TRUCK, TRACTOR, HEAVY, MC4

INTERNATIONAL SF2670 W/INTEGRAL SLEEPER

TECHNICAL DESCRIPTION

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

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INTRODUCTION

1. This EMEI contains the technical description of the Truck, Tractor, Heavy Mobility Category (MC) 4 as shown in Figure 1. All relevant weights, dimensions and performance figures are detailed in EMEI Vehicle G 880.

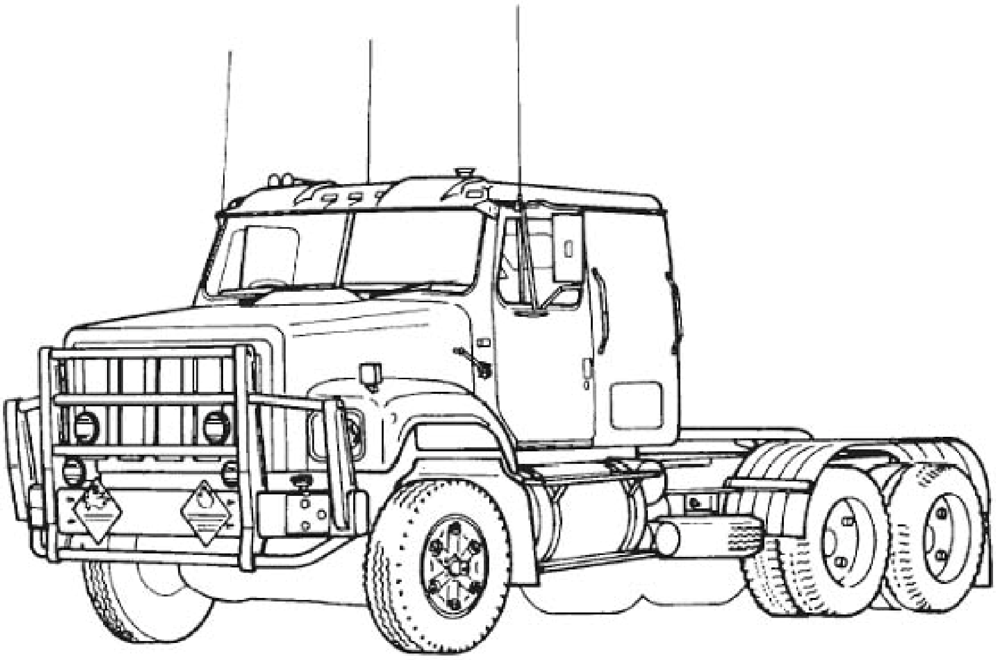


Figure 1 Truck, Tractor, Heavy, MC4

GENERAL INFORMATION

Engine

2. The engine used in the vehicle is a Cummins NTG365 14.0 litre, in-line six cylinder, four-cycle diesel, equipped with a Cummins HT3B turbocharger (Figures 2 and 3). Three cross flow cylinder heads are used on the engine, each with eight valves (four per cylinder). The engine has a compression ratio of 14.0:1, with bore and stroke dimensions of 140 mm x 152 mm respectively. The power developed by the engine is 272 kW (365 bhp) at 2100 rpm, with a peak torque of 1797 N.m (1325 lbf.ft) at 1300 rpm.

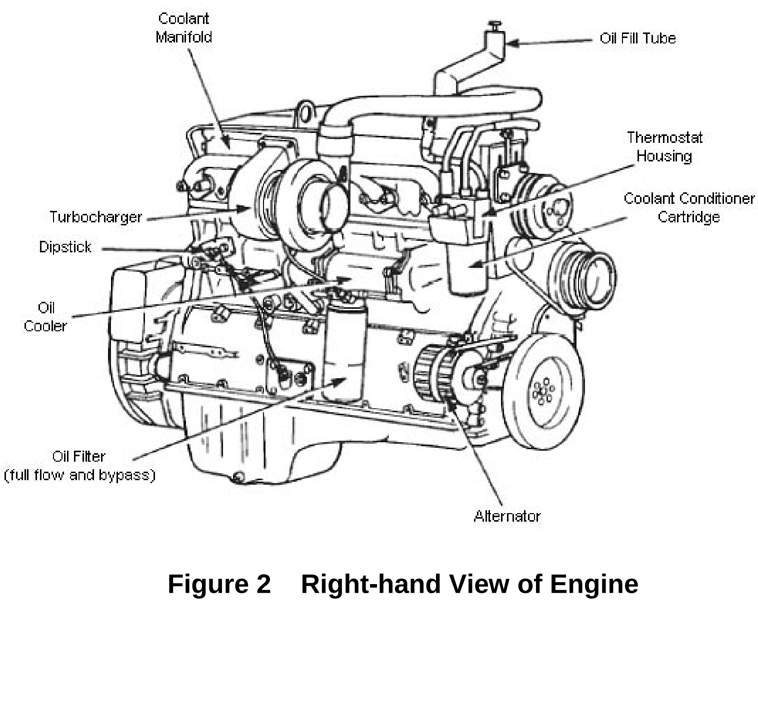


Figure 2 Right-hand View of Engine

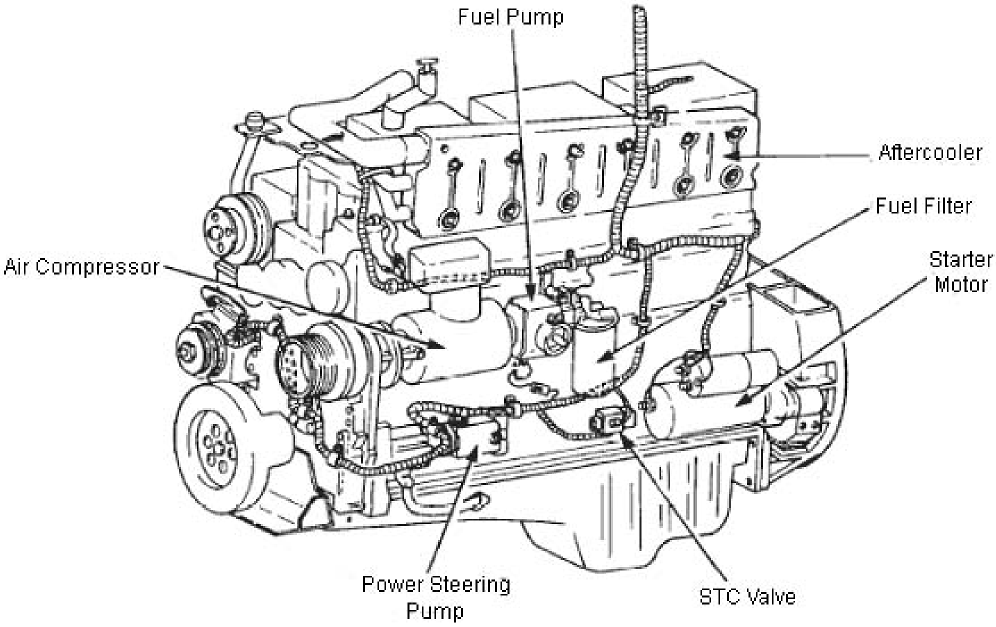


Figure 3 Left-hand View of Engine

Engine C-Brake

3. The engine is fitted with a Cummins C-Brake which, when activated, converts the normal operation of the engine to that of an energy absorbing device, similar to the operation of a compressor, increasing the retardation forces of the engine. When activated by the driver, the C-brake assists the vehicle's service braking system, improving the vehicle's braking efficiency.

Fuel System

4. The vehicle's fuel system provides fuel storage and a means of filtering and pumping the fuel from storage to the engine. The pump also controls the pressure and quantity of fuel delivered to the injectors, which meter the fuel and inject the exact amount of fuel required to maintain optimum engine efficiency.

Clutch

5. A Spicer AS-1552 clutch, positioned between the engine and transmission, is used to provide a means of transmitting engine drive to the transmission. The clutch is a driver controlled, pedal actuated device.

Transmission

6. The transmission is a Spicer 1420-38 20-speed. The transmission is primarily a 12-speed progressive type fitted with a high/low ratio splitter, effectively giving the vehicle twenty forward gears and four reverse gears.

Power Take-off (PTO)

7. A Powauto AH30BLll power take-off is bolted to the underside of the transmission to provide drive for the hydraulic pump. When operating, the power take-off selector gear is meshed with and driven by a gear in the transmission. The power take-off then transmits drive to the hydraulic pump.

Hydraulic Pump

8. A Powauto DO24 pump is used to provide hydraulic fluid, under pressure, to operate the winch on the tank/transport trailer. The pump is secured to the output shaft flange on the power take-off and is driven by the output shaft. The hydraulic fluid is stored in a 227 litre tank on the right hand side of the vehicle.

Propeller Shafts

9. The vehicle is equipped with three Spicer propeller shafts. Two 1810 series propeller shafts, joined by a centre bearing, transmit drive from the transmission to the intermediate axle, and a 1710 series shaft transmits drive from the intermediate axle to the rear axle.

Rear Axle Bogie

10. Rockwell SSHD tandem axles are used as drive axles. An inter-axle power divider lockout is incorporated in the intermediate axle to provide driver controlled positive drive to both the intermediate and rear axles. The bogie assembly has a load rating of 20.9 tonne.

Front Axle

11. The front axle is a Rockwell FG941 reversed Elliot I-beam type with a load rating of 6.6 tonne.

Brakes

12. The service brakes on the vehicle are a dual circuit, air actuated S-cam type, with spring actuated emergency/parking brakes.

Air System

13. A Cummins air compressor, installed on the engine, provides the air required to operate the vehicle's braking system. The pressurised air is stored in reservoirs attached to the vehicle's chassis.

Front Suspension

14. The vehicle's front suspension comprises two semi-elliptic leaf springs and two double-acting shock absorbers.

Rear Suspension

15. The vehicle's rear suspension comprises two camel-back leaf springs and six torque rods.

Steering

16. A Sheppard M392/292 power assisted steering system, including a slave steering box, is used to provide driver control of the front (steerable) wheels.

Electrical

17. A 12-volt electrical system is used on the vehicle, providing vehicle lighting and a means of starting the engine. The vehicle is equipped with both civilian and military lighting; either can be selected as necessary. A Leece-Neville alternator is used for battery recharging and provides power to the electrical system. A Delco Remy 42 MT series, non-reduction type starter motor is used to crank the engine.

Chassis

18. The vehicle's chassis consists of two parallel rails, which are held in position by means of four crossmembers. The chassis forms the basis of the vehicle, as all components are secured either directly or indirectly to the chassis.

19. The vehicle's body consists of two box sections, an engine compartment and a two door cab (with an integral sleeper cab).

Wheels

20. The wheels on the vehicle consist of 8.25 DC x 22.5 inch one piece rims on cast spoke hubs. Each rim is fitted with an 11 R22.5 16 ply tubeless radial tyre

DETAILED TECHNICAL DESCRIPTION

ENGINE

Construction

21. The engine block (Figure 4) is a one-piece casting made of alloy cast-iron. It comprises the cylinder block (upper section) and the crankcase (lower section).

22. The engine's cylinders are formed by removable press-fit wet liners which are installed in the upper section of the engine block. When installed, the cylinder liners form part of the water jacket where engine coolant can dissipate the heat directly from the liners, hence the term 'wet liners'.

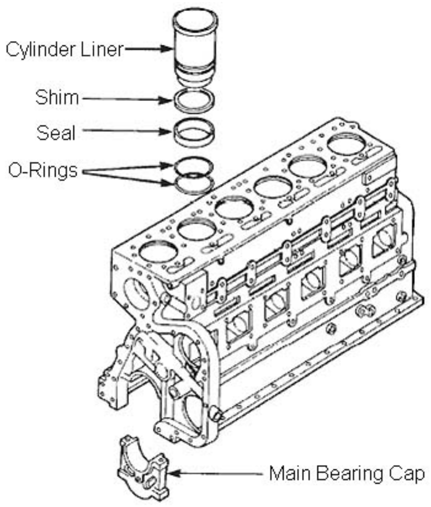


Figure 4 Engine Block Assembly

23. The crankshaft (Figure 5) is made from a high tensile steel forging which is machine ground to close limits and fully counterweighted. The crankshaft revolves in seven replaceable precision shell-type main bearings. Bearing caps and bolts secure the crankshaft to the lower section of the engine block. The crankshaft end-float is controlled by thrust bearings located at the number seven main bearing.

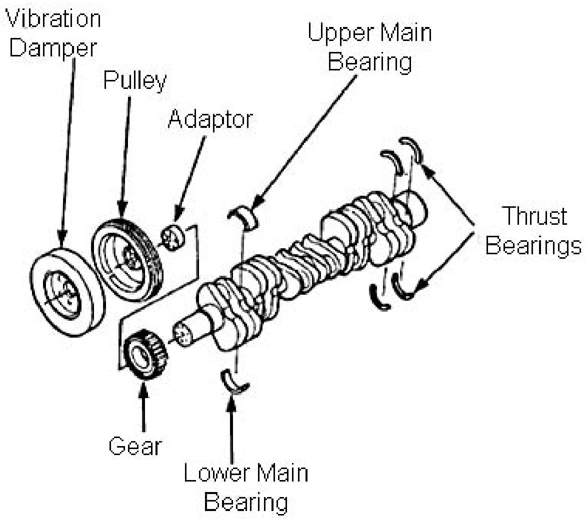


Figure 5 Crankshaft Assembly

24. The piston connecting rods (Figure 6) are made of drop-forged steel and machined to fit a bearing at the crankshaft (or large) end, and a bush at the piston (or small) end. The connecting rod is used as a means of connecting the piston to the crankshaft. A removable bearing cap, which is bolted to the large end of the connecting rod, enables a precision shell-type bearing to be installed and the connecting rod secured to the crankpin on the crankshaft. A passageway through the length of the connecting rod permits pressurised oil from the passageway in the crankpin to lubricate the gudgeon pin (piston pin).

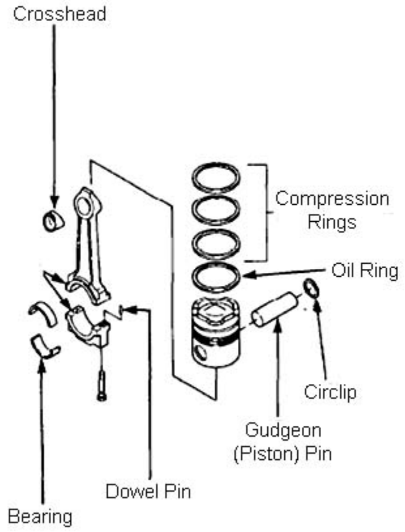


Figure 6 Piston and Connecting Rod

25. The pistons (Figure 6) are made of high strength aluminium alloy with a nickel iron alloy insert cast into each piston. The insert forms the top two ring grooves of the piston, and helps to extend both piston and ring life. Each piston is fitted with three compression rings and one oil ring. The recess cast into the top of the pistons forms the combustion chamber for each cylinder, while the four indents machined into the crown of the pistons, permit the inlet and exhaust valves to open without making contact with the piston. The pistons are fully floating and secured to the connecting rod by means of a gudgeon pin (piston pin) which is held in position in the piston by two circlips.

26. Figure 7 illustrates one of the three detachable cylinder heads used to seal the engine's cylinders (one cylinder head per two cylinders). The cylinder heads are manufactured from alloy cast iron and provide the cylinders with inlet and exhaust ports. Dual inlet and exhaust valves and seats are used to effectively seal the inlet and exhaust ports. Each valve is 47 mm in diameter across the head, and the exhaust valves have a wear and high temperature resistant face. The valve seats are inserts secured in position in the cylinder heads by an interference fit. Coil springs are used to close each valve against the valve seats, while pushrods, rocker arms and crossheads are used to open the valves. Water jackets cast into the cylinder heads direct coolant flow around the valve stems, valve seats and the inlet and exhaust ports to dissipate the heat from the cylinder head. Provision is made in the cylinder heads for the fitting of the fuel injectors, which enables fuel to be injected directly into the combustion chamber in each piston. A clamp secures each injector assembly to the cylinder head.

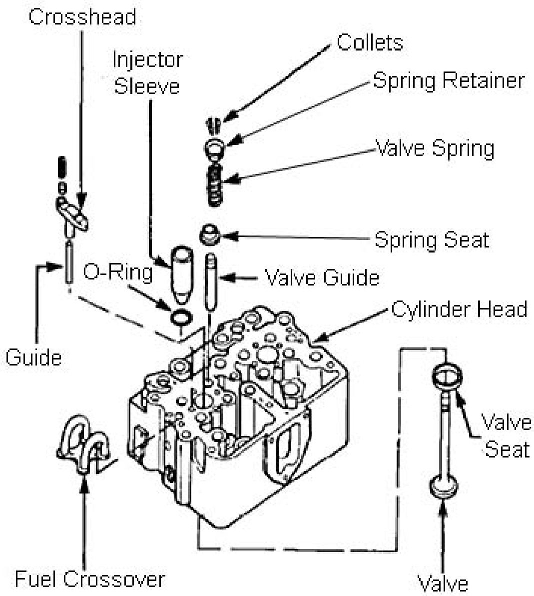


Figure 7 Cylinder Head - Exploded View

27. The camshaft (Figure 8) controls the opening and closing of the inlet and exhaust valves. The camshaft is precision ground from a solid drop forging and comprises eighteen lobes and seven bearing journals. Each of the engine's cylinders use three lobes, of which two control the inlet and exhaust valve opening and closing, while the remaining lobe controls the operation of the fuel injector. The camshaft revolves in seven replaceable precision bearings located in a bore in the crankcase section of the engine block. Drive for the camshaft comes directly from the crankshaft by means of timing gears fitted to the crankshaft and to the end of the camshaft. The timing gears have a two to one ratio i.e. the crankshaft revolves twice for every one revolution of the camshaft.

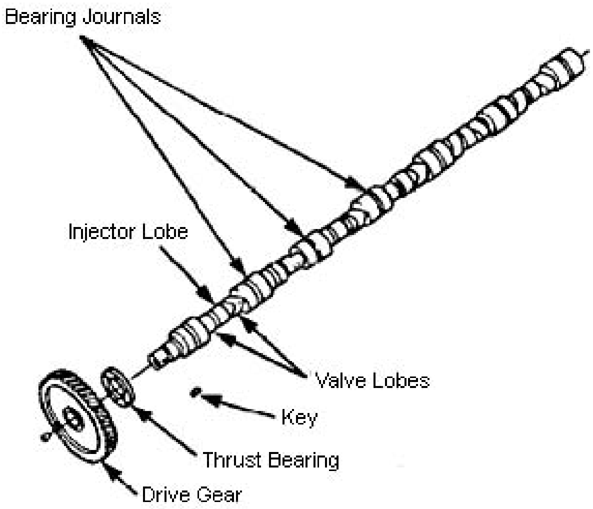


Figure 8 Camshaft

28. The flywheel assembly (Figure 9) is bolted to the rear flange on the crankshaft. It is machined from a solid drop forging and performs three functions for the engine. Firstly, the flywheel provides a large circumference onto which a ring gear is heat shrunk, providing the starter motor with the gearing required to rotate the crankshaft and start the engine. Secondly, the mass of the flywheel keeps the crankshaft rotating between the power strokes of the six cylinders, which are 120^{o} apart, enabling the engine to run smoothly. Thirdly the flywheel provides for the mounting of the clutch assembly, as well as the surface area required to operate the clutch.

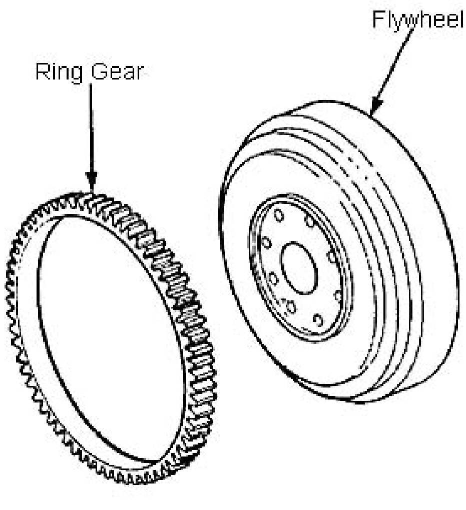


Figure 9 Flywheel and Ring Gear

Lubrication System

29. The function of the engine's lubrication system (Figure 10) is to provide the working components of the engine with the lubricant required to function smoothly with minimal frictional loss. The lubrication system also assists with the engine's cooling by providing a jet of oil to the underside of each piston, lowering the operating temperature of the pistons. The lubrication system comprises the:

a. oil pan (sump);

b. oil pump;

c. pressure regulating valve and limiting valve;

d. temperature controlled oil cooler valve;

e. oil cooler;

f. oil filter; and

g. oil galleries.

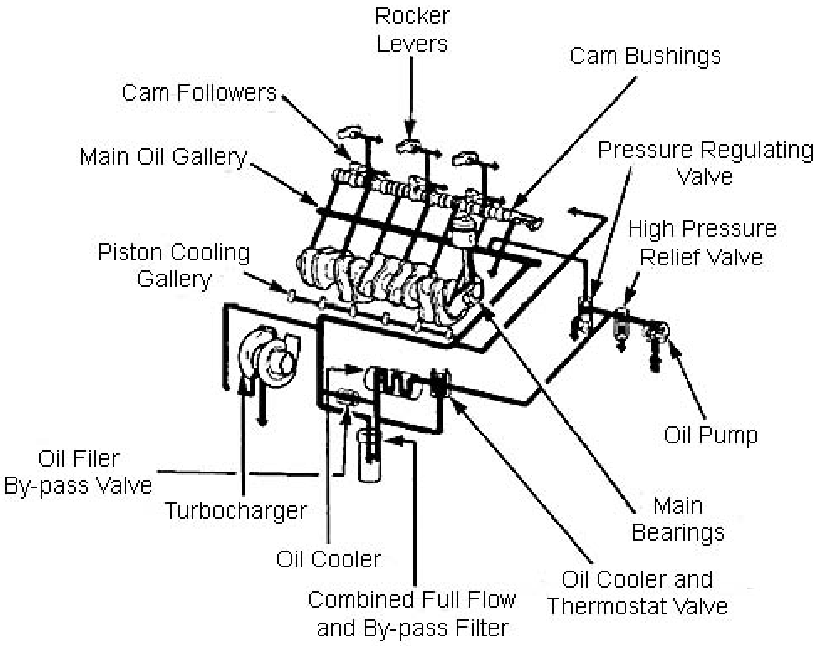


Figure 10 Engine Lubrication System

30. The oil pan assembly (Figure 11) is of pressed steel construction and secured by bolts to the bottom of the engine block to provide a storage reservoir for the engine's lubricating oil. The oil pan has a storage capacity of approximately 39 litres, which can be monitored for both quantity and quality by means of a dipstick located on the right-hand side of the engine.

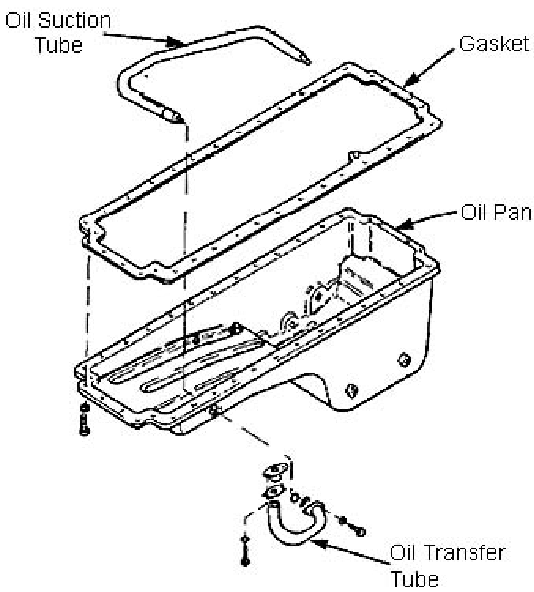


Figure 11 Oil Pan Assembly

31. The oil pump (Figure 12) is a spur gear type located on the left-hand side of the engine at the rear of the timing case. The pump, which is driven by the camshaft timing gear, uses a pair of meshing spur gears; one gear is driven by the pump drive shaft, while the second gear is caused to rotate by the first. The pump is a self priming type i.e. when the pump gears are rotating, a low pressure area is created within the pump housing, atmospheric pressure then forces oil through the inlet strainer and inlet tube into the pump housing. The meshing of the spur gears displaces the oil from the pump into the oil galleries, where it flows through the oil cooler and oil filter to the various components requiring lubrication.

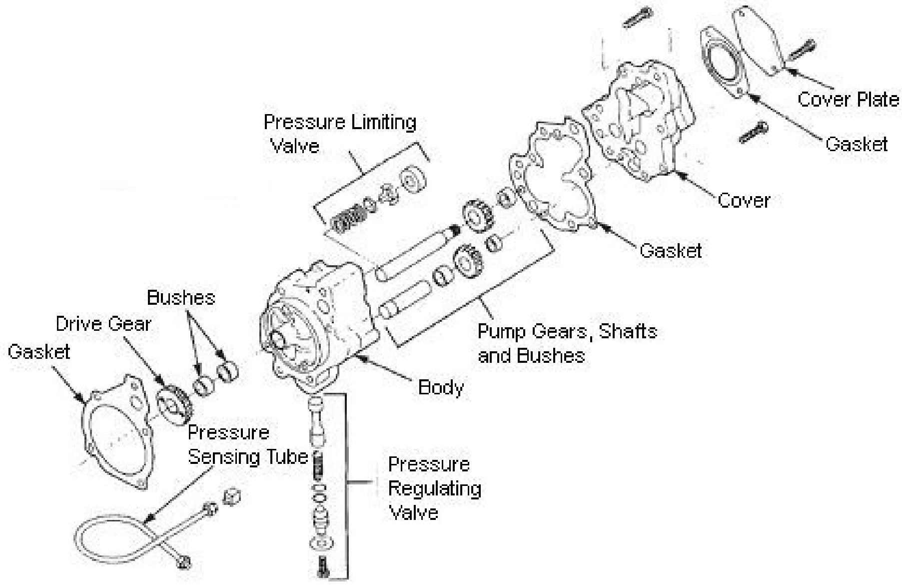


Figure 12 Oil Pump - Exploded View

32. Because of the close tolerances of the working components of the engine, the oil flow from the galleries to these components is restricted. As the pump operates continuously while the engine is running, these restrictions cause the oil to increase in pressure as it accumulates in the galleries. To prevent an excessive build-up of oil pressure, which could damage bearings and oil seals, an oil pressure regulating valve and a high pressure limiting valve (Figure 13) have been incorporated in the lubrication system.

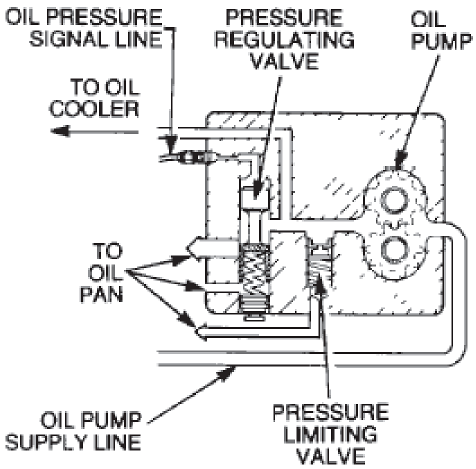


Figure 13 Pressure Regulating Valve and Pressure Limiting Valve Operation

33. Both the regulating valve and the limiting valve are located in the oil pump housing. The regulating valve comprises a plunger and a compression spring whilst the limiting valve comprises a disc valve and a compression spring. While oil pressure in the galleries remains below 275 kPa (40 psi) both valves remain closed. However, if the oil pressure exceeds 275 kPa (40 psi) the regulating valve applies pressure to move against the existing pressured spring, opening a return port which allows excess oil to return to the oil pan, thus regulating the oil pressure to approximately 240-319 kPa (35-46 psi) at 2100 rpm.

34. The high pressure limiting valve is a lubrication system protection valve, which remains in the closed position while the oil pressure in the lubrication system is below 965 kPa (140 psi). If the oil pressure exceeds 965 kPa (140 psi), e.g. during cold start-up, the limiting valve moves against spring pressure and allows excess oil to flow to the oil pan via a port located below the valve, preventing damage to the lubrication system components.

35. The pressurised oil from the oil pump flows through a gallery to the oil cooler and oil filter assembly (Figure 14) where a temperature controlled oil cooler by-pass valve directs the oil either through the oil cooler to the oil filter or directly to the oil filter, depending upon the temperature of the oil. When the temperature of the oil is below 110°C (230°F) e.g. cold start up, the temperature sensitive by-pass valve is in the retracted position, allowing approximately 60% of the oil from the pump to flow directly to the oil filter. Once the oil temperature exceeds 110°C (230°F) the by-pass valve expands and closes off the by-pass port, redirecting the oil through the oil cooler to the oil filter. After the oil has cooled below 107°C (225°F) the by-pass valve opens the by-pass port and allows approximately 50% of the oil to flow directly to the oil filter, by-passing the oil cooler. In this manner the by-pass valve enables the oil to be maintained at a constant operating temperature.

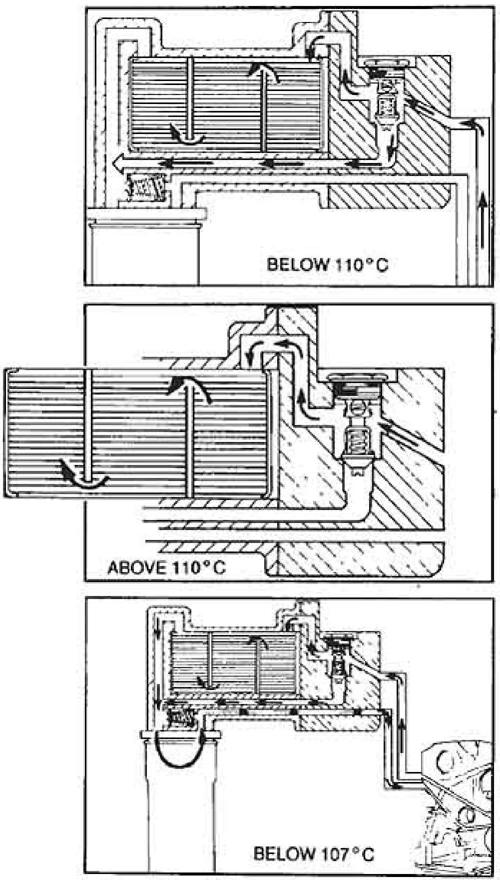


Figure 14 Temperature Controlled Oil Cooler By-pass Valve Operation

36. The oil cooler assembly (Figure 15) consists of an aluminium housing with a cylindrically shaped core, which is made up of a series of tubes connected by fins and positioned in the housing. The housing assembly is bolted to a mounting adapter, which is bolted to the engine block. Engine coolant enters the oil cooler through the rear of the oil cooler and flows forward through the tubes in the core, dissipating the heat from the oil before flowing through the mounting adapter and by-pass pipe to the thermostat housing. Oil is pumped through a port in the oil cooler mounting adapter into the oil cooler housing via the temperature controlled by-pass valve. The oil then circulates over and around the tubes and fins of the core within the housing and the coolant flowing through the core dissipates the heat from the oil. The oil then flows through the oil filter where contaminants are extracted before flowing into the engine's oil galleries via a second port in the oil cooler mounting adapter. A pressure relief valve is incorporated in the oil filter inlet port on the oil cooler housing to allow oil to by-pass the oil filter in the event of oil filter blockage. The by-pass comprises a by-pass valve piston, a pressure sensing piston, a bypass valve plunger and two compression springs. The turbocharger oil supply line is connected to the oil filter inlet port, ensuring that the turbocharger has lubrication the instant the engine is started, thereby preventing turbocharger bearing damage.

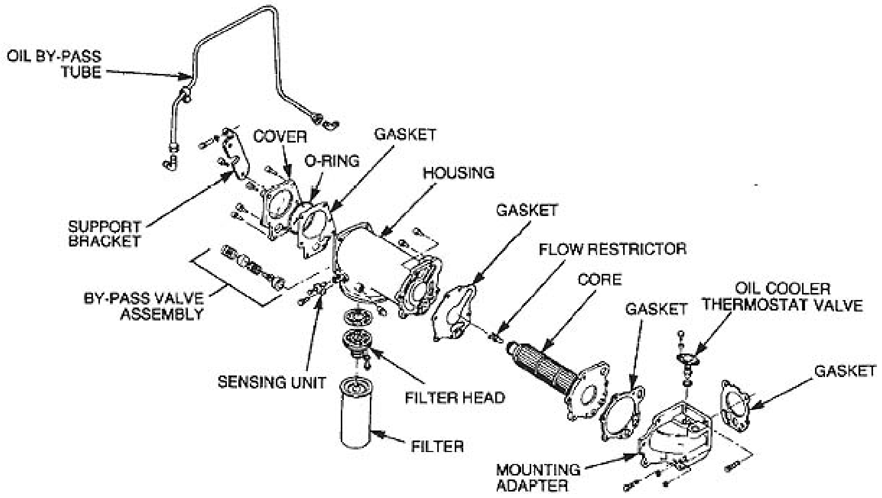


Figure 15 Oil Cooler - Exploded View

37. The oil galleries are passageways within the engine block and cylinder heads which carry the lubricating oil to the various components of the engine, e.g. crankshaft bearings, camshaft bearings and lobes, piston cooling nozzles and valve rocker components.

Cooling System

38. The cooling system on the vehicle not only provides a means of maintaining the engine's operating temperature at a constant level, but also provides a means of cooling the engine's intake air. The system is called optimized after-cooling (OAC) and comprises:

- **a.** thermostats (two of);
- **b.** a multi-pass radiator;
- **c.** an intake air aftercooler.
- **d.** water jackets (engine block and cylinder heads);
- **e.** the water pump; and
- **f.** the cooling fan.

39. The OAC (Figure 16) uses two flow routes or loops for the coolant, the block loop and the cooling loop.

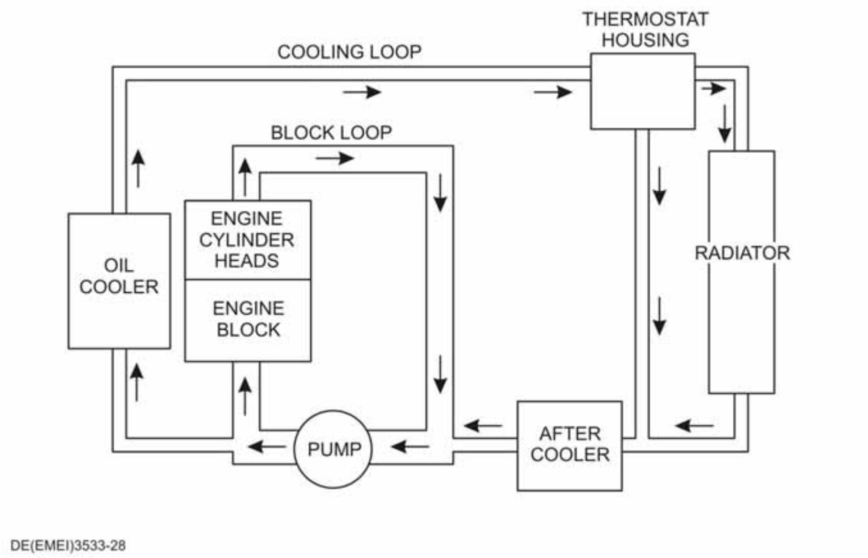


Figure 16 Cooling System Flow Routes

40. In the block loop, the coolant flows from the water pump into the engine block, through the engine block to the cylinder heads. The coolant then flows through balance orifices into the water manifold where it returns to the water pump. Approximately 85% of the coolant in the cooling system flows through the block loop while the engine is running.

41. In the cooling loop, coolant flow is controlled by two thermostats, the by-pass and radiator thermostats. When the coolant temperature is below 79°C (174ºF), the radiator thermostat is closed and the by-pass thermostat is wide open. Coolant is directed to flow from the water pump into a gallery in the engine block and from the gallery into the oil cooler. The coolant enters at the rear of the oil cooler (Figure 17) and flows forward through the oil cooler to the mounting adapter, via a by-pass pipe, into the thermostat housing.

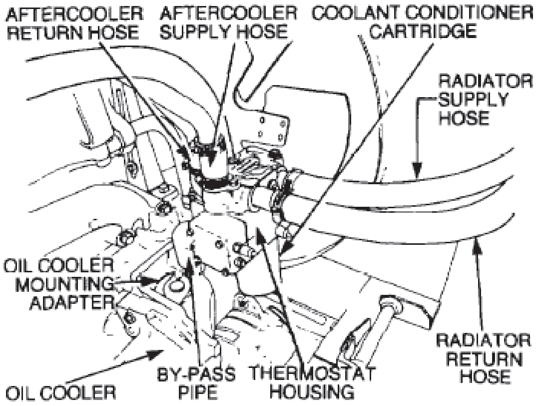


Figure 17 Thermostat Housing Location

42. The coolant flows through the by-pass thermostat to the OAC (Figure 18) circulates through the OAC and returns to the water pump, via the thermostat housing.

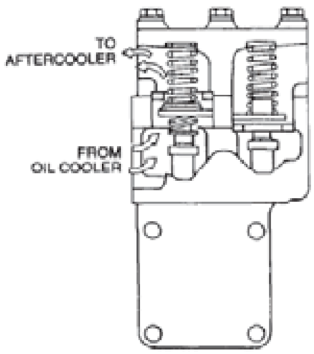


Figure 18 Coolant Flow Through By-pass Thermostat

43. When the temperature of the coolant reaches 79°-85°C (174°-185°F) the by-pass thermostat begins to close and the radiator thermostat begins to open. At this stage, coolant flows through both thermostats as they work together to control the flow and stabilise the temperature of the coolant to the OAC (Figure 19).

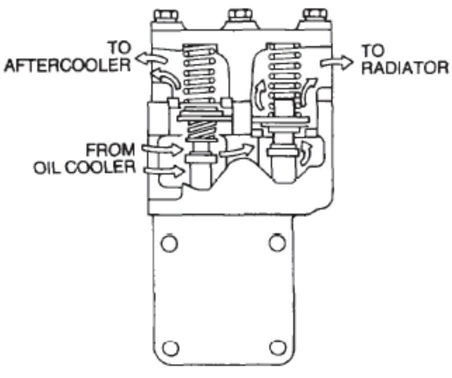


Figure 19 Coolant Flow Through Both Thermostats

44. The by-pass thermostat is closed when the coolant temperature reaches 85°C (185°F) and the radiator thermostat is fully open when the coolant temperature is above 90°C (194°F). Coolant is now directed to flow through the radiator (Figure 20) to be cooled before flowing to the OAC, via the thermostat housing, instead of flowing from the oil cooler to the OAC, via the thermostat housing.

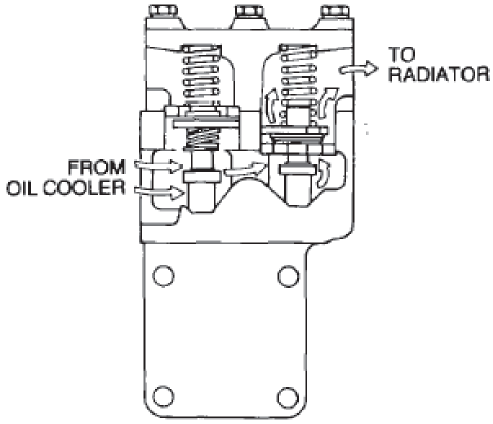


Figure 20 Coolant Flow Through Radiator Thermostats

45. The radiator (Figure 21) is a specially designed low flow rate multi-pass cross-flow type, with a small (32 mm diameter) inlet and outlet ports located in the same end-tank. Although the inlet and outlet ports are adjacent to one another, a baffle plate installed in the end tank keeps both parts separate. Coolant flows from the thermostat housing to the upper (inlet) port on the end tank and from there to the tank on the opposite end of the radiator, via the flutes in the upper half of the radiator core. When the coolant reaches the end tank, gravity causes the coolant to flow downward to the lower flutes where it is drawn back across the radiator core to the outlet (lower) port. Tubulated flutes (with either dimpled or Z-wire pattern internal walls) are used to allow the coolant to make contact with the walls of the flutes, transferring the heat to the flutes and the fins. The air flow through the radiator core dissipates the heat from the flutes and fins. The multi-passing of the coolant in the radiator and the low flow rate and the large surface area of the radiator cools the coolant to a lower temperature than can be achieved by a conventional system.

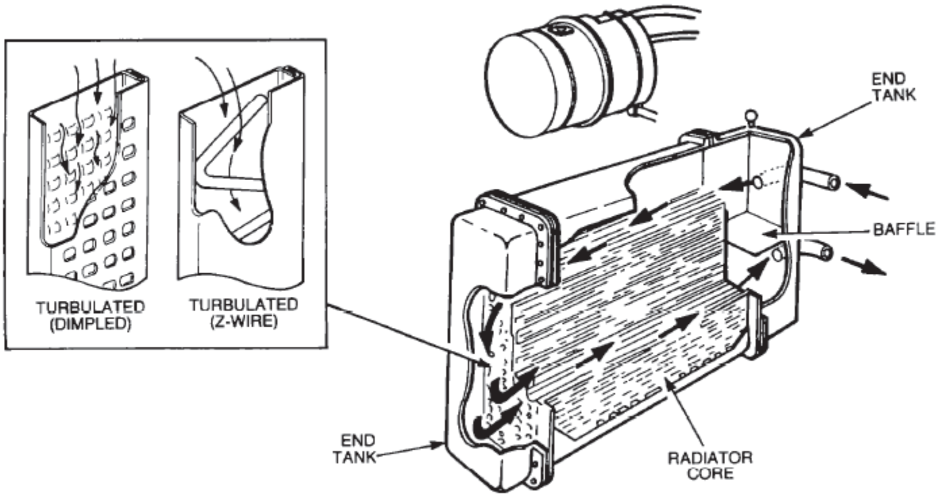


Figure 21 Radiator Coolant Flow

46. After being cooled in the radiator, the coolant flows to the OAC via the thermostat housing. The OAC is a small version of the cooling system radiator, completely enclosed in housing, except for the coolant inlet and outlet ports. Coolant flows through the lower (inlet) port to the lower half of the OAC core where it flows along the flutes to the end tank (Figure 22). The coolant then flows upward to the upper section of the core, through the flutes to the outlet (upper) port, and from there to the thermostat housing. The engine intake air, which is heated by the compressor action of the turbocharger, passes over the fins and flutes of the OAC core, transferring the heat to the core. The coolant flow through the OAC core dissipates the heat from the core, cooling the intake air, which increases in density as it cools and ensures optimum combustion of the fuel in the engine.

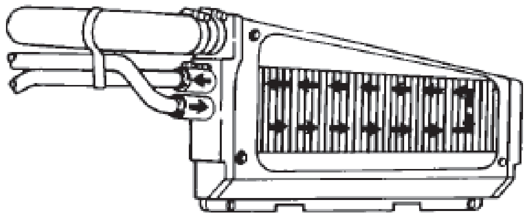


Figure 22 Coolant Flow Through the OAC

47. The water jackets are passageways for coolant, which are incorporated in the engine block and cylinder heads during the initial casting procedure. The water jackets (Figure 23) permit coolant to flow over the areas where most of the engine's heat is generated, enabling the engine's hot spots to be maintained at a constant temperature, without which the engine would overheat and eventually seize.

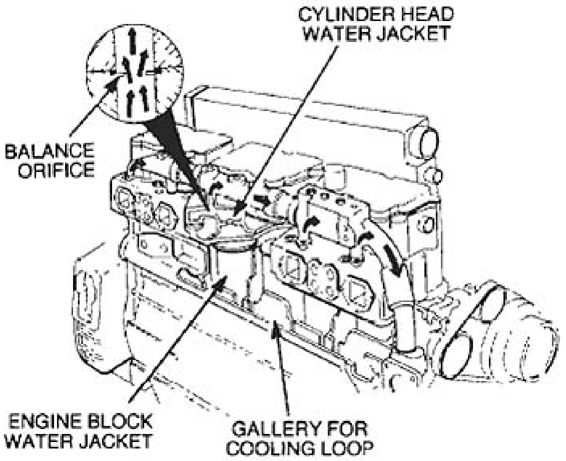


Figure 23 Water Jacket Locations

48. The water pump is an assembly bolted to the front of the engine block below the cylinder head. The assembly comprises a housing, a pulley, two bearings, a shaft, a seal and an impeller. The pump is a belt driven centrifugal type (Figure 24). Drive for the water pump comes from the auxiliary drive shaft via a multi-vee drive belt. An adjustable idler pulley, located on the side of the water pump housing, is used for drive belt tension adjustment.

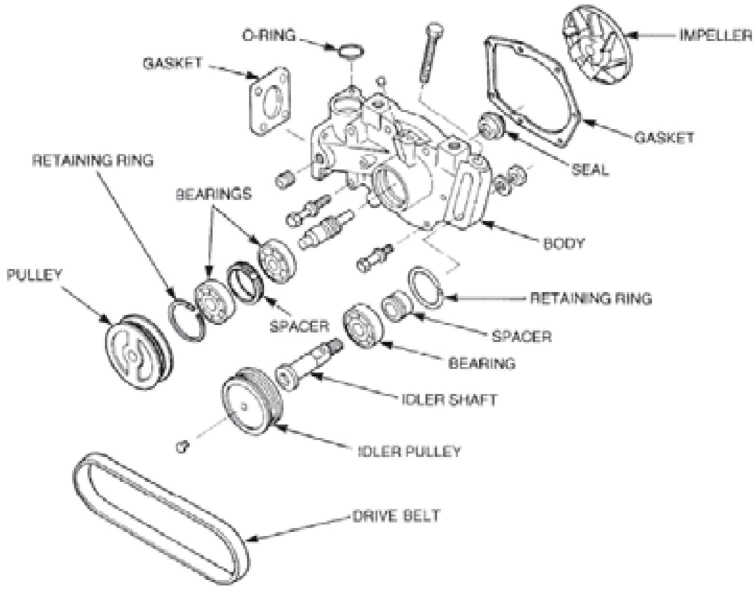


Figure 24 Water Pump and Idler - Exploded View

49. An eight-blade fan is used to assist with engine cooling by drawing air over the radiator fins, cooling the contents of the radiator, and circulating the air over the extremities of the engine. The fan is secured to a Horton fan clutch (Figure 25) which is a belt driven, clutch-controlled hub secured to a mounting bracket bolted to the top of the engine block. The fan or hub clutch is actuated by compressed air, which is controlled by a temperature sensing switch installed in the engine's cooling system. When the engine's temperature reaches a predetermined level, the temperature sensing switch closes, allowing a current to flow to a solenoid controlled air valve, energising the solenoid, which opens the air valve and allows pressurised air to flow to the fan clutch. The pressurised air actuates the fan clutch, which causes the fan to rotate with the belt driven pulley. As the engine's coolant temperature falls below the predetermined level, the temperature sensing switch opens, stopping the current flow to the solenoid controlled air valve, de-energising the solenoid, which closes the air valve and stops the air flow to the fan clutch. The clutch disengages from the pulley, allowing the fan to free wheel or stop.

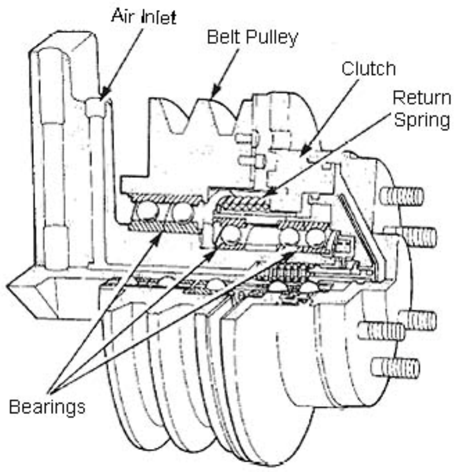


Figure 25 Fan Clutch Assembly - Sectional View

Engine C-Brake

50. The engine C-brake (Figure 26) comprises three housings, one housing for each cylinder head. Each of the housings comprises a solenoid valve, two control valves, two slave pistons and two master pistons.

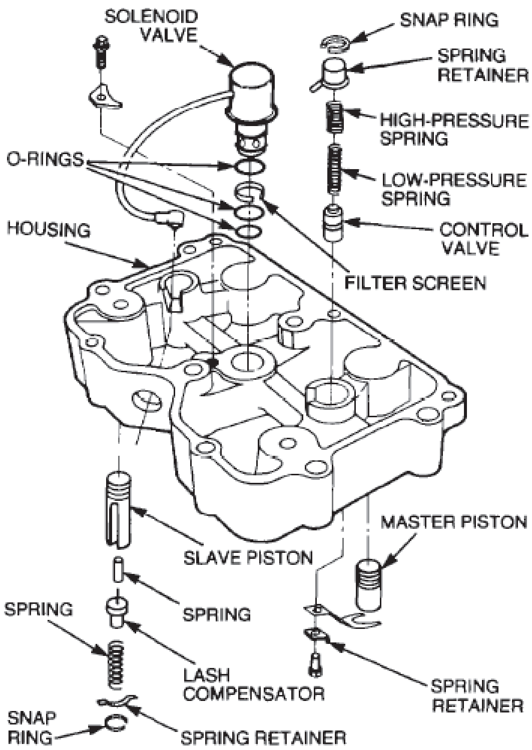


Figure 26 C-Brake Assembly - Exploded View

51. The C-brake system is operated by engine oil at a minimum pressure of 124 kPa (18 psi). The flow of oil through the system in each of the three housings is controlled by the solenoid valves, which are activated by current flow through a series of three switches (Figure 27), the C-brake ON-OFF switch (located on the dashboard), the clutch switch (located on the clutch pedal mounting bracket), and the fuel pump switch (located on the fuel pump and activated by the throttle lever).

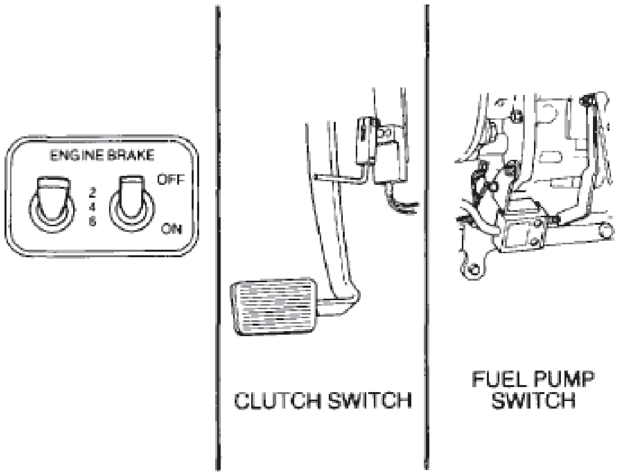


Figure 27 C-Brake Control Switches

52. A fourth switch, which is a three-position switch (located on the dashboard) allows the driver to select the amount of engine retardation required. Position 1 on the switch will activate only one solenoid (two cylinders), position 2 activates two solenoids (four cylinders), and position 3 activates the three solenoids, bringing the six cylinders into operation for maximum engine retardation (Figure 28).

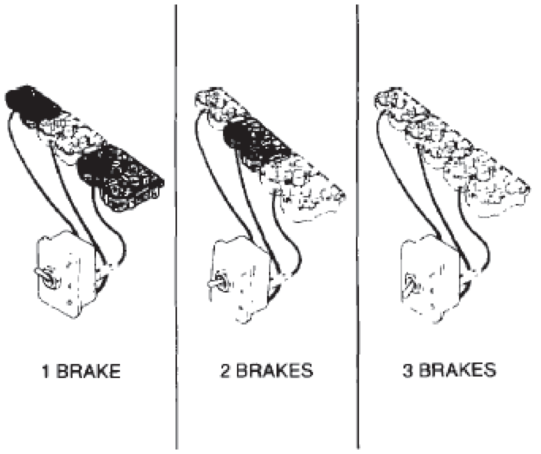


Figure 28 Variable Engine Retardation Selection Switch

53. When the engine is operating normally (the C-brake not applied), engine oil is directed to the solenoid valve, but because all three switches are in the OFF position, current cannot flow and energise the solenoid. When the braking effort of the engine is required, the C-brake switch must be turned ON, and both the clutch and throttle pedals fully released to bring the clutch and fuel pump switches into the ON position. This allows current to flow and energise the solenoid valve. Once the solenoid valve is open, the pressurised engine oil flows through a passage in the C-brake housing to the base of the control valve. The pressure of the oil unseats the ball check valve within the control valve, but the oil cannot flow until the passageway in the control valve aligns with the high pressure oil passage in the housing. A minimum oil pressure of 124 kPa (18 psi) is required to move the control valve to align the passageway with the passage. The oil then flows into the high pressure passage and fills the recesses above the slave pistons and the master pistons. The pressure of the oil forces the master piston (Figure 29) to make contact with the injector rocker arm and adjusting screw and the slave piston moves down to rest against its lash compensator.

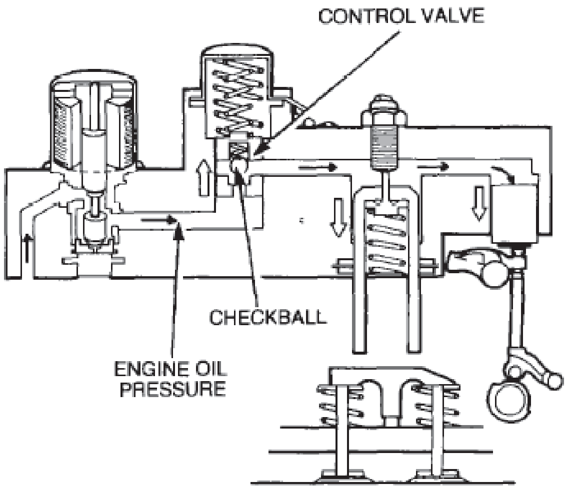


Figure 29 Initial Oil Flow During C-Brake Operation

54. As the injector rocker arm moves upward, in accordance with the rotation of the camshaft, the master piston, which is in contact with the adjusting screw on the rocker arm, also moves upward, reversing the oil flow which closes the ball check valve, trapping the oil in the passage. As the master piston continues to move upward in accordance with the rocker arm movement; the increased oil pressure acts against the slave piston, forcing the slave piston against the spring pressure and making contact with the exhaust valve crosshead. Further upward movement of the master piston (Figure 30) causes the slave piston to open the exhaust valves and allow compressed air to escape from the cylinder.

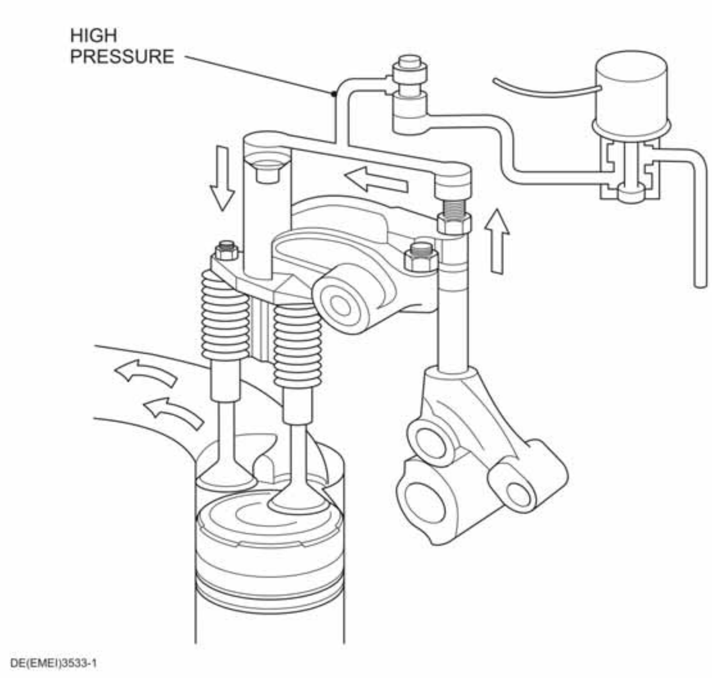


Figure 30 C-Brake Operation

NOTE

If the operating pressure of the oil in the high pressure passage becomes excessive 414 kPa (60 psi) or more, the control valve assembly moves against spring pressure to allow the oil to return to the engine, via the solenoid valve drain aperture.

55. When the C-brake is de-activated the solenoid valve becomes de-energised, blocking off the oil passage from the engine and at the same time opening another passage to allow the oil beneath the control valve to bleed back to the engine. Spring pressure causes the control valve to retract which allows the oil trapped in the high pressure passage to bleed out through the control valve spring retainer. Spring pressure causes both the master piston and the slave piston to retract, allowing normal operation of the engine (Figure 31).

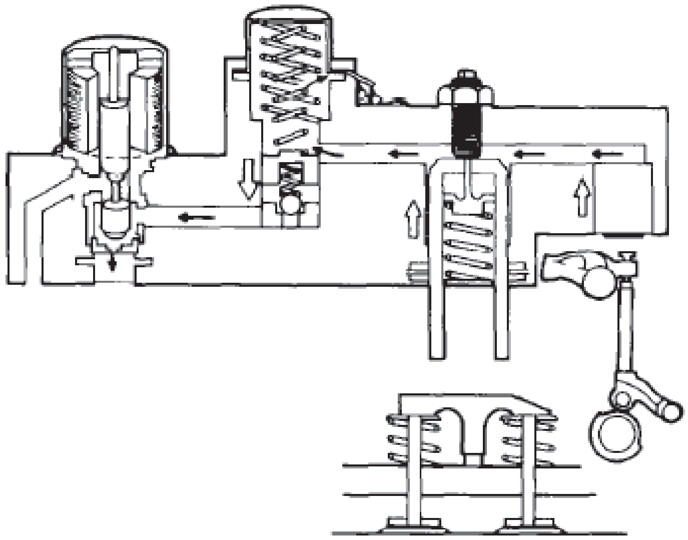


Figure 31 C-Brake De-activated

FUEL SYSTEM

56. The fuel system (Figure 32) comprises:

- **a.** two fuel tanks (a 360 litre tank and a 273 litre tank);
- **b.** a fuel pump and filter assembly; and
- **c.** fuel injectors.

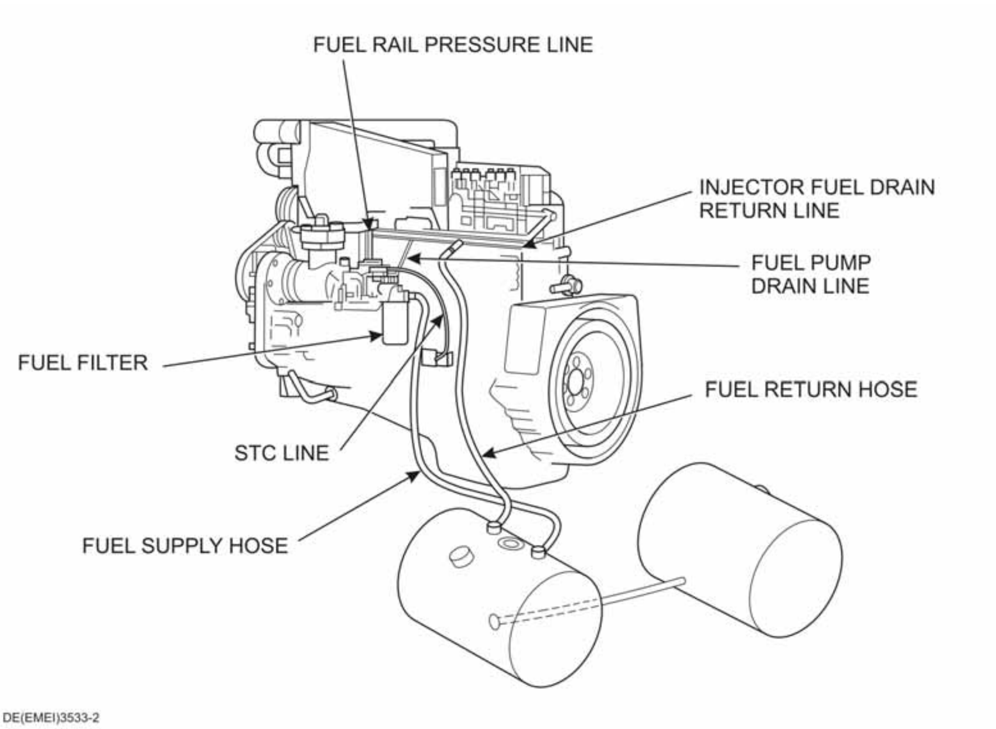


Figure 32 Fuel System

57. Fuel storage is provided by two cylindrical aluminium tanks. Each tank is mounted on two J-brackets and secured to the J-brackets by stainless steel straps (Figure 33). The J-brackets are bolted to the chassis rails, below the cab on either side of the vehicle. The larger fuel tank (360 litres) is located on the left-hand side of the vehicle, and the smaller fuel tank (273 litres) is located on the right-hand side of the vehicle. Both fuel tanks have baffle plates welded to the inside of the tank to reduce fuel surge.

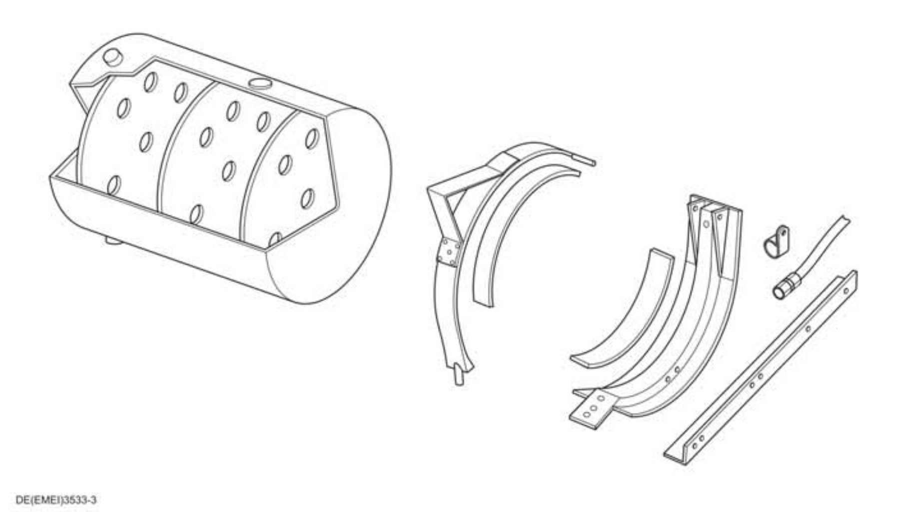


Figure 33 Fuel Tank and Mounting Brackets

58. Fuel for the engine is drawn from the left-hand tank, and fuel overflow from the engine is returned to this tank. A balance hose, connected to an elbow at the bottom of the right-hand tank and to a tap at the bottom of the left-hand tank, interconnects both tanks, enabling fuel to be drawn simultaneously from both tanks. The tap on the left-hand tank provides a means of isolating the right-hand tank, should the need arise.

59. A fuel gauge sender unit is installed in the left-hand fuel tank. The sender unit comprises a float mounted on an arm (Figure 34) which is connected to a rheostat (variable resistor). 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.

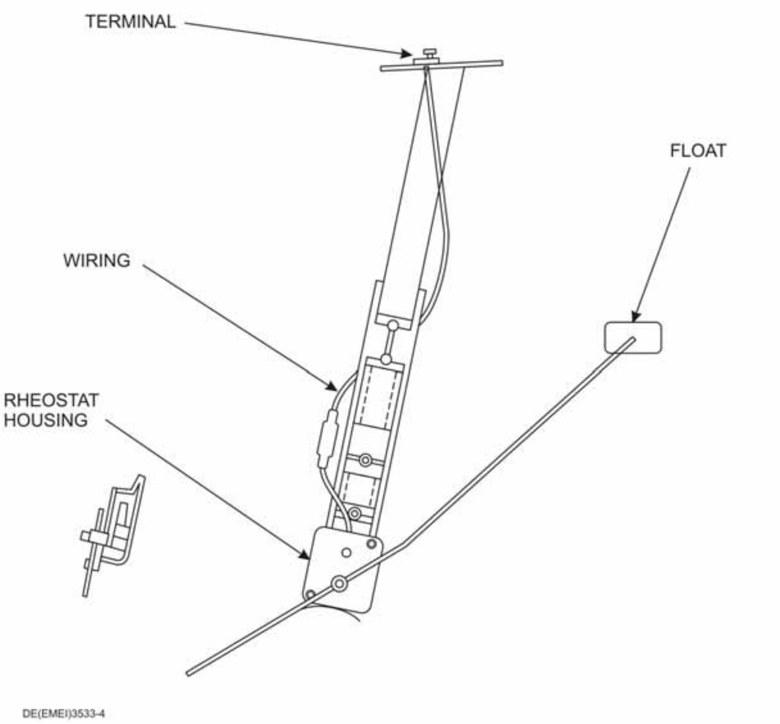


Figure 34 Fuel Gauge Sender Unit

Fuel Flow

60. The fuel drawn from the tanks passes through a disposable spin-on filter before flowing into the fuel pump, where it enters the pressure/time (PT) control section of the fuel system. In this section of the fuel system, the pressure of the fuel delivered to the injector inlet is controlled by the fuel pump, while the time available to fill the cup in the injector is controlled by the engine speed, via the camshaft and injection train.

61. The fuel pump provides the means of maintaining fuel supply from the fuel tanks to the injectors at the flow rate and pressure required to enable the engine to function correctly under varying loads and speeds. Figure 35 illustrates the various components incorporated in the fuel pump which supply and regulate the flow and the pressure of the fuel delivered to the injectors.

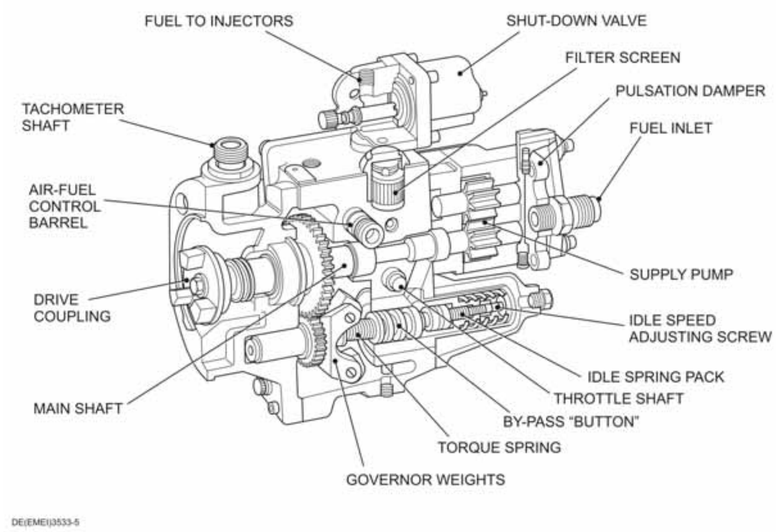


Figure 35 Fuel Pump - Sectional View

62. When the engine is either being started or is operating at idle, the fuel pump, which is mounted on the rear of the air compressor and driven by the compressor crankshaft, is also operating. Fuel is drawn from the fuel tank, through the filter into the low pressure area created in the pump by the action of the rotating spur gears. The fuel (Figure 36) is carried around the outside diameter of the spur gears and displaced through an outlet (discharge) port into a gallery which directs the fuel through a filter (a wire mesh magnetic filter) to the governor supply passage.

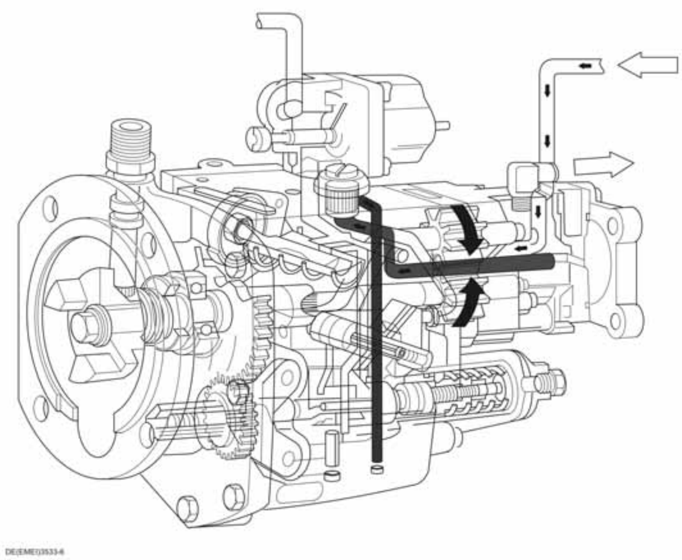


Figure 36 Fuel Flow from Pump to Governor

63. With the engine in either the starting mode or idling, the centrifugal force generated by the flyweights is minimal, allowing the torque control spring to hold the governor plunger in the position that allows fuel to flow through the idle and main fuel passages to the throttle shaft. When the throttle is closed (idle position), fuel flows through the idle passage and around the throttle shaft to the air/fuel control (AFC) barrel (Figure 37). A small amount of fuel also flows through the variable orifice in the throttle shaft to the AFC barrel and this flow is termed throttle leakage.

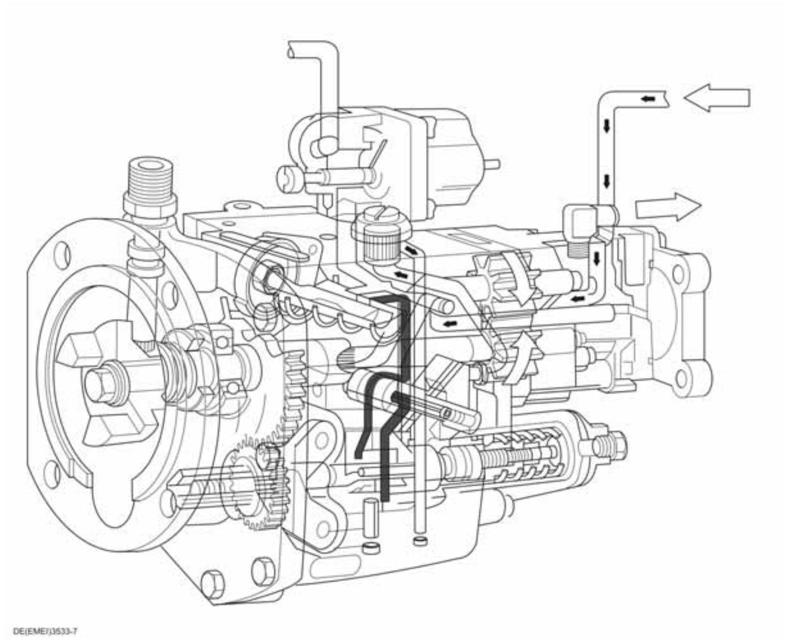


Figure 37 Fuel Flow from Governor to AFC Barrel

64. At this stage with very little or no inlet manifold pressurised air to act on the AFC barrel diaphragm, spring pressure holds the barrel in the closed position. Fuel (Figure 38) is now directed past the no-air adjusting screw to the shut-down solenoid valve, through the valve to the injector supply pipe and on to the injectors.

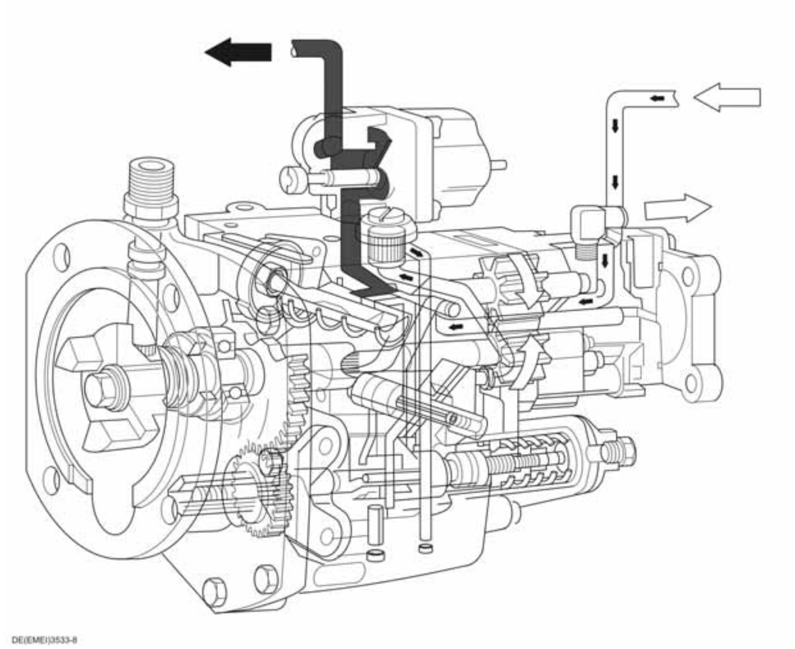


Figure 38 Fuel Flow Through AFC Barrel and Shut-down Solenoid Valve

65. When the fuel reaches the injectors it passes through a filter screen then an adjustable (replaceable) orifice and into the passageway within the injector body (Figure 39). The fuel flows through the passageway to the annular groove in the injector cup. When the injector plunger is at the bottom of its stroke, an undercut in the plunger uncovers a port which allows fuel to flow from this port, through the undercut and out through a passageway to be returned to the fuel tank. This action provides cooling for the injector and also warms the fuel in the fuel tank.

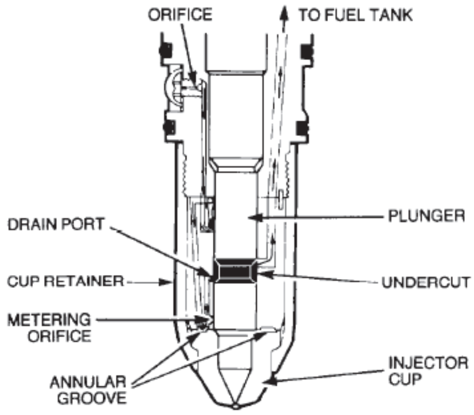


Figure 39 Fuel Circulation Through Injector

66. As spring tension moves the plunger upward, the undercut in the plunger moves away from the drain port, stopping fuel flow to the fuel tank. The upward movement of the plunger uncovers the metering orifice, above the annular groove, allowing fuel to flow into the injector cup. The amount of fuel flowing into the injector cup is determined by the fuel pressure (Figure 40).

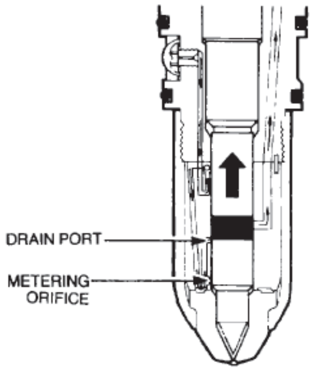


Figure 40 Fuel Entering Injector Cup

67. As the plunger moves downward on the injection stroke, the metering orifice is closed off by the plunger, stopping fuel flow into the injector cup, at the same time the undercut in the plunger uncovers the drain port allowing fuel to circulate through the injector. The plunger (Figure 41) continues its downward movement, forcing the fuel in the injector cup out through tiny equally sized holes located in the injector cup. The high pressure exerted by the plunger on the fuel, causes the fuel to enter the combustion chamber in the form of a very fine spray, thus promoting complete combustion of the fuel. During the injection stroke, the ball valve closes-off the fuel inlet passageway, preventing the back-flow of fuel.

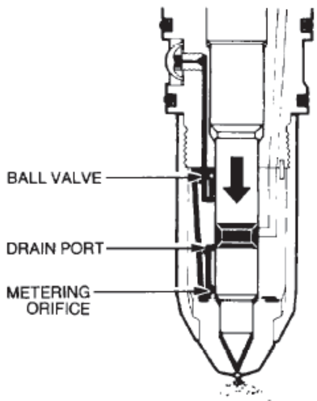


Figure 41 Fuel Injection

Fuel Pump

68. The supply pump comprises two meshing spur gears, each mounted on a shaft and encased within a housing. The housing contains a fuel supply port and a fuel discharge port and is secured, by bolts, to the rear of the fuel pump body. One gear is driven by the pump main-shaft (Figure 42) which in turn is driven by the air compressor crankshaft, via a drive coupling, while the second gear is driven by the meshing action of the first (drive) gear. When the engine is operating, the rotating action of the gears creates a low pressure area in the supply pump housing. Atmospheric pressure, acting on the fuel in the tanks, forces fuel into the fuel supply hose, through the fuel filter and into the pump housing via the supply port. The rotating action of the gears carries the fuel around the outside of the gears (Figure 42 inset) and displaces the fuel through the discharge port to flow to the governor, via a filter screen.

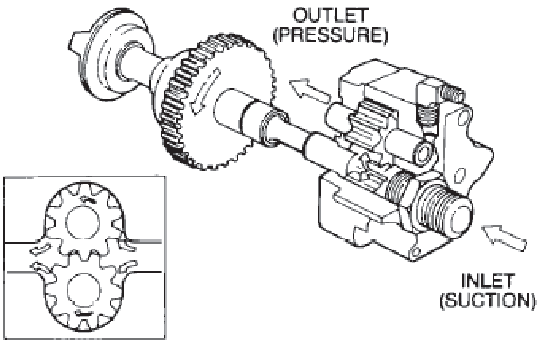


Figure 42 Fuel Supply Pump Operation

69. The fuel enters the governor and is delivered to either or both the idle and the main fuel passages (depending on engine requirements). If the fuel pressure exceeds the desired limits, fuel can also be directed out the by-pass passage simultaneously (Figure 43) to maintain the fuel at the correct pressure.

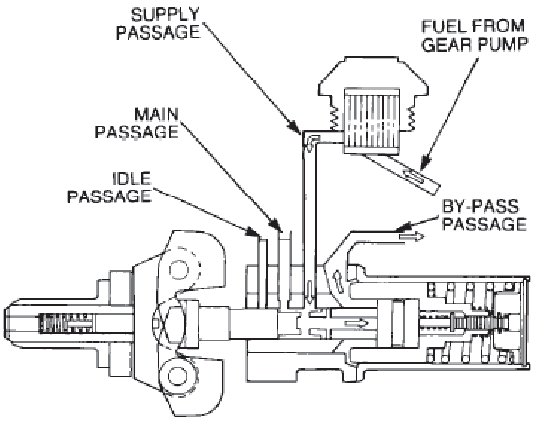
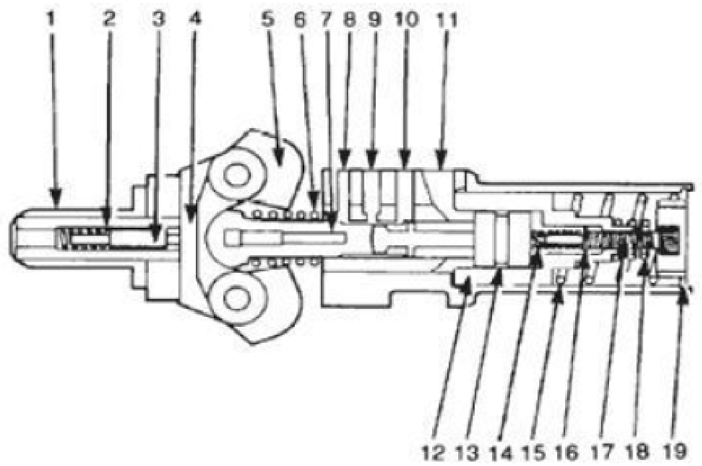


Figure 43 Fuel Flow at Governor

Governor

70. The governor is gear driven by the pump main-shaft and comprises the items shown in Figure 44. The flyweights, plungers and springs regulate the fuel pressure and govern the engine idle and maximum speeds.



1.	Weight Assist Spring	8.	Idle Passage	15.	Governor Spring
2.	Weight Assist Spring Shims	9.	Main Passage	16.	Idle Spring Seat Washer
3.	Weight Assist Plunger	10.	Supply Passage	17.	Idle Speed Adjusting Screw
4.	Governor Weight Carrier	11.	By-pass Passage	18.	Idle Screw Retention Spring
5.	Governor Flyweights	12.	Idle Plunger Guide	19.	Governor Shims
6.	Torque Control Springs	13.	Idle Spring Plunger (Button)		
7.	Governor Plunger	14.	Idle Spring		

Figure 44 Governor Assembly - Sectional View

71. While the engine is operating, the governor flyweight and plunger assembly is caused to rotate by the gear on the pump main-shaft. As the flyweight and plunger assembly rotates, centrifugal force causes the flyweights to move outward, pivoting on the flyweight pivot pins. This pivoting action of the flyweights (Figure 45) causes the foot on each flyweight to exert an axial force on the governor plunger, moving the plunger into the bore of the plunger barrel.

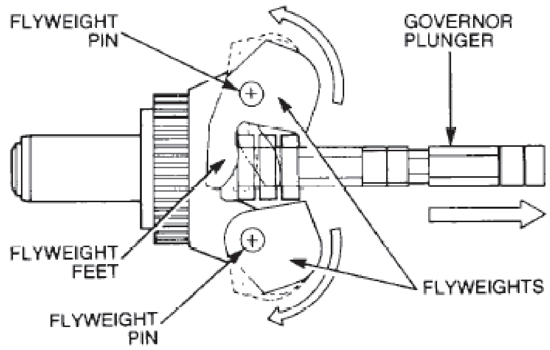


Figure 45 Governor Flyweight and Plunger Operation

72. To control the movement of the plunger, three springs are used:

a. the idle spring,

b. the governor spring, and

c. the torque spring.

73. While the engine is operating at idle, movement of the governor plunger is controlled by the idle spring acting against the idle plunger (button), which butts against the end on the governor plunger. As the governor plunger moves into the bore, it pushes against the idle plunger, which in turn acts against the idle spring. Because the effort exerted by the flyweights is minimal, the relatively light idle spring balances the effort exerted by the flyweights and holds the governor plunger in a position where fuel can flow through both the idle and main fuel passages (Figure 46).

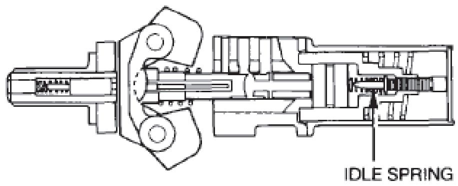


Figure 46 Idle Spring Operation - Idle Speed

74. As engine speed increases, the centrifugal force acting on the flyweights also increases. The effort exerted by the flyweights moves the governor plunger further into the bore, overcoming the resistance of the idle spring and causing the idle plunger to bottom out on the idle plunger guide, which in turn, acts against the governor spring. The tension of the governor spring holds the effort exerted by the flyweights in balance. The governor plunger is now positioned where the idle fuel passage is closed (Figure 47) and maximum fuel flow is directed through the main fuel passage. The engine speed is close to, but below, torque peak speed.

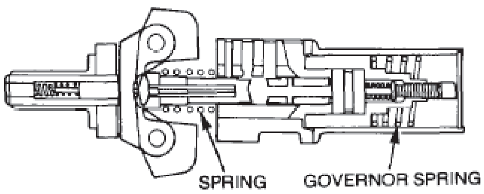


Figure 47 Governor Spring Operation - Below Torque Peak Speed

75. When the engine speed is increased to operate between torque peak and rated speeds, the force exerted by the flyweights is now balanced by the combined force of the governor spring and the torque spring (Figure 48). The idle fuel passage is closed and the cut-off shoulder on the governor plunger is at the edge of the main fuel passage, allowing full fuel flow to the main fuel passage.

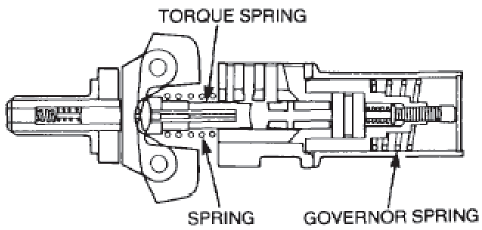


Figure 48 Governor and Torque Spring Operation - Between Torque Peak and Rated Speeds

76. In the event of the engine rated speed being exceeded, the force of the flyweights overcomes the effort exerted by both the governor and torque springs, and moves the governor plunger towards closing-off the main fuel passage and is termed the governor break. This action restricts the flow of fuel to the injectors (Figure 49), thus reducing the engine speed to the point where the governor and torque springs once again balance the force exerted by the flyweights, moving the governor plunger to open the main fuel passage.

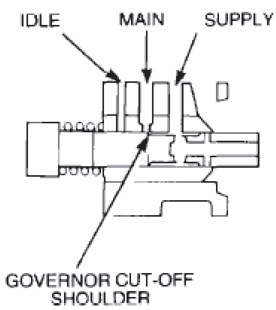


Figure 49 Governor Plunger in Maximum Speed Position

77. While the governor plunger controls the flow of fuel toward the injectors, the idle plunger (button) controls the fuel pressure. The idle plunger, held against the end of the governor plunger by spring force, has the pressure of the fuel, within the bore of the governor plunger, acting against it (Figure 50).

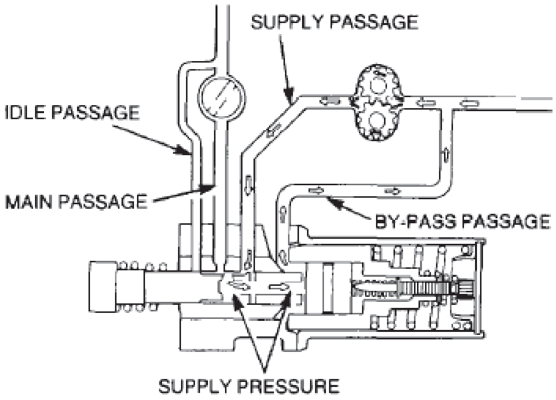


Figure 50 Fuel Pressure Control

78. As the pressure of the fuel in the governor plunger increases, it pushes against the idle plunger until the effort applied to the idle plunger overcomes spring pressure and forces the idle plunger away from the governor plunger, allowing fuel to flow out to the by-pass passage. Although the idle plunger can be held against the governor plunger by varying spring forces, the recess machined into the governor plunger side of the idle plunger also governs the pressure at which the excess fuel is bled-off. The smaller the recess the higher the fuel pressure and the larger recess has the opposite effect (Figure 51).

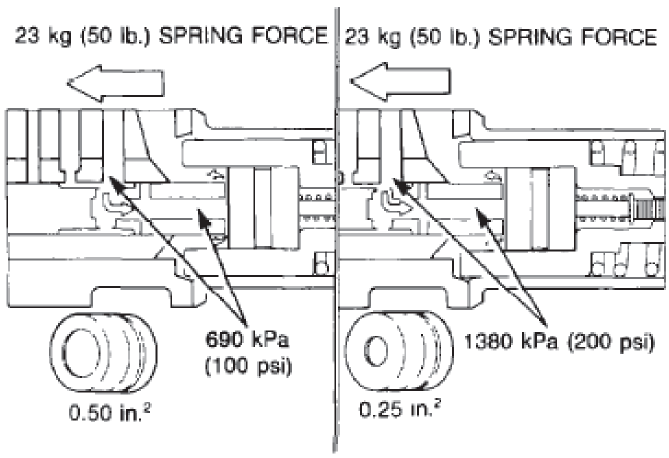


Figure 51 Idle Plunger Recess Variance

Throttle Shaft

79. The throttle shaft provides the driver with a means of controlling the engine power to the level required. This is accomplished by means of an orifice in the throttle shaft, and the throttle shaft inlet and outlet ports in the pump body. When the throttle pedal is pushed to the full throttle position, the orifice aligns with both the inlet and outlet ports, allowing maximum fuel flow through the throttle shaft. However, while the throttle pedal is positioned between idle and near to but below full throttle position (Figure 52), the orifice does not align with the inlet and outlet ports, limiting the flow of fuel. In this manner the orifice acts as a variable area orifice, which opens wider as the throttle pedal is pushed toward the full throttle position.

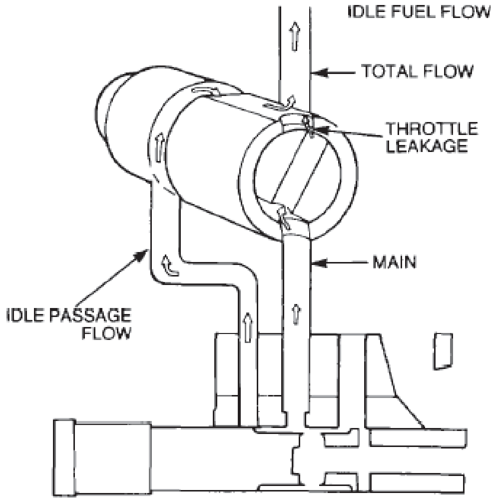


Figure 52 Throttle Shaft Fuel Flow at Idle

80. Incorporated within the throttle shaft is a fuel adjusting screw (Figure 53), which provides fine adjustment of the fuel flow through the throttle shaft, and is used to adjust the fuel pressure to the injectors during calibration.

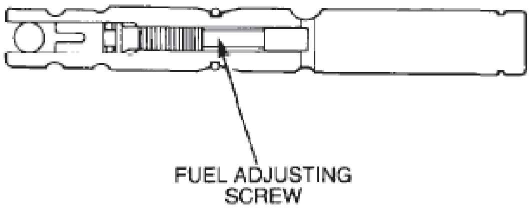


Figure 53 Throttle Shaft and Fuel Adjusting Screw

Air Fuel Control

81. The air fuel control (AFC) assembly (Figure 54) is used to regulate the fuel flow to the injectors and is controlled by the intake manifold air pressure. A pipe connected to the AFC assembly and to the bottom of the OAC housing enables the pressurised air in the intake manifold to act on the diaphragm within the AFC assembly. When there is little or no pressurised air in the intake manifold, the diaphragm spring in the AFC assembly closes the valve and causes the fuel to be directed past the no-air adjusting screw (Figure 55) which limits the fuel flow to the injectors.

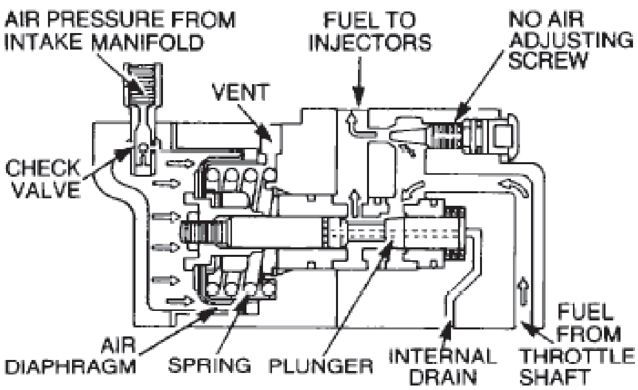


Figure 54 AFC Assembly

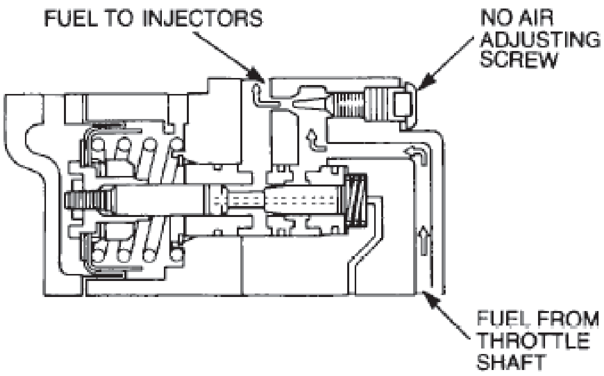


Figure 55 AFC Operation - No Air Pressure

82. As the throttle is moved toward the full throttle position, the engine speed increases, as does the air pressure in the intake manifold due to the increased output of the turbocharger. The fuel requirement of the engine also increases. The pressurised air in the intake manifold acts on the diaphragm in the AFC assembly compressing the diaphragm spring and moving the plunger to uncover a passage (Figure 56) which allows extra fuel to flow to the injectors, enabling the engine to maintain the required rpm.

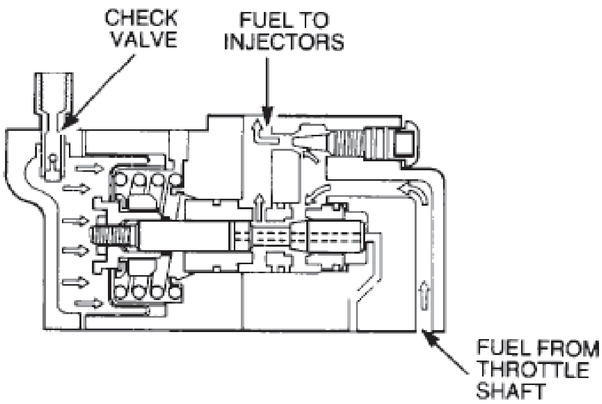


Figure 56 AFC Operation - Air Pressure Applied

Shut-down Valve

83. The fuel from the AFC assembly flows through a passage to the shut-down valve before flowing to the injectors. The shut-down valve is controlled by a solenoid which is activated by the ignition switch. When the ignition is turned OFF (solenoid de-energised) a belleville spring (spring washer) seats a disc against the fuel ports, preventing fuel flow to the injectors (Figure 57), thus providing the driver with a means of shutting down the engine. When the ignition is turned ON, the solenoid becomes energised creating an electromagnetic force (Figure 58), which overcomes the force of the belleville spring and unseats the disc permitting fuel to flow to the injectors.

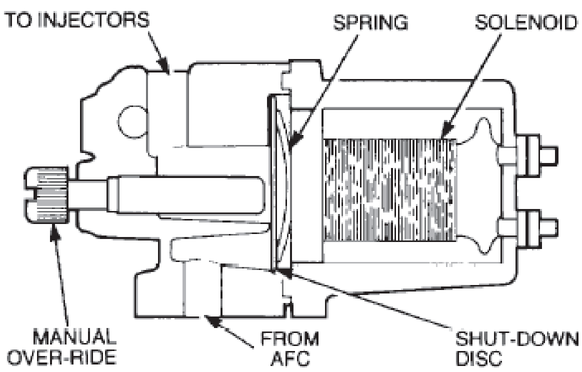


Figure 57 Shut-down Valve - Solenoid De-energised

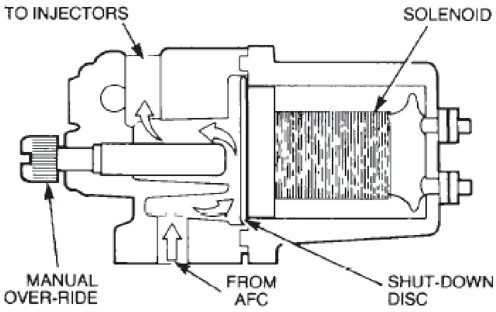


Figure 58 Shut-down Valve - Solenoid Energised

84. Fuel flows from the fuel pump, through a steel pipe to the rear of the rear cylinder head, where it enters a passageway in the cylinder head. Each cylinder head has two passageways, an injector supply passageway and an injector fuel return passageway, with crossover pipes connecting the passageways between the cylinder heads. Fuel flows into the injector, and depending on the position of the injector plunger, either flows into the injector cup to be injected into the combustion chamber, or flows through the injector and fuel return passageway to return to the fuel tank. This flow of fuel acts as a coolant for the injector.

Fuel Injectors

85. The fuel injectors are mechanically operated by means of the engine's camshaft, camshaft followers, push rods and rocker arms. The camshaft has additional lobes which are specifically machined for the correct operation of the injectors. When the camshaft follower roller travels down the retraction ramp to the inner base circle of the lobe (Figure 59) spring pressure raises the injection plunger, which blocks off the drain port and opens a metering orifice allowing fuel to flow into the injector cup. As the camshaft rotates and causes the camshaft follower to travel up the injection ramp, the injector plunger moves down the bore and injects the fuel, and at the same time uncovers the drain port, allowing fuel to flow through the injector to the fuel tank, cooling the injector as it flows (Figure 60).

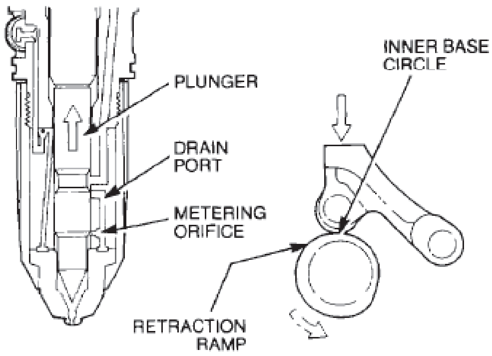


Figure 59 Fuel Flow into Injection Cup and Blockage of Drain Port

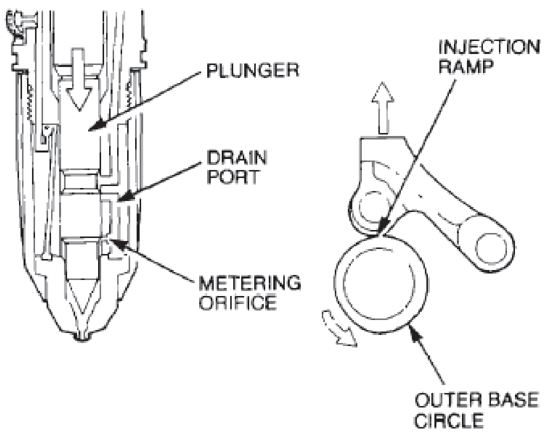
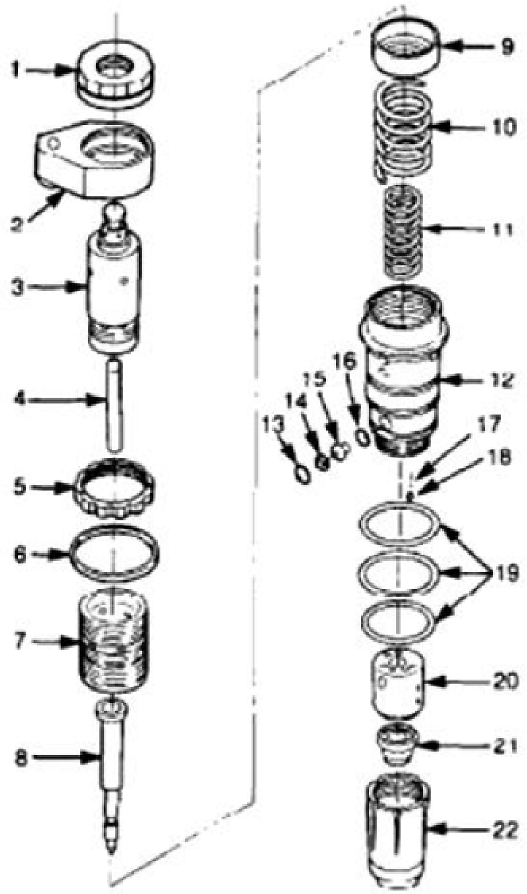


Figure 60 Fuel Injection and Opening of Drain Port

86. Figure 61 illustrates the components of the Step Timing Control (STC) injector used on the engine.



1.	Cap	9.	Spring Retainer	16.	Gasket
2.	Upper Lock-nut and STC Oil Inlet	10.	Spring, Plunger Return (Outer)	17.	Roll-pin
3.	STC Tappet	11.	Spring, Plunger Return (Inner)	18.	Ball Check Valve
4.	Injector Link	12.	Injector Adaptor	19.	O-ring Seal
5.	Lock-nut	13.	Screen Retainer	20.	Barrel
6.	Plain Washer	14.	Filter Screen	21.	Injector Cup
7.	Stop Screw	15.	Orifice Plug	22.	Cup Retainer
8.	Plunger				

Figure 61 STC Injector Assembly - Exploded View

Step Timing Control

87. The STC tappet assembly, incorporated with the injector, provides the means for advancing the injection timing to improve cold weather performance and light load economy. The tappet assembly is hydraulically operated and is actuated by means of the STC system control valve. The control valve is located on the left-hand side of the engine (Figure 62) and uses both fuel pressure and spring pressure, or the engine lubrication oil pressure (from the C-brakes) to control the flow of engine oil from the control valve to the hydraulic tappet (Figure 63).

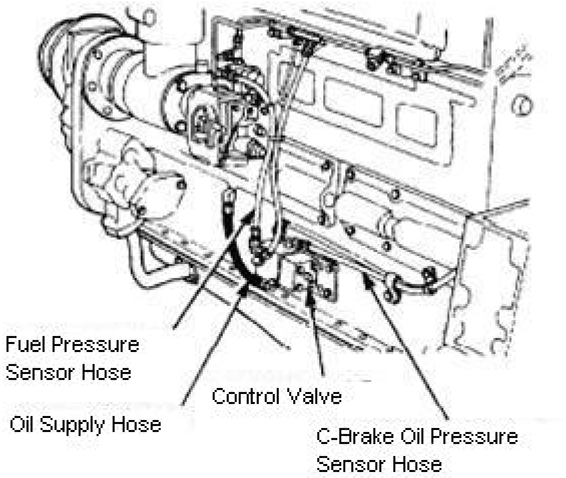


Figure 62 STC System Control Valve - Location

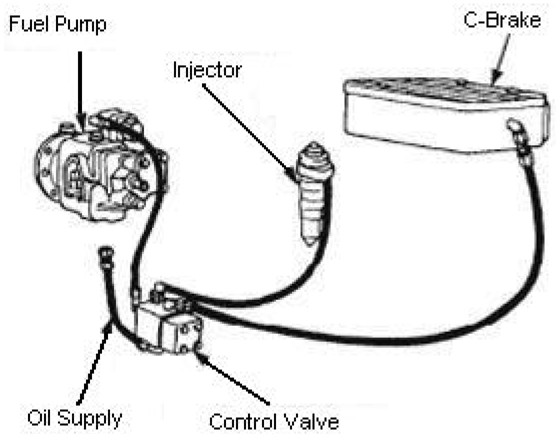


Figure 63 STC System

88. The STC system control valve comprises a plunger, a spring (with tension adjustment screw) and a valve body (Figure 64), which incorporates a fuel pressure sensing port, an oil pressure sensing port and two oil supply ports (one from the engine lubrication system and one to the injectors).

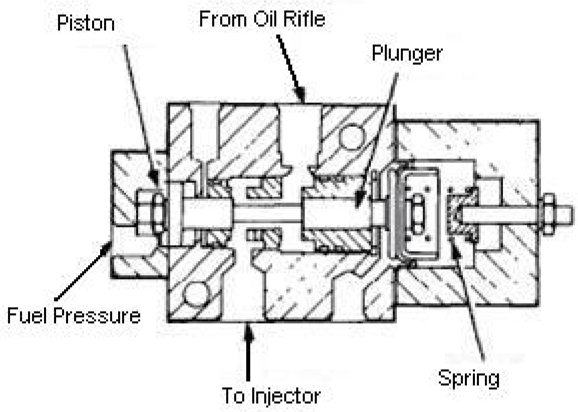


Figure 64 STC System Control Valve - Sectional View

89. When the control valve is in the timing advance mode, spring force overcomes the low fuel pressure acting on the piston and moves the plunger to open a passage between the oil supply ports, allowing pressurised oil to flow to the hydraulic tappets and initiate timing advance (Figure 65).

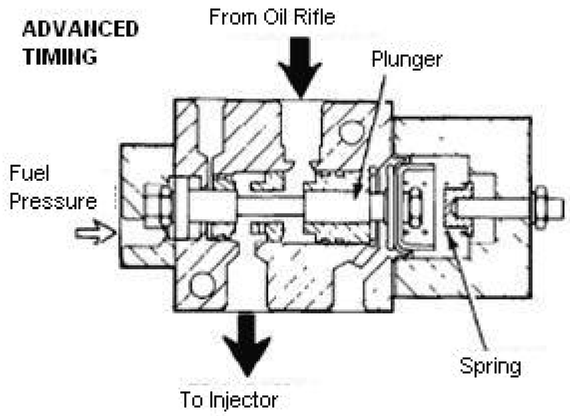


Figure 65 Control Valve - Timing Advance Position

90. As the fuel pressure increases, the force applied to the piston overcomes the spring force and moves the plunger to block the passage between the oil supply ports, stopping the flow of oil to the hydraulic tappets (Figure 66) which causes the advanced timing to revert to normal timing. However, the timing will advance and return to normal in accordance with a decrease or increase of fuel pressure.

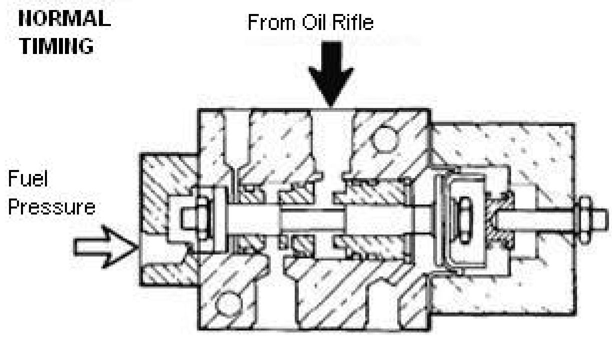


Figure 66 Control Valve - Normal Timing Position

91. When the C-brake is activated, pressurised oil from the C-brake housing is directed through the hose to the control valve. This oil acts on the diaphragm and forces the plunger to move against spring pressure, and block the passage between the oil supply ports, stopping oil flow to the hydraulic tappet and reverting the timing to normal, where it remains as long as the brake is activated (Figure 67).

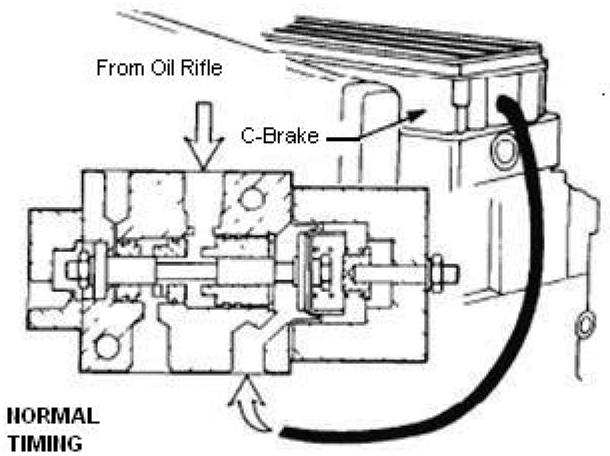
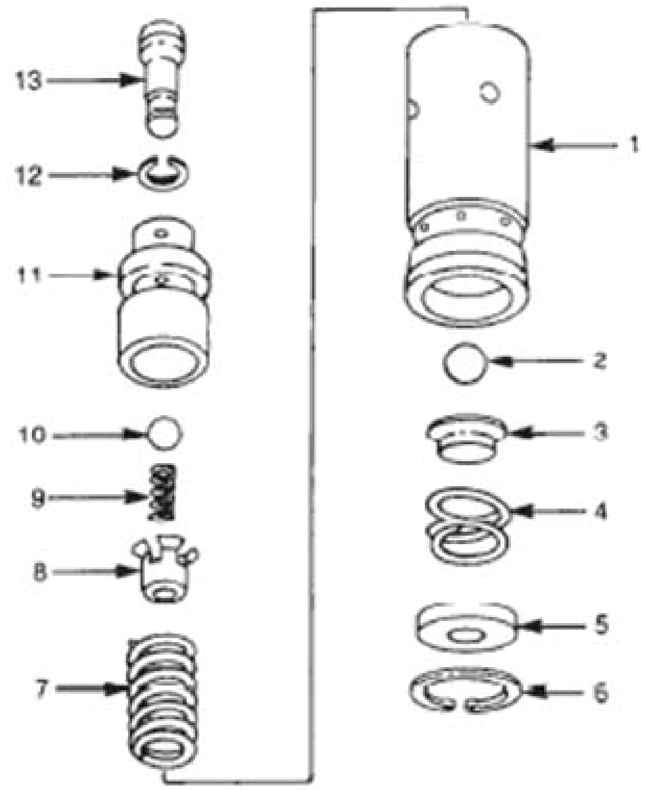


Figure 67 Control Valve - C-brake Applied

92. Figure 68 illustrates the various components of the hydraulic tappet assembly.



1. Tappet Sleeve
2. Check Ball
3. Spring Guide
4. Spring
5. Tappet Socket
6. Circlip
7. Spring
8. Spring Guide
9. Spring
10. Check Ball
11. Tappet Plunger
12. Spring Clip
13. Pluger Link

Figure 68 Hydraulic Tappet - Exploded View

93. When the STC system is operating in the normal timing mode, no pressurised oil is directed to the hydraulic tappet. As the camshaft follower moves up the injection ramp, it is transferred to the injector rocker arm by the push rod, causing the rocker arm to pivot (or rock) on the shaft. As the rocker arm moves it acts on the injector plunger link, which is secured to the top of the inner piston of the hydraulic tappet assembly, pushing the plunger link and the inner piston downward. The inner piston moves down within the bore of the outer piston, overcoming spring pressure before butting against the shoulder of the outer piston. As the downward movement is transferred to the outer piston, the tappet socket, located in the base of the outer piston, pushes against the top of the injector plunger (Figure 69) and forces the injector plunger down, against the pressure of the injection plunger return springs, to inject fuel into the combustion chamber. When the camshaft follower moves down the retraction ramp, mechanical force is removed from the tappet assembly, allowing spring pressure to return the plunger and pistons to their no-load position.

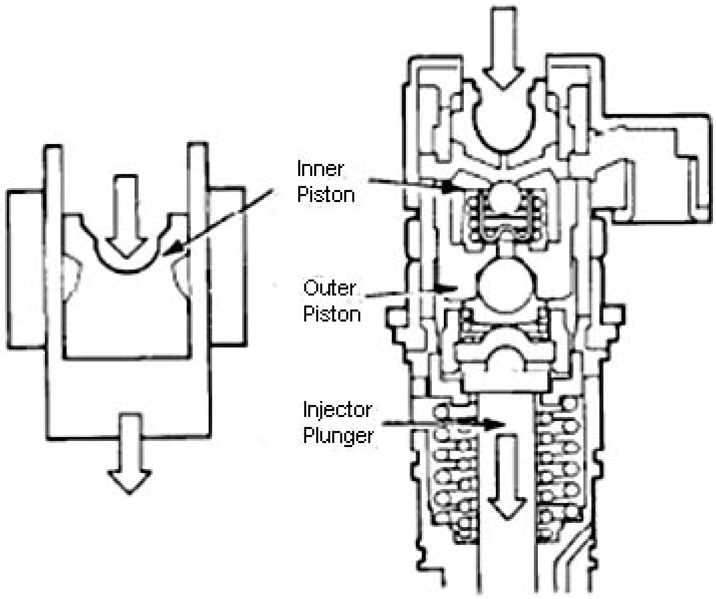


Figure 69 Hydraulic Tappet Operation - Normal Timing Mode

94. During the advanced injection timing mode, the STC system control valve directs oil to flow through a port in the top-stop locknut at the top of the injector assembly, through ports in the outer piston of the hydraulic tappet assembly into the inner piston. The pressurised oil unseats and flows past the ball in the upper check valve into the space between the base of the inner piston and the shoulder of the outer piston. When the camshaft follower begins to move up the injection ramp on the camshaft lobe, the downward movement of the inner piston, caused by the action of the rocker arm, now acts on the oil between the base of the inner piston and the shoulder of the outer piston. As the oil cannot be compressed, the outer piston is caused to move by the pressure of the oil, and in turn, the injector plunger is moved by the outer piston (Figure 70). In the advanced timing mode the injector plunger bottoms in the injector cup before the camshaft follower reaches the top of the injection ramp to allow for extra camshaft lift and preventing damage to the injector plunger and cup. The extra pressure exerted on the oil between the pistons, when the plunger bottoms, causes the lower ball valve to become unseated allowing the trapped oil to flow out and the tappet to collapse. When the camshaft follower moves down the retraction ramp, mechanical force is removed from the tappet assembly, allowing spring pressure to return the plunger and pistons to their no-load position.

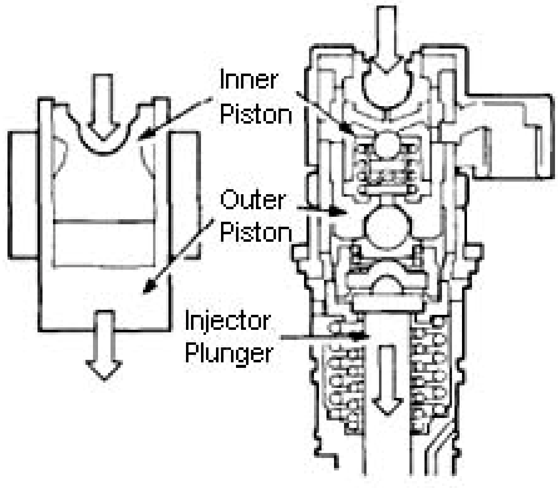


Figure 70 Hydraulic Tappet Operation - Advanced Timing Mode

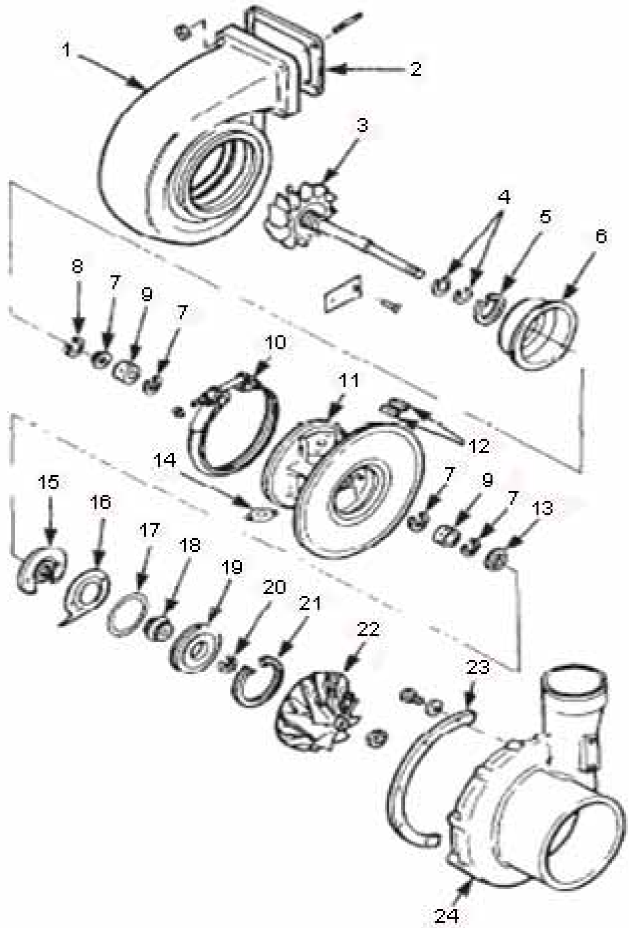
TURBOCHARGER

95. Figure 71 illustrates the components of the Cummins HT3B turbocharger.

96. The turbocharger supplies compressed air to the engine's combustion chambers, thus promoting more complete combustion of the fuel, which increases engine output and economy. The turbocharger comprises three main components, the turbine housing, the bearing housing and the compressor housing, the assembly is mounted on the exhaust manifold and is driven by the engine’s exhaust gases. The exhaust gas enters the turbine housing, flowing around the housing in a decreasing spiral where it acts against the turbine wheel, causing the turbine wheel and shaft to rotate before the gas is discharged through the centre of the turbine housing into the exhaust system.

97. The turbine wheel and shaft are manufactured in one piece, with the shaft being supported by sleeve type bearings located in the bearing housing, which is secured to the turbine housing by a V-band clamp. Pressurised oil from the engine’s lubrication system is piped to and from the turbocharger bearing housing to provide lubrication and cooling for the bearings.

98. The impeller or compressor wheel is secured to the free end of the turbine wheel shaft and is located in the compressor housing which is bolted to the bearing housing. As the turbine wheel and shaft rotate in accordance with exhaust gas flow, the impeller is also caused to rotate, drawing air into the centre of the impeller, which then causes the air to flow rapidly outward through the diffuser in an increasing spiral. The cross-section area of the scroll increases to slow the air, converting air velocity into air pressure. The compressed air leaves the compressor housing through a tangential outlet and flows into the crossover tube where it is ducted to the OAC to be cooled before entering the combustion chamber.



1. Turbine Housing
2. Gasket
3. Turbine Wheel and Shaft
4. Split Ring Seals
5. Circlip
6. Heat Shield
7. Circlip
8. Oil Control Sleeve
9. Bearing
10. V-band Clamp
11. Bearing Housing
12. Roll Pins
13. Thrust Collar
14. Flange Gasket
15. Thrust Bearing
16. Oil Bafle
17. O-ring
18. Oil Slinger
19. Oil Seal Plate
20. Split Ring Seal
21. Circlip
22. Impleller
23. Clamp Plate
24. Compressor Housing

Figure 71 Turbocharger - Exploded View

99. The turbocharger is a precision machined assembly, with extremely fine tolerances. The delicately balanced turbine wheel and shaft together with the impeller enable the turbocharger to operate at speeds of approximately 80 000-90 000 rpm. To enable these speeds to be maintained, adequate lubrication of the sleeve bearings is essential. However, damage to these bearings can occur during the period between engine start-up and the point where oil under pressure is available at the turbocharger bearings. This period is termed oil lag, and it is during this period that the engine is not to be accelerated. Always allow the engine to idle for several seconds before using the throttle. Bearing damage can also occur during engine shut-down. To avoid damage to the bearings, always allow the engine to idle for three or four minutes to allow time for the turbocharger to slow down and to dissipate the heat build-up. If the engine is shut-down immediately after operating at high rpm for extended periods, the turbocharger continues to rotate at high speed without lubrication, and when combined with the heat of the turbocharger, bearing damage results. A dashboard mounted engine idle timer control is incorporated to maintain the engine idling for approximately five minutes before shutting down the engine. When the timer is activated and the ignition is turned OFF, the timer maintains a current flow to the fuel pump solenoid, keeping the solenoid energised and maintaining fuel flow to the injectors. After approximately five minutes, the idler timer control opens the fuel pump solenoid circuit, causing the solenoid to de-energise and block the fuel flow to the injectors, causing the engine to shut-down.

EXHAUST SYSTEM

100. Figure 72 illustrates the exhaust system and mounting arrangement.

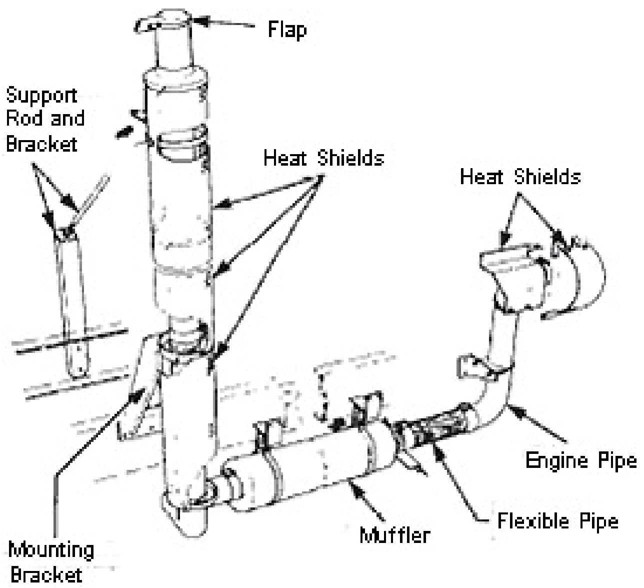


Figure 72 Exhaust System and Mounting Arrangement

101. The vehicle’s exhaust system comprises three tubular steel pipes, a flexible steel pipe and a cylindrically shaped muffler, all of which are joined together by steel broad-band clamps. The vertical section of the exhaust system is encased in a perforated steel heat shield. Special clamps secure the heat shield to the vertical section of the exhaust system, and also maintain the exhaust pipe centrally within the heat shield. A capping is positioned at the top to seal off the opening between the heat shield and exhaust pipe, and to hold the heat shield equidistant from the exhaust pipe. The flap fitted to the top of the exhaust pipe prevents moisture entering the exhaust system when the engine is not operating.

102. The front (engine) pipe is connected by a clamp, to the turbocharger exhaust outlet and held in position by a rigid mounting bracket attached to the side of the engine block. The flexible pipe connecting the engine pipe to the muffler insulates the exhaust system from engine vibrations and also allows the muffler, which is shackle-mounted to the chassis, to move independent of the movement of the engine or the distortion of the chassis. The vertical section, which comprises two pipes clamped together, is connected to the muffler outlet and is rigidly mounted on the chassis and held in the vertical position by means of a mounting bracket, connected to the lower section, and a support rod, connected to the upper section (Figure 73).

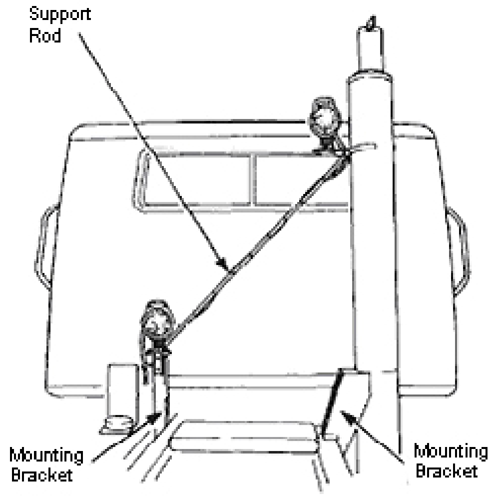


Figure 73 Mounting Bracket and Support Rod - Exhaust Vertical Section

CLUTCH AND CLUTCH BRAKE

103. The Spicer AS-1552 clutch (Figure 74) is a dry disc, manual adjust, pull-type design, utilizing six angle springs which are centrally located and entirely isolated from the heat of the pressure plate. The pressure plate is secured to the flywheel ring by four expansion type coil springs. Mating lugs on both the flywheel ring and the pressure plate transmit drive from the flywheel ring to the pressure plate. Drive for the intermediate plate also comes from the flywheel ring, via the slots in the flywheel ring and the lugs on the intermediate plate. Two ceramic type clutch discs are used, which have four ceramic buttons riveted to both sides of the disc. The hubs on the clutch discs are dampened by eight coaxial springs, i.e. spring within a spring, which help to absorb shock loads to the clutch and torsional vibrations in the drive train.

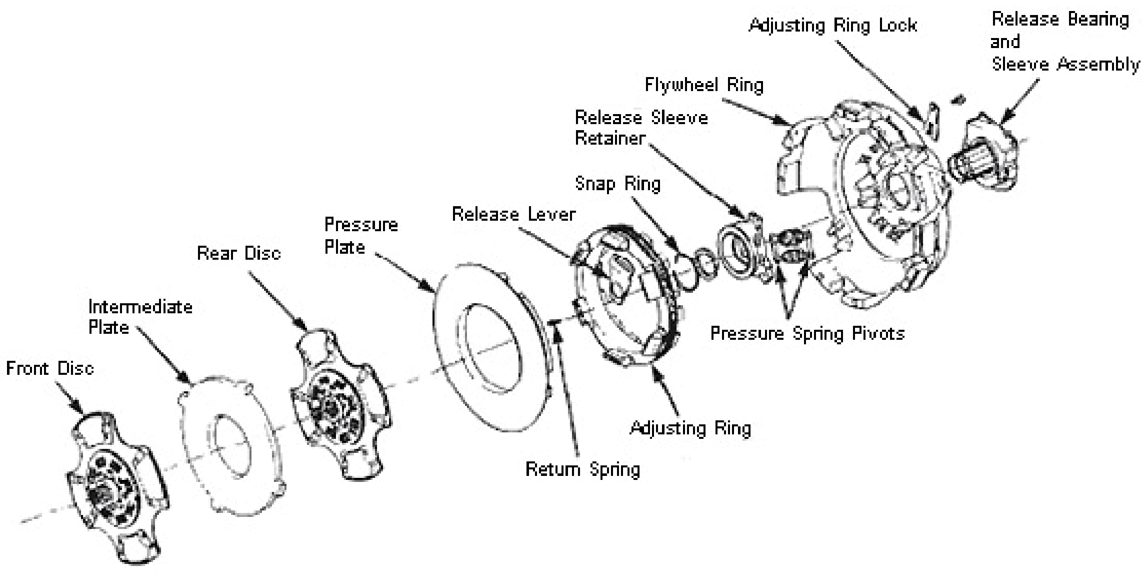


Figure 74 Clutch Assembly - Exploded View

104. The clutch is pedal, rod and lever actuated. The clutch pedal rod connects the clutch pedal to the relay shaft and the lower control rod is the connection between the relay shaft and the release lever, which is secured to the cross-shaft (Figure 75). When the pedal is depressed the rods and relay shaft move the release lever, causing the release bearing yoke to pivot and move the release bearing rearward, releasing the clutch discs and stopping the drive being transmitted to the transmission.

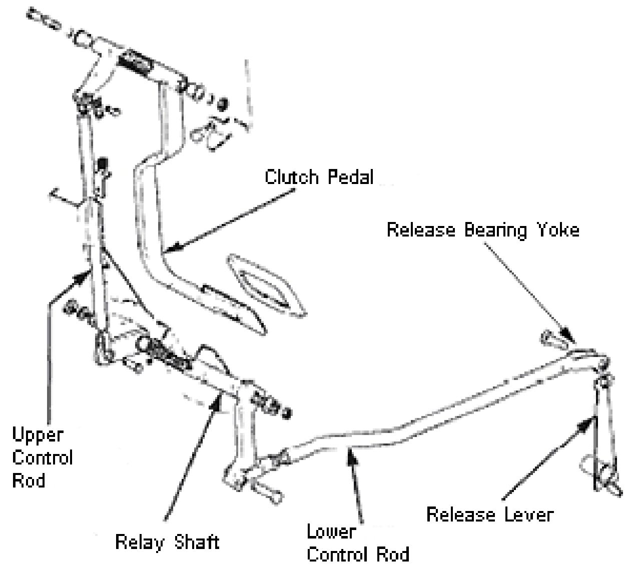


Figure 75 Clutch Actuator Assembly

105. A Spicer torque limiting clutch brake (Figure 76) is fitted to the vehicle. 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.

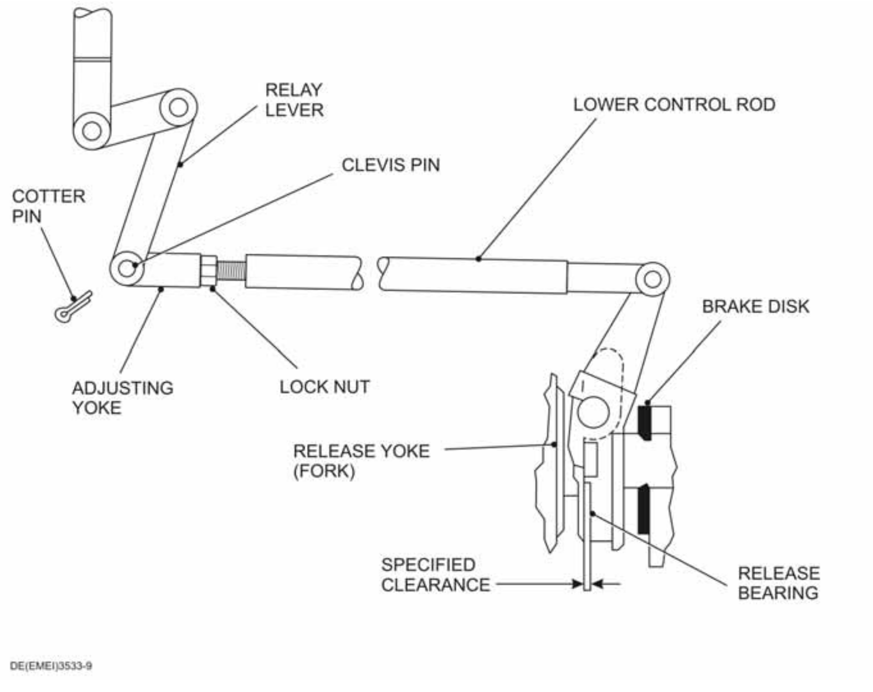


Figure 76 Clutch Brake Operation

TRANSMISSION

106. The Spicer 1420-38 transmission provides the vehicle with twenty forward gears and four reverse gears, although the gear lever is only moved through five forward gear positions, and one reverse position. The various ratios required for twenty forward and four reverse gears are obtained by means of splitter and range gears. A four position air control switch (valve), located on the gear lever enables the driver to select the desired ratios, as required, to maintain optimum engine performance. When hauling heavy loads or on steep gradients, both low and high ratios are used for forward or reverse gears when initially moving off. The control switch directs air (under pressure) to the piston assemblies at the rear of the transmission (Figure 77) which controls the selection of the splitter and range gears. The left-hand piston controls the selection of high or low ratio on the splitter gears, while the right-hand piston controls the selection of high or low ratio on the range gears. Movement of the control switch left of position 3, causes the low ratio on the range gears to be engaged, while selection of positions 1 or 2 engages either low or high ratio of the splitter gears. When the control switch is moved right of position 2, the high ratio of the range gears is engaged and either the low or high input gears on the splitter gears is engaged when either position 3 or 4 is selected by the control switch.

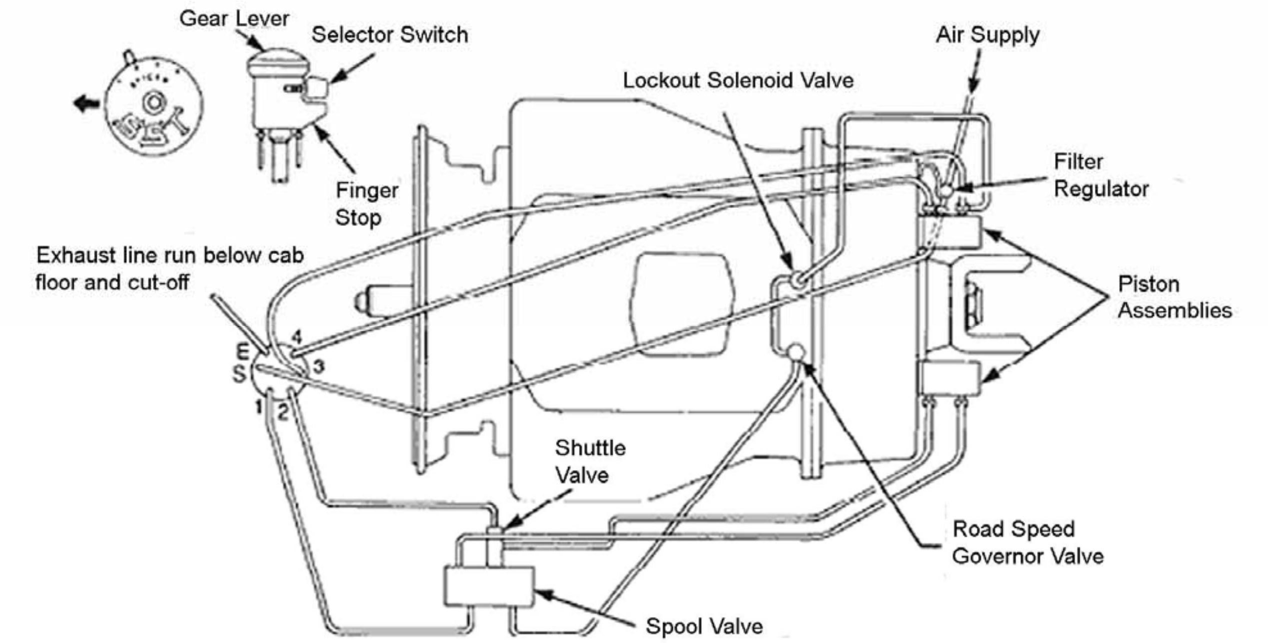


Figure 77 Splitter Gear Air Control Switch and Air Circuit

107. The transmission comprises two (front and rear) cast iron housings. Located within the front housing are the input shaft, the main-shaft, and two countershafts. Located within the rear housing are the output shaft and two countershafts (Figure 78). All gears on the input shaft and main-shaft are in constant mesh with the gears on the countershafts. The gears on the main-shaft revolve independent of the main-shaft, so drive has to be transferred from the gears to the main-shaft via a sliding clutch, which is splined to the main-shaft and moved into mesh with the splines on the selected gear. Drive is now transferred from the input shaft, through either the high or low splitter gears to the countershafts, from the countershafts to the main-shaft, via the selected gear and sliding clutch and from the main-shaft to the output shaft, via the range gears.

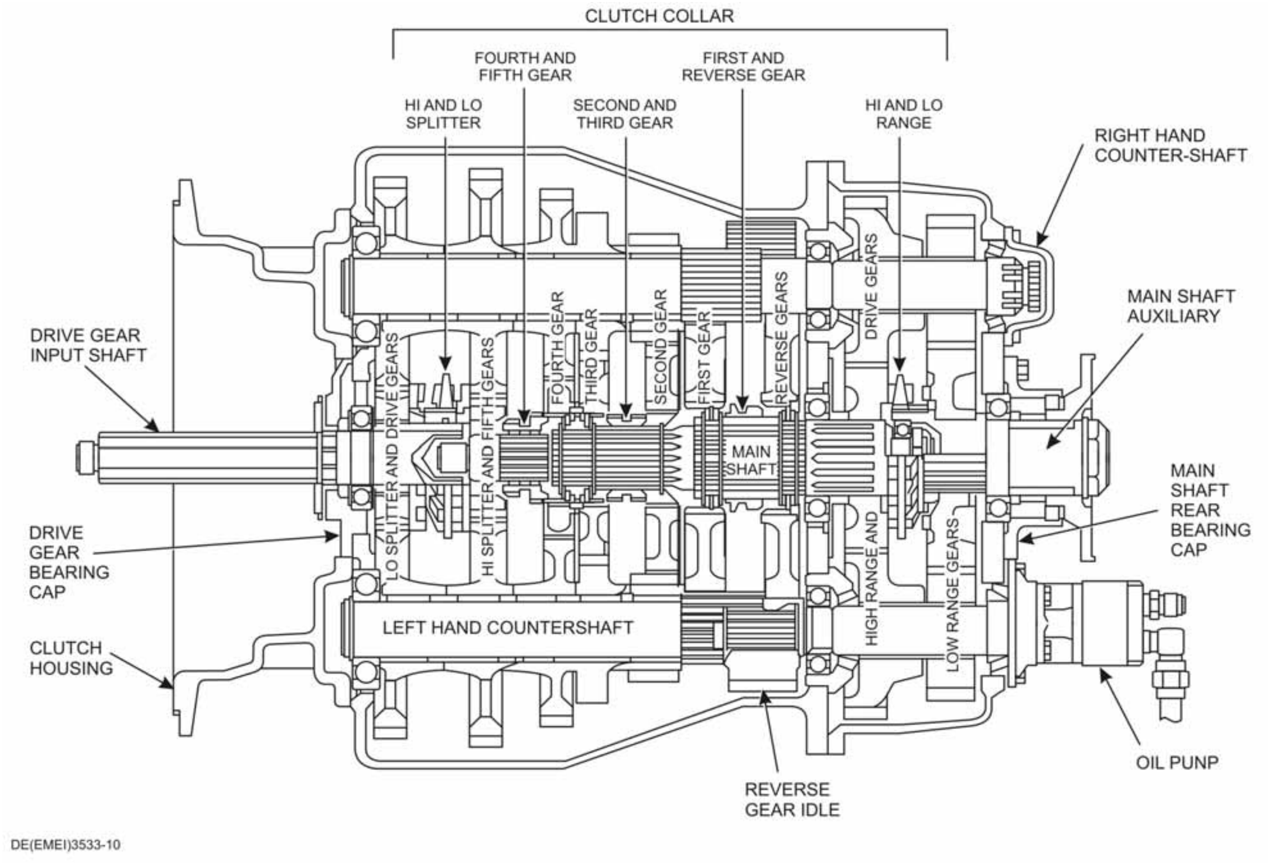


Figure 78 Transmission Assembly - Sectional View

Power Take-off (PTO)

108. The Powauto AH30BLll series power take-off is a single speed gear driven type mounted on an adapter plate, which is secured to the bottom of the transmission. When the dashboard mounted air control switch is placed in the ON position, compressed air is directed to the power take-off, where it actuates a piston, which operates the gear selector fork. The selector fork (Figure 79) moves the selector gear to mesh with both the gear in the transmission and the power take-off driven gear, which is splined to the output shaft. Drive is now transferred from the power take-off to the hydraulic pump by the output shaft.

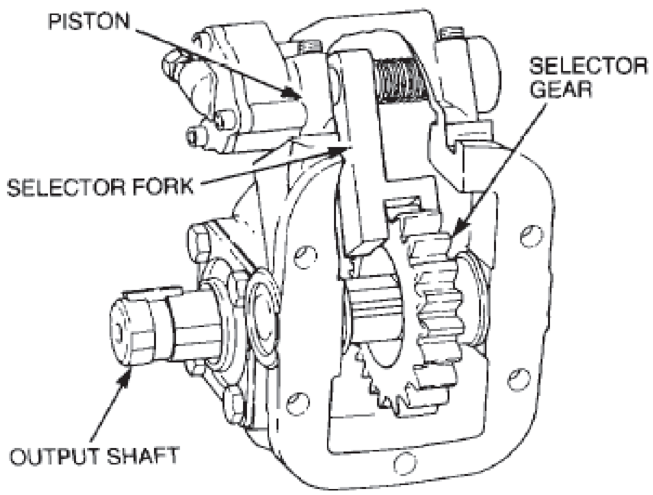


Figure 79 Power Take-off

Hydraulic Pump

109. The Powauto DO24 hydraulic pump (Figure 80) consists of front and rear covers, which house a drive gear and an idler gear. The pump is flange mounted to the output shaft end of the power take-off. Splines in the bore of the power take-off output shaft mesh directly with the splines on the pump drive gear shaft, transmitting rotational force to the pump drive gear, which meshes with the idler gear, causing the idler gear to rotate.

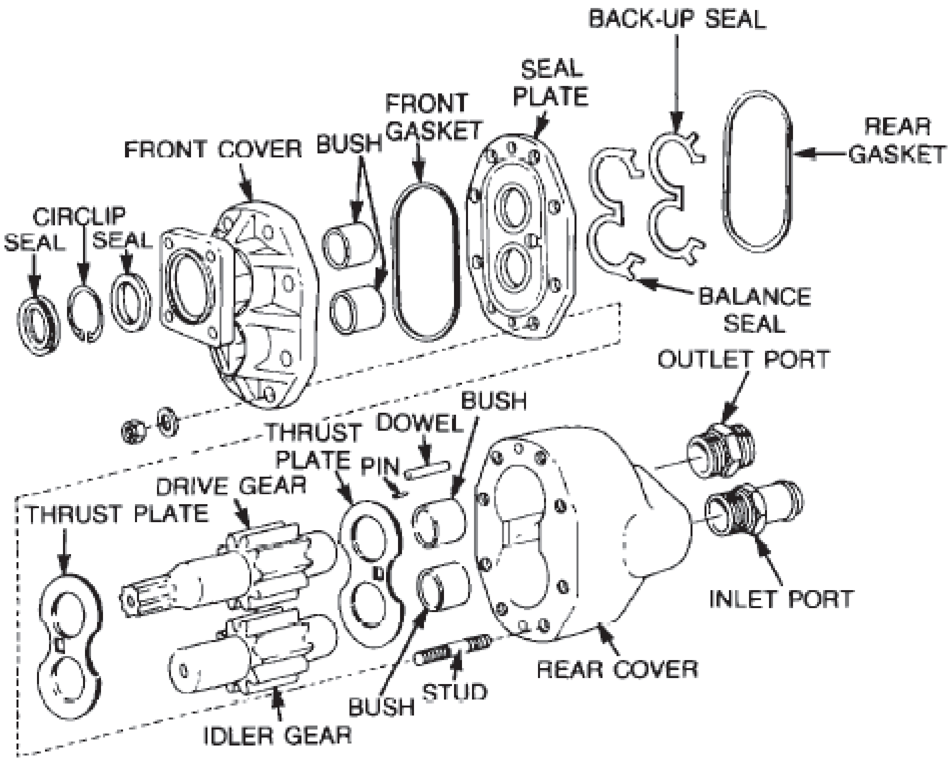


Figure 80 Hydraulic Pump - Exploded View

110. When the pump is operating, the meshing action of the gears creates a low pressure area within the pump, causing hydraulic fluid to flow, under atmospheric pressure, from the reservoir to the pump. The rotating gears then displace the fluid through the outlet port to the winch drive, via hydraulic pressure hose. A second hose returns the hydraulic fluid from the winch drive to the reservoir. The hydraulic fluid also provides lubrication for the working components of the pump.

Propeller Shafts

111. Two 1810 series propeller shafts are used to transmit the drive from the transmission to the intermediate axle carrier. The first of the two shafts is the transmission (front) shaft, which is a fixed length shaft with two universal joint yokes, one of which is removable to allow access to the centre bearing fitted to the shaft (Figure 81).

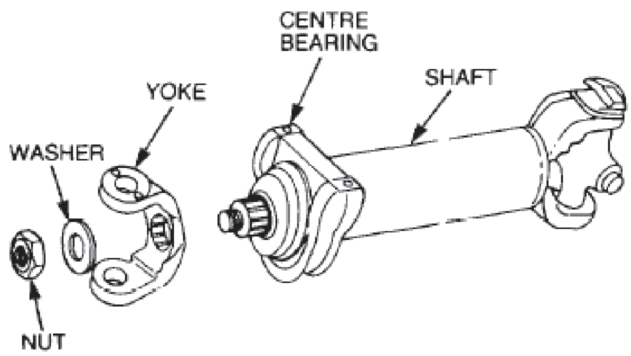


Figure 81 Transmission Propeller Shaft and Centre Bearing

112. The centre bearing is a self-centring, twin-row ball type inserted in a rubber bush and installed on the propeller shaft toward the rear yoke. A metal bracket (Figure 82) fits over the rubber bush, enabling the centre bearing to be secured to the chassis crossmember. The rubber bush surrounding the bearing insulates drive line vibrations from the chassis and also absorbs transmission movement.

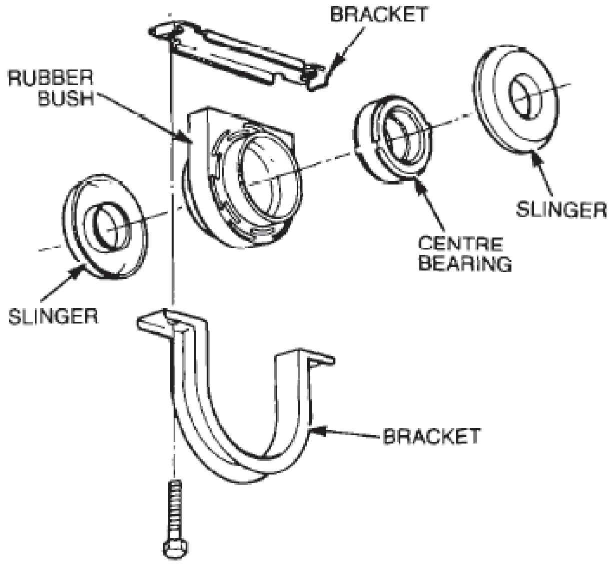


Figure 82 Centre Bearing Assembly

113. The second of the two shafts is the intermediate shaft (Figure 83). This is connected by a universal joint to the rear yoke on the transmission shaft and transmits the drive from the transmission shaft to the intermediate axle. The intermediate shaft is equipped with two universal joint yokes and a slip joint, which allows the length of the shaft to vary in accordance with the up and down movement of the intermediate axle.

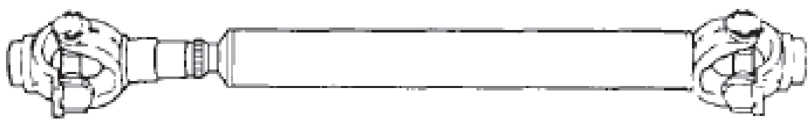


Figure 83 Intermediate Propeller Shaft

114. A third propeller shaft, a 1710 series (Figure 84) is an inter-axle propeller shaft, which transmits drive from the intermediate axle differential carrier to the rear axle differential carrier. The shaft uses two universal joint yokes and a slip joint, which allows for independent up or down movement of both the intermediate and rear axles.

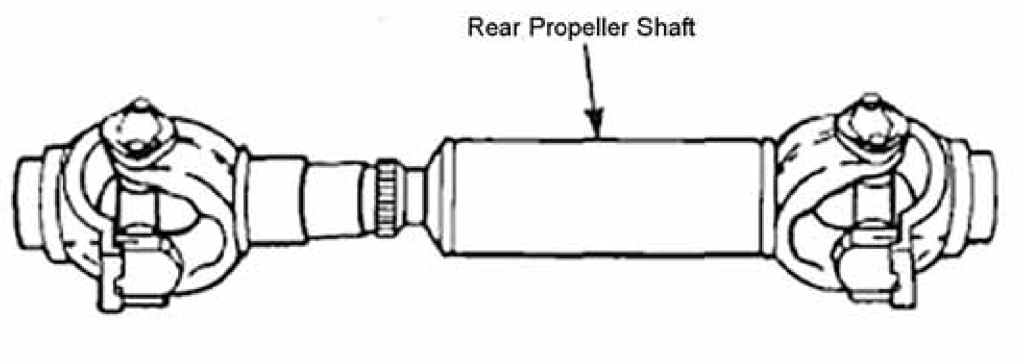


Figure 84 Inter-axle Propeller Shaft

Tandem Rear Axles

115. The tandem rear axle (bogie) assembly (Figure 85) comprises a Rockwell six rod, multi-leaf single point suspension and a Rockwell SSHD hypoid, single reduction, tandem bogie. The bogie assembly has a load carrying ability of 20.9 tonne (46 000 lb).

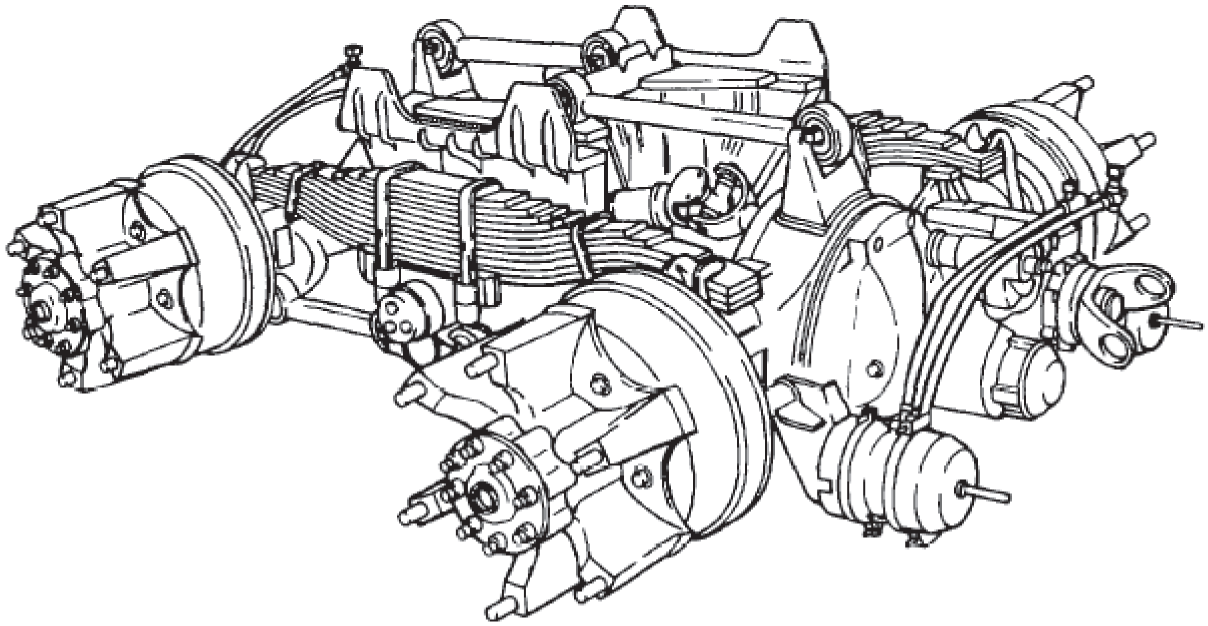


Figure 85 Tandem Rear Axle (Bogie) Assembly

116. The axle housings are constructed from hot forged steel and house the axle shafts. The differential carriers, secured to the axle housings, carry hypoid gear sets, which transmit drive from the propeller shafts to the axle shafts at a reduction of 4.89:1. An inter-axle differential (power divider) incorporated in the intermediate axle differential carrier (Figure 86) provides equal drive to both the intermediate and rear differentials and prevents drive line wind-up between the two differentials. A driver actuated lock-out is incorporated on the inter-axle differential to provide positive drive to both the intermediate and rear axles when the need arises.

117. Drive from the intermediate propeller shaft is transmitted to the input shaft and to the cross-shaft in the inter-axle differential. Due to the action of the inter-axle differential, drive is transmitted to both the intermediate differential (via a pair of bevel gears, one of which forms a side gear on the inter-axle differential, the other bevel gear is splined to the pinion shaft), and the rear differential, via the through shaft and a propeller shaft. Drive for the rear differential is transmitted directly from the propeller shaft to the pinion shaft (Figure 87).

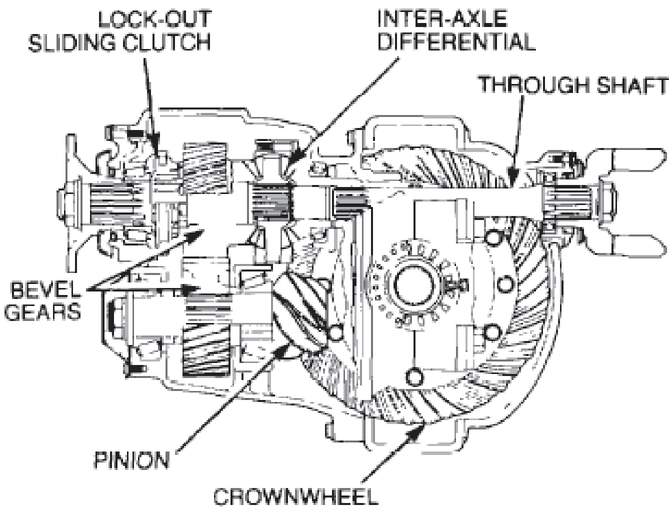


Figure 86 Intermediate Differential with Inter-axle Differential

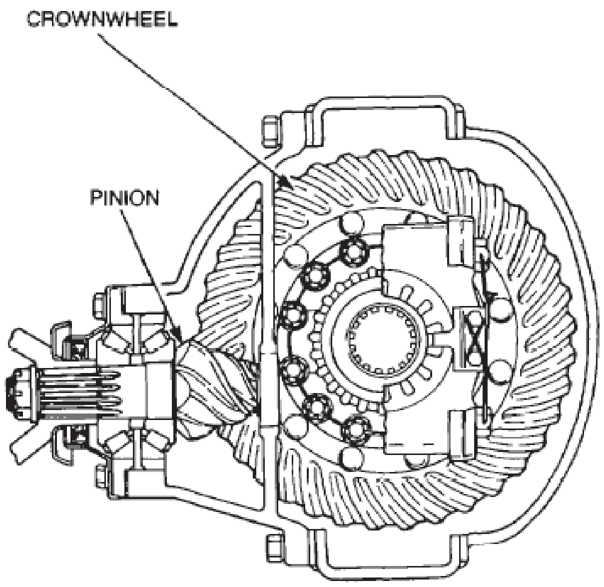


Figure 87 Rear Differential - Sectional View

118. The axle shafts, which are splined (on the inner end) to the differential side gears and flange bolted to the wheel hubs (on the outer end) transmit the drive from the differentials to the hubs and wheels. The hubs (Figure 88) are supported on two tapered roller bearings and positioned on the axle housing spindles. Two nuts (an adjusting nut and a locknut) secure each hub to the spindles.

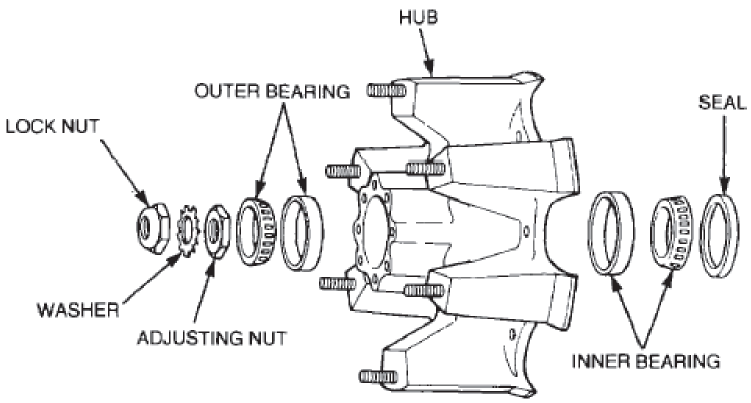


Figure 88 Rear Hub Assembly - Exploded View

Front Axle

119. The front, non-driving, axle (Figure 89) is constructed from a heat-treated steel forging, with an l-beam section and integral spring pads. Steering knuckles are attached to each end of the axle beam by means of straight king pins, which are secured to the ends of the axle beam by tapered pins. The king pins form the fulcrum on which the steering knuckles pivot. Bushes installed in the upper and lower king pin bosses on the steering knuckle enable the steering knuckles to pivot freely about the king pins. A thrust bearing, which uses roller bearings, is positioned between the lower surface of the axle-end and the upper surface of the lower king pin boss on the steering knuckle to take the weight and allow the steering knuckle to pivot freely on the axle-end.

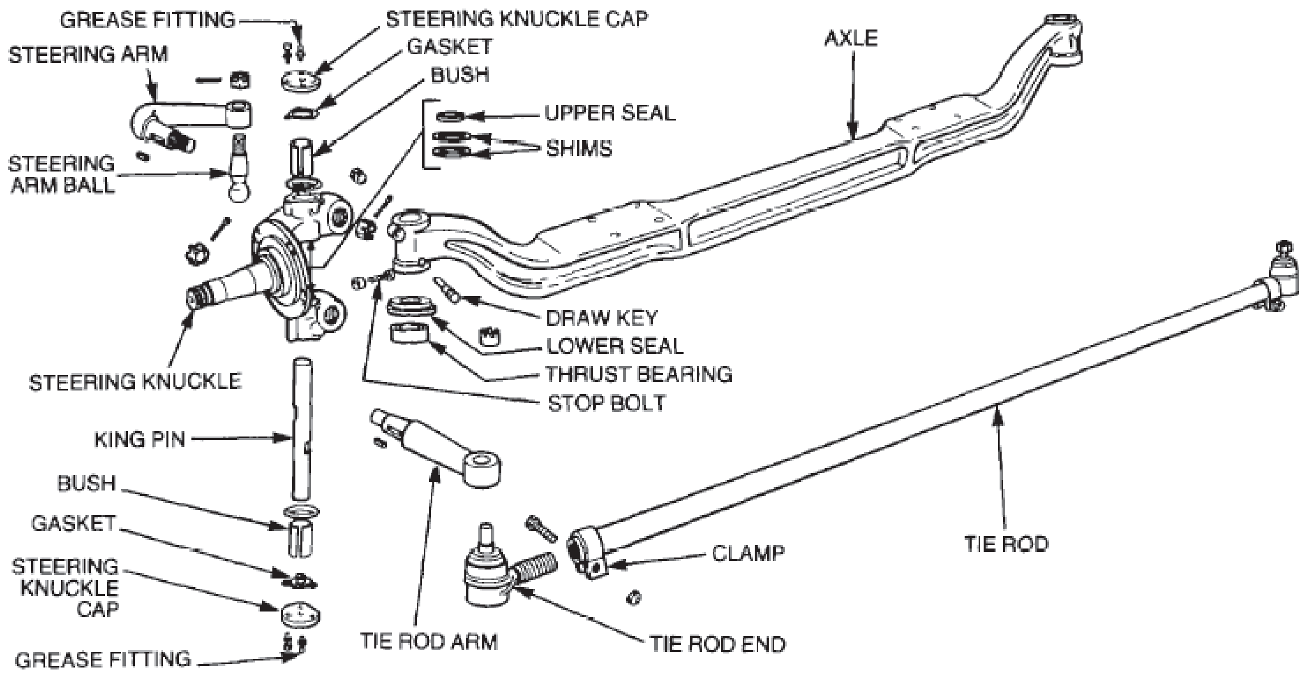


Figure 89 Front Axle and Steering Knuckle Assembly

120. The front hubs (Figure 90) are each supported on two tapered roller bearings and mounted on the steering knuckle stub axles. Two nuts (an adjusting nut and a locknut) secure each hub to the stub axles.

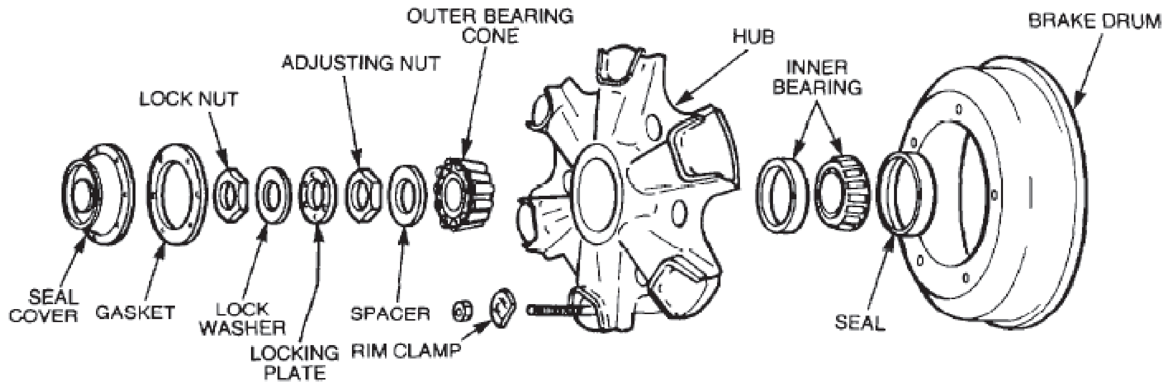


Figure 90 Front Hub Assembly

BRAKES

Service Brakes

121. The air required to operate the service brakes (Figure 91) is supplied by the air compressor located on the left-hand side of the engine and is stored in four separate tanks, two primary and two secondary. Part of the lower secondary tank is sectioned off to form the wet tank (Item l), which receives the air directly from the air compressor. The air, heated during compression, cools in the wet tank where the moisture in the air condenses and collects in the bottom of the tank. The cooled air then flows, via one-way check valves and hoses, from the wet tank to both the primary and the secondary storage tanks (Items 2 and 3). The low air pressure switch (Item 4), connected by air lines to the wet tank, controls the operation of the low air pressure warning device in accordance with the pressure in the wet tank. When air pressure drops below 550 kPa (80 psi) the warning devices are activated and remain activated until the pressure builds up to above 550 kPa (80 psi). The operation of the air compressor is controlled by a governor, which monitors the air pressure in the wet tank and operates the compressor in accordance with the pressure. The air compressor begins to operate when air pressure drops below 725 kPa (105 psi) and ceases to operate when the air pressure reaches 860 kPa (125 psi).

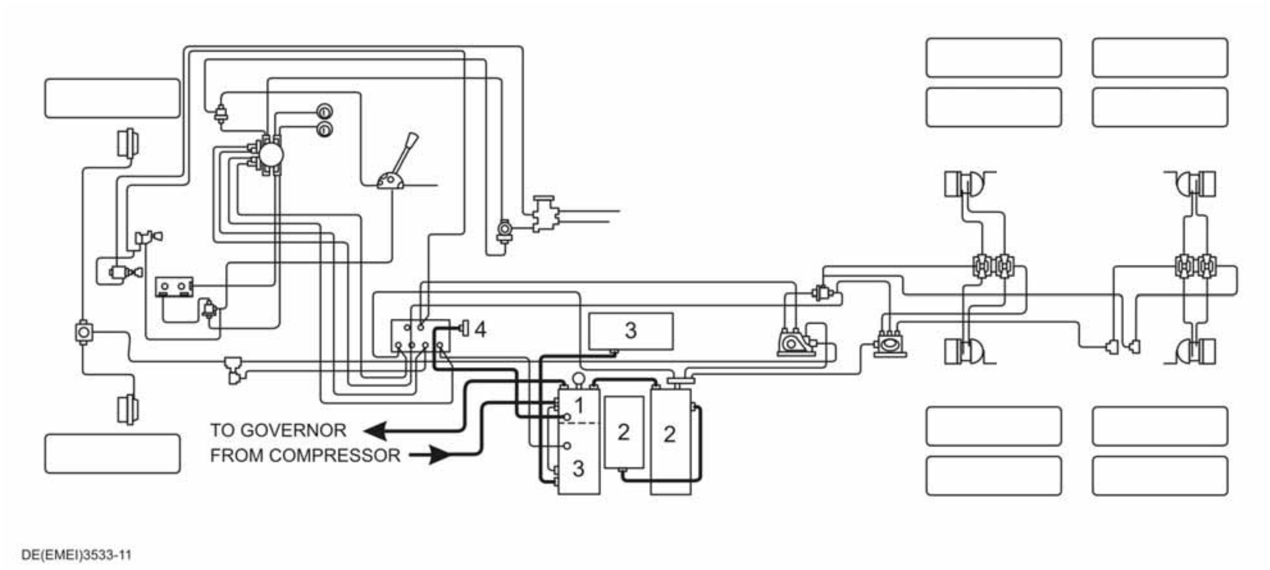


Figure 91 Brake System Air Supply

122. The service brakes consist of two separate brake circuits, the primary and the secondary. The primary circuit (Figure 92) actuates the brakes on the intermediate and rear axles and uses the pressurised air in the primary storage tanks (Item 2). Pressurised air flows forward to a manifold (Item 5), and from the manifold to the lower section of the brake treadle valve (Item 6) through the treadle valve to the air pressure gauge (Item 7) and to a double-check valve (Item 8). The air flows through the double-check valve to the parking brake control valve (Item 9) and to the trailer brake hand control valve (Item 10). Air also flows directly from the storage tanks to the service brake relay valve (Item 11) and the spring brake inversion valve (Item 12). When the parking brake control valve is in the RELEASE position, air flows through the inversion valve to the spring brake chambers (Item 13) where it acts against a diaphragm in the spring brake chambers causing the actuating springs to be compressed and the brakes to be released.

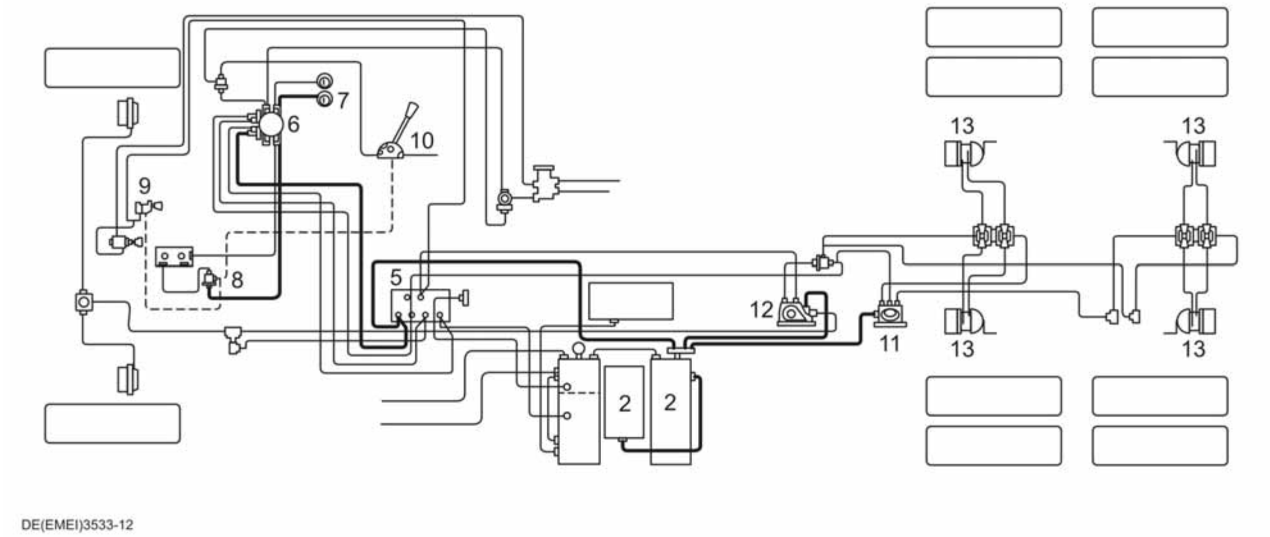


Figure 92 Primary Brake Circuit

123. The secondary circuit (Figure 93) uses the air stored in the secondary tanks (Item 3) to actuate the front brakes. Air from the tanks flows forward to a manifold (Item 5). From the manifold it flows to the upper section of the brake treadle valve (Item 6), through the treadle valve to the air pressure gauge (Item 14), and to a manifold (Item 15). At this manifold air is directed to the power divider control valve, the air horn control valve, the front seats' suspension and to the double-check valve (Figure 92 Item 8). The air flows through the double-check valve to the parking brake control valve (Figure 92 Item 9) and also to the trailer brake hand control valve (Figure 92 Item 10).

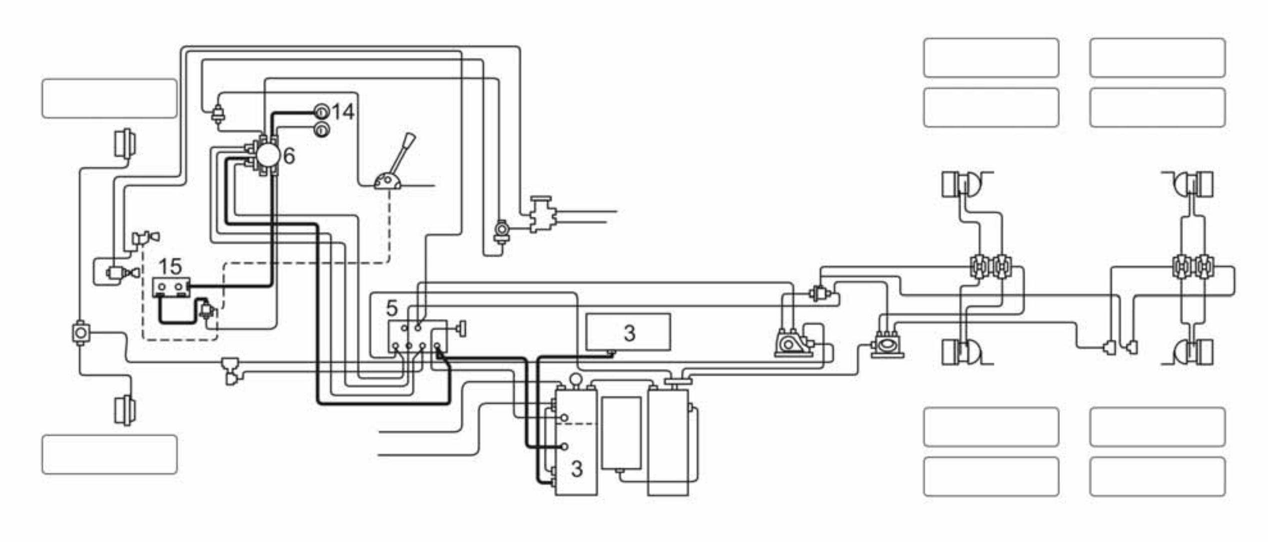


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Figure 93 Secondary Brake Circuit

124. When the brakes are applied, both the primary and the secondary circuits are activated. Air from the primary circuit (Figure 94) of the treadle valve (Item 6), flows to the manifold (Item 5), where it is directed to the double check valve (Item 14) and the service brake relay valve (Item 11) at the rear of the vehicle. This air supply at the relay valve acts as a signal, which causes the relay valve to open ports that allow air direct from the storage tanks (Item 2) to flow through to the service brake chambers (Item 15) via the quick release valves (Item 16) on both the intermediate and rear axles, applying the brakes.

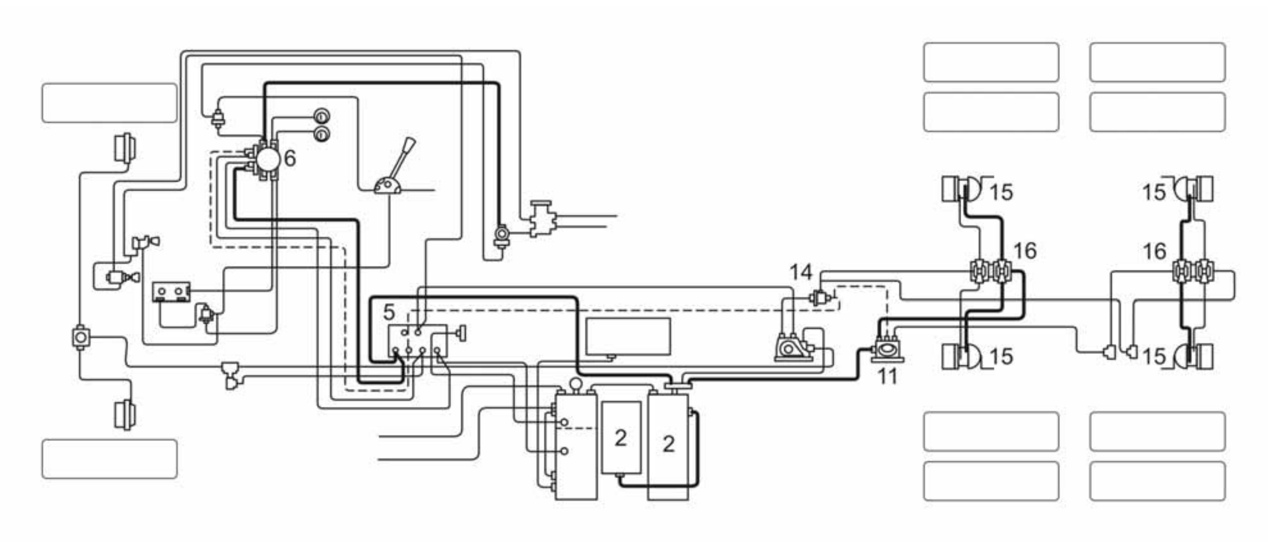

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Figure 94 Primary Circuit - Brakes Applied

125. The air from the secondary circuit (Figure 95) of the treadle valve (Item 6) flows to the manifold where it is directed to a two-way connector (Item 17). One way it flows rearward to the spring brake inversion valve (Item 12), the other way it flows forward to the quick release valve (Item 18) through the release valve to the front brake chambers (Item 19) to apply the brakes.

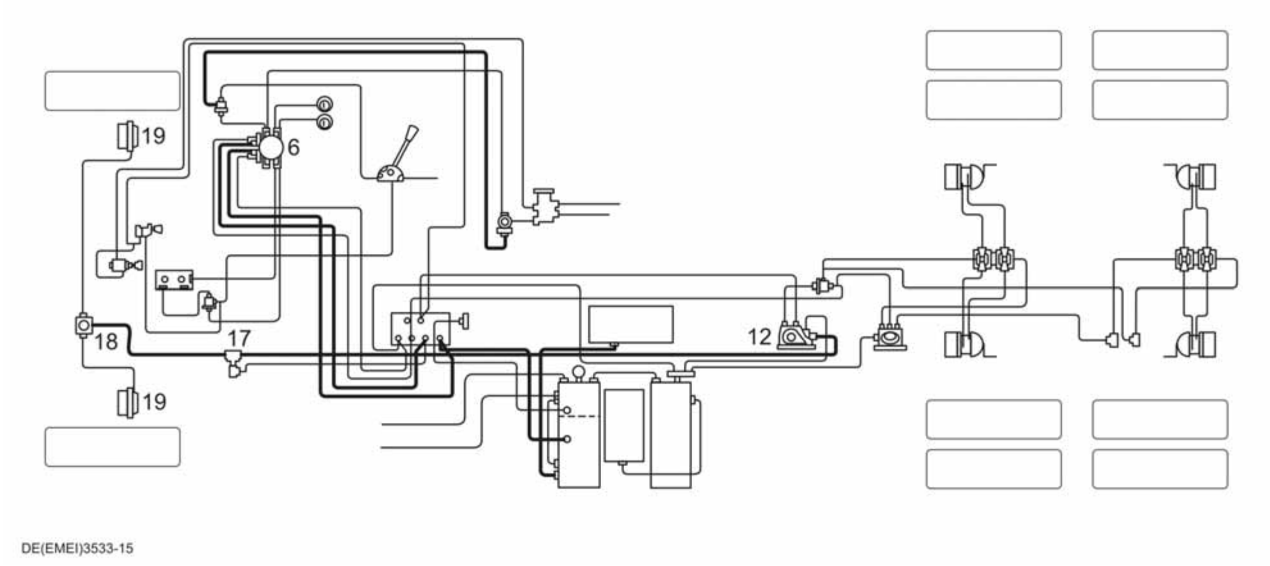

Figure 95 Secondary Circuit - Brakes Applied

126. When the brake treadle valve is released, the pressurised air in the service brake relay valve signal line is released to the atmosphere, causing the relay valve to close the supply port and open a vent to dump the air from the lines between the relay valve and the quick release valves. The pressurised air in the service brake chambers now acts on the quick release valves, causing the valves to open and allow the air to escape to the atmosphere. Once the pressure is released from the rear service brake chambers, the brakes are released. The same applies to the secondary brake circuit. Once the pressurised air in the circuit between the treadle valve and both the quick-release valve and the spring brake inversion valve is released to the atmosphere, the pressurised air in the front service brake chambers acts on the quick-release valve, causing the valve to open, and allow the air to escape to the atmosphere. Pressure in the front brake chambers drops off and releases the brakes.

127. In the event of air pressure loss in the primary system alone, near normal braking can still be achieved through the secondary brake system. The vehicle’s front brakes still operate as normal, but the spring brakes now apply the brakes at the rear. As the driver actuates the brake treadle valve to apply the brakes, secondary air flows to the front brake chambers, via the quick release valve, and also to the spring brake inversion valve. At the inversion valve, the secondary air flows through an inlet valve to the underside of the large piston, where it causes the piston to move up against spring pressure to open an exhaust port. The pressurised air between the inversion valve and the pressure holding valves is now vented to the atmosphere, via the exhaust port (Figure 96). With the reduction of air pressure at the supply port of the pressure holding valve, the pressure of the air in the spring brake chambers acts on the piston in the pressure holding valve which opens the exhaust port and allows air from the spring brake chambers to be vented to the atmosphere. The springs now apply the brakes in proportion to the amount of treadle valve application i.e. the rate at which the air is vented and the amount of air vented.

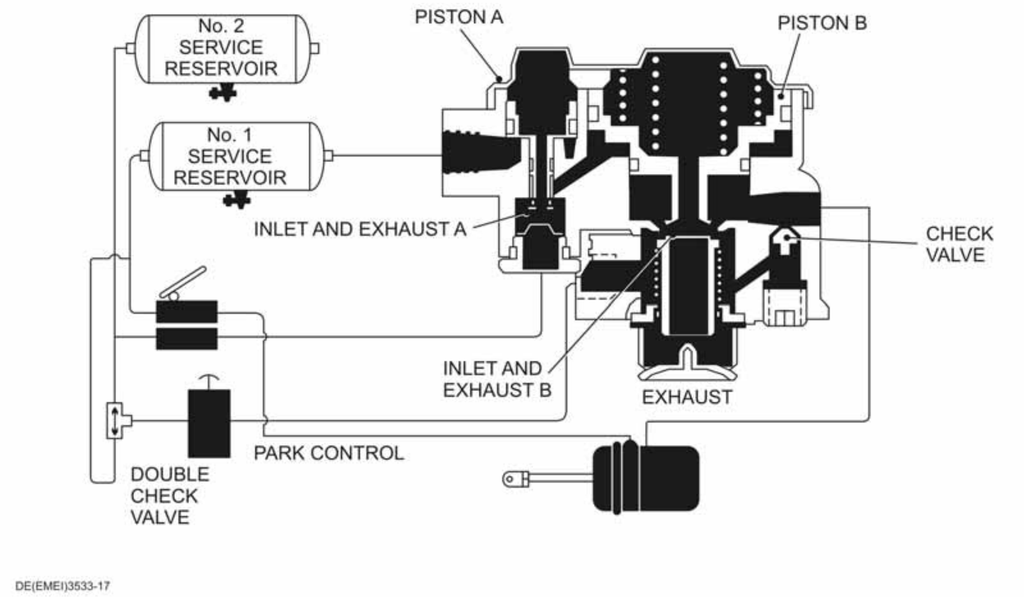

Figure 96 Inversion Valve Operation - Secondary Brakes Only

128. When the treadle valve is released, air pressure in the line between the treadle valve and the spring brake inversion valve and the air below the large piston in the inversion valve is vented to the atmosphere via the treadle valve. Spring pressure now moves the large piston down closing the exhaust port and opening the inlet port (Figure 97). Air from the park brake control valve now flows through the inversion valve to the spring brake chambers via the pressure holding valves. The pressurised air acts on the diaphragms in the spring brake chambers compressing the spring and releasing the brakes.

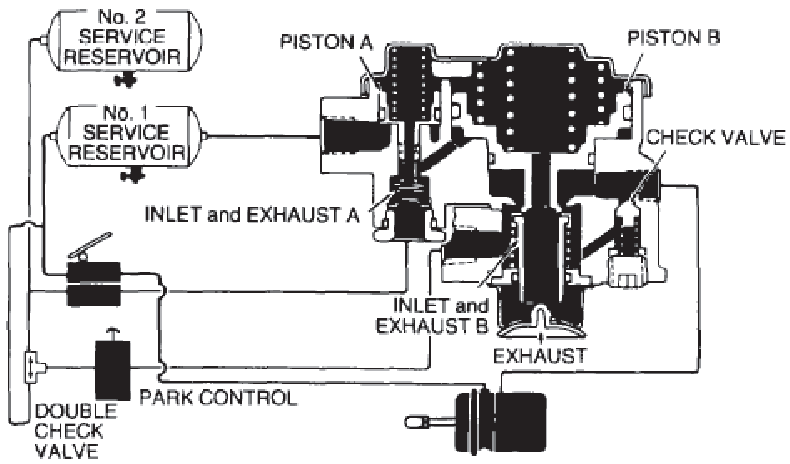

Figure 97 Flow through Inversion Valve - Brakes Released

129. If air pressure in the secondary system is lost or drained off, the brakes are not totally lost. The primary air system still supplies air to the brake treadle valve and to the tractor protection control valve. When the brakes are applied, the rear brakes (and trailer brakes if a trailer is coupled) operate as normal, but the vehicle's front brakes do not operate.

Parking Brake

130. The vehicle's parking brake (Figure 98) is controlled by a push-pull valve (Item 9) located on the dashboard. When the control knob (Item 9) is pulled out, to apply the parking brake, the pressurised air in the parking brake circuit between the control valve and the pressure holding valves (Item 20) is vented to the atmosphere through the exhaust port in the control valve. When air pressure in the supply port of the pressure holding valves becomes less than the residual air pressure in the spring brake chambers (Item 13), the pressure of the air in the spring brake chambers acts against the piston in the pressure holding valve causing the piston to move and open the exhaust port.

Pressurised air from the spring brake chambers is vented through the exhaust port in the pressure holding valves allowing the springs in the spring brake chambers to expand and apply the brakes.

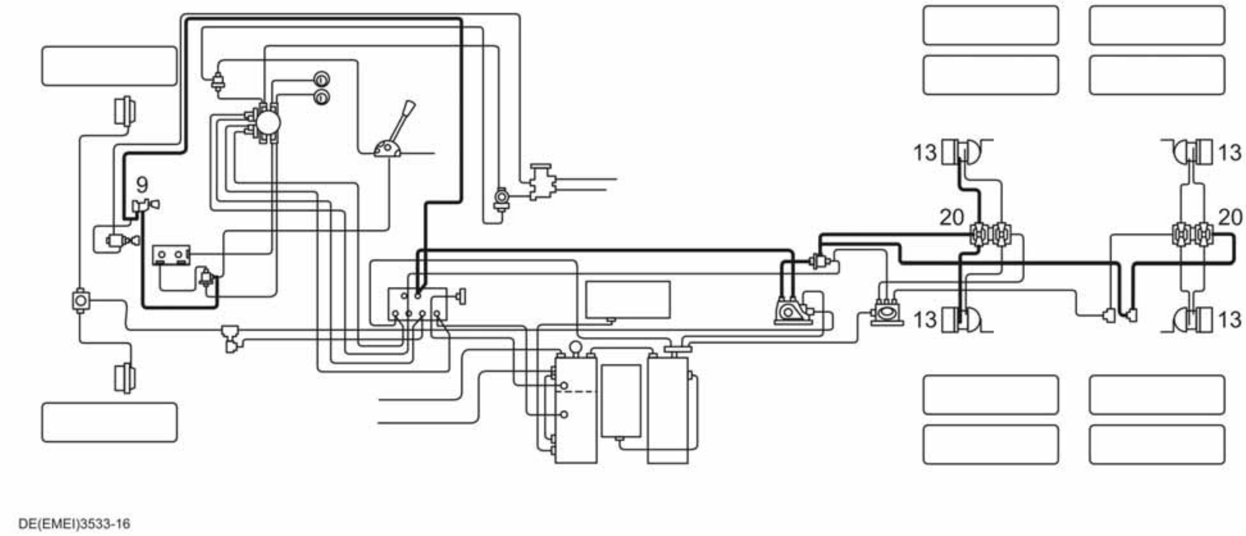

Figure 98 Parking Brake Circuit - Brakes Released

131. When the control knob is pushed in to release the parking brake, the primary/secondary air sourced from the double check valve flows through the open control valve and the spring brake inversion valve to the pressure holding valves. The air pressure in the supply port of the pressure holding valves moves the pistons within the holding valves to close the exhaust ports. Air is now directed into the spring brake chambers where it acts against diaphragms causing the diaphragms to expand and compress the springs and release the brakes. The brakes remain in the released position while pressurised air acting against the diaphragms holds the springs in compression.

132. To operate the trailer brakes, the tractor protection control valve located on the dashboard must be pressed in to supply air to the emergency port of the tractor protection (breakaway) valve. When air is supplied to the emergency port of the protection valve, it acts on the plunger within the valve, pushing the plunger against spring pressure and opening the emergency air outlet port. Air now flows through the protection valve to the air storage tanks on the trailer. As the plunger moves to permit air flow through the emergency ports, it also opens a passage joining the two service ports (Figure 99).

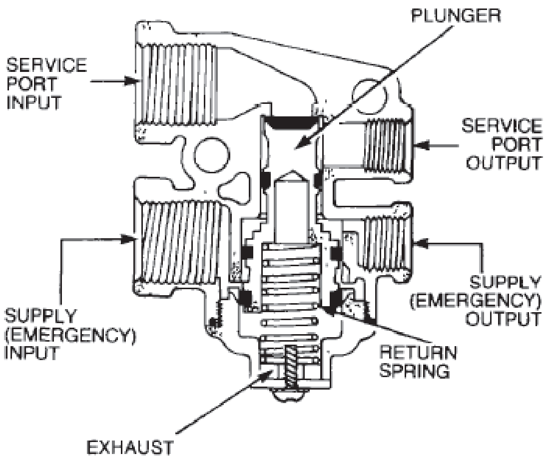

Figure 99 Tractor Protection Valve Operation

133. When the treadle valve is operated to apply the vehicle’s service brakes or the trailer brake hand control valve on the steering column is operated, primary or secondary air flows through the service ports of the protection valve to the relay valves on the trailer. This pressurised air acts on the relay valves, causing the valves to open ports to allow air from the trailer air storage tanks to flow to the brake chambers and apply the brakes.

134. When the brakes are released, air in the service line is exhausted through the actuating valve (either the treadle valve or the hand control valve), relieving the air pressure acting on the trailer relay valves. The relay valves close off the brake chamber supply ports and open an exhaust port, allowing the air in the service brake chambers to flow back through the relay valve and out the exhaust port, releasing the service brakes.

Brake Treadle Valve

135. The foot operated brake treadle valve (Figure 100) is a Bendix Westinghouse E-7 type, which controls the air pressure being delivered to the service brake chambers. The amount the brake pedal is moved to 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 brakes are partially or fully released, a proportional amount of air in the brake chambers is released through relay and quick release valves.

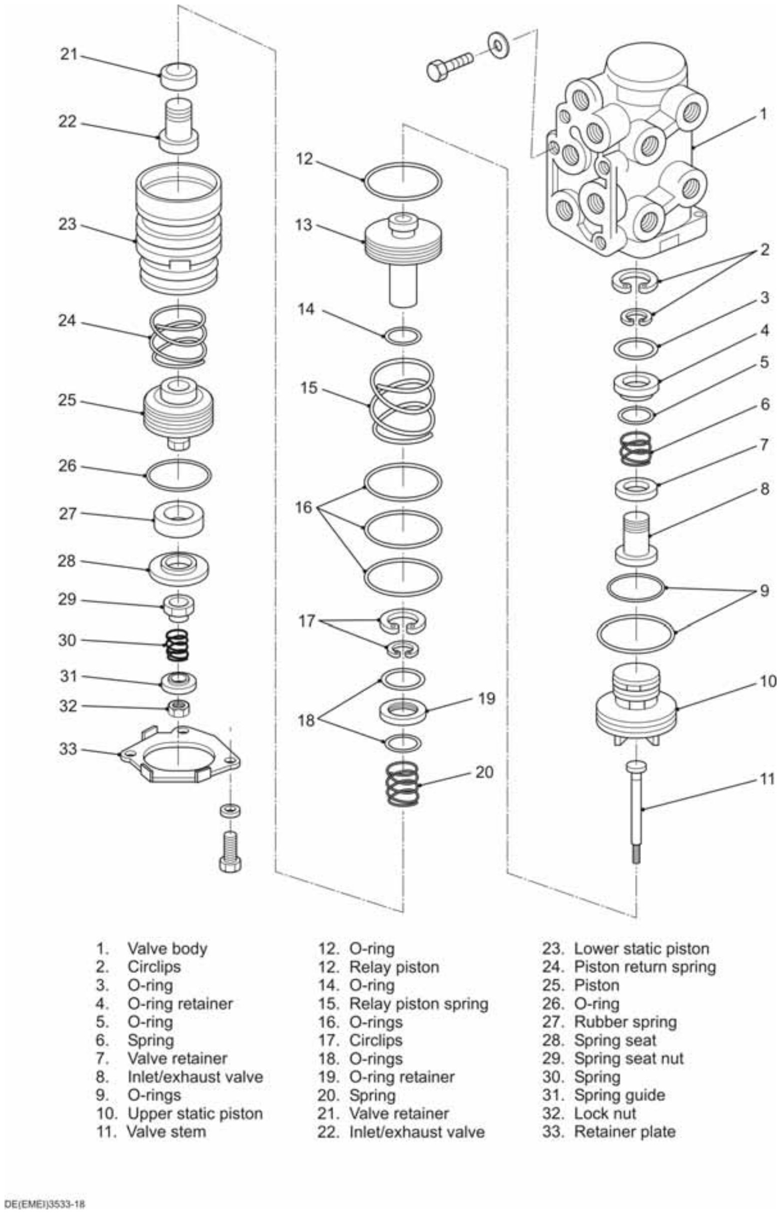

Figure 100 Brake Treadle Valve - Exploded View

136. The relay valve is a high capacity remote controlled brake valve used to supply air, direct from the storage tank, to the rear service brake chambers. The operation of the relay valve is controlled by the brake treadle valve. When the treadle valve is operated (to apply the brakes) pressurised air is directed to the control port of the relay valve. The air flows through the control port and into a cavity above the piston. Air pressure forces the piston down against the modulation tube to close the exhaust valve port. Further downward movement of the piston and modulation tube opens the inlet valve (Figure 101) allowing air from the brake system primary storage tank to flow through the supply port to the service brake chambers (via the quick release valves) to apply the brakes.

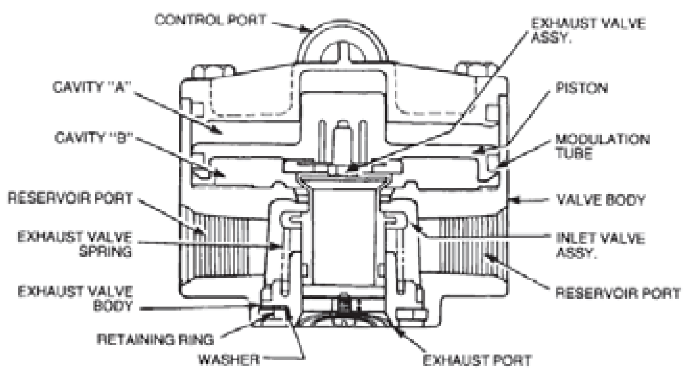

Figure 101 Relay Valve Operation - Brakes Applied

137. When the brakes are released, the pressurised air above the piston is vented to the atmosphere through the exhaust port on the brake treadle valve. A combination of the modulation tube return spring pressure and air pressure in the circuit between the relay valve and the quick release valves moves the piston and the modulation tube upward, closing the inlet valve and opening the exhaust valve (Figure 102). Air in the circuit between the relay valve and the quick release valves is now released through the exhaust valve port. With the air pressure relieved on the quick release valve supply port, air pressure in the brake chambers now causes the exhaust port in the quick release valve to open and release the air in the brake chambers to the atmosphere releasing the service brakes.

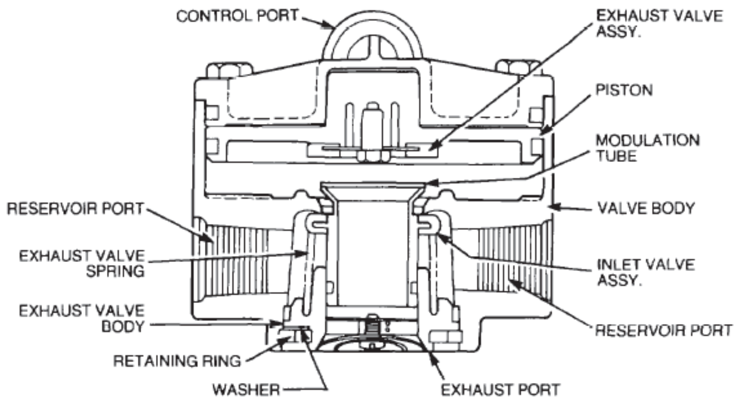

Figure 102 Relay Valve Operation - Brakes Released

Quick Release Valve

138. The quick release valve provides a localised means of releasing the air from the brake chambers the instant the treadle brake valve is released. The quick release valve (Figure 103) is T-shaped and incorporates a supply port, two delivery ports, an exhaust port and a spring loaded diaphragm. When the brakes are actuated, air flows through the inlet (supply) port and forces the diaphragm down, against spring pressure, to close the exhaust port. The air is now directed through the delivery ports to the brake chambers. When the pressure in the supply port is released, the force of the spring moves the diaphragm to open the exhaust port and allow the pressurised air in the brake chambers to be vented to the atmosphere.

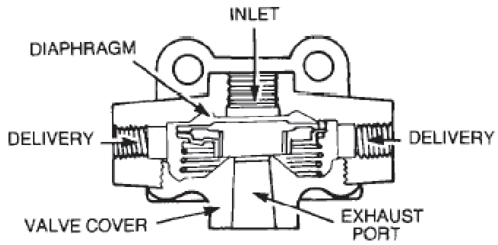

Figure 103 Quick Release Valve - Sectional View

Pressure Holding Valve

139. The pressure holding valve is similar to the quick release valve in design and operation but uses a piston instead of a diaphragm. When the parking brakes are released, pressurised air delivered to the supply port of the holding valve moves the piston down to block the exhaust port and open the delivery ports. The air flows through the delivery ports to the spring brake chambers to release the spring brakes.

140. When the spring brakes are operated, the pressurised air in the supply port is vented to the atmosphere. With no air pressure acting on the top of the piston, residual air pressure in the spring brake chambers acts against the piston causing the piston to move up to block the supply port and open the exhaust port. This allows the air in the brake chambers to escape, the springs to expand and apply the brakes.

Slack Adjusters

141. The vehicle's brakes are equipped with slack adjusters which not only provide a means of connecting the brake chamber push rod to the S-cam shaft but also a means of adjusting the brake shoe to drum clearance. The slack adjuster is splined to the S-cam shaft and connected to the brake chamber push rod by clevis and pin. When the brakes are applied, the push rod acts against the slack adjuster causing the slack adjuster to rotate the shaft. The S-cam, which is welded to the shaft, rotates with the shaft and causes the brake shoes to expand against the drum to create the braking effort required to stop the vehicle.

142. The slack adjuster (Figure 104) comprises a lever, an adjusting screw and a wheel. The wheel is splined internally to mesh with the splines on the S-cam shaft, while the teeth machined into the outer circumference, mesh with the thread on the adjusting screw. Both the wheel and the adjusting screw are housed within the lever and held in position by two plates which are riveted to the lever. A spring loaded sleeve incorporated in the lever provides a means of locking the adjusting screw in position and preventing the brake adjustment slackening off due to road shocks or vibration. A grease nipple is installed in the lever to enable the components of the slack adjuster to be lubricated without the need to disassemble.

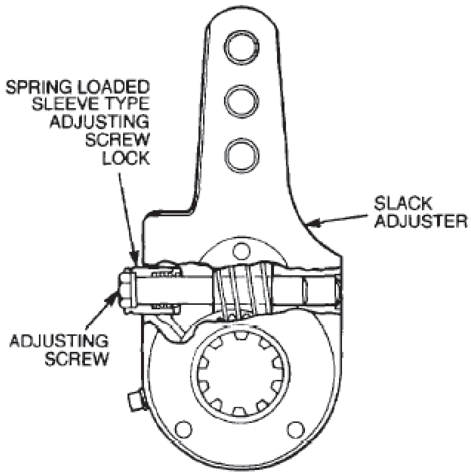

Figure 104 Slack Adjuster - Sectional View

Hand Control Valve

143. The hand control valve provides the driver with a means of applying the trailer brakes independently of the vehicle's braking system should the need arise. The control valve (Figure 105) is triple ported at its base for supply, delivery and exhaust connections. The manually operated control valve is located on the steering column and provides brake application, hold and release positions within the 90 degrees of lever travel.

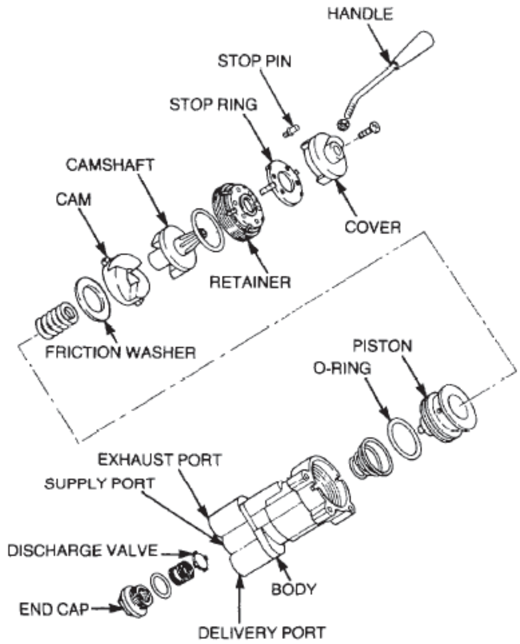

Figure 105 Hand Control Valve - Sectional View

Air System

144. The vehicle is equipped with a Cummins single cylinder water-cooled compressor which is mounted on the left-hand side of the engine and driven by the engine's timing gears via a splined coupling from the accessory drive shaft. The compressor has a piston displacement of 296 cm^3 with bore and stroke dimensions of 92.05 mm by 44.45 mm respectively. Cooling of the compressor is accomplished by utilizing the engine's cooling system. Coolant is piped from the engine to the compressor cylinder head where it circulates before being piped back to the engine. Lubrication of the compressor also comes from the engine. Oil is fed into the compressor through the accessory drive shaft opening and returned to the engine through a port below the accessory drive shaft.

145. The compressor runs continuously while the engine is running but the actual compression of the air is controlled by the governor which is located on the top of the air compressor. The governor acts in conjunction with the unloader valve in the compressor top cover and controls the operation of the compressor by either loading or unloading the compressor. When pressure in the air storage tanks falls below 717 kPa (104 psi) the governor loads the compressor starting the compression of air in the governor body (Figure 106). Air pressure acts to overcome the pressure setting spring and control the inlet and exhaust valves, which either admit or exhaust air from the compressor unloading mechanism.

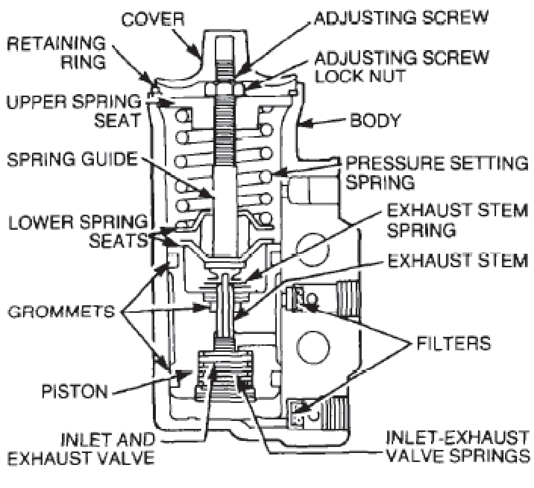

Figure 106 Air System Governor - Sectional View

SUSPENSION

Front Suspension

146. The front suspension (Figure 107) comprises two semi-elliptic springs and two telescopic shock absorbers. Each spring consists of eight leaves held together by a centre bolt and kept in alignment by four clips. The springs are secured to the chassis by a fixed-shackle mounting bracket at the front, and a swing-shackle mounting bracket at the rear. The front axle is slung under the springs and secured to each spring by two U-bolts. Two rubber bump-stops are bolted to the chassis and positioned above each spring to stop metal to metal contact of the springs with the chassis. The shock absorbers are a double acting hydraulic type used for absorbing shock loads and to dampen spring rebound rate. The shock absorbers are secured by bolts to a chassis mounted bracket at the top, and to a plate positioned between the spring and the axle at the bottom.

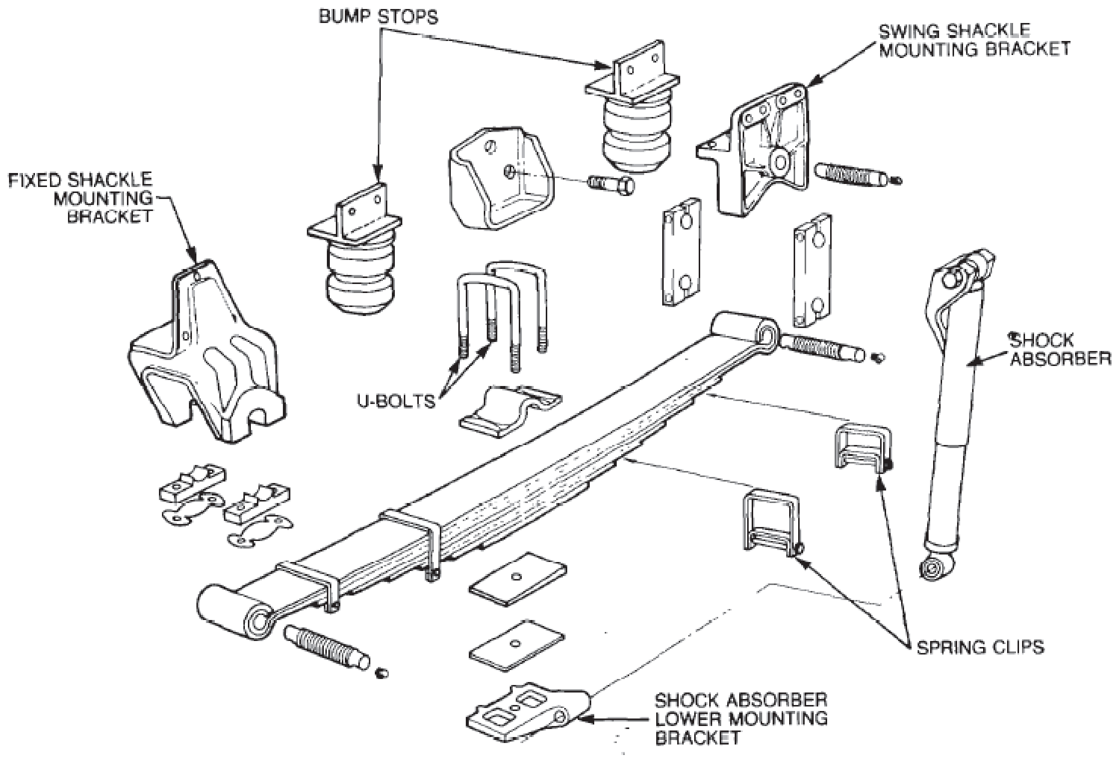

Figure 107 Front Suspension

Rear Suspension

147. The rear suspension (Figure 108) is a Rockwell ACG, which is a six rod, multi-leaf, single point suspension. The six torque rods are rubber bushed at both ends to absorb shock loads and are installed to housings in a parallelogram configuration to enable the load to be distributed equally between the intermediate and rear axles. The torque rods not only keep the axles in proper driving alignment but also help to absorb tractive torque and braking forces. The drive shaft angles are adjusted by means of spacers between the torque rod ends and the axle housing. The rear bogie is suspended by multi-leaf camel back springs which are secured at the centre to the trunnion brackets by means of U-bolts. The trunnion brackets are mounted on the trunnion shaft and form a pivot about which the spring assembly oscillates. The free ends of the spring float in axle spring rebound and guide brackets located on top of the axle shaft housings.

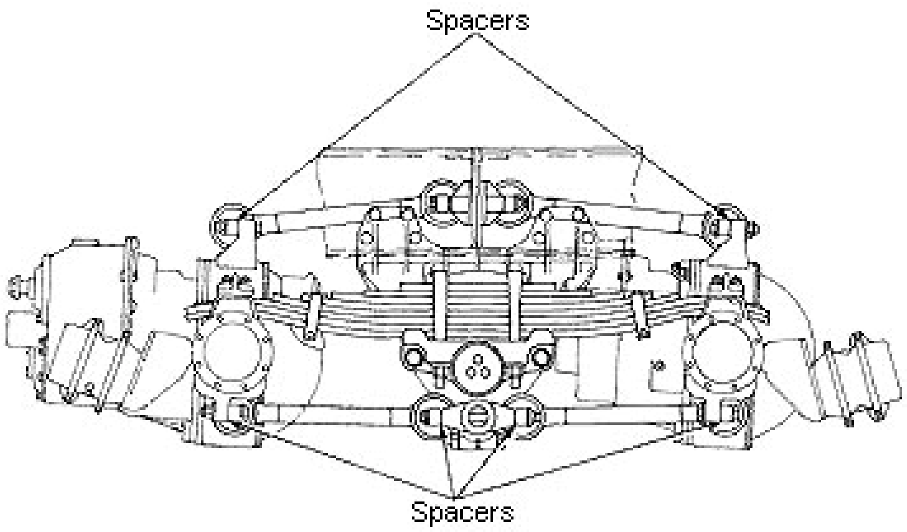

Figure 108 Rear Suspension

STEERING

148. The Sheppard power assisted steering system uses two integral steering assemblies, an M392 main steering box and an M292 slave steering box. Both steering boxes are secured to the vehicle chassis forward of the front axle. The main steering box located on the right hand chassis rail and connected to the steering wheel by the steering column. The slave steering box is located on the left hand chassis rail and connected to the main steering box by means of high pressure hydraulic pipes. Although both steering boxes are similar in appearance Figure 109 illustrates the differences between the two.

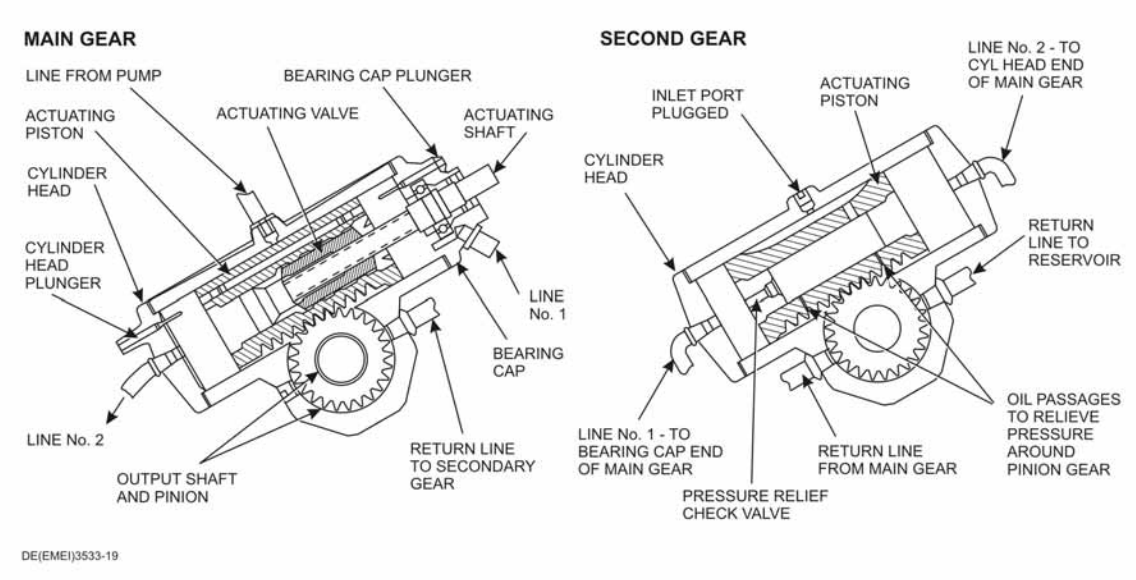

Figure 109 Steering Boxes - Sectional Views

149. When the steering wheel is turned in either direction, the steering column transmits the rotating action of the steering wheel to the actuating shaft in the main steering box. The actuating shaft has an Acme type, multiple start thread which engages with a similar type thread in the actuating valve located within the bore of the actuating piston. Linear movement of the actuating valve is limited (approx 0.8 mm) within the piston and this movement causes the actuating piston to move. The piston has a rack machined on one side which meshes with a gear splined onto the output shaft. As the actuating shaft rotates, in accordance with the rotation of the steering wheel, the actuating valve travels along the actuating shaft due to the design of the threads taking the piston with it and causing the output shaft to rotate.

150. To operate the slave steering box hydraulic pressure is required. This is provided by the Vickers V2OF series pump which provides oil under pressure to the main steering box controlling the oil flow to the slave steering box. Oil under pressure is delivered to the main steering box while the engine is running. Figure 110 illustrates oil flow with the steering box in the neutral position.

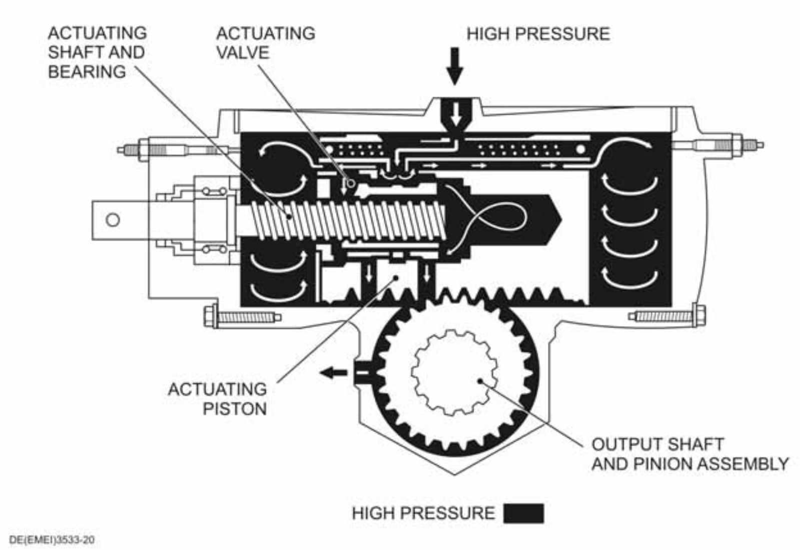

Figure 110 Steering in Neutral Position

151. When the steering wheel is turned the rotating action of the actuating shaft causes the actuating valve to move within the piston bore of the piston opening a port to allow the pressurised oil to flow in through a passageway in the piston to the chamber behind the piston (Figure 111).

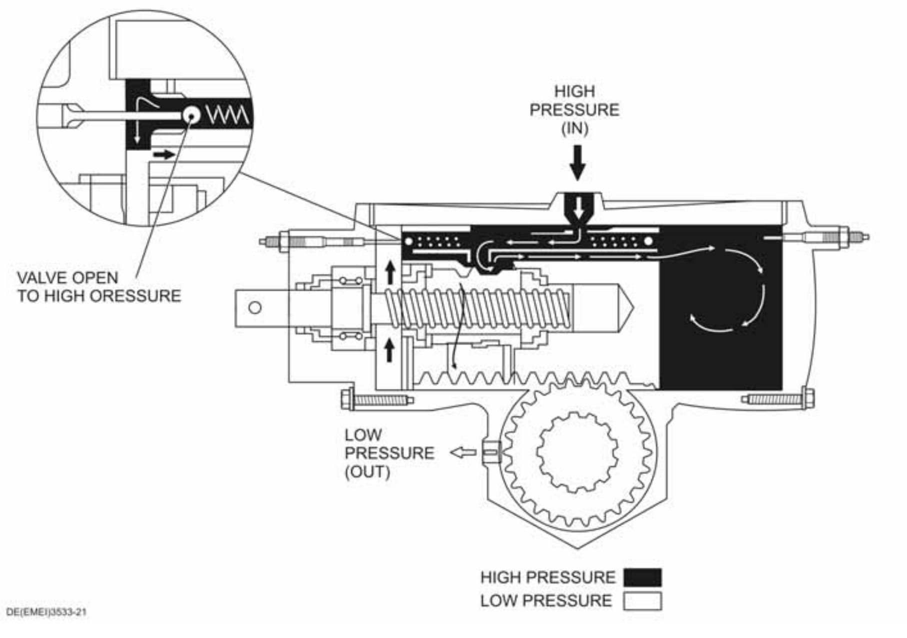

Figure 111 Steering in Operational Position (Right Lock)

152. The pressurised oil now assists the actuating shaft and valve to move the piston in the required direction. When power assisted steering is no longer required, return springs centralize the actuating valve within the piston, closing the port and stopping the flow of oil into the steering box. When the steering wheel is turned in the opposite direction, the actuating valve moves to open the port but directs the oil to the other end of the piston to assist the actuating shaft and valve to centralize the steering or turn towards the opposite lock. A relief valve is installed at each end of the piston which is activated by an adjustable plunger. One plunger is installed in the bearing cap and the other in the cylinder head. When the piston nears the end of the housing, the plunger unseats the relief valve ball and allows pressurised oil to flow through to the non-pressurised end, thus relieving the pressure of the oil acting on the piston.

153. The Vickers V2OF series pump is secured to the rear flange on the engine oil pump and is driven by the oil pump drive shaft. The V2OF is a vane type pump consisting of a body, a cover, a drive shaft assembly, a pressure plate and a pumping cartridge (Figure 112).

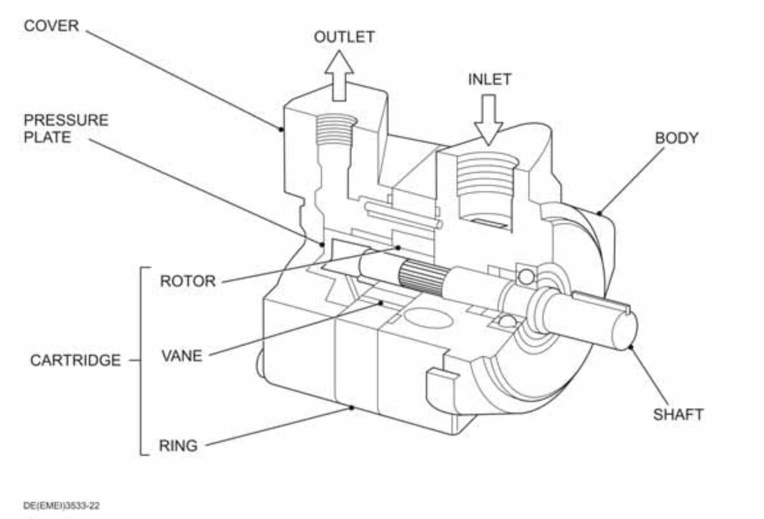

Figure 112 Steering Pump - Sectional View

154. The pumping cartridge comprises the vanes, a slotted rotor and a ring. The inner rotor is splined to the drive shaft. When the pump is operating, 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 ducted into the low pressure areas formed at the point where chamber volume is greatest. This oil is carried around by the vanes and discharged through the outlet port located at the point of minimum chamber volume (Figure 113).

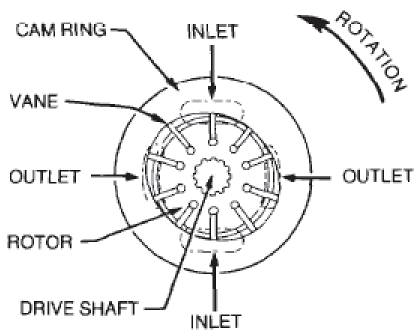

Figure 113 Steering Pump - Operation

ELECTRICAL

Starter Motor

155. The Delco Remy 42-MT series starter motor is a solenoid actuated drive type, i.e. the starter solenoid provides a means of engaging the drive pinion with the flywheel ring-gear for cranking the engine. The solenoid comprises a coil, a plunger and a lever. When the ignition is turned off and current ceases to flow through the windings of the solenoid, the plunger and lever are held in the released position by spring pressure (Figure 114).

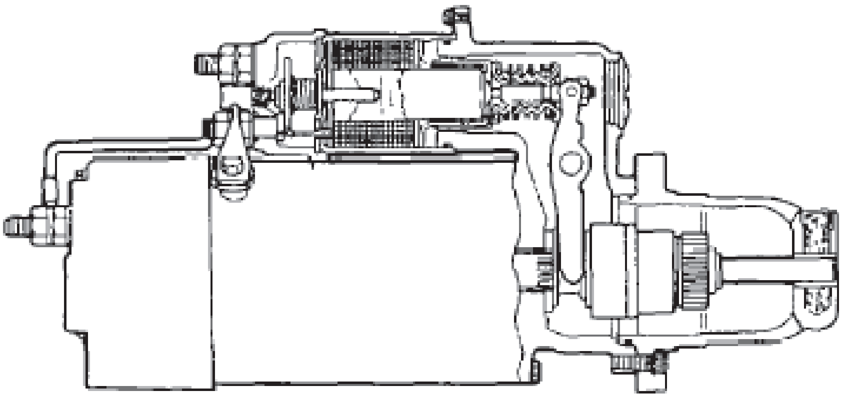

Figure 114 Ignition Switch OFF

156. When the ignition is turned to the ON position, current flows through the coil in the solenoid creating a magnetic field which overcomes spring pressure and draws the plunger through the centre of the coil. As the plunger moves the lever which is connected to the plunger also moves. The pivoting action of the lever moves the starter motor drive pinion into mesh with the flywheel ring-gear (Figure 115).

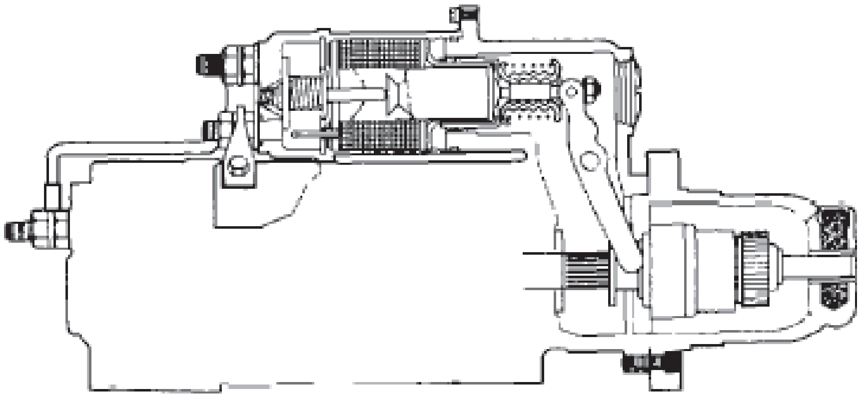

Figure 115 Ignition Switch START

157. When the plunger reaches the end of its travel, it closes a set of contacts within the solenoid permitting full current flow direct from the battery to the starter motor. This current creates magnetic fields in both the field and the armature windings. The magnetic fields created in the armature oppose the magnetic fields created in the field windings and cause the armature to rotate. As the armature rotates, the drive pinion which is splined to the armature shaft and the flywheel ring-gear which is meshed with the drive pinion rotates.

158. Figure 116 illustrates a sectional view of the starter motor assembly.

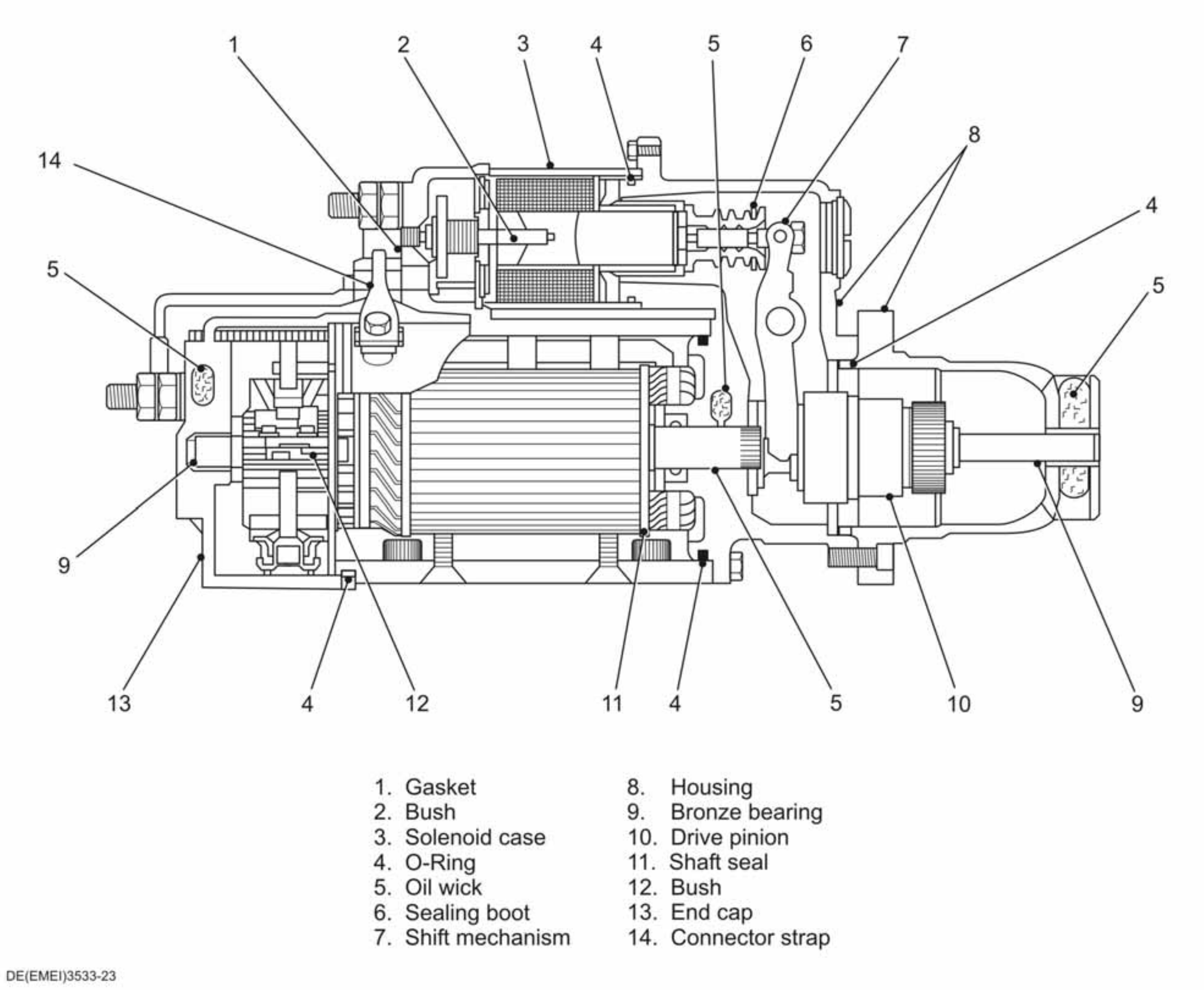

Figure 116 Starter Motor - Sectional View

Alternator

159. The Leece-Neville alternator is a 14-volt self load limiting type which is driven by the engine crankshaft pulley via twin V-belts. The alternator has an output of 90 amps at 14.0 volts and can operate up to a maximum speed of 8000 rpm. A solid state voltage regulator is incorporated in the alternator.

160. The rotor assembly is a dynamically balanced, heavy duty construction which uses a 7/8 in diameter straight shaft. The assembly is supported on two bearings. A sealed ball bearing at the drive-end and a heavy-duty roller bearing, which is enclosed at one end and equipped with a built-in seal to protect against contaminates at the slip-ring end. Both the rotor and stator coil windings are impregnated with varnish for maximum protection.

161. Six silicon diodes are used to rectify the alternating current created by the alternator to a direct current for use in the vehicle’s electrical system. The diodes are mounted in heat sinks which dissipate the heat generated by the diodes during operation. A capacitor is connected between the two heat sinks to assist in suppressing transient voltage spikes which could damage the diodes. The brushes and the voltage regulator are located in a waterproof housing.

162. Figure 117 illustrates the various components of the alternator.

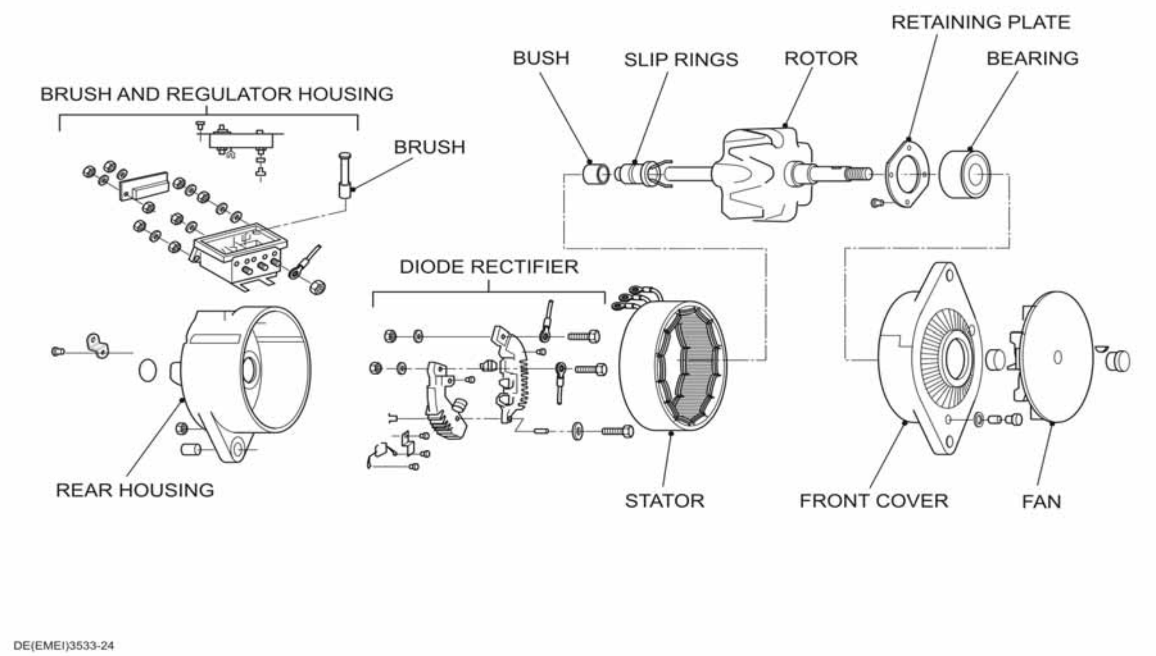

Figure 117 Alternator Assembly - Exploded View

Lighting

163. The vehicle is equipped with three modes of lighting. They are normal, blackout and reduced. Selection of the required mode of lighting is controlled by a three position switch located on the dashboard as follows:

- **a.** NORMAL - all regulation (on highway) lighting is operable which includes the head, tail, stop, parking, number plate (included with the right hand tail light), turn indicator, reversing, clearance, width, dash instrument, map reading and cab courtesy lights.
- **b.** BLACKOUT - all of the NORMAL lighting is switched off, with the exception of the dash instrumentation, warning and map reading lights. In this mode, the blackout marker lights, located at the front and rear of the vehicle, and the blackout stop lights function.
- **c.** REDUCED - the blackout lighting is used with the inclusion of the reduced headlights. (In both the blackout and reduced lighting modes, the CB radio can also be operated).

NOTE

The dash instrument lights are provided with a dimming switch, enabling the instrument lights to be dimmed or switched off, irrespective of the mode of lighting selected.

Table 1 Globe Wattage

Light	Quantity	Wattage
External		
Headlights high/low	2	100/55 watt, Halogen
Park lights	2	3 watt
Driving lights	2	55 watt, Halogen
Fog lights	2	55 watt, Halogen
Turn indicator lights	4	32 candlepower
Stop lights	2	21 watt
Tail lights	2	5 watt

Table 1 Globe Wattage (Continued)

Light	Quantity	Wattage
Front marker lights	2	3 candlepower
Roof clearance	5	3 candlepower
Mirror clearance lights	2	2 candlepower
Work lights	2	55 watt, Halogen
Internal		
Console light	1	12 candlepower
Map reading light	1	5 watt, Halogen
Dome light	1	12 candlepower
Tachograph	3	1.2 watts
Warning lights	7	2 candlepower
Air pressure gauges	2	1.2 watts
Other gauges	4	2 watts
Heater/A.C. controls	1	32 candlepower
Sleeper cab	1	12 candlepower
Military		
Blackout lights	4	LED Module
Reduced headlights	2	18 watt

Wiring Harnesses

164. The vehicle's electrical system comprises four main wiring harnesses. Two of the harnesses are located in the engine compartment. One is used by the horn, windscreen wipers and the various lighting at the front of the vehicle (Figure 118). The other harness is connected to the alternator, starter motor and the various sender units, solenoids and switches on the engine.

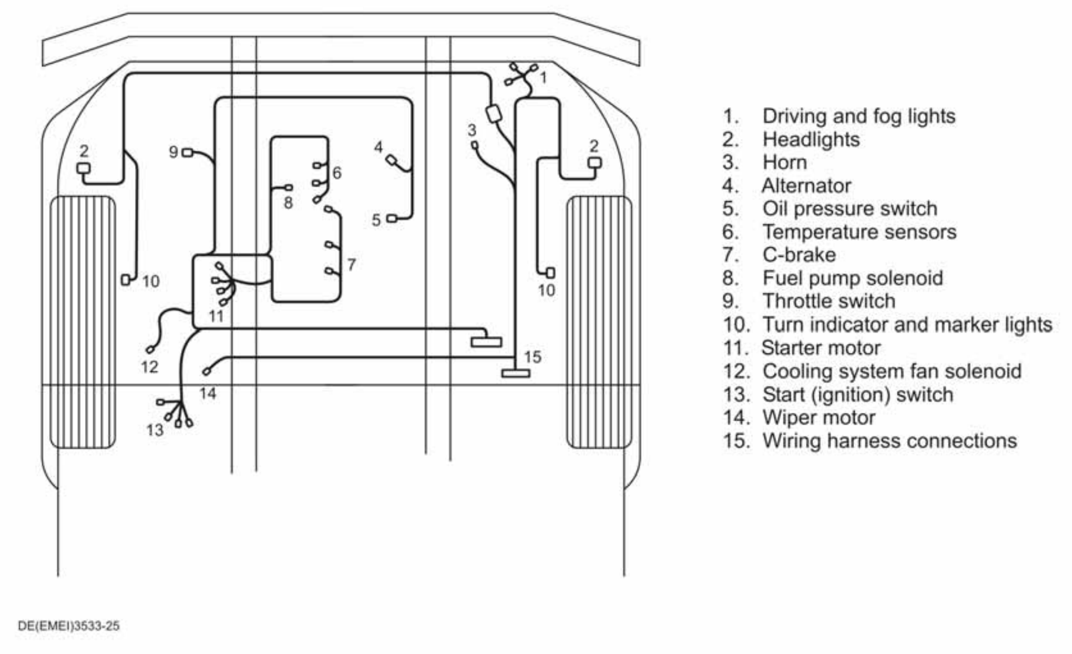

Figure 118 Engine Compartment Wiring Harnesses

165. The cab wiring harness (Figure 119) is joined to the engine compartment harnesses at the firewall by two multi-pin connectors. The cab harness not only transmits the signals from the switches and sender units on the engine to the various gauges and switches on the dashboard but also provides the illumination of these dashboard instruments. This harness is also used by the heater air conditioner, the two radios, the cab interior lighting, the fuel level sender unit, the overdrive lockout solenoid, the stoplights, tail lights and the turn indicator/reversing lights.

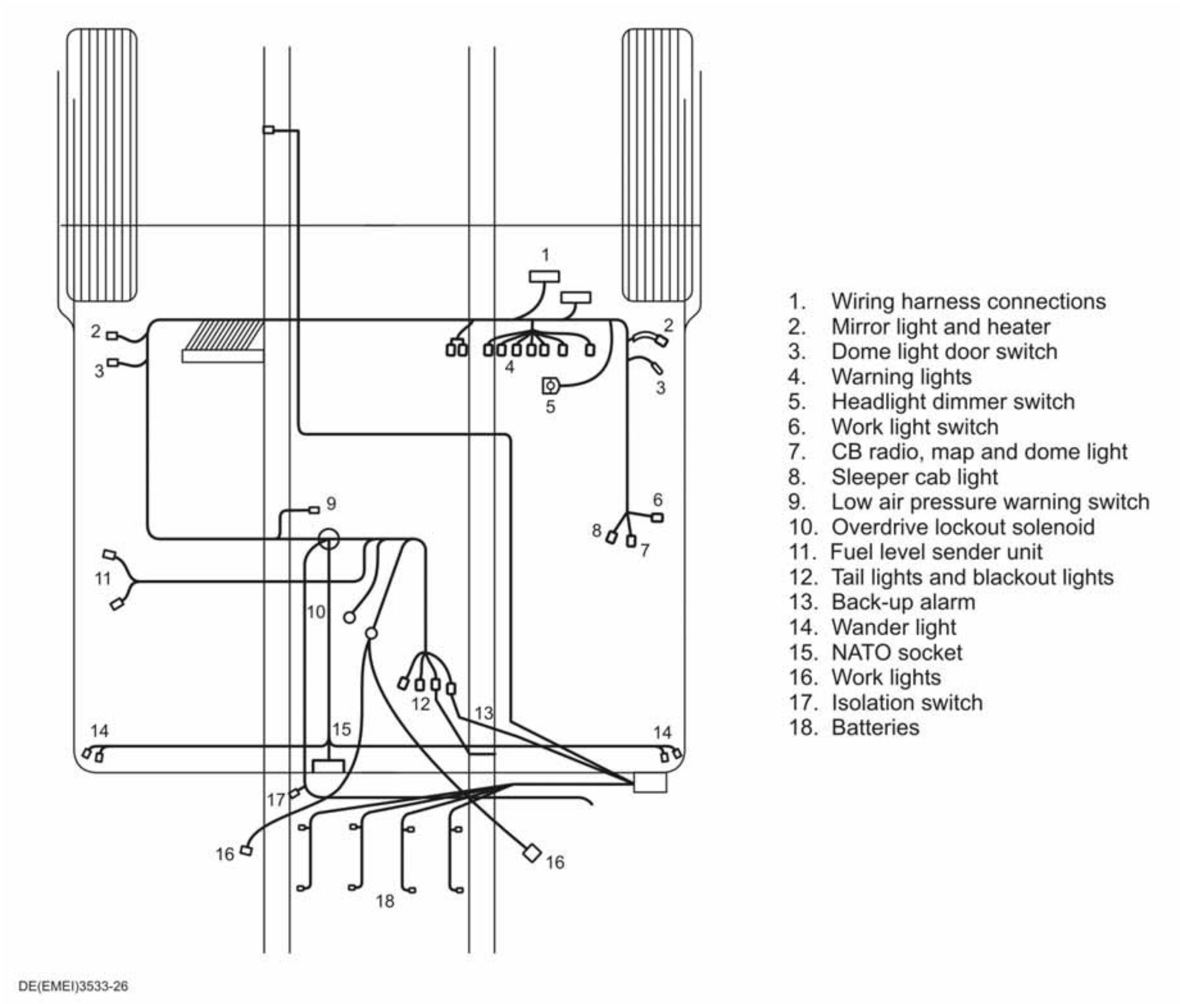

Figure 119 Cab Wiring Harness

166. The rear wiring harness interconnects the cab wiring harness to the lights at the rear of the vehicle (Figure 120).

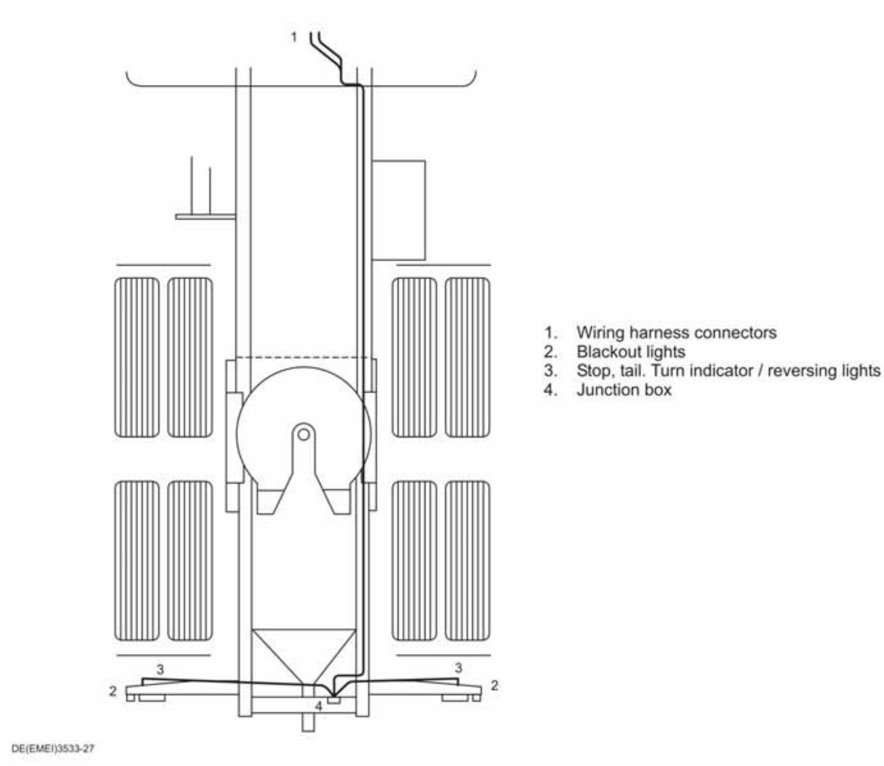

Figure 120 Rear Wiring Harness

AIR CONDITIONING

167. The integrated air conditioning system (Figure 121), comprises five basic components:

- **a.** a Compressor;
- **b.** a Condenser;
- **c.** a Receiver-Drier;
- **d.** an Expansion Valve; and
- **e.** an Evaporator.

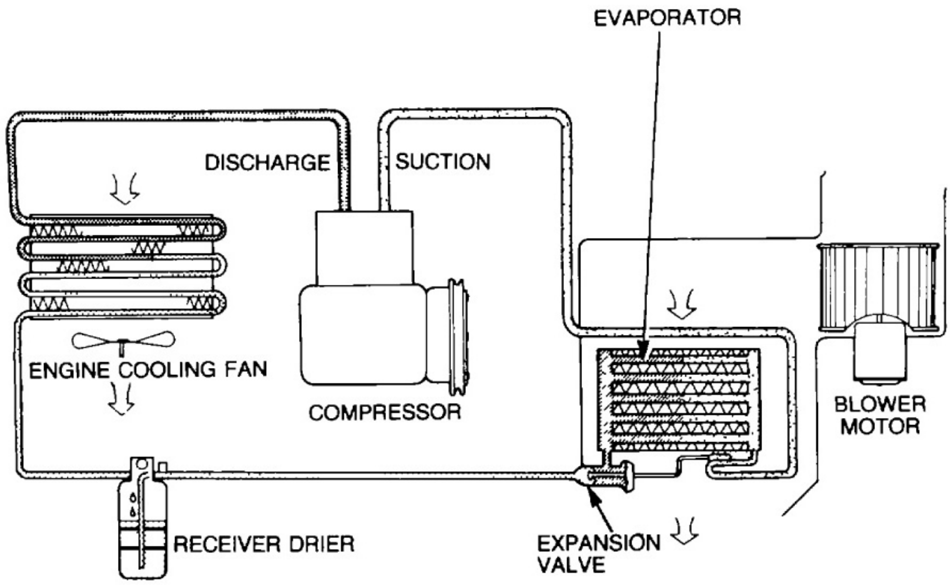

Figure 121 Air Conditioning System

168. The compressor is a belt driven reciprocating piston type located on the left-hand side of the engine. A V-belt, connected to the accessory drive pulley transmits drive to the compressor pulley. An electro-magnetic clutch is built into the compressor pulley which allows the pulley to rotate without driving the compressor until the air conditioner is turned on. The functions of the compressor are to raise the temperature of the refrigerant to a higher degree than the ambient temperature by compression and to circulate the required volume of vaporised refrigerant through the system.

169. The condenser consists of a tubular coil mounted in a series of thin cooling fins and is used to cool the very hot, high pressure refrigerant vapour to a warm high pressure liquid. The condenser is located in front of the vehicle's radiator to obtain maximum air flow over the cooling fins.

170. The receiver-drier acts as a storage tank for the liquid refrigerant, and provides a means of filtering and retaining foreign particles from the refrigerant. A desiccant (silica gel or other drying agent) is also incorporated in the receiver/drier to remove and retain moisture from the refrigerant.

171. The expansion valve is a metering device incorporated in the system to change the pressure of the liquid refrigerant from a high pressure to a low pressure. The action of the metering device cools the refrigerant to a temperature lower than that in the cabin and also causes the liquid refrigerant to be atomized. The modulating action of the expansion valve regulates the volumetric flow of the liquid through the evaporator and also ensures that the refrigerant reaches the compressor to be recycled.

172. The evaporator is a tubular coil mounted in thin fins and located in the housing on the left-hand side of the cab. The cold, low pressure atomized refrigerant from the expansion valve passes through the evaporator coils where warm air, drawn in from the cab or outside the vehicle by the blower fan, is directed through the fins of the evaporator. As the air flows through the evaporator, the refrigerant absorbs the latent heat from the air, substantially lowering the temperature of the air while the refrigerant heats up and vaporizes. The blower fan disperses the cold air through ducting into the vehicle's cab while the vaporized refrigerant is drawn into the compressor to be recycled through the system.

173. The refrigerant used in the air conditioning system is Refrigerant R134a (HFC-134a) which readily vaporises to absorb the latent heat of evaporation at temperatures between - 12°C and 0°C while under a pressure in the range of 82 - 186 kPa (12 - 27 psi) at the evaporator. At higher pressures R134a will condense and give off its latent heat of condensation at temperatures between 54°C and 65°C while at pressures between 1344 - 1779 kPa (195 - 258 psi) at the condenser.

FRAME

Tow Coupling

174. The Holland tow coupling secured to the rear chassis cross member is a pintle hook (Figure 122). The pintle hook section of the tow coupling has a vertical load capacity of 2700 kg (5952 lb) and a maximum gross trailer weight capacity of 13 600 kg (29 982 lb).

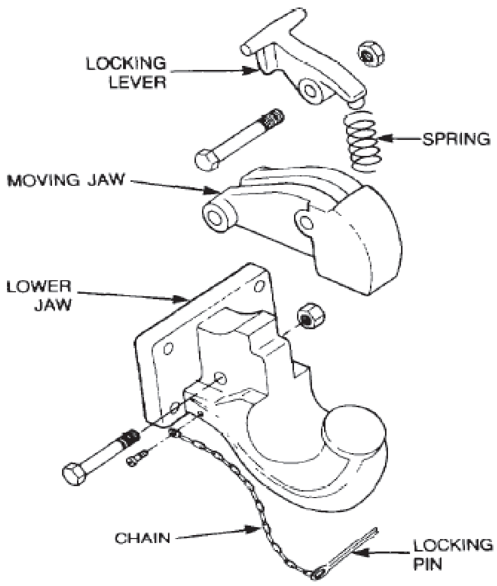

Figure 122 Tow Coupling - Exploded View

Fifth Wheel

175. Figure 123 illustrates the Holland Hitch FW70-K-P26 fifth wheel (turntable) which is fitted to the vehicle. The fifth wheel is constructed of cast iron and secured by two pivot bolts to mounting brackets which are secured to the vehicle's chassis. The pivoting action of the fifth wheel allows the fifth wheel to tilt rearward, providing a ramp affect which assists when coupling or uncoupling a trailer to or from the fifth wheel. The fifth wheel is designed for use with 90 mm king pin trailer connections.

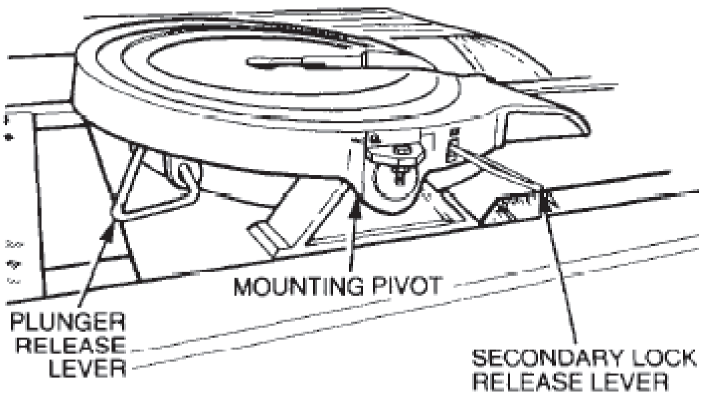

Figure 123 Fifth Wheel

176. When a trailer is being coupled, the trailer king pin is guided into the open lock where it hits against the foot of the hinged lock causing the hinged lock to close behind the king pin. As the hinged lock moves behind the king pin it nudges a plunger which is held open against spring pressure by the release handle. This slight movement of the plunger relieves the spring pressure acting on the release handle which then causes the release handle to fall from the detent allowing the plunger to move behind the hinged lock securing the hinged lock in the closed position trapping the king pin. A secondary lock which is a spring loaded pivoted arm and also controlled by a release handle moves into position behind the hinged lock as the hinged lock snaps closed behind the king-pin. The secondary lock acts as a back-up to the hinged lock plunger.

BODY

177. The body of the vehicle comprises a two-door enclosed type cab with an integral sleeper cab. The cab is constructed of pressed steel and mounted at three points to the chassis (Figure 124). U-shaped and circular insulators are used on the front mountings and four square shaped insulators are used on the rear mountings. The doors are constructed of pressed steel and incorporate window winder regulators to raise and lower the windows. Each door is mounted on two hinges and each hinge has elongated bolt holes to enable the doors to be correctly aligned within the door opening and to obtain a flush fit with the cab. A rubber weather strip is fitted to the doors which butts against the door surround to effectively seal the cab when the doors are closed. Storage space is provided beneath the seat in the sleeper cab and this space is divided into three compartments which are accessible from inside the cab. The two outer compartments can also be accessed through external lockable panels which are unlocked by control knobs located inside the cab at each end of the sleeper seat base.

178. Two Bostrom air suspension seats (Figure 125) are manually adjustable in height, seat back-rest angle, seat tilt and fore and aft movement. Weight adjustment is automatic by means of the air suspension. A small storage area is provided in the base of each seat. Seating at the rear of the cab is provided by a sponge-rubber seat and two backrests.

179. Cab heating is provided by a heater core located within the air conditioning housing. Heated engine coolant is channelled via flexible rubber hoses to and from the heater core providing the heating agent. The blower fan, incorporated in the housing, draws air from outside the vehicle and blows the air through the fins of the heater core. As the air passes through the core heat is transferred to the air by conduction, which is then ducted into the cab. The heater controls are combined with the air conditioning controls located in the centre of the dashboard.

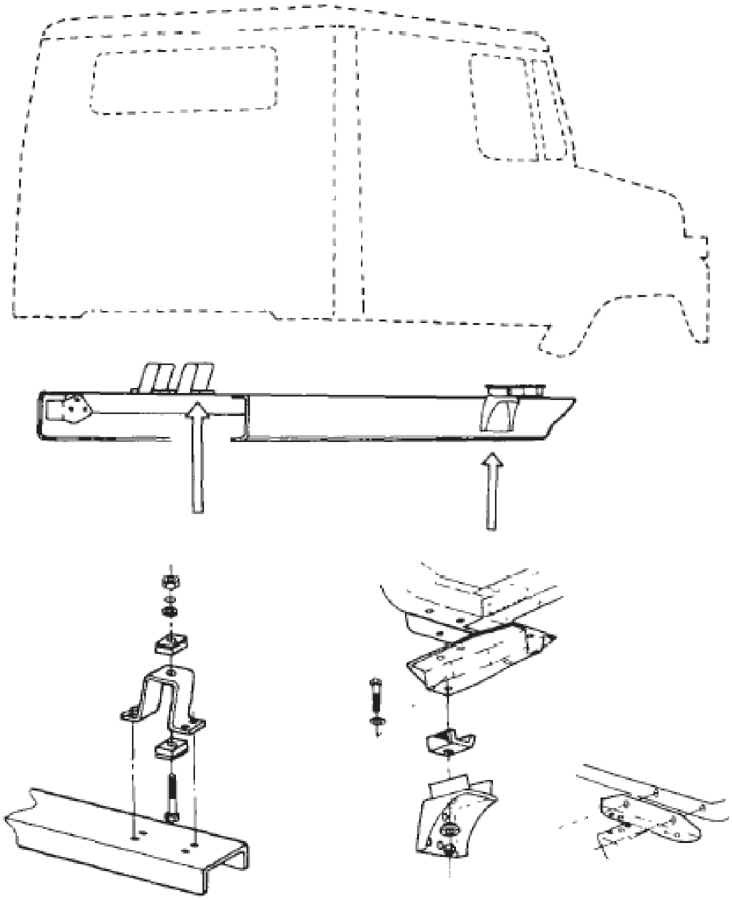

Figure 124 Cab Mounting Locations

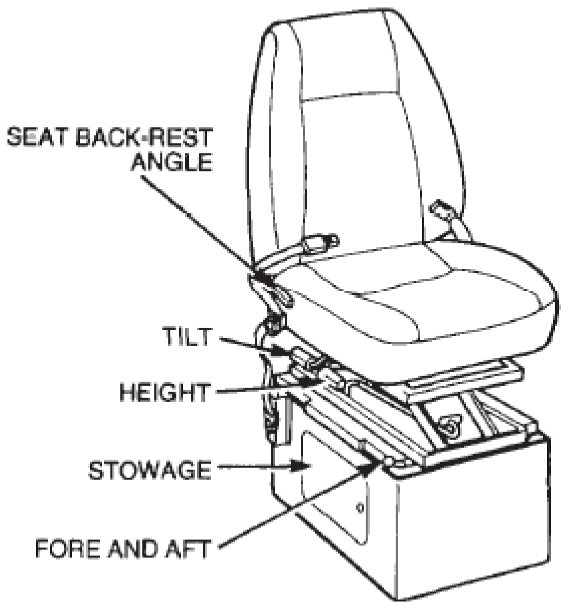

Figure 125 Front Seat Adjustment Locations

END

Distribution List: **VEH G 71.0 – Code 1** (Maint Level)
(Sponsor: LV SPO, Mdm/Hvy B Vehicles)
(Authority: TRAMM)