TRUCK, CARGO, MEDIUM, MC2 – UNIMOG

TRUCK CARGO MEDIUM WINCH MC2

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 describes the technical detail of the Truck, Cargo, Medium, MC2 – Unimog with or without winch (Unimog).

General

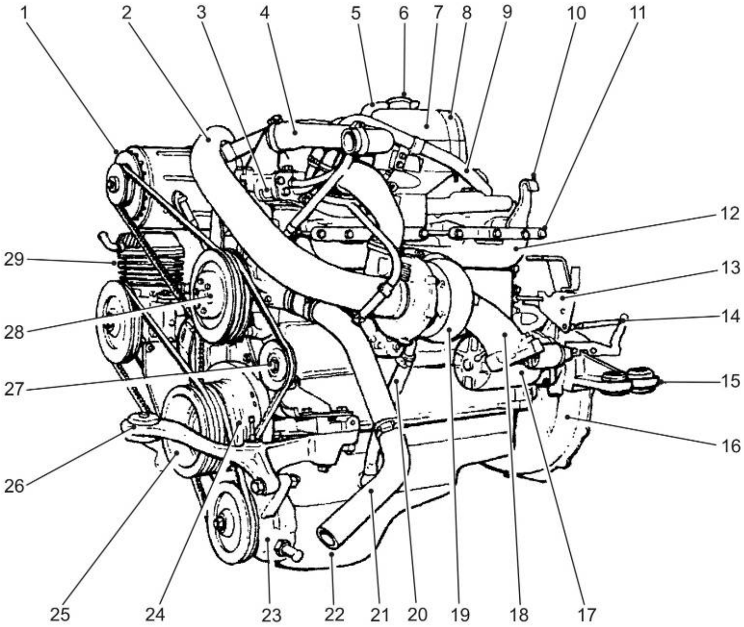
2. The Unimog is powered by a Mercedes Benz OM 353.939 diesel engine. The engine drives an eight-speed, manually-shifted, Daimler-Benz UG3/40-8/13.01 GPA transmission. The truck is fitted with power-assisted steering, which is hydraulically operated. The hydraulically operated disc brakes, which operate on all wheels, are controlled pneumatically.

Role

3. The Unimog is intended primarily for the carriage of unit equipment and stores, together with related personnel. The truck also tows single-axle and double-axle equipment larger than half-tonne trailers and the 105 mm howitzer. The truck is the basis of Army's second line transport and is a significant part of Army's third line transport.

ENGINE

4. The engine (Figure 1) is an in-line, six-cylinder, four-cycle, direct-injected, water-cooled, turbocharged diesel with a maximum output of 124 kW at 2 800 rpm.



1. Generator
2. Air intake line
3. Coolant manifold
4. Coolant line
5. Vent line
6. Filter cap
7. Expansion tank
8. Retaining bracket
9. Cab heating lines
10. Lifting bracket
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22. Sump
23. Power steering pump
24. Vibration damper
25. Crankshaft pulley
26. Engine front mounting
27. Jockey pulley
28. Water pump
29. Air compressor

Figure 1 Left-hand Side View of Engine

Engine Numbers

5. Two engine number plates are fitted, one is located on the forward end of the cylinder head cover and the other is located on the lower right-hand side of the crankcase.

Construction

6. The engine has the following characteristics:

a. The fuel injection pump is mounted on the right-hand side of the engine and the exhaust-gas-driven turbocharger is mounted on the left-hand side. A vibration damper is mounted on the front end of the crankshaft.

b. The cylinder block and crankcase is cast in one piece and carries the crankshaft main bearings. Coolant circulation passages, which surround the cylinders, are connected to the coolant passages in the cylinder head.

c. Oil for the engine lubrication system is supplied under pressure by the oil pump. Oil spray from the revolving crankshaft is distributed to the cylinder walls, pistons and other moving parts inside the engine.

d. Alloy valve seats are shrunk into place in the cylinder head. Valves and valve seats are cooled by continuous circulation of coolant through the coolant passage in the cylinder head.

e. The detachable cast-iron cylinder head is bolted to the cylinder block, and a gastight and watertight seal is maintained by means of a gasket. A one-piece, cast-iron exhaust manifold is bolted to the left-hand side of the cylinder head to mate with the exhaust outlet ports. The inlet ports are located on the top face of the cylinder head above the exhaust ports. The cylinder head cover is divided into two sections. One section encloses the inlet ports and is connected to the turbocharger by a flexible hose (this section acts as an inlet manifold). The other section of the cylinder head cover encloses the engine valves and operating mechanism.

f. The precision-ground crankshaft is forged steel, counterweighted and balanced statically and dynamically. The crankshaft is mounted in seven replaceable shell bearings; number seven bearing also accommodates axial thrust.

g. The aluminium alloy pistons are fitted with two compression rings and one oil-control ring. The piston pins are held in place by snap rings.

h. The flywheel, which is bolted to the rear of the engine, and the vibration damper, which is bolted to the front of the crankshaft, absorb torsional vibration within the engine at all operating speeds.

Engine Brake

7. The exhaust pipe is fitted with a pneumatically-operated butterfly valve, which is used as an engine brake. When engine braking is required, the butterfly valve restricts the flow of exhaust gases to retard the engine. The engine brake is an economical way of providing truck braking as it does not have any wearing parts.

Drive Belts

8. A series of V-section drive belts (Figure 2) is used to drive various units in the truck. The drive for the belts is taken from the pulley bolted to the spigot of the crankshaft at the front of the engine (Figure 1 Item 25 and Figure 2 Item 8).

9. The units driven by the V-belts are as follows:

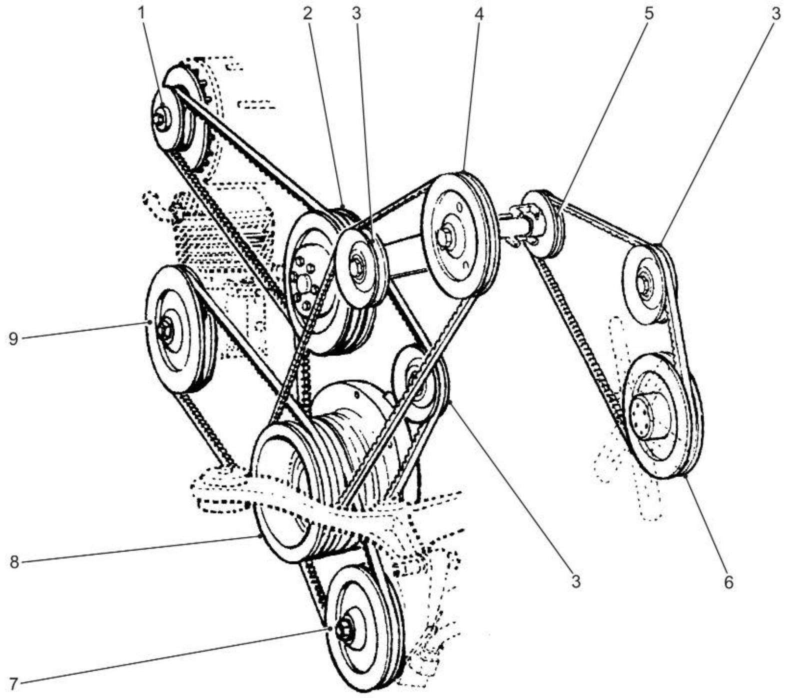
a. a generator;

b. a coolant pump;

c. a cooling fan;

d. a power steering pump; and

e. an air compressor.



1. Generator pulley
2. Coolant pump pulley
3. Jockey roller
4. Front intermediate pulley
5. Rear intermediate pulley
6. Fan pulley
7. Power steering pulley
8. Crankshaft pulley
9. Air compressor pulley

Figure 2 Drive Belt Arrangement

FUEL SYSTEM

10. The fuel system, shown schematically in Figure 3, consists of three basic sections:

a. a fuel tank,

b. fuel filters, and

c. a fuel injection pump.

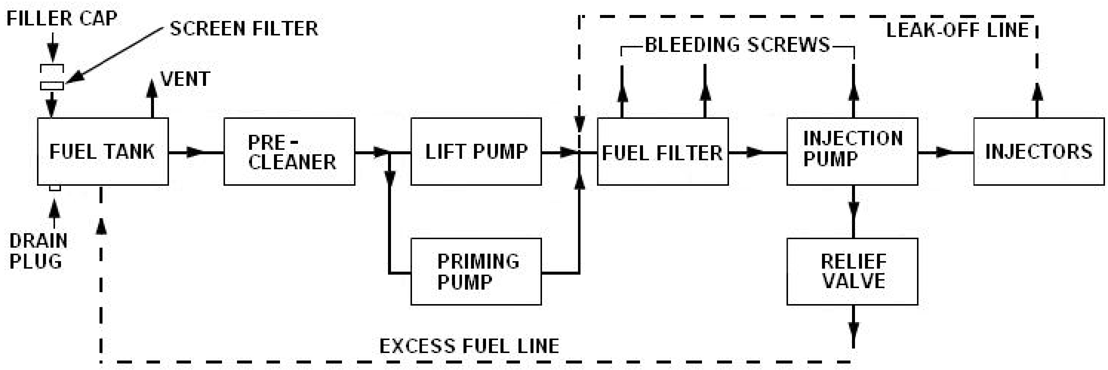


Figure 3 Fuel System Schematic

11. The fuel flow and the arrangement of fuel system components are shown in Figure 4.

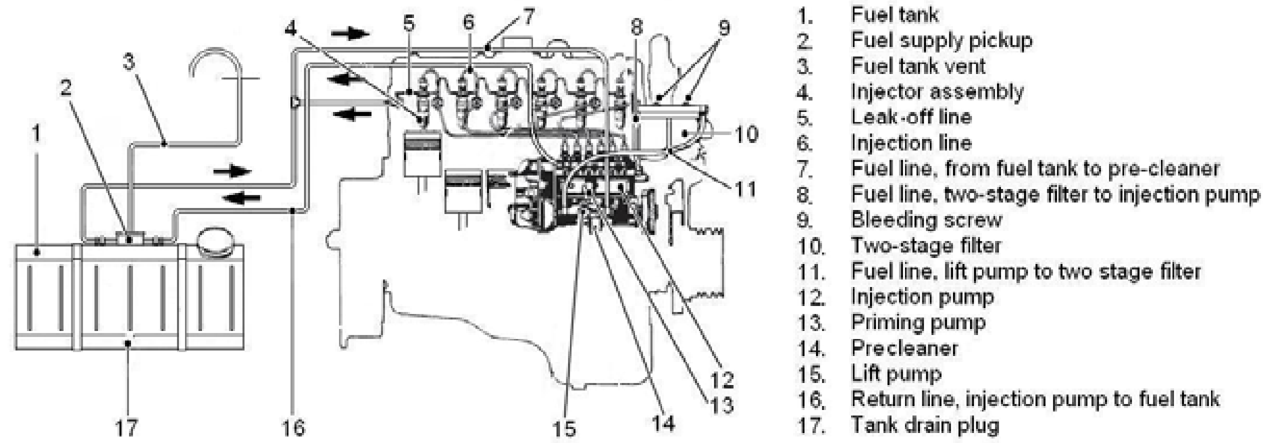


Figure 4 Fuel System Arrangement

Fuel Tank

12. The fuel tank has a capacity of 160 litres and is fitted with a sealed filler cap. A tank vent allows for volumetric changes due to fuel usage and temperature variation. A drain valve is fitted to the bottom of the tank and a removable screen filter is provided at the tank inlet.

Fuel Filter

13. The fuel filter (Figure 5) consists of two replaceable elements contained in sheetmetal housings. Whenever an element is replaced, the fuel system must be bled. For this purpose, bleeding screws are fitted to each filter element housing. The screws are loosened before the hand priming pump is operated. When the fuel expelled from the filters is air-free, the bleeding screws are tightened.

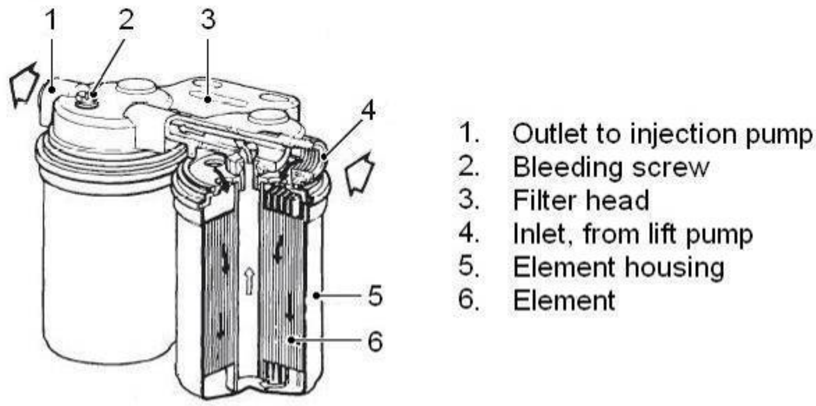
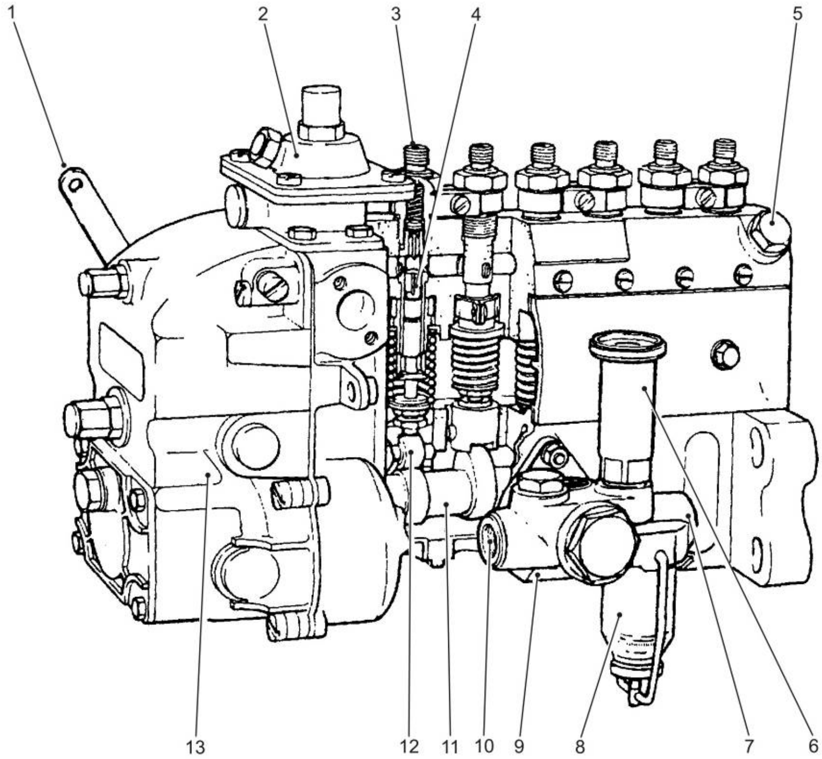


Figure 5 Fuel Filter

Fuel Injection Pump

14. The fuel injection pump (Figure 6) delivers fuel to the injectors in a controlled quantity dependent upon the engine load and the accelerator position. A bleeding screw is fitted to the fuel injection pump to enable the fuel system to be primed with air-free fuel. A relief valve, fitted to the fuel injection pump, bypasses excess fuel delivered by the lift pump to the fuel tank. The fuel injection pump consists of the following four main sections:

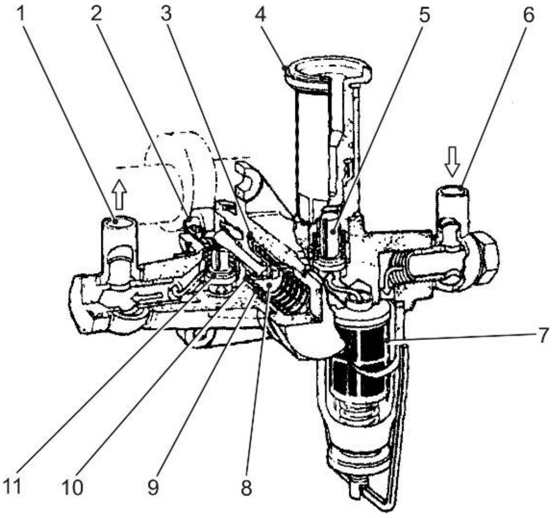
- **a.** a lift pump, pre-cleaner and priming pump;
- **b.** a pump timing device;
- **c.** a smoke limiter; and
- **d.** a governor.



1. Throttle control
2. Smoke limiter
3. Output to injectors
4. Control helix
5. Bleeding screw
6. Priming pump
7. Inlet from fuel tank
8. Fuel pre-cleaner
9. Lift pump
10. Outlet to two-stage filter
11. Pump camshaft
12. Roller tappet
13. Governor

Figure 6 Fuel Injection Pump

15. Lift Pump, Pre-cleaner and Priming Pump. The lift pump (Figure 7) draws fuel from the fuel tank through a pre-cleaning filter element and delivers it to the fuel filter. The lift pump is cam-driven from the fuel injection pump camshaft. A hand-operated priming pump is fitted to the lift pump to enable the fuel system to be primed with air-free fuel.

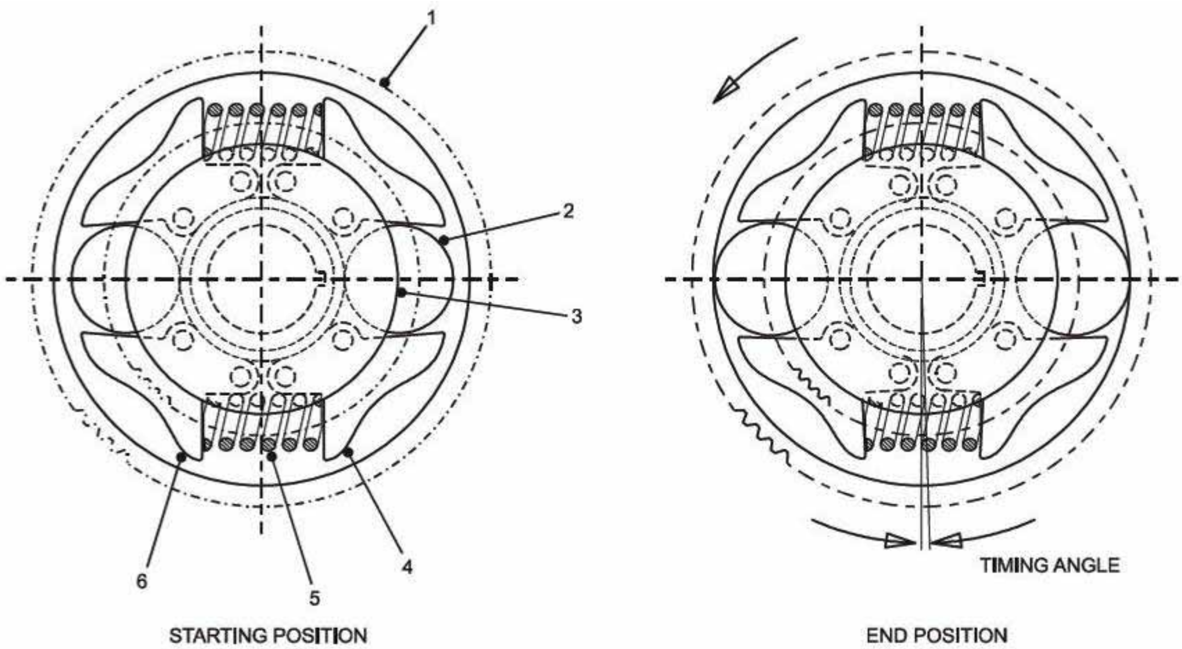


1. Outlet to fuel filter
2. Roller tappet
3. Delivery chamber
4. Priming pump
5. Inlet valve
6. Inlet
7. Pre-cleaner element
8. Suction chamber
9. Plunger spring
10. Plunger
11. Outlet valve

Figure 7 Lift Pump with Pre-cleaner and Priming Pump

16. Pump Timing Device. The pump timing device is mounted on the engine camshaft and drives the fuel injection pump input shaft. During fuel injection the nozzle is opened by the fuel pressure wave which is propagated at approximately the velocity of sound. As the engine speed (rpm) increases, the start of the injection time and the injection process lag with respect to the crankshaft angle. To counter this, the injection pump timing must be advanced as the engine rpm increases. The pump timing device advances the pump camshaft by up to 8º (with respect to the crankshaft). The pump timing device operates automatically and uses centrifugal force, which is proportional to the engine rpm, to control the amount of advance applied. Figure 8 shows the pump timing device which operates as follows:

- **a.** The housing is driven by the engine camshaft and the hub drives the injection pump camshaft.
- **b.** The lower camplates are fixed to the housing and the upper camplates are fixed to the hub.
- **c.** The springs between the camplates hold the flyweights in against the centre of the hub. As engine rpm increases, the flyweights move outwards due to centrifugal force, and the upper and lower camplates are forced apart causing the hub to rotate in relation to the housing and the injection pump timing is advanced.
- **d.** As engine rpm decreases, the centrifugal force acting on the flyweights decreases, the spring tension forces the flyweights inwards, the hub returns towards its initial position with respect to the housing and the injection pump timing is retarded.



1. Housing	3. Hub	5. Spring
2. Flyweights	4. Lower camplate	6. Upper camplate

Figure 8 Mechanical Operation of the Pump Timing Device

17. Smoke Limiter. The smoke limiter senses the inlet manifold pressure (charge pressure) and adjusts the full load delivery volume of the fuel injection pump. When the charge pressure is too low to allow burning of the full load volume, the smoke limiter decreases the full-load delivery by a preset amount. If the charge pressure is sufficient, it allows the normal full-load delivery to be maintained. The smoke limiter prevents engine operation with an excessively rich fuel/air mixture.

18. Governor. The governor is fitted to the rear of the fuel injection pump and is driven by the fuel injection pump camshaft. The governor contains flyweights that, via mechanical linkages, control the fuel rack within the fuel injection pump. The governor limits the idle and maximum engine speeds to 700 rpm and 2 800 rpm respectively.

19. Injectors. The fuel injection pump delivers fuel at high pressure (up to 100 MPa) to each injector. Each injector tip has four spray orifices that atomise the fuel. Fuel that leaks past each injector valve stem is returned to the inlet port of the lift pump.

LUBRICATION SYSTEM

20. The engine lubrication system supplies lubricating oil to the engine, fuel injection pump, turbocharger and air compressor. The system consists of the following components:

a. an oil pump;

b. an oil filter; and

c. an oil cooler.

Oil Pump

21. The gear type oil pump is driven from the engine camshaft and draws oil from the sump through a mesh screen. A preset relief valve is fitted to the outlet port of the oil pump to prevent damage to the pump if the oil passages become blocked.

Oil Filter

22. The oil filter head is bolted to the lower rear right-hand side of the crankcase. Replaceable paper elements (two in early versions, only one in later versions) are contained in individual sheetmetal housings, which are bolted to the filter head. An oil pressure sensor is fitted to the filter head.

Oil Cooler

23. The oil supply to the engine and other components is cooled by the oil cooler, which is mounted on the left-hand side of the crankcase water jacket. The oil cooler uses the engine coolant flow to cool the oil.

COOLING SYSTEM

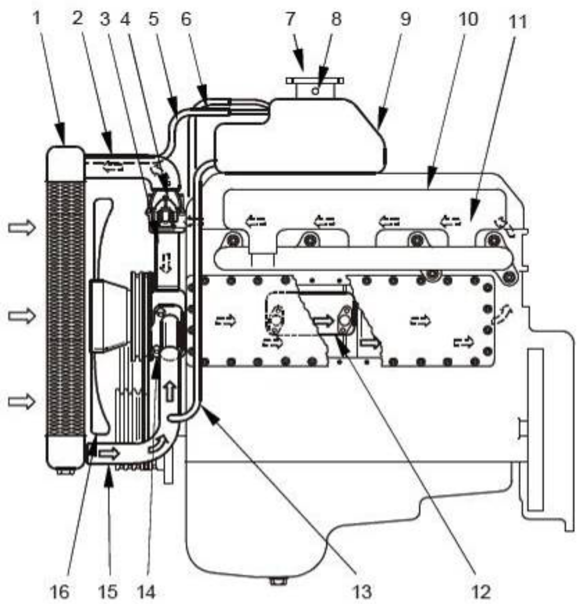
24. The engine is liquid cooled by thermo-siphon action, assisted by a coolant pump and a fan. A corrosion inhibitor is added to the coolant to reduce scale build-up in the cooling system. Scale build-up within the engine components reduces heat transfer and coolant flow rates. The cooling system circulates coolant through the engine cooling jacket and the oil cooler (Figure 9). The cooling system consists of the following components:

a. a pump;

b. a thermostat;

c. a radiator and fan; and

d. a coolant expansion tank.



1. Radiator	5. Radiator vent line	9. Coolant expansion tank	13. Filler line
2. Radiator supply line	6. Engine vent line	10. Coolant manifold	14. Coolant pump
3. By-pass line	7. Filter cap	11. Engine cooling jacket	15. Radiator return line
4. Thermostat	8. Overflow line	12. Oil cooler	16. Fan

Figure 9 Engine Cooling System

Pump

25. The pump is a centrifugal type fitted with an eight-blade impeller and is driven by a V-belt from the engine crankshaft pulley.

Thermostat

26. The thermostat is mounted in a housing, which interconnects the engine cooling water return line, bypass line and pump inlet line.

Radiator and Fan

27. The radiator is fitted to the left-hand side of the engine bay. A fan, driven by a V-belt from an intermediate pulley, induces air flow through the radiator. The intermediate pulley is driven by a V-belt from the engine crankshaft pulley. The radiator is not fitted with a filler cap.

Coolant Expansion Tank

28. The expansion tank (Figure 9, Item 9) is fitted with a pressure cap that vents at 170 kPa. The expansion tank filler cap can be removed to add coolant to the system. Any air present in the coolant is vented through the radiator and engine vent lines to the expansion tank. A filler line connects the bottom of the expansion tank to the radiator return line; this enables the cooling system to be filled without the coolant going through the coolant pump.

Cooling System Operation

29. After cooling the engine and oil, the coolant is directed through the engine return line to the thermostat. The direction of coolant flow from the thermostat is dependent on the coolant temperature. When the coolant temperature is below 83°C, the thermostat is closed (Figure 10a) and coolant is directed to the pump through the bypass line. If the coolant temperature is 95ºC or higher, the thermostat is open (Figure 10b) and coolant is directed to the radiator. At coolant temperatures between 83°C and 95ºC, the coolant flow is directed to both the bypass line and the radiator because the thermostat is partially open. The coolant is cooled in the radiator by the fan-induced air flow and is delivered to the coolant pump through the radiator return line.

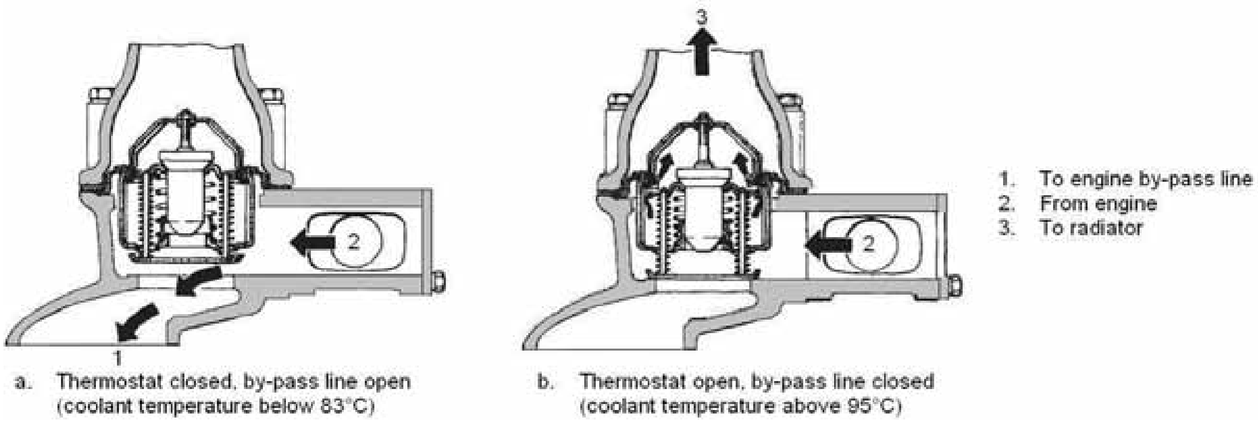


Figure 10 Thermostat Operation

AIR INTAKE SYSTEM

30. The air intake system consists of the following components:

- **a.** an air breather;
- **b.** an air cleaner; and
- **c.** a turbocharger.

Air Breather

31. The air breather is a long pipe secured to the right-hand side windscreen pillar. Air is drawn into the top of the pipe and routed to the inlet of the air cleaner. The pipe ensures that water cannot enter the air intake system when the vehicle is fording.

Air Cleaner

32. The air cleaner is fitted with a paper element and an integral indicator. The indicator shows a red ring when the element requires cleaning or replacing.

Turbocharger

33. The turbocharger (Figure 11) is mounted on the engine exhaust manifold. Air is drawn through the air cleaner by the compressor, compressed and delivered to the engine inlet manifold causing the following results:

- **a.** When an engine inlet valve opens, air is forced into the combustion chamber. Initially, due to valve overlap, this air assists with exhaust scavenging whilst the exhaust valve remains open. When the exhaust valve closes, the combustion chamber fills with air from the inlet manifold.
- **b.** Fuel is then admitted by the injector during the following compression stroke and combustion occurs as the piston compresses the fuel/air mixture.
- **c.** When the exhaust valve opens, the high temperature and pressure exhaust gases expand into the exhaust manifold. The outlet of the exhaust manifold is connected to the turbine housing of the turbocharger. The rapidly expanding exhaust gases drive the turbine wheel, which in turn drives the compressor, as they are mounted on a common shaft. After the exhaust gases pass through the turbine they are routed to atmosphere via the exhaust system.
- **d.** As the engine load increases, more fuel is delivered to the engine, which in turn produces more exhaust gases and causes the turbocharger to rotate faster and deliver more air to the engine. The increase in compressed air supply in turn allows more fuel to be burnt to produce more power.

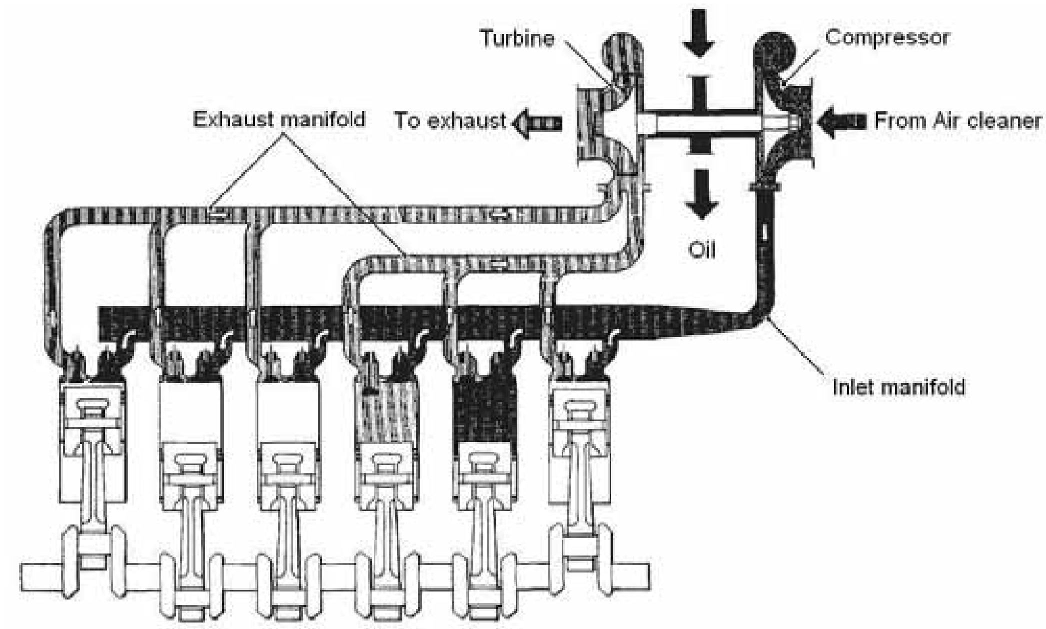


Figure 11 Turbocharger Operation

EXHAUST GAS SYSTEM

34. The exhaust gas system consists of the following components:

- **a.** an exhaust manifold;
- **b.** a turbocharger;
- **c.** an exhaust pipe; and
- **d.** a muffler and tailpipe.

Exhaust Manifold

35. The exhaust manifold is mounted to the left-hand side of the cylinder head. The manifold consists of four ducts that mate with the four exhaust ports in the cylinder head and a single exhaust flange onto which the turbocharger is bolted. Exhaust gas is routed to the turbocharger through the manifold.

Exhaust Pipe

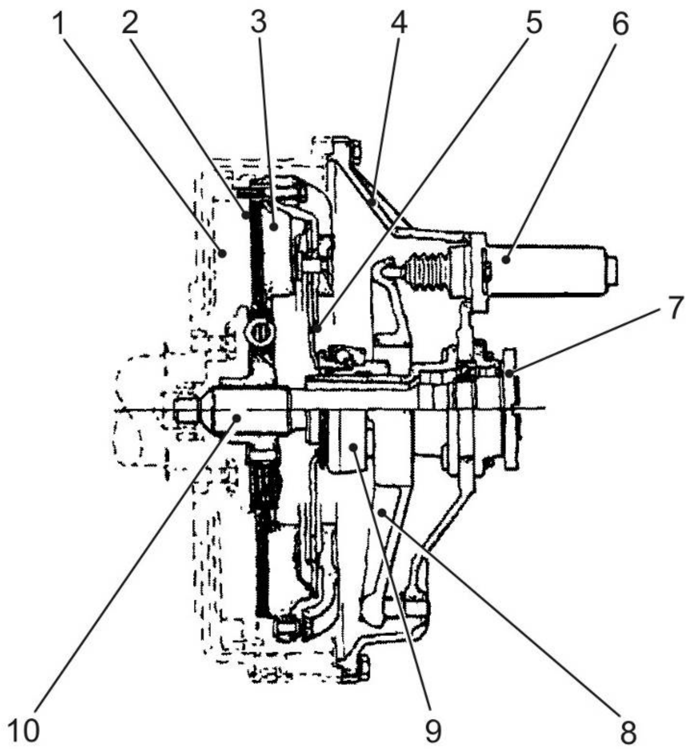
36. The exhaust pipe is pre-formed and connected between the exhaust brake on the turbocharger and the muffler. The exhaust pipe is mounted to the left-hand side of the chassis by a series of clamps. Exhaust gas from the turbocharger is routed through this pipe to the muffler.

Muffler and Tailpipe

37. The muffler consists of a gas expansion and resonator box. The exhaust gas passes into the muffler where it expands rapidly, losing energy. It then passes through the tailpipe to the atmosphere. The muffler and tailpipe are clamped to the rear end of the exhaust pipe and secured to the chassis immediately in front of the rear wheels. The tailpipe crosses under the chassis, over the torque tube, from left to right, and is bolted to a bracket on the right-hand side chassis rail.

CLUTCH

38. The clutch (Figure 12) is a hydraulically-operated, dry, single-plate type GFM 330 K. It consists of a pressure plate, a clutch plate and a throw-out mechanism. The thickness of each lining is 3.5 mm; the permissible wear per side is 1.5 mm. Eight coil springs, fitted to the clutch plate assembly, allow for the relative movement between the linings to dampen torsional vibration.



1. Flywheel
2. Clutch plate
3. Pressure plate
4. Clutch bell-housing
5. Diaphragm spring
6. Clutch slave cylinder
7. Power output flange
8. Throw-out fork
9. Throw-out bearing
10. Power output shaft

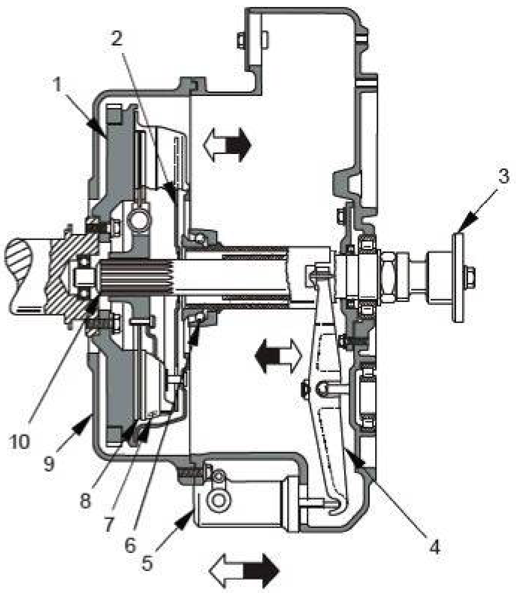
Figure 12 Clutch Assembly

Clutch Actuation

39. When the clutch pedal is depressed, hydraulic fluid is delivered to the clutch slave cylinder. The piston in the slave cylinder is forced out against the throw-out fork. The throw-out fork pushes the throw-out bearing against the diaphragm springs, moving the pressure plate off the clutch plate. No power is transmitted from the flywheel to the primary shaft. Releasing the clutch pedal allows the slave cylinder to be pushed back by the diaphragm springs acting through the throw-out bearing and throw-out fork. The diaphragm spring forces the pressure plate against the clutch plate providing power transmission from the flywheel to the primary shaft.

Clutch Actuation with Power Take-off (PTO)

40. The operation of the clutch on the truck equipped with PTO is the same as described in Para 39. The layout of the clutch mechanism differs slightly (Figure 13).

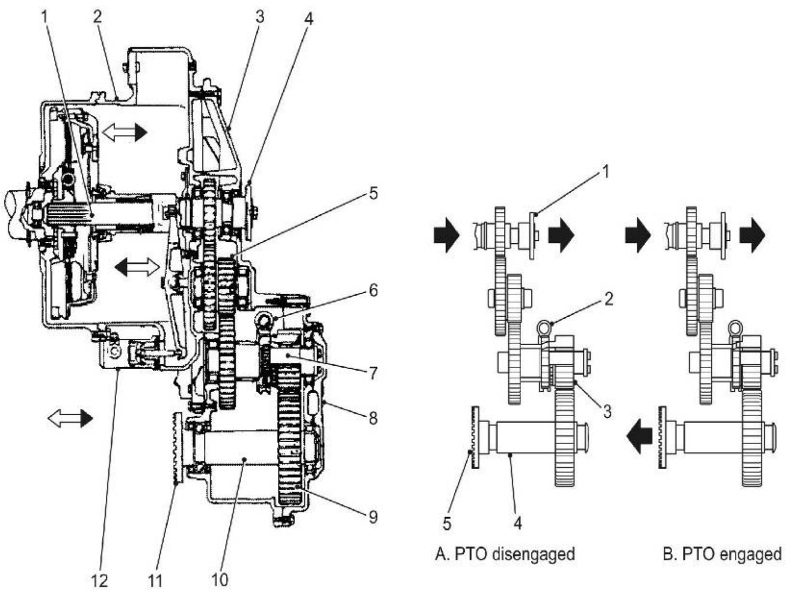


1. Flywheel
2. Clutch plate
3. Pressure plate
4. Diaphragm spring
5. Power output flange
6. Throw-out fork
7. Clutch slave cylinder
8. Throw-out bearing
9. Clutch bell-housing
10. Power output shaft

Figure 13 Clutch Assembly with PTO

PTO TRANSMISSION

41. The PTO transmission (Figure 14) drives the winch input shaft at 540 rpm when the engine is running at 2 800 rpm. The PTO control lever in the cabin engages and disengages the transmission via the PTO selector fork (Figure 14, Item 6). Drive to the PTO transmission is controlled by the clutch and the PTO can be used when the vehicle is moving or stationary. The PTO transmission is oil-splash lubricated.



1. Power input shaft
2. Clutch housing
3. Transmission housing
4. Power output flange
5. Idler gears
6. PTO selector fork
7. Intermediate shaft
8. End cover
9. PTO output gear (540 rpm)
10. PTO output shaft
11. Power output flange
12. Clutch slave cylinder

Figure 14 PTO Transmission

Output Shaft

42. The output shaft couples the PTO transmission to the winch. The shaft has two universal joints; one is flange-connected to the PTO output shaft, the other directly connected to the winch drive shaft. The splined winch drive shaft is supported in roller bearings secured to the front cross-member.

MAIN TRANSMISSION

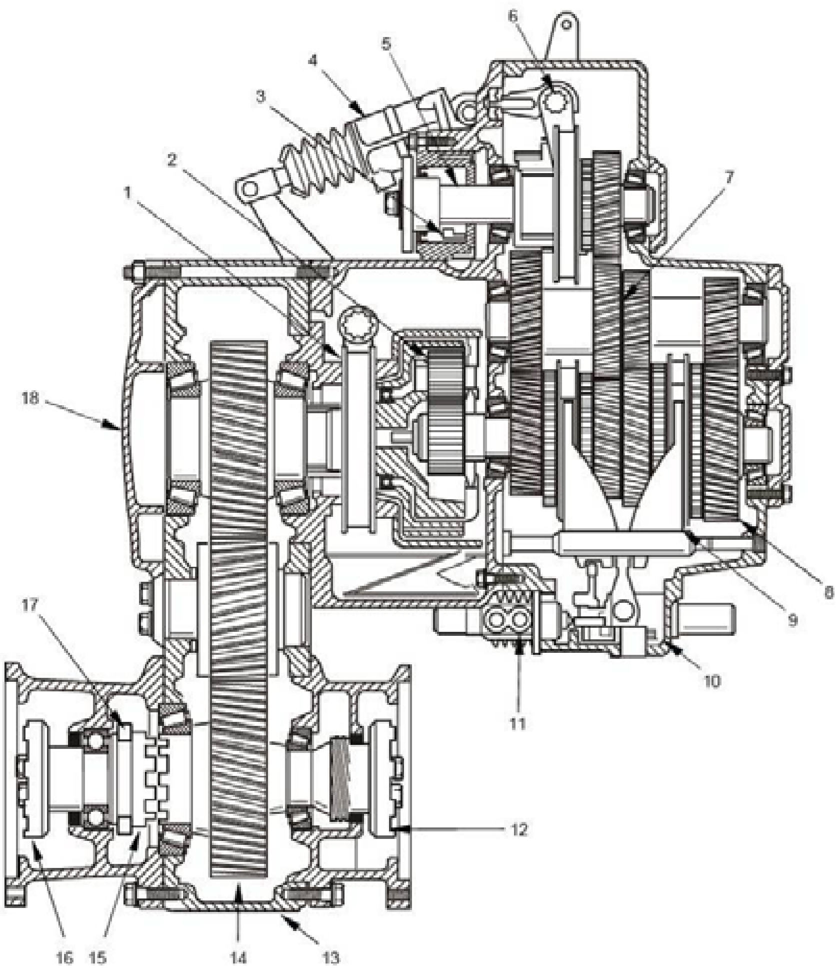
43. The manually-shifted main transmission (Figure 15) is composed of the following four functional areas:

a. **Forward/Reverse Change.** Located on the input shaft, the forward/reverse change allows all eight ratios to be selected in either forward or reverse.

b. **Four-speed Synchromesh Gear Box.** Provides four selectable drive ratios.

c. **Planetary Gear Set.** The planetary gears double the number of available ratios by being pneumatically engaged and disengaged by the shift mechanism. They are engaged for first gear to fourth gear and disengaged for fifth gear to eighth gear.

d. **Front-wheel Drive Dog Clutch.** A pneumatically-operated dog clutch on the front axle drive shaft allows four-wheel drive to be engaged or disengaged.



1. Planetary gear selector	7. Countershaft	13. Intermediate housing
2. Planetary gear set	8. Mainshaft assembly	14. Final drive gear
3. Oil pump	9. Selector forks	15. Dog clutch – front wheel drive
4. Shift cylinder	10. Mainshaft selector	16. Power output to front axle
5. Input shaft	11. 4/2 shift valve	17. Selector fork – dog clutch
6. Fwd/Rev selector	12. Power output to rear axle	18. Transmission front casing

Figure 15 Main Transmission

Input Shaft

44. Power from the engine is transmitted through a propeller shaft to the input shaft (Figure 15, Item 5). An internal-gear oil pump (Figure 15, Item 3) is driven by the input shaft. The forward and reverse gears are supported in needle roller bearings and are separated by a sliding collar controlled by the forward/reverse selector fork (Figure 15, Item 6).

Power Flow

45. Figure 80 shows the power flow for each ratio and the effect of the planetary gears.

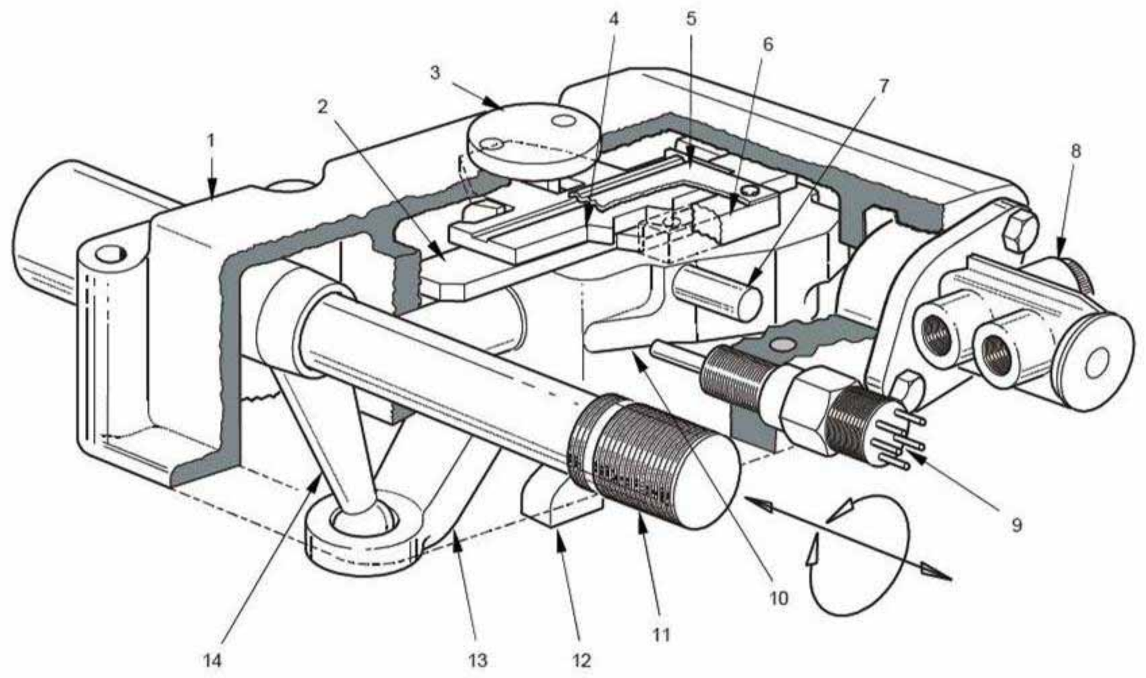
Planetary Gear Shift

46. The planetary gear set (Figure 15, Item 2), is automatically engaged when first, second, third or fourth gear ratios are selected. When fifth or higher gear ratios are selected, the planetary gear set is automatically disengaged. The planetary gear shift lever is actuated by a double-acting pneumatic cylinder, which is pivot-mounted on the main transmission housing. A four-way, two-position pneumatic shift valve (Figure 15, Item 11) controls the planetary gear shift cylinder.

Shift Housing

47. The shift housing (Figure 16) contains the following:

- **a.** a shift finger;
- **b.** a four-way, two-position shift valve;
- **c.** a gate position switch; and
- **d.** a neutral detent mechanism.



1. Shift hosing	5. Spring plate	9. Gate position switch	12. Shift finger
2. Lower detent plate	6. Fixed detent	10. camplate	13. Shift bush
3. Detent stop	7. Detent plunger	11. Shift shaft	14. Shift arm
4. Upper detent stop	8. 4/2 shift valve		

Figure 16 Shift Housing

48. Shift Finger. The shift finger (Figure 16, Item 12) moves parallel to the shift shaft whenever a gear ratio is selected. The finger engages the actual gears via synchronised cones on the gear clusters.

49. Four-way, Two-position Shift Valve. The four-way two-position shift valve is actuated by the camplate (Figure 16, Item 10) on the shift bush. When neutral position A or B (Figure 17) is selected, the shift valve is not actuated by the camplate. When the neutral position C or D (Figure 17) is selected the camplate actuates the shift valve. The shift valve directs compressed air to the planetary gear shift cylinder which disengages the planetary gears.

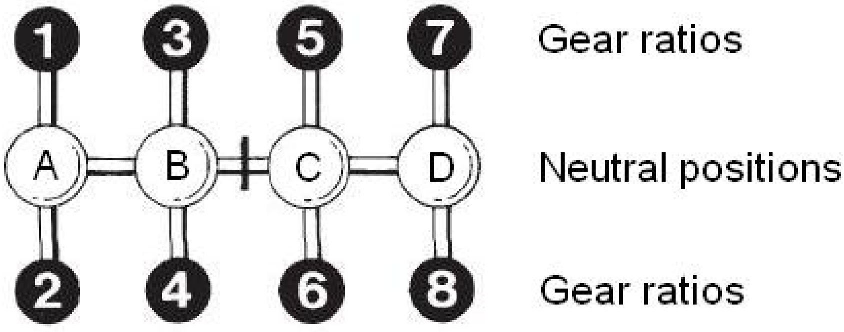


Figure 17 Neutral Positions

50. Gate Position Switch. The gate position switch (Figure 16, Item 9) is actuated by the camplate on the shift bush. As the camplate is moved through the gears the plunger on the gate position switch actuates contacts within the switch, which illuminate the appropriate light on the gate position indicator (Para 180.).

51. Neutral Detent Mechanism. The gear shift lever in the cabin has four neutral positions (Figure 17). The neutral detent mechanism allows only two of these positions to be available at the one time; the only combinations available are A and B, B and C, or C and D. The neutral detent mechanism utilises the upper and lower detent plates, detent stop, spring plate, fixed detent, detent plunger and shift bush (Figure 16). The upper and lower detent plates can move towards and away from the fixed detent. The shift bush moves at right angles to the upper and lower detent plates. The mechanism operates as follows:

- **a. Neutral A.** If the gear lever is positioned at neutral position A, the neutral detent mechanism is set as shown in Figure 18. The shift bush can only move to the right, because of the interference between it and the upper and lower detent plates at point X.

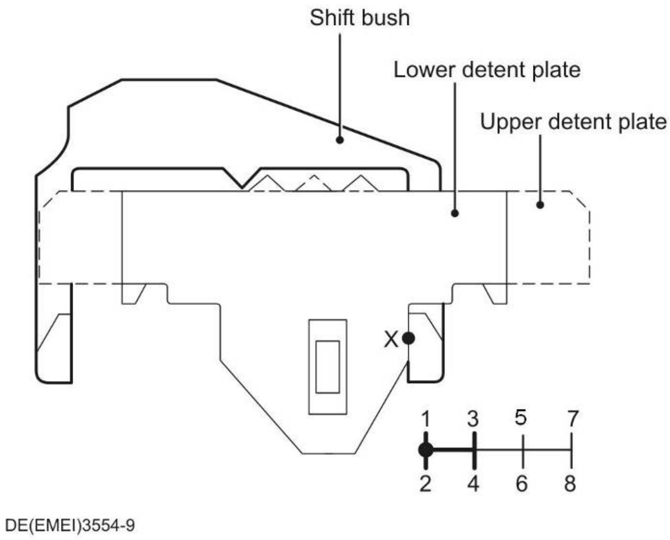


Figure 18 Neutral A

- **b. Neutral B.** The shift shaft is rotated when the gear shift lever is moved from neutral A to neutral B. The shift arm connected to the shift shaft causes the shift bush to move to the position shown in Figure 19. The lower detent plate moves away from the shift bush because of the interaction between the fixed detent and the lower detent plate. The interference between the shift bush and the lower detent plate at point Y prevents the selection of neutral C. At this stage only neutral A or B is available, i.e. first to fourth gear ratios only can be selected.

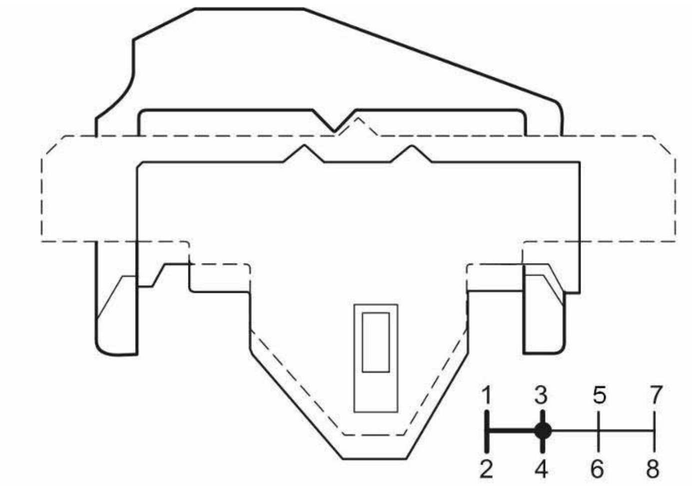


Figure 19 Neutral B

c. Third or Fourth Gear Selected. If third or fourth gear ratio is selected, the lower detent plate is moved by the detent plunger. The arrangement of the neutral detent mechanism at this stage is as shown in Figure 20. The path to neutral A or C is now available.

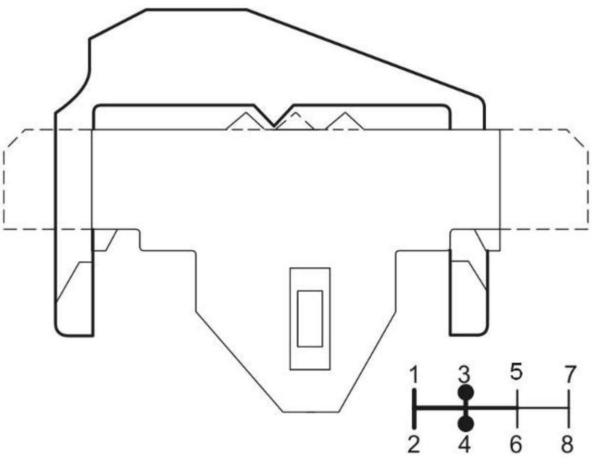


Figure 20 Third or Fourth Gear Selected

d. Neutral C. If neutral C is selected, the upper detent plate is moved away from the shift bush by the detent plunger. The neutral detent mechanism blocks the path to neutral A and D, as shown in Figure 21.

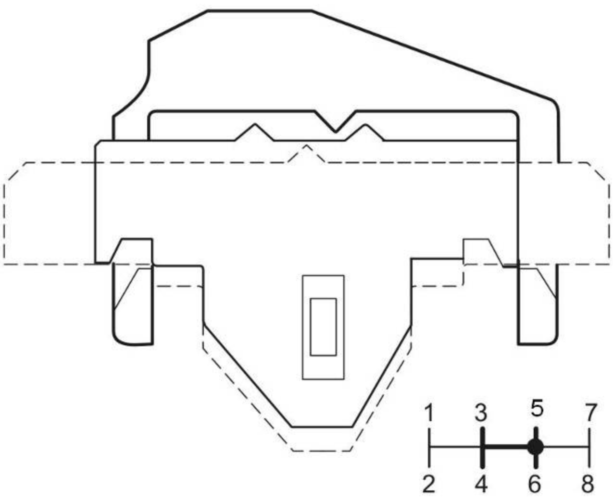


Figure 21 Neutral Position C

e. **Fifth or Sixth Gear.** When fifth or sixth gear is selected, the upper detent plate is moved towards the shift bush by the detent plunger, as shown in Figure 22. The neutral detent mechanism now allows the selection of neutral B or D from the neutral C position.

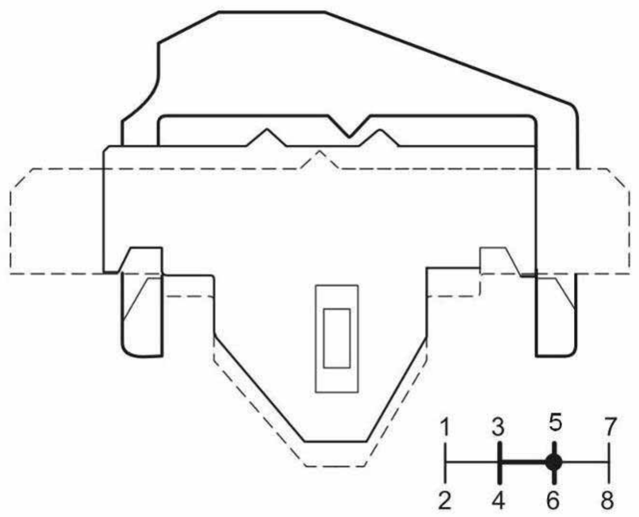


Figure 22 Fifth or Sixth Gear

f. **Neutral D.** If the neutral D is selected, the detent plunger shifts the lower detent plate away from the shift bush. This action only allows the selection of neutral C (Figure 23) due to the interference between the shift bush and the upper and lower detent plates at point Z.

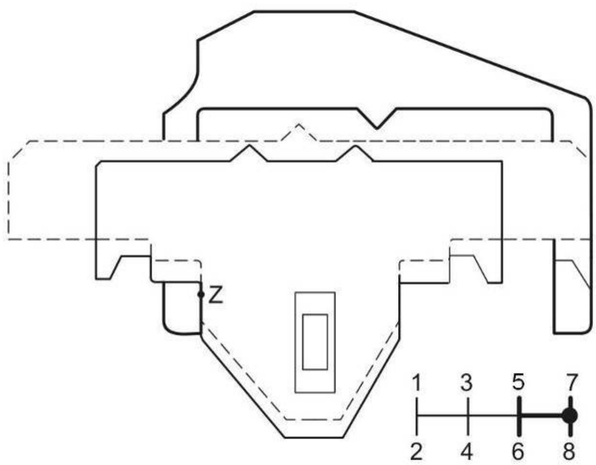


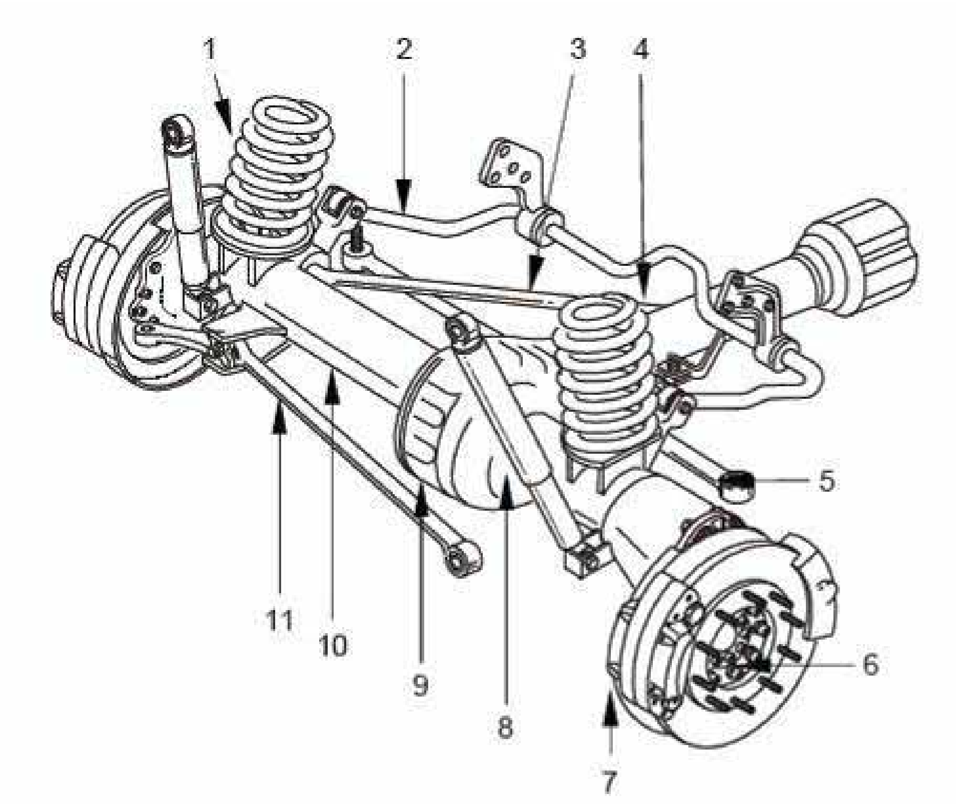
Figure 23 Neutral D

g. **Down Shifting.** Shifting from neutral D to neutral C and selecting fifth or sixth gear ratios allows the selection of neutral B or D when neutral C is re-selected (Figure 23). Similar down-shifting through third or fourth gear ratios will enable the selection of first or second gear ratios.

FRONT AXLE

52. The front axle (Figure 24) is of a rigid portal design and has a total reduction of 6.38:1. It consists of the following:

- **a.** a torque tube;
- **b.** a differential;
- **c.** a differential lock;
- **d.** two axles;
- **e.** two wheel hub drives; and
- **f.** two disc brakes.



1. Coil spring
2. Stabiliser bar
3. Axle strut
4. Torque tube
5. Tie rod
6. Wheel hub assembly
7. Disc brake assembly
8. Shock absorber
9. Differential casing
10. Half-shaft casing
11. Transverse link

Figure 24 Front Axle

Torque Tube

53. The torque tube encloses the propeller shaft and prevents torque reaction from twisting the axle on its springs. The torque tube is bolted to the axle housing and to the axle take-off torque ball joint on the main transmission. It is further stabilised by two axle struts bolted between the torque tube and the axle housing.

Differential

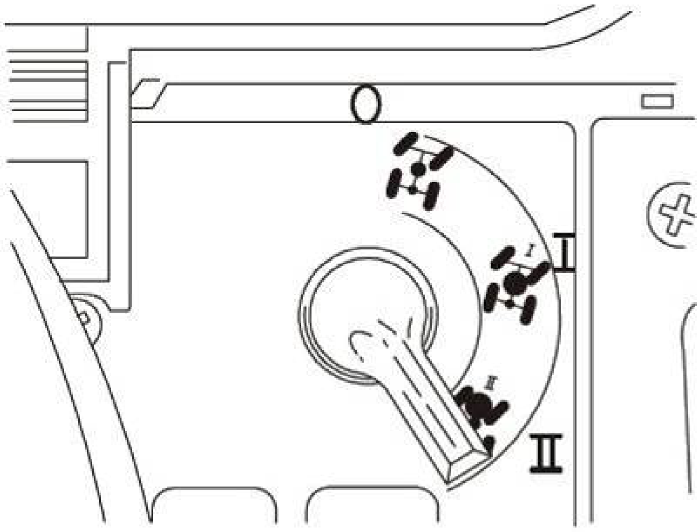
54. The differential consists of a crown wheel and a pinion, each of which is supported on two taper roller bearings. One of the bearings on the pinion gear shaft is a thrust bearing.

Differential Lock

55. The pneumatically-operated differential lock is fitted to the differential housing and is controlled by the selector switch on the top right-hand side of the instrument panel.

Axles

56. The axles transmit power from the differential through constant-velocity joints to the wheel hub drives. When the differential lock is required, the selector switch is positioned, as shown in Figure 25. The differential lock locks the crown wheel to the left-hand half-shaft. This renders the spider gears inoperative and causes the wheels to rotate at the same speed.



Position 0 = Two-wheel drive (rear axle)

Positon I = Four-wheel drive

Position II = Differential locks engaged

Figure 25 Drive Selector Switch

Wheel Hub Drives

57. Each wheel hub drive transmits power from the axle to a wheel. Each wheel hub drive is a spur gear reduction drive; both spur gears are supported on roller and ball bearings.

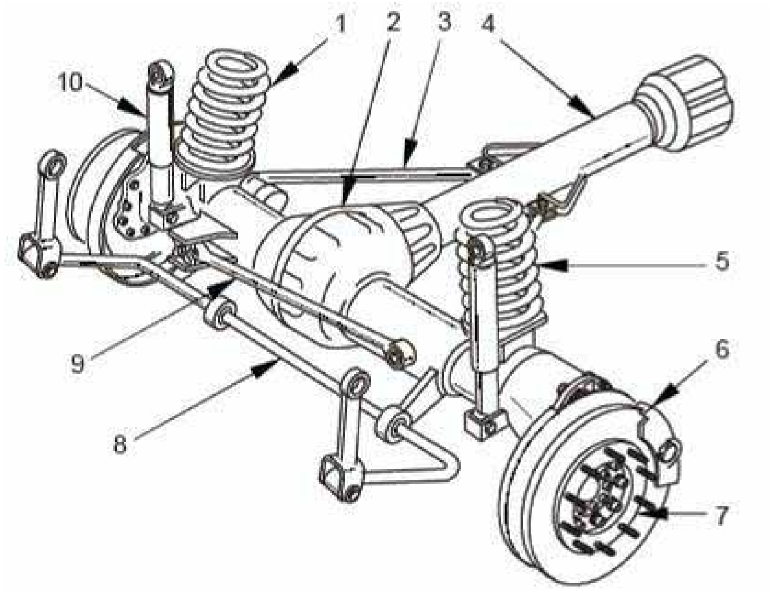
Disc Brakes

58. The disc brakes are hydraulically operated and consist of two fixed callipers and a disc mounted to the wheel hub.

REAR AXLE

59. The rear axle (Figure 26) is of a rigid portal design and has a total reduction of 6.38:1. It consists of the following:

- **a.** a torque tube;
- **b.** a differential;
- **c.** a differential lock;
- **d.** two axles;
- **e.** two wheel hub drives;
- **f.** two disc brakes; and
- **g.** two parking brakes.



1. Coil spring
2. Differential casing
3. Axle strut
4. Torque tube
5. Coil spring
6. Disc brake assembly
7. Wheel hub assembly
8. Stabiliser bar
9. Transverse link
10. Shock absorber

Figure 26 Rear Axle

Torque Tube

60. The torque tube encloses the propeller shaft and prevents torque reaction from twisting the axle on its springs. The torque tube is bolted to the axle housing and to the axle take-off torque ball joint on the main transmission. It is also stabilised by two axle struts bolted between the torque tube and the axle housing.

Differential

61. The differential consists of a crown wheel and pinion, each of which is supported on two taper roller bearings. One of the bearings on the pinion gear shaft is a thrust bearing.

Differential Lock

62. The pneumatically-operated differential lock is fitted to the differential housing. It is controlled by the selector switch on the top right-hand side of the instrument panel.

Axles

63. The axles transmit power from the differential to the wheel hub drives. When the differential lock is required, the selector switch is positioned, as shown in Figure 25. The differential lock locks the crown wheel to the right-hand half-shaft. This renders the spider gears inoperative and causes the wheels to rotate at the same speed.

Wheel Hub Drives

64. Each wheel hub drive transmits power from the axle to a wheel. Each wheel hub drive is a spur gear reduction drive; both spur gears are supported on roller and ball bearings.

Disc Brakes

65. The disc brakes, which are hydraulically operated, consist of a fixed calliper and a disc mounted to the wheel hub.

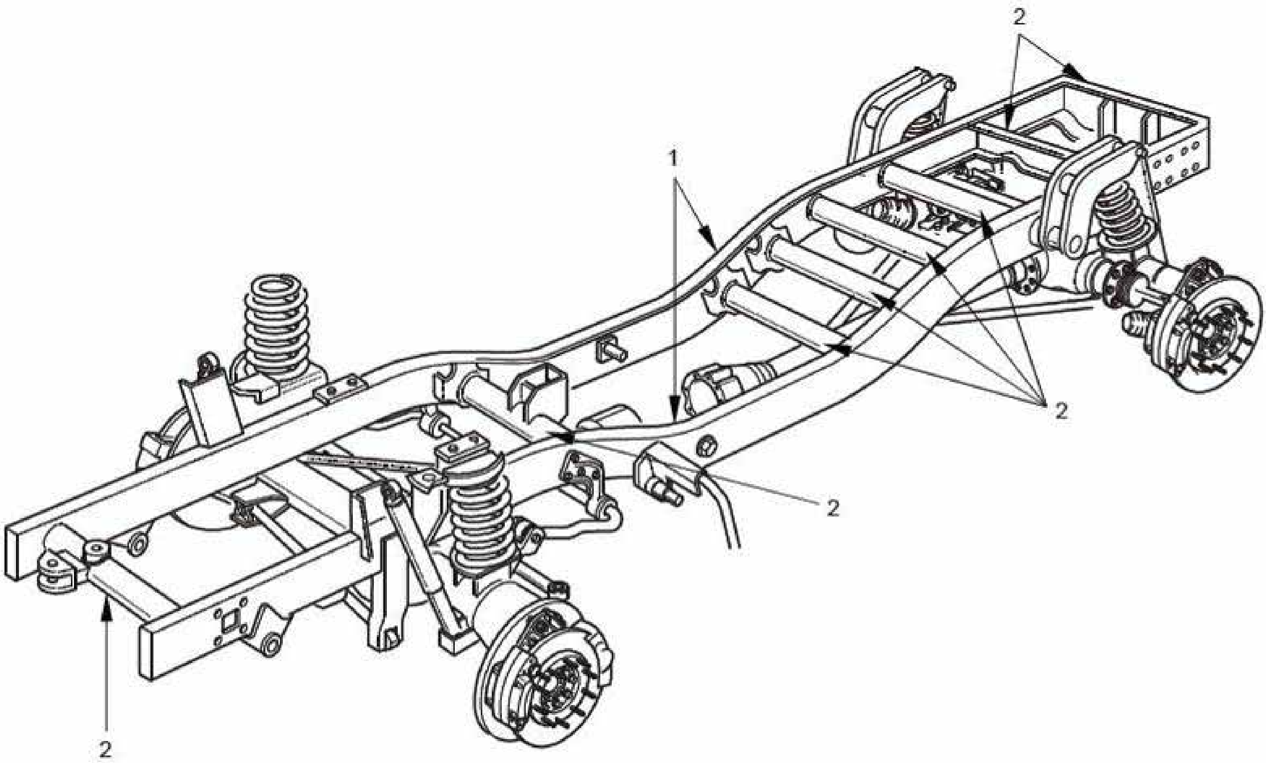
Parking Brake

66. Pneumatically-released parking brake actuators are fitted to the rear callipers. The parking brake actuators are spring-loaded cylinders that override the brake callipers.

CHASSIS AND SUSPENSION

Chassis

67. The chassis consists of two U-section channel rails (Figure 27) and eight cross-members. The engine is supported by the front cross-member and the two rails.



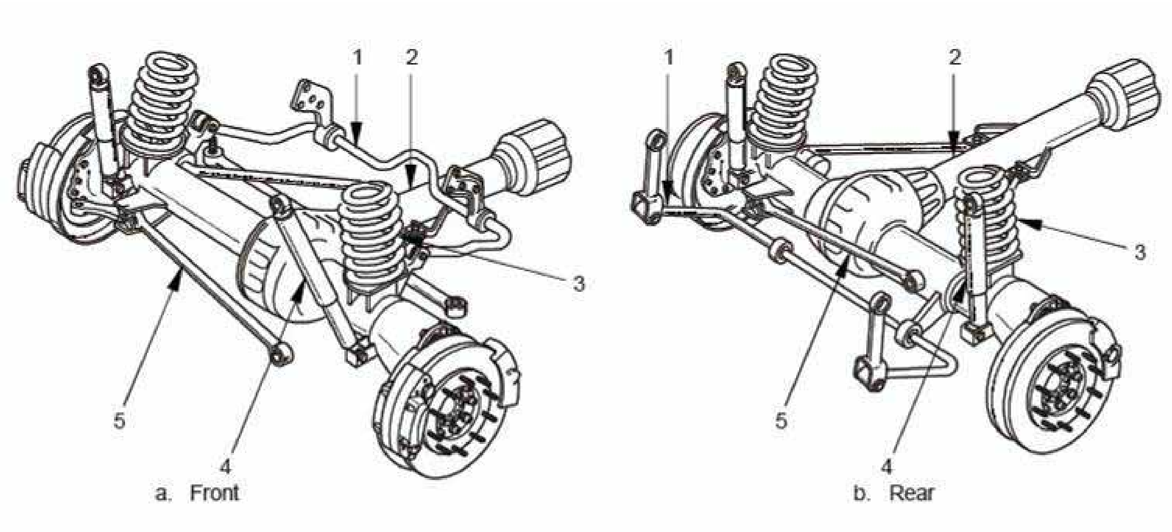
1. Chassis rails	2. Chassis cross-members

Figure 27 Chassis

Suspension

68. The suspension (Figure 28) consists of the following:

- **a.** Springs;
- **b.** shock absorbers;
- **c.** transverse links;
- **d.** torque tubes; and
- **e.** stabiliser bars.



1. Stabiliser bar 2. Torque tube 3. Spring 4. Shock absorber 5. Transverse links

Figure 28 Suspension

69. Springs. Progressive-action tapered springs are fitted to both axles. The springs have a linear response for small variations in spring length and a progressively stiffer response for larger variations in spring length. Auxiliary tapered springs are fitted within the rear springs to further stiffen the response.

70. Shock Absorbers. Double-acting shock absorbers are fitted adjacent to the springs on both axles to dampen spring oscillations.

71. Transverse Links. To ensure lateral location of the axles, transverse links are fitted between each axle and the chassis.

72. Torque Tubes. The drive shafts to the front and rear axles are located in torque tubes. The torque tubes have a triple function as follows:

- **a.** to ensure longitudinal location of the axles;
- **b.** to allow the axles to twist in relation to the chassis; and
- **c.** to transfer the pushing/pulling brake force to the chassis.

73. These functions are achieved by the rigid construction of the torque tubes twisting the torque tube ball joints at the main transmission.

74. Stabiliser Bars. Stabiliser bars are fitted to both axles. Due to their torsional rigidity, these bars absorb minor axle movements; however, any large movement of one wheel is transmitted to the other wheel. This tends to keep the wheels at the same level and limit lateral variations in the load platform angle.

BRAKE SYSTEM

75. The truck is fitted with hydraulic disc brakes, which are pneumatically controlled and actuated. The system has the following features:

- **a.** dual-circuits for truck and trailer brakes;
- **b.** automatic, load-dependant, control of truck braking effort;
- **c.** two line trailer brake control;
- **d.** a break-away safety device for fast trailer breaking if the trailer brake control fails;
- **e.** a parking brake;
- **f.** an engine brake; and
- **g.** a test facility to ensure that the truck parking brake alone will hold the truck and trailer on an incline.

76. The brake system consists of pneumatic and hydraulic devices, interconnected by metal or thermoplastic lines and hoses. The location of the devices and their interconnections are shown in Figure 86. Circuit diagram symbols used to represent the devices are shown in Figure 85.

Pneumatic Devices

77. The pneumatic devices used in the brake system and the pneumatic controls are as follows:

a. an air-compressor;

b. compressed air receivers;

c. non-return valves;

d. a shuttle valve;

e. single-acting cylinders;

f. double-acting cylinders;

g. pressure-limiting valves;

h. a pressure regulator;

i. a four-circuit protection valve;

j. a dual-circuit, service brake valve;

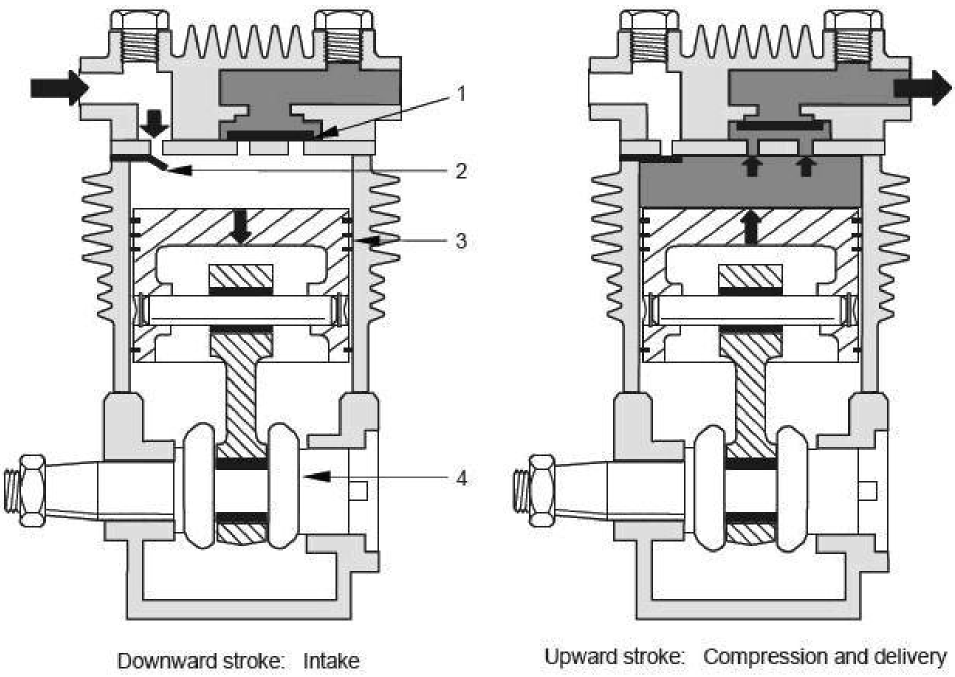
k. a three-way, two-position engine valve;

l. a combined trailer brake control break-away valve;

m. a four-way, two-position planetary-gear-set shift-valve;

n. directional control valves; and

o. trailer brake couplings.



1. Output valve
2. Input valve
3. Piston
4. Crankshaft

Figure 29 Air Compressor

78. Air Compressor. The air-cooled, reciprocating-piston compressor (Figure 29) is driven by a belt from the crankshaft pulley and generates high-pressure air for the truck pneumatic devices as follows:

a. On the downward (intake) stroke, the piston creates a low pressure in the chamber, which opens the intake valve and closes the output valve. Air is drawn in to the compressor chamber through the intake valve.

b. On the upward (compression) stroke, the increase in chamber pressure closes the input valve and opens the output valve. The air is further compressed by the piston and forced out through the output valve.

79. Compressed Air Receivers. The compressed air receivers stabilise the supply by smoothing pressure fluctuations and acting as reservoirs during periods of high air usage. The large surface area of the receivers cools the compressed air, causing moisture in the air to condense. Manually-operated valves drain the condensation from the air receivers.

80. Non-return Valves. The non-return valves (Figure 30) permit flow in one direction and stop flow in the opposite direction. The pressure at the input overcomes the spring tension and air flows through valve. When the input pressure is removed, the spring closes the valve and the back pressure fully seals the valve.

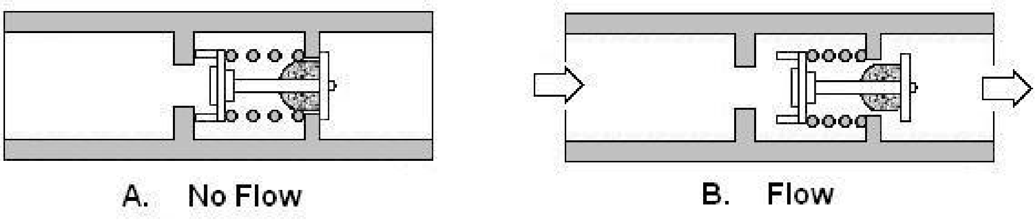


Figure 30 Non-return Valve

81. Shuttle Valve. The shuttle valve (Figure 31) enables two supplies to be connected to one port. When pressure is applied to one input port (Inlet 1), the ball seals off the other port (Inlet 2) and connects the pressure to the output. When pressure is applied to the other input port (Inlet 2), the ball shuttles across, seals the opposite port (Inlet 1) and connects the pressure to the output.

Figure 31 Shuttle Valve

82. Single-acting Cylinder. The single-acting cylinder (Figure 32) converts a pneumatic input to a linear output. When pressure is applied to the input port, the piston is driven along the cylinder, extending the piston rod and compressing the internal spring. When the pressure is removed, the return movement of the piston is effected by the compressed internal spring.

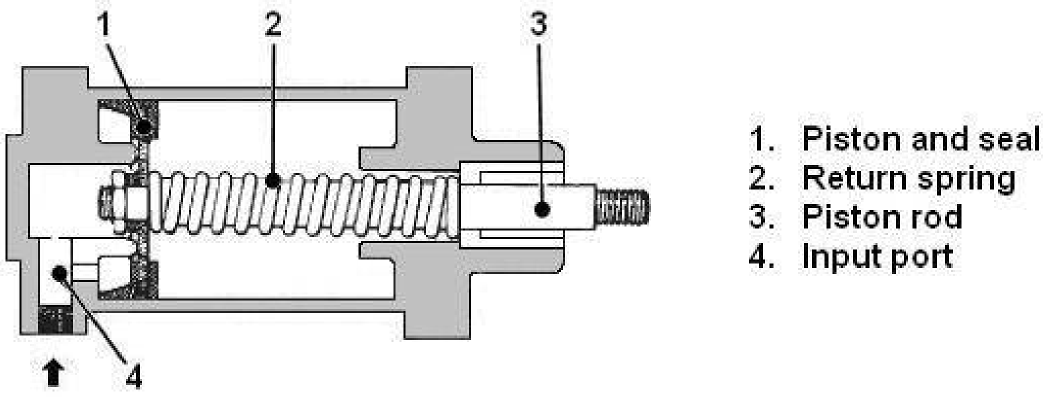


Figure 32 Single-acting Cylinder

83. Double-acting Cylinder. The double-acting cylinder (Figure 33) is used where work is required on the advance and return movements of the piston. Input pressure at either port causes the piston to move away from that port. When the pressure is removed, the piston stops and remains static until pressure is again applied to one of the input ports.

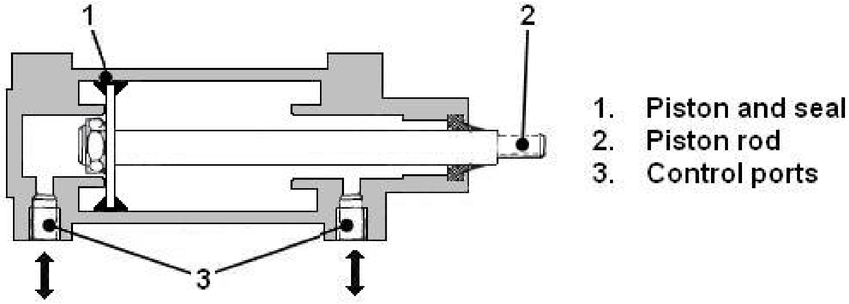


Figure 33 Double-acting Cylinder

84. Pressure-Limiting Valves. Two types of pressure-limiting valves are used; one type in the brake circuit and the other in the fording pressurisation circuit. These valves are used to limit the high pressure stored in the compressed air receivers to the lower pressure levels required for the operation of loads. The two types are as follows:

a. Fording Circuit. The fording circuit regulator (Figure 34) operates as follows:

(1) The air fed into the inlet (Item 9) flows through the valve (Item 2) to the outlet (Item 3).

(2) The piston (Item 8) is held at the top of its stroke by the spring (Item 7).

(3) When the pressure in the outlet (Item 3) reaches the pressure set by the screw (Item 5) on the spring (Item 7), the force on the piston via the relief port (Item 4) overcomes the force of the spring and the piston slides down, closing the inlet valve (Item 2) and stoping the flow from the inlet.

(4) If the pressure in the outlet (Item 3) exceeds the correct outlet level, the piston moves further down and opens the exhaust valve (Item 1).

(5) The excess air is vented to atmosphere through the piston and the vent valve (Item 6).

(6) If the pressure in the outlet line drops, the piston raises the valve and opens the inlet allowing air to flow again.

(7) The set pressure limit can be altered by changing the compression of the spring (Item 7) with the set screw (Item 5).

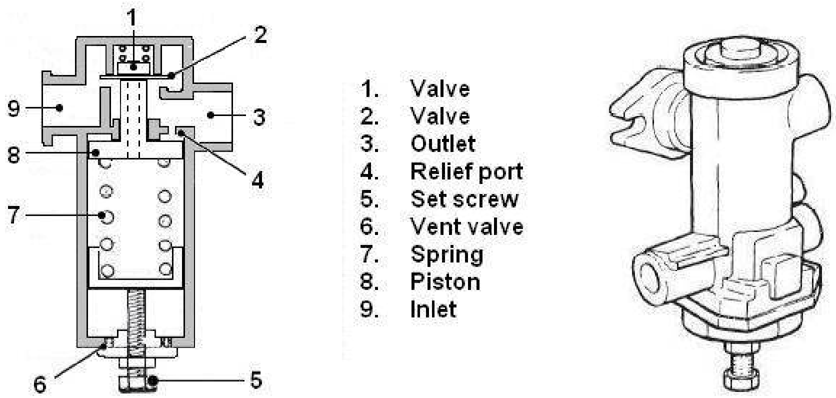


Figure 34 Pressure Limiting Valve (Fording Circuit)

b. Brake Circuit. A representation of the brake circuit valve is shown in Figure 35. The valve is shown with no compressed air input. The piston (Item 6) is at the top stop due to the compression of the spring (Item 10). Compressed air is fed to the inlet port (Item 7), flows through the gap between the sealing cone (Item 9) on the piston and sealing ring (Item 8) and flows to the load through the outlet (Item 1). As the pressure at the outlet port increases it forces the piston down against spring force until the sealing cone comes into contact with the sealing ring, thus isolating the inlet from the outlet at the required pressure. If the outlet pressure drops slightly, the piston opens the passage until the required outlet pressure is re-established. If the inlet pressure drops below the outlet pressure, the compressed air flows via the non-return sealing lip (Item 2) on the sealing ring to the inlet port. The scavenging area of the plunger is vented to atmosphere via the vent port (Item 3) and the non-return valve (Item 4). The set pressure limit can be altered by changing the compression of the spring by means of the set screw (Item 5).

Figure 35 Pressure Limiting Valve (Brake Circuit)

85. Pressure Regulator. The primary function of the pressure regulator (Figure 36) is to regulate the pressure of the compressed air being fed to the compressed air receivers from the air compressor. The regulator also filters the air and has a tyre inflating output port. When the compressed air receivers are filling, the air flows into the inlet port (Item 10) through the filter and strainer (Item 11 and 12) and into the ducts (Item 4 and 3). This air forces open the non-return valve (Item 6) and air is fed to the compressed air receivers through the outlet port (Item 5). When the correct pressure is reached in the receivers, the diaphragm (Item 17) moves up against the force of the spring (Item 18), the control valve (Item 14) is lifted off the valve seat just before the hollow bolt (Item 15) seals under the adjusting bolt (Item 19) and compressed air is applied to the piston (Item 13). With the extension of the piston, the idle valve (Item 9) opens; the air is vented to atmosphere and the non-return valve (Item 6) closes to prevent air escaping from the compressed air receivers. If the pressure in the receivers falls, the force of the spring (Item 18) moves the diaphragm down and closes the control valve (Item 14). The compressed air above the piston (Item 13) escapes through the hollow bolt (Item 15) and the vent hole in the top of the housing. The plunger is pushed by the return spring (Item 8) and the idle valve closes. When a tyre inflating hose is connected to the regulator, the hollow tappet (Item 1) is pushed back, pushing the valve cone (Item 2) onto the valve seat opposite and sealing the duct (Item 3). No more compressed air can reach the outlet port and the air flows out of the tyre inflating port. Since the control valve does not switch off in this condition, the idle valve opens when the safety pressure is reached. The regulator pressure is set by the adjusting bolt (Item 19).

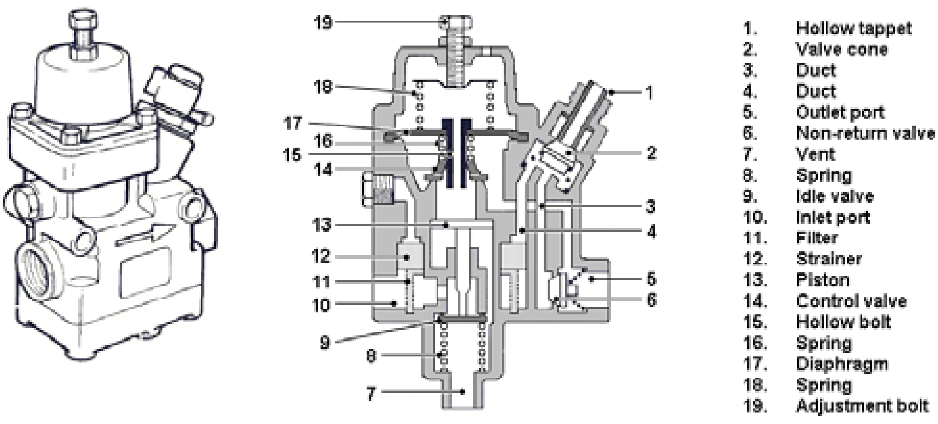


Figure 36 Pressure Regulator

86. Four-circuit Protection Valve. The four-circuit protection valve is used to route the compressed air and to safeguard the pressure in both service brake circuits, the parking brake circuit, the trailer brake circuit and the auxiliary load circuit. The protection valve described is the five-connector type, while the valve fitted to the truck is the seven-connector type. The functional difference is shown in Figure 37. The valves operate in the same manner, with the difference being the air supply to circuits 3 and 4. The air supply to these circuits is from the compressed air receivers via pressure limiting valves. The operation of the protection valve (Figure 38), is as follows:

a. **Filling.** When the compressed air receivers are empty, the compression spring (Item 7) presses the plunger (Item 6) onto the valve seat (Item 5) and the valve is closed. As soon as the input pressure reaches the opening pressure of the valve, the plunger lifts slightly and compressed air flows to Circuit 1. The effective area of the cap seal on the plunger is larger than the area of the plunger end; therefore, as pressure builds up at the output port, increased force is exerted on the plunger because of the additional cap seal area available when the plunger (Item 6) leaves the valve seat (Item 5). This has the effect of increasing the rate of counteracting the compression spring and the valve opens quickly until it is fully open. This action withdraws the throttling pin (Item 4) from the valve opening and allows full air flow to the compressed air receivers. The compressed air receivers in Circuit 1 and Circuit 2 are filled simultaneously, or in succession, depending on the opening pressures of valves I and II. Compressed air is fed via the non-return valves (Item 1 and 3) to valves III and IV. Valves III and IV are set to the same opening pressure as valves I and II, and operate in the same way. The fixed restrictions (2) downstream of valves III and IV prevent the valves closing during temporary large demands in Circuit 3 and Circuit 4.

b. **Failure of Circuit 1 or Circuit 2.** If one of these circuits loses air, the pressure of both circuits drops to the valve closing pressure of the failed circuit. As the pressure drops, the valve closes slowly until the throttling pin enters the valve opening; the area under the cap acted upon by input pressure is thereby decreased and the valve is closed rapidly by the spring. When the valve is closed, the air compressor refills the intact circuit to the opening pressure of the faulty circuit. This pressure is greater than or equal to 670 kPa for zero pressure in the faulty circuit. The non-return valves prevent a drop in pressure in Circuit 3 and Circuit 4.

c. **Failure of Circuit 3 and 4.** If one of these circuits fails, the pressure in the intact circuit falls to the closing pressure of the faulty circuit. The pressure then rises to the opening pressure of the faulty circuit.

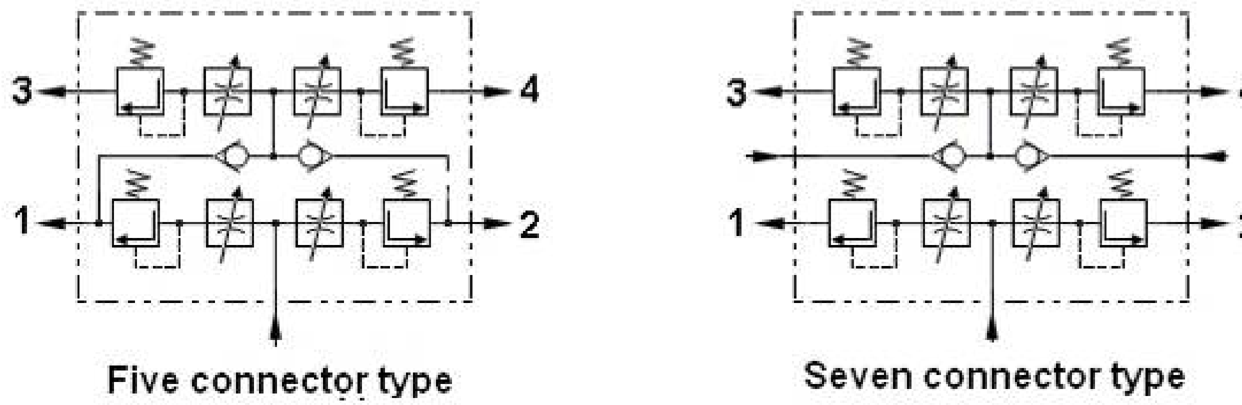


Figure 37 Four-circuit Protection Valve

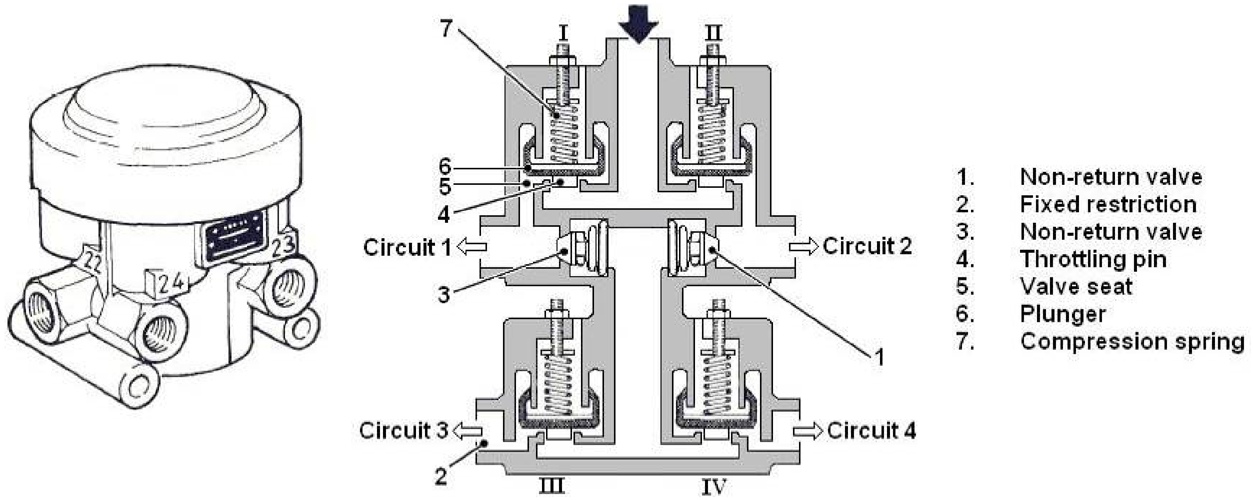


Figure 38 Functional Diagram, Four-circuit Protection Valve

87. Dual-circuit, Service Brake Valve. The service brake valve (Figure 39) gives sensitive control of the truck brakes and a fail safe facility if either brake circuit fails. On applying the service brake, the tappet resting in the spring plate (Item 1) moves the piston (Item 9) downwards. This closes the exhaust port (Item 8) and opens the inlet (Item 7). Air from Input 1 flows through space A to Circuit 1. At the same time, air flows through the drilling (Item 6) into space B and acts upon the top of the piston (Item 5). The piston moves downwards, closing the exhaust port (Item 4) and opening the inlet (Item 3). Air from the Input 2 flows through space C to Circuit 2. The pressure building up in space A acts on the underside of the piston (Item 9) and the piston moves upwards against the force of the rubber spring (Item 2) until the forces are equal on both sides of the piston. In this position, the inlet (Item 7) and exhaust (Item 8) are both closed and equilibrium is established. In the same way, the rising pressure in Space C moves the piston (Item 5) upwards until the inlet (Item 3) and exhaust (Item 4) are both closed. With maximum brake application, the piston (Item 9) moves to the bottom of its stroke and the inlet (Item 7) remains open. The pressure acting through the drilling (Item 6) in space B also moves the piston (Item 5) to the bottom of its stroke and holds the inlet (Item 3) open. If Circuit 2 fails, Circuit 1 will still operate as described. If Circuit 1 fails, the application of the service brake is mechanically fed to the piston (Item 5) to move it downwards. The exhaust (Item 4) closes, the inlet (Item 3) opens and Circuit 2 operates as previously described.

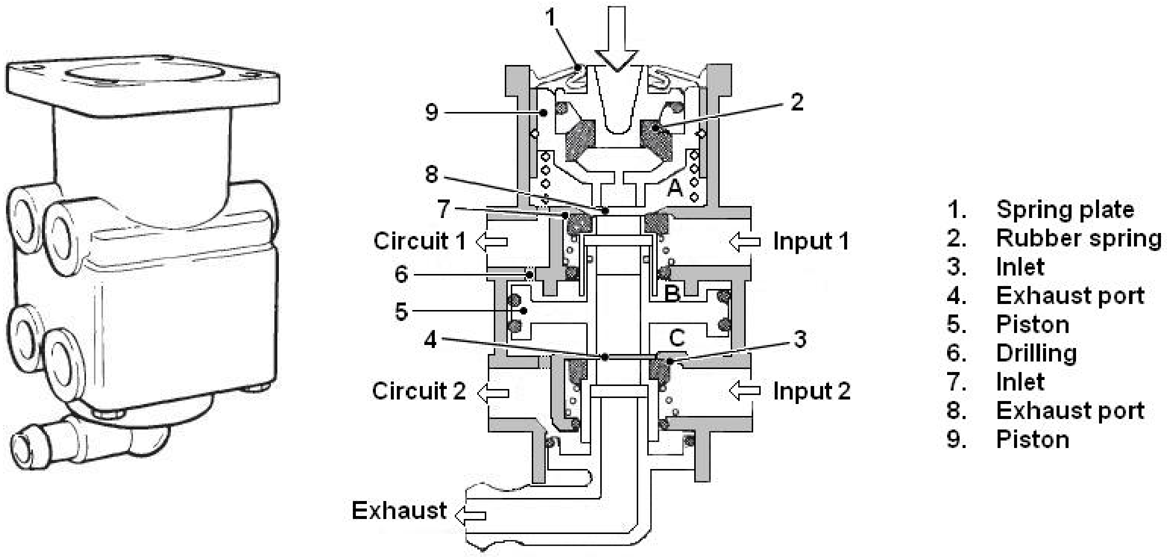


Figure 39 Dual-circuit Service Brake Valve

88. Engine Brake Valve. The engine brake valve (Figure 40) is an example of a three-way, two position directional control valve with mechanical actuation. This means it has two operational positions and three ports. In this case, the positions are ON and OFF, and the ports are supply output to a load and an exhaust. In the normal (OFF) position, the air supply to the input port is stopped by the closed inlet valve (Item 4). When the plunger (Item 1) is depressed, the hollow stem (Item 2) first seals on top of the inlet valve and then opens the valve and allows the air to pass through the output port to the load. When the plunger is released, the stem returns to its upper position under the pressure of the spring (Item 3) and the inlet valve closes under the pressure of the spring (Item 5). The output line is exhausted through the vents (Item 6) to the exhaust port.

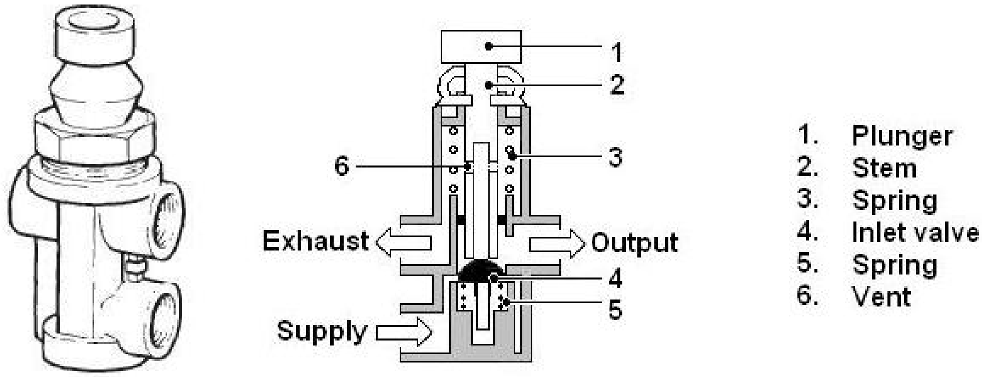


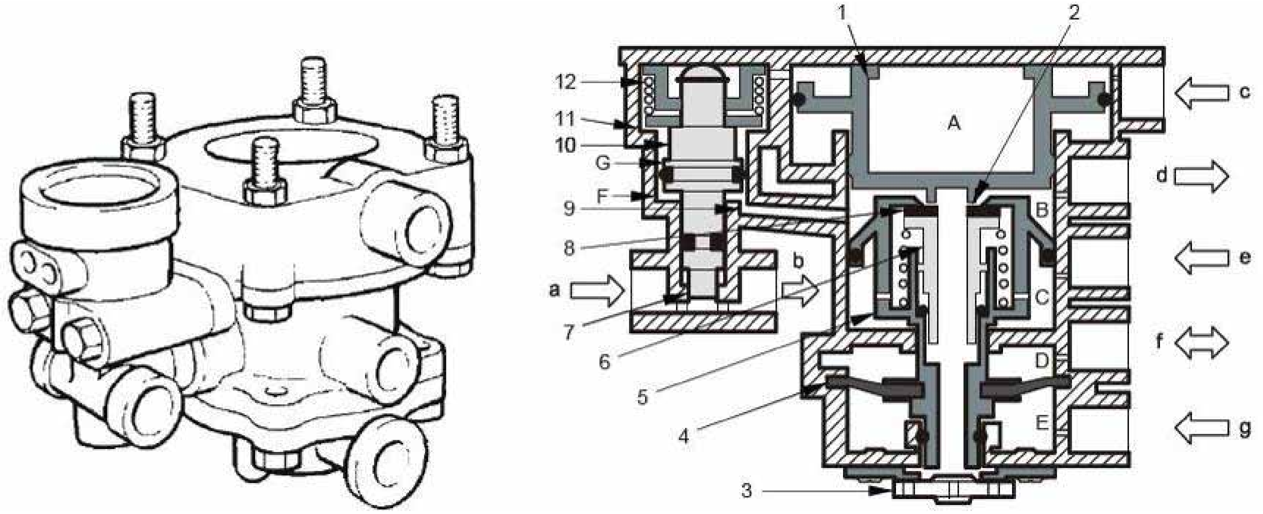
Figure 40 Engine Brake, 3/2-Way Valve

89. Trailer Brake Control Valve. The trailer brake control valve (Figure 41) is a pressure-controlled three-way, two-position throttling valve. The circuit control valve controls the outputs to the trailer brake lines and the throttling valve is used as a break-away safety valve. When the brake system is pressurised, air flows into the supply port (a) and acts on the bottom of throttling pin (Item 7), moving the piston (Item l0) to the top of its stroke. The air also flows out of the trailer supply port (b) to the trailer supply line and is fed back to the feedback port (e) and space C from the trailer supply coupling-head (not shown).

When the service brake is applied, air flows from circuit 1 through the circuit 1 port (c) into the spaces A and G, and acts upon the two pistons (1 and 10). The larger piston (Item 1) moves downwards to the contacting valve (Item 6), closing the exhaust (Item 2) and opening the inlet (Item 8). The air supply in space C flows through space B to the trailer control port (d) and pressurises the trailer brake control line to the same pressure as brake circuit 1. At the same time, air flows through the channel (Item 9) into space F and acts upon the bottom of the throttling piston (Item 10). The top of the piston is acted upon by the pressure from circuit 1. With a control pressure of around 400 kPa, the force is greater above the piston due to the spring (Item 12) and the piston moves downwards to the step in the housing (Item 11). This imbalance is built into the valve to prevent piston seizure. The pressure building up in space B acts upon the bottom of the larger piston (Item 1), moving the piston up against the control pressure in space A. The contacting valve (Item 6) closes the inlet (Item 8) and reaches a point of equilibrium. With full brake force applied, the pressure in space A is greater and the inlet valve stays open.

At the same time as these operations, brake circuit 2 applies pressure through the circuit 2 port (g) to space E under the diaphragm (Item 4). Space D is pressurised by the release pressure of the parking brake and space E by the service brake pressure in circuit 2, the pressure above the diaphragm is greater than that below and the position of the piston (Item 5) does not alter. If brake circuit 1 fails, there is no pressure in space A and the diaphragm (Item 4) moves the piston (Item 5) and the valve (Item 6) upwards. The piston (Item 1) is held at the top of its stroke, closing the exhaust (Item 2), opening the inlet (8) and pressurising the trailer brake control line. Pressure builds up in space B. moving the piston (Item 5) downwards until the inlet (8) closes and a shut-off point is reached. With full braking force applied the pressure in space E is greater than in space B and the inlet stays open. If the trailer control line connected to the trailer port (d) ruptures, the application of the service brake does not produce a pressure build up in spaces B and F. The throttling piston (Item 10) is moved downwards by the pressure in space G, the throttling pin (Item 7) is inserted in the trailer supply line and the trailer supply is throttled.

The trailer supply feedback to the feedback port (e) also falls because of the feed through the opened inlet (Item 8) to the ruptured line connected to trailer port (d). The fall in supply line pressure automatically applies the trailer brakes. The application of the parking brake vents space D, the pressure in space C moves the piston (Item 5) upwards and the trailer brakes are applied. At the end of braking operations, the service brake ports (c and g) are vented and parking brake port (f) filled. Pressure at supply port (a) returns the piston (Item 10) to the top of its stroke, pressure on the diaphragm (Item 4) at space D is greater than the pressure in space C and the piston (Item 5) remains depressed. The exhaust (Item 2) opens and the trailer control line exhausts to atmosphere through the contacting valve (Item 6) and the vent valve (Item 3).



1. Piston
2. Exhaust
3. Vent valve
4. Diaphragm
5. Piston
6. Contacting valve
7. Throttling pin
8. Inlet
9. Channel
10. Throttling piston
11. Housing step
12. Spring

a. Supply
b. Trailer supply line
c. Service brake circuit 1
d. Trailer control line
e. Feedback supply from trailer supply line
f. Parking brake line
g. Service brake circuit 2 and trailer brake valve

Figure 41 Trailer Brake Control Valve

90. Planetary-gear-set Shift-valve. This valve is a four-way, two-position valve (4/2 valve) used to control a double-acting piston. Figure 42 illustrates a typical four-way, two-position valve, which operates as follows:

- **a. Normal Position.** When the plungers are not depressed the supply pressure forces the valve seals (Item 1 and 2) into the positions shown. The supply is fed through the valve seal (Item 1) to the first side of the double-acting piston (side 1) and air from the other side of the piston (side 2) is exhausted back through the plungers as shown.
- **b. Plungers Depressed.** When the plungers are depressed, valve seals (Item 1 and 2) are forced down reversing the supply and exhaust lines to the piston. The supply is now connected to the second side of the double acting piston (side 2) and the piston drives in the opposite direction, the exhaust from the first side of the piston (side 1) is now connected to the exhaust port via the second valve seal (Item 2). When the plungers are released, the valve-seal springs and the supply pressure return the valve seals to their original positions.

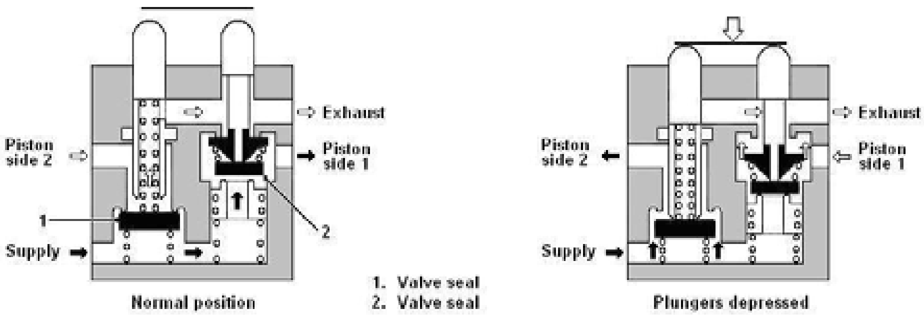


Figure 42 Planetary-Gear Set, 4/2 Valve

91. Directional Control Valves. The engine brake valve (Para 88) and planetary-gear-set shift-valve (Para 90) are examples of directional control valves. The other directional control valves used in the truck have the same principles of operation, with various combinations of actuation, number of positions and number of connectors.

92. Trailer Brake Couplings. Two types of couplings are fitted to the truck; the supply coupling (Figure 43) which is self-sealing and the control coupling (Figure 44), which is open when disconnected.

a. Supply Coupling. When the trailer brake lines are not connected to the truck, the spring (Item 4) pushes the valve plate (Item 5) against the valve seat (Item 6) and the supply line is blocked. When the trailer supply line is connected, the seal ring (Item 1) pushes down the thrust member (Item 2) and forms a seal between the two heads. At the same time, the movement of the thrust member opens the valve seat and lets the supply flow to the trailer and through the hollow bolt (Item 3) to the trailer brake control valve (Para 89).

b. Control Coupling. When the trailer control line is connected, the two seal rings form a seal between the heads and air flows to the trailer. When the trailer control line is not connected, the control coupling is open.

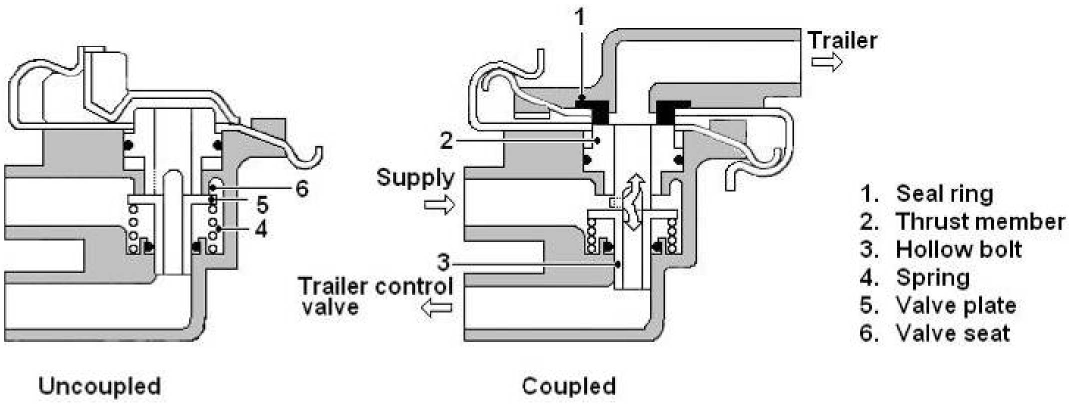


Figure 43 Trailer Brake Supply Coupling

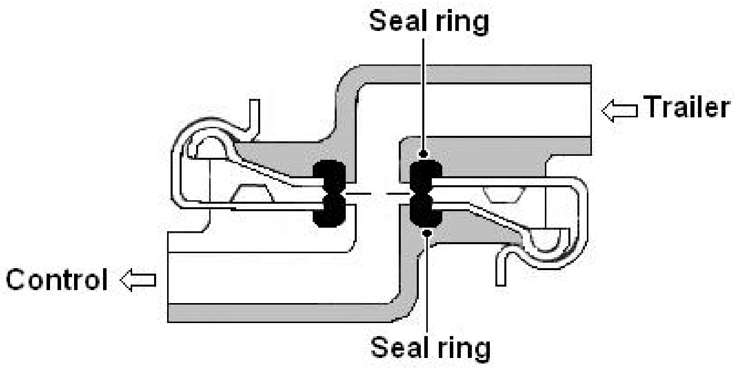


Figure 44 Trailer Brake Control Coupling

Hydraulic Devices

93. The hydraulic devices used in the brake system are as follows:

a. a dual-circuit master cylinder;

b. an Automatic Load-dependent Brake (ALB) valve;

c. disc brakes; and

d. disc brakes fitted with parking brakes.

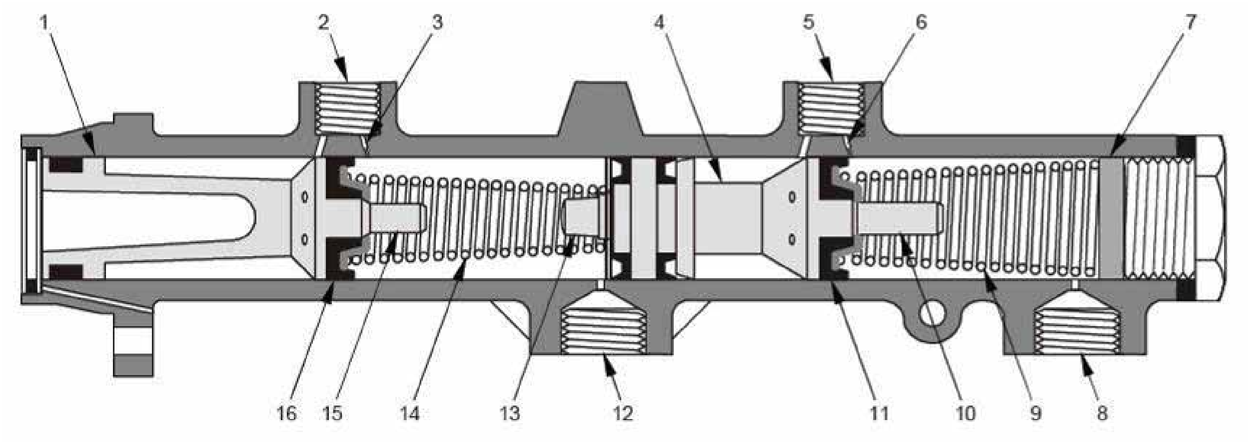
94. Dual-circuit Master Cylinder. The dual-circuit master cylinder (Figure 45) converts a mechanical input at the push-rod piston (Item 1) into hydraulic outputs for the dual-brake circuits. The dual-circuit master cylinder acts as follows:

a. **Driving Position.** In this position, the two pressure chambers (Items 9 and 14) are connected to the fluid reservoirs with the expansion bores (Items 3 and 6) and the fluid reservoir connections (Items 2 and 5).

b. **Braking Position.** When the service brake is applied, the push-rod pushes the push-rod piston of circuit 1 against the oil in the pressure chamber (Item 14) of circuit 1. The pressure build-up is transmitted to the pressure chamber (Item 9) of circuit 2 by the intermediate piston (Item 4). Consequently, the pressure conditions in both pressure chambers are the same and the intermediate piston follows any movement of the push-rod piston. When the pistons move a short distance, the sleeves (Items 11 and 16) close the expansion bores. The displaced fluid flows from the pressure chambers through the outputs (Items 8 and 12) and into the two brake circuits.

c. **Failure of Brake Circuit 1.** When a leak develops in brake circuit 1, the push-rod piston cannot establish pressure in the pressure chamber (Item 14) of circuit 1. The piston moves through the pressure chamber until the journal (Item 15) on the piston meets journal (Item 13) on the intermediate piston and pushes the latter against the oil in the pressure chamber (Item 9) of circuit 2. Brake circuit 2 continues to operate at full efficiency.

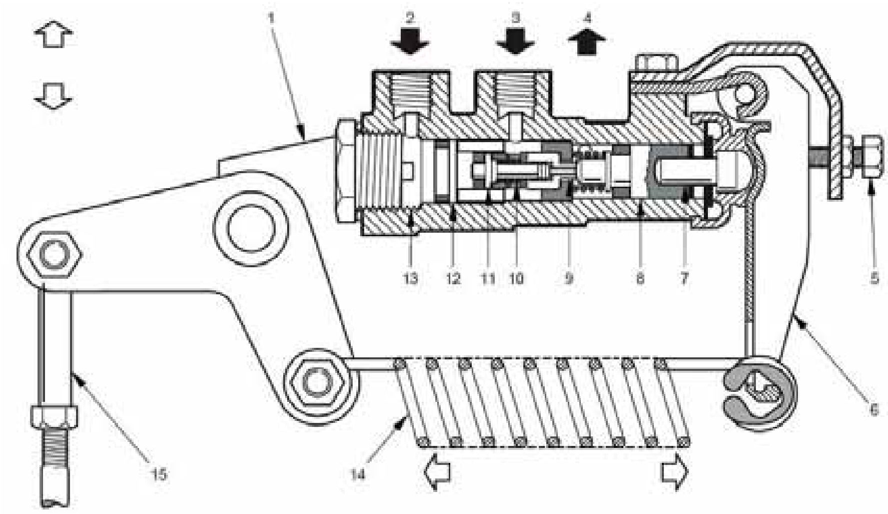
d. **Failure of Brake circuit 2.** When a leak develops in brake circuit 2, the intermediate piston (Item 4) cannot establish pressure in the pressure chamber (Item 9) of circuit 2. The intermediate piston moves through the pressure chamber until journal 2 (Item 10) rests against the plate (Item 7). Brake circuit 1 continues to operate at full efficiency.



1. Push-rod piston
2. Fluid reservoir, connection circuit 1
3. Expansion bore, circuit 1
4. Intermediate piston
5. Fluid reservoir connection, circuit 2
6. Expansion bore, circuit 2
7. Plate
8. Output, circuit 2
9. Pressure chamber, circuit 2
10. Journal 2, intermediate piston
11. Sleeve, circuit 2
12. Output, circuit 1
13. Journal 1, intermediate piston
14. Pressure chamber, circuit 1
15. Journal, push-rod piston
16. Sleeve, circuit 1

Figure 45 Dual-circuit Master Cylinder

95. **Automatic Load-dependent Brake Valve (ALB Valve).** The tension in the draw spring (Figure 46) is dependent on the truck load; a heavier load increases the tension. The draw-spring (Item 14), when fully tensioned, causes the lever (Item 6) to pivot, and the thrust pin (Item 7) and control piston (Item 8) to move to the left and fully open the control valve (Item 9). Full pressure is transmitted from supply A (Item 3) to the output port (Item 4). Simultaneously, this pressure acts on the control piston to generate a force opposite to that of the control piston. When the draw spring is not fully tensioned, the pressure on the control piston overcomes the draw spring tension and the control piston moves to the right. The valve spring (Item 10) closes the valve and prevents any further increase in pressure at the output port. The point at which the valve opens and closes and the pressure at the output port are dependent on the tension of the draw spring. The ALB valve is connected as shown in Figure 47. The load-dependent pressure at the output port can vary from 3 kPa to 15 MPa. If supply B (Item 2) fails, supply A pressure moves the safety piston (Item 11) to the left. The shoulder on the safety piston shaft moves the control valve to the left, connecting supply A at an unreduced pressure to the output port. The leak chamber (Item 12), in addition to its primary role, acts as a buffer between the two supply circuits.



1. Mounting bracket	4. Output port	7. Thrust pin	10. Valve spring	13. Pressure chamber
2. Supply B	5. Adjusting bolt	8. Control piston	11. Safety piston	14. Draw spring
3. Supply A	6. Lever	9. Control valve	12. Leak chamber	15. Linkage to torque tube

Figure 46 ALB Valve

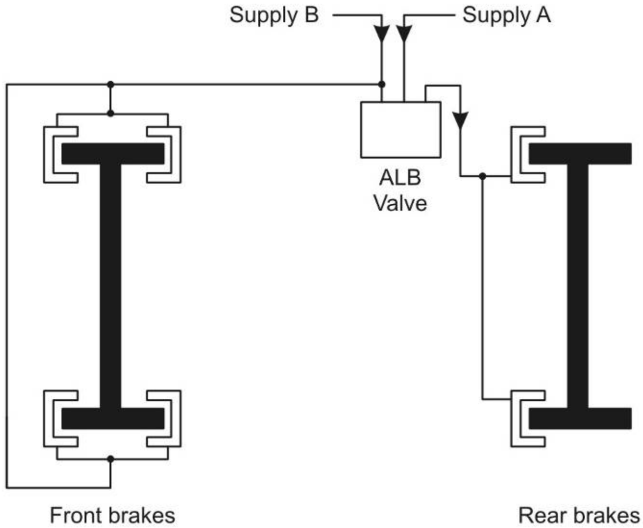
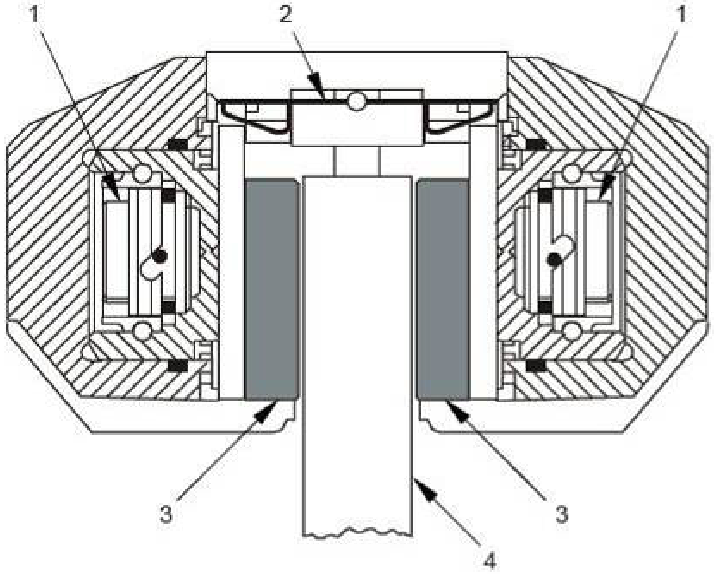


Figure 47 ALB Valve Connections

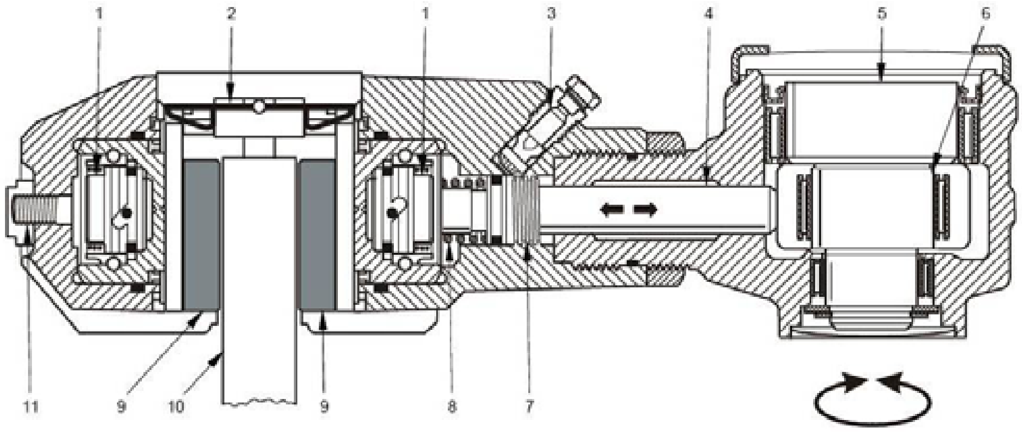
96. Front Disc Brakes. The front disc brakes (Figure 48) consist of a brake disc (Item 4) and a pair of brake callipers (Item 5) on each front wheel; the brake discs are fixed to the wheel hubs. When the foot brake is applied, hydraulic fluid under high pressure is fed to the pistons (Item 1). The pistons force the brake pads against the brake disc, simultaneously compressing the expander spring (Item 2). When the pedal pressure is removed, the expander spring forces the brake pads away from the brake disc. The brakes are self-adjusting.



1. Piston 2. Expander spring 3. Brake pad 4. Brake disc

Figure 48 Front Disc Brake Calliper

97. Rear Disc Brakes. The rear disc brakes (Figure 49) consist of a brake disc (Item 10) and a brake calliper on each rear wheel. The brake discs are fixed to the wheel hubs and the brake callipers are fitted with a parking brake mechanism. When the foot brake is applied, hydraulic fluid under high pressure is fed to the pistons (Item 1). The pistons force the brake pads against the brake disc, simultaneously compressing the expander spring (Item 2). When the pedal pressure is removed, the expander spring forces the brake pads away from the brake disc. When the parking brake is applied, a lever arm (Item 5) rotates a cam (Item 6), which drives an actuating shaft (Item 4) towards the piston. This action forces the inner brake pads against the brake disc, simultaneously compressing the return spring (Item 8). When the parking brake is released, the cam rotates and the return spring forces the inner brake pads away from the brake disc. The parking brake adjusting screw (Item 3) sets the clearance of the inner brake pads and the brake pad adjusting screw (Item 11) sets the clearance of the outer brake pads.



1. Piston
2. Expander spring
3. Parking brake adjusting screw
4. Actuating shaft
5. Lever arm
6. Cam
7. Drive screw
8. Return spring
9. Brake pad
10. Brake disc
11. Brake pad adjusting screw

Figure 49 Rear Disc Brake Calliper

System Operation

98. The output of the air compressor (Figure 86, Item 13) is regulated to 1.8 MPa by a pressure regulator (Item 14) and fed to a four-circuit protection valve (Item 15). The four circuit protection valve supplies compressed air to two main receivers (Item 10); each receiver output is connected to a pressure limiter. Circuit 1 pressure limiter (Item 11) is a dual-pressure device and reduces the receiver output pressure to either 950 kPa, no trailer connected, or 700 kPa when a trailer is connected. The pressure limiter (Item 27) in circuit 2 reduces the receiver output pressure to 700 kPa. The limiter outputs are connected to the four-circuit protection valve and the service brake valve (Item 18).

99. Service Brakes. The service brake valve outputs are proportional to the force applied to the foot brake pedal. The outputs are fed to the trailer brake valve (Figure 86, Item 6) and to the dual-circuit servo valve (Item 19). The dual-circuit servo valve and the master cylinder (Item 20) convert the pneumatic input signals to a hydraulic output. One output from the master cylinder is fed to the disc brakes (Item 23) on each front wheel and the other output is fed to the ALB valve (Item 22). The output pressure of the ALB valve is proportional to the load on the vehicle and is fed to a disc brake (Item 24) on each rear wheel. As the truck load increases, the ALB valve delivers higher pressure to the rear disc brakes (Para 95.).

100. Parking Brakes. The parking brake valve (Figure 86, Item 3) is supplied with compressed air from the four-circuit protection valve (Item 15). When the parking brake is released, compressed air is supplied to the two spring-applied brake actuating cylinders (Item 5), which release the parking brakes. When the parking brake is applied, the actuating cylinder lines are vented and the springs apply the parking brakes. The supply of compressed air to the parking brake system is connected to an auxiliary compressed air receiver (Item 2). If the supply of compressed air from the four-circuit protection valve is interrupted, the compressed air stored in the receiver enables the parking brakes to be applied or released three times. A non-return valve, which is fitted to the parking brake supply line, prevents the compressed air receiver exhausting back into the interrupted or failed supply from the four-circuit protection valve.

101. Trailer Brakes. Compressed air is connected to the trailer supply line and the trailer brake valve. The trailer brakes have four operating conditions as follows (Figure 50):

a. **Parking Brake Applied.** When the parking brake is applied, the control line is vented. The trailer brake control signal to the trailer brake valve causes the trailer brakes to be fully applied.

b. **Parking Brake Released.** When the parking brake is released, the trailer brake valve releases the trailer brakes.

c. **Foot Brake Applied.** When the parking brake is released and the foot brake is operated, the trailer brake control signal causes the trailer brakes to be applied in proportion to the force applied to the foot brake pedal.

d. **Manual Trailer Brake Control Valve Operated.** When the parking brake is released and the manual trailer brake control valve is operated, the trailer brake control signal is proportional to the position of the manual trailer brake control valve handle position. The manual trailer brake control valve may be operated independently to provide trailer braking without applying the vehicle brakes.

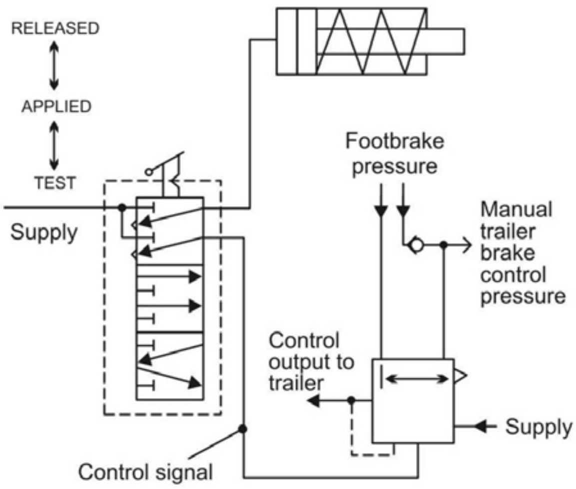


Figure 50 Trailer Brake Control

102. Engine Brake. The engine brake control valve (Figure 86, Item 26) is supplied with compressed air from the four-circuit protection valve (Item 15). When the engine brake is applied, the spring-loaded engine brake operating cylinder (Item 25) closes a butterfly valve in the exhaust manifold and pushes the fuel injection pump control-rod to its zero position. This retards the engine and effectively brakes the truck. When the engine brake is released, the operating cylinder line is vented and the spring-loaded cylinder opens the butterfly valve in the exhaust manifold, allowing the accelerator pedal to set the fuel injection pump control-rod to the desired position.

103. Parking Brake Test Facility. The parking brake test facility allows the trailer brakes to be released when the truck parking brakes are applied. This ensures that the truck parking brake alone will hold the truck/trailer combination on a gradient.

a. Normal Condition. When the parking brake is applied the control signal line is vented, the control output line to the trailer is pressurised and both truck and trailer brakes are applied.

b. Test Conditions. When the parking brake lever is depressed and pushed fully backwards to the test position, the truck parking brakes remain applied, the control output line to the trailer is vented and the trailer brakes are released.

104. Break-away Valve. The break-away valve (Figure 51) ensures that the trailer brakes are applied automatically if the control signal line fails or is disconnected. The break-away valve compares the service brake valve signal pressure with the control signal pressure; if a difference of 450 kPa is detected, the break-away valve operates. The trailer brake supply pressure is exhausted through a throttle valve and the trailer brakes are applied. The throttle valve ensures that the trailer brakes are applied rapidly, but not instantaneously.

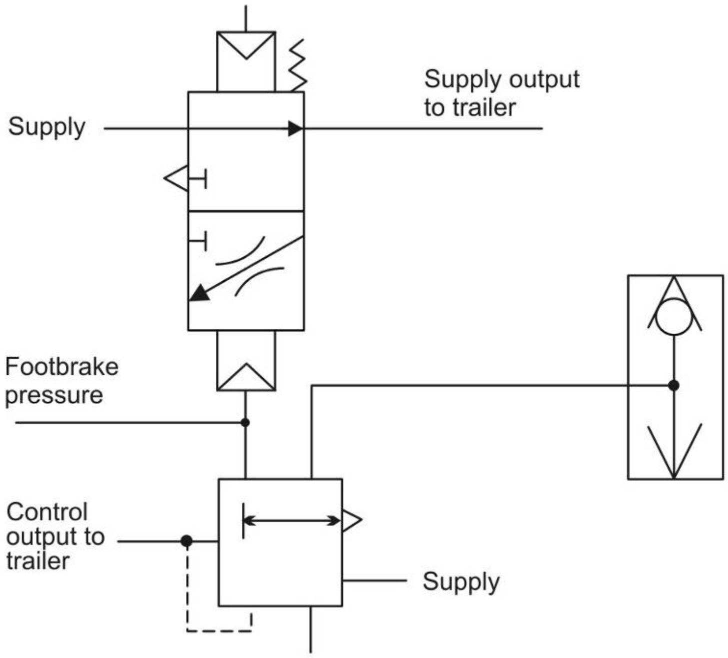


Figure 51 Break-away Valve

System Monitoring Facilities

105. To warn the driver of system malfunctions the brake system is fitted with the following warning lights:

a. compressed air receiver pressure warning light;

b. a hydraulic differential-pressure warning light; and

c. disc brake pad wear warning light.

106. Compressed Air Receiver Pressure Warning Light. If the pressure in either receiver is less than 1.2 MPa, a warning light on the instrument panel is illuminated.

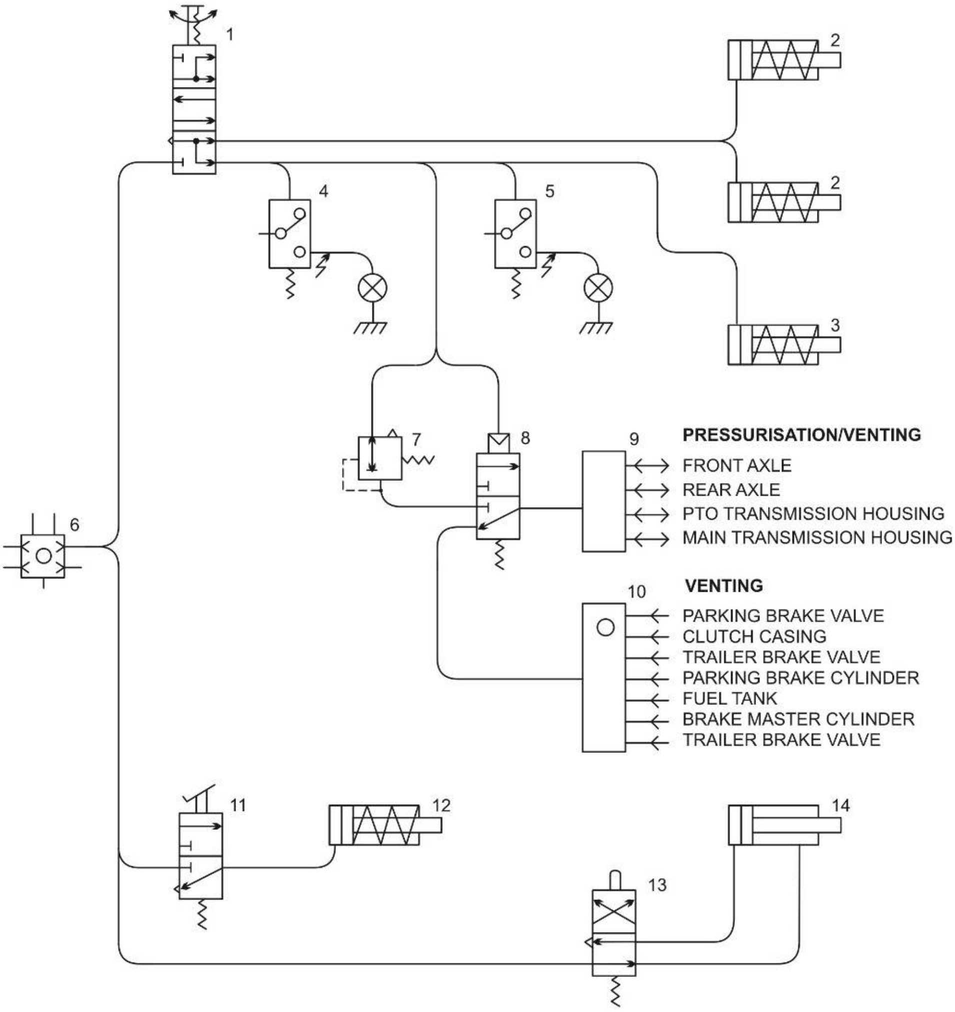
107. Hydraulic Differential-pressure Warning Light. The differential-pressure switch compares the master cylinder hydraulic pressure outputs. If a pressure difference is detected, a warning light on the instrument panel is illuminated.

108. Disc Brake Pad Wear Indicating Warning Light. Transmitters are fitted to front left and rear left brakes. Electrical contacts are embedded in the brake pads. When a pad wears down to 2 mm thick, the electrical contact is earthed through the brake disc and a warning light on the instrument panel is illuminated.

Auxiliary Pneumatic Devices

109. The auxiliary pneumatic devices (Figure 52) are supplied with regulated compressed air from the four-circuit protection valve. The auxiliary devices are as follows:

- **a.** an engine brake;
- **b.** a planetary-gear-set shift-control;
- **c.** four-wheel drive and differential lock clutches; and
- **d.** a pressurisation and venting system.



1. Drive selection valve
2. Differential lock actuating cylinder
3. Four-wheel drive actuating cylinder
4. Four-wheel drive pressure switch
5. Differential lock pressure switch
6. Four-circuit protection valve
7. Pressure limiting valve
8. Pressurisation and venting manifold
9. Central venting port
10. Engine brake control valve
11. Engine brake control valve
12. Engine brake actuating cylinder
13. Planetary-gear-set shift valve
14. Planetary-gear-set actuating cylinder

Figure 52 Auxiliary Pneumatic Devices

110. Planetary-gear-set Shift Valve. The planetary-gear-set shift valve (Figure 52, Item 13) is mechanically linked to the shift mechanism on the main transmission. The shift valve controls a double-acting cylinder (Item 14) connected to the planetary gear set shift lever. When changing gears from 4th to 5th or from 5th to 4th, the cylinder disengages or engages the planetary-gear-set in the main transmission gear train.

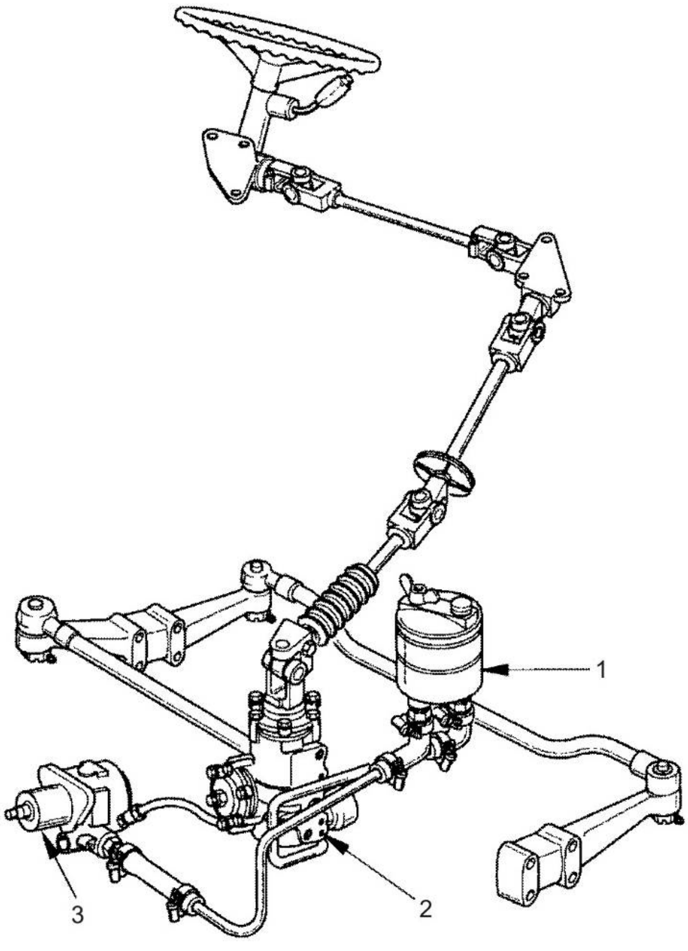
111. Four-wheel Drive and Differential Lock Clutches. When four-wheel drive is selected, a drive selection valve (Figure 52, Item 1) actuates the clutch cylinder (Item 3) to engage four-wheel drive. When the differential locks are selected, the four-wheel-drive clutch remains engaged and a drive selection valve (Item 1) actuates the differential lock cylinders (Item 2) to engage the differential locks. When two-wheel drive is selected, the actuating cylinders are exhausted to disengage the four-wheel-drive clutch or the differential locks.

112. Pressurisation and Venting System. To prevent the ingress of water to the axles and transmission during fording, all ventilation lines are connected to a central vent point located behind the cab. When four-wheel drive or differential locks are engaged, the pressurisation control valve supplies low-pressure compressed air (25 kPa) to the front axle, rear axle, PTO transmission and main transmission housing. When two-wheel drive is selected, the pressurisation control valve connects these lines to the central vent point.

POWER STEERING

113. The Mercedes Benz LS3B power steering system (Figure 53) is an integral hydraulically-assisted recirculating ball-nut system with adjustable hydraulic steering limiters. The components of the system are as follows:

- **a.** a fluid reservoir;
- **b.** a hydraulic pump;
- **c.** a steering box; and
- **d.** mechanical linkages.



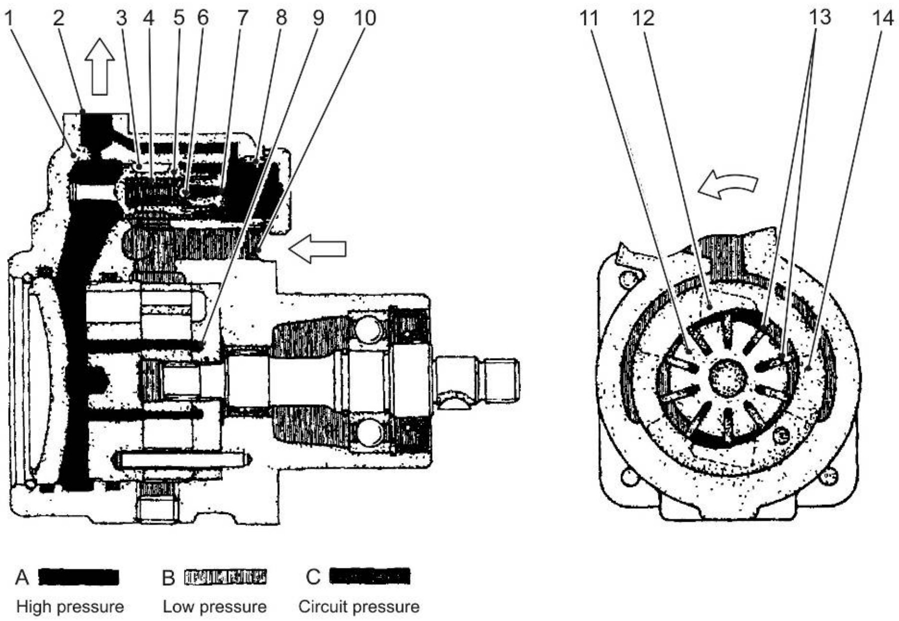
1. Fluid reservoir 2. Steering box 3. Hydraulic pump

Figure 53 Power Steering Components

Fluid Reservoir

114. The fluid reservoir and steering system components contain 2.25 litres of hydraulic fluid. The reservoir has an outlet line to the hydraulic pump and a return line from the steering box. A filter is fitted in the return line. The reservoir has a combined filler and breather cap.

115. Hydraulic Pump. The fixed-displacement vane pump is driven by a belt from the engine crankshaft pulley (Figure 54). The vanes are mounted in slots in the rotor. Centrifugal force, generated by the rotation of the rotor, forces the vanes out against the cam ring. The eccentric shape of the cam ring causes the volume between the vanes to vary as they rotate. As the vanes pass the inlet ports, the volume between the vanes increases, which causes a reduction in pressure and hydraulic fluid is drawn in from the reservoir. As the vanes rotate further, the volume between the vanes decreases and forces the hydraulic fluid into the outlet ports. This pressurised fluid is piped to the steering box and pressurised fluid is also fed to the inner ends of the vanes. This fluid enhances the action of the centrifugal force, ensuring efficient contact between the vane tips and the cam ring.



1. Control orifice
2. Output
3. Relief channel
4. Pilot valve spring
5. Control valve spool
6. Pilot ball valve
7. Pilot valve orifice
8. Control valve spring
9. Pressure channels
10. Input
11. Rotor
12. Flow channels
13. Vanes
14. Input ports

Figure 54 Power Steering Hydraulic Pump

116. Flow Control and Relief Valve. Because a constant flow of hydraulic fluid to the steering box is required, a flow control and relief valve (Figure 55) is fitted to the hydraulic pump and operates as follows:

- **a. Low-Speed Drive.** Due to the flow across the control orifice, the differential pressure developed lowers the pressure in B with respect to A. The control valve spool remains to the left because the force generated by the pressure at A does not exceed the thrust of the control valve spring; all fluid is delivered to the steering box.

- **b. High-Speed Drive.** The increased fluid flow causes a greater pressure drop across the control orifice than at low pump speeds. This causes the pressure in B with respect to A to decrease further; the spring force is overcome and the control valve spool moves to the right. This allows excess fluid to be diverted back to the low pressure section of the pump.

- **c. Excessive Pressure at Output Port.** The excessive pressure overcomes the relief valve spring and unseats the ball in the pilot valve. This allows the excess pressure to be relieved through the pilot valve orifice to the low-pressure section of the pump.

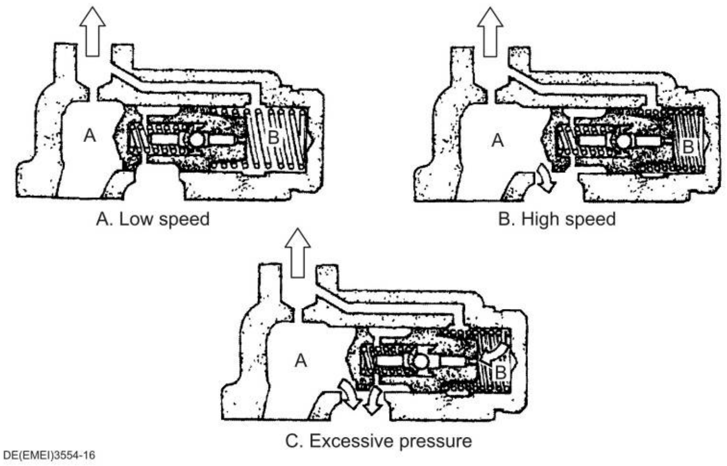
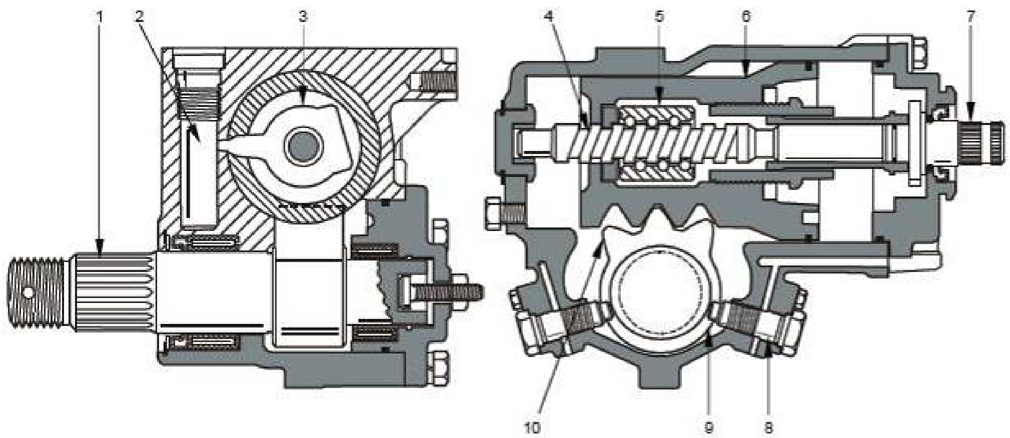


Figure 55 Flow Control/Relief Valve Operation

Steering Box

117. As the steering wheel is turned, the steering column rotates the worm gear (Figure 56, Item 4). When the worm gear (Item 4) rotates, the movement is transmitted to the recirculating ball-nut (Item 5), which can partly rotate within the piston (Item 6). A control valve actuating arm (Item 3), which is attached to the nut, shifts the control valve spool (Item 2). When the valve is in the central position, the oil pressure at its two output ports is low and equal and has no effect on the piston. When the valve spool is moved off-centre, it connects one of the valve outlet ports to the pressure port. This causes an increase in pressure on one side of the piston; at the same time, the other side of the piston is connected to the return port so that oil can return to the reservoir. This drives the piston and applies force to the gear sector (Item 10).

When the turning effort at the steering wheel is decreased the spring-loaded control valve spool centralises, locking the piston in position. Just before the piston reaches the end of its stroke, the cams (Item 9) on the gear sector engage pressure limiting valves (Item 8). These valves provide a bypass to the reservoir for hydraulic fluid under high pressure, thus reducing the driving force as the steering approaches full lock. This eliminates excessive heat build-up and overloading of the steering linkage components. Adjusting screws permit adjustment of the pressure limiting points. If the hydraulic system fails, manual steering is still available, but with a considerable increase in effort. The worm shaft is threaded onto the recirculating ball-nut in the piston and rack. Rotation of the worm shaft moves the piston and rack back and forth within the gear housing. The rack engages the gear sector, which transmits the drive to the mechanical linkages.

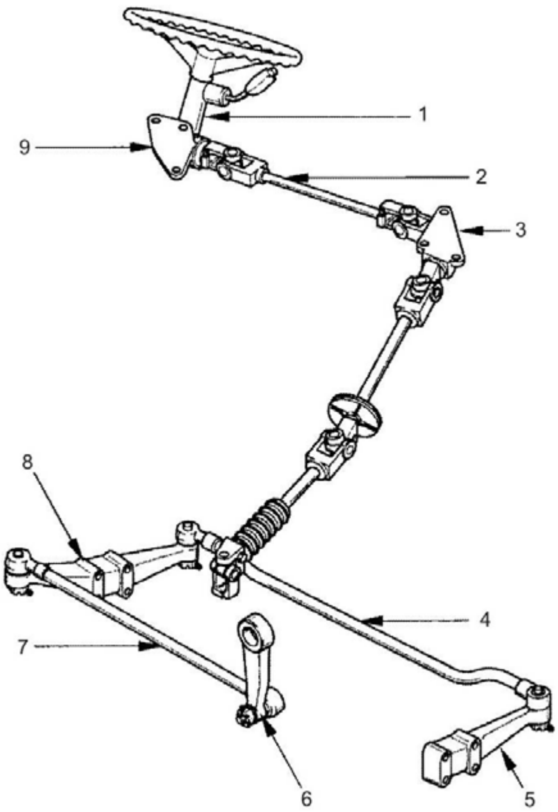


1. Output to pitman arm
2. Valve spool
3. Valve actuator arm
4. Worm gear
5. Recirculating ball-nut
6. Piston and rack
7. Steering wheel input
8. Pressure limiting valve
9. Pressure limiting valve operating cam
10. Gear sector

Figure 56 Steering Box

Mechanical Linkages

118. The steering column (Figure 57, Item 1) transmits the rotation of the steering wheel to the steering box. A drag link (Item 7) transmits the output from the steering box pitman arm (Item 6) to the right-hand side wheel steering arm (Item 8). The right-hand side wheel steering arm is connected to the left-hand side wheel steering arm (Item 5) by a tie rod (Item 4).



1. Steering column
2. Cross link
3. Angle drive
4. Tie rod
5. Left-hand side steering arm
6. Pitman arm
7. Drag link
8. Right-hand side steering arm
9. Angle drive

Figure 57 Mechanical Linkages

CABIN

119. The cabin is manufactured from pressed steel panels welded together. It is secured by four rubber anti-vibration mountings under the driver’s seat, the passenger's seat, the driver’s pedals and at the passenger's foot space. The cabin may be tilted by a telescopic hydraulic cylinder or overhead lifting device to permit access to the engine and transmission. The cylinder, which is fitted between the cab and chassis, is extended by a hand-operated portable hydraulic pump. The cabin is fitted with the following items:

- **a.** Doors;
- **b.** rear windows;
- **c.** seats;
- **d.** an observation hatch;
- **e.** an instrument panel;
- **f.** a combination switch;
- **g.** shift controls;
- **h.** a centre console;
- **i.** pedals and hand throttle; and
- **j.** accessories.

Doors

120. Two hinged doors, each with an integral map pocket, are fitted to the cabin. The following items are fitted to each door:

- **a.** a door handle and lock;
- **b.** a window; and
- **c.** an external rear-vision mirror.

121. Door Handles and Locks. The doors are fitted with external and internal door handles. The press-button, externally-operated handles are key-lockable. Each internally-operated handle has a hinged door-latch lever combined with a door-pull. A door-locking lever is fitted to the inside of each door.

122. Windows. Each door is fitted with two laminated glass windows; a wind-up window regulated by a winder on the door and a fixed quarter-vent window.

123. External Rear-vision Mirror. An adjustable, rectangular rear-vision mirror is fitted to each doorframe.

Rear Windows

124. Two laminated glass windows are fitted to the rear panel of the cabin. These windows cannot be opened.

Seats

125. Driver’s Seat. The driver’s seat is made up of a squab and a backrest. The seat can slide on two floor rails and the height is adjustable. The front and rear squab height adjustments are controlled separately. The backrest may be tilted forwards and backwards. An inertia-reel lap and sash seat belt is fitted for the driver.

126. Passenger’s Seat. The passenger seat is not adjustable, but the back of the seat may be folded down to form a stable base on which to stand. An inertia-reel lap and sash seat belt is fitted for the passenger seated beside the door and an inertia-reel lap seat belt is fitted for the second passenger.

Observation Hatch

127. A hinged, circular observation hatch is fitted on the left-hand side of the roof. The hatch may be opened by first releasing two locking handles and then folding the hatch on to the cabin roof.

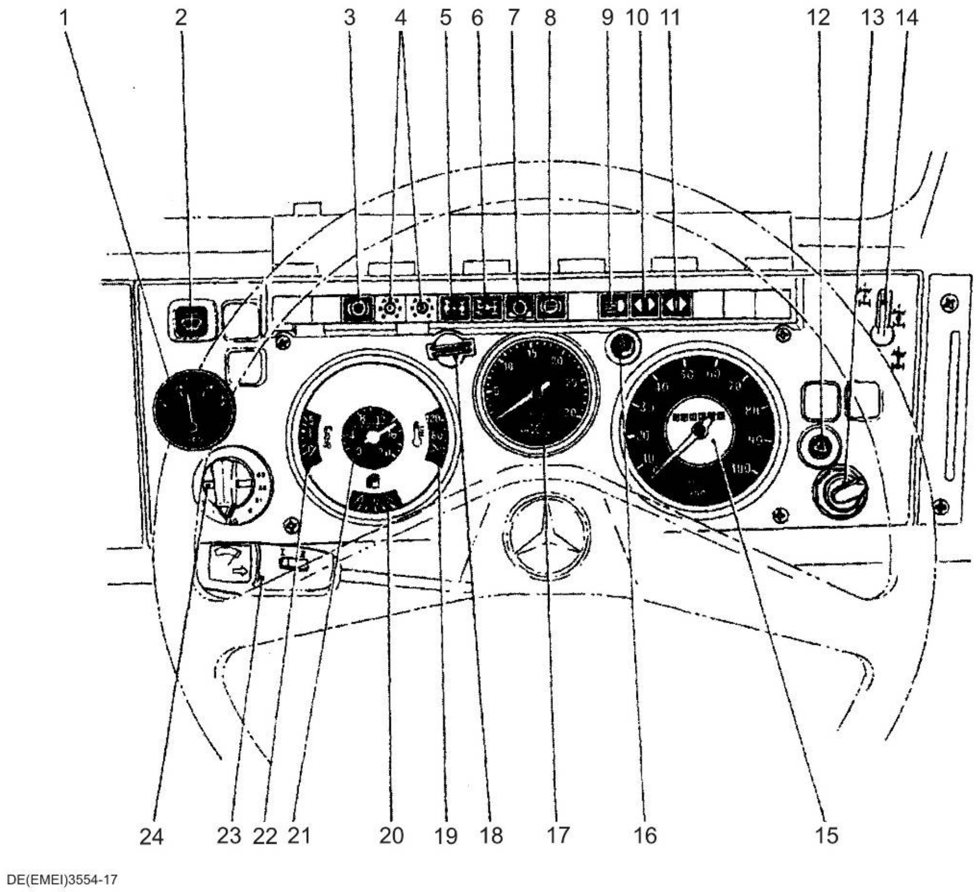
Instrument Panel

128. The instrument panel is fitted with the following items (Figure 58):

- **a.** indicator lights;
- **b.** warning lights;
- **c.** instruments and gauges;
- **d.** switches and controls; and
- **e.** auxiliary fittings.

129. Indicator Lights. Indicator lights are fitted to indicate when:

- **a.** the differential locks are engaged;
- **b.** four-wheel drive is selected;
- **c.** high beam is selected;
- **d.** the truck turn indicators are operating;
- **e.** the trailer turn indicators are operating; and
- **f.** the parking brake is applied.



1. Charge indicator voltmeter
2. Washer switch and light
3. Low air warning light
4. Brake wear warning lights
5. Differential lock indicator light
6. Four-wheel-drive indicator light
7. Parking brake light
8. Differential pressure warning light
9. High beam indicator light
10. Truck turn indicator light
11. Trailer turn indicator light
12. Hazard switch and light
13. Ignition/start switch
14. Drive selector switch
15. Speedometer
16. Instrument light control
17. Tachometer
18. Power socket
19. Temperature gauge
20. Fuel gauge
21. Double pressure gauge
22. Oil pressure gauge
23. Combination switch
24. Main/blackout lights switch

Figure 58 Dashboard

130. Warning Lights. Warning lights are fitted to indicate the following conditions:

- **a.** low coolant level;
- **b.** low oil pressure;
- **c.** high temperature;
- **d.** brake pad wear;
- **e.** low air pressure; and
- **f.** hydraulic brake system malfunction.

131. Audible Alarms. A warning buzzer sounds whenever the low coolant level light, the low oil pressure light or the high temperature light illuminates. The buzzer mutes when all the lights are extinguished.

132. Instruments and Gauges. The following instruments and gauges are fitted:

- **a.** an oil pressure gauge;
- **b.** a dual air pressure gauge;
- **c.** an odometer;

d. a speedometer;

e. a tachometer;

f. a coolant temperature gauge;

g. a fuel quantity gauge; and

h. a voltmeter.

133. Switches and Controls. The following switches and controls are fitted:

a. Combined Windscreen Washer Switch and Light. The windscreen washer switch is a push on, hold on switch. A green light in the switch illuminates when the headlights or marker lights are on. The light does not operate when the main/blackout light switch is in position S1 or S3 (Para 160).

b. Main/Blackout Light Switch. The six-position main/blackout light switch (Figure 58) controls the lights in the following manner:

(1) Position 0 – all lights are off.

(2) Position Tag – the switch detent can be released in this position (Tag = Day).

(3) Position 1 – the front and rear markers and clearance lights are turned on.

(4) Position 2 – the headlights, front and rear markers and clearance lights are turned on.

(5) Position S1 – the convoy cross light and the blackout marker lights are turned on.

(6) Position S2 – this position is not used.

(7) Position S3 – the reduced headlight is turned on; the convoy lights and blackout marker lights remain on.

c. Instrument Lights. The instrument lights are turned on using the control on the instrument panel (Figure 58). Clockwise rotation of the control brightens the lights.

d. Two/Four-wheel Drive and Differential Lock Selector. This selector is used to engage two-wheel drive, four-wheel drive or four-wheel drive with differential locks.

e. Combined Hazard Light Switch and Indicator. This switch is a push on-push off switch. A red light on the switch flashes synchronously with the hazard lights when the switch is on. The hazard lights do not operate when the main/blackout light switch is in position S1 or S3.

f. Ignition Switch. The ignition switch has a permanently locked-in key. It has three positions:

(1) Position 0 – ignition off;

(2) Position I – ignition on; and

(3) Position 2 – start engine.

134. Auxiliary Fittings. The following auxiliary fittings are located on the instrument panel:

a. a hinged translucent screen to mask the indicating and warning lights when operating in blackout conditions;

b. a side window demisting outlet; and

c. a trouble-light socket.

Combination Switch

135. The combination switch (Figure 59) controls the following functions:

a. low beam headlights;

b. high beam headlights;

c. headlight flasher;

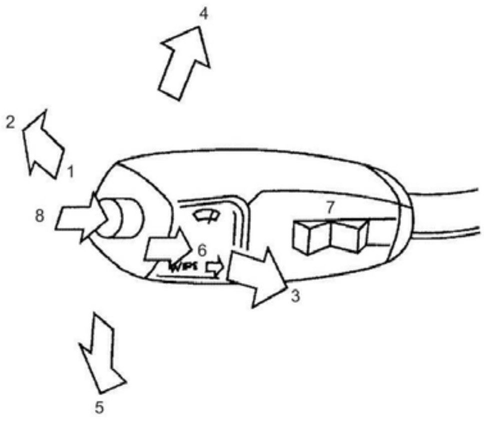
d. right-hand turn indicators;

e. left-hand turn indicators;

f. windscreen wipers;

g. windscreen wiper speed; and

h. the horn.



1. Low beam	2. High beam	3. Headlight flasher	4. Right turn indicator
5. Left turn indicator	6. Windscreen wiper – push on, push off	7. Windscreen wiper speed (**I** – slow, **II** – fast)	8. Horn

Figure 59 Combination Switch

Shift Controls

136. The following shift controls (Figure 60) are located on the floor at the left of the driver's seat:

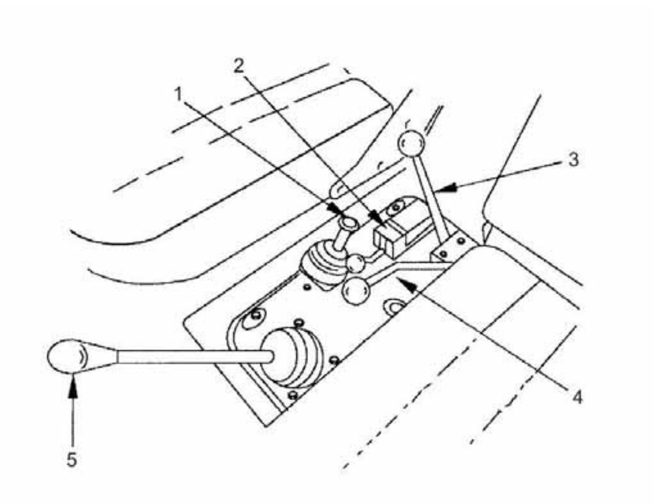
a. an eight-speed shift lever;

b. a forward/reverse shift lever;

c. a PTO shift lever (fitted with winch variant);

d. a parking-brake lever; and

e. a trailer-brake lever.



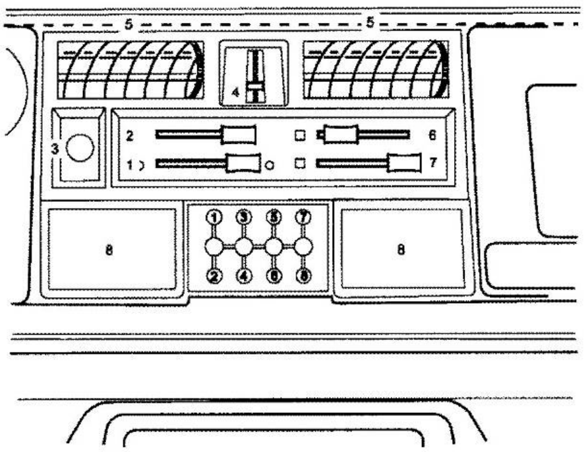
1. Parking brake	2. Trailer brake	3. PTO lever	4. Fwd/Rev lever	5. Gear shift lever

Figure 60 Shift Controls

Centre Console

137. The following controls and indicators are located on the centre console (Figure 61):

- **a.** personal rotary vents;
- **b.** the rotary-vent air regulator;
- **c.** the windscreen and side window demisting regulator;
- **d.** the floor-vent regulator;
- **e.** the cabin vent flap;
- **f.** the gear-shift-gate position indicator;
- **g.** the air temperature control;
- **h.** the fresh air/recirculation control; and
- **i.** the fan control switch.



1. Temperature control	2. Floor vent regulator	3. Fan control switch	4. Rotary vent regulator
5. Personal rotary vents	6. Windscreen and side window demisting regulator	7. Fresh air/reticulation control	8. Cabin vent flap

Figure 61 Heating and Venting Controls

138. Personal Rotary Vents. The personal rotary vents are used to direct air towards the driver and the passenger. The spiral vents are adjustable to allow the optimum air flow direction.

139. Rotary-vent Regulator. The rotary vent regulator controls the air flow rate from the personal rotary vents. In the fully upward position, no air is available from the personal rotary vents. In the fully downward position, full air flow is available.

140. Windscreen and Side Window Demisting Regulator. With the windscreen and side window demisting regulator in the left-hand position, no air is delivered to the windscreen and side window demisting outlets. In the right-hand position, full air flow is available.

141. Floor-vent Regulator. With the floor-vent regulator in the right-hand position, no air is delivered to the floor space. In the left-hand position, full air flow is available.

142. Cabin Vent Flap. The cabin vent flap (Figure 62) can be opened to direct air into the cabin area in addition to air being delivered via the other vents.

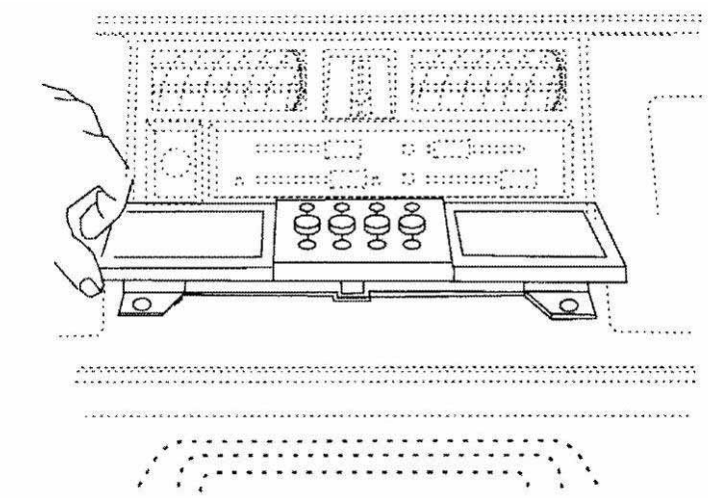


Figure 62 Cabin Vent Flap Open

143. Gear-shift-gate Position Indicator. The gear-shift-gate position indicator, fitted to the cabin vent flap, shows the location of the gear shift lever within the gear gate (Para 50.).

144. Temperature Control. With the temperature control in the left-hand position, only air at ambient temperature is delivered to the various vents. With the lever in the right-hand position, the air is heated by the engine coolant. The degree of heating is determined by the position of the lever.

145. Fresh Air and Recirculation Control. With the fresh air/recirculation control in the left-hand position, fresh air from outside the truck is delivered to the various vents. When the fresh air/recirculation control is in the right-hand position, cabin air is recirculated.

146. Fan Control Switch. The fan control switch controls the fan, which recirculates cabin air or boosts the flow of fresh air from outside the truck.

Pedals and Hand Throttle

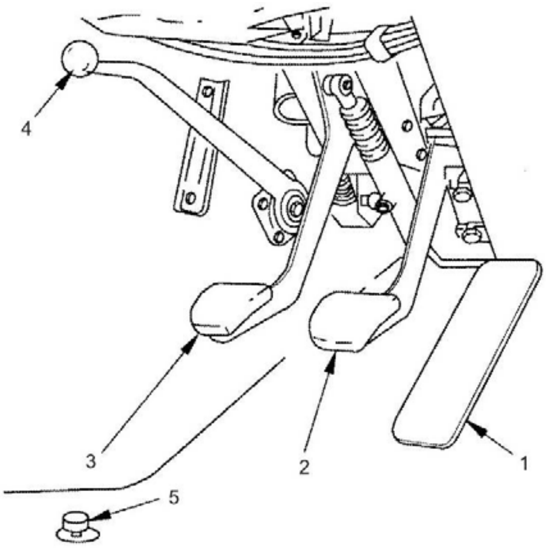
147. Accelerator Pedal. The accelerator pedal is used to control the engine speed. It is spring loaded to the upward position.

148. Footbrake Pedal. The footbrake pedal is used to apply the truck brakes. When a trailer is being towed, it also controls the trailer brakes. It is spring loaded to the upward position.

149. Clutch Pedal. The clutch pedal is used to disengage and engage the clutch. It is spring loaded to the upward position.

150. Hand Throttle. The hand throttle enables a constant engine speed to be set or the engine to be shut-down. When not in use, it must be placed in the idle detent position. To set the engine to a particular rpm, the throttle lever is pushed downwards until the tachometer indicates the desired rpm. The hand throttle is to be used for setting a constant engine speed when negotiating very rough terrain or operating the winch. It is not to be used to set the cruising speed on highways. To shut down the engine, move the hand throttle to the fully up position (shut-down detent).

151. Engine Brake Control Switch. When the engine brake control switch is depressed, the engine brake is applied.



1. Accelerator pedal
2. Footbrake pedal
3. Clutch pedal
4. Hand throttle
5. Engine brake control switch

Figure 63 Pedals and Hand Throttle

Accessories

152. The following accessories are located in the cabin:

- **a.** a fire extinguisher;
- **b.** a map-reading light;
- **c.** weapon clips;
- **d.** a dome light and switch; and
- **e.** a glove box.

ELECTRICAL SYSTEM

153. The truck uses a 24 V negative-to-earth electrical system. The components of the system are interconnected by cable looms with branches at intermediate points. The wires are individually colour-coded; all wires to earth are coloured brown. Any component that is not earthed through its mountings has an earth return to an earth connection on the instrument panel, the frame or the cab. Two main junction boxes are fitted, one in the engine compartment at the front left of the cab and one at the rear of the truck on the inside of the left chassis rail. A wiring diagram for the truck is shown in Figure 87.

154. The electrical system consists of the following:

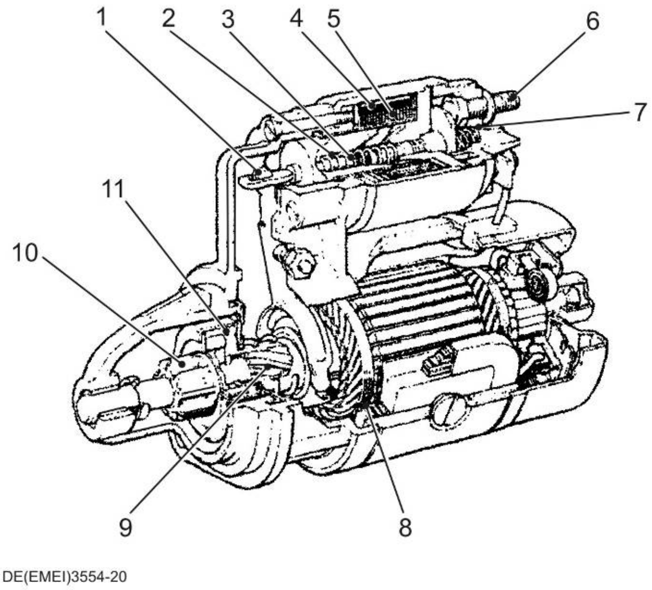
- **a.** two batteries;
- **b.** a starting system;
- **c.** a charging system;
- **d.** overload protection circuit breakers;
- **e.** a lighting system;
- **f.** instruments;
- **g.** indicator and warning lights;
- **h.** a trailer wiring system; and
- **i.** auxiliary electrical equipment.

Batteries

155. Two 12 V, 55 Ah batteries are housed in an enclosed lockable carrier mounted on the right-hand chassis rail behind the cab.

Starting System

156. The truck is fitted with a Bosch 4 kW starter motor with a solenoid-operated, pre-engaged drive (Figure 64). When the ignition switch is turned to the start position, power is applied via the connecting terminal to the draw-in coil (Item 5). The coil draws the solenoid armature (Item 3) inwards and the shift lever (Item 1) pushes the pinion (Item 10) forward. When the solenoid switch contact (Item 7) closes, current flow in the draw-in coil ceases, and current flow in the hold-in coil (Item 4) and the starter motor commences. The starter motor armature (Item 8) rotates and due to the multi-start thread (Item 9) on the armature shaft, the pinion is screwed forwards until it is engaged with the ring gear on the flywheel. The drive/free-wheel mechanism (Item 11) transmits the drive from the armature to the pinion and the engine turns. When the engine fires and the ignition switch is released to the normal operating position, the shift lever is pulled back by the return spring (Item 2). If the pinion is still engaged when the engine is rotating faster than the starter, damage to the starter is prevented by the roller-operated drive/free-wheel mechanism until the starter pinion disengages itself from the flywheel and rewinds onto the starter armature multi-start thread in preparation for the next start attempt.

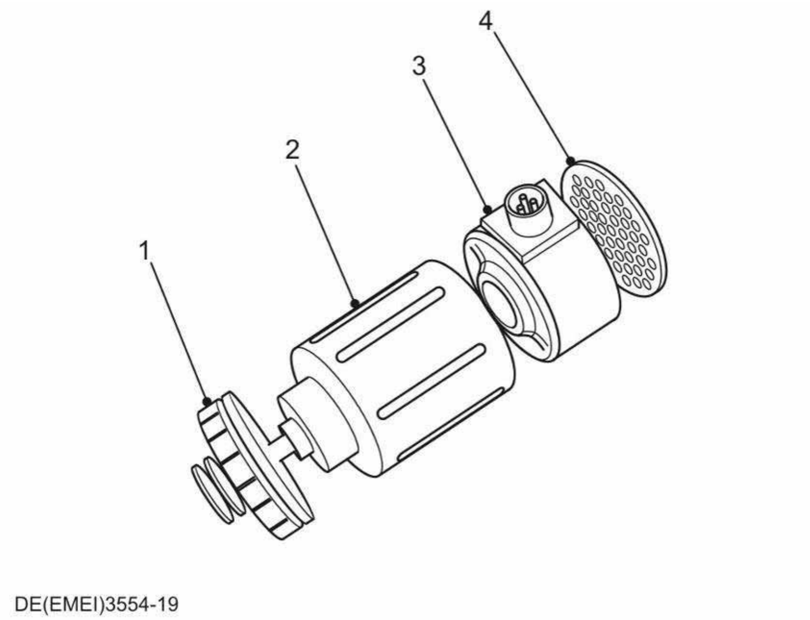


1. Shift lever	2. Return spring	3. Solenoid armature	4. Hold-in coil
5. Draw-in coil	6. Connecting terminal	7. Solenoid switch contact	8. Armature
9. Multi-start thread	10. Pinion	11. Drive/Free wheel mechanism	

Figure 64 Starter Motor

Charging System

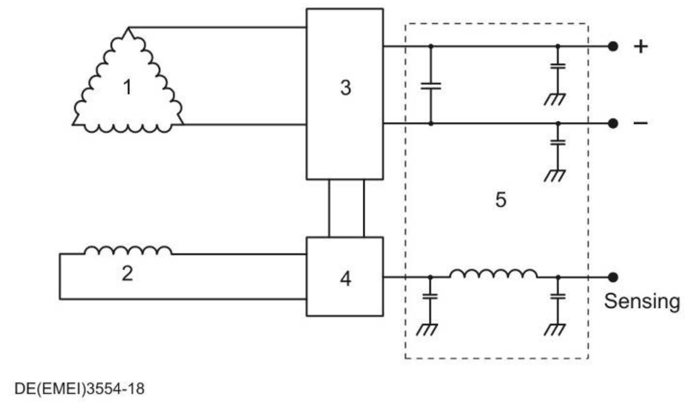
157. The truck is fitted with a Generator, Engine Accessory, 100 A, 28 V dc. The generator has integral rectification, regulation and radio interference suppression. It is mounted to the upper right-hand side of the engine above the air compressor by exterior body clamps, and is driven by a belt from the engine crankshaft pulley via the coolant pump pulley. The generator construction is shown in Figure 65. A voltmeter is connected to the supply, after the ignition switch. When the engine is running, the voltmeter displays the generator output voltage. The generator output is connected to the positive terminal of the battery and the truck electrical system.



1. Rotor and cooling fan 2. Stator assembly 3. Regulator/rectifier 4. Rear air grille

Figure 65 Generator

158. The generator three-phase ac output (Figure 66) is rectified by an integral three-phase bridge rectifier connected between the stator windings and the output terminals. A separate three-phase rectifier provides output to the regulator. The regulator sensing line is connected to circuit breaker A10 (Table 1), which is at the supply voltage when the engine is running. Voltage variations at the sensing point cause the integral transistorised regulator to change the generator output by varying the field current. Radio interference suppression is achieved by using feed-through capacitors in the output lines and a pi-filter in the sensing line. A detailed description of the generator is contained in EMEI Electrical P 412.



1. Main windings 2. Field windings 3. Rectifiers
4. Regulator 5. Radio interference suppression

Figure 66 Generator Wiring

Overload Protection Circuit Breakers

159. The electrical circuits are protected by re-settable circuit breakers. Any overload of an individual circuit causes the relevant circuit breaker to operate and open-circuit the supply to that circuit. The circuit breakers are in two blocks of twelve, labelled A and B, and are mounted in front of the driver at the top of the dashboard. The functions and ratings of the individual circuit breakers are listed in Tables 1 and 2.

Table 1 Circuit Breaker Bank A

Serial	Rating (A)	Load
1	8	Left high beam, high beam indicator
2	8	Right high beam
3	8	Left low beam
4	8	Right low beam
5	8	Brake lights
6	8	Horn
7	8	Windshield washer
8	8	Windshield wiper motor and switch, instrument lights
9	12	Ventilation blower motor
10	8	Instrument cluster and tachometer, indicator and warning lights, alternator sensing line
11	12	Turn indicators and dashboard indicators, reversing lights, neutral indicator, headlight flasher, dome light
12	8	Hazard lights switch

Table 2 Circuit Breaker Bank B

Serial	Rating (A)	Load
1	8	Left front marker, left clearance light, windshield washer switch light
2	8	Right front marker, neutral indicator light-dark relay, right clearance light
3	8	Left rear marker
4	8	Right rear marker
5	8	Speedometer, map light
6	8	Dashboard power socket
7	8	Trailer lightning socket (pin K)
8	8	Reduced headlight
9	8	Convoy cross light
10	8	Rear blackout markers
11	8	Left front blackout marker
12	8	Right front blackout marker

Lighting System

160. Main/Blackout Light Switch. The main/blackout switch, which is mounted on the instrument panel, controls the conventional exterior lighting, the blackout lighting and the convoy cross light. The switch (Figure 67) has two positions (1 and 2) for normal road lights and two positions (S1 and S3) for blackout and reduced lights. When the lights are not in use, the switch is left in the Tag position.

- **a. Position 1.** At position 1, power is fed from the main light switch to the front marker lights and the mirror-mounted clearance lights via circuit breaker B1 and B2; to the right rear marker light via circuit breaker B4; and to the left rear marker light via circuit breaker B3. The right rear marker light illuminates the ARN plate. Tray-mounted extremity marker lights are connected to the rear marker lights.

- **b. Position 2.** At position 2, the supply is maintained to circuit breaker B1, B2, B3 and B4 and is also applied via the high/low beam switch to circuit breakers Al and A2 for headlight high beam and A3 and A4 for headlight low beam.

c. **Position S1.** At position S1, power is fed to the following:

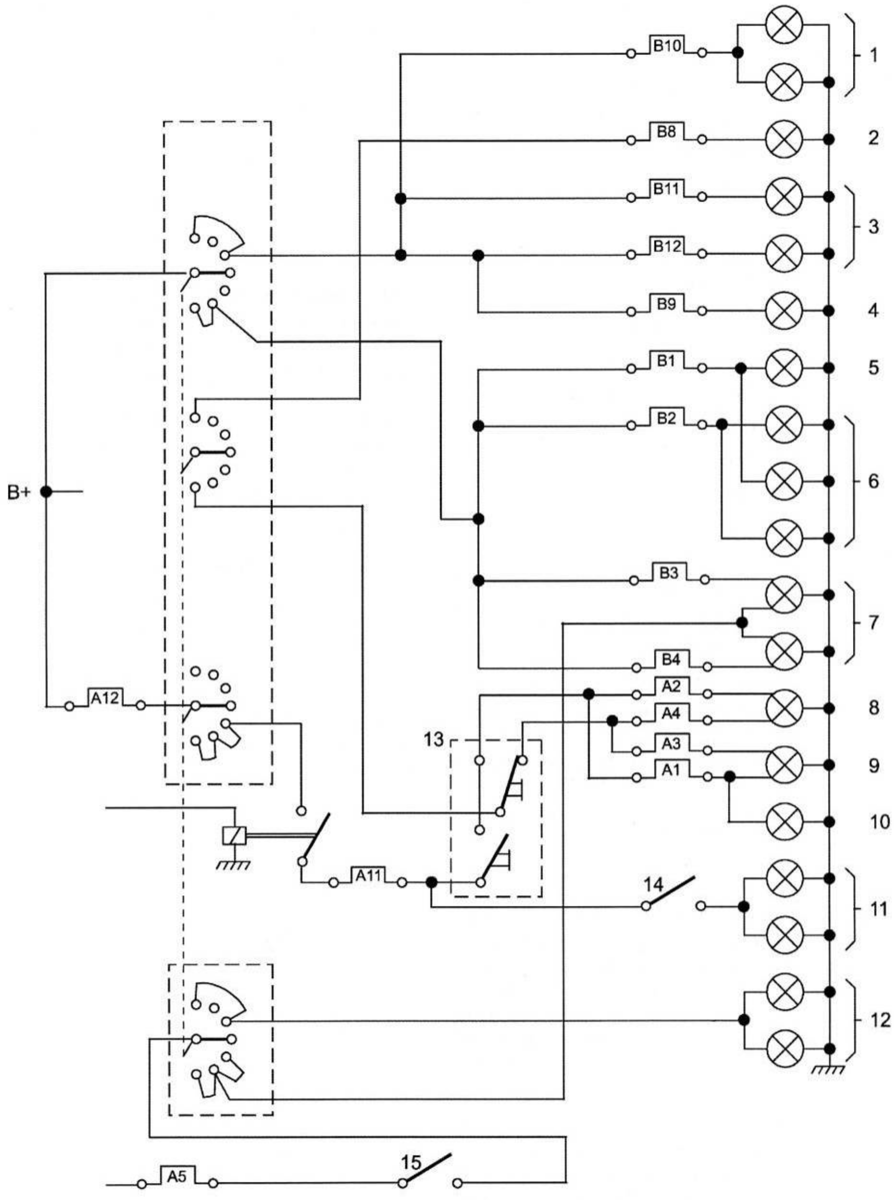
(1) the convoy cross light via circuit breaker B9;

(2) the front blackout marker lights via circuit breaker B11 and B12; and

(3) the rear blackout marker lights via circuit breaker B10.

d. **Position S2.** This position is not used.

e. **Position S3.** At position S3, power is fed to circuit breaker B9, B10, B11, B12 and to the reduced headlight via circuit breaker B8.



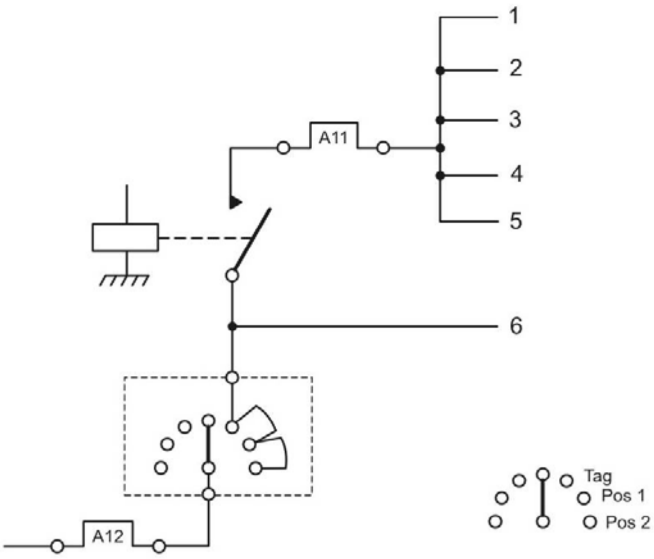
1. Rear blackout marker lights
2. Reduced headlight
3. Front blackout marker lights
4. Convoy cross light
5. Front marker lights
6. Clearance lights
7. Rear marker/brake lights
8. Right headlight
9. Left headlight
10. High-beam indicator
11. Reversing lights
12. Blackout brake lights
13. High/Low and flasher switches
14. Reversing switch
15. Brake switch

Figure 67 Truck Lights

161. Blackout Isolation Circuit. To ensure that only blackout lights are shown when under blackout conditions, a blackout isolation circuit (Figure 68) is fitted. All functions that require isolation are supplied from circuit breaker A11. This circuit breaker is only supplied with power when the isolation relay is energised and the main/blackout light switch is in positions Tag, 1 or 2. The relay is energised when the ignition is switched on. The functions supplied from circuit breaker A11 are as follows:

- **a.** a reversing light;
- **b.** a headlight flasher;
- **c.** a dome light;
- **d.** a turn indicator unit; and
- **e.** gate indicator lights.

162. The hazard light supply is connected to the positions Tag 1 or 2, and is also isolated under blackout condition.



1. Reversing lights 2. Headlight flasher 3. Turn indicator unit
4. Dome light 5. Gate indicator lights 6. Hazard lights

Figure 68 Blackout Isolation Relay

163. Headlight Flasher Switch. The headlight flasher switch is part of the combination switch mounted on the steering column. When the switch is operated (Figure 68), power is fed from circuit breaker A11 to the high-beam headlights. The headlight flasher does not operate under blackout conditions.

164. Brake Lights. Power is fed from circuit breaker A5 to the brake-light pick-up (Figure 68). The pick-up micro-switch is mechanically linked to the footbrake pedal. When the pedal is operated, power is fed to the main light switch. At positions Tag, 1 and 2 of the main light switch, power is fed to the normal brake lights. At positions S1 and S3, power is fed to the blackout brake lights.

165. Reversing Lights. Power is fed from circuit breaker A11 (Figure 68) to the forward/reverse pick-up mounted on the main transmission. When reverse gear is selected, the pick-up micro-switch closes and power is supplied to the reversing lights. The reversing lights do not operate under blackout conditions.

166. Turn Indicator Lights. Power is fed from circuit breaker A11 to the flasher unit (Figure 69) via the normally closed contact of the hazard lights switch. A pulsed output is fed to the right-turn or left-turn indicator selector in the combination switch and back to the flasher unit. The flasher unit routes the pulsed output to either the right or left truck and trailer indicator lights and instrument panel indicators. The indicators do not operate under blackout conditions.

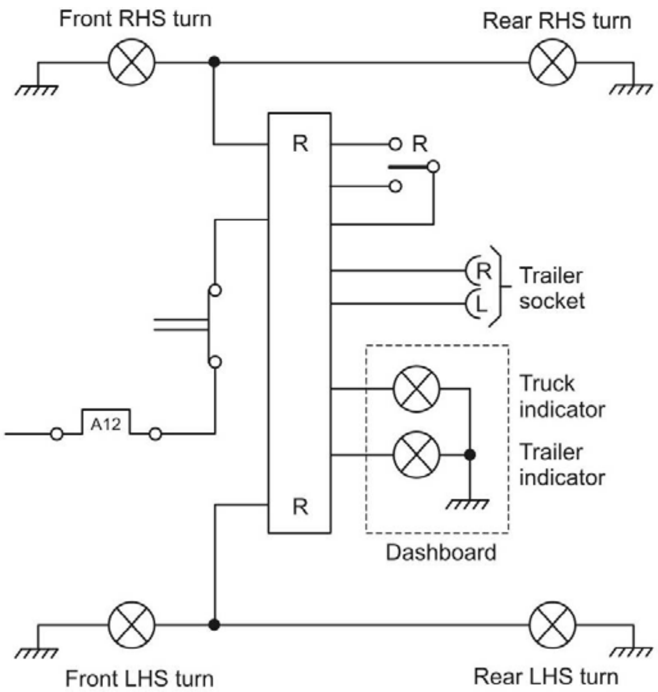


Figure 69 Turn Indicator Lights

167. Hazard Lights. When the hazard lights switch (Figure 70) is operated, contact ‘a’ opens and removes the normal supply to the flasher unit. A separate supply is fed, via contact ‘b’, to the flasher unit. The hazard lights do not operate under blackout conditions. The pulsed supply to the centre contact of the right-turn and left-turn indicator selector is fed, via contacts ‘c’, ‘d’ and ‘e’, to both right and left flasher inputs and causes both right-turn and left-turn indicators to operate. The centre contact pulsed supply is also returned to earth via the light in the hazard lights switch causing the light to flash.

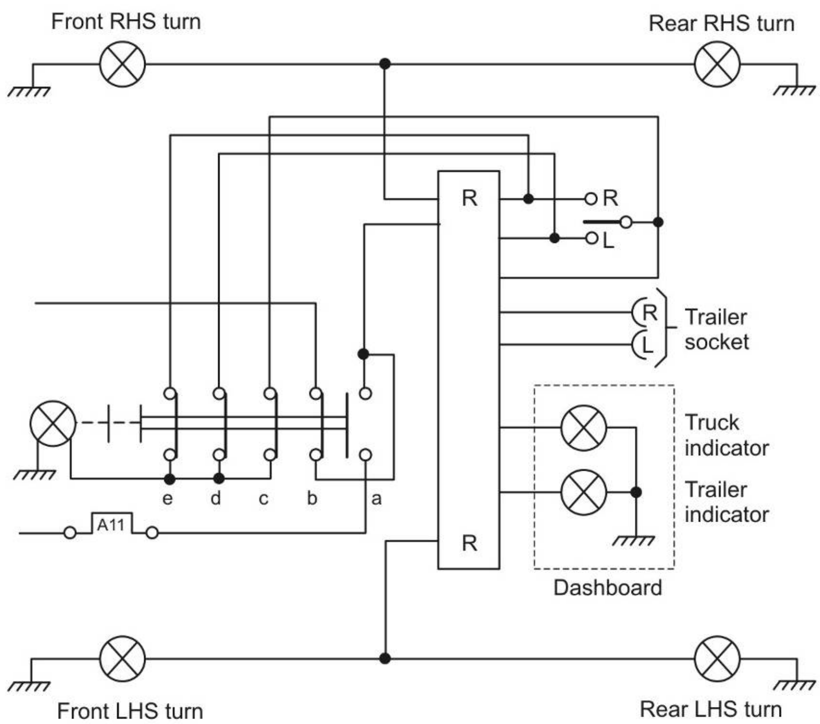


Figure 70 Hazard Warning Lights

168. Dome Light. The dome-light (Figure 71) is powered from circuit breaker A11. The light is controlled by the integral dome-light switch or the micro-switch on the driver's door; it does not illuminate under blackout conditions.

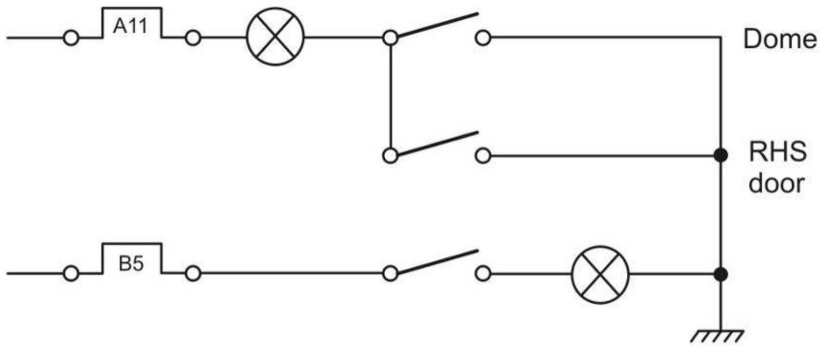


Figure 71 Dome and Map Lights

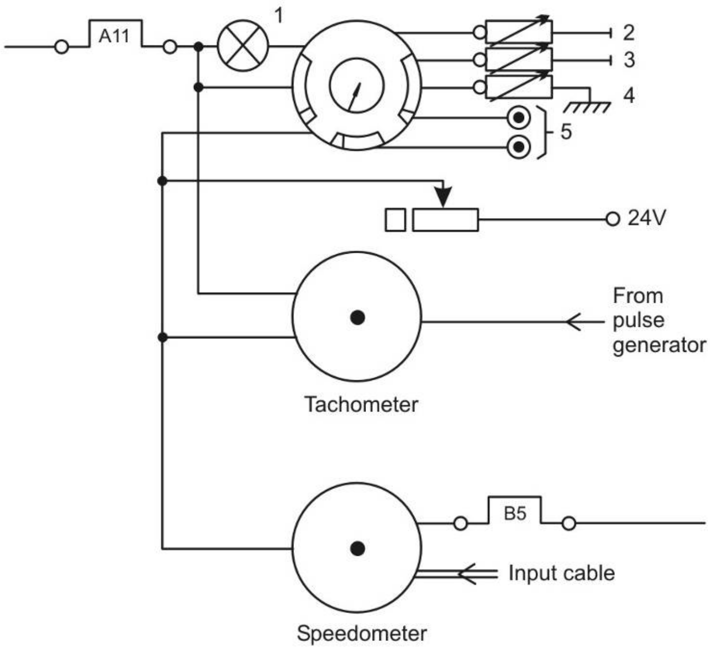
169. Map Light. The map light (Figure 71) is powered from circuit breaker B5 and controlled by the map light switch, which operates automatically when the map light cover is opened.

Instruments

170. The instrument lights (Figure 72) are supplied with power via circuit breaker A11 after the ignition is turned on. The light's brightness is varied using the dashboard-mounted potentiometer. The instruments consist of the following:

- **a.** an instrument cluster,
- **b.** a tachometer, and
- **c.** a speedometer.

171. Instrument Cluster. The inputs from the coolant temperature, engine oil pressure and fuel level sensors are displayed on the instrument cluster (Figure 72). Air lines from the two air tanks are fed to the cluster to the double pressure gauge. Connected to these lines are pressure switches that close and illuminate the air pressure supply warning light if the air pressure in either tank drops below 1.2 MPa.



1. Low-air warning light
2. Coolant temperature sensor
3. Oil pressure sensor
4. Fuel level sensor
5. Air lines

Figure 72 Instruments

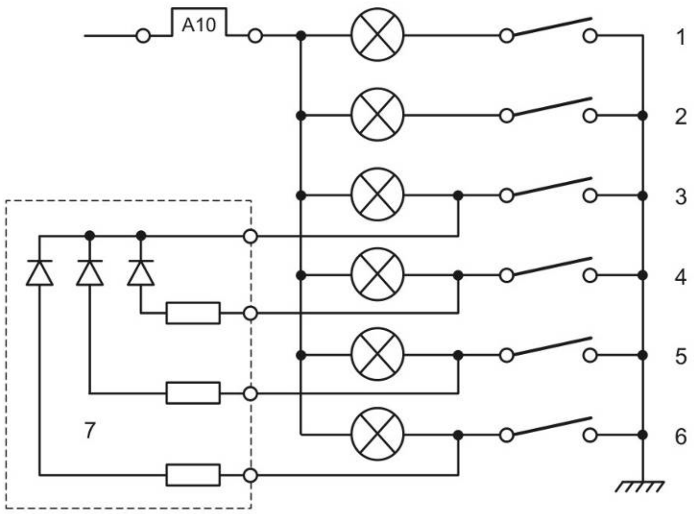
172. Tachometer. The pulse generator, which is driven by the engine camshaft, provides the drive input to the tachometer.

173. Speedometer. The input to the speedometer is by cable drive from the main transmission.

Indicator and Warning Lights

174. The indicator and warning lights (Figure 73), which are mounted on the top right-hand side of the instrument panel, are fitted with a flip-down panel to shield the lights under blackout conditions. The air-pressure, high-beam, turn-indicator and hazard-lights indicators have been described in previous Para s. The remaining indicator and warning lights are as follows:

- **a.** brake differential pressure warning light;
- **b.** parking brake warning light;
- **c.** four-wheel drive and differential lock indicator light;
- **d.** brake wear warning lights; and
- **e.** gate indicator lights.



1. Four-wheel drive
2. Differential lock
3. Parking brake
4. Differential pressure
5. Front brake-wear
6. Rear brake-wear
7. Diode group

Figure 73 Indicator Lights and Check Circuit

175. Brake Differential-Pressure Warning Light. The differential pressure warning light illuminates when there is a difference in pressure between the two hydraulic brake circuits.

176. Parking Brake Warning Light. The parking brake warning light illuminates if the air pressure in the parking brake system is below 600 kPa or if the parking brake is applied.

177. Four-wheel Drive and Differential-Lock Indicator Lights. If four-wheel drive or differential lock is selected by the driver, pressure-operated switches close and the corresponding indicator light illuminates.

178. Brake Wear Warning Light. Sensors fitted in the front-left and rear-left brake pads detect brake wear level and illuminate the corresponding indicator.

179. Warning Lights Check Circuit. When the parking brake is applied, the earth from the parking brake switch (Figure 73) is fed through the diode group to illuminate the differential pressure, front brake wear and rear brake wear warning lights. This acts as a check circuit for the three indicators.

180. Gate Indicator Lights. The four gate indicator lights (Figure 74) show the position of the gear shift lever within the gate by illuminating the light for the gate in use. When the main light switch is at positions 1 or 2, power is fed to a relay via circuit breaker B2. The relay is energised, a resistor is connected in series with the indicator lights and the lights are dimmed for night time use. The lights are supplied from circuit breaker A11 and do not operate under blackout conditions.

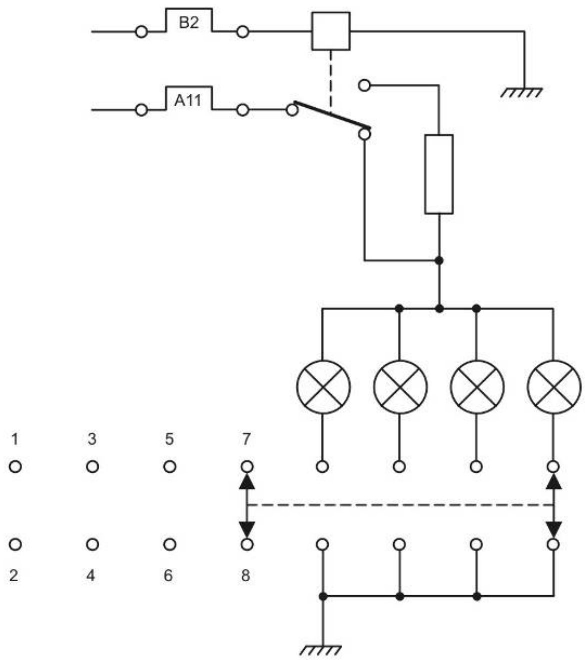


Figure 74 Gate Indicator

Trailer Wiring System

181. A 13-pin NATO plug is connected in parallel with the truck lighting. The outputs are listed in Table 3.

Table 3 NATO Plug

Pin	Load	Pin	Load
A	Right-rear blackout marker	H	Convoy cross light
B	Turn indicator, left	I	Turn indicator, right
C	Left-rear blackout marker	J	24 V
D	Truck earth	K	Truck earth
E	Rear marker lights	L	Not connected
F	Blackout brake-lights	M	Brake lights
G	Not connected		

Auxiliary Electrical Equipment

182. The auxiliary electrical equipment consists of the following:

- **a.** a 24 V supply socket;
- **b.** windscreen wipers;
- **c.** a windscreen washer;
- **d.** a horn; and
- **e.** a ventilation blower.

183. 24 V Supplies. Power is available at a dashboard-mounted socket and at the trailer lighting connector on pin K.

184. Windscreen Wipers. The self-parking wipers (Figure 75) may be operated at two speeds. When the ignition is switched on, power is applied to circuit breaker A8. In position 1 (slow), power is fed to the wiper motor and the wipers drive at normal speed. In position II (fast), the field intensity of the wiper motor is increased and the wipers drive at fast speed. When the wipers are switched off, the motor continues to drive until the supply to the motor is removed by the internal park switch.

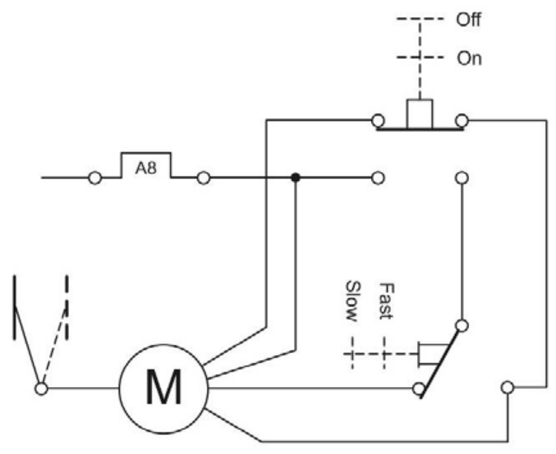


Figure 75 Windscreen Wipers

185. Windscreen Washer. When the ignition is switched on, power is supplied to circuit breaker A7. When the washer (Figure 76) is switched on, power is applied to drive the washer pump motor. At positions 1 and 2 of the main light switch, power is supplied via circuit breaker B1 to illuminate the washer switch light.

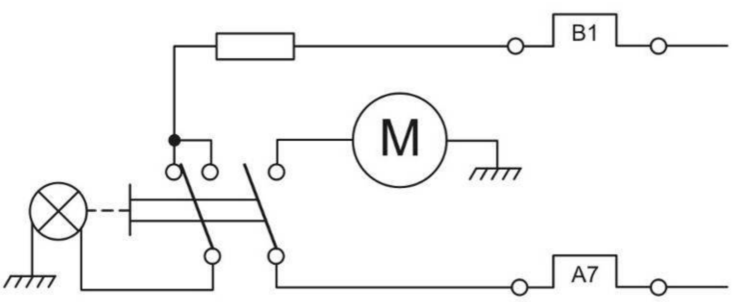


Figure 76 Windscreen Washers

186. Horn. When the ignition is switched on, power is supplied via circuit breaker A6 to the horn circuit (Figure 77).

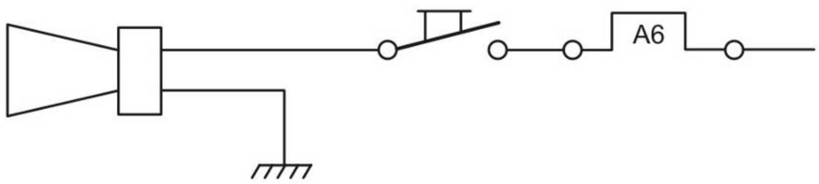


Figure 77 Horn

187. Ventilation Blower. When the ignition is switched on, power is supplied via circuit breaker A9 to the blower motor (Figure 78). The blower control on the dashboard has an off position and three drive positions to enable the required air flow to be selected.

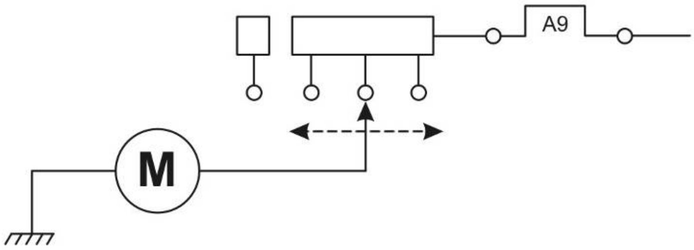
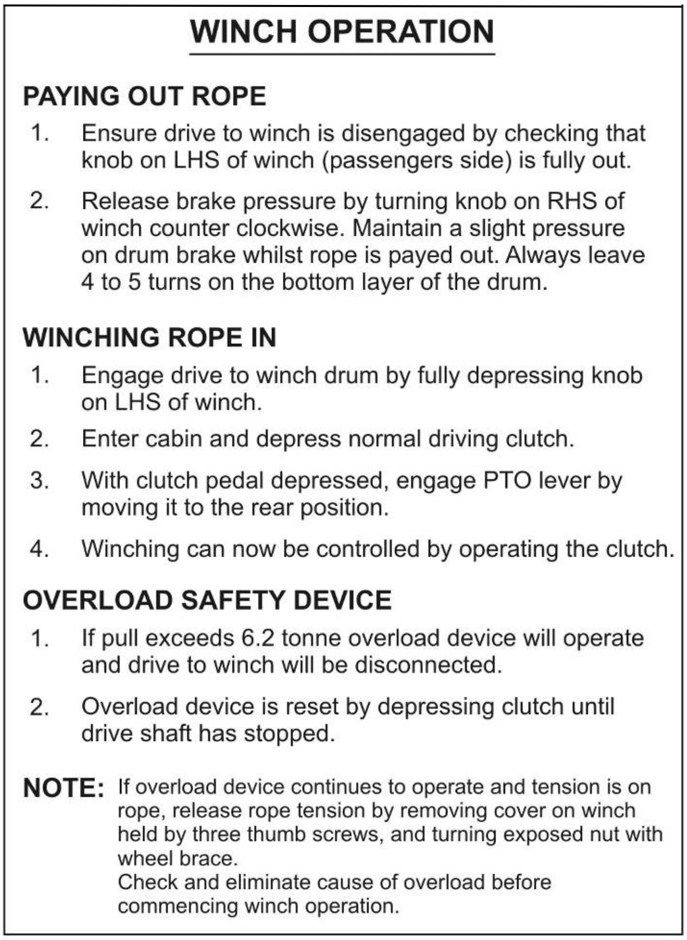


Figure 78 Ventilation Blower

WINCH VARIANT

188. A 6.2 tonne capacity winch is mounted on the front of the truck. The PTO transmission drives the winch. The winch contains a worm drive and a manually-actuated dog clutch. A flexible wire rope is wound on to the winch drum. The winch may be used with the vehicle stationary; it may also be used with one of the main transmission drive gears engaged in a low range gear to facilitate self recovery. A fairlead device in the winch ensures that the cable is wound evenly onto the drum when winching the cable in. The fairlead is driven by a triplex chain drive from the main-shaft of the drum. The triplex chain is in the right-hand side of the winch. A spring-loaded press roller is fitted above the fairlead to assist in winching the rope onto the drum evenly. An overload safety device fitted to the winch automatically disengages the drive to the winch if the load on the rope exceeds 6.2 tonnes. A manually controlled friction brake on the winch prevents the rope unspooling when there is no load on the winch. The maximum angle of pull when using the winch is 15º to the left or right. When the overload device functions, it may be necessary to release the tension on the rope. Removal of an access plate on the front of the winch allows the tension to be wound off using a wheel brace. A winch operating instruction plate is located in the cab (Figure 79).


WINCH OPERATION

PAYING OUT ROPE

1. Ensure drive to winch is disengaged by checking that knob on LHS of winch (passengers side) is fully out.
2. Release brake pressure by turning knob on RHS of winch counter clockwise. Maintain a slight pressure on drum brake whilst rope is payed out. Always leave 4 to 5 turns on the bottom layer of the drum.

WINCHING ROPE IN

1. Engage drive to winch drum by fully depressing knob on LHS of winch.
2. Enter cabin and depress normal driving clutch.
3. With clutch pedal depressed, engage PTO lever by moving it to the rear position.
4. Winching can now be controlled by operating the clutch.

OVERLOAD SAFETY DEVICE

1. If pull exceeds 6.2 tonne overload device will operate and drive to winch will be disconnected.
2. Overload device is reset by depressing clutch until drive shaft has stopped.

NOTE: If overload device continues to operate and tension is on rope, release rope tension by removing cover on winch held by three thumb screws, and turning exposed nut with wheel brace.
Check and eliminate cause of overload before commencing winch operation.

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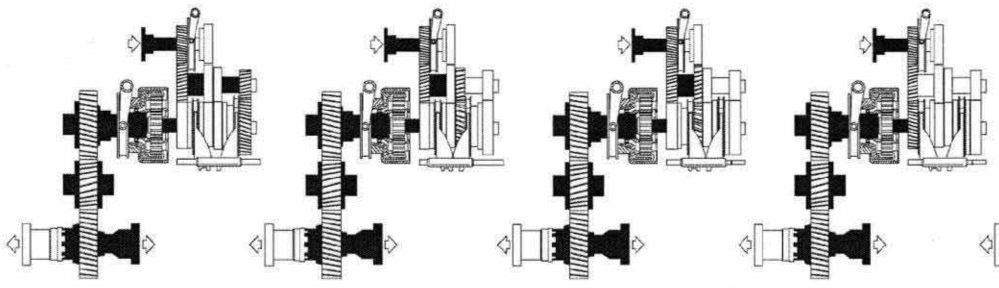
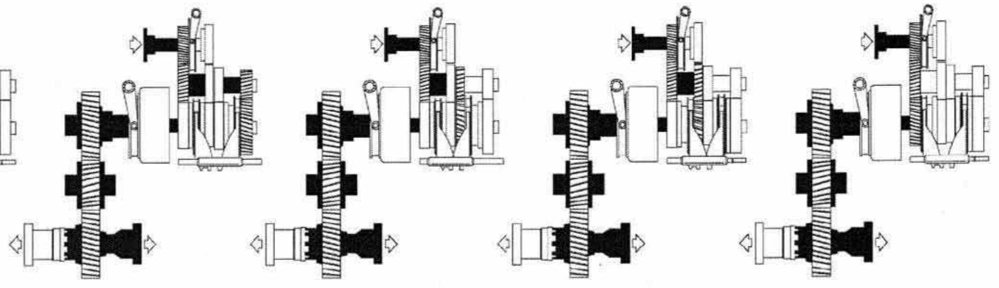
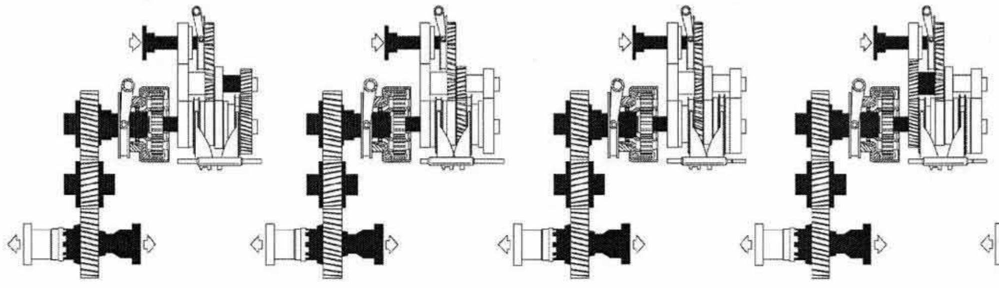
Figure 79 Winch Operation Instruction Plate



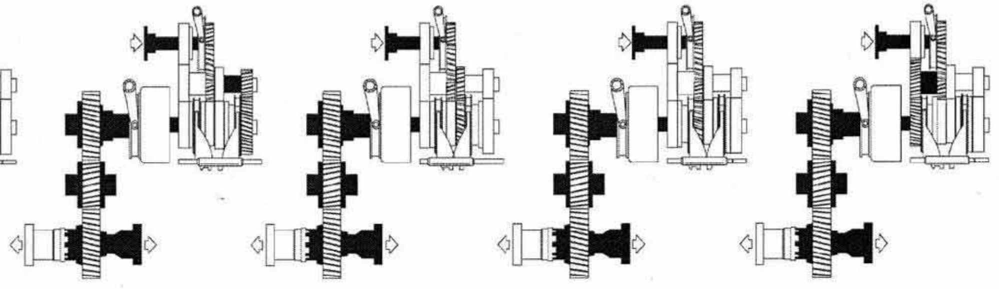
a. Forward, 1st to 4th gears, planetary gearing on



b. Forward, 5th to 8th gears, planetary gearing off



c. Reverse, 1st to 4th gears, planetary gearing on



d. Reverse, 5th to 8th gears, planetary gearing off

Figure 80 Main Transmission Power Flow Diagram

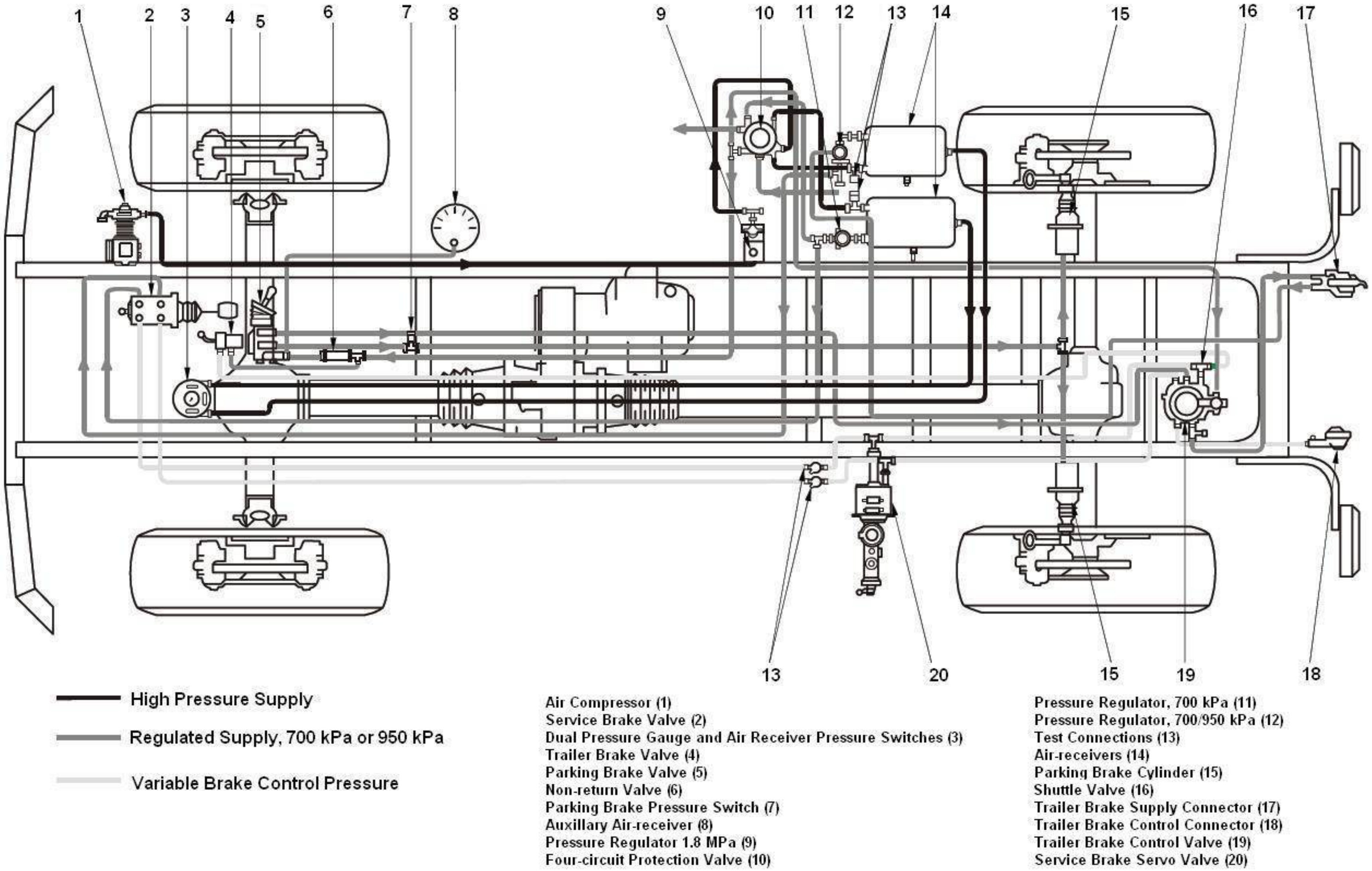


Figure 81 Brake Pneumatic Circuit Interconnections

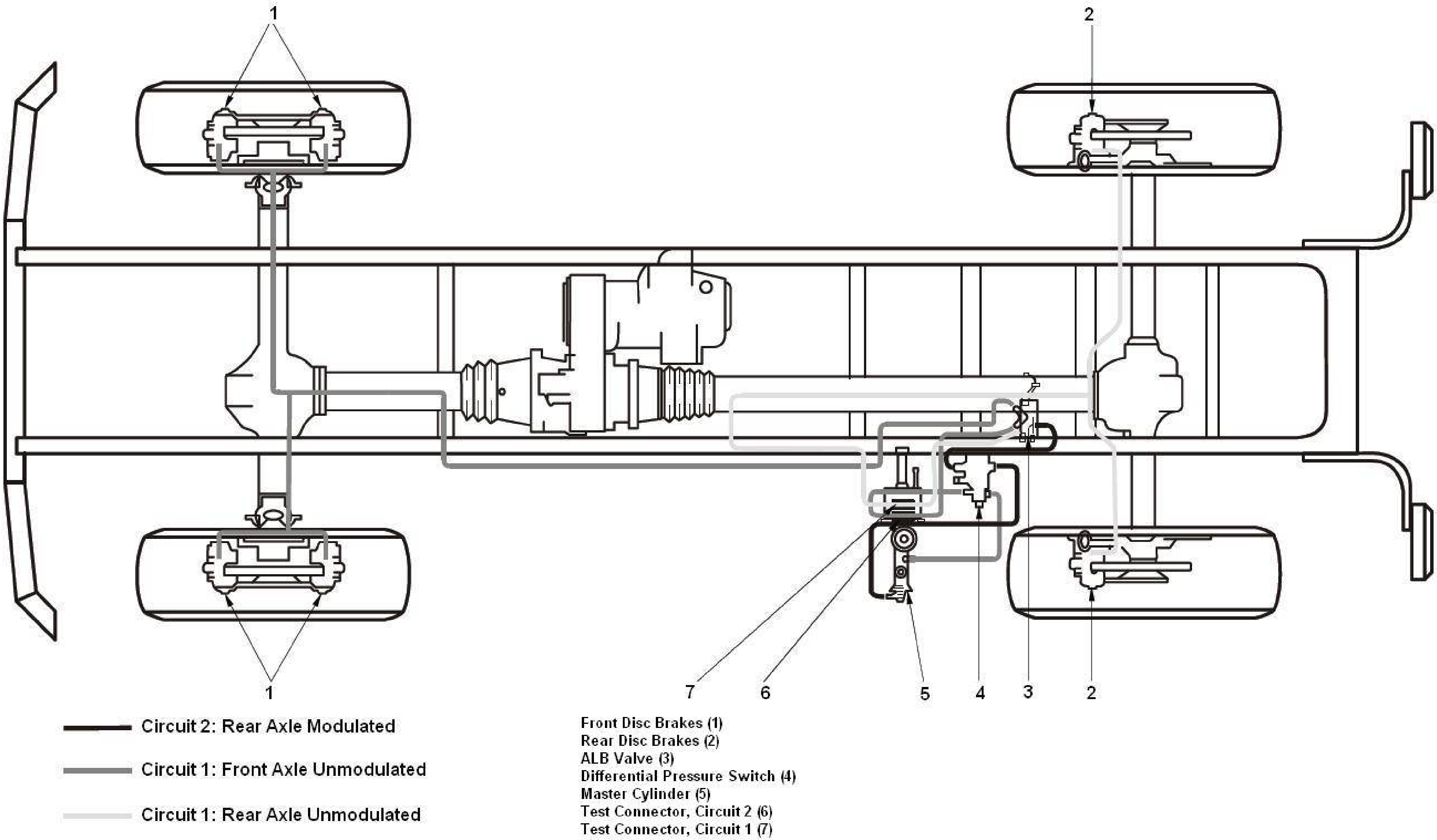


Figure 82 Brake Hydraulic Circuit Interconnection

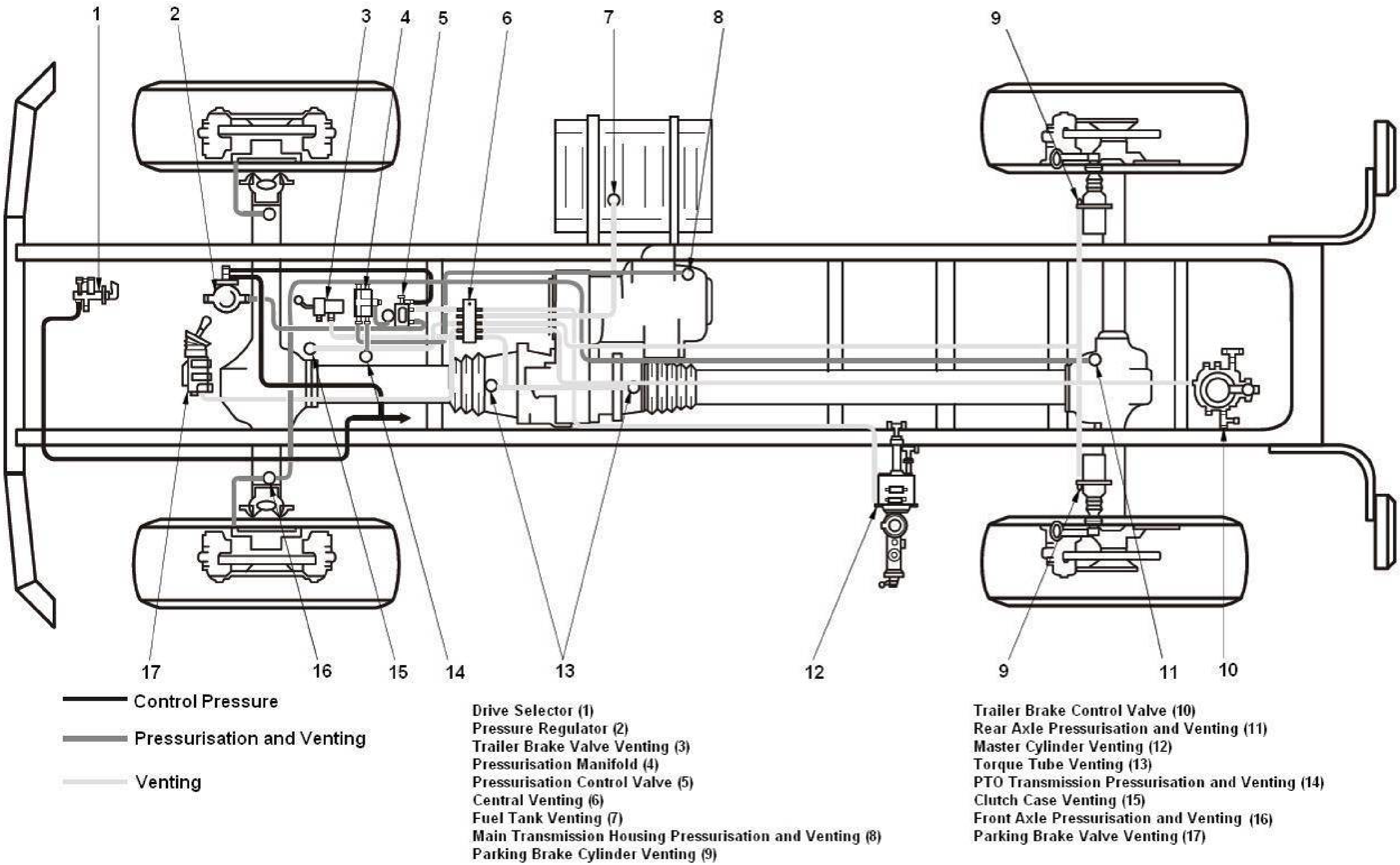


Figure 83 Pressurisation and Venting Circuit Interconnections

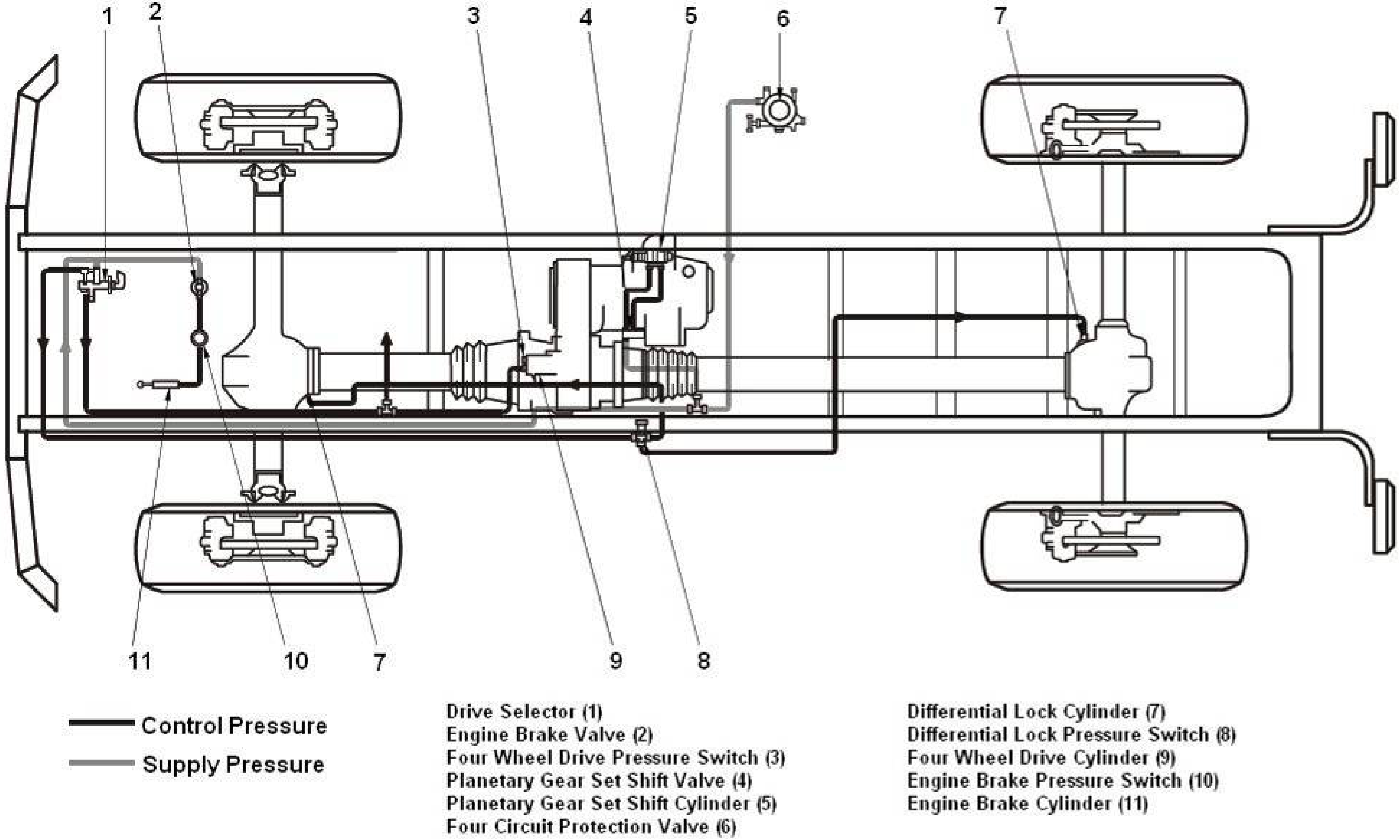


Figure 84 Auxiliary Pneumatic Devices Interconnections

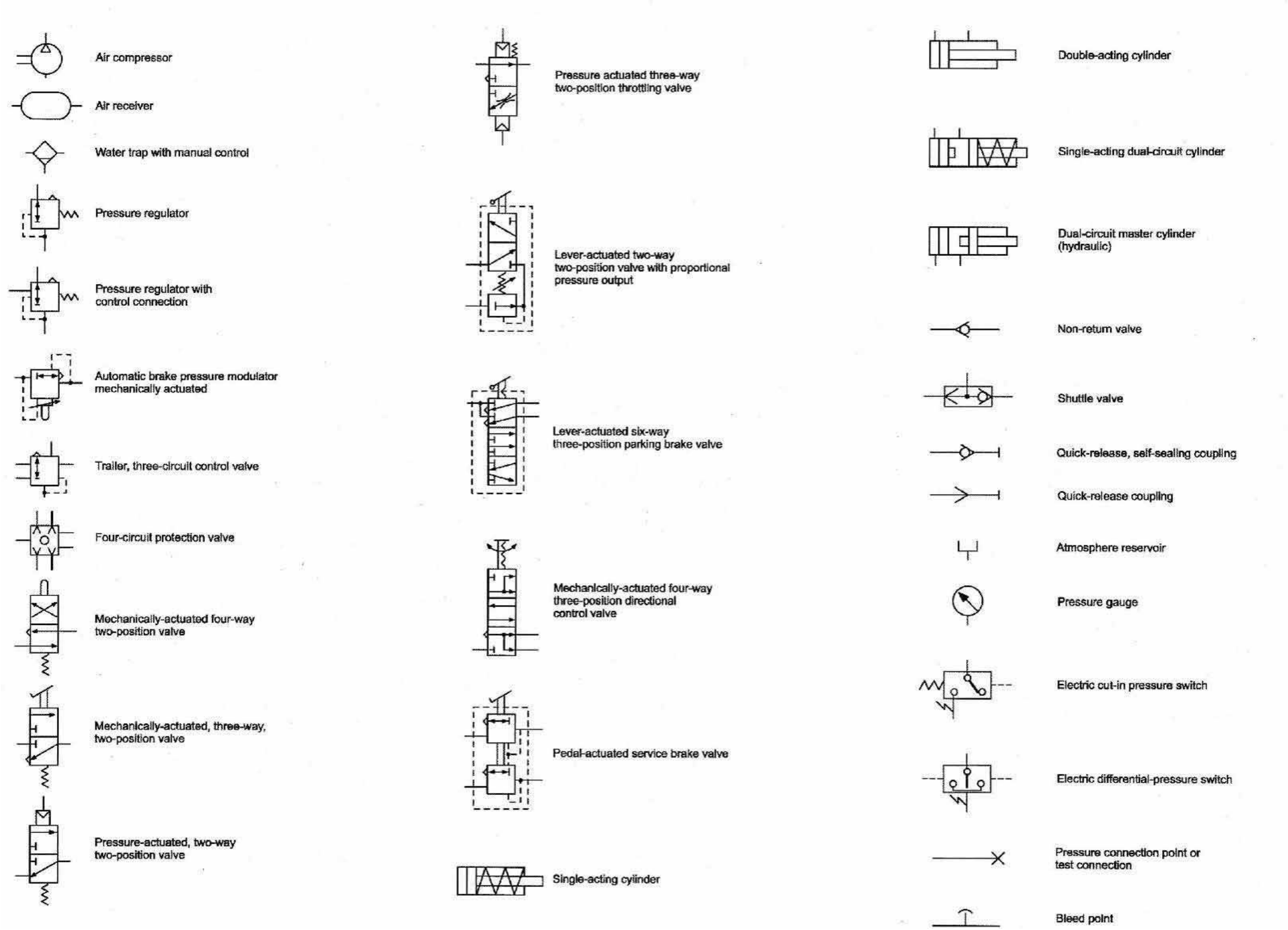
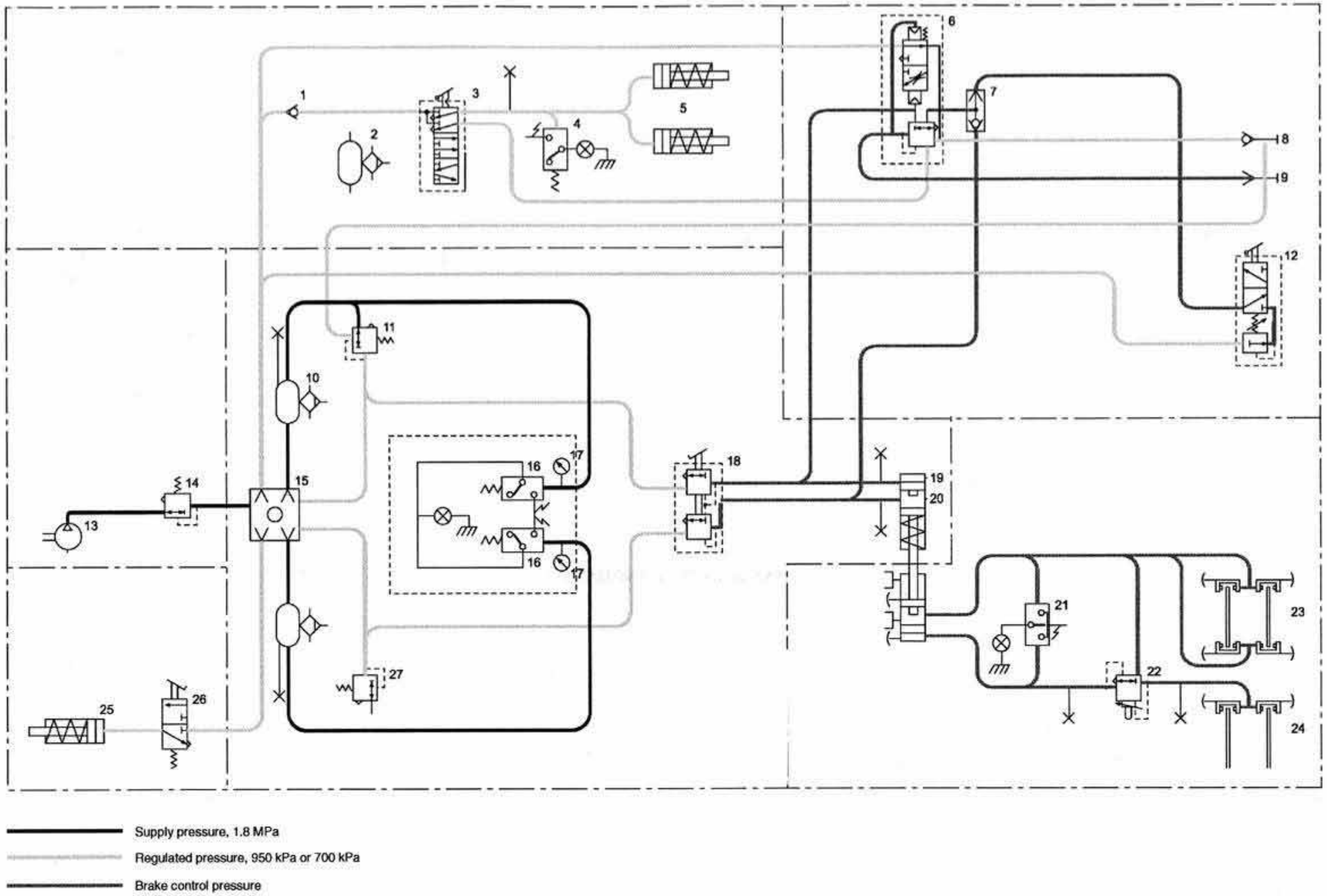


Figure 85 Symbol Annotation to Figure 86



Item	Description	Item	Description	Item	Description	Item	Description	Item	Description
1	Non return valve	6	Trailer brake control valve	12	Trailer brake valve	18	Service brake valve	24	Rear disc brakes
2	Auxiliary compressed air receiver, with drain	7	Shuttle valve	13	Air-compressor	19	Dual-circuit servo valve	25	Engine brake, actuating cylinder
		8	Trailer brake supply coupling, self-sealing	14	Pressure regulator, 1.8 MPa	20	Dual-circuit master cylinder	26	Engine brake valve
3	Parking brake valve	9	Trailer brake control coupling	15	Four-circuit protection valve	21	Differential pressure switch	27	Pressure limiter, 700 kPa
4	Parking brake pressure switch	10	Compressed air receiver, with drain	16	Air-receiver pressure switch	22	ALB valve		
5	Parking brake actuating cylinders	11	Dual pressure limiter, 700/950 kPa	17	Dual pressure gauge	23	Front disc brakes		

Figure 86 Braking System – Functional Diagram

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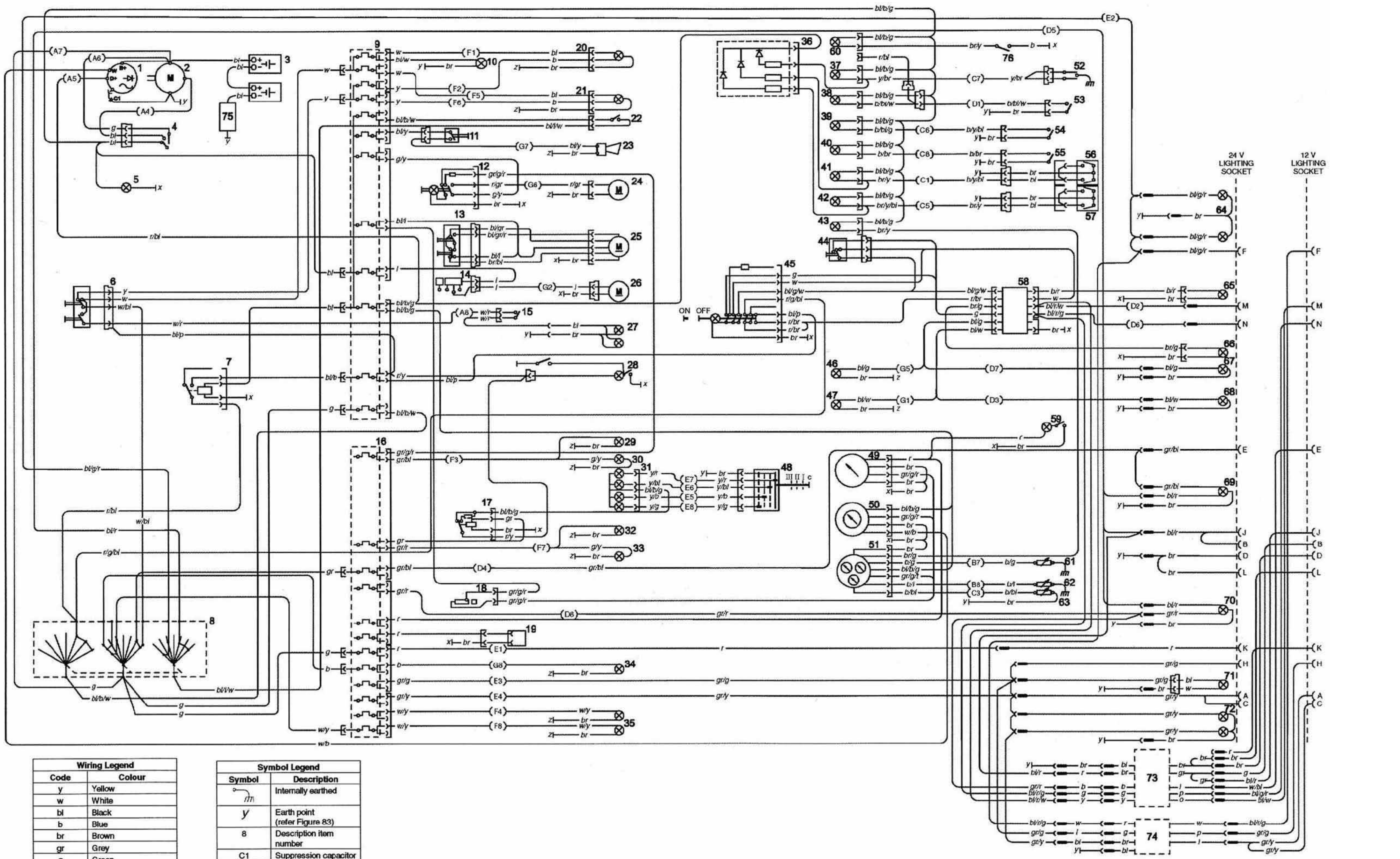
Item	Description
1	Alternator
2	Starter motor
3	Batteries
4	Ignition switch
5	Alternator warning light
6	High/low beam switch and flasher
7	Blackout isolating relay
8	Main/masked light switch
9	Cut-outs, block A
10	High beam indicator
11	Horn switch
12	Windscreen washer switch
13	Windscreen wiper switches
14	Ventilation blower control
15	Reversing lights switch
16	Cut-outs, block B
17	Gate indicator lights, light/dark relay
18	Instrument lights/control
19	Dashboard power socket
20	Left headlight
21	Right headlight
22	Brake light switch
23	Horn
24	Windscreen washer motor
25	Windscreen wiper motor
26	Ventilation blower motor
27	Reversing lights
28	Dome light
29	Left clearance light
30	Left front marker light
31	Gate indicator lights
32	Right clearance light
33	Right front marker light
34	Reduced headlight
35	Masked front marker lights
36	Indicator lights check diodes
37	Differential pressure warning light
38	Parking brake indicator light
39	Four-wheel drive indicator light
40	Differential lock indicator light
41	Rear brake wear warning light
42	Front brake wear warning light
43	Air pressure warning light
44	Turn indicators switch
45	Hazard lights switch
46	Front right turn light
47	Front left turn light
48	Gate indicator switch
49	Speedometer
50	Tachometer
51	Instrument cluster
52	Master cylinder pressure switch
53	Parking brake switch
54	Four-wheel drive switch
55	Differential lock switch
56	Rear brake wear contact
57	Front brake wear contact
58	Turn indicator flasher unit
59	Map reading light
60	Air cleaner condition warning light
61	Oil pressure sensor
62	Coolant temperature sensor
63	Fuel level sensor
64	Masked brake lights
65	Dashboard trailer turn indicator
66	Dashboard truck turn indicator
67	Rear right turn light
68	Rear left turn light
69	Left rear marker/brake light
70	Right rear marker/brake light
71	Convoy cross light
72	Masked rear marker lights
73	12 V trailer lighting transformer
74	12 V trailer lighting transducer
75	Battery isolator
76	Air cleaner condition sender unit



Wiring Legend

Code	Colour
y	Yellow
w	White
bl	Black
b	Blue
br	Brown
gr	Grey
g	Green
l	Lilac
p	Pink
r	Red
o	Orange

Symbol Legend

Symbol	Description
	Internally earthed
y	Earth point (refer Figure 83)
8	Description item number
C1	Suppression capacitor
W	Square wave tacho
B+	Positive connection
(A7)	Connector code

Figure 87 Truck Wiring Diagram

END

Distribution List: **VEH G 31.0 – Code 1** (Maint Level)
(Sponsor: CGSVSPO, Mdm/Hvy B Vehicles)
(Authority: ECO CGSVSPO 04/11)