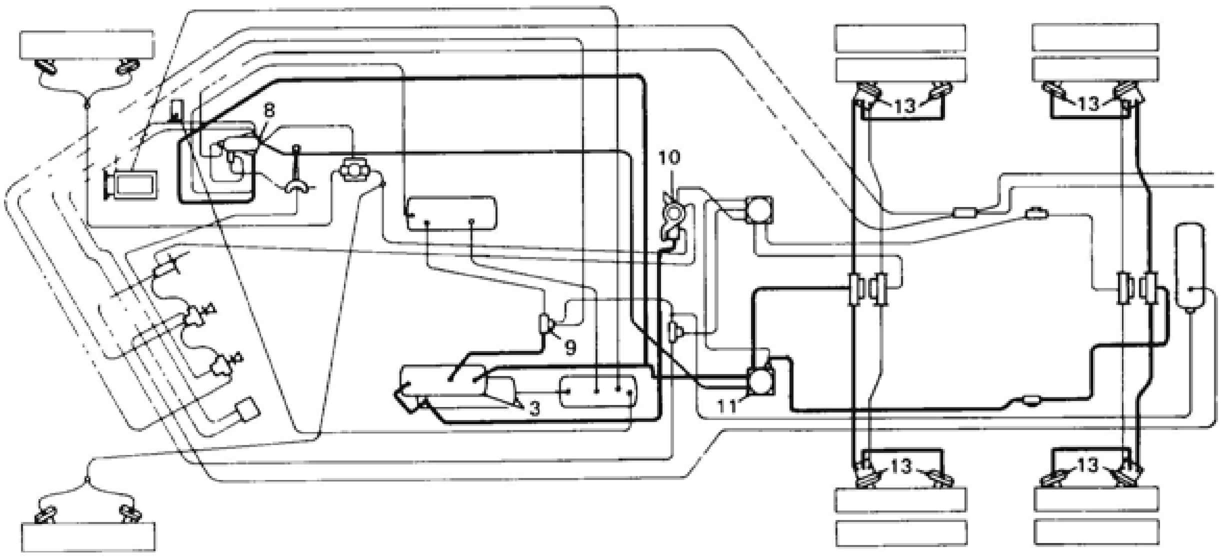


Figure 93 Brake System – Primary Circuit

143. The secondary storage tank (Figure 94, Item 4) supplies air to the lower section of the treadle valve (Figure 94, Item 14) and to the double check valve (Figure 94, Item 9) on the opposite side to the primary air connection. When the treadle valve is depressed, air flows through the quick release valve (Figure 94, Item 15) to the front service brake chambers (Figure 94, Item 16) and applies the wedge brakes. It also flows to the spring brake control valve (Figure 94, Item 10) and to the double check valve (Figure 94, Item 17). When the pedal is released, pressure between the treadle valve (Figure 94, Item 14) and the inlet port of the quick release valve (Figure 94, Item 15) drops. This pressure drop combined with air pressure accumulated in the service brake chambers (Figure 94, Item 16) causes the diaphragm in the quick release valve (Figure 94, Item 15 and Figure 95) to close off the inlet port and open the exhaust port, allowing the accumulated air in the brake chambers to flow back through the quick release valve and be exhausted to the atmosphere. This action takes place the instant the treadle valve is released.

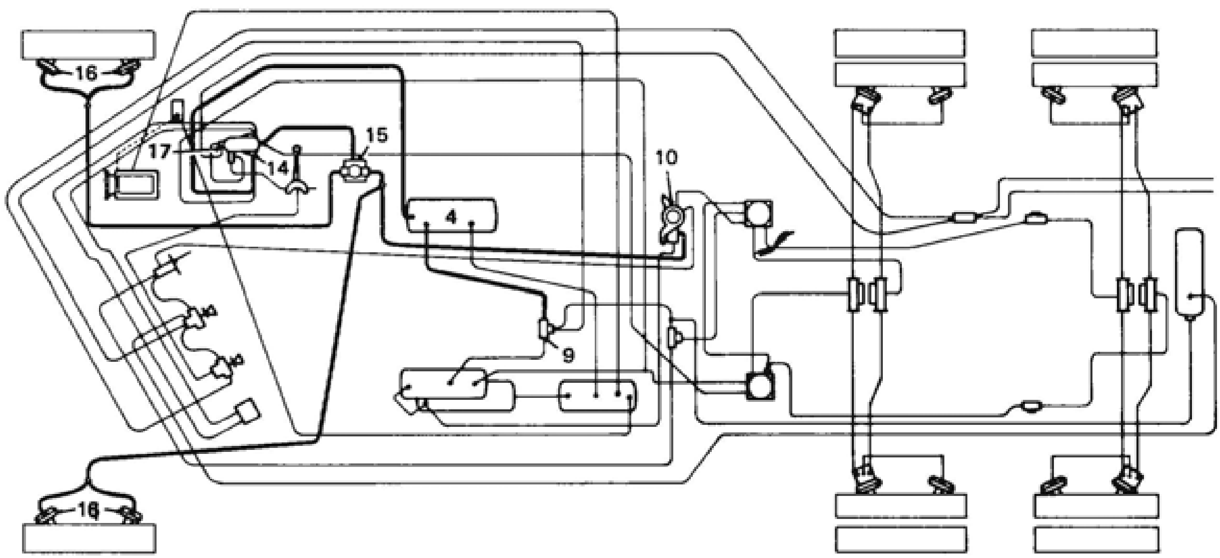


Figure 94 Brake System – Secondary Circuit

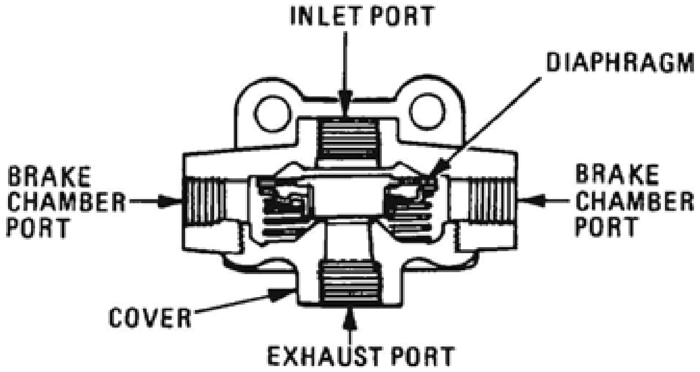


Figure 95 Quick Release Valve

144. The reserve air storage tank (Figure 96, Item 20) receives its air supply from a double check valve (Figure 96, Item 9). This double check valve is supplied with air from both the primary and secondary systems. The air flows from double check valve (Figure 96, Item 9) to double check valve (Figure 96, Item 18). A ‘T’ connection in this line allows air to flow through one-way check valve (Figure 96, Item 19) into the reserve air storage tank (Figure 96, Item 20). Air also flows from the double check valve (Figure 96, Item 9) to the back of the reserve air valve (Figure 96, Item 21), which is also supplied with air directly from the reserve air storage tank (Figure 96, Item 20). With the reserve air valve (Figure 96, Item 21) in the normal run position, air flows from the reserve air valve (Figure 96, Item 21) to the tractor protection control switch (Figure 96, Item 23) and to the emergency/parking brake switch (Figure 96, Item 22). From the emergency/parking brake switch (Figure 96, Item 22), it flows to the double check valve (Figure 96, Item 18) and from there it flows to the spring brake relay (Figure 96, Item 12) supplying air to the relay.

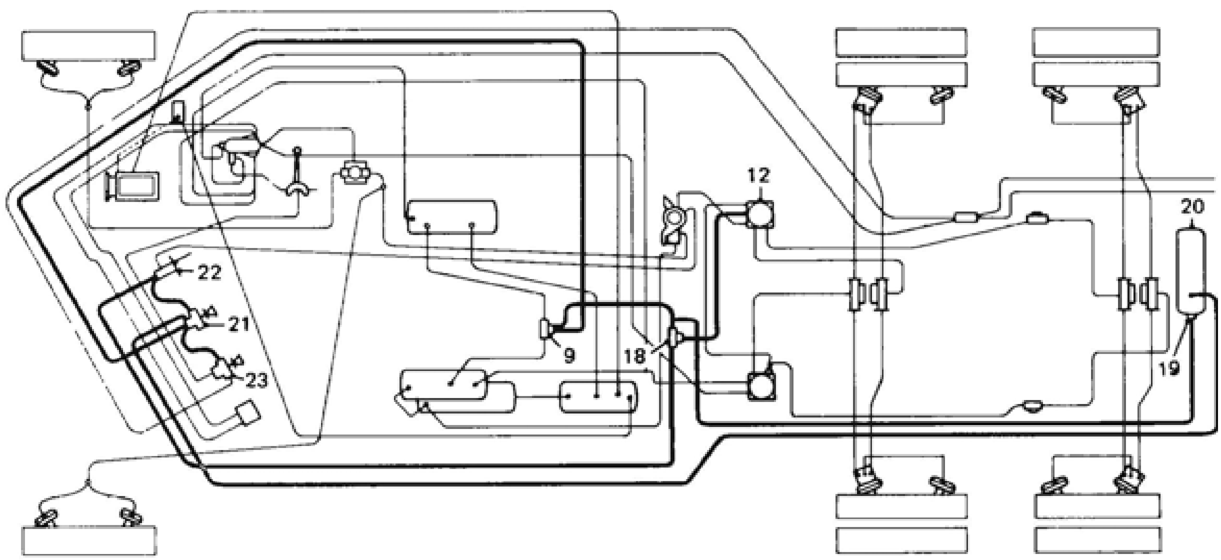


Figure 96 Brake System – Reserve Air Supply Circuit

145. To move the vehicle, the parking brake must be released. To do this, air sourced from the reserve air valve is supplied through the emergency/parking brake switch (Figure 97, Item 22) to the spring brake control valve (Figure 97, Item 10). If all systems are functioning properly, the air flows through the spring brake control valve (Figure 97, Item 10) unhindered to the spring brake relay (Figure 97, Item 12). This is the trigger or pilot line. When this signal is transmitted to the spring brake relay (Figure 97, Item 12), main air pressure supplied from double check valve (Figure 97, Item 18) flows through the spring brake relay (Figure 97, Item 12) to the spring brake chambers (Figure 97, Item 24) releasing the spring brakes.

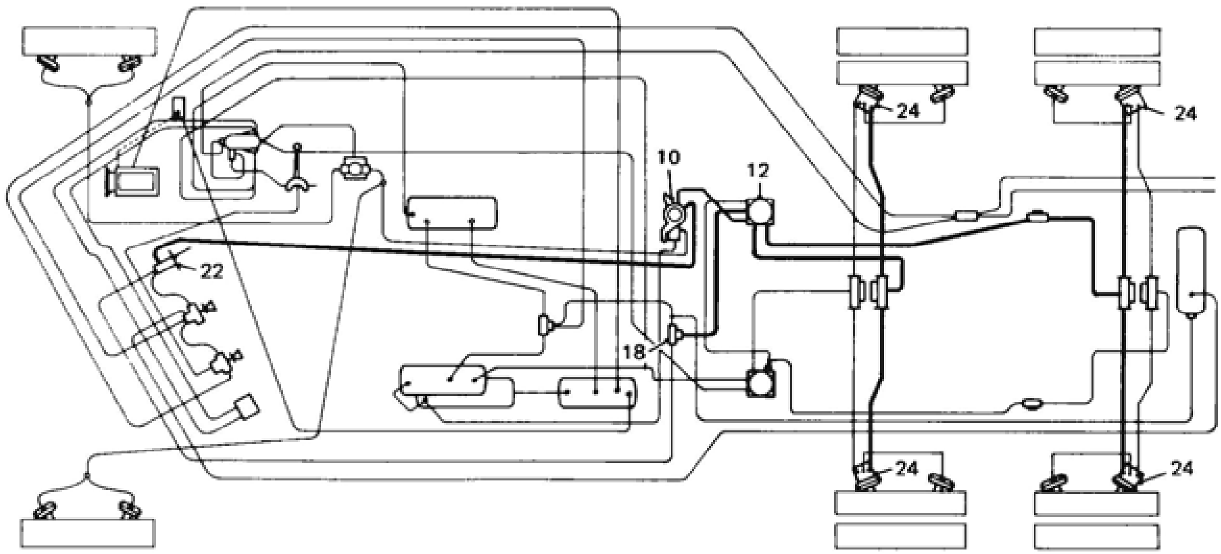


Figure 97 Brake System – Parking Brake Release Circuit

146. To stop the vehicle, depress the treadle valve. This allows primary air to flow through the top section (Figure 98, Item 8) to the service brake relay (Figure 98, Item 11). This is a trigger line signalling the relay (Figure 98, Item 11) to supply the rear service brakes (Figure 98, Item 13) with air. It also supplies double check valve (Figure 98, Item 25) with air. Also, as the treadle valve is operated, the lower section (Figure 98, Item 14) is opened allowing secondary air to flow through the quick release valve (Figure 98, Item 15) to the front service brake chambers (Figure 98, Item 16). Air is also supplied to the spring brake control valve (Figure 98, Item 10) and to the double check valve (Figure 98, Item 17) from the lower section (Figure 98, Item 14), thus applying all brakes.

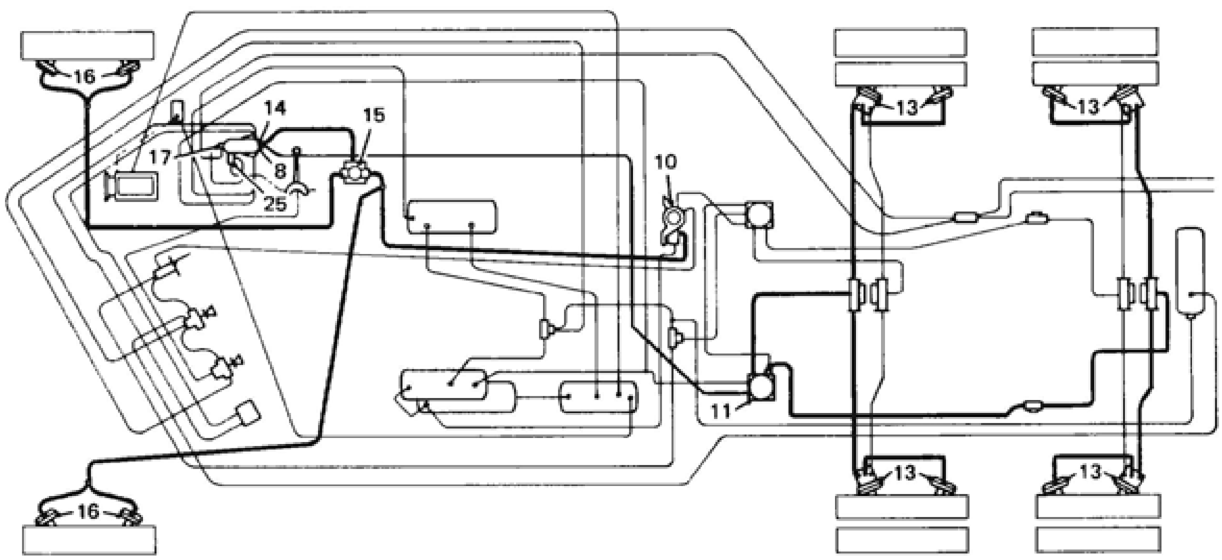


Figure 98 Brake System – Service Brake Circuit

147. To operate the trailer brakes, the tractor protection control switch (Figure 99, Item 23) located on the dashboard must be pressed in. Air is supplied from the control switch (Figure 99, Item 23) to the hand control valve (Figure 99, Item 26) and remains there until the hand control valve (Figure 99, Item 26) is operated. Air is also supplied from the tractor protection control switch (Figure 99, Item 23) to the tractor protection valve (Figure 99, Item 27) opening the valve allowing air to flow to the reservoirs on the trailer. The tractor protection switch (Figure 99, Item 23) is an air balance valve; air pressure difference from one side of the valve to the other shuts off the air supply. The valve is held in balance by air pressure on either side of it.

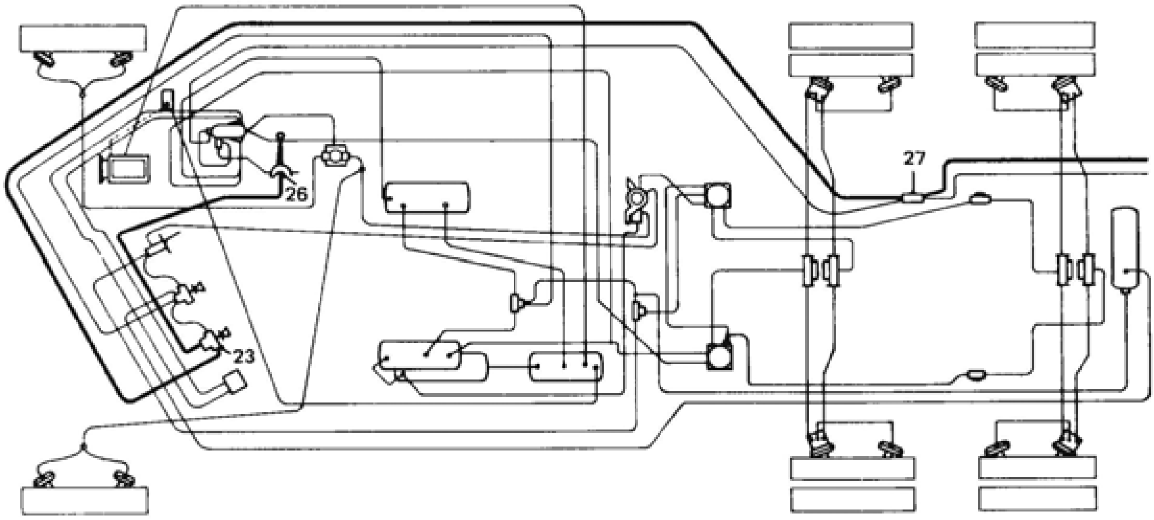


Figure 99 Brake System – Trailer Brake Air Supply (Emergency Line)

148. Open the hand control valve (Figure 100, Item 26) and the primary/secondary air supplied to the hand control valve (Figure 100, Item 26) now flows to the double check valve (Figure 100, Item 25), and from there to double check valve (Figure 100, Item 17). There are now three sources of air supply to the double check valve (Figure 100, Item 17): primary or secondary as supplied from the treadle valve (Figure 100, Item 8 and, Item 14) or air supplied from the hand control valve (Figure 100, Item 26). From the double check valve (Figure 100, Item 17), air now flows to the service side of the tractor protection valve (Figure 100, Item 27) giving the trailer a supply of air in the service line as shown in Figure 100. Only with air at the emergency line will air be supplied to the service line; this is because of the function of the tractor protection valve (Figure 100, Item 27).

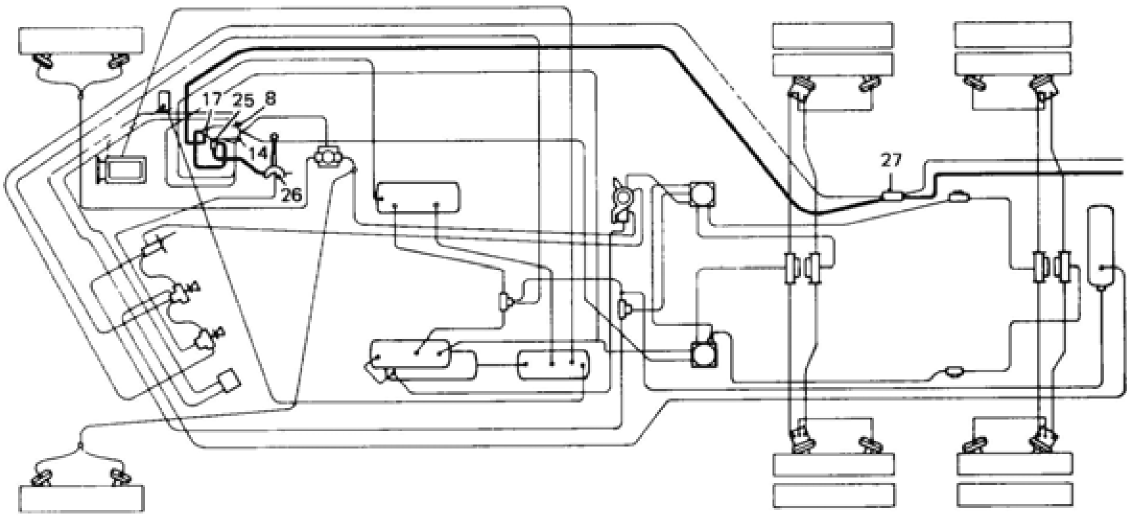


Figure 100 Brake System – Trailer Brake Air Supply (Service Line)

149. When air is lost or drained from the primary system alone, the vehicle does not totally lose braking ability. This is because the secondary system takes over and enables the vehicle to retain approximately 70 per cent of its braking ability. Secondary air is still supplied to the lower section of the treadle valve (Figure 101, Item 14) and the double check valve (Figure 101, Item 9) from where it then flows in two directions: to the double check valve (Figure 101, Item 18) and to the reserve storage tank (Figure 101, Item 20) through the one-way check valve (Figure 101, Item 19). It also supplies air to the reserve air valve (Figure 101, Item 21) and there automatically supplying air to the emergency/parking brake switch (Figure 101, Item 22) and the tractor protection control switch (Figure 101, Item 23), which when pushed in supplies air to both the hand control valve (Figure 101, Item 26) and the tractor protection valve (Figure 101, Item 27). A continuous supply of air flows from the emergency/parking brake switch (Figure 101, Item 22) to the spring brake control valve (Figure 101, Item 10) and from there to the spring brake relay (Figure 101, Item 12). It also supplies air to the other side of the double check valve (Figure 101, Item 18). A supply of air also flows from the double check valve (Figure 101, Item 18) to the spring brake relay (Figure 101, Item 12).

150. When the treadle valve is depressed, air flows from the lower section of the treadle valve (Figure 101, Item 14) through the quick release valve (Figure 101, Item 15) to the front service brake chambers (Figure 101, Item 16) and also to the spring brake control valve (Figure 101, Item 10). But with no sensor line pressure from the primary storage tank (Figure 101, Item 3) acting on the spring brake control valve (Figure 101, Item 10), the control valve goes into an emergency situation and blocks off air supply from the emergency/parking brake switch (Figure 101, Item 22) to the spring brake control valve (Figure 101, Item 10). It then exhausts the air between the spring brake control valve (Figure 101, Item 10) and the spring brake relay (Figure 101, Item 12). In so doing, it exhausts air from the spring brake chambers (Figure 101, Item 24) allowing the spring brakes to be applied. This air is exhausted in proportion to the amount of pressure exerted on the treadle valve by the driver. It also gives trailer braking, as the air flow from the lower section of the treadle valve (Figure 101, Item 14) to double check valve (Figure 101, Item 17) flows straight to the tractor protection valve (Figure 101, Item 27) giving secondary system mode braking to the trailer.

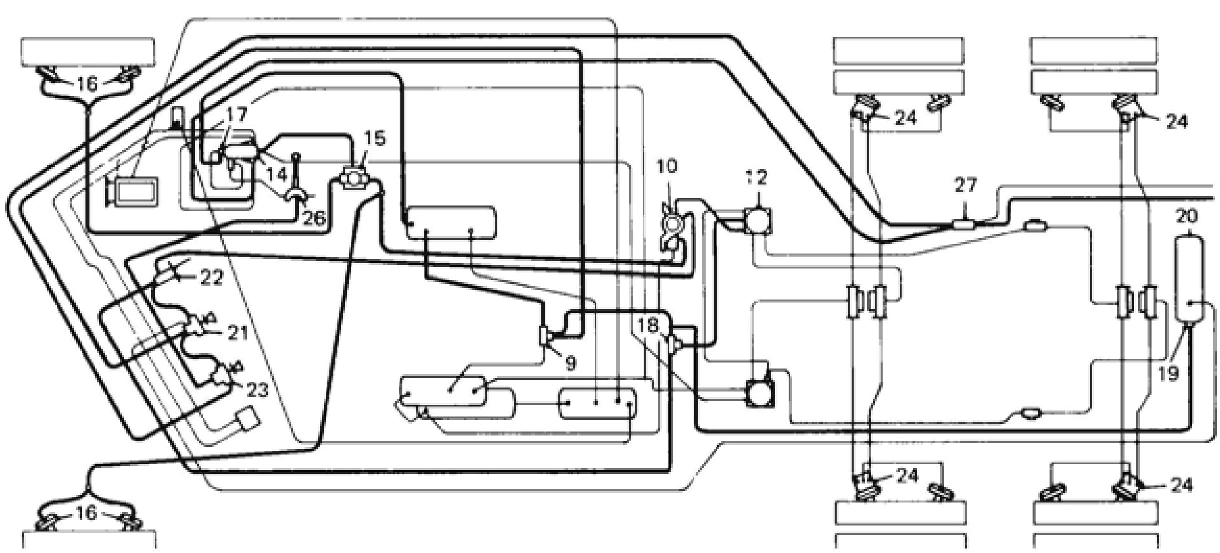


Figure 101 Brake System – Secondary System Brakes

151. In the situation where the air supply in the secondary system only is lost or is drained off, the brakes again are not totally lost. The primary air system still supplies air to the top section of the treadle valve (Figure 102, Item 8), the spring brake control valve (Figure 102, Item 10) and to the double check valve (Figure 102, Item 9). From here it flows in two directions: to the double check valve (Figure 102, Item 18) and to the reserve storage tank (Figure 102, Item 20) through a one-way check valve (Figure 102, Item 19). The primary system also supplies air to the rear service brake relays (Figure 102, Item 11). Air supply for the reserve air valve (Figure 102, Item 21) is drawn off the air line between the double check valve (Figure 102, Item 9) and the reserve air storage tank (Figure 102, Item 20), automatically supplying air to the tractor protection control switch (Figure 102, Item 23), which when pushed in supplies air to the hand control valve (Figure 102, Item 26) and the tractor protection valve (Figure 102, Item 27). Air also automatically flows from the reserve air valve (Figure 102, Item 21) to the emergency/parking brake switch (Figure 102, Item 10) and from there to the double check valve (Figure 102, Item 18), the spring brake control valve (Figure 102, Item 10) and then to the spring brake relay (Figure 102, Item 12). A supply of air also flows from the double check valve (Figure 102, Item 18) to the spring brake relay (Figure 102, Item 12).

152. When the treadle valve is depressed, air flows through the upper part of the treadle valve (Figure 102, Item 8) to the service brake relay (Figure 102, Item 11). This air acts as a signal, opening the service brake relay (Figure 102, Item 11) allowing the air sourced from the supply tank (Figure 102, Item 3) to flow through the relay into the rear service brake chambers (Figure 102, Item 13) applying the wedge brakes. It also gives trailer braking, as air supplied from the upper section of the treadle valve (Figure 102, Item 8) passes through double check valve (Figure 102, Item 25) to double check valve (Figure 102, Item 17) and from there straight to the tractor protection valve (Figure 102, Item 27).

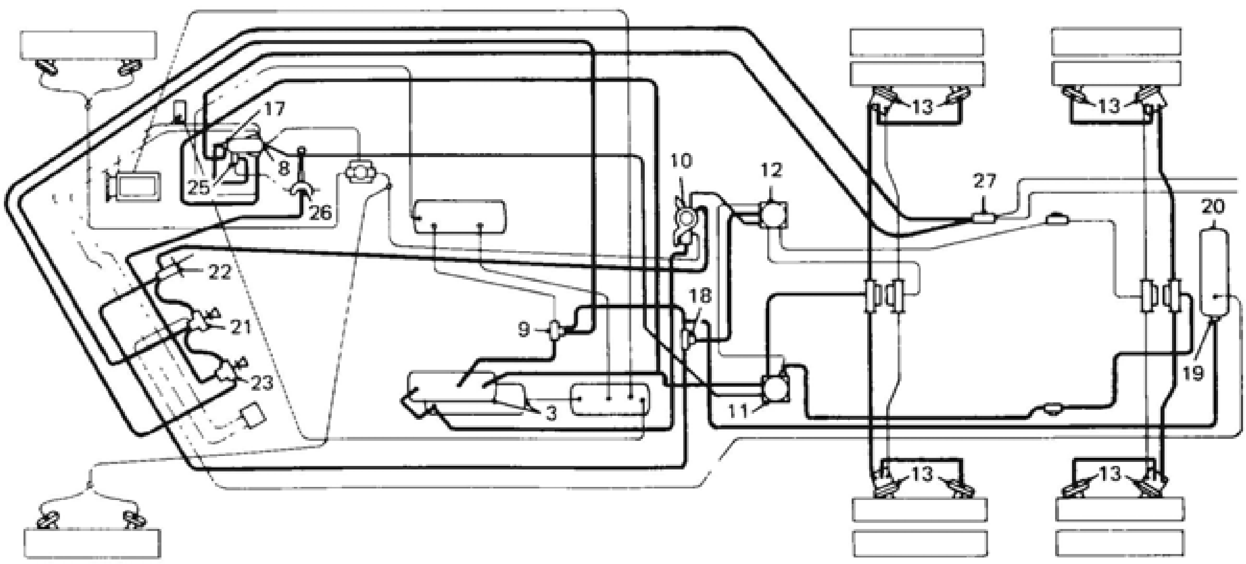


Figure 102 Brake System – Primary System Brakes

Spring Brakes

CAUTION

This method offers extremely limited braking, which may be used for moving the vehicle to a safe working area only.

153. In the event of air loss in both the primary and secondary systems, the spring brakes are automatically applied. This is because there is no compressed air acting on the diaphragm, which holds the spring in a compressed state within the spring brake chambers. As the air is lost, the spring expands and pushes against a push rod, which in turn drives a wedge between the brake shoes, expanding them against the brake drum, locking the brakes. A supply of air is available for the emergency release of the spring brakes. This air is stored in the reserve air storage tank (Figure 103, Item 20) and supplies air to the back of the reserve air valve (Figure 103, Item 21), which, when pressed, allows air to flow to the emergency/parking brake switch (Figure 103, Item 22) and to the double check valve (Figure 103, Item 18), from there to the spring brake relay (Figure 103, Item 12) as the main supply. Air is also supplied from the reserve air valve (Figure 103, Item 21) to the tractor protection control switch (Figure 103, Item 23). Air flows through the emergency/parking brake switch (Figure 103, Item 22) to the spring brake control valve (Figure 103, Item 10). As there is no primary or secondary air acting on this valve, it remains open, allowing the reserve air supply to flow through to the spring brake relay (Figure 103, Item 12) where it acts as the signal pressure required to open the spring brake relay (Figure 103, Item 12) and allow the supply pressure to flow through to the spring brake chambers (Figure 103, Item 24) releasing the spring brakes. When the tractor protection control switch (Figure 103, Item 23) is pushed in, a supply of air flows to the hand control valve (Figure 103, Item 26) and also to the tractor protection valve (Figure 103, Item 27) flowing on to the trailer and releasing the trailer brakes. To stop the vehicle, throw the emergency/parking brake switch (Figure 103, Item 22), which exhausts the air from the spring brake chambers. A gradual application of the switch will bring the vehicle to a controlled stop. If a trailer is fitted, the hand control valve (Figure 103, Item 26) may be used to stop the vehicle.

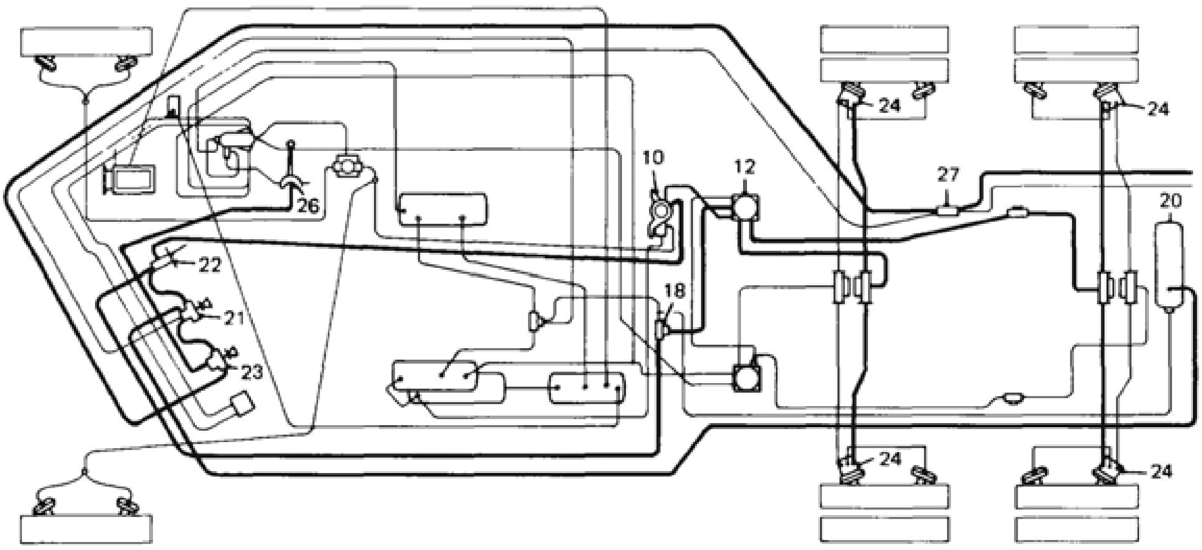


Figure 103 Brake System – Emergency Spring Brake Release

WARNING

Without an air supply, and with the springs in the spring brake chambers held in compression, the vehicle is now without brakes. It is, therefore, essential that the vehicle be either lift-towed or towed by means of an A-bar to a safe working area for repairs.

154. The emergency brake is a self actuating device. When air pressure in both the primary and secondary systems drops below 275 kPa (40 psi) the heavy, compressed springs in the rear spring brake chambers expand applying the rear brakes. If the cause of the low pressure in the primary and secondary systems cannot be found and rectified, an alternate means of releasing the brakes is available. First, chock the wheels to prevent the vehicle rolling. Then remove the plastic cap from the compression spring chamber. Remove the release stud from the side pocket and insert into the pressure receptacle. Turn the release stud l/4 turn to seat cross pm into pressure plate receptacle (Figure 104) then it nut. Turn the nut with a spanner until the compression spring is caged (Figure 105). Repeat this operation at other wheels, releasing all spring brakes.

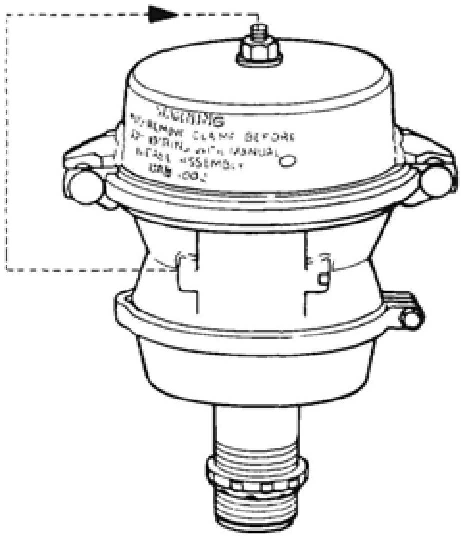


Figure 104 Location of Release Stud

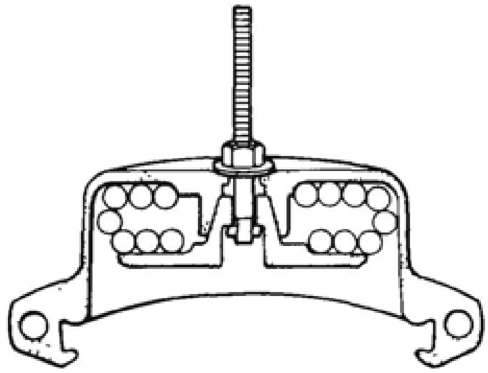


Figure 105 Spring, Locked in Compressed State (No Brakes)

Double Check Valve

155. Double check valves are used to automatically direct the flow of air pressure into a common line from either of two other lines. The valve consists of a cast body, two end caps, a brass shuttle and two rubber seal gaskets (Figure 106). When air pressure from one of the feed lines drops off, the line with the greater pressure forces the shuttle to slide across sealing off the low pressure line and allowing the high-pressure air to flow through the outlet port. When air pressure in both feed lines is equal, the shuttle is centralised in the valve and air from both sources flows through the outlet port via small drillings from the central chamber to the outlet port.

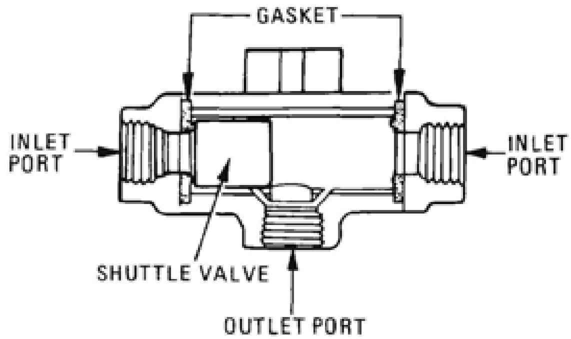


Figure 106 Sectional View of Double Check Valve

Safety Valve

156. The air system is protected against excessive air pressures with the safety valve, which is located in the wet tank. A spring-loaded check valve lifts and permits air to exhaust to the atmosphere if the pressure in the reservoir rises above its setting (Figure 107). The safety valve setting for the relief of excessive pressure is 1 025 kPa (150 psi).

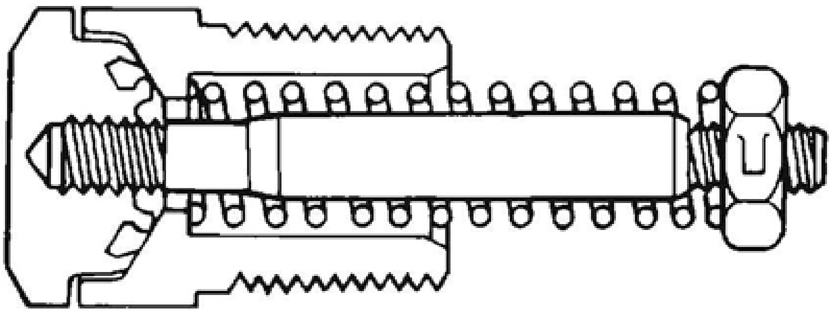


Figure 107 Sectional View of Safety Valve

Low Air Pressure Indicator Switch

157. The indicator is a safety device designed to give an automatic warning to the driver whenever the air pressure in the primary or secondary systems falls below the safe operating range. The assembly consists of a body and cover between which is clamped a spring-loaded rubber diaphragm. It is also fitted with electrical contacts and terminals. The low pressure indicator switch is sealed, making a dust and watertight unit (Figure 108).

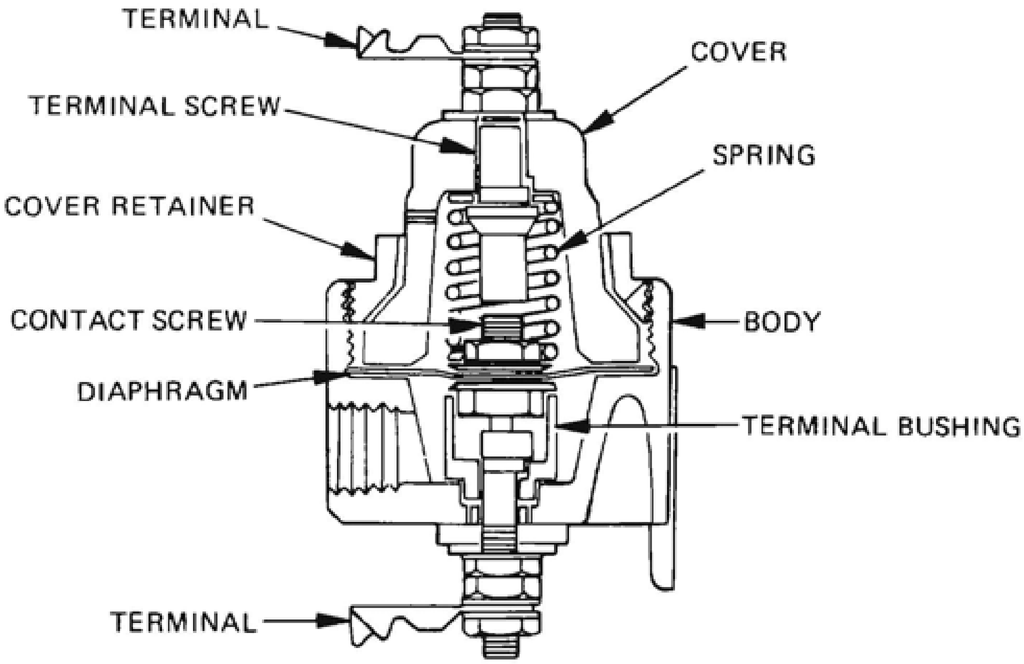


Figure 108 Sectional View of Low Pressure Indicator Switch

Stop Light Switch

158. The stop light switch operates in conjunction with the brake treadle valve and consists primarily of a cast body, a rubber diaphragm and an insulated cover with electrical connections (Figure 109). When the treadle valve is depressed, air pressure flows into the stop light switch forcing the diaphragm up against spring pressure making a contact between earth and the positive terminal, completing the stop light electrical circuit.

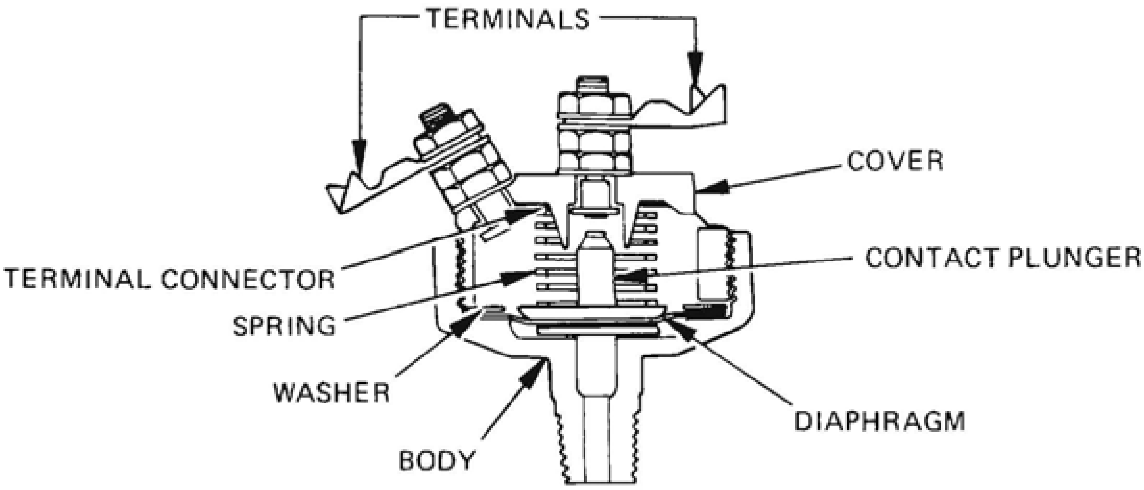


Figure 109 Sectional View to Stop Light Switch

Brake Treadle Valve

159. Treadle operated, this valve controls the air pressure being delivered to the brake actuators. The amount the treadle is moved towards the fully applied position, or the position at which it is held, determines in relative proportion the pressure delivered to and held in the brake chambers. When the brake valve is released, all air is exhausted from the brake actuators. If the brake valve is only partially released, there will be a proportional reduction in the air pressure in the brake actuators (Figure 110).

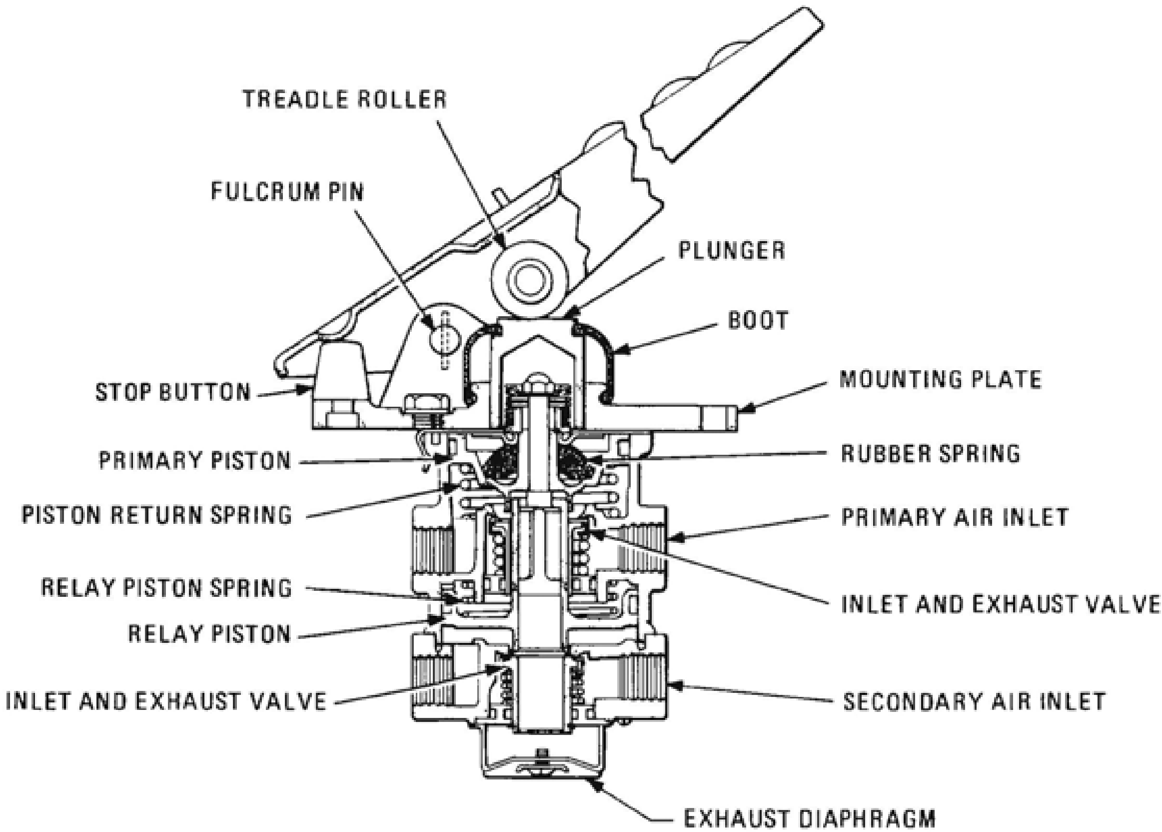


Figure 110 Sectional View of Brake Treadle Valve

Relay Valve

160. The relay valve is used to operate the brakes on the rear axles and is operated by the brake treadle valve. It delivers the same air pressure to the brake actuators as is being delivered to the relay valve by the brake treadle valve. Because the relay valve has a direct air supply, it operates as a high capacity remote controlled brake valve (Figure 111).

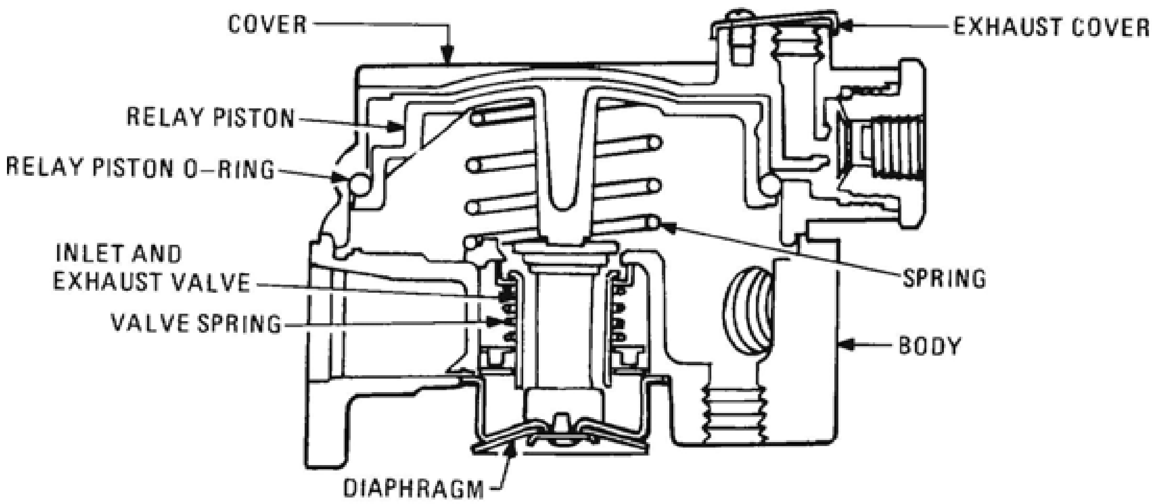


Figure 111 Sectional View of Relay Valve

Hand Control Valve

WARNING

The hand control valve should never be used to hold the brakes applied when the vehicle is parked unattended.

161. The hand control valve is a means for the driver to operate the trailer brakes independently of the vehicle's braking system, should the need arise. The valve is mounted on the right-hand side of the steering column for convenient operation. It is triple ported at its base for supply, delivery and exhaust connections. The manually controlled lever gives brake application, hold or release positions within its 90 degrees of travel (Figure 112).

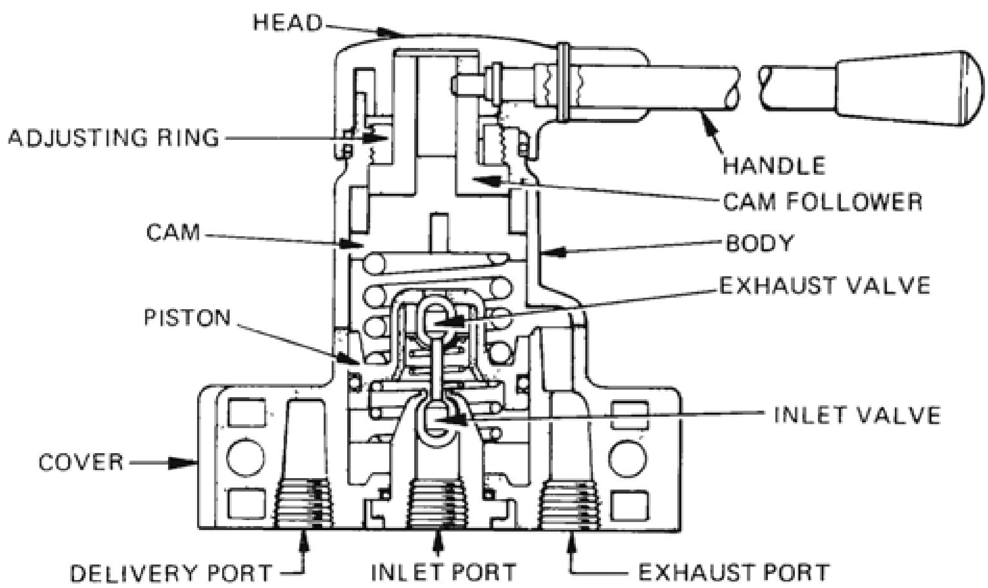


Figure 112 Sectional View of Hand Control Valve

Emergency/Parking Brake Switch

162. This switch is mounted on the dashboard for ease of driver operation and is used to modulate parking and emergency brakes. In the normal run or release position, the switch allows pressurised air to be supplied to the spring brake chambers, holding the spring brakes in the released position. When the vehicle is stationary and the switch is moved to park position, air is exhausted from the spring brake chambers, applying the spring brakes. The switch is locked in this position by a locking button preventing the switch moving into the release position accidently (Figure 113). In the emergency situation when air pressure is lost in both the primary and secondary systems, the switch, when moved gradually from release to park position, will release air from the spring brake chambers in proportion to the amount of movement of the switch, bringing the vehicle to a controlled stop.

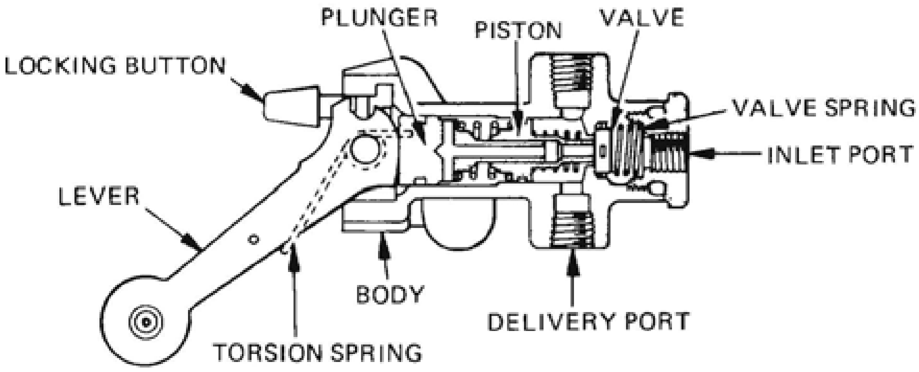


Figure 113 Sectional View of Emergency/Hand Brake Switch

Air Hose Coupling (Glad Hand)

163. Made of aluminium, the hose coupling incorporates a steel strip, cast and locked in the body to prevent wear with its mating part (Figure 114).

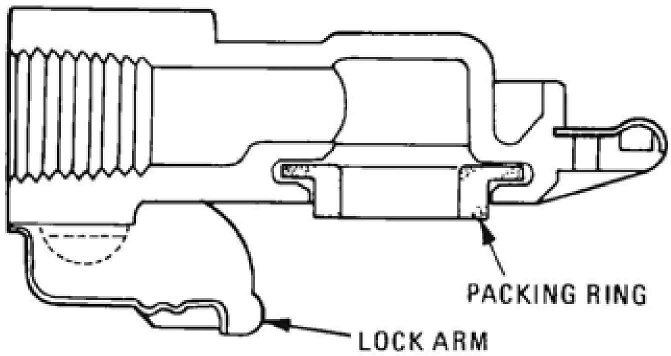


Figure 114 Sectional View of Brake Air Hose Coupling

AIR SYSTEM

164. The vehicle is equipped with a Bendix-Westinghouse TuFlo 501 compressor. This is a twin-cylinder, air and water cooled series. The cylinder block is finned for air cooling, while the cylinder head contains water jackets for water cooling. In accordance with piston displacement, the rated capacity of the compressor is 0.34 m^3 (12 cu. ft.) per minute at 1 250 rev/min and is governed to a pressure of 827 kPa (120 psi). The inlet valves are an automatic type and the unloading mechanisms are located in the cylinder block, leaving no externally moving parts. The compressor is mounted on the right-hand side of the engine towards the rear and is driven by an auxiliary shaft. Air supply for the compressor is pressurised air drawn from the intake manifold on the left-hand side of engine.

165. The compressor runs continuously while the engine is running, but the actual compression of the air is controlled by the air compressor governor. Acting in conjunction with the unloading mechanism in the compressor cylinder block, the governor starts or stops the compression of air by loading or unloading the compressor. When pressure in the air brake system falls below the desired minimum pressure of 655 kPa to 680 kPa (95 psi to 100 psi), the governor loads the compressor, starting the compression of air. The governor does this by means of a piston – contained within the governor body – upon which air pressure acts to overcome the pressure setting spring and control the inlet and exhaust valves to either admit or exhaust air to or from the compressor unloading mechanism (Figure 115).

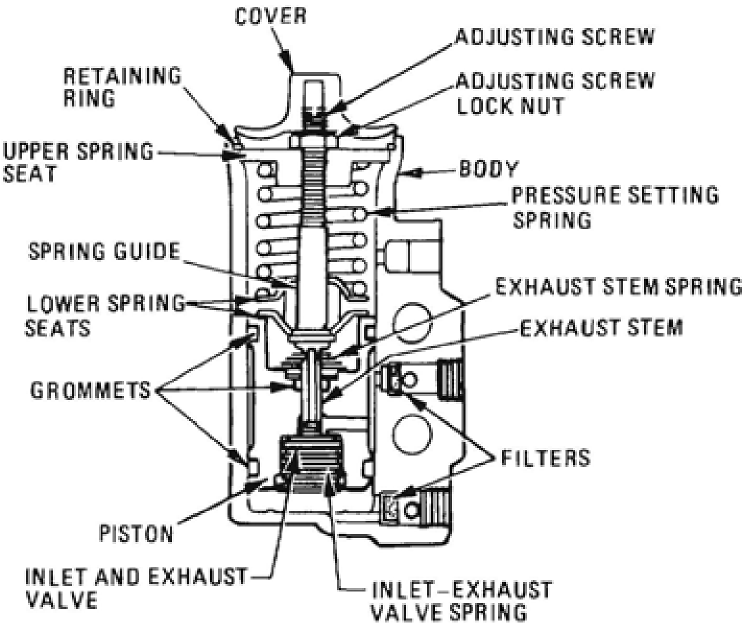


Figure 115 Sectional View of Air System Governor

166. During operation of the compressor, the piston moving down the cylinder creates a partial vacuum above the piston. This vacuum unseats the inlet valve allowing air drawn from the engine inlet manifold to enter the cylinder above the piston (Figure 116). As the piston moves up the cylinder, the air pressure within the cylinder acts upon the top of the inlet valve and, combined with the inlet valve return spring, closes the inlet valve. As the air above the piston is compressed, the pressure built up within the cylinder opens the discharge valve, allowing the compressed air to flow through the discharge port to the wet tank and on to the air storage tanks (Figure 117). As the piston starts its down stroke to repeat the cycle, the discharge valve shuts preventing the flow of compressed air back into the cylinder.

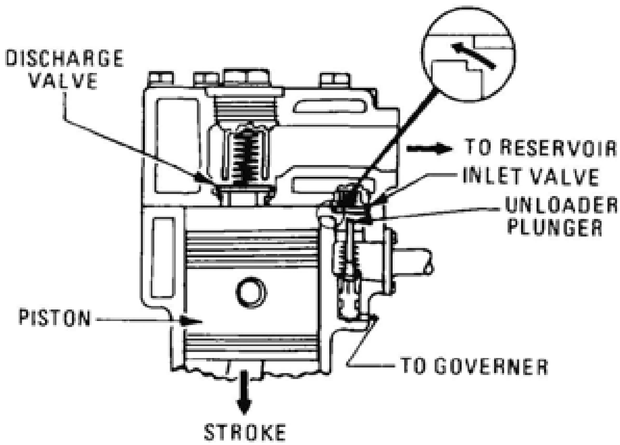


Figure 116 Intake Stroke

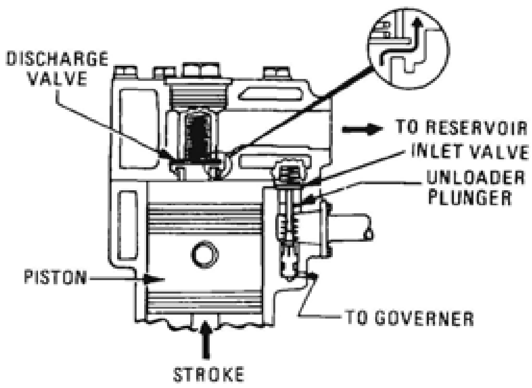


Figure 117 Compression Stroke

167. When the air pressure in both the air start system and the air brake system reaches the maximum governed pressure of 827 kPa (120 psi), the compressed air in the wet tank passes through the air compressor governor into the cavity below the unloading pistons in the cylinder block. This air pressure lifts the unloading pistons, which in turn lift the inlet valves off their seats (Figure 118). With the inlet valves held off their seats, the air during each upstroke of the piston is forced through the air inlet cavity into the other cylinder where the piston is on the down stroke. The air is pumped back and forth until air pressure in the air brake system is reduced to the minimum setting of the governor. The governor releases the air pressure beneath the unloading pistons, allowing the piston return springs to force the pistons down, and the inlet valve springs to return the valves to their seats. The compressor now resumes the operation of compressing air.

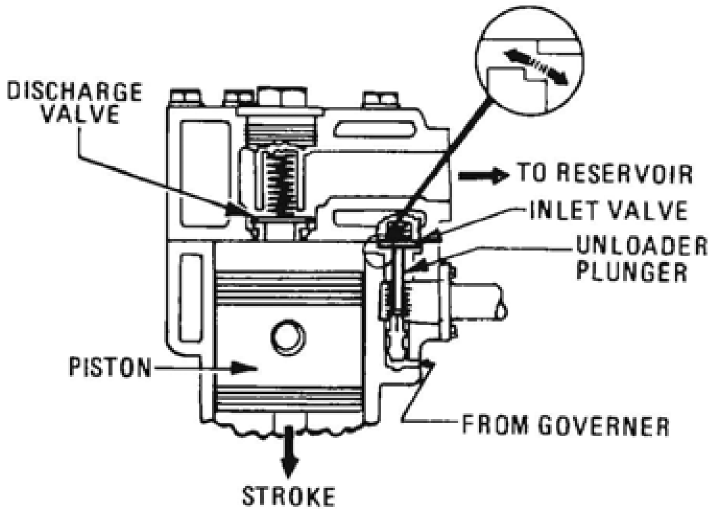


Figure 118 Unloading Operation

AIR STARTING SYSTEM

168. An Ingersoll-Rand 150 BM series air driven starting motor is used for starting the diesel engine. It consists of a five-varied air motor with gear reduction, which drives the engine flywheel through a conventional Inertia drive. An air storage reservoir provides air for the engine starter motor at a maximum pressure of 827 kPa (120 psi). A muffler is installed on the starter motor air outlet to bring starter noise down to an acceptable level. To keep the air starter lubricated, a special lubricator is used. The lubricator meters out the exact amount of diesel fuel required at each start to prolong starter life and performance (Figure 119).

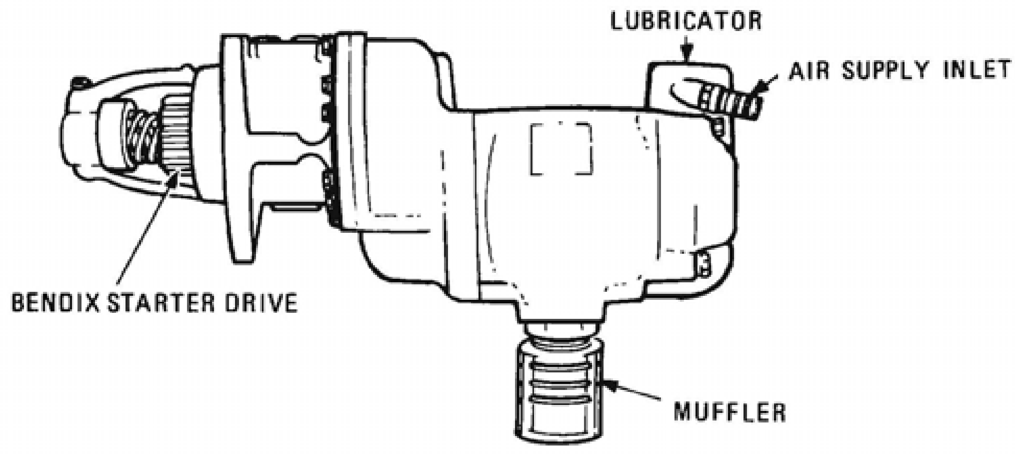


Figure 119 Air Starting Motor

169. To operate the starter motor, the inversion valve and the solenoid valve must both be open to allow signal air to flow to the pilot relay valve. The signal air causes the relay valve to open the main feed line permitting a surge of air to flow directly from the storage tank to the starter motor. This surge of air causes the rotor within the starter motor to spin. In so doing, the inertia created by the spinning rotor forces the drive pinion to mesh with the flywheel causing the crankshaft to rotate. The inversion valve and the solenoid valve are controlled by the parking brake switch and the starter switch (key) respectively. The parking brakes must be applied and the starter switch key turned to the ‘start’ position to allow the signal air to flow from the storage tank to the pilot relay valve (Figure 120).

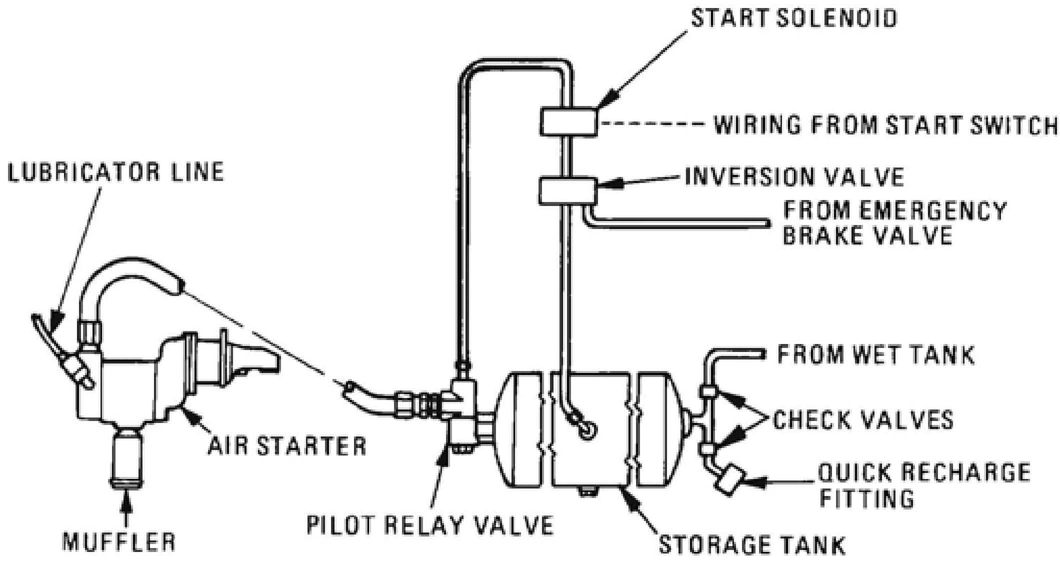


Figure 120 Air Starting System

170. An emergency start is incorporated in the air start system. If the key operated starter switch malfunctions, the vehicle can be started by means of a ballpoint pen or similar sized object. First, ensure the transmission is in neutral, then push the engine stop control in, set the hand throttle part the way out and apply the parking brake. To start the vehicle, insert the ballpoint pen into the under side of the solenoid valve, located above the chassis rail under the cabin left-hand foot well, and press. This will open the solenoid valve allowing the signal air to flow to the pilot relay valve, opening the main air feed line between the storage tank and the starter motor (Figure 121).

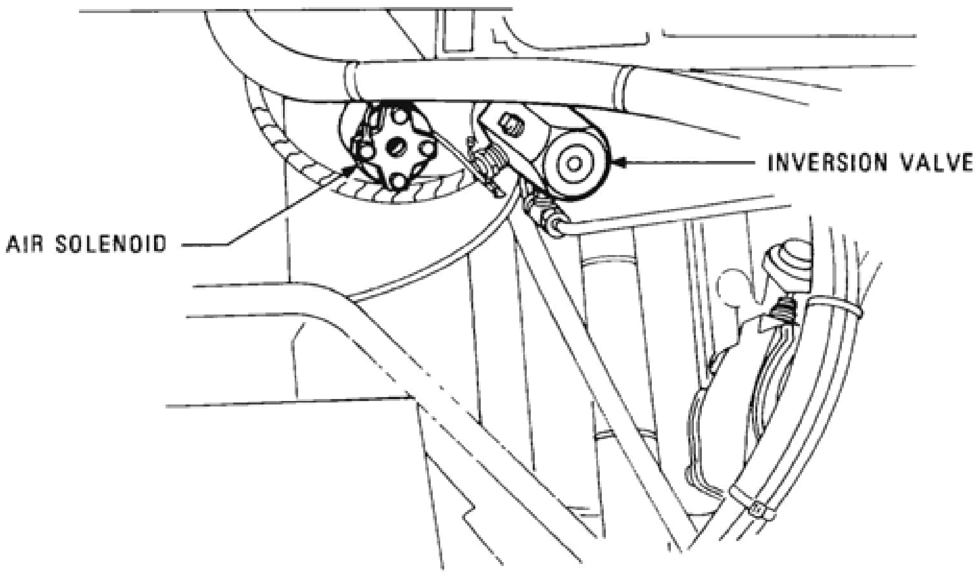


Figure 121 Air Solenoid and Inversion Valves

ELECTRICAL

Description

171. The vehicle electrical system provides internal and external lighting, warning lights and alarms, Dynatard engine brake operation and the means to monitor engine operation and fuel supply. To enable the electrical system to function, items such as switches, sensors, solenoids, lights and batteries are required. The switches are operated either manually, mechanically or by compressed air and are connected to the various sensors, lights or solenoids by wiring and connectors.

172. Two 12-volt batteries connected in series are used to store electrical energy for the circuits when the engine is not running. The batteries supply, via the ignition switch, the initial current to the field (excitation) windings in the generator creating the magnetic field. When the engine is running and the generator output exceeds battery voltage, the generator takes over from the batteries and supplies all the electrical energy requirements for the vehicle. The change over from batteries to generator as the source of electrical energy is controlled by the regulator.

173. Relays are fitted to the electrical system to remove the need to have heavy currents flowing through switches on the dashboard. As the switch on the dashboard is tripped, a small current flows through the switch to the relay. At the relay, the current flows through coil windings creating a magnetic field, which causes a set of points within the relay to close, completing a circuit which allows a heavier current to flow and operate the device, e.g. headlights, horn, etc (Figures 122 and 123).

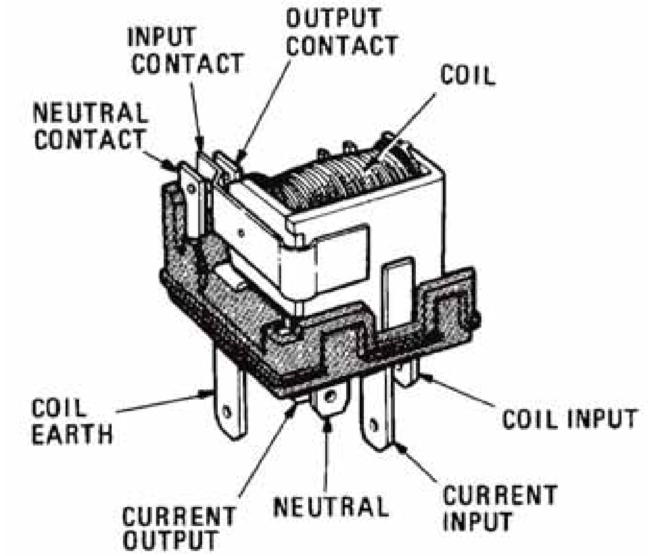


Figure 122 Relay

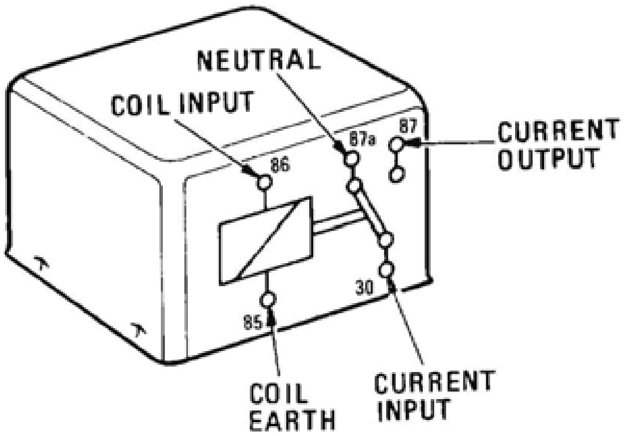


Figure 123 Relay Cover (Showing Circuit Diagram)

174. To protect the various circuits in the electrical system, circuit breakers are installed. The circuit breaker effectively cuts off the current flow when a short develops in a circuit. It does this by means of a bi-metal strip that is in a bakelite housing. This bi-metal strip is fixed at one end to a terminal (output) and the other end makes contact via a set of points with another terminal (input). The current flows through the input terminal, contact points, bi-metal strip and out through the output terminal. When a short develops, a surge of current flows through these items, but the extra current causes the bi-metal strip (which is rated at a specified amperage) to heat up and distort, opening the contact points and breaking the circuit.

175. One type of circuit breaker has a heater coil wound around the bi-metal strip (Figure 124). When the bi-metal strip heats and breaks the circuit, the heater coil, which is connected to both the input and output terminals still has a current (300 Ma maximum) flowing through it. This current flow is enough to cause the heater coil to heat up and, because the coil is wound on the bi-metal strip, the heat is transferred to the strip, keeping the strip distorted, the points open and the circuit broken.

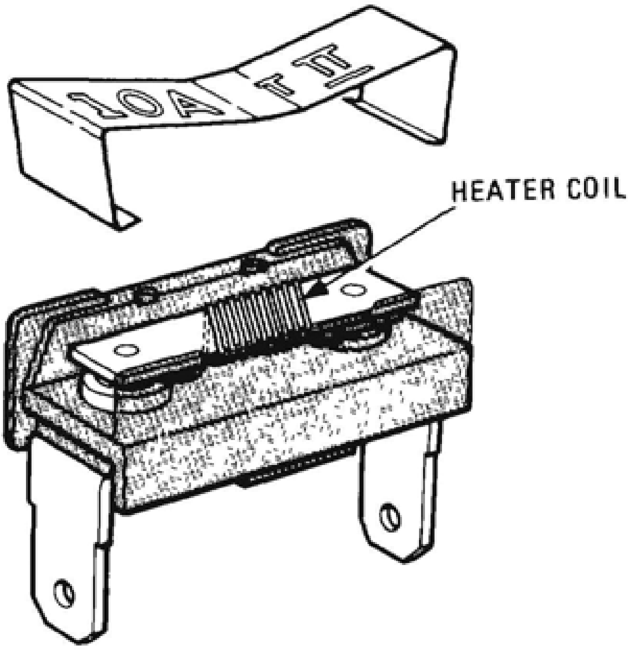


Figure 124 Circuit Breaker (with Heater Coil)

176. The other type of circuit breaker installed in the system does not have a heater coil (Figure 125). When its bi-metal strip heats up and breaks the circuit, the current ceases to flow. Without a current flow or the aid of a heater coil, the bi-metal strip cools and eventually returns to its normal position, completing the circuit. This circuit breaker will continue to make and break the circuit until the fault is rectified.

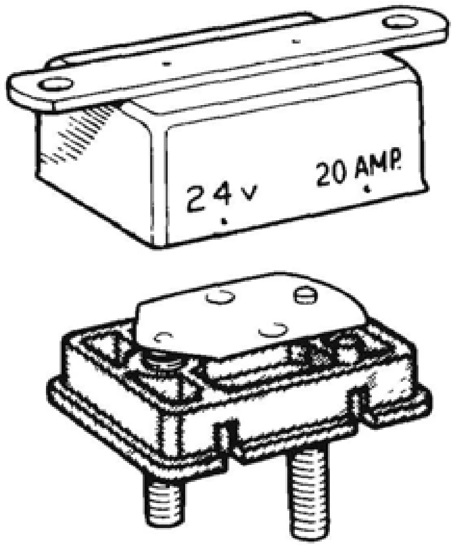


Figure 125 Circuit Breaker

Generator

177. The vehicle is fitted with an EDE 28 volt – 100 ampere generator. Refer to EMEI Electrical P 412 for the technical description of this generator.

Lighting

178. The required stage of lighting can be selected by turning the three-position switch (Figure 126) located on the instrument panel (Figure 146, Item 18) to the required position.

179. The three-position (normal, blackout and reduced lighting) switch provides the following functions:

a. **Normal Lighting.** Normal lighting allows the use of head, tail, stop, parking, clearance, number plate, direction turn indicator, instrument, map reading and cab courtesy lights.

b. **Blackout Lighting.** Blackout lighting allows only the use of blackout marker, blackout stop, convoy, instrument and map reading lights.

c. **Reduced Lighting.** Reduced lighting allows the use of only the reduced headlight, blackout marker, blackout stop, convoy, instrument lights and the map reading light. Provision for dimming and switching off the instrument lights is provided.

NOTE

The instrument light switch (located on the left-hand instrument panel) allows the instrument lights to be dimmed or switched off as required.

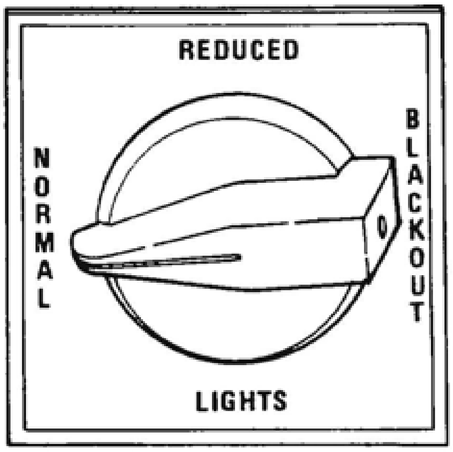


Figure 126 Three-position Lighting Switch

180. The globe wattage for external, internal and military lighting is listed in Table 2:

Table 2 Globe Wattage

Item	Quantity	Wattage
External		
Headlights, high/low beam	2	Quartz Halogen 75/70 watt
Park lights	2	2 watt
Stop and tail lights	2	21/5 watt
Turn indicator lights	4	18 watt
Clearance lights	2	2 watt
Cab side marker lights	2	5 watt
Body side marker lights	12	3 watt
Reversing lights	2	18 watt
Internal		
Dome light	1	5 watt
Map reading light	1	5 watt
Gauges and warning lights	12	2 watt
Fibre optic light	1	3 watt
Turn indicator light	1	2 watt
Military		
Blackout lights	6	5 watt
Reduced headlight	1	18 watt
Convoy light	1	5 watt
Gauges	5	3 watt
Pyro gauge light	1	2 watt

CHASSIS

Description

181. The chassis is made up of two side rails held in parallel by means of four crossmembers (Figure 127). The flared and tapered side rails are of channel section made from heat treated high tensile steel. With the exception of the rear crossmember, chassis mounted components are bolted to the web (vertical section) of the side rails and not the flanges (horizontal sections). This is because any hole drilled or made in flanges could induce fracturing of the side rail when high stresses are exerted on that section of side rail due to the twisting action of the chassis. All chassis and chassis mounted components, which can be subjected to high stress are fixed in position by body bound bolts, which ensure an interference dowel fit.

CAUTION

Before attempting repairs on the chassis, observe the cautionary notice located on the chassis rails between the bogie axles.

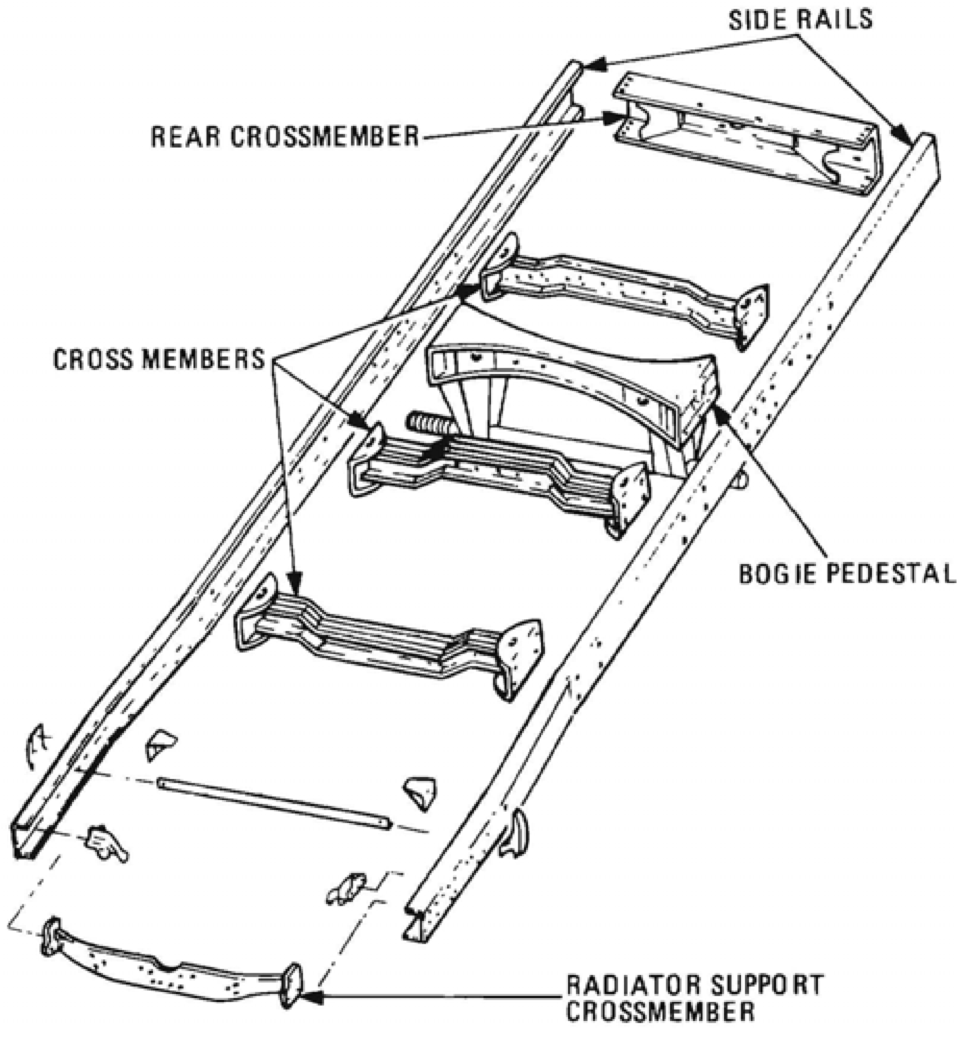


Figure 127 Exploded View of Chassis

CABIN EXTERNAL

Description

182. The cabin is a two-door enclosed type, constructed of pressed steel and mounted at three points as shown in Figure 128. Rubber sleeve-type insulators are used on the front mountings and four rubber insulator bushes are used on the rear mounting. The doors, also constructed of pressed steel, are each mounted on two hinges. The hinge mounting bolt holes are elongated, allowing adjustment of the door to obtain a flush fit with the cab and an even gap around the door when it's closed. A rubber weather strip is installed in the cabin body around the door opening. The door when closed butts against the weather strip, effectively sealing the cab.

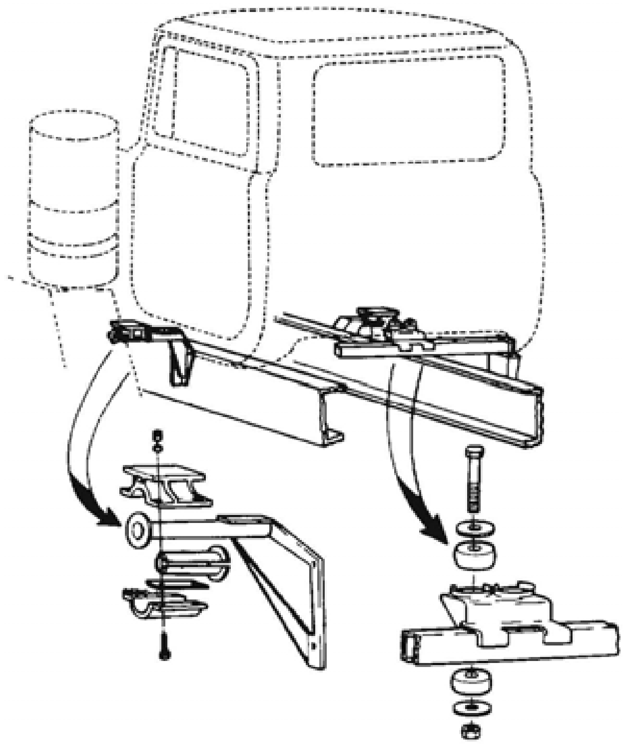


Figure 128 Cab, Mounting Locations

Windscreen Washer System

183. The vehicle cab is fitted with air operated variable speed windscreen wipers to maintain clear forward visibility for the driver. The wiper assembly is mounted behind the dash panel with the pivot drives extending out through the scuttle to which wiper arms and blades are attached. The air driven wiper motor is mounted on the firewall in the engine compartment and is connected to the pivot drive arms by means of a driver assembly. The compressed air required to operate the wiper motor is taken from the power divider lockout valve and directed to the wiper control valve, which regulates the flow of air to the wiper motor. A control knob located on the left-hand instrument panel is connected directly to the control valve, giving the driver control of the operation and speed of the windscreen wipers (Figure 129).

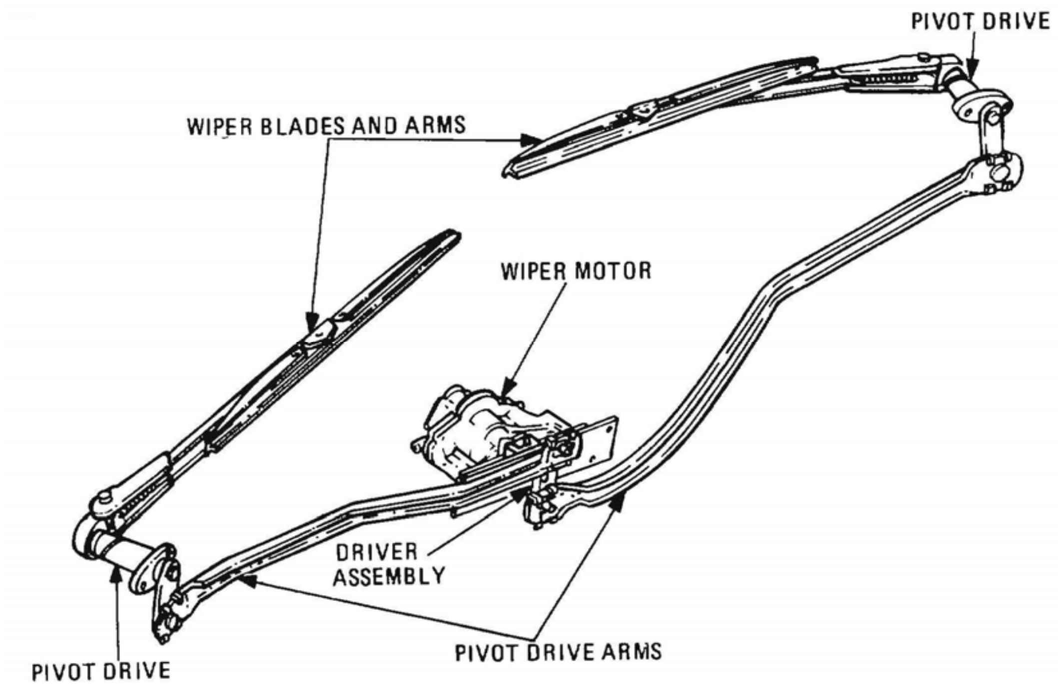


Figure 129 Windscreen Wiper Assembly

184. A windscreen washer system is fitted to the vehicle to assist the windscreen wipers. The water for the washer system is stored in a fill able reservoir mounted in the driver's door. A button located next to the windscreen wiper control knob operates an electrically driven pump, which pumps water from the reservoir through tubing to outlets located on the wiper arms where it is sprayed onto the windscreens (Figure 130).

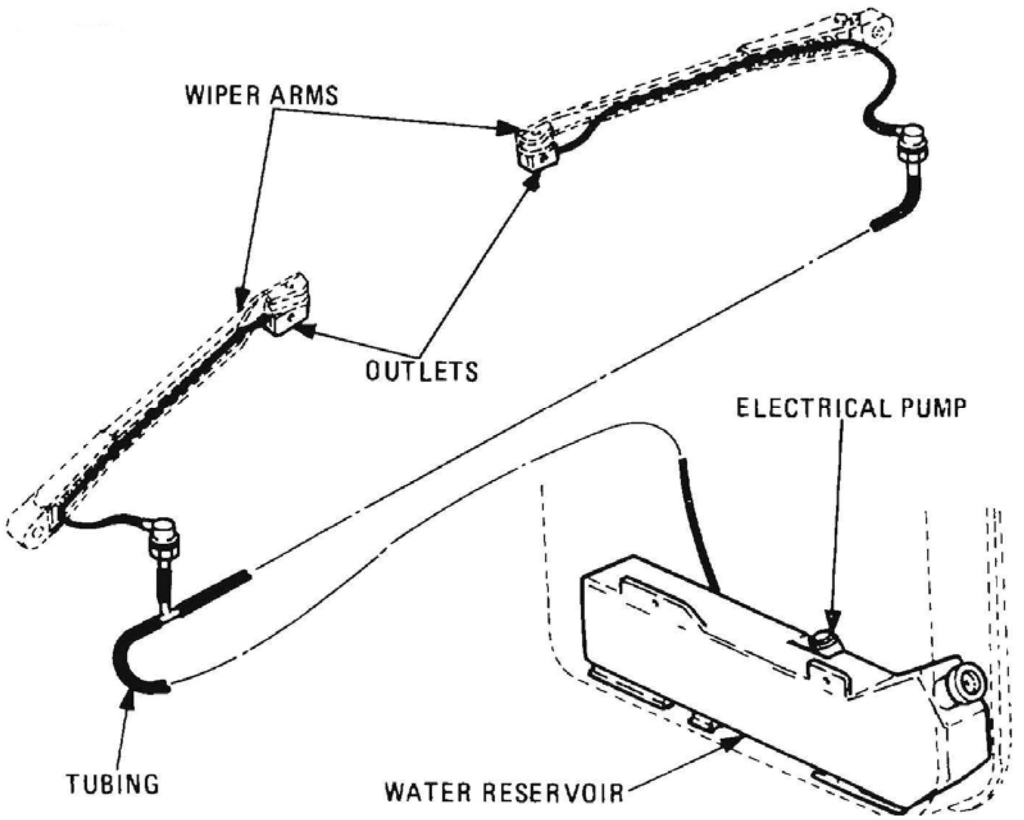


Figure 130 Windscreen Washer System

Bonnet

185. The vehicle's bonnet is designed to protect the engine from the weather and also assist in engine cooling. The bonnet ensures that the cooling air drawn through the radiator circulates over the engine, helping to keep the engine at normal operating temperature, before allowing the cooling air to enter the air stream around the vehicle.

186. The bonnet is made of sheet steel and constructed in two sections. Bracing is bolted to each section to give added strength and prevent the bonnet losing shape. Part of the central hinge is welded and bolted to each section of the bonnet and a third part of the hinge is slid over the other parts, completing the hinge and joining the two sections of the bonnet together (Figure 131). The front end of the hinge is mounted on the radiator top tank and the rear end is mounted on a bracket forward of the cab scuttle, forming a centre support for the bonnet and enabling the bonnet to be opened either or both sides giving access to the engine compartment. A support strut located on the radiator stay brackets on either side of the engine compartment retains the bonnet in the open position (Figure 132) and rubber latches lock the bonnet down when in the closed position (Figure 133).

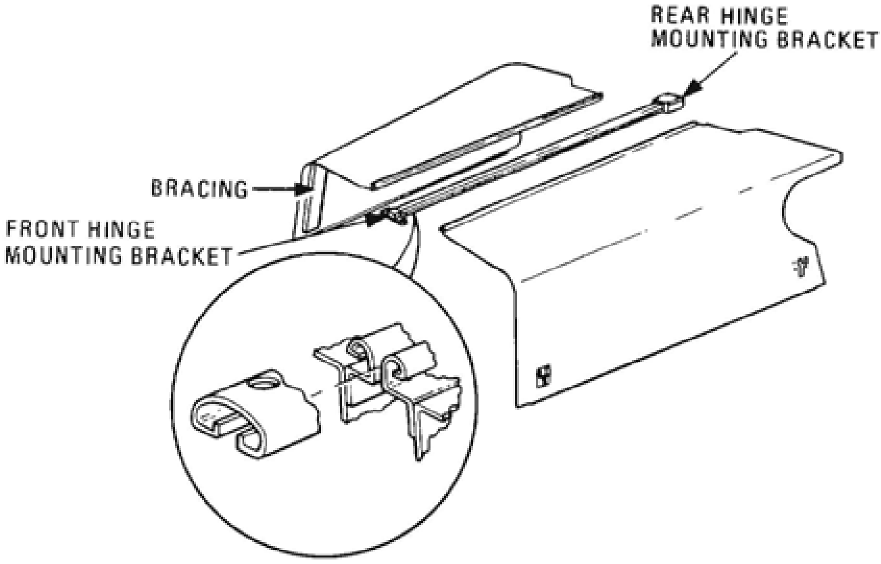


Figure 131 Bonnet and Hinge Assembly

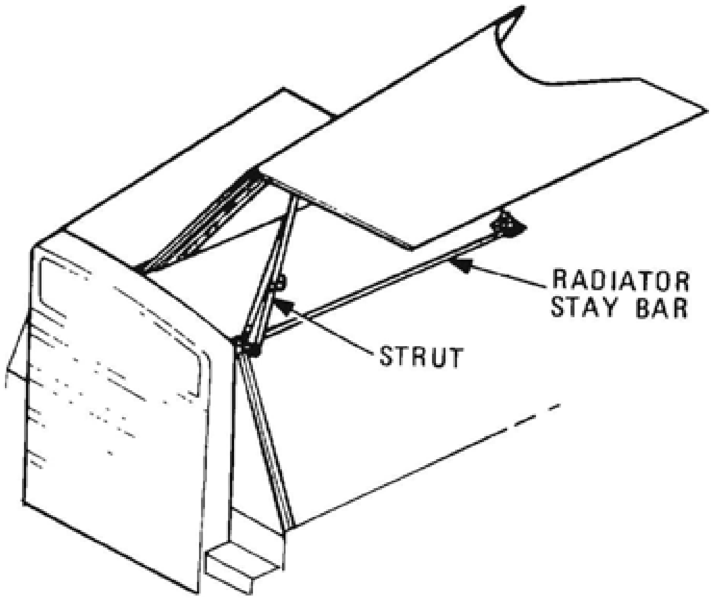


Figure 132 Bonnet Support Strut in Position (Bonnet Open)

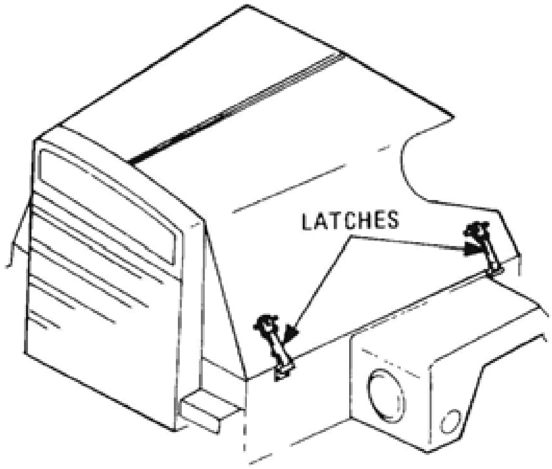


Figure 133 Bonnet Lock Down Latch Location

Mudguards

187. The front mudguards are made in two sections. The rear section is made up of three panels, cut from sheet steel and pressed into the shapes shown in Figure 134, then joined together to form the rear section as shown in Figure 135. The rear section is then positioned and bolted to a mounting bracket, which is bolted to the cab firewall. A bracket located under the cab floor also supports the rear section. Also bolted to the rear section is a canvas reinforced rubber mudflap, which effectively extends the mudguard below the cab step.

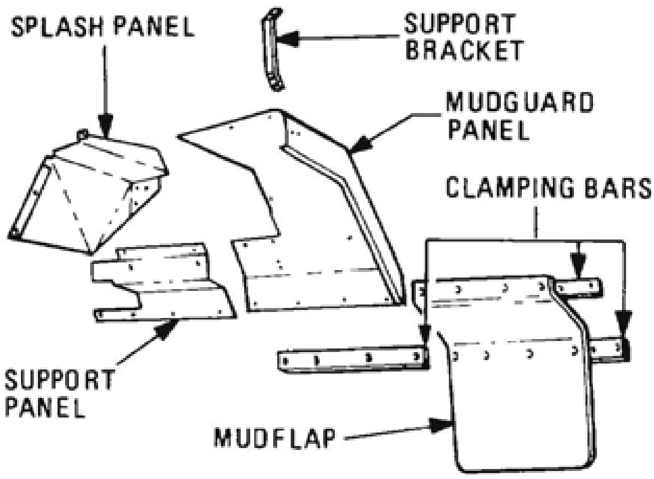


Figure 134 Exploded View Front Mudguard (Rear Section)

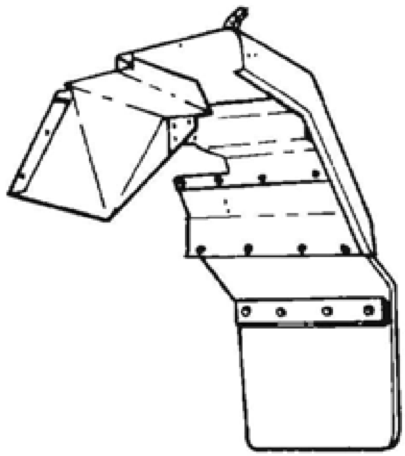


Figure 135 Front Mudguard, Rear Section Complete

188. The front section is made up of six panels, each cut from sheet steel and pressed into the various shapes shown in Figure 136. The panels are then bolted together to form the front section as shown in Figure 137. The front section is positioned on the radiator cross tube and retained by a bolt and washer screwed in the end of the tube.

NOTE

The cross tube acts as a pivot, allowing the mudguard to be tilted forward giving more access to the engine compartment.

It is also bolted to the radiator side panel at the front and the mounting bracket at the rear. The headlight, turn indicator light, blackout light, side marker light and marker post are mounted on the front section.

NOTE

Both the air horn and electric horn are mounted on the front section of the left-hand mudguard.

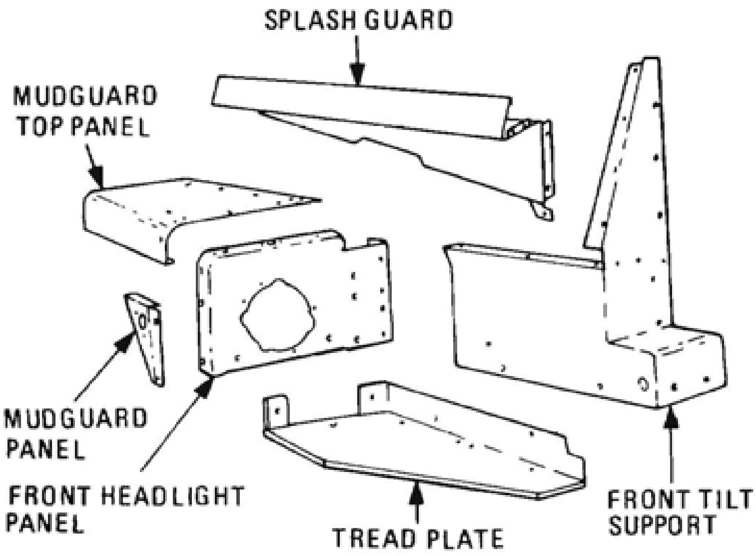


Figure 136 Exploded View Front Mudguard (Front Section)

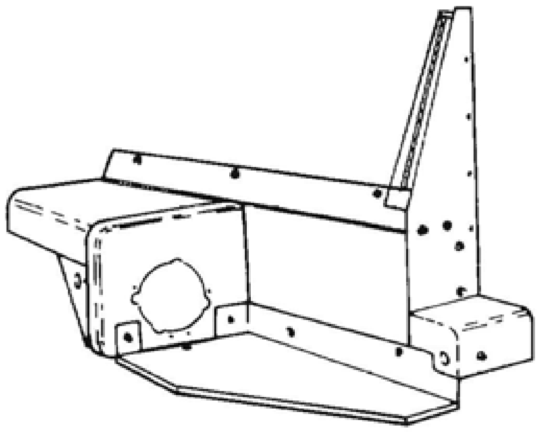


Figure 137 Front Mudguard, Front Section Complete

189. The mudguards located forward of the intermediate axle are made from sheet steel and bolted directly to the cargo tray crossmember. An angle iron brace secured by a cargo tray mounting bolt is bolted to the mudguard (Figure 138).

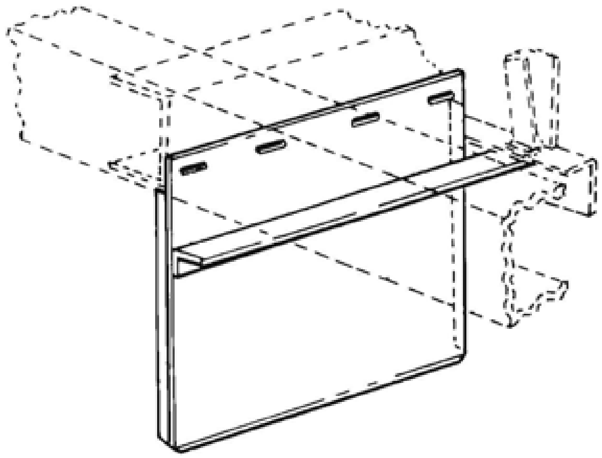


Figure 138 Mudguard Forward of Intermediate Axle

190. The rear mudflaps are made from canvas reinforced rubber sheet. The left-hand side mudflap (Figure 139) is bolted to the mounting brackets located on the tool box support straps. Chains attached to the tool box support straps are connected to the mudflaps to prevent the mudflaps being dragged onto the wheels when reversing over an object, e.g. kerb, which could cause the mudflap to be torn off. The mudflap on the right-hand side (Figure 140) is bolted to the forward fuel tank mounting bracket. This mudflap is mounted further rearward than that on the left-hand side and does not require chains.

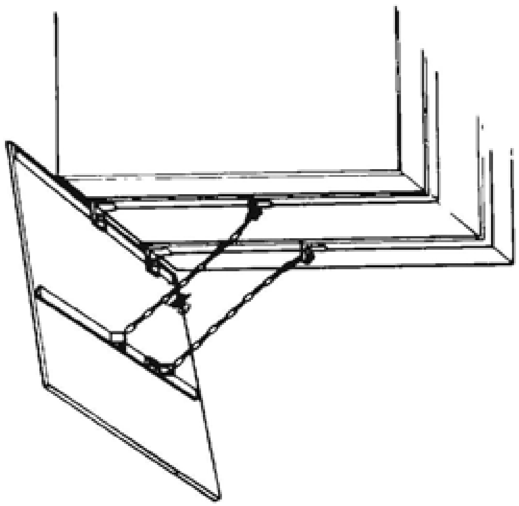


Figure 139 Left-hand Rear Mudflap

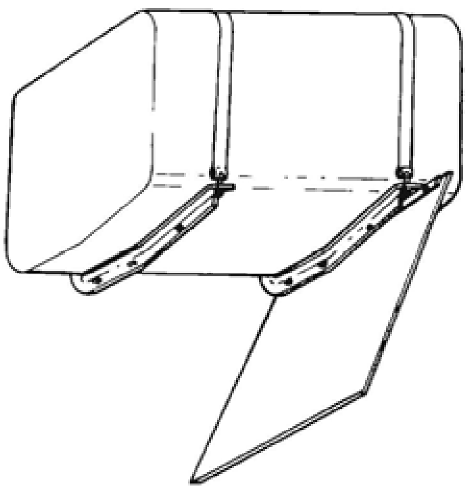


Figure 140 Right-hand Rear Mudflap

CABIN INTERNAL

Controls – Forward Cabin Area

191. Steering Column Adjuster. This allows the steering column to be moved fore and aft approximately 76 mm. Press down to release, up to lock (Figure 141, Item 1).

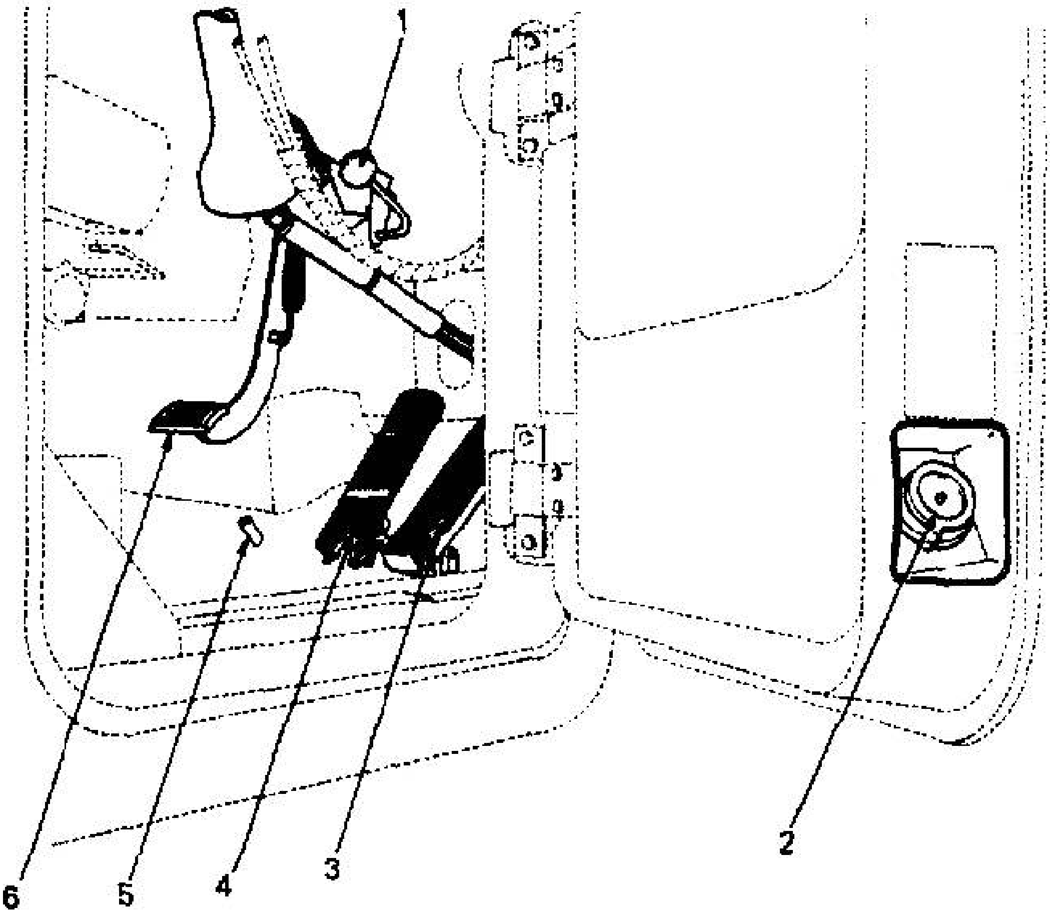
192. Windscreen Washer Reservoir. Refer Para 184 (Figure 141, Item 2).

193. Accelerator Pedal. The accelerator pedal is air operated and is used to control engine speed. Depress to increase speed as required (Figure 141, Item 3).

194. Brake Pedal. Depress pedal progressively to apply increased braking pressure. Brake pedal is interconnected to Dynatard (Figure 141, Item 4).

195. High-Low Beam Dipper Switch. Press down to switch from high to low beam or from low to high beam (Figure 141, Item 5).

196. Clutch Pedal. Depress pedal to disengage clutch. The last 25 mm of pedal travel operates the clutch brake (Figure 141, Item 6).



1	Steering wheel adjustment control	3	Accelerator pedal	5	High/low beam switch
2	Windscreen washer reservoir	4	Brake pedal	6	Clutch pedal

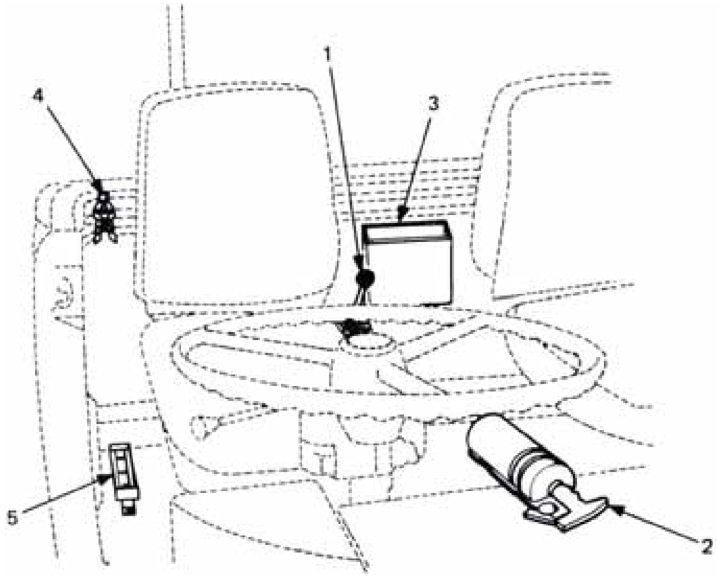
Figure 141 Controls – Forward Cabin Area

Controls and Stowage – Rear Cabin Area

197. Transfer Case Shift Lever. Manually changes gear ratios in the transfer case (Figure 142, Item 1).

198. Fire Extinguisher. A fire extinguisher is mounted on the floor between gear lever and passenger seat (Figure 142, Item 2).

199. Rifle Clips and Butt Boxes. A rifle mounting position is provided for both driver and passenger; these are located between seat and door (Figure 142, Item 4 and Item 5).



1	Transfer case gear lever	3	Document holder	5	Butt box
2	Fire extinguisher	4	Rifle clip		

Figure 142 Controls And Stowage – Rear Cabin Area

Cabin Seating

200. The vehicle is fitted with suspension seats with adjustments for seat cushion height and tilt, seat back angle, seat fore and aft movement and suspension unit loadings as detailed below:

a. Seat cushion height and tilt (Figure 143, Item 1)

(1) Height range .... 65 mm in six steps

(2) Forward tilt .... 11 degrees

(3) Rearward tilt .... 13 degrees

b. Seat back angle (Figure 143, Item 2)

(1) Forward tilt .... 4 degrees

(2) Rearward tilt .... 60 degrees

(3) Adjustment .... 32 steps at 2 degrees increments

c. Suspension unit (Figure 143, Item 3)

(1) Load range .... 60 kg to 130 kg

(2) Load adjustment .... Infinitely variable with visual indicator

(3) Stroke .... 80 mm, hydraulic shock absorber and progressive bump stops

d. Seat slides (Figure 143, Item 4)

(1) Total movement .... 175 mm

(2) Adjustment .... 11 steps at 17.3 mm increments

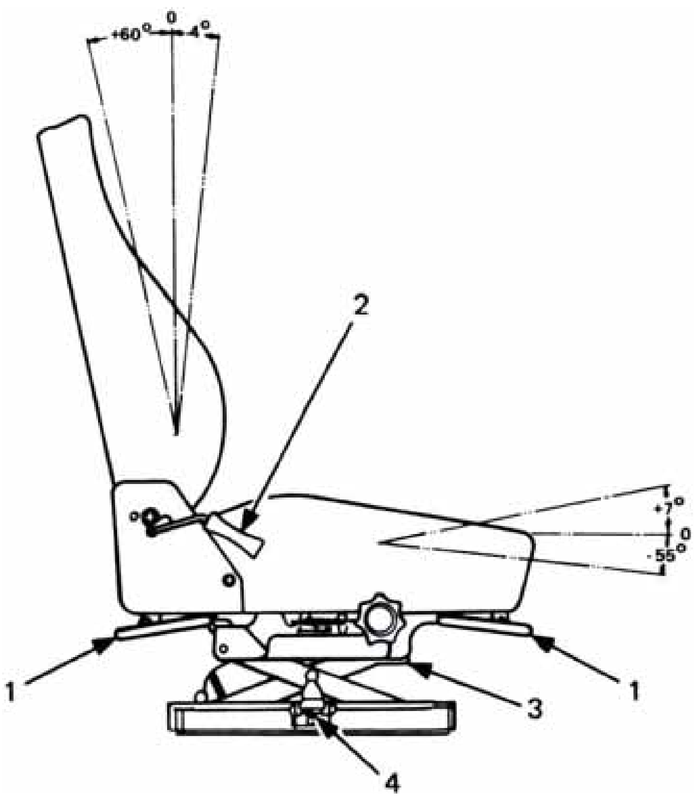


Figure 143 Seating Adjustment Positions

Cabin Heating and Ventilation System

Description

201. The cabin is equipped with a heater, which is heated by means of the engine coolant. The coolant flows from the water outlet manifold, through a hose to the heater tap. It then circulates through the heater core and feeds back to the engine through a hose to the inlet side of the water pump. As the engine coolant is the means of heating for the heater core, the engine/engine coolant must be warm before the heater can produce any heat. A booster fan fitted within the heater housing draws air through the heater core and pushes the heated air into the cabin.

202. This heater is designed with sufficient capacity to supply uniform defrosting for both left and right-hand windshields, and at the same time maintain comfortable cabin temperatures.

203. Top Cowl Vent. Rotating the control clockwise closes the ventilator, anticlockwise opens it. When open at normal highway speeds, this will provide warm air circulation for heating and defrosting without operating the heater fan motor. Under severe cold conditions, the fan motor may also be used to supplement the ram air. In summer, this ventilator may be used for fresh air ventilation (Figure 144, Item 1).

204. Left-hand Heat Outlet Door. When opened will provide warm air to the passenger area (Figure 144, Item 2).

205. Fan Control. Turn clockwise from off position to desired fan speed, low, medium or high. Turn anticlockwise to shut off (Figure 144, Item 3).

206. Temperature Control. Operates the water flow supplying the heater core. Push right to obtain desired temperature. Full right position is high, full left is off. There is a control flow tap mounted on the left rear of the engine. This allows water flow to be turned off during summer (Figure 144, Item 4).

207. Defroster Control. Provides entire flow of air to either the defroster or cab interior with any intermediate combination required. Pull left to increase defrosting action. Pull right diverts air flow to cab. Adjust for desired combination (Figure 144, Item 5).

208. Right-hand Heat Outlet Door. Provides additional warm air to driver (Figure 144, Item 6).

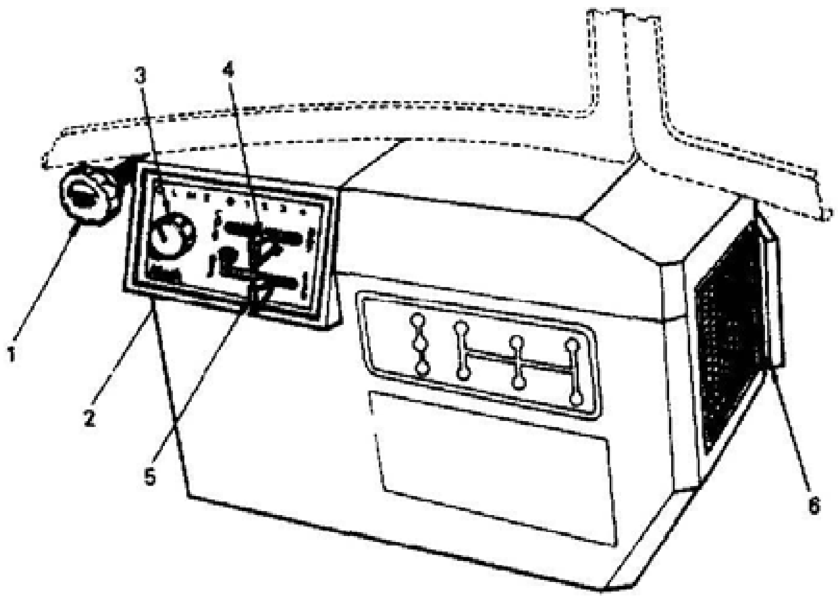


Figure 144 Cowl Vent and Heater Controls

209. Two fresh air vents are fitted to the cab. One located in the roof, as shown in Figure 145, and the other is located in the cowl in front of the windscreen. The cowl vent opening and closing is controlled by a screw knob located beneath the left-hand dashboard, alongside the heater controls as shown in Figure 144.

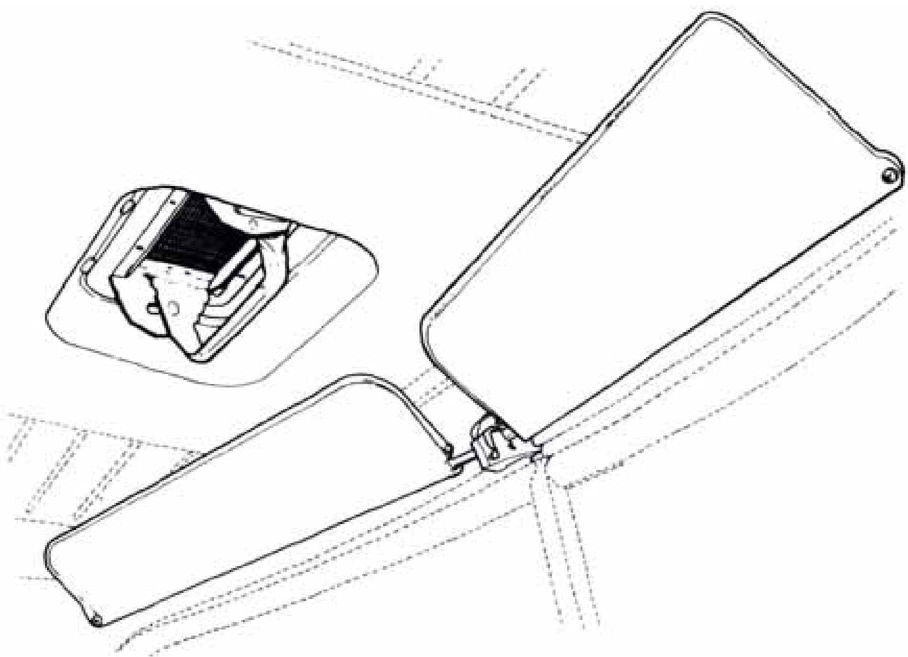
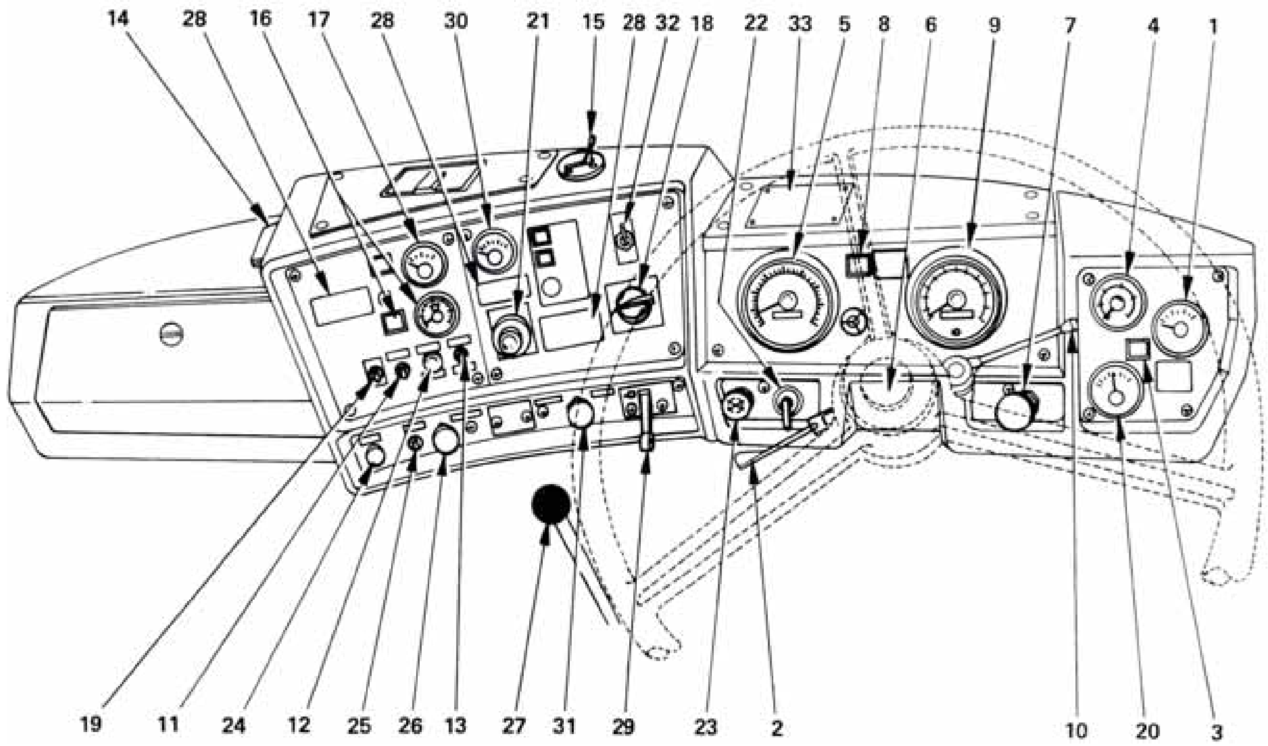


Figure 145 Cabin Roof Ventilation

Instrument Panel



1	Coolant temperature gauge	12	Instrument lights (panel)	23	Engine stop control
2	Directional signal/hazard switch	13	Headlights/parking lights	24	Air operated windscreen wipers
3	Engine warning light	14	Map reading light	25	Electric windscreen washers
4	Oil pressure light	15	Power divider lock out	26	Tractor protection valve
5	Tachometer	16	Air pressure gauge	27	Main transmission shift lever
6	Electric horn button	17	Fuel gauge	28	Engine operating instruction plates
7	Air horn	18	Normal, blackout and reduced lighting switch	29	Parking brake (emergency stop)
8	Emergency/parking brake warning light	19	Dynatard engine brake switch	30	Exhaust pyrometer
9	Speedometer and odometer	20	Voltmeter	31	Reserve air supply
10	Trailer brake level	21	Hand throttle	32	Winch clutch control
11	Clearance light switch	22	Electrical system ignition/start switch	33	Winch operation plate

Figure 146 Instrument Panel

210. Coolant Temperature Gauge. The proper operating temperature of the engine coolant is between 80 ºC and 85 °C. Extremely high ambient, slow operating conditions with heavy loads or steep grades at high altitudes affects temperatures. As long as loss of coolant does not occur, higher than normal operating temperatures are not harmful (Figure 146, Item 1).

211. Directional Signal Switch. Push lever forward for right turn signals and pull rearwards for left turn signals. Return to mid position manually after turn is made. There is also an audible sound from a dash mounted indicator mounted between tachometer and speedometer (Figure 146, Item 2).

212. Hazard Switch. The hazard switch is incorporated into the directional indicator switch. Pull lever out to actuate four-way flasher. To deactivate the hazard warning lights, move the lever forward or rearward and return to central position (Figure 146, Item 2).

213. Engine Warning Light. When coolant level in radiator drops below required level, oil pressure drops to 70 kPa or coolant temperature exceeds 93 °C, an engine warning light will illuminate on the instrument panel and a bell will sound. Stop the engine and determine the cause (Figure 146, Item 3).

214. Oil Pressure Gauge. Under normal operating conditions, the engine oil pressure will be between 275 kPa and 660 kPa, depending on engine speed and oil viscosity. Oil pressure may drop below 275 kPa at engine idling speed. Should pressure at operating speeds drop suddenly from normal reading, stop the engine immediately and determine the cause (Figure 146, Item 4).

215. Tachometer. Engine speed is indicated in revolutions per minute. The tachometer readings should be used as a guide for shifting and selecting the various transmission speeds. The number of hours running is also recorded (Figure 146, Item 5).

216. Electric Horn Button. Depression of the centre button of the steering column operates the horn (Figure 146, Item 6).

217. Air Horn. Operated by a push button on the right-hand side of the dash panel (Figure 146, Item 7).

218. Emergency/Parking Brake Warning Light. The vehicle must not be moved when this light is on as the emergency/parking brakes are applied (Figure 146, Item 8).

219. Speedometer and Odometer. Indicates road speed in kilometres per hour and total distance vehicle has travelled. High beam indicator is shown by light symbol (Figure 146, Item 9).

220. Trailer Brake Lever. Pull trailer brake lever back to apply brakes. Push away to release (Figure 146, Item 10).

221. Reversing Lights. Lights automatically when shift lever is moved to the reverse gear position. Do NOT leave gear lever in reverse when parking.

222. Clearance Lights Switch. This switch controls the clearance lights on the vehicle’s mirrors (Figure 146, Item 11).

223. Instrument Lights (Panel). Turn knob right to ‘ON’ position and keep turning until desired intensity is obtained. Ensure the instrument lights are turned off during day time operation as they are controlled independently of the headlights (Figure 146, Item 12).

224. Headlights/Park Lights. Switch down for park lights (including body side lights) and up for headlights (Figure 146, Item 13).

225. Map Reading Lamp. Located on the left-hand side of the dash panel (Figure 146, Item 14).

226. Power Divider Lockout (PDLO). Supplies increased traction when necessary. Switch to the left, PDLO activated. Switch to the right, normal driving position, PDLO disconnected. When PDLO is activated, a warning buzzer will sound and a light will illuminate on the instrument panel. Switch is located on the top of the dash (Figure 146, Item 15).

227. Air Pressure Gauge. The operating air pressure is between 655 kPa and 830 kPa. If the pressure should drop below 480 kPa, the low pressure warning buzzer will operate, as well as a warning light on the dash, indicating an unsafe vehicle. Cause of the failure should be determined before proceeding. Vehicle should not be moved until air pressure has reached at least 480 kPa and the buzzer and light have been switched off. This gauge has readings of primary and secondary air supplies. The primary system has a green indicator needle and the secondary a red indicator needle. Engine starting air pressure is not indicated (Figure 146, Item 16).

228. Fuel Gauge. This gauge registers fuel level in the supply tank (Figure 146, Item 17).

NOTE

> On early models the fuel gauge will read a maximum of approximately 3/4 to 7/8 when full. However, the gauge is accurate below 3/4.

229. Normal, Blackout and Reduced Lighting Switch. Refer to Para 179.

230. Dynatard Engine Brake Switch. Switch to ‘OFF’ position when not in use. When in ‘OFF’ position, light application of the brake pedal will operate the Dynatard brake. When in ‘ON’ position, as the foot lifts off the throttle, the Dynatard is automatically engaged (Figure 146, Item 19).

231. Voltmeter (Figure 146, Item 20)**.**

- **a.** The voltmeter is graduated from 18 to 32 volts.
- **b.** The voltmeter is wired through the ignition switch and will show the condition of the batteries only when the ignition switch is turned ‘ON’. This reading should be approximately 24 volts.
- **c.** With the engine is running at operating speed, the voltmeter will show the condition of the charging system. This reading should be between 24 and 28 volts.
- **d.** Any prolonged reading below or above these figures indicates the batteries or charging system requires a complete check.

232. Hand Throttle. For a quick response, press the button and pull the knob out. Minor adjustment may be carried out by turning the knob. For cancellation, press the button and fully return the knob (Figure 146, Item 21).

233. Electrical System Ignition/Start Switch. When switch is straight up and down, switch is off. Turn clockwise to activate vehicle electrical system and further movement to operate air starter (Figure 146, Item 22).

234. Engine Stop Control. Pull out to stop engine. Leave in 'OUT' position whenever engine is not running. Return to 'IN' position prior to starting. To release, turn clockwise to disengage ratchet and push 'IN' (Figure 146, Item 23).

NOTE

On some early models, the stop control is not fitted with a ratchet.

235. Air Operated Windscreen Wipers. Pull out to operate. Turn knob for speed control. To cancel, push in and hold in until wipers have parked, then release (Figure 146, Item 24).

236. Electric Windscreen Washers. Push button in and hold as long as water is required (Figure 146, Item 25). The windscreen washers are incorporated in the blade, while the water supply is in the driver's door (Figure 141, Item 2).

237. Tractor Protection Valve. Push to release. Pull to apply. **DO NOT USE FOR PARKING** (Figure 146, Item 26)**.**

238. Main Transmission Shift Lever. Manually changes gear ratios in the main transmission (Figure 146, Item 27).

239. Engine Operating Instruction Plates. Observe correct operating procedure (Figure 146, Item 28).

240. Parking Brake (Emergency Stop). Push lever down, hold down and push lock slide to the right. To release, push lever down slightly, push lock slide to the left, then release lever to 'OFF' position (Figure 146, Item 29).

241. Exhaust Pyrometer. Indicates temperature of exhaust gases at the exhaust manifold aiding the operator to avoid excessive exhaust temperature by correct selection of gear ratio for load and grade conditions (Figure 146, Item 30). Maximum operating temperature is shown on the pyrometer facia nameplate. An indication of readings are:

- **a.** 350 °C to 450 °C light load;
- **b.** 450 °C to 550 °C heavy load; and
- **c.** 550 °C to 650 °C overload.

242. Reserve Air Supply. Pull out for normal operation and push in for reserve air supply. This only supplies air for the emergency release of the spring brakes (Figure 146, Item 31).

243. Winch Clutch Control. This control remains in the engaged position except when free spooling the winch (Figure 146, Item 32).

244. Winch Operation Plate. Observe correct winch operating instructions. This plate is mounted on top of the dash in front of the driver (Figure 146, Item 33).

245. Servicing Data and Tyre Pressure Plate. Observe correct servicing data and tyre pressures (Figure 147). This plate is located on the inside lower section of the left-hand door.

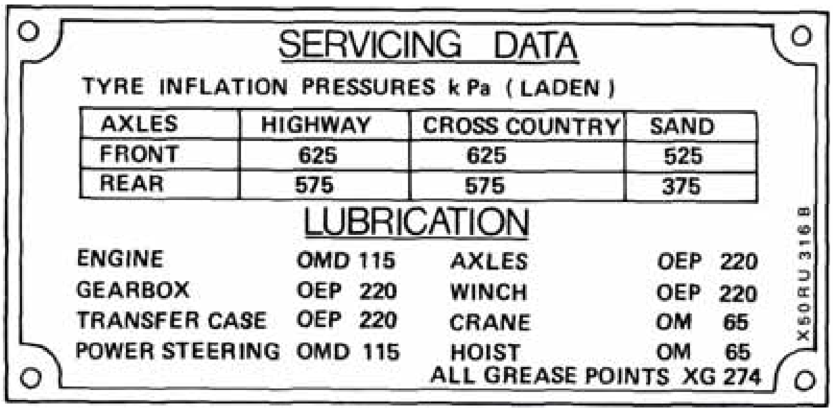


Figure 147 Servicing Data and Tyre Pressure Plate

246. **Main Transmission Shift Diagram Plate.** Illustrates main transmission shift pattern (Figure 148).

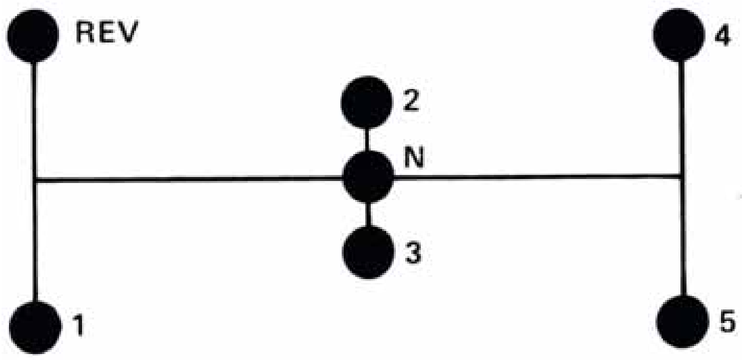
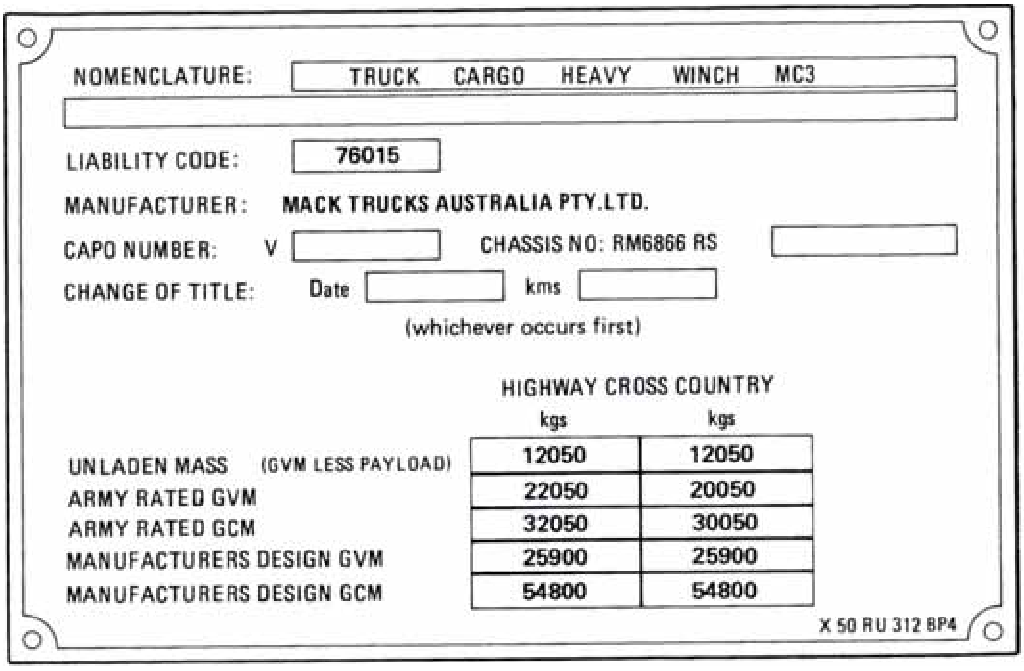


Figure 148 Main Transmission Shift Diagram Plate

247. **Transfer Case Shift Pattern.** Illustrates transfer case shift pattern and operating instructions (Figure 149).

Figure 149 Transfer Case Shift Pattern

248. **Nomenclature Plate.** This plate is located on the inside lower section of the left-hand door (Figure 150).



NOMENCLATURE: TRUCK CARGO HEAVY WINCH MC3

LIABILITY CODE: 76015

MANUFACTURER: MACK TRUCKS AUSTRALIA PTY.LTD.

CAPO NUMBER: V CHASSIS NO: RM6866 RS

CHANGE OF TITLE: Date kms

(whichever occurs first)

	HIGHWAY kgs	CROSS COUNTRY kgs
UNLADEN MASS (GVM LESS PAYLOAD)	12050	12050
ARMY RATED GVM	22050	20050
ARMY RATED GCM	32050	30050
MANUFACTURERS DESIGN GVM	25900	25900
MANUFACTURERS DESIGN GCM	54800	54800

X 50 RU 312 8P4

Figure 150 Nomenclature Plate

Cargo Body

249. The cargo body consists of a tray, front and side panels, tailgate, upper front panel, seats and back rests, canopy bows and canopy.

250. The tray consists of a frame (Figure 151) made of steel channel crossmembers with two mounting brackets (pedestals) welded to each crossmember and two coaming rails to which each crossmember is welded. The coaming rails locate the crossmembers and also form the sides of the cargo tray. Hinges and mounting brackets are welded to the coaming rails to support and locate the cargo body side panels. The coaming rails also retain the outer edges of the tray (deck) panels and house the side marker lights. Both the tail light mounting brackets and the tool box mounting brackets are welded to the cargo tray crossmembers. The tool boxes are then secured to the brackets by steel straps. The cargo tray mounting brackets (pedestals) are positioned on, and bolted to, two angle mounting brackets (Figure 151), which are bolted to the web of the chassis rails.

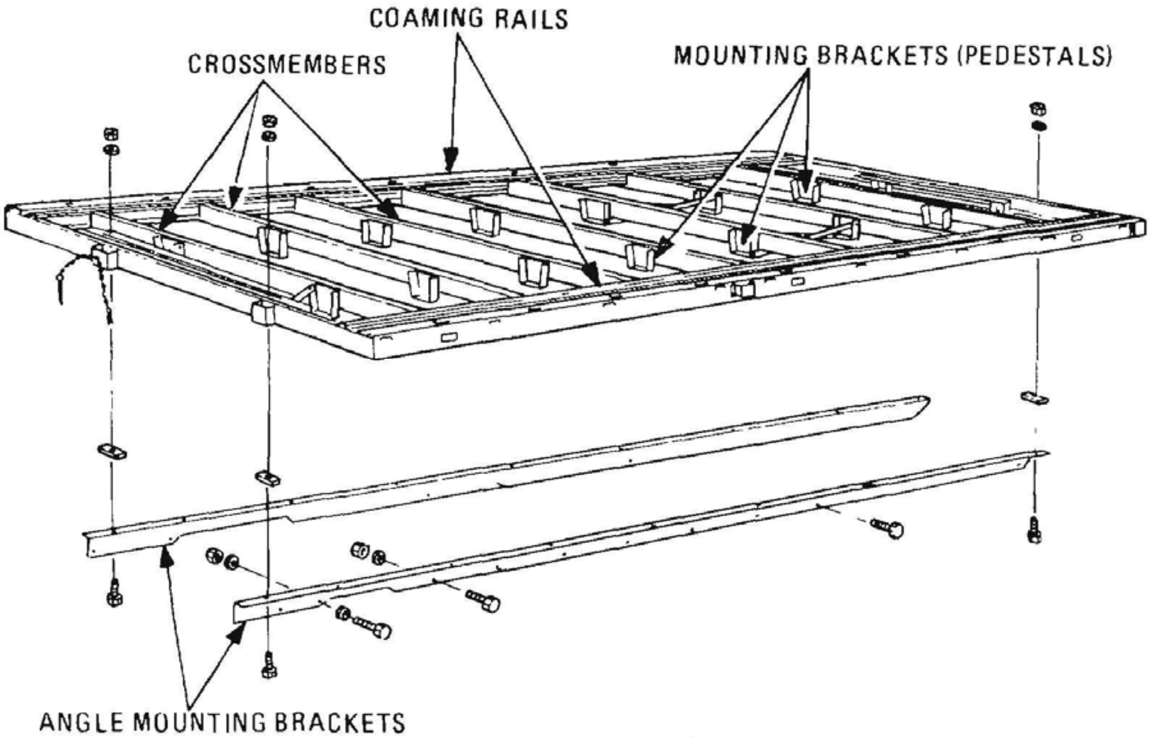


Figure 151 Cargo Tray Frame

251. The deck of the cargo tray is constructed from extruded aluminium. The centre panel of the deck is held in position by two retaining bars, which are bolted to the crossmembers. The remaining panels are bolted directly to the crossmembers. Anchor rings and rope tie side rails (Figure 152) are fitted to the crossmembers for securing cargo. The anchor rings are used when cargo needs to be chained down and the rope tie side rails are used when the cargo can be secured with rope. The anchor rings when not in use, fall into a recess with the top of the ring sitting slightly above the deck surface leaving an unobstructed load area.

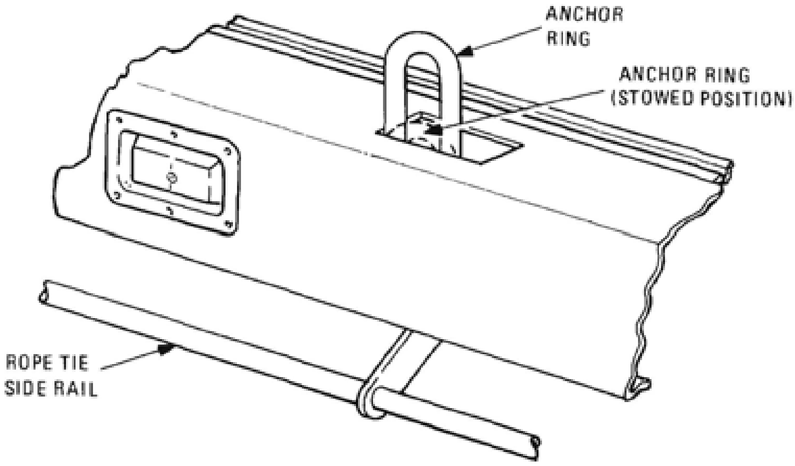


Figure 152 Anchor Ring and Rope Tie Side Rail

252. The lower panels of the cargo body shown in Figure 153 are constructed from sheet steel and rectangular tube steel. The front panel is mounted in brackets welded to the front crossmember. Removable retaining pins prevent the panel falling out while the vehicle is moving. The side panels and tailgate are mounted on the hinges welded to the coaming rail and rear crossmember respectively. Rectangular tube steel posts inserted in brackets located at the centre and rear corner of the coaming rails retain the side panels and tailgate in the vertical position with the aid of removable retaining pins.

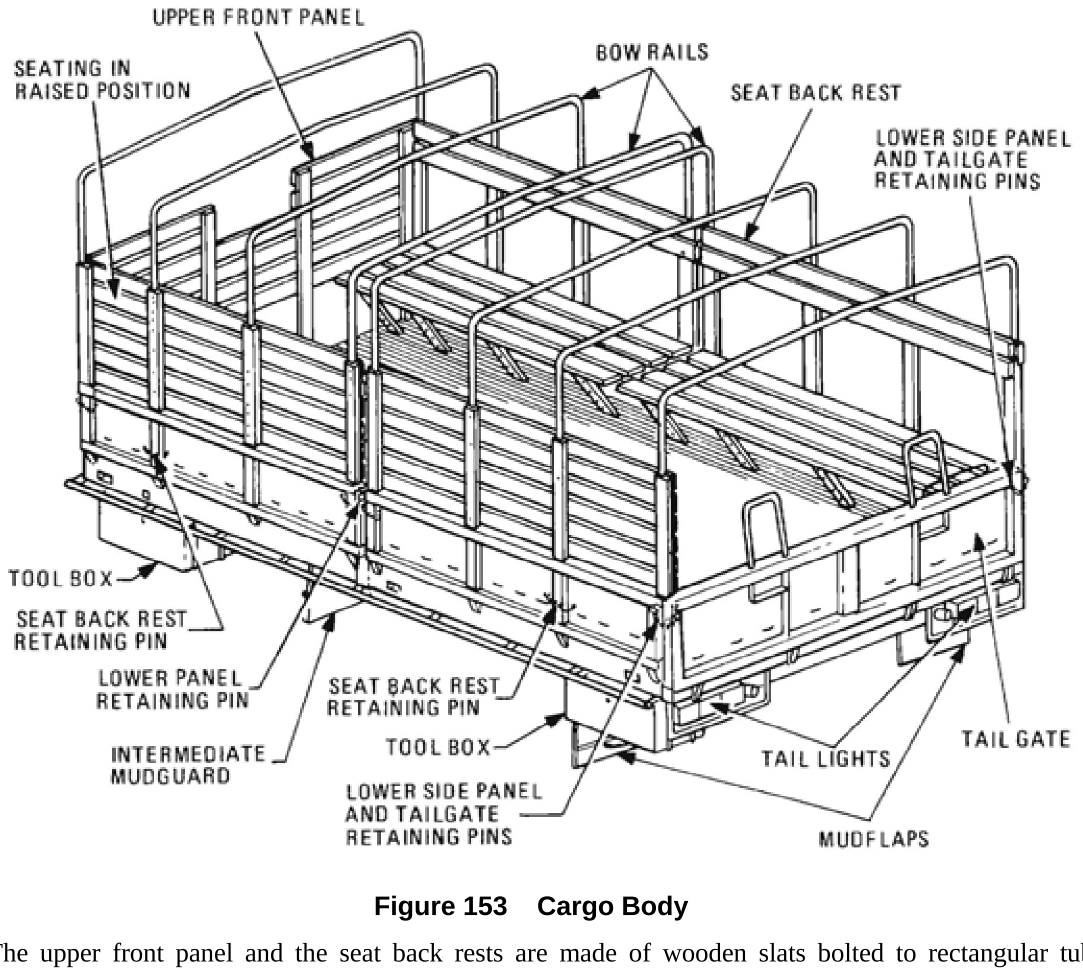


Figure 153 Cargo Body

253. The upper front panel and the seat back rests are made of wooden slats bolted to rectangular tube steel uprights. The front panel and back rests fit into holes located in the top of the lower panels. Removable retaining pins are used to prevent the front panel and the back rests lifting out while the vehicle is on the move. Seats, also made of wooden slats bolted to rectangular tube steel are bolted to the seat back rests. These bolts act as hinges allowing the seats to be raised and stowed in the raised position when cargo space is required. The seats and back rests are normally removed or installed as an assembly.

254. The canopy bows are made from round tube steel and their purpose is to support the centre of the canvas canopy. The ends of the bars are inserted into channels in the top of the seat back rests. The canopy is placed over the bows and secured by elastic cord and rope to hooks located on the outside of the cargo body lower panels as shown in Figure 154.

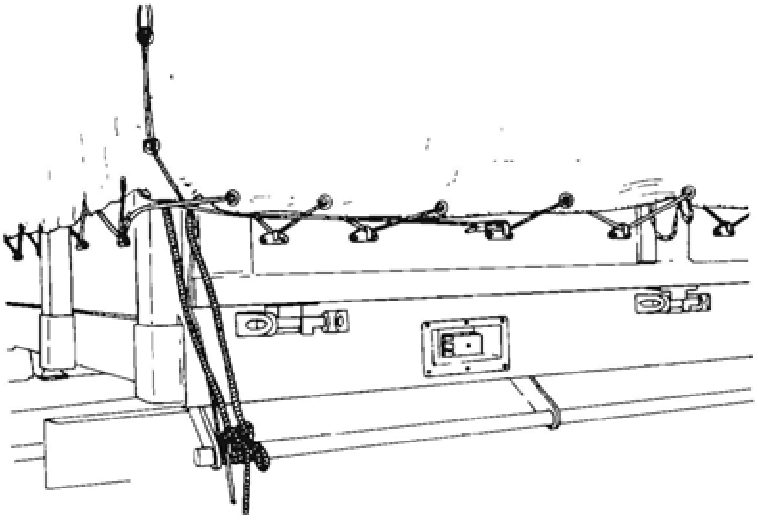


Figure 154 Canopy Tie-down

Wheels and Tyres

255. The wheel rim is of the disc type consisting of three pieces:

- **a.** the rim,
- **b.** the side ring, and
- **c.** the lock ring.

256. Ten studs retain the wheel on the hub.

- **a.** Rim dimensions are 203 mm x 508 mm (8.00 in x 20.00 in)
- **b.** Tyres used are 305 mm x 508 mm (12.00 in x 20.00 in) 18 ply rating radial.

257. The spare wheel is located behind the driver's cabin and is mounted in a hydraulically operated cradle, as shown in Figure 155.

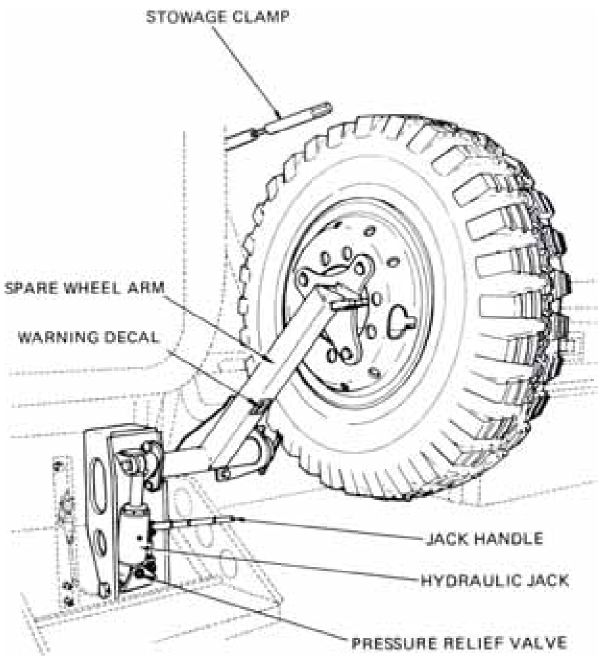


Figure 155 Spare Wheel Stowage and Lowering Assembly

258. The wheels are mounted on studs on the axle hubs and secured in place by means of wheel nuts (Figures 156 and 157). In the case of the dual rear wheels, the inner wheel is positioned on the hub studs and secured by inner wheel nuts. The outer wheel is installed onto the inner wheel nuts with the dished side of the rim facing out and secured by the outer wheel nuts (Figure 158).

NOTE

Wheel nuts and studs on the left-hand side of the vehicle have left-hand threads. Before installing the outer wheel, install a valve extension on the inner wheel and ensure the inner wheel nuts are tightened securely.

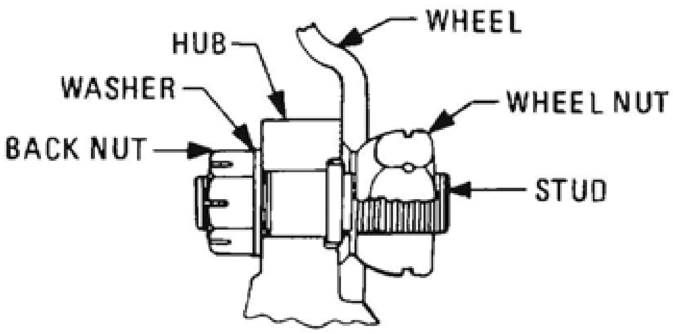


Figure 156 Front Wheel Securing Nut and Stud

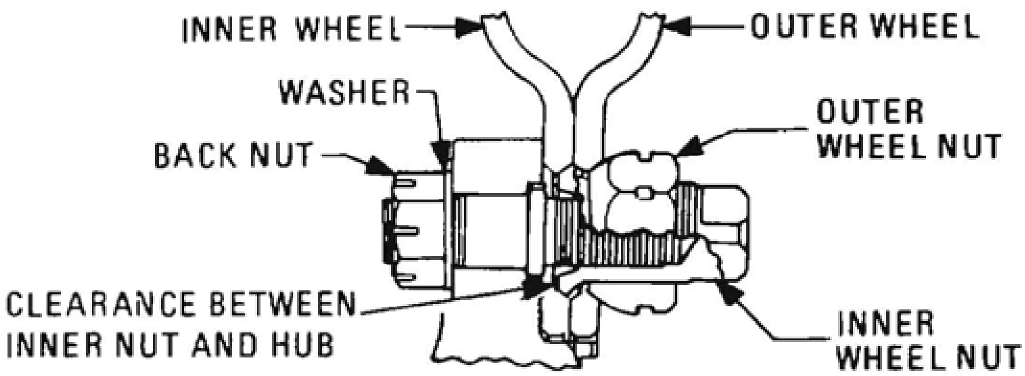


Figure 157 Rear Wheel Securing Nut and Stud

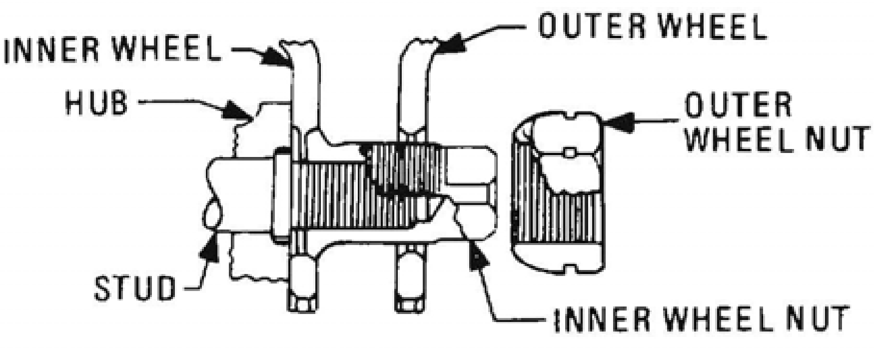


Figure 158 Order of Assembly of Rear Wheels

NOTE

Tighten all wheel nuts evenly and in sequence shown in Figure 159. Ensure the wheel nuts are rechecked for tightness after vehicle has completed 40 kilometres (25 miles). Outer wheel nuts must be slackened before the inner wheel nuts can be checked for tightness. Recheck the outer wheel nuts after a further 40 kilometres (25 miles).

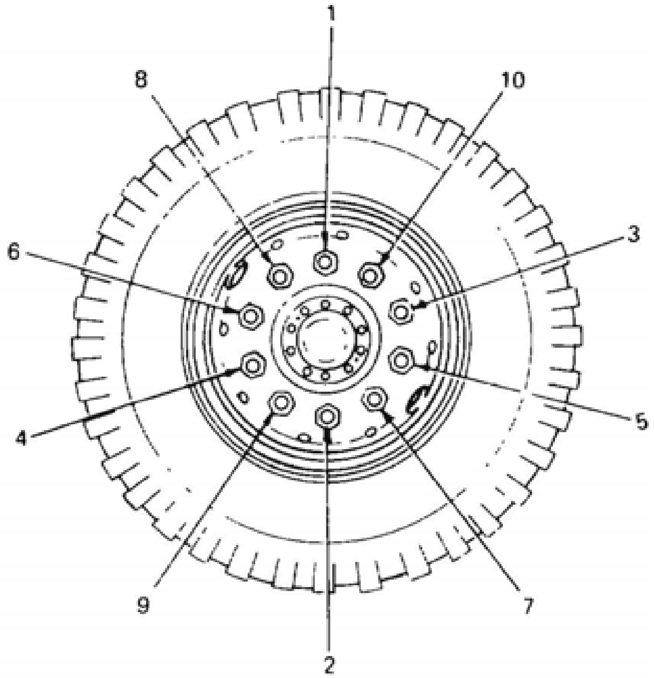


Figure 159 Wheel Nut Tightening Sequence

Towing Attachment

259. A Ringfeder 663 K1D automatic trailer coupling is fitted to the vehicle. The coupling is mounted on the rear crossmember and retained by four bolts. Recommended towed loads for the vehicle are:

- **a.** Highway..........17 000 kg (37 400 lb)
- **b.** Cross country..........10 000 kg (22 000 lb)

The design of the coupling allows for a large degree of trailer articulation in both the vertical and horizontal planes (Figures 160 and 161). In the event of an accident or trailer roll over, the coupling is designed to axially rotate through 360°, if necessary, preventing the vehicle from rolling with the trailer.

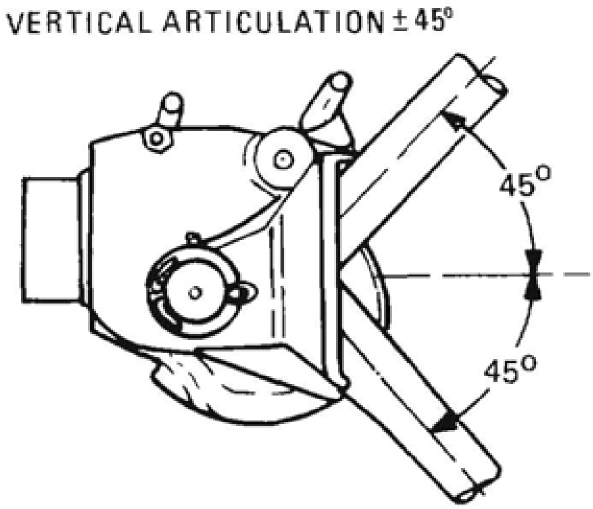


Figure 160 Tow Coupling Articulation (Vertical)

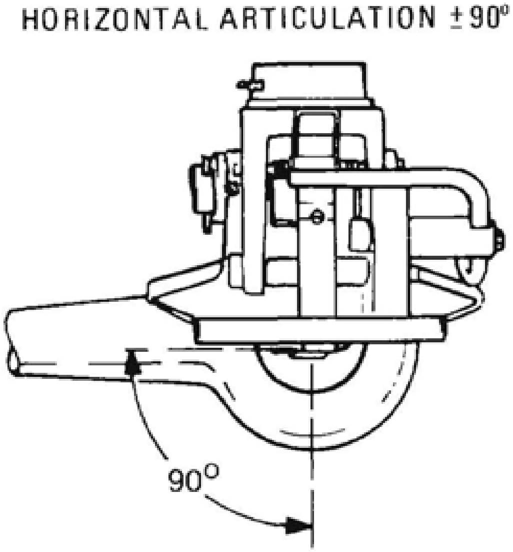


Figure 161 Tow Coupling Articulation (Horizontal)

260. When connecting a trailer to the coupling, pull the retaining shackle (Figure 163, Item 1) outward and swing rearward, push the handle (Figure 163, Item 2) forward, raise the trailer towing eye and hold at the same level as the coupling. Reverse the vehicle until the towing eye strikes the coupling. This will cause the tow hook to close and lock automatically (Figure 163). Should the hook not close due to misalignment of the towing eye, pull the handle (Figure 163, Item 2) rearward until the retaining shackle (Figure 163, Item 1) clicks into place. Ensure the towing eye and retaining shackle is properly engaged before proceeding.

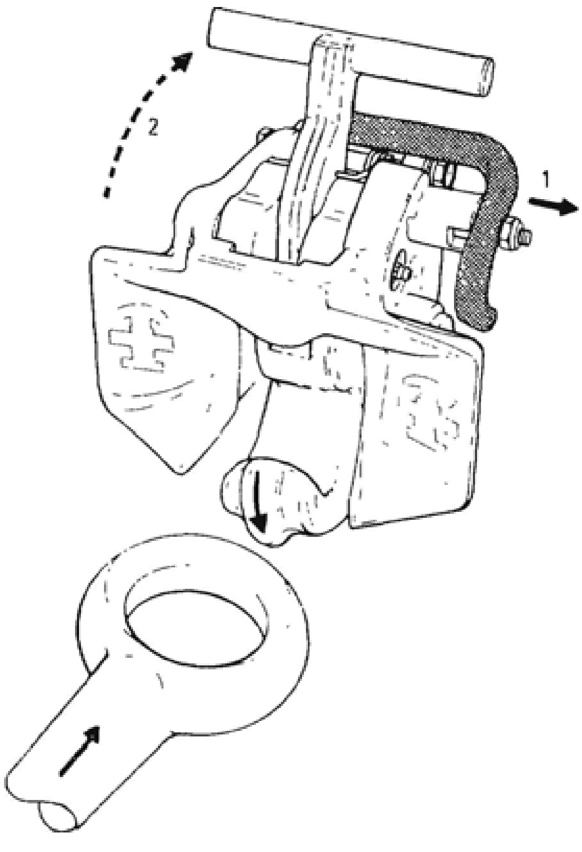


Figure 162 Tow Coupling in Open Position

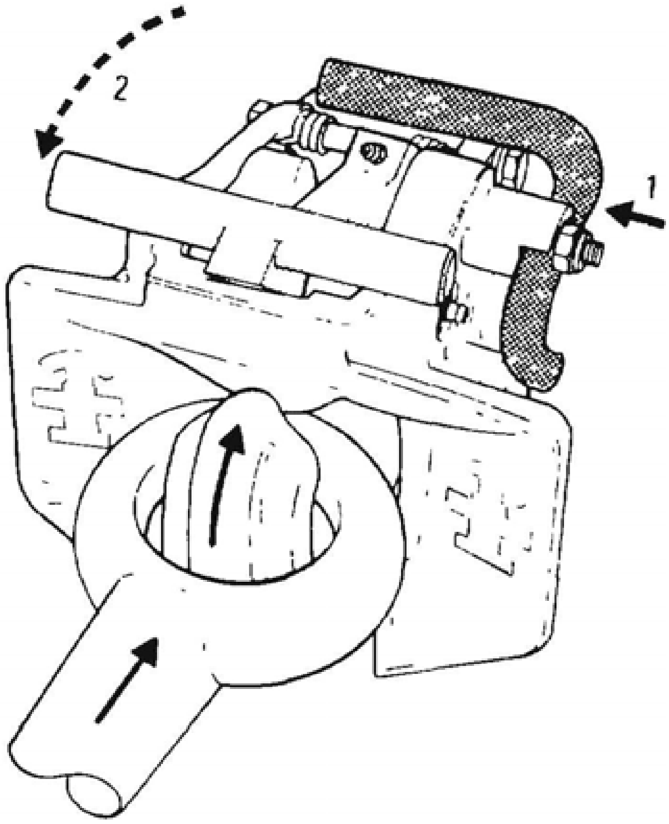


Figure 163 Tow Coupling in Locked Position

WINCH

261. The winch fitted to the vehicles is Ateco Olding type 24L, which has a maximum safe working load of 10 500 kg (24 000 lb). It is located across the vehicle frame, below the cargo body, and to the rear of the transfer case (Figure 164). The winch is enclosed in a light alloy housing, fitted with a left-hand worm and worm gear with a reduction ratio of 29:l. Drive for the winch is taken from a PTO located on the left-hand side of the gearbox and transmitted to the winch worm shaft via a propeller shaft and a chain drive. The control for the PTO is located between the seats forward of the document holder (Figure 165).

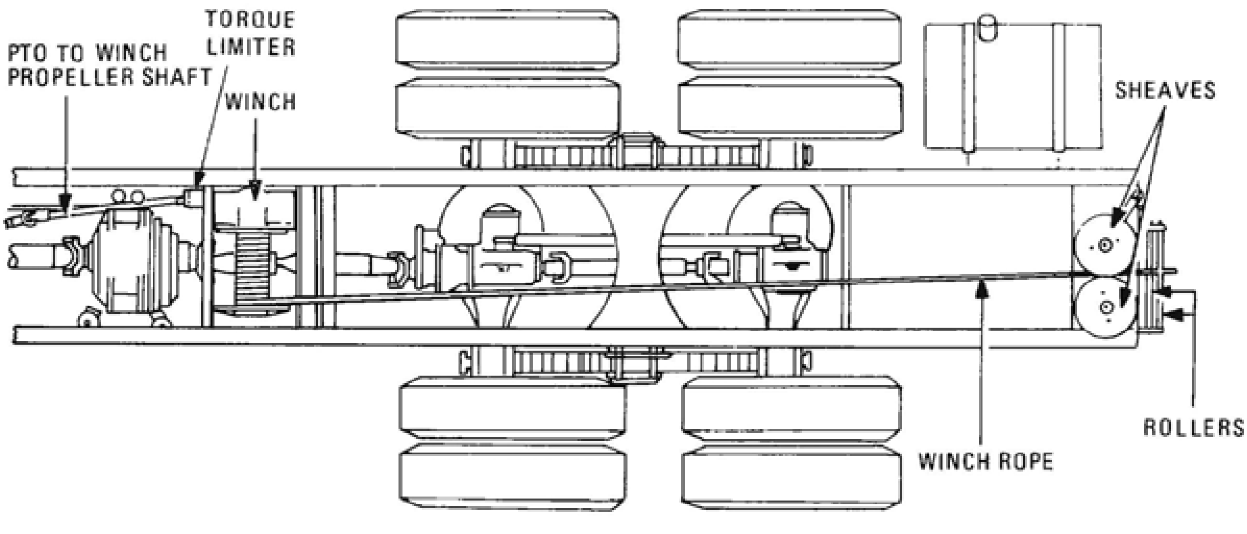
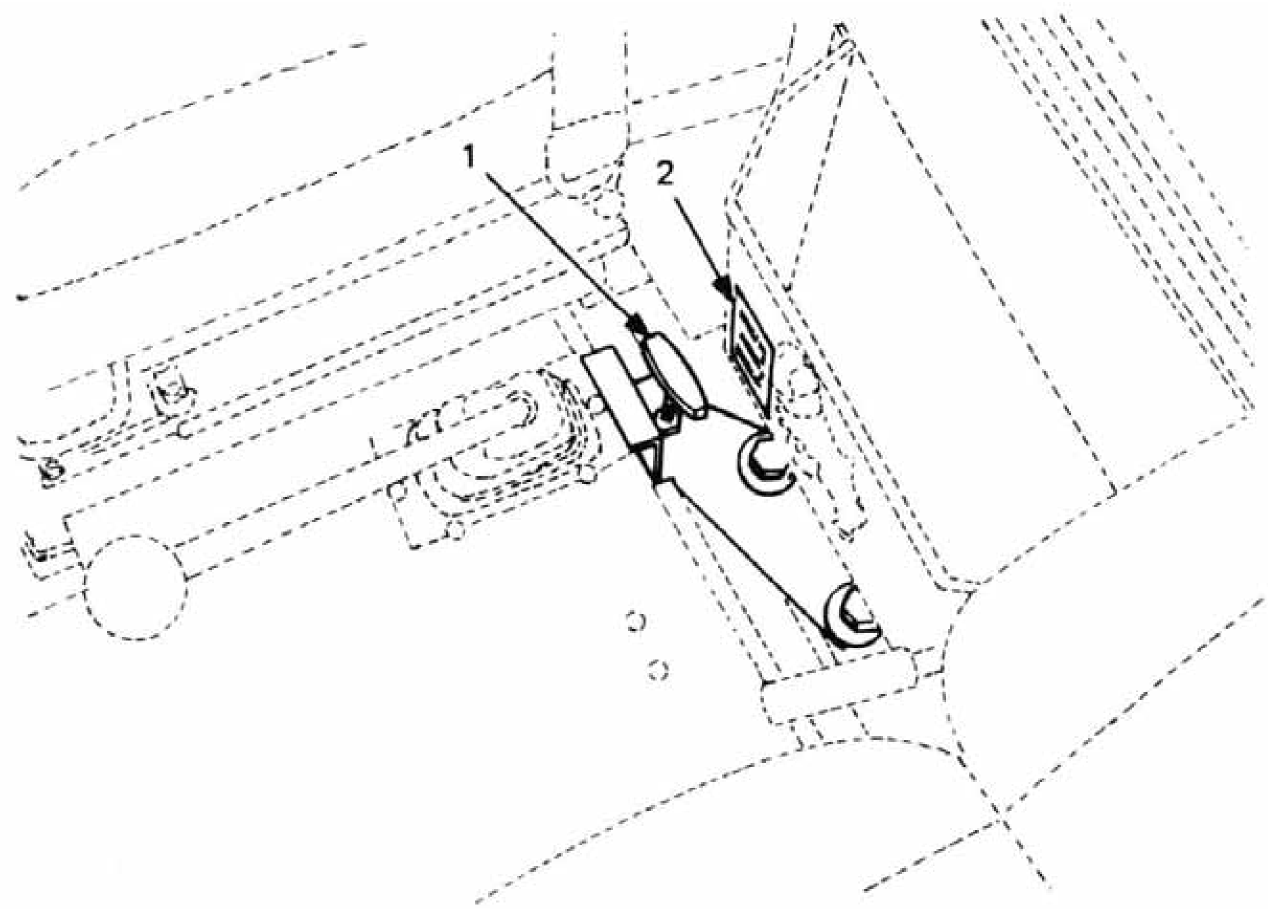


Figure 164 Winch, Sheaves and Roller Locations (Rear of Vehicle)



1 PTO lever 2 PTO position plate

Figure 165 Power Take Off Control (Winch)

262. The winch drum can be engaged or disengaged from the drive shaft by means of a clutch located in the winch housing. The clutch is operated by a compressed air cylinder mounted on the winch crossmember and controlled by a switch on the instrument panel (Figure 166).

NOTE

The winch clutch control switch is to be left in the engaged position when the winch is not in use, as this prevents the winching drum from rotating.

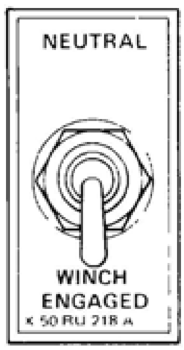


Figure 166 Winch Clutch Control Switch

263. As a safety measure a spring-loaded brake, which operates on a drum keyed to the winch worm shaft, is fitted to the winch. While the winch is pulling or raising a load, spring tension on the brake relaxes, but tightens again when the winch drum stops or is reversed. The brake automatically holds a load when the winch is stopped and prevents reverse rotation of the drum when the take off control is in the neutral position. The brake will hold any load within or near the rated capacity of the winch.

264. To ensure that neither the winch gear nor the rope is overloaded, a safety device is incorporated in the winch drive line. If the rope tension exceeds 10 500 kg (24 000 lb) when winching on the bottom layer of the drum, 8 400 kg (19 000 lb) on the centre layer and 6 600 kg (15 000 lb) on the top layer of the drum, a spring-loaded ball ratchet type clutch is activated, which separates the drive line from the winch. The overload clutch automatically resets itself once the vehicle's clutch pedal has been depressed.

265. The winch is equipped with a wire rope 60 m (200 ft) long and 18 mm (0.75 in) diameter. This is a special improved plough steel 1694-1848 MPa (110 to 120 tons per square inch) rope, right-hand ordinary lay, preformed with an independent wire rope core. The free end of the rope has a thimble and Talurit fitting attached to it.

266. Sheaves and rollers are fitted to the vehicle (Figures 167 and 168) to guide rope over or past the chassis and body of the vehicle giving the rope a clear unobstructed path; however, they do create frictional losses. So where possible, heavy winching should be undertaken from the rear of the vehicle as the frictional losses are high when winching from the front of the vehicle. When winching is completed, shackle the winch rope to the hook provided (Figure 169) when winching from the rear, or to the right-hand towing lug when winching from the front.

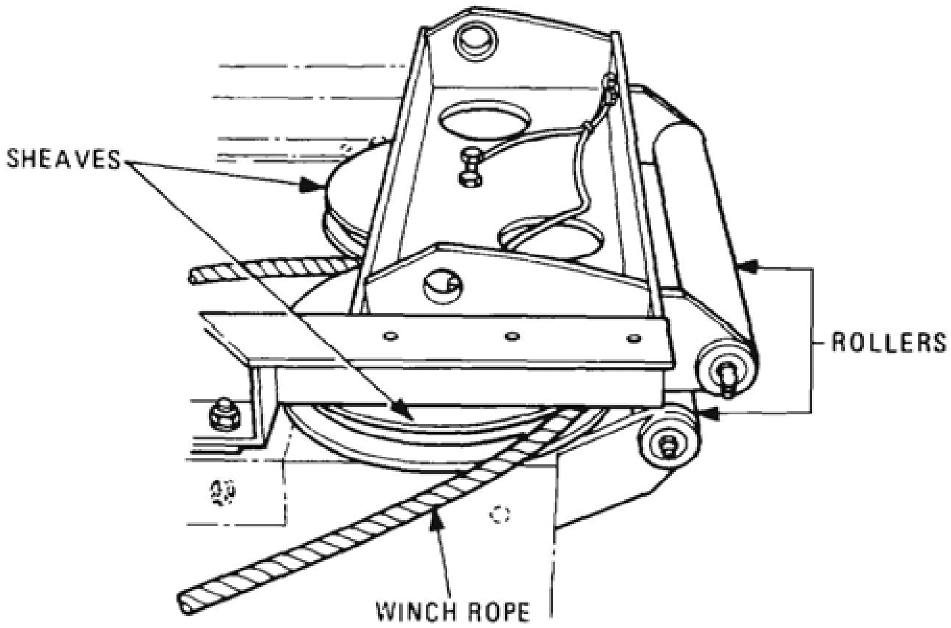


Figure 167 Rear Sheaves and Rollers

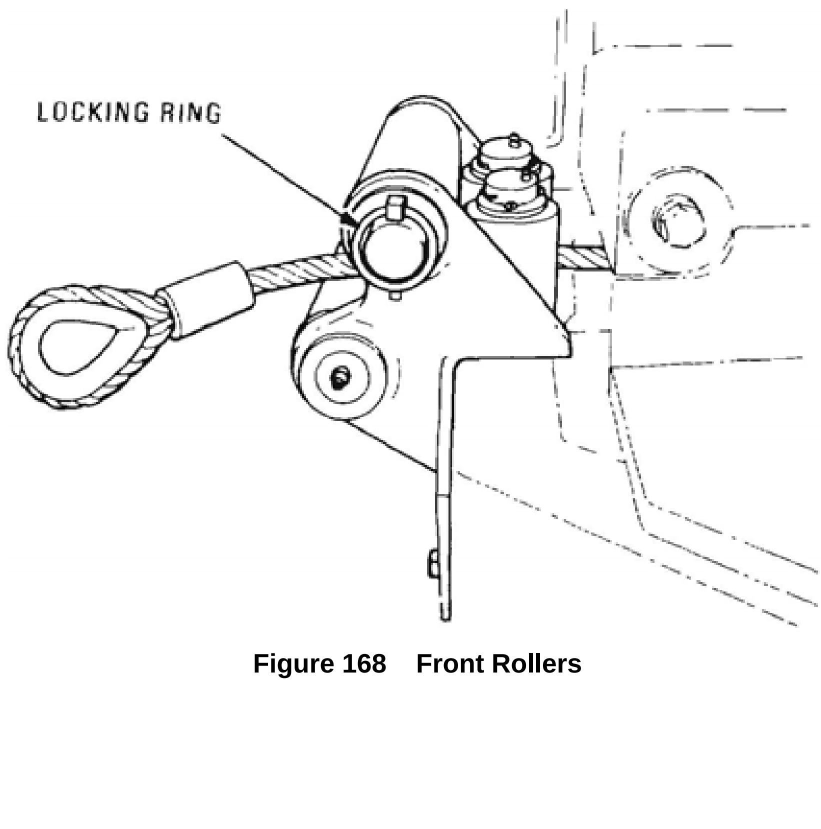


Figure 168 Front Rollers

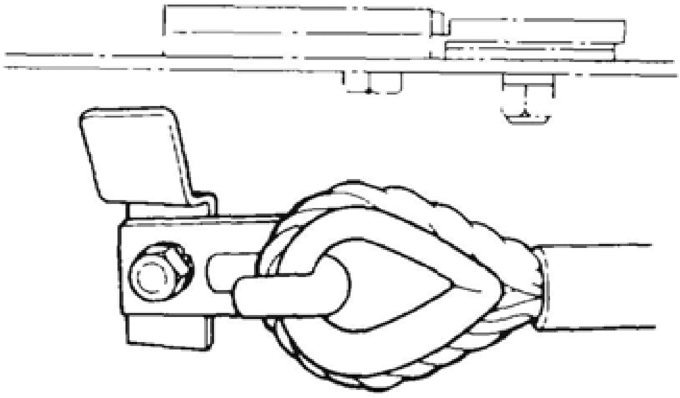


Figure 169 Winch Rope Retaining Hook

AIR SPRING SUSPENSION SYSTEM

Introduction

267. The Air Spring Suspension System (Mack SA441W) is fitted to a selected cross section of the in-service Mack RM6866RS derivative vehicles.

268. The ride characteristics of the system are controlled by height and levelling control valves utilising the vehicle's air system to maintain the required ride height. Air is automatically added to or exhausted from the air system to maintain a constant static design height.

269. The SA441W Air Spring Suspension System replaces the SS44 1 W Camel Back Suspension System to provide a cushioned ride throughout the load range, from unladen to laden, under ON or OFF road conditions. The suspension system provides excellent side-to-side and axle-axle loading, which helps equalise and control braking under all conditions.

Air Spring Suspension

270. The suspension system comprises four air springs located between the chassis and the two transverse beams (Figure 170), which are attached to four heavy duty under-slung equalising beams. Two heavy duty shock absorbers are attached to the front and rear transverse beams and to mounting brackets attached to the front and rear chassis crossmembers.

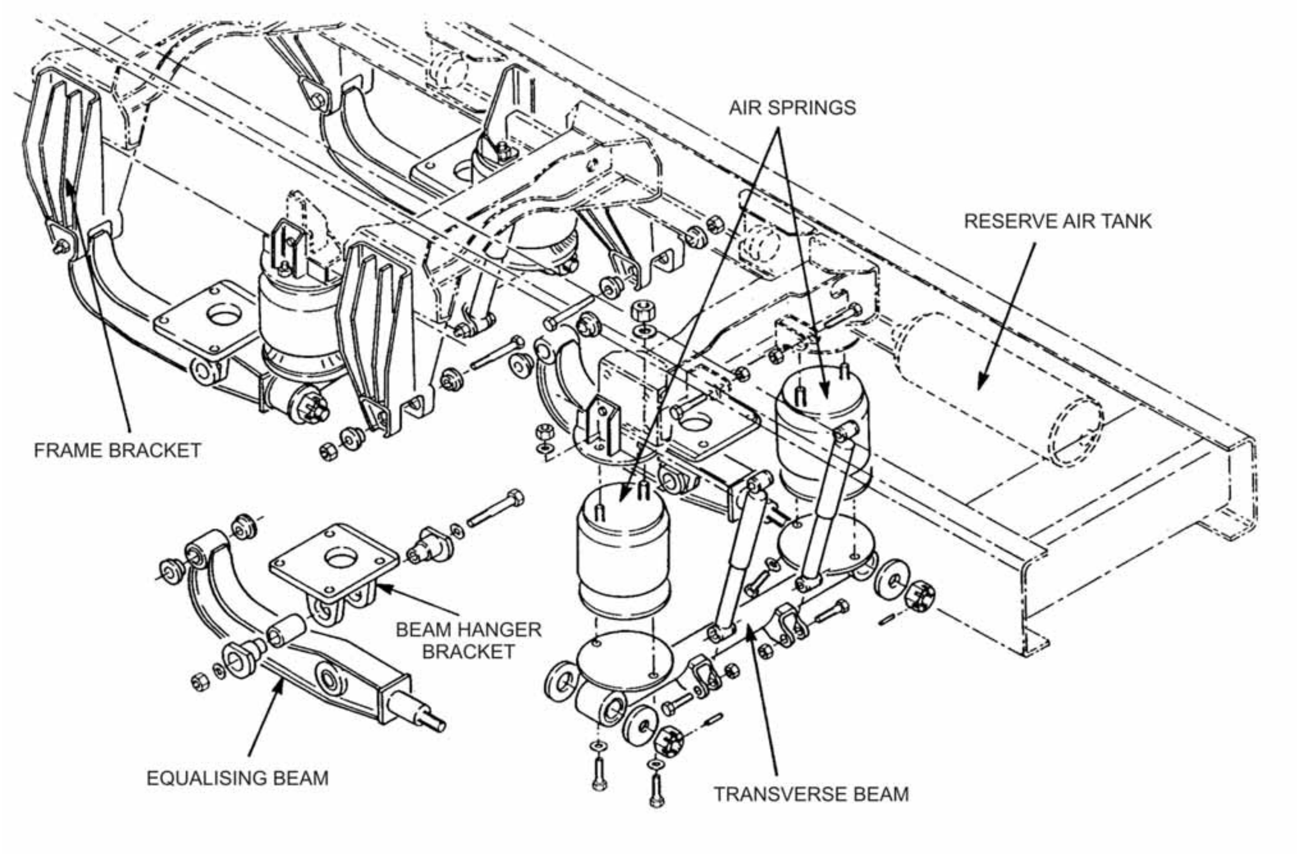


Figure 170 Air Spring Suspension System

Chassis

271. To incorporate the suspension system, the chassis has been modified with the removal of the trunnion bracket assembly, the replacement of the front and centre crossmembers and the rear crossmember has been inverted. Frame mounting brackets are attached to the chassis at the front and centre crossmembers to support the equalising beam assemblies. Air spring mounting plates are attached to the chassis at the rear crossmember and forward of the centre cross-member.

Air System

272. Air supply for the air springs is obtained from the reserve air tank, which is attached to the right-hand chassis rail at the rear of the vehicle. Air is supplied to the air springs via a Pressure Protection Valve (PPV) located at the rear of the air tank (Figure 171). Air from the valve flows through Synflex tubing to a maxitorque air filter, which filters out any water in the supply. From the filter, air is routed to the left and right-hand levelling valves, the inversion valves and the air springs. A dump valve is located at the lower right-hand side of the dash that is used to control the deflation of the air springs via the inversion valves. Shut-off valves are located at each air spring that can be used to isolate any air spring that may be punctured.

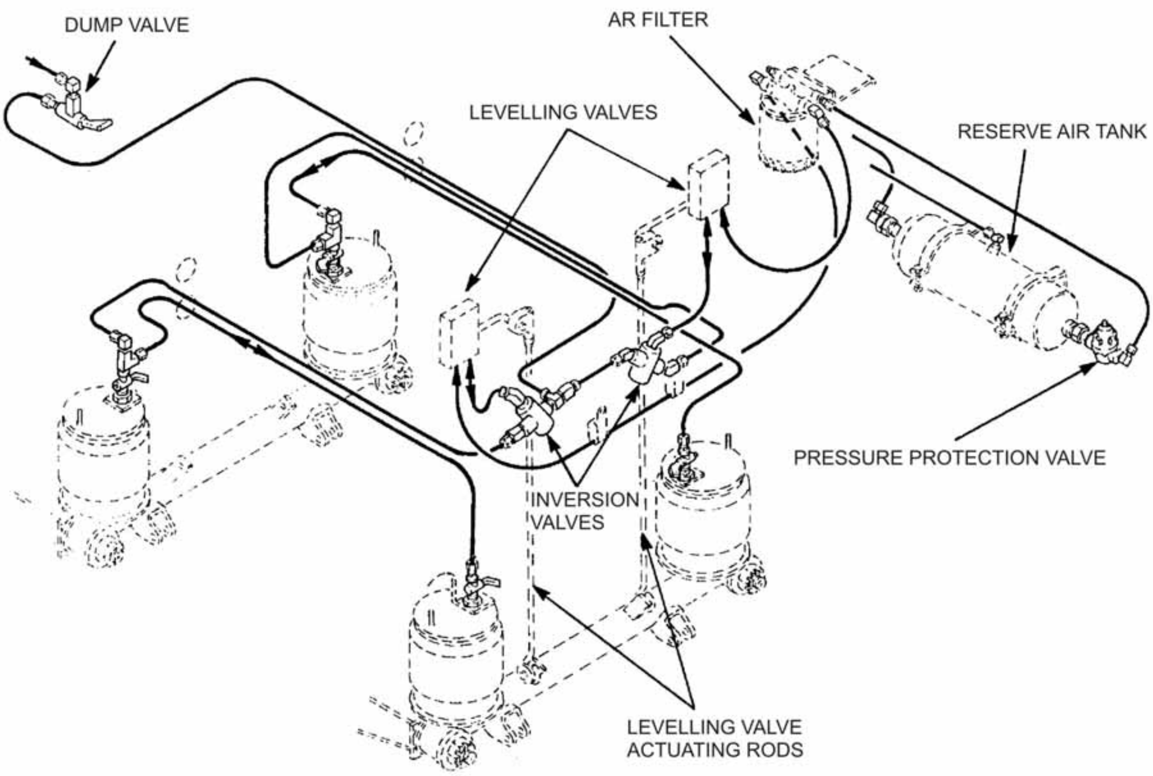


Figure 171 Air Spring Suspension System – Air Supply

273. One levelling valve and one inversion valve are used to control the two air springs on each side of the vehicle. With the engine running and an air pressure of 448 kPa at the pressure protection valve, the valve opens and allows air to flow to the air springs via the air filter, levelling valves and the inversion valves.

274. The levelling valve (Figure 172) maintains the desired ride height by automatically adding air to or exhausting air from the system, via the action of the levelling valve linkage attached to the rear axle assembly and the levelling valve eccentric shaft. As load is applied, the levelling arm moves from its neutral position to the UP (intake) position. The levelling valve is then open allowing air to pass to the air springs, which raises the vehicle body and brings the levelling arm back to a neutral position closing OFF the air supply. As load is removed, the levelling arm moves from its neutral position to the DOWN (exhaust) position. This opens a port in the levelling valve and allows air to pass from the air springs via the inversion valve to exhaust. When the set ride height is obtained, the flexible link moves the inversion valve and allows the air in the air springs to exhaust.

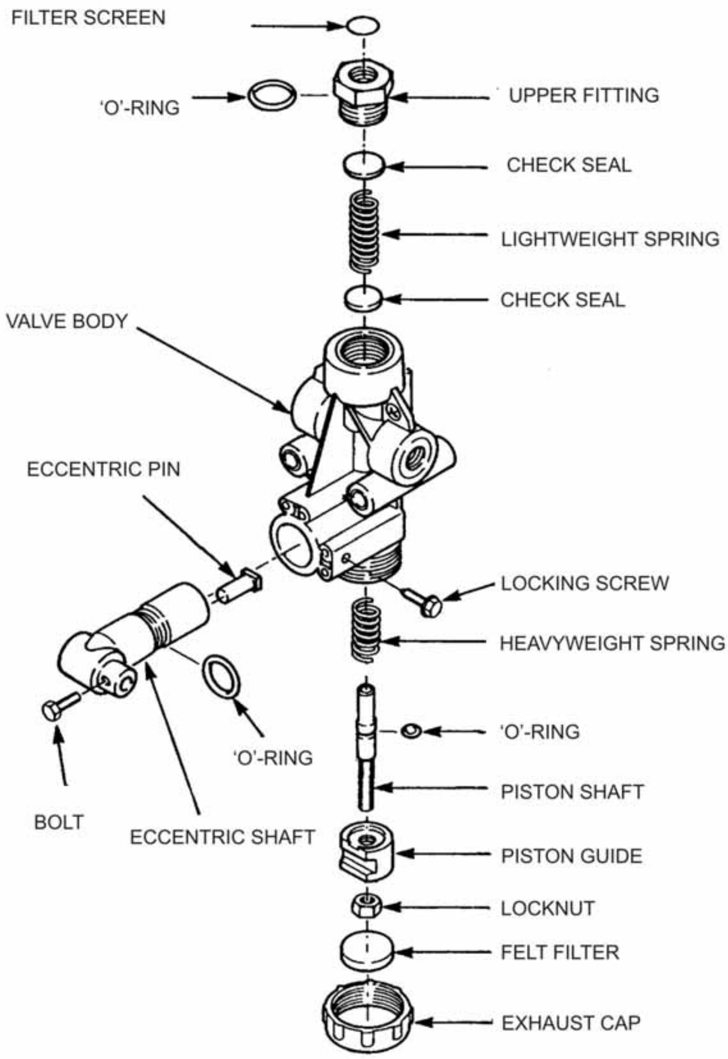


Figure 172 Levelling Valve – Exploded View

275. When the dump valve toggle switch is returned down to the inflate position, air supply to the inversion valves is ceased. This allows the levelling valve air pressure to close the inversion valve exhaust port and allow the air springs to inflate. The inversion valves, in conjunction with the cabin mounted dump valve, allows the air springs to be deflated if a requirement exists.

276. Air supply for the dump valve is sourced from the secondary tank via the air horn switch. The inversion valve (Figure 173) is a normally open valve that is closed by using air pressure from the reserve air tank via the levelling valve. With the engine running and the dump valve toggle switch raised, air supply from the secondary tank will flow from the dump valve to the inversion valve. This air pressure is greater than that supplied from the levelling valve; therefore, the inversion valve piston will rise and close OFF the air supply from the levelling valves.

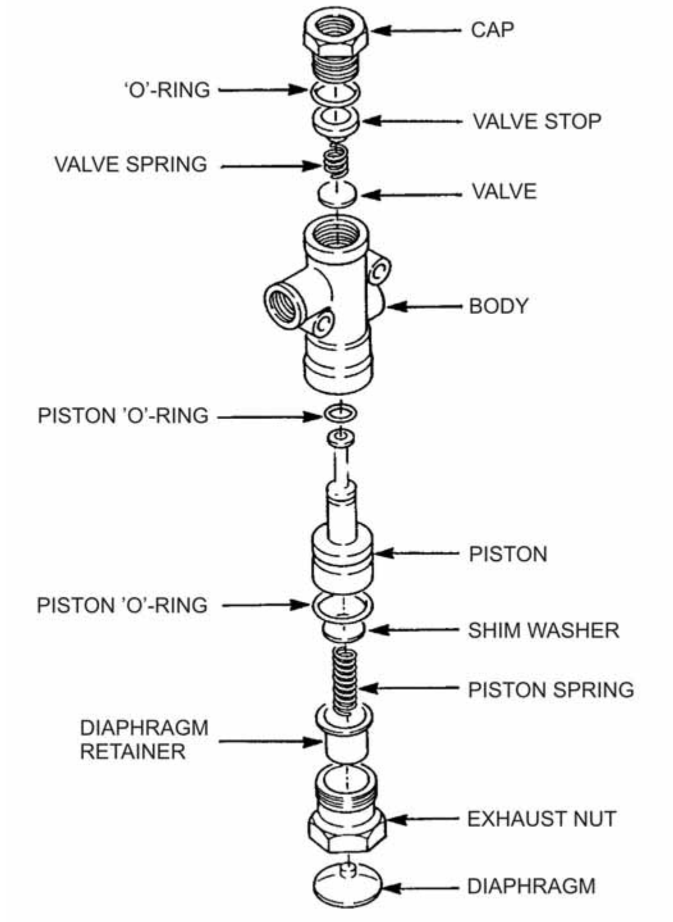


Figure 173 Inversion Valve – Exploded View

277. Each rear axle assembly has a mounting plate attached to the rear of the assembly to locate the transverse torque rods. The rear/rear brake air chamber and spring brake assemblies on each side are transposed to provide clearance for the air springs.

278. The axle assemblies are attached to the axle beam hangers by bolts, washers and nuts, with the beam hangers then secured to the four under-slung equalising beams by bolts, washers, adaptor bushings and nuts.

END

Distribution List: **VEH G 51.0 – Code 1** (Maint Level)
(Sponsor: LVSPO, Medium/Heavy B Vehicles)
(Authority: CGSVSPO 32/11)