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28-Feb-17 Our Reference: FOI2017/00418

[redacted]

Thank you for your e-mail dated 10th January 2017 requesting the following information:

> *We have purchased the above detailed Alvis Shielder armoured vehicle which was recently released via your disposal agents Witham Specialist Vehicles.*
>
> *The vehicle has mechanical and electrical issues which need resolving and I therefore request if you could help with any information you have in this respect. I believe that the information we need will be held in the relevant AESP under the '302 – Technical Description' section. If this is correct then could you please supply a copy of this document if possible.*
>
> *Any information would gratefully receive and would be for personal use as described. Electronic copies of any available information would be preferable but paper copies would be acceptable.*

I am treating your correspondence as a request for information under the Freedom of Information Act 2000 (FOIA).

A search for the information has now been completed within the Ministry of Defence, and I can confirm that all the information in scope of your request is held.

The information you have requested can be found attached below, but some of the information falls entirely within the scope of the absolute exemption provided for at section 40 (Personal Data) and qualified exemption provided for at section 26 (Defence), of the FOIA and has been redacted and withheld.

Section 40(2) has been applied to some of the information in order to protect personal information as governed by the Data Protection Act 1998. Section 40 is an absolute exemption and there is therefore no requirement to consider the public interest in making a decision to withhold the information.

Section 26, is a qualified exemption and is subject to public interest testing which means that the information requested can only be withheld if the public interest in doing so outweighs the public interest in disclosure.

Section 26(1)b has been applied to some of the information because it contains details which are operationally sensitive and would prejudice the capability and effectiveness of our armed forces by providing information that could assist a potential enemy. The balance of public interest was found to be in favour of withholding the information given that, over all, the public interest is best served in not releasing these details. This would prejudice the security of UK personnel serving abroad and would provide tactical advantage to our enemies. It is for these reasons I have set the level of prejudice against release of the exempted information at the higher level of "would" rather than "would be likely to".

If you are not satisfied with this response or you wish to complain about any aspect of the handling of your request, then you should contact me in the first instance. If informal resolution is not possible and you are still dissatisfied then you may apply for an Independent Internal Review by contacting the Information Rights Compliance Team, Ground Floor, MOD Main Building, Whitehall, SW1A 2HB (e-mail cio-foi-ir@mod.uk). Please note that any request for an internal review must be made within 40 working days of the date on which the attempt to reach informal resolution has come to an end.

If you remain dissatisfied following an Internal Review, you may take your complaint to the Information Commissioner under the provisions of section 50 of the Freedom of Information Act. Please note that the Information Commissioner will not investigate your case until the MOD Internal Review process has been completed. Further details of the role and powers of the Information Commissioner can be found on the Commissioner's website, http://www.ico.org.uk.

Yours Sincerely

[redacted]

[redacted]
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CONDITIONS OF RELEASE

1 ~~This information is released by the UK Government for Defence purposes only.~~

2 ~~This information must be accorded the same degree of security protection as that accorded thereto by the UK Government.~~

3 ~~This information may be disclosed only within the Defence Department of the recipient Government, except as otherwise authorized by the Ministry of Defence (Army).~~

4 ~~This information may be subject to privately owned rights.~~

CARRIER, FULL TRACKED, VEHICLE LAUNCHED SCATTERABLE MINE SYSTEM (VLSMS), 'SHIELDER'

TECHNICAL DESCRIPTION

REPRINTED INCORPORATING AMDTS 1-6

BY COMMAND OF THE DEFENCE COUNCIL

Ministry of Defence
Issued by
ARMY TECHNICAL SUPPORT AGENCY
DIRECTORATE OF TECHNICAL SERVICES

AMENDMENT RECORD

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1 Engine
2 Fuel system
3 Cooling system
4 Transmission, final drives, steering and brakes
5 Driver controls, including main and parking brakes
6 Suspension and tracks
7 Hull and fittings
8 Electrical
9 Environmental control systems

PREFACE

Sponsor: DDOR (Engr and NBC)
File ref: D/DOR/34/10/1
Publication Agency: ATSA, TS 3.2a
Project No: 95/32d/0i/(126)
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INTRODUCTION

1 Service users should forward any comments on this publication through the channel prescribed in AESP 0100-P-011-013. An AESP Form 10 is provided at the end of this publication; it should be photocopied and used for forwarding comments on this AESP.

2 AESPs are issued under Defence Council authority and where AESPs specify action to be taken, the AESP will in itself be sufficient authority for such action and also for the demanding of the necessary stores, subject to the provisions of Para 3 below.

3 The subject matter of this publication may be affected by Defence Council Instructions (DCIs), Standard Operating Procedures (SOPs) or by local regulations (LRs). When any such Instruction, Order or Regulation contradicts any portion of this publication they are to be taken as the overriding authority.

RELATED AND ASSOCIATED PUBLICATIONS

Related publications

4 The octad for the subject equipment consists of the publications shown below. All references are prefixed with the first eight digits of this publication. The availability of the publications can be checked by reference to the relevant Group Index (see AESP 0100-A-001-013).

Category/Sub-category			Information Level			
			1 User/ Operator	2 Unit Maintenance	3 Field Maintenance	4 Base Maintenance
	0	Purpose and Planning Information	101	101	101	101
1	1	Equipment Support Policy Directives	111	111	111	111
2	0	Operating Information	201	*	*	*
	1	Aide Memoire	211	*	*	*
	2	Training Aids	221	221	221	221
3		Technical Description	201	302	302	302
4	1	Installation Instructions	*	*	*	*
	2	Preparation for Special Environments	*	*	*	*
5	1	Failure Diagnosis	201	512	512	512
	2	Maintenance Instructions	201	522	523	524
	3	Inspection Standards	*	532	533	533
	4	Calibration Standards	*	*	*	*
6		Maintenance Schedules (Army)	601	*	*	*
7	1	Illustrated Parts Catalogues	711	711	711	711
	2	Commercial Parts Lists	*	*	*	*
	3	Complete Equipment Schedule, Production	*	*	*	*
	4	Complete Equipment Schedule, Service Edition (Simple Equipment)	741	741	741	741
	5	Complete Equipment Schedule, Service Edition (Complex Equipment)	*	*	*	*
8	1	Modification Instructions	+	*	*	*
	2	General Instructions, Special Technical Instructions and Servicing Instructions	+	*	*	*
	3	Service Engineered Modification Instructions	*	*	*	*

* Category/Sub-category not published

+ Category/Sub-category produced when required

Associated publications

5 The following publications are associated with this publication.

Reference	Title
AESP 2540-C-100-302	Vehicle Body Heaters.
EMER T&M A028 Chap 650	Inspection and Testing of Lifting Equipment.
A.C. 61393	User Handbook, Radio Station UK/VRC 353.
A.C. 61172	User Handbook, Clansman Radio Control Harness.
AESP 5820-H-210 Series	Command, Control and Communications Installations (C^3I) in 'Shielder'.
A.C. 71276	Standing Orders for the Safety of Crews of AFV's.
AESP 2350-T-125-601	Maintenance Schedule.
AESP 1005-N-510-201	General Purpose Machine Gun 7.62 mm L7A2 and Derivatives.
AESP 1095-G-100-Series	Mine Launcher Equipment.

ABBREVIATIONS

6 The following abbreviations are used in this publication:

FWD.....Forward
REV.....Reverse
LH .....Left Hand
RH .....Right Hand

CAUTION

SOLVENT VAPOURS. When carrying out functional tests the NBC system must not be operated in a vicinity in which painting is taking place, or where vapours from solvents such as Benzine, or CTC, etc are present. Such vapour can seriously shorten the life of the filters.

CHAPTER 1

ENGINE

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27	Timing gear case and gears	
	Induction system	
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31	Pre-cleaner	
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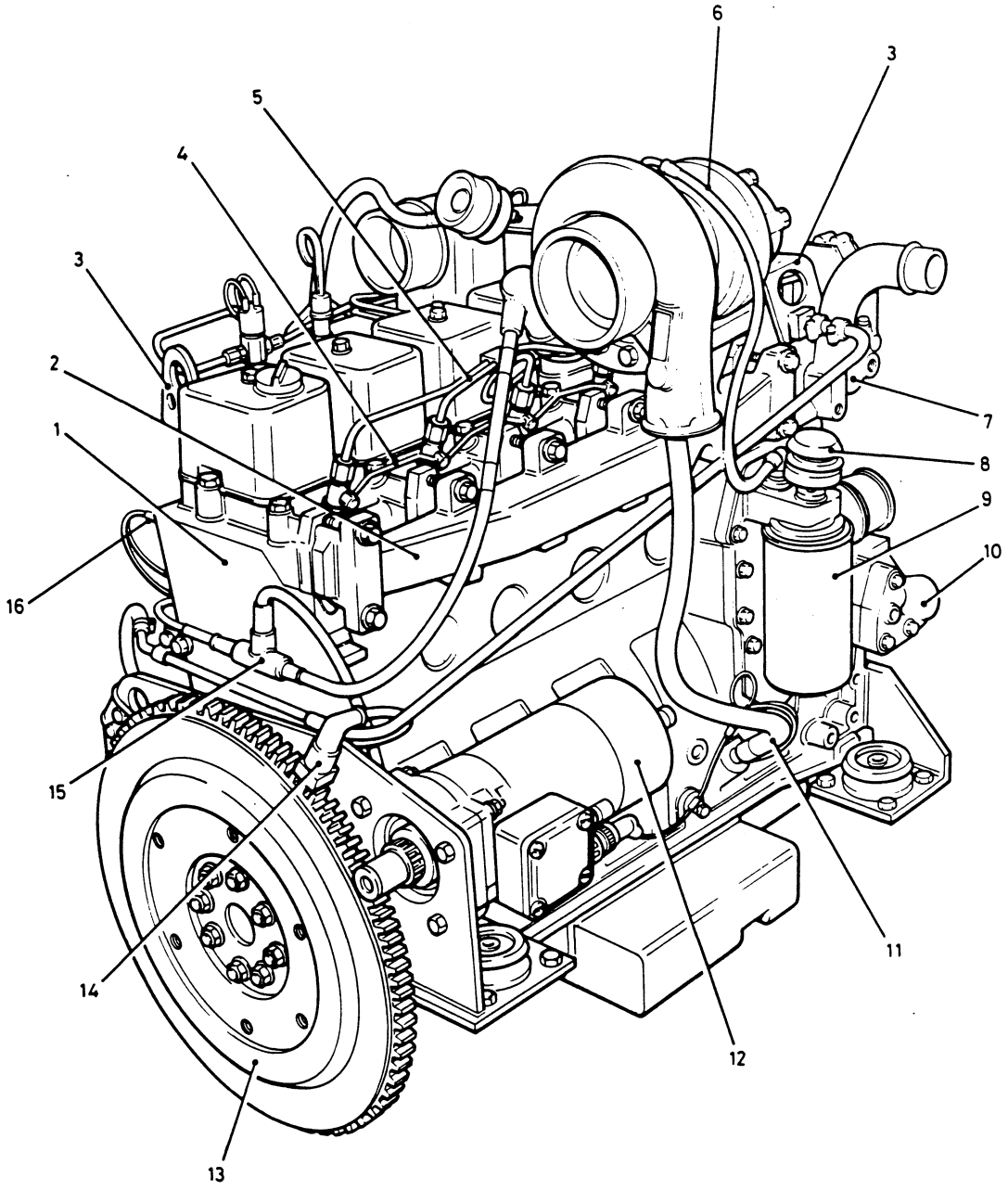

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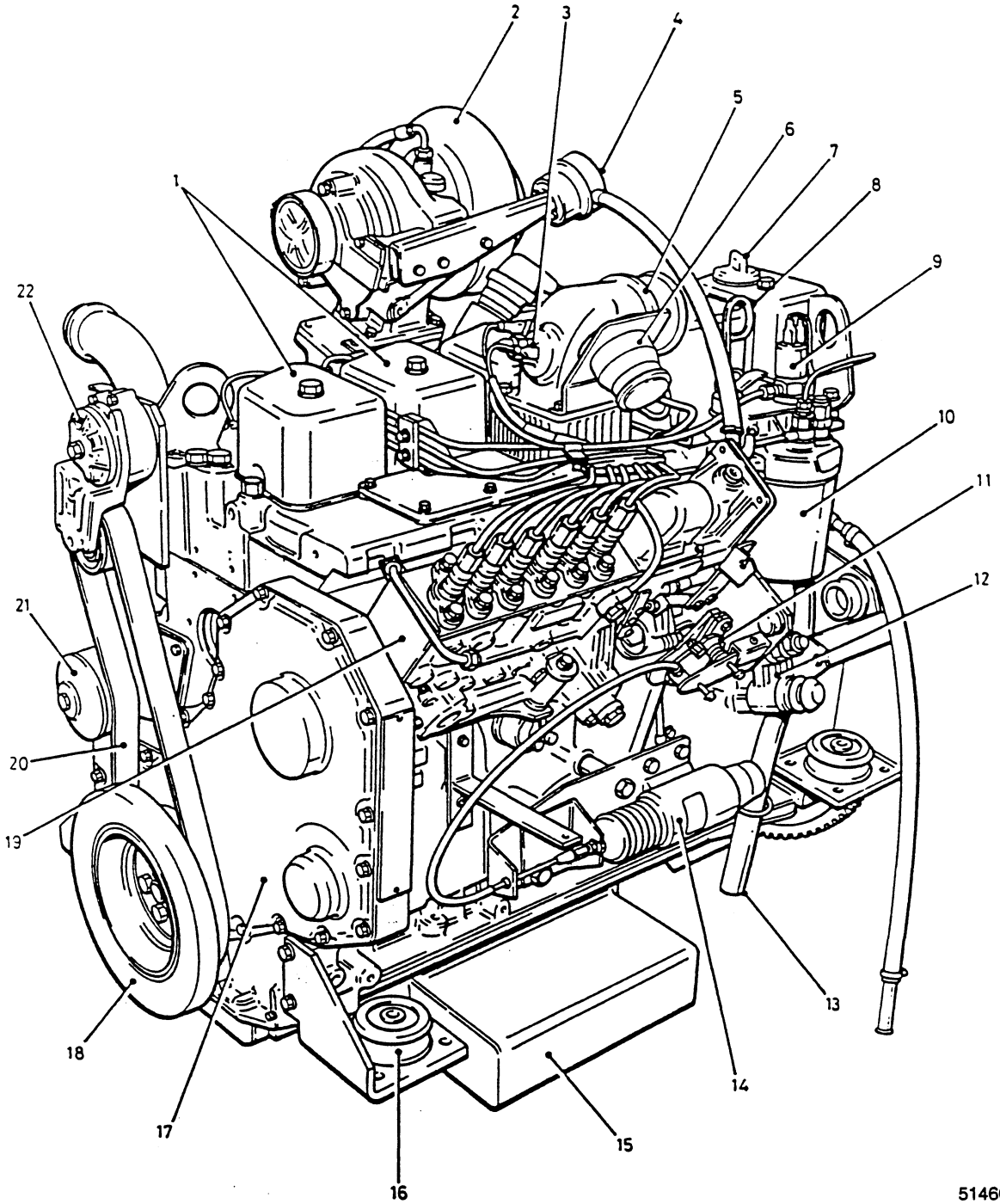
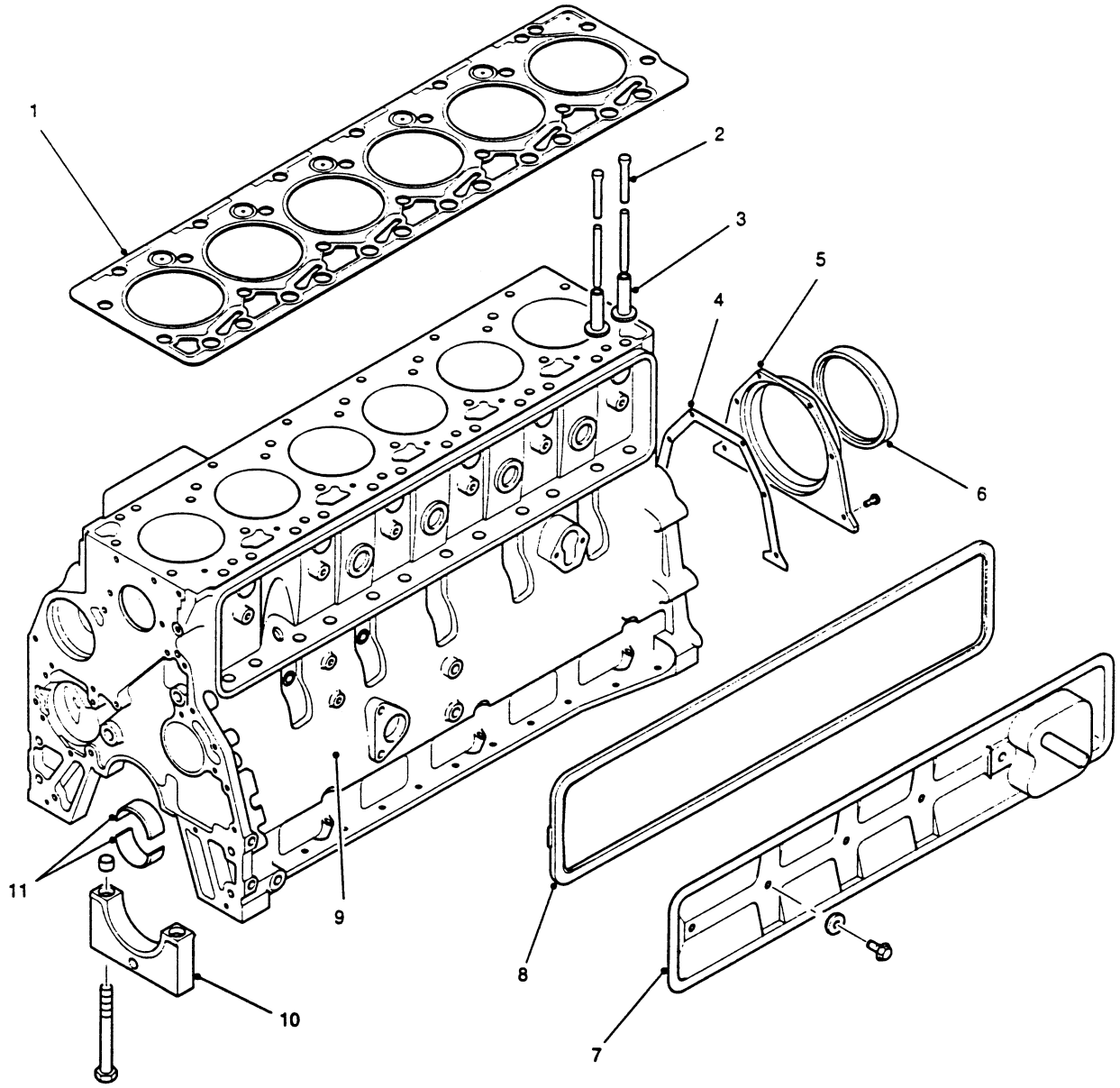
1	Cylinder head	9	Oil filter and cooler assembly
2	Exhaust manifold	10	Coolant inlet
3	Lifting bracket	11	Turbocharger lubrication return pipe
4	Fuel leak-off pipe	12	Starter motor
5	High pressure fuel pipes	13	Flywheel
6	Turbocharger lubrication feed pipe	14	Engine speed probe
7	Thermostat housing	15	Engine wiring harness
8	Oil pressure switch	16	Temperature gauge transmitter

Fig 1 Engine general three quarter view - drive end



1	Rocker covers	12	Fuel lift pump
2	Turbocharger	13	Crankcase breather
3	Cold start device	14	Throttle dip solenoid
4	Turbocharger wastegate capsule	15	Oil sump
5	Air inlet connection	16	Engine mounting
6	Hour meter	17	Timing gear case
7	Oil filler cap	18	Vibration damper and crankshaft pulley
8	Oil dipstick	19	Fuel injection pump
9	Cold start device fuel pump	20	Coolant pump drive belt
10	Fuel filter	21	Coolant pump
11	Fuel control lever	22	Belt tensioner

Fig 2 Engine general three quarter view - coolant pump end



1 Cylinder head gasket
2 Push rod
3 Cam follower
4 Rear cover gasket
5 Rear cover
6 Oil seal
7 Push rod cover
8 Push rod cover gasket
9 Cylinder block
10 Main bearing cap
11 Main bearing shells

Fig 3 Cylinder block

INTRODUCTION

1 This chapter gives a technical description of the Cummins B series engine, fitted to the Shielder vehicle.

2 Throughout this chapter the following terms are used to describe the location of components on the engine, as the engine is fitted in the vehicle:

2.1 Drive end - the end from which the drive is taken, ie the flywheel end.

2.2 Coolant pump end - the non-drive end.

ENGINE

3 The engine is an in line, six cylinder, overhead valve, liquid cooled, 5.9 litre, turbocharged, direct injection, four stroke diesel.

Cylinder block and liners

4 The cylinder block (Fig 3 (9)) is made of cast iron and is integral with the crankcase and the auxiliary drive housing.

5 The cylinder bores are machined directly into the cylinder block, no liners being fitted.

6 If the bores are found to be worn over the acceptable limits (see Category 532 - Inspection Standards), they can be bored oversize to accept oversize pistons, and ultimately dry liners to utilise standard pistons.

Crankshaft and main bearings

7 The crankshaft (Fig 4 (6)) is a balanced, forged steel unit which runs in seven pre-finished replaceable shell bearings (4, 5, 7).

8 End float of the crankshaft is controlled by the main bearing between number 3 and 4 cylinders. The upper half shell (5) has flanges to form thrust pads which bear against machined faces on the crankshaft.

9 For maximum permissible crankshaft end float see Category 532 - Inspection Standards.

10 The crankshaft has a pulley (2) fitted at the coolant pump end of the engine. The pulley carries a belt to drive the coolant pump. The crankshaft gear (3) drives the camshaft, lubricating oil pump and fuel injection pump via the timing gears. These are further described in Para 27. A dowel (10) locates the gear accurately on the crankshaft.

11 The drive end of the crankshaft has a flange which carries the flywheel.

Flywheel assembly

12 The flywheel assembly consists of the flywheel (Fig 1(13)) and starter ring gear, and is secured to the crankshaft flange by eight capscrews.

13 The starter ring gear is shrunk on to the flywheel.

14 The starter motor and two metacone engine mountings are secured to the engine mounting plate which is bolted to the drive end of the engine.

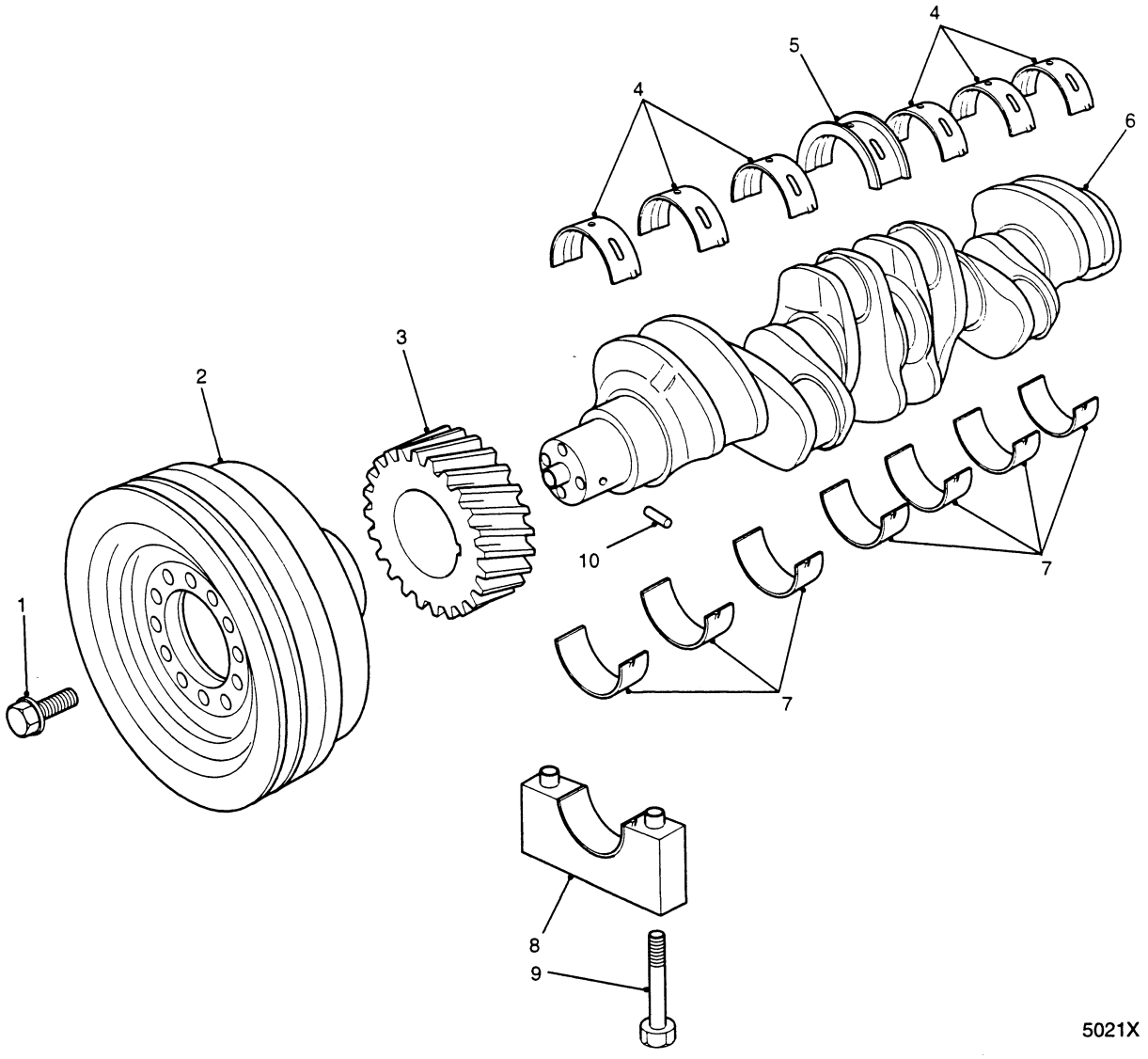
Connecting rods and pistons

15 The piston and connecting rod assembly is shown in (Fig 5). Shell bearings (9) are fitted to the big ends and bushes (7) to the small ends. The piston (6), connecting rod (8) and cap (10) should be kept together as an assembly with the relevant big end shell bearings.

16 The small end and bush are drilled to allow the passage of oil. Therefore when the bush is fitted to the small end the oilway holes must be aligned.

17 Similarly it must be ensured that the upper half of the shell bearings are correctly located in the big ends and the tabs fit in the shell recesses.

18 The piston is secured to the small end by means of a fully floating gudgeon pin (5). The connecting rod cap (10) is secured by two setscrews (11).



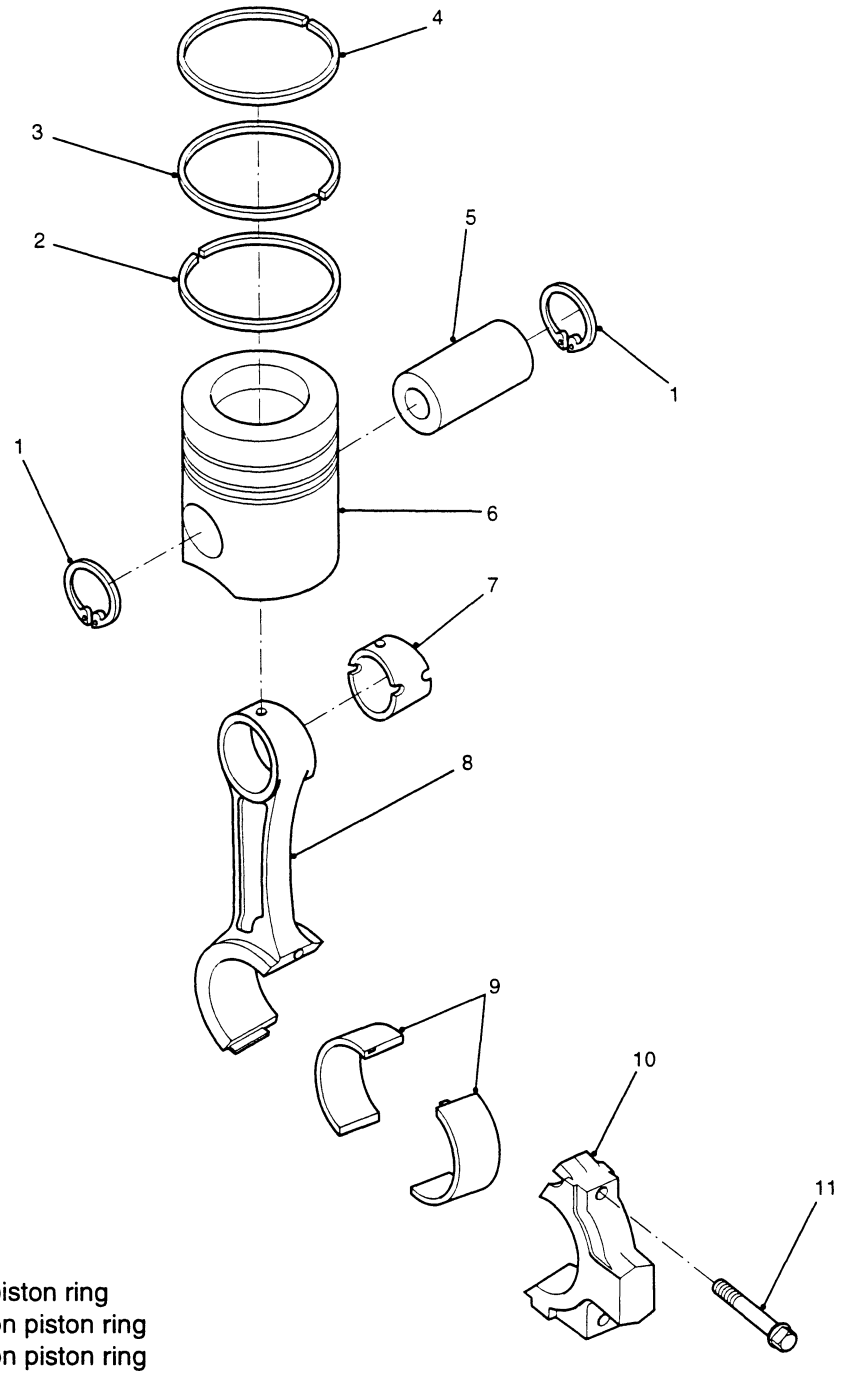
1	Setscrew	6	Crankshaft
2	Vibration damper and Polyvee pulley	7	Lower main bearing shell
3	Crankshaft gear	8	Main bearing cap
4	Upper main bearing shell	9	Main bearing cap setscrew
5	Thrust main bearing shell	10	Dowel

Fig 4 Crankshaft assembly

19 The pistons are cast from aluminium and have annular grooves for three piston rings.

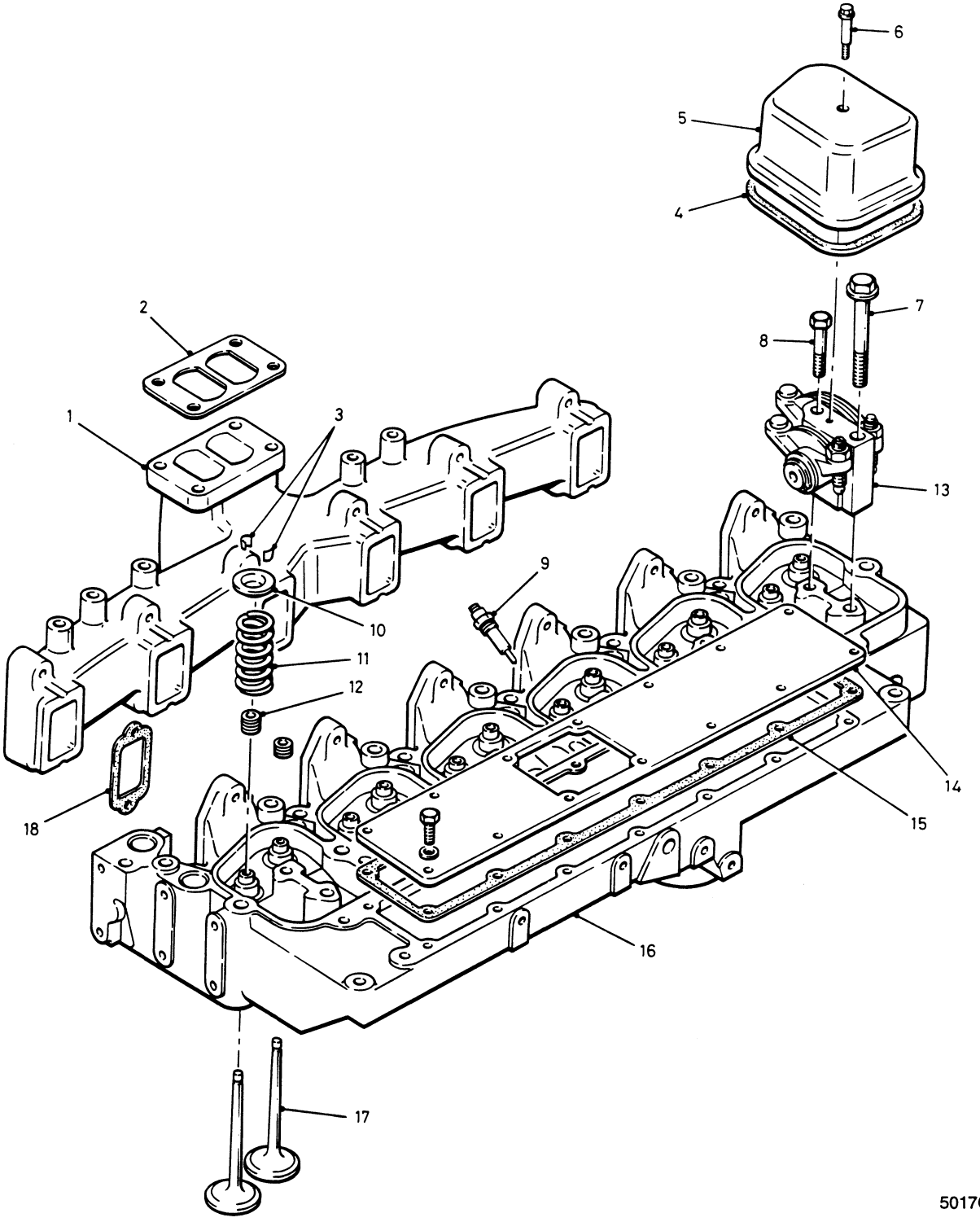
20 The top ring (4) is of the wedge type. The middle ring (3) is of rectangular cross section with a chamfered upper inner edge. Both top and middle rings are compression rings. The bottom ring (2) is the oil control ring and is of the spring loaded type.

21 When the piston rings are fitted the ring gaps are equally spaced around the piston and the gaps are not in line.



1 Circlip
2 Oil control piston ring
3 Compression piston ring
4 Compression piston ring
5 Gudgeon pin
6 Piston
7 Small end bush
8 Connecting rod
9 Shell bearings
10 Connecting rod cap
11 Setscrew

Fig 5 Piston and connecting rod assembly



1	Exhaust manifold	10	Valve spring retainer
2	Gasket	11	Valve spring
3	Split collets	12	Valve stem seal
4	Rocker cover gasket	13	Rocker arm assembly
5	Rocker cover	14	Inlet manifold cover plate
6	Rocker cover securing screw and washer	15	Inlet manifold cover plate gasket
7	Setscrew	16	Cylinder head
8	Setscrew	17	Valve
9	Fuel injector	18	Exhaust manifold gasket

Fig 6 Cylinder head assembly

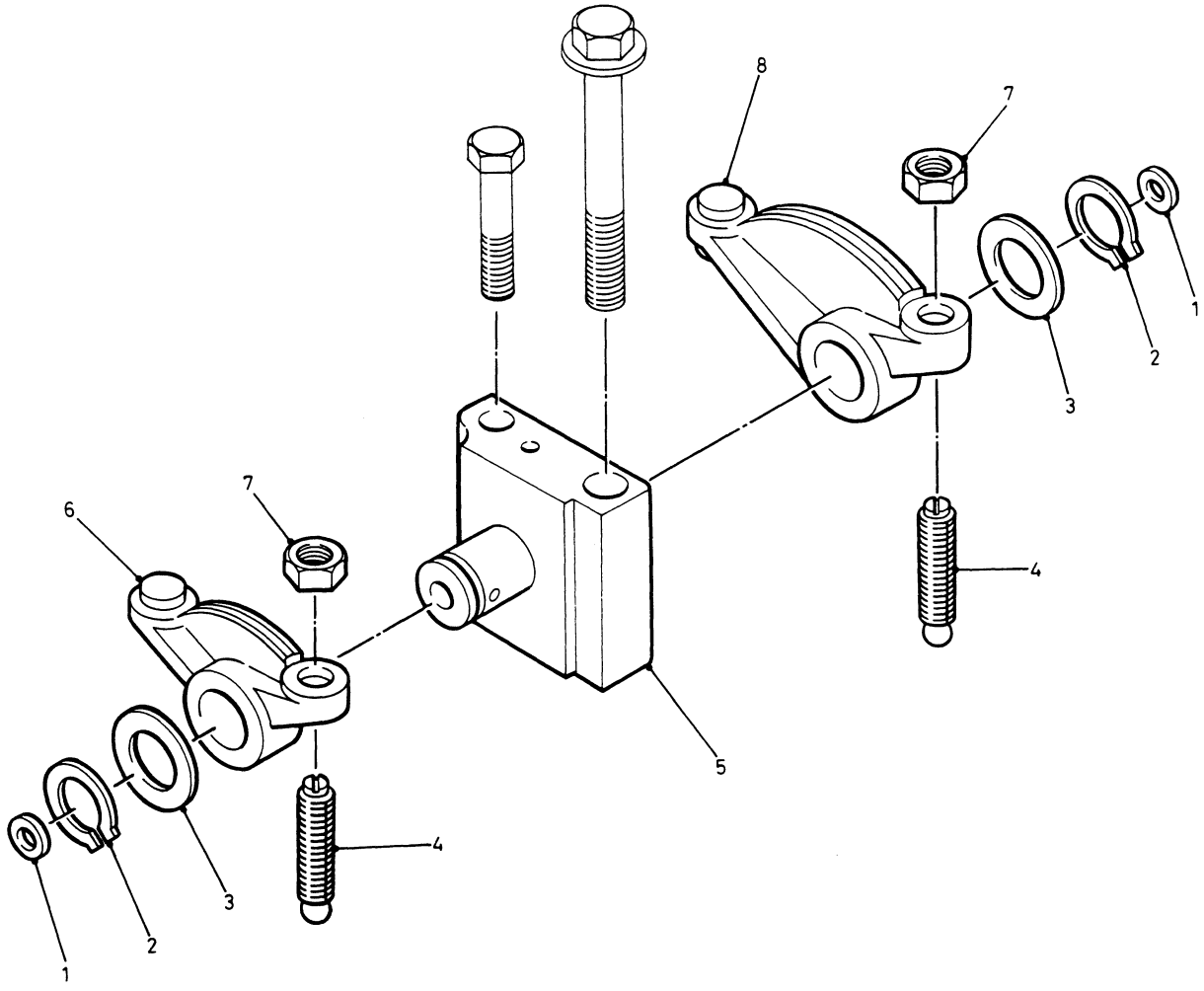
Cylinder head

22 The cylinder head (Fig 6) is a one piece, crossflow design with two valves per cylinder. The head features integrally cast valve guides with induction hardened valve seats, an integral intake manifold and thermostat housing.

23 Each combustion chamber is machined to accept a fuel injector (9).

24 Each valve is closed by a spring (11) held by a retainer (10) secured by conventional split collets (3). A seal (12) is fitted over the valve stem.

25 A separate rocker shaft assembly is provided for each cylinder. The rocker shaft assembly (Fig 7) comprises two rocker arms (6) and (8) mounted on the rocker shaft and retained with washers (3) and circlips (2). The rocker shaft forms a sub-assembly (5) with a supporting pedestal. Drillings in the pedestal and rocker shaft route oil to the rocker arms. The axial drilling through the rocker shaft is sealed at each end by expansion plugs (1). An adjusting screw (4) with locknut (7) in each rocker arm enables the valve clearance to be adjusted.



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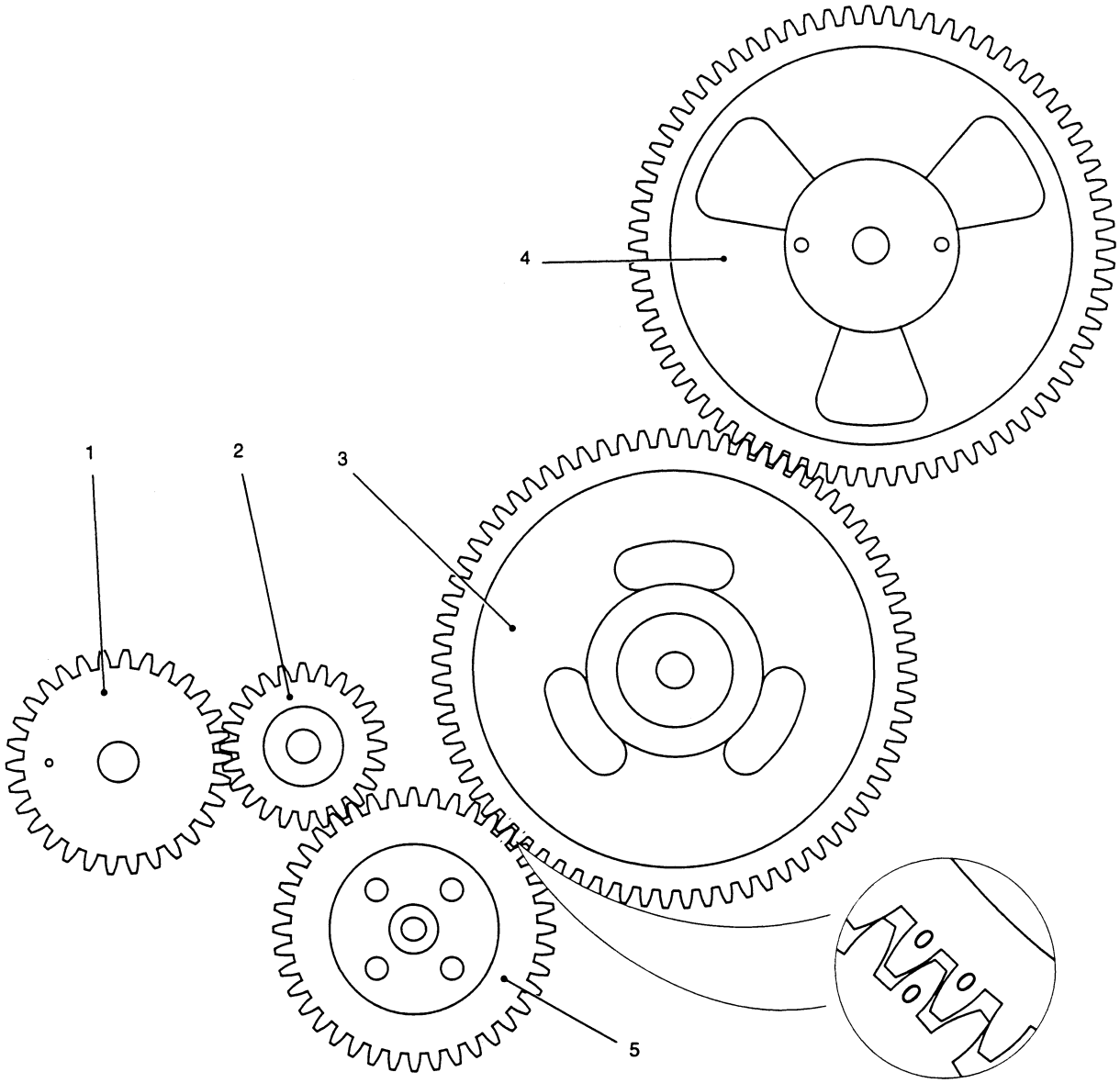
1 Expansion plug
2 Circlip
3 Flat washer
4 Adjusting screw
5 Rocker shaft and pedestal
6 Inlet valve rocker arm
7 Nut
8 Exhaust valve rocker arm

Fig 7 Rocker shaft assembly



1 Lubricating oil pump gear
2 Idler gear
3 Camshaft gear
4 Fuel injection pump gear
5 Crankshaft gear

Fig 8 Timing gears

Rocker ~~box cover~~

26 Each cylinder has an individual rocker box cover. The rocker box covers (Fig 6(5)) are each secured to the cylinder head (16) by a single setscrew (6) and washer positioned in the centre top of the cover. A replaceable gasket (4) ensures an oil tight seal between the cover and cylinder head.

Timing gear case and gears

27 The timing gear case (Fig 9(3)) is secured to the engine by capscrews. A gasket (2) between the timing gear case and crankcase forms an oil tight seal. The timing case also provides a support for the fuel injection pump and the timing pin which is used for setting the engine timing.

28 The timing gears are shown in Fig 8. They include a camshaft gear (3), an idler gear (2), lubricating oil pump gear (1) and the fuel injection pump gear (4), all driven from the crankshaft gear (5). Provision is made for the incorporation of an auxiliary drive gear, should this be required.

29 When the engine timing is set by the manufacturer, markings are made on the crankshaft gear (5) and the camshaft gear (3) with the engine set with No 1 piston at Top Dead Centre (TDC) on its compression stroke, to ensure correct tooth engagement.

NOTE

No 1 piston is at the coolant pump end of the engine.

INDUCTION SYSTEM

Air filtration unit

30 The two stage filtration unit comprises a cyclone type pre-cleaner and pleated element second stage filter (Fig 10). The filters are mounted in a fabricated [redacted] which forms the air trunking between them. The air intake is connected via a fabricated plenum (1) to the air inlet. Air is drawn into the pre-cleaner (5) via an intake louvre (2), [redacted] A grille is fitted to the louvre to prevent the ingress of debris, leaves etc.

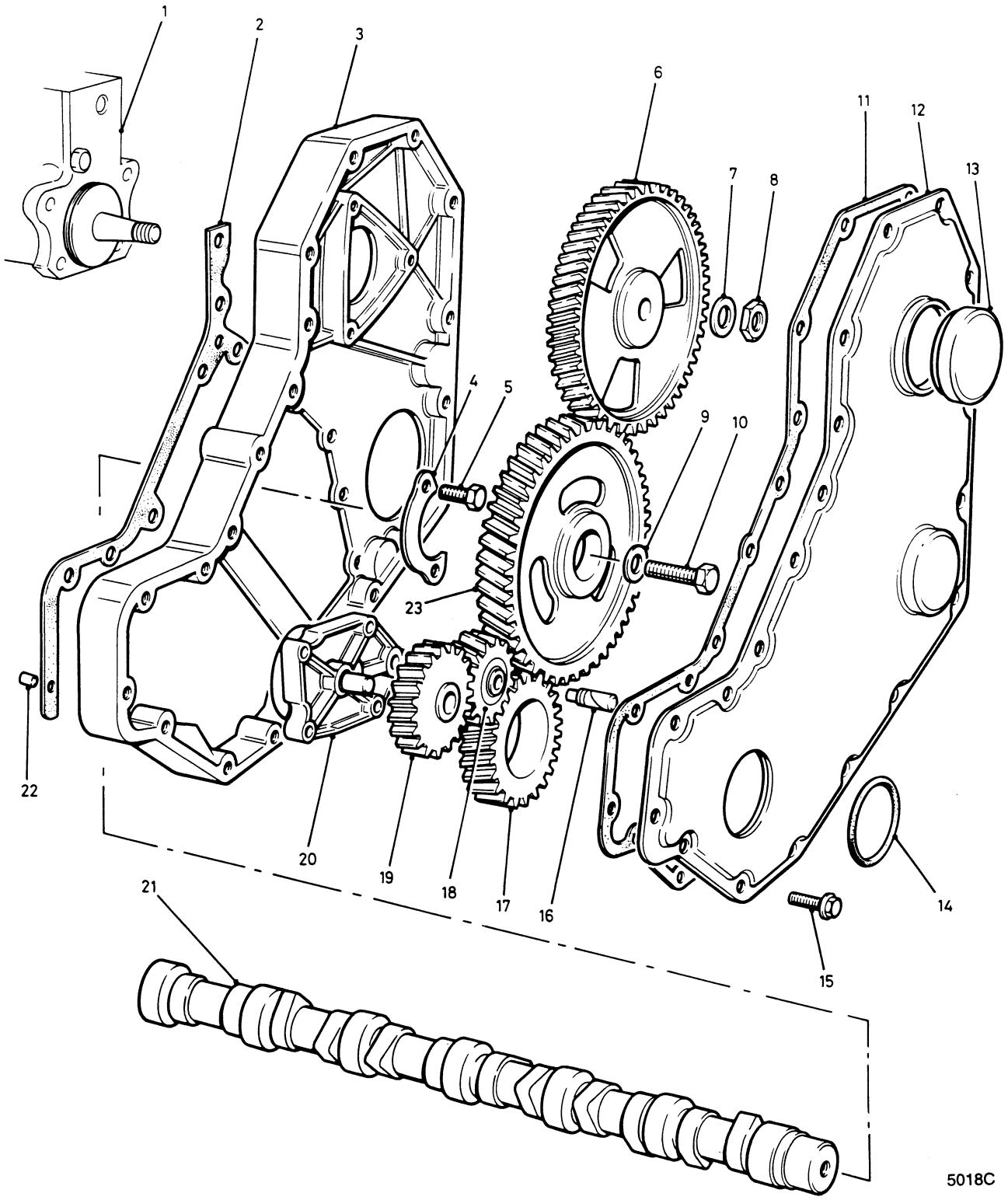
Pre-cleaner

31 The Pre-cleaner Filter unit (5) is a cyclone type, a term which describes the manner in which air is forced to flow through it. The unit is housed at the foremost section of the filtration assembly and comprises a stack of extractor tubes (4) which act as tunnels for incoming air. Spiral vanes (3) inside the tubes impart a rotary motion to the air flow. Heavy dust particles in the air stream are flung outwards under the influence of the centrifugal forces. The air in the centre of the tubes thus becomes depleted of heavy particles, and then passes to the second filter stage via conical tubes (6). The dust particles fall into the gravity discharge valve (10) below.

32 The gravity discharge valve is held closed while the engine is running, but opens when the engine is not running, allowing the deposited particles to be discharged into the engine compartment.

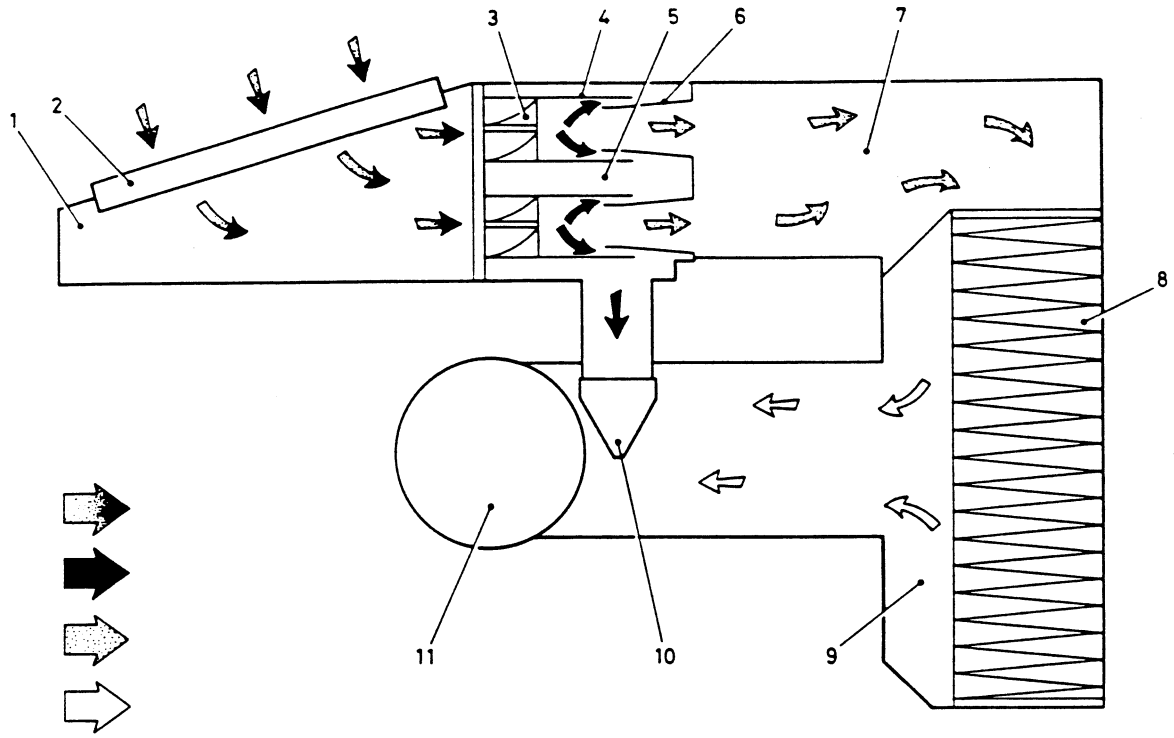
Air filter - second stage

33 The pre-filtered air from the pre-cleaner stage is drawn via trunking (7) through the pleated filter element (8), which removes fine particles and any remaining contamination etc. from the air stream. The final filtered air passes into the outlet plenum chamber (9) and through pipework (11) to the turbocharger compressor inlet.



1	Fuel injection pump	9	Washer	17	Crankshaft gear
2	Gasket	10	Bolt	18	Idler gear
3	Timing gear case	11	Timing gear cover gasket	19	Oil pump drive gear
4	Camshaft thrust plate	12	Timing gear cover	20	Oil pump
5	Setscrew	13	Access plug	21	Camshaft
6	Fuel injection pump drive gear	14	Oil seal	22	Dowel
7	Washer	15	Setscrew	23	Camshaft gear
8	Nut	16	Idler gear spindle		

Fig 9 Timing gear case and drive assembly



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A UNFILTERED AIR
B HEAVY DUST PARTICLES
C PRE-FILTERED AIR
D FINAL FILTERED AIR
1 Air intake plenum
2 Intake louvre
3 Spiral vanes
4 Extractor tubes
5 Pre-cleaner
6 Conical tubes
7 Trunking
8 Air filter-second stage
9 Outlet plenum
10 Gravity discharge valve
11 Pipework (compressor inlet)

Fig 10 Filtration unit - schematic

Service indicator

34 A filter service indicator is mounted on the outlet plenum chamber and is sensitive to the pressure variations within the induction system. During normal service with the filter element clean the indicator shows low pressure readings. As the filter becomes gradually blocked with the filtered contaminant during service, the induction depression rises - this being indicated by the service indicator. When the service indicator reading rises to 25 in H_2O continuous, a filter change is necessary. When the element has been changed, the indicator is reset by pressing the button on the top of the unit.

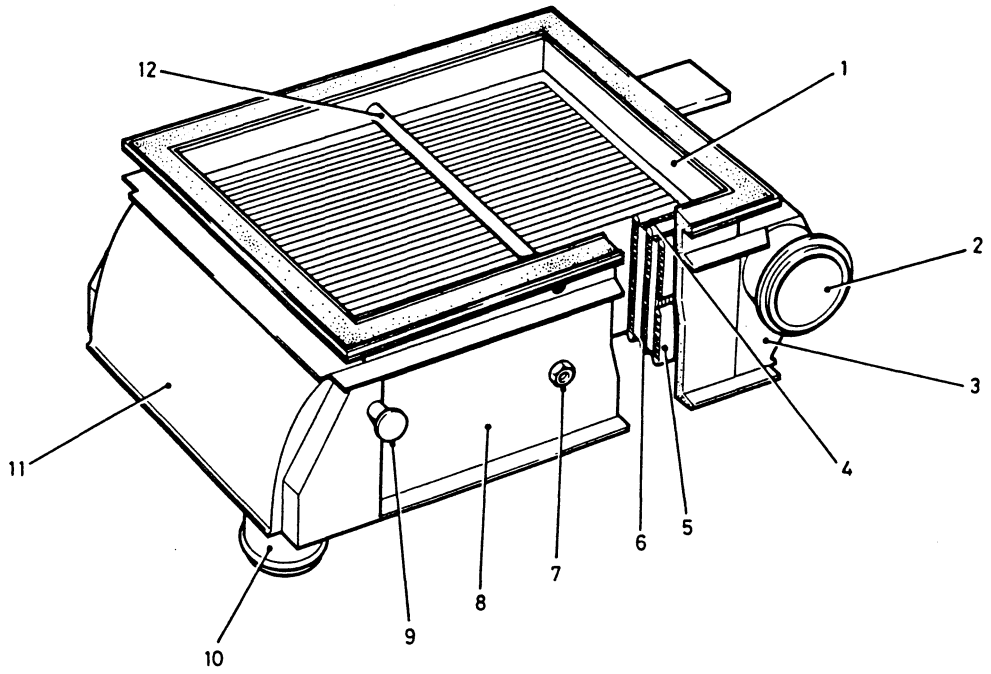
Charge air cooler

35 The charge air cooler (Fig 11), fitted as part of the engine cooling system, is an air-to-air heat exchanger which cools the compressed air leaving the turbocharger to within 20 or 30 deg C above the ambient cooling air being drawn over it.

36 The heat exchanger is constructed entirely of non-ferrous materials and comprises inlet (3) and outlet (11) tanks, header plates (1), finned air tubes (5) and side plates (8).

37 The inlet and outlet tanks, fabricated from sheet brass, are fitted with inlet (2) and outlet stubs (10) and are assembled using silver solder. The header plates (1), fabricated from brass sheet, are assembled between the inlet and outlet tanks and finned air tubes (5). The air tubes are made from solid drawn brass and carry the hot compressed air between the inlet and outlet tanks. Cooling fins (6) inside the air tubes collect heat from the charge air and conduct this heat into the flat walls of the tubes. The outer cooling fins (4) conduct heat away from the air tubes for dissipation into the cooling air flow. All cooling fins consist of copper foil, coated with soft solder. The stainless steel side plates (8) are stud mounted to the inlet and outlet tanks as main structural members and carry the mounting points (9) for the heat exchanger. Tie screws (7), fitted between the side plates, clamp the heat exchanger matrix to prevent deformation by internal pressure.

38 Only minimal maintenance is required for the charge air cooler and is normally confined to cleaning the cool side airways to remove any dirt and debris drawn in with the cooling air. Hot side cleaning should not be necessary, except after any oil leakage resulting from turbocharger oil seal failure.



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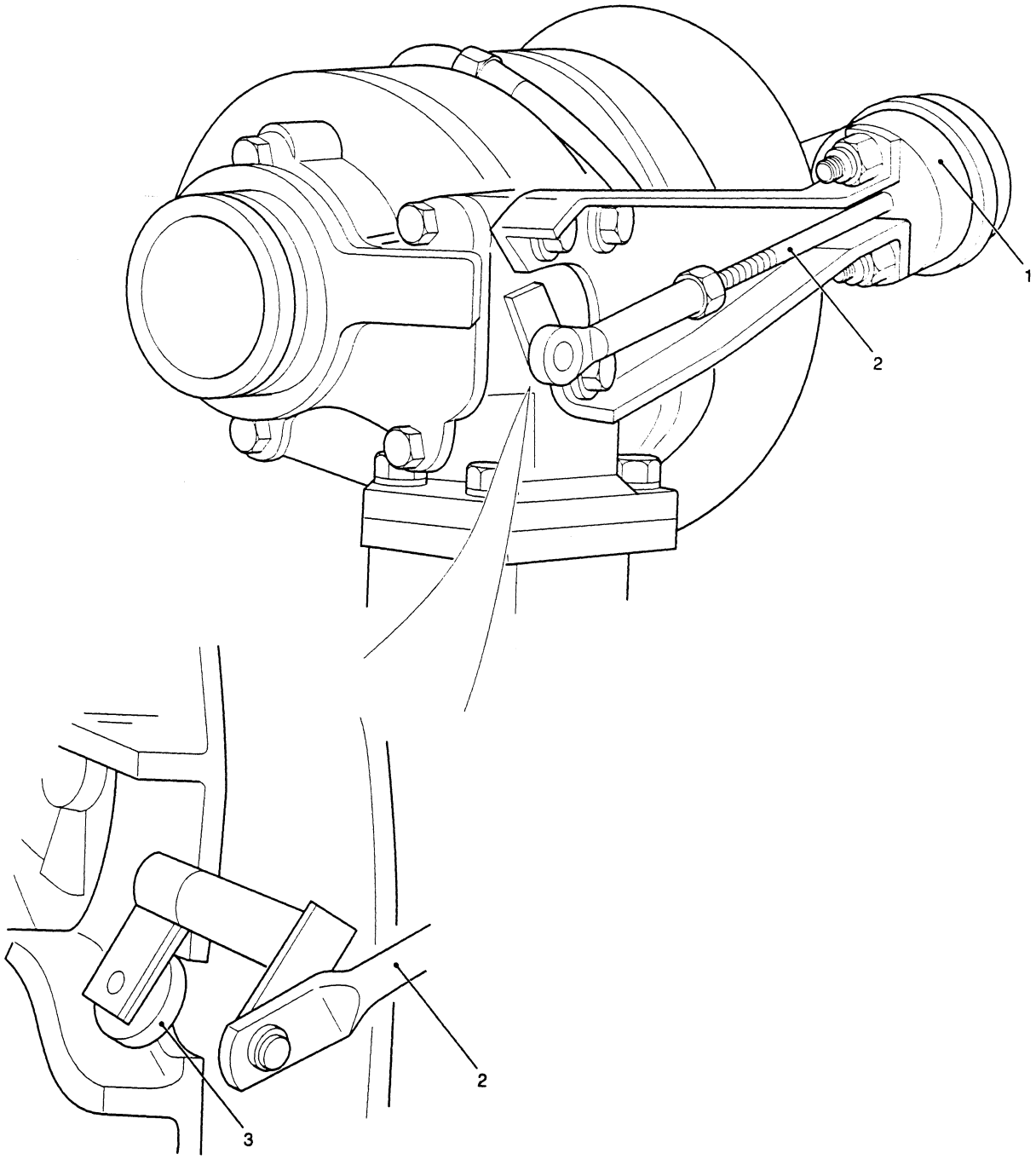
1	Header plate	7	Tie screws
2	Inlet stub	8	Side plate
3	Inlet tank	9	Mounting point
4	Outer cooling fins	10	Outlet stub
5	Finned air tubes	11	Outlet tank
6	Inner cooling fins	12	Lifting handle

Fig 11 Charge air cooler

EXHAUST SYSTEM

39 The exhaust manifold comprises a cast iron assembly flanged to fit the cylinder head outlet ports. A flanged elbow at the centre of the manifold forms a mounting for the turbocharger with integral waste gate.

40 The turbocharger outlet exhaust elbow connects up to the exhaust pipework via a fabricated steel expansion bellows. The expansion bellows allows for movement of the exhaust pipework and fittings due to the high temperatures generated within the system. From the bellows the exhaust pipe is routed directly to the right hand wall of the hull, [redacted]



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1 Wastegate capsule
2 Mechanical linkage
3 Bypass valve

Fig 12 Wastegate

Waste gate

41 The waste gate (Fig 12) is fitted to reduce the amount of exhaust gas available to drive the turbine of the turbocharger at the higher engine speeds and thereby reduce the boost pressure.

42 Boost pressure is communicated to the wastegate capsule (1) through a flexible pipe from the inlet manifold. As the boost pressure increases, a diaphragm inside the capsule opens a bypass valve (3) via mechanical linkage (2). When the valve opens, some of the exhaust gas bypasses the turbocharger turbine and passes directly to the exhaust pipe downstream of the turbocharger. Less exhaust gas is available to turn the turbine and the speed of the turbine decreases. As the turbine is connected directly to the compressor wheel of the turbocharger, the compressor output, and consequently the boost pressure, is reduced.

Turbocharger

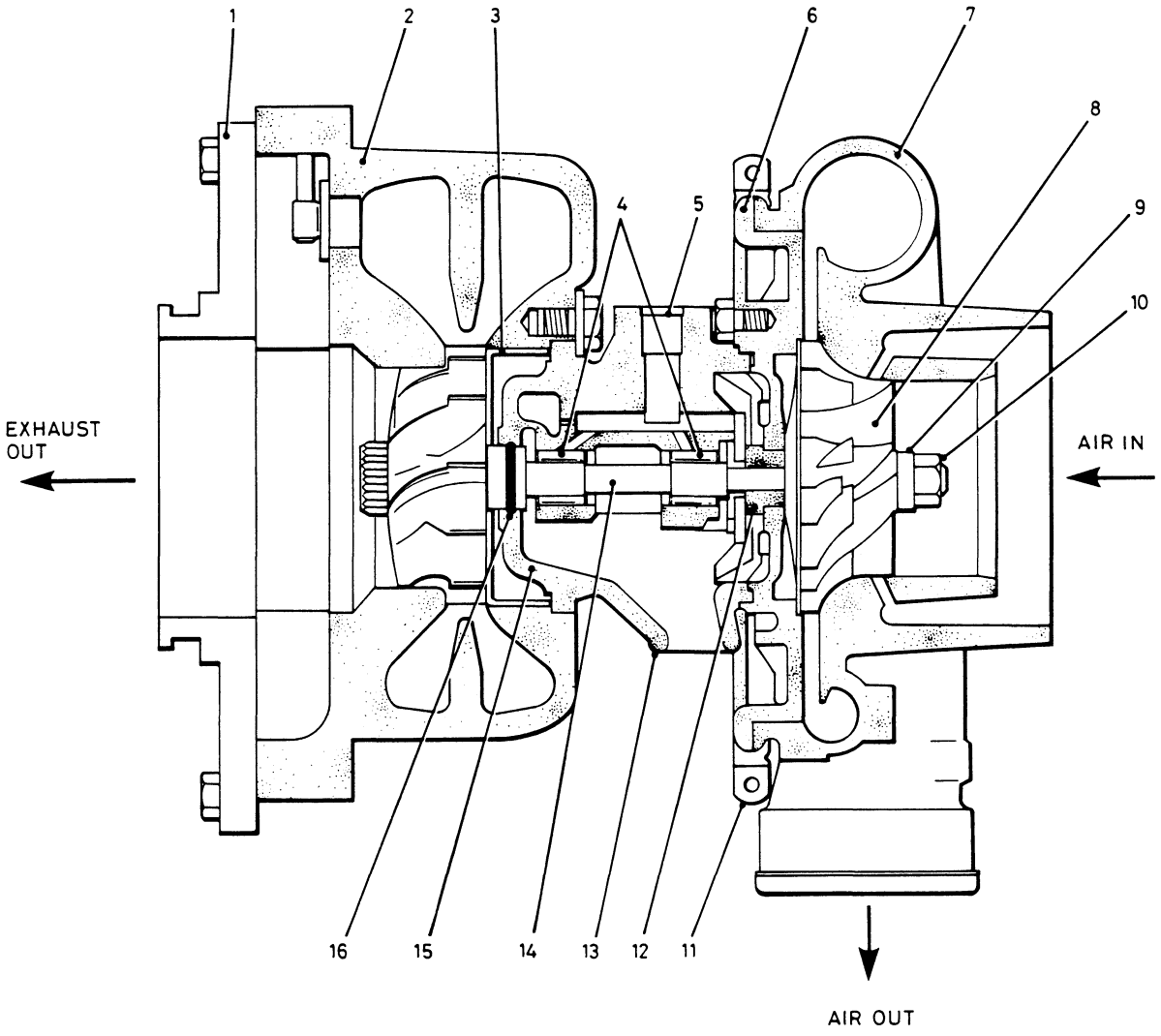
43 The turbocharger (Fig 13) comprises an axial/radial flow compressor (8) mounted on a common turbine/shaft assembly (14).

44 The compressor chamber is a cast aluminium alloy assembly comprising a compressor housing (7) with an integral outlet duct for connection to the charge air cooler pipework. The chamber is connected to the compressor backplate (6) by a locking ring (11).

45 The bearing housing (15) houses the main bearings (4). These are supplied with oil through a flexible hose connected between the oil filter head and an oil inlet connection (5) in the housing. Drillings carry the oil to the bearings. Drain oil is routed into the base of the housing and through a flanged oil outlet connection (13) to the sump. The compressor backplate (6) is bolted to the housing. Seal rings (16) and (12) prevent exhaust gas and compressed air respectively from entering the bearing housing.

46 The turbine housing (2) is manufactured in close grain, cast iron with a flanged intake to attach to the exhaust manifold. The high tensile steel turbine/shaft assembly (14) has a stepped shaft with two case hardened bearing surfaces and an annular groove at the turbine end for location of a seal ring (16). The cast aluminium alloy compressor wheel (8) is fitted against a shoulder on the shaft, secured by a locknut (10) and washer (9). A shroud (3) protects the bearing housing from heat of the exhaust gases in the turbine.

47 A flanged connector (1) bolted to the turbine housing facilitates the connection of the exhaust system to the turbocharger.



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1	Flanged connector	9	Washer
2	Turbine housing	10	Locknut
3	Shroud	11	Locking ring
4	Bearing	12	Seal ring
5	Oil inlet connection	13	Oil outlet connection
6	Compressor backplate	14	Turbine/shaft assembly
7	Compressor housing	15	Bearing housing
8	Compressor wheel	16	Seal ring

Fig 13 Turbocharger

CHAPTER 2

FUEL SYSTEM

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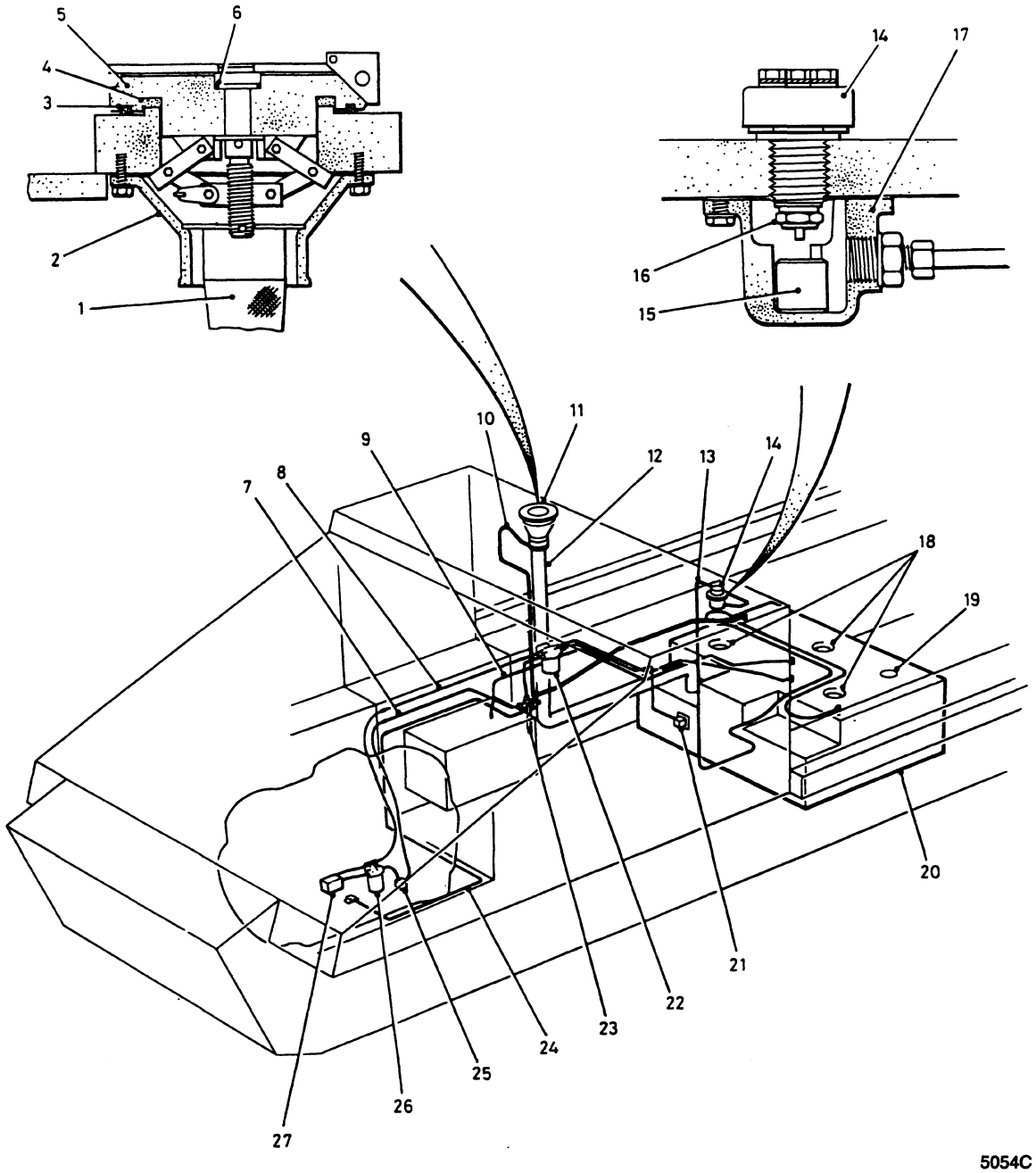
GENERAL

1 The fuel tank (Fig 1(20), is filled via a large diameter filler pipe (12). Air is vented from the tank during refuelling through a pipe (10) connected between a boss on top of the tank and the filler pipe at a point just below the filler cap. A separate breather (14), which incorporates a non-return device to prevent the escape of fuel if the vehicle should overturn, is connected by another pipe (13) to a second boss on top of the fuel tank.

2 A gauze type strainer (1) is fitted into the filler bowl (2).

3 Fuel is drawn from the tank by the fuel lift pump (25) through a dip tube mounted on a fuel tank block (21) that is secured to the front face of the tank. The fuel flows via the sedimenter (22) and a two-way tap (23), through the feed pipe (7) to the engine mounted lift pump. The fuel then flows through a filter (26) to the fuel injection pump (27) which supplies the fuel injectors. Surplus fuel from the filters and injectors is fed back to the fuel tank via the return pipe (8). Fuel can be drained from the tank when necessary via the tap (23) and drain pipe (24), the end of which is situated adjacent to an armoured access plate beneath the engine. A pipe (9) supplies fuel from the tank to the commander's compartment heater.



1	Strainer	10	Fuel vent pipe	19	Fuel gauge sender unit
2	Filler bowl	11	Fuel filler	20	Fuel tank
3	Outer seal	12	Fuel filler pipe	21	Fuel tank block
4	Inner seal	13	Fuel breather pipe	22	Fuel sedimenter
5	Filler cap	14	Fuel breather assembly	23	Fuel tap
6	Sealing ring	15	Breather plunger	24	Fuel drain pipe
7	Fuel feed pipe	16	Non-return needle valve	25	Fuel lift pump
8	Fuel return pipe	17	Breather body	26	Fuel filter
9	Crew heater fuel pipe	18	Fuel tank mountings	27	Fuel injection pump

Fig 1 Fuel system

DESCRIPTION

Fuel tank

4 The fuel tank (Fig 1(20)), is a single unit fabricated from stainless steel, with a total capacity of [redacted] The tank is secured to the vehicle by three flexible mountings (18). The tank is fitted with a fuel gauge sender unit (19) and connectors for the feed and return pipes, vents and breathers.

Fuel filler

5 The fuel filler (Fig 1(11)) comprises a cap and a handle assembly with latch. The arms and links of the cap pivot on steel pins to secure or release the cap, as the handle is rotated. A sealing ring (6) is fitted in the upper central recess of the cap; lower outer and inner seals (3) and (4) seal the cap to the filler neck. The cap is loosely attached, by a retaining chain and ring assembly, to the filler neck.

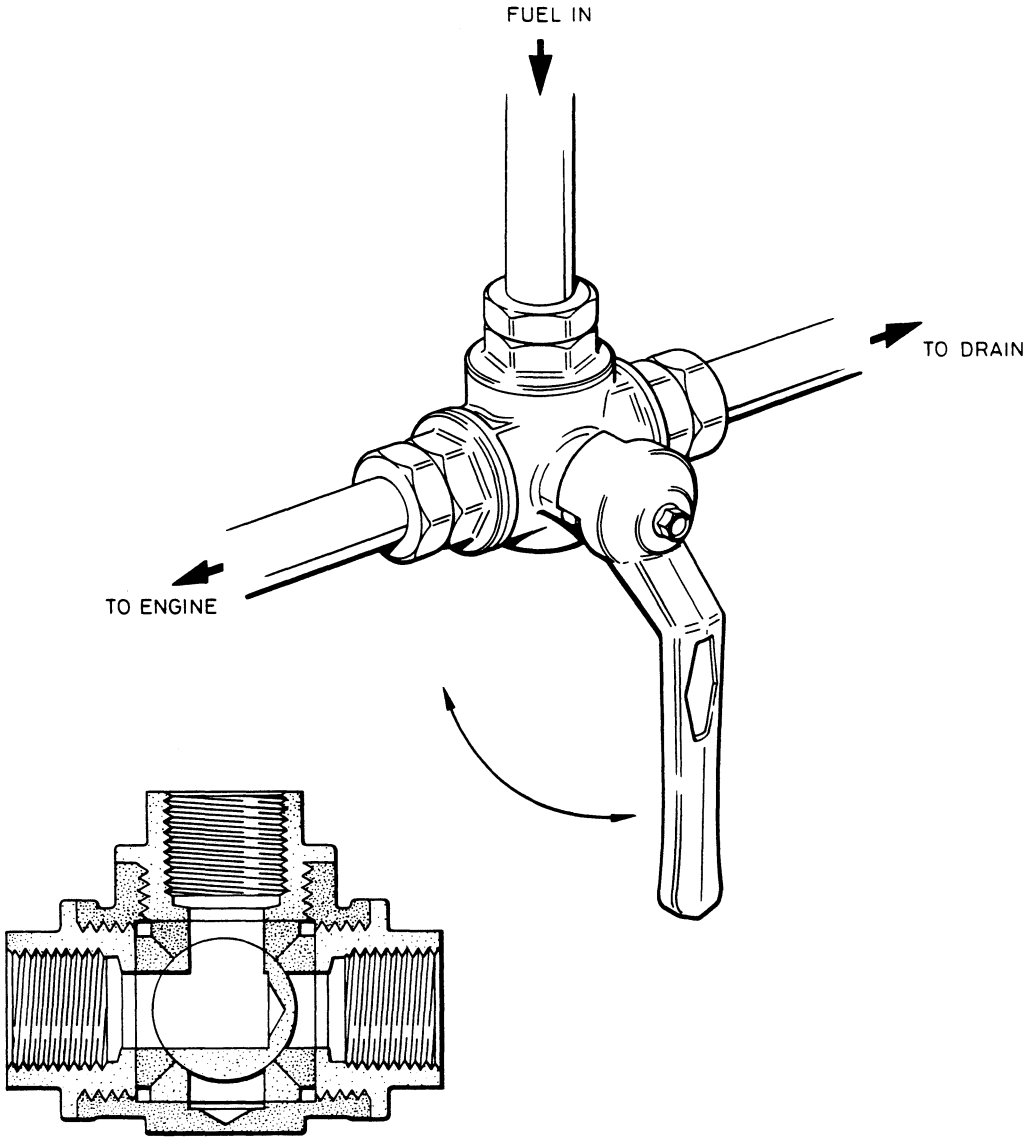


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Fig 2 Fuel tap

Strainer

6 The strainer (Fig 1 (1)) consists of a flanged brass tube with locating pin and a 40 mesh/inch woven wire brass gauze tapered filter. The complete strainer assembly is approximately 309.9 mm (12.2 in) in length and has an upper flange diameter of 71.1 mm (2.8 in).

Fuel tap

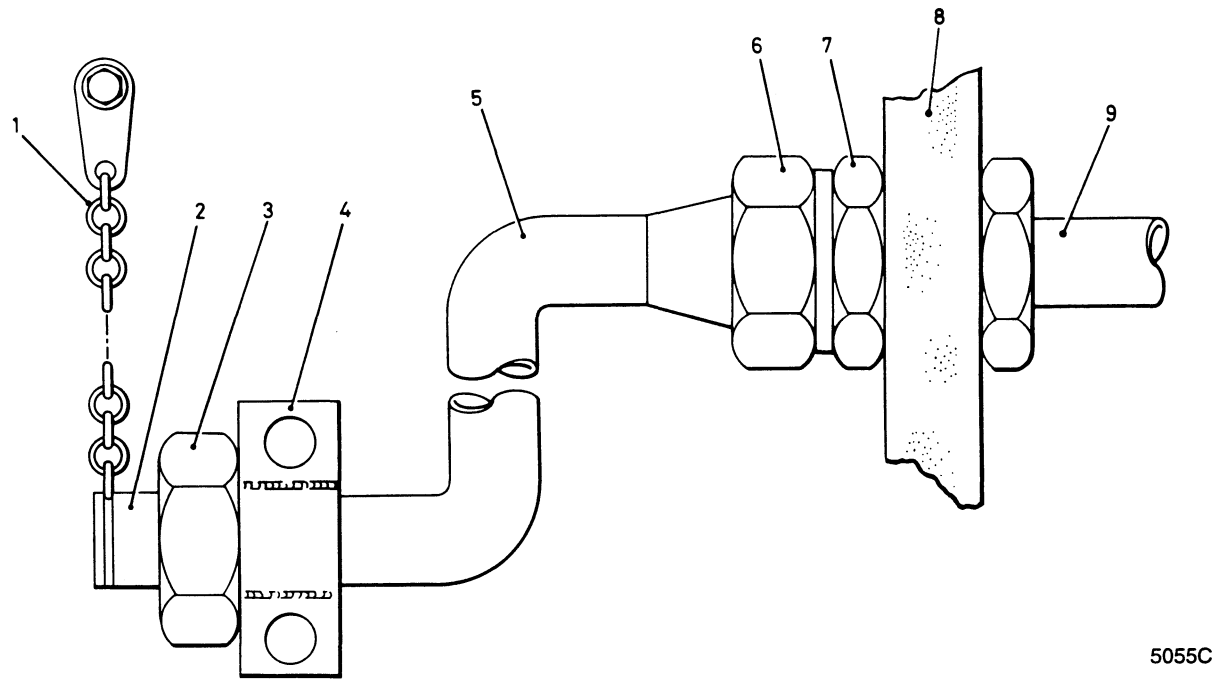
7 The fuel tap (Fig 2) is a two-way ball valve. The tap consists of a steel body machined to accept three threaded unions which connect with the pipes that carry fuel in from the sedimenter and out to the engine or to drain. A ball with a right angled drilling turns under the control of the operating handle to connect the 'fuel in' port to either the drain or the engine fuel system.

Fuel drain

8 The fuel drain system comprises the fuel tap (Fig 2) and various pipe sections terminating in a drain plug which has blanking plug and retaining chain. The fuel drain pipe section from the fuel tap is connected to a bulkhead union at the engine/commander's compartment bulkhead. Further pipes connect the bulkhead union to the drain plug (Fig 3 (2)) which is located under the engine adjacent to an armoured inspection cover. The fuel is drained by removing the blanking plug and connecting a pump which draws fuel from the tank and discharges into a container.

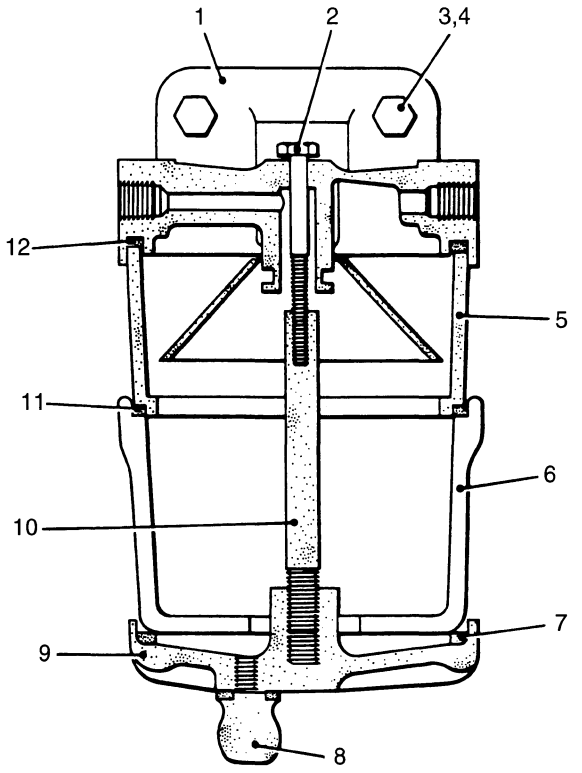
Fuel sedimenter

9 The fuel sedimenter (Fig 4) is mounted at the rear right hand side of the commander's compartment. The sedimenter consists of a head (1) with tapped bosses to accommodate the fuel inlet and outlet pipes, an element (5), transparent bowl (6) and a base (9) with drain plug (8). A centre tube (10) and bolt (2) secure the parts, which are assembled with sealing rings (7), (11) and (12). Any water and sediment trapped within the transparent bowl can be released via the drain plug.



1	Chain assembly	5	Drain pipe	8	Engine/crew compartment bulkhead
2	Drain plug	6	Tube nut		
3	Nut	7	Bulkhead adaptor	9	Drain connection to fuel tap
4	Bracket				

Fig 3 Fuel drain



1	Head	7	Sealing ring
2	Centre bolt	8	Drain plug
3	Screw	9	Base
4	Washer	10	Centre tube
5	Element	11	Sealing ring
6	Transparent bowl	12	Sealing ring

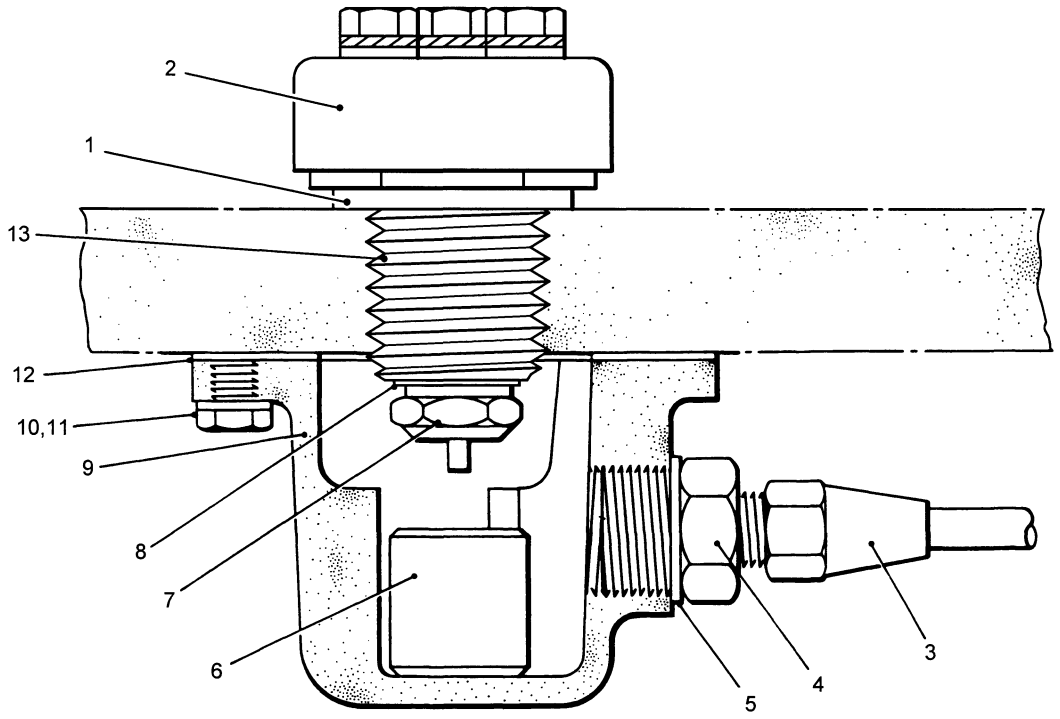
Fig 4 Fuel sedimenter

Fuel tank breather

10 The fuel tank breather (Fig 1(14)) is located on the top plate of the commander's compartment. The breather pipe from the fuel tank is connected by a union (Fig 5 (3)) to an adaptor (4) which is screwed into the breather body (9). Screws (10) secure the breather body to the underside of the commander's compartment roof plate, with a gasket (12) to form a seal.

11 A breather bolt (13) with top cover (2) is screwed into the roof plate. A joint washer (1) forms an airtight seal. The breather is vented from beneath the cover to atmosphere.

12 A non-return needle valve assembly (7) is screwed into the bottom of the breather bolt. The valve operating plunger (6) located within the breather body (9) is free to move under the influence of gravity. Should the vehicle overturn, the plunger falls against the centre pin of the needle valve, closing the valve to prevent the escape of fuel.



1	Joint washer	8	Gasket
2	Top cover	9	Breather body
3	Breather pipe union	10	Screw
4	Adaptor	11	Washer
5	Seal	12	Gasket
6	Plunger	13	Breather bolt
7	Non-return needle valve		

Fig 5 Fuel tank breather

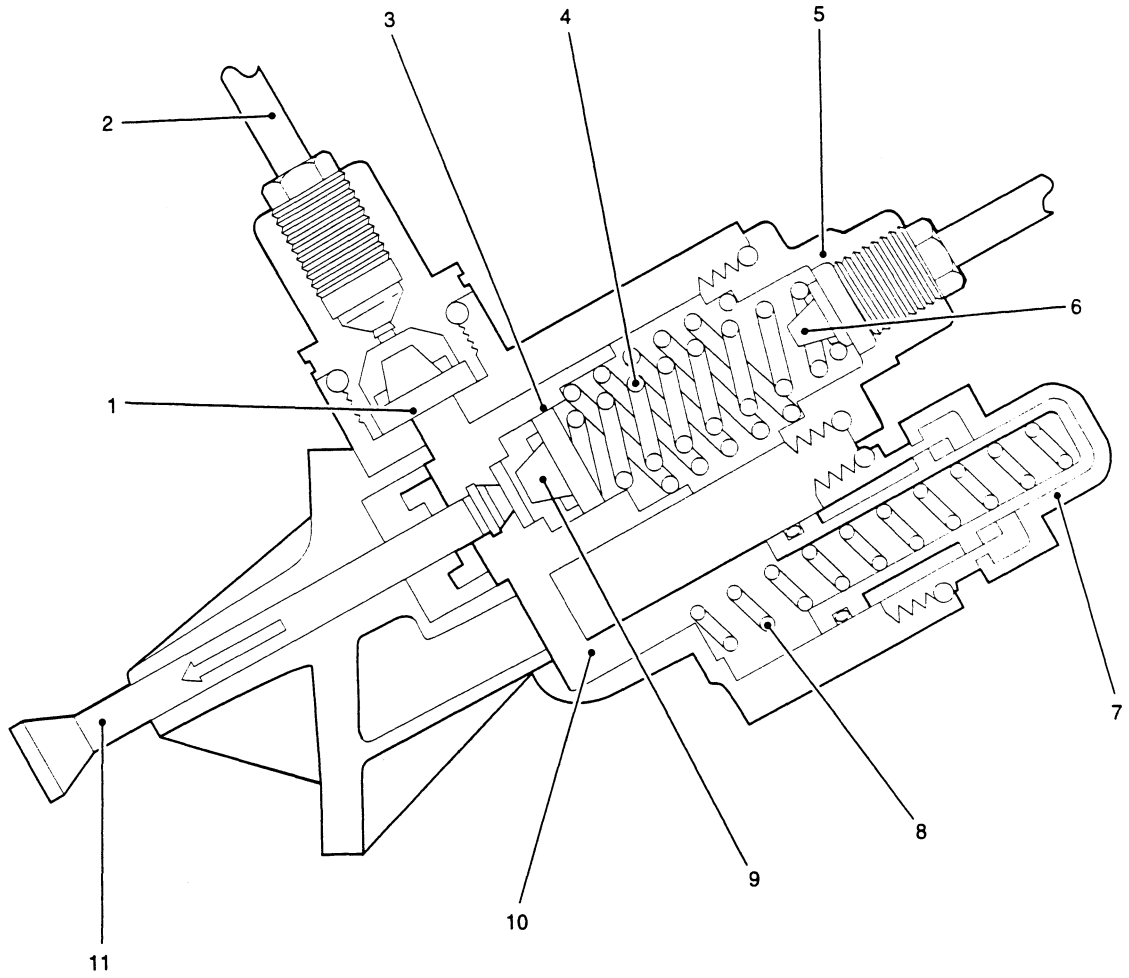
Fuel lift pump

13 The plunger type fuel lift pump (Fig 6) is fitted on the side of the engine below and to the rear of the fuel injection pump, and is operated by an eccentric on the camshaft.

14 The pump body (10) has two cylinders. One cylinder houses a piston (3) and return springs (4), and is closed by the fuel inlet connection (5). The other cylinder houses a spring loaded plunger (7).

15 As the camshaft rotates, the eccentric forces the actuator (11) into the pump body, moving the piston (3) into the cylinder and compressing the return springs (4). Check valve (6) closes and check valve (9) opens due to the pressure generated within the cylinder. Fuel flows from the cylinder through check valve (9) into the space between check valves (9) and (1). Further rotation of the camshaft moves the high point of the eccentric past the actuator, allowing the return springs push the piston back down the cylinder causing check valve (9) to close and check valve (6) to open, drawing fuel into the cylinder. The pressure between check valves (9) and (1) rises, opening check valve (1) and forcing fuel into the outlet pipe (2).

16 The plunger (7) allows manual priming and bleeding of the fuel system. When the plunger is pressed, check valve (9) prevents back flow and fuel is forced through check valve (1). When the plunger is released, the spring (8) forces the plunger outwards. This action create a suction that causes check valve (1) to close and draws fuel through check valves (6) and (9).



1	Check valve	7	Plunger
2	Fuel outlet pipe	8	Spring
3	Piston	9	Check valve
4	Return springs	10	Pump body
5	Fuel inlet connection	11	Actuator
6	Check valve		

Fig 6 Fuel lift pump

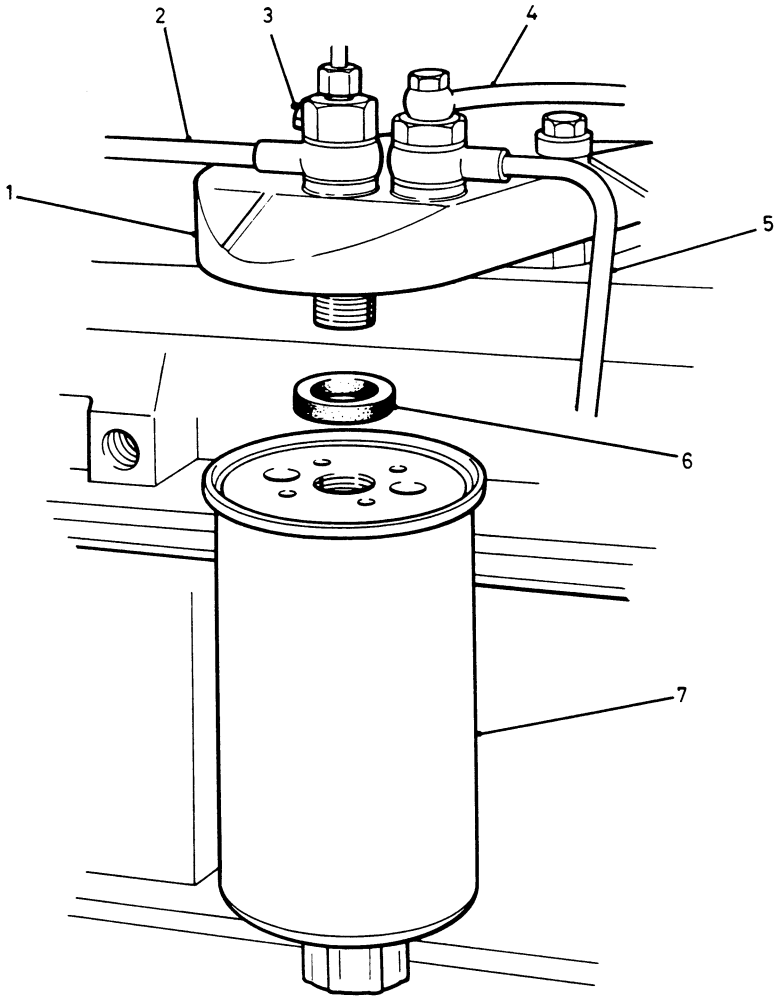
Fuel filter

17 The fuel filter (Fig 7) is mounted on the side of the engine adjacent to the fuel injection pump.

18 Fuel enters the filter head (1) from the lift pump through the fuel inlet pipe (5) and is forced through the filter element (7). An `O' ring seal (6) is fitted between the filter element and filter head to ensure a leakproof joint.

19 Fuel leaves the filter through the feed pipe (2). A bleed screw (3) is fitted into the banjo bolt of the fuel outlet connection to allow bleeding of the fuel system.

20 Excess fuel from the injectors and fuel injection pump is returned to the filter through the spill pipe (4).



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1 Filter head
2 Fuel feed pipe
3 Bleed screw
4 Spill pipe
5 Fuel inlet pipe
6 'O' ring seal
7 Filter element

Fig 7 Fuel filter

Fuel injection pump

21 The fuel injection pump (Fig 8) is mounted on the right-hand side of the engine looking from the coolant pump end, and is driven by a gear wheel in the timing gear case. The pump is a compact, oil tight unit, lubricated throughout by engine oil.

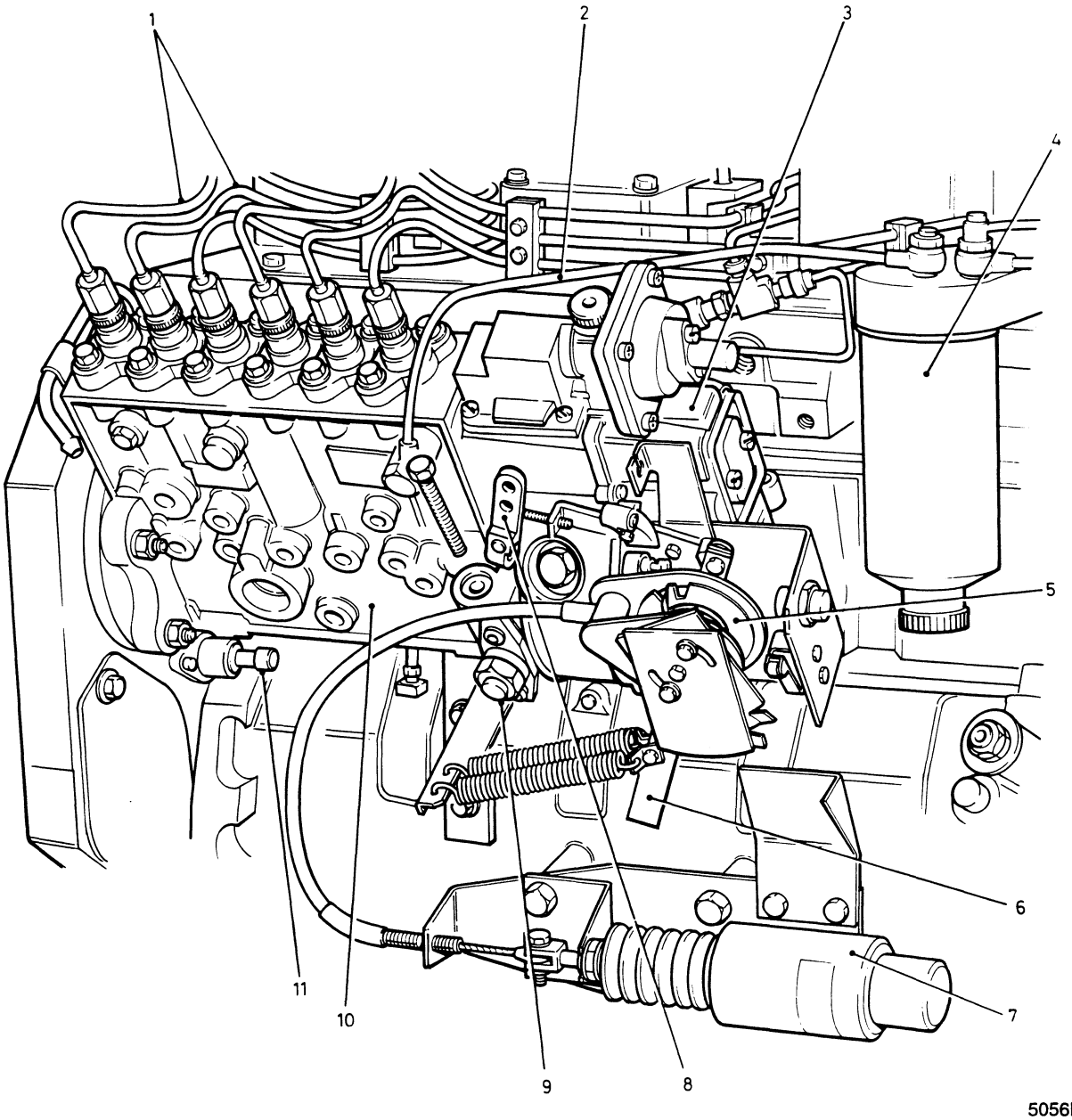
22 The pump comprises a body (10) in the lower part of which is a camshaft with six lobes. The camshaft is supported by roller bearings located in machined housings at each end of the pump body. Six cylinders in a line at right angles to the axis of the camshaft house spring loaded plungers whose lower ends bear on the lobes. As the camshaft is turned due to the action of the timing gears the reciprocating motion of the plungers draws fuel oil into the cylinders and discharges it through delivery valves via the high pressure pipes (1) to the injectors.

23 Speed control is maintained by a mechanical flyweight governor assembly (3) and gives accurate control of engine speed under all load conditions.

24 The governor controls the effective stroke of the pump plungers. This in turn controls the amount of fuel passed to the cylinders via the injectors. The stroke of the plungers is also controlled by the throttle control mechanism which is operated by the driver via the cable operated throttle lever (6) in association with the throttle dip solenoid (7) and throttle variable link (5).

25 The cable operated fuel cut-off lever (8) controls the supply of fuel to the plungers to enable the engine to be stopped.

26 A timing pin housed beneath a screwed plug (9) is used in conjunction with the engine timing pin (11) to accurately set the pump timing when a pump is replaced.



1	High pressure fuel pipe	5	Throttle variable link	9	Screwed plug
2	Fuel feed pipe	6	Throttle control lever	10	Injection pump body
3	Governor assembly	7	Throttle dip solenoid	11	Engine timing pin
4	Fuel filter	8	Fuel cut-off lever		

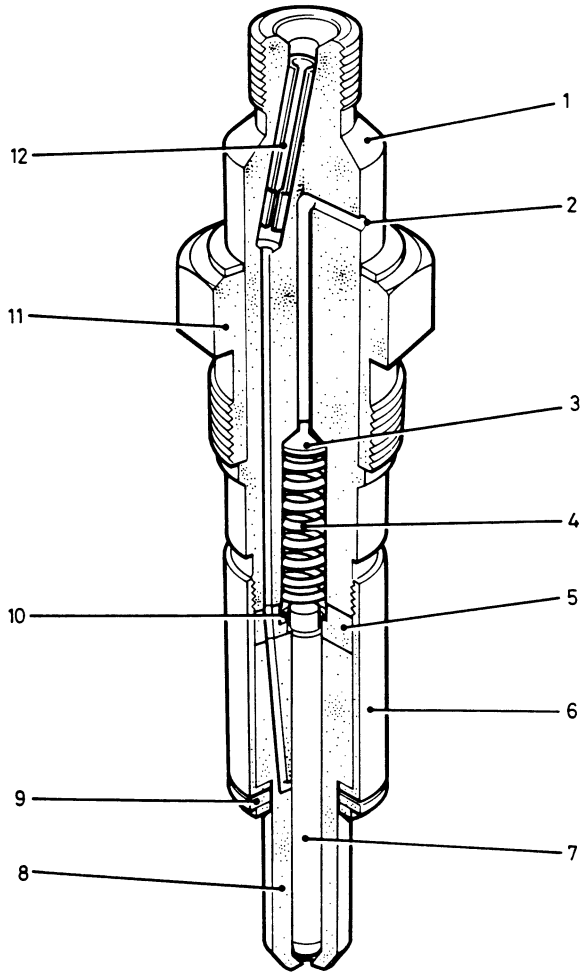
Fig 8 Fuel injection pump

Fuel injectors

27 The straight through fuel injectors (Fig 9) are of conventional closed nozzle, hole-type design. High pressure fuel from the fuel injector pump enters the injector through the fuel inlet passage (12) and is led to the injector nozzle (8) by an internal drilling. The pressure of the fuel causes the needle valve (7) to lift against the pressure of the spring (4) and admits the fuel to the combustion chamber as a spray.

28 Fuel that leaks past the needle valve passes through the intermediate plate (5), passes the pressure spindle (10), spring (4) and shims (3), and enters the fuel leak off passage (2) in the nozzle holder (1). A return pipe conveys the leak off fuel back to the fuel tank, together with surplus fuel from the fuel filter.

29 The injectors are retained by hold down nuts (11) that screw into the cylinder head. Sealing rings (9) are fitted between the cylinder head and the injectors.



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1	Nozzle holder	5	Intermediate plate	9	Sealing ring
2	Fuel leak off passage	6	Nozzle nut	10	Pressure spindle
3	Shim	7	Needle valve	11	Hold down nut
4	Pressure spring	8	Injector nozzle	12	Fuel inlet passage

Fig 9 Fuel injector

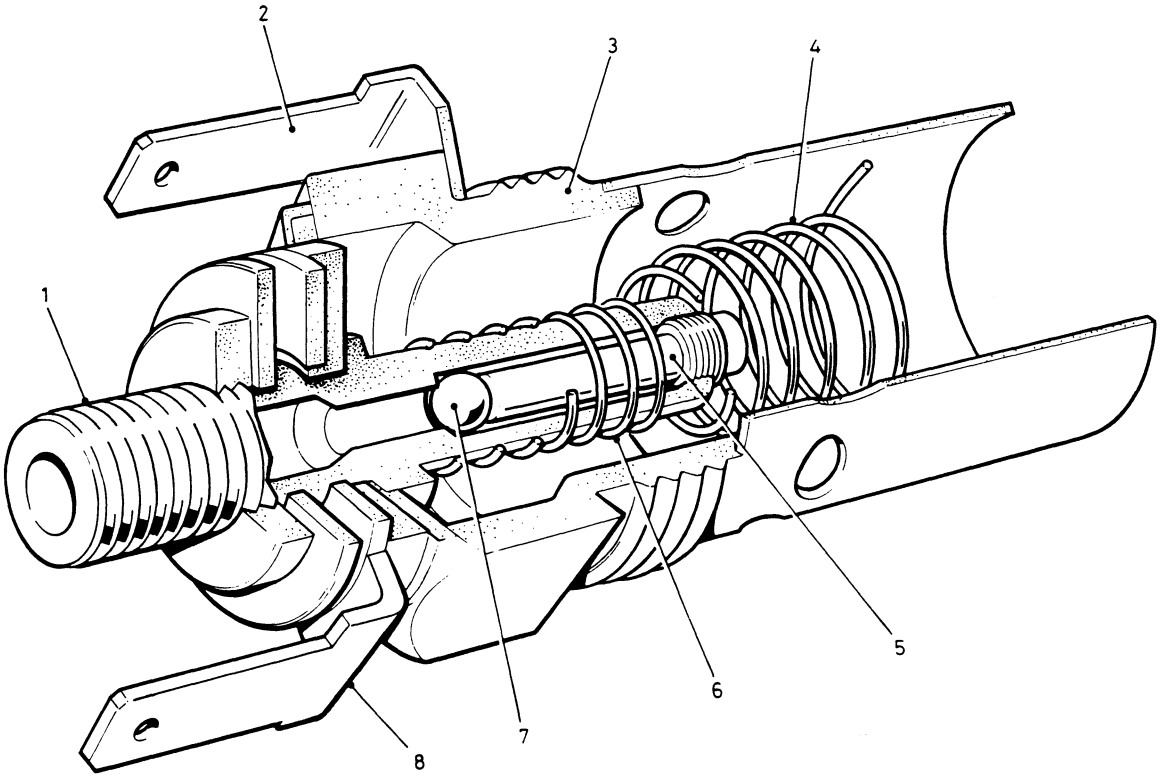
Cold start device

30 The cold start device comprises a thermostart unit and a solenoid valve.

31 The thermostart unit (Fig 10) consists of a body (3) which is screwed into a boss on the air inlet elbow which is in turn secured to the inlet manifold cover plate. Screwed into the centre of the body is a valve body (1) which is surrounded by a heater coil (6) and houses a ball valve (7) and a valve stem (5). An igniter coil (4) is attached to the inner end of the valve body. Terminals (2 and 8) are provided for the connection of power supply and earth leads.

32 The solenoid valve, which is mounted on a bracket above the fuel filter, is connected to the thermostart unit by a small bore pipe. Under normal running conditions and when the engine is stopped the solenoid valve is closed, and is only energised when the engine start/thermo switch on the driver's switch panel is set to the THERMO position. Fuel is then admitted to the thermostart unit.

33 The supply from the driver's switch panel is also supplied to the heater and igniter coils in the thermostart unit. The heater coil causes the ball valve to lift and allow fuel to flow through the thermostart unit. This fuel is ignited by the igniter coil. As the engine cranks, the burning fuel is drawn into the engine to aid starting.



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1 Valve body
2 Terminal (-ve)
3 Body
4 Igniter coil
5 Valve stem
6 Heater coil
7 Ball valve
8 Terminal (+ve)

Fig 10 Cold start device

CHAPTER 3

COOLING SYSTEM

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1 Introduction
Description
3 General
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19 Engine oil cooler
20 Radiator
22 Coolant pump
23 Gearbox oil heat exchanger
28 Thermostat
32 Fan

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10 Gearbox oil heat exchanger 10
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12 Cooling fan 13/14

INTRODUCTION

1 The cooling system (Fig 2) is designed to cool the engine, lubricating oil and gearbox oil. Coolant is circulated around the engine, engine oil cooler (10) and gearbox oil heat exchanger (7) by a belt driven coolant pump (11) and is subsequently cooled by passing through an air cooled radiator (4). Cooling air is drawn through the radiator by a belt driven fan (3) mounted between the engine and transmission compartments.

2 A temperature sensor incorporated in the system, relays information to an engine coolant temperature gauge and warning light on the drivers instrument panel, to alert the driver should the temperature exceed the permitted level.

DESCRIPTION

General

3 The cooling system is designed to cool the engine, lubricating oil and gearbox oil. Coolant is circulated around the engine, engine oil cooler and gearbox heat exchanger by a belt driven integral coolant pump and is subsequently cooled by passing through an air cooled radiator. Cooling air is drawn through the radiator by a belt driven fan mounted between the engine and transmission compartments.

COOLANT CIRCULATION

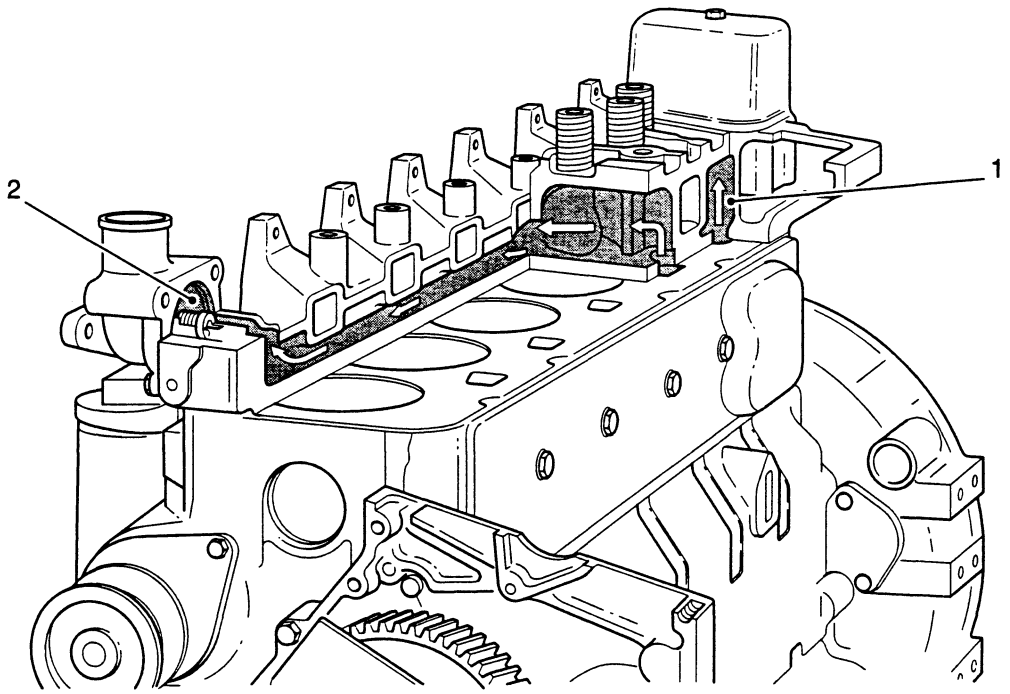
4 Coolant is introduced into the system via a header tank which accepts coolant due to expansion and supplies coolant required due to contraction.

5 Coolant is drawn in through the coolant inlet (Fig 3(1)) by the coolant pump (2) and passes into the engine oil cooler cavity (3) of the cylinder block.

6 The coolant circulates around the cylinders (Fig 4(1)) and crosses the block through internal galleries to the fuel injection pump side of the engine. At the same time coolant flows up into the cylinder head (Fig 1 (1)), crosses the valve bridges and down the exhaust manifold side of the engine to the integral thermostat housing (2). As coolant flows across the cylinder head towards the thermostat housing, it provides cooling for the injectors.

7 The thermostat incorporates a small disc valve which controls coolant recirculation (or by-pass) within the engine. When the engine is below operating temperature the thermostat is closed, preventing coolant flow from the engine to the radiator. In this mode the disc valve is open, allowing coolant to by-pass the thermostat and circulate round the engine before returning to the inlet side of the coolant pump. Galleries within the thermostat housing also allow approximately one third of the recirculating coolant to bleed off and supply the gearbox oil heat exchanger.

8 When operating temperature is reached the thermostat opens, allowing full coolant flow through the radiator and gearbox oil heat exchanger before returning to the inlet side of the coolant pump. In this mode the disc (or by-pass) valve is closed, blocking of the thermostat by-pass passage and gearbox oil heat exchanger bleed line, forcing all coolant to flow through the thermostat. Cooling system efficiency would be greatly reduced if the by-pass valve remained open as this would allow heated coolant to recirculate within the engine and gearbox oil heat exchanger without being cooled by the radiator.



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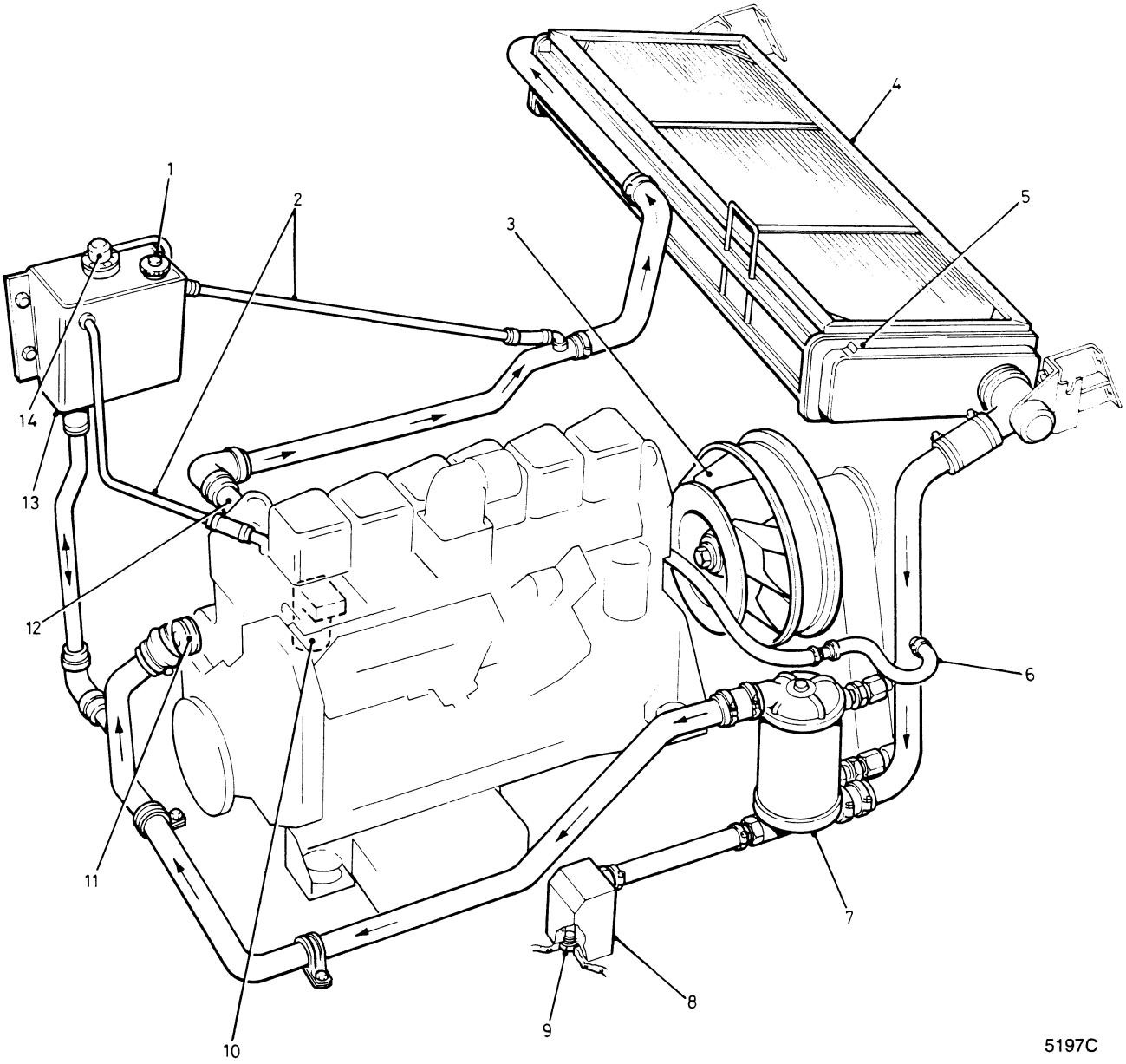
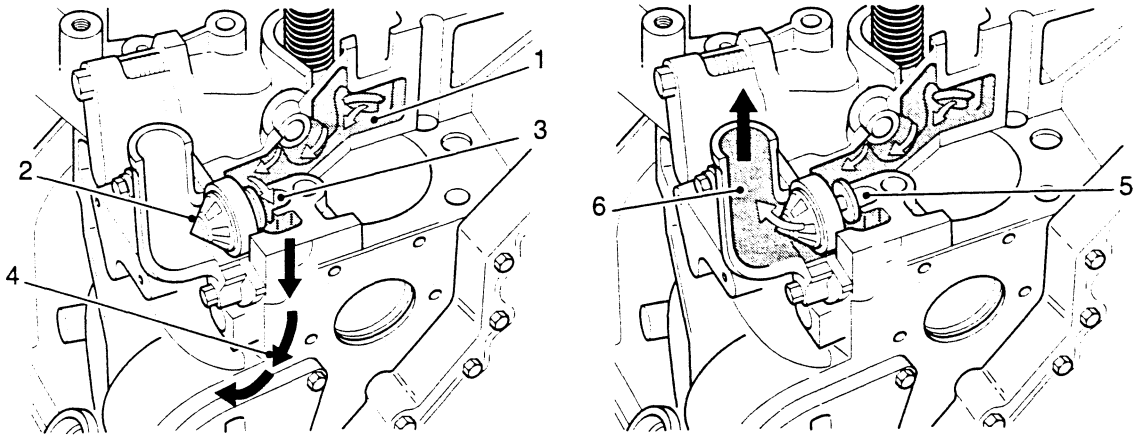
1 Coolant flow from cylinder block 2 Thermostat housing

Fig 1 Cylinder head cooling (typical)



1	Filler cap
2	Constant bleed pipework
3	Fan
4	Radiator
5	Bleed screw
6	By-pass
7	Gearbox oil heat exchanger
8	Coolant drain block
9	Coolant drain plug
10	Engine oil cooler
11	Coolant pump
12	Thermostat housing
13	Header tank
14	Pressure vacuum relief valve

Fig 2 Coolant circulation (thermostat open)



Thermostat closed

Thermostat open

1 Coolant flow past injector
2 Thermostat
3 Coolant by-pass drilling
4 Coolant flow to pump inlet
5 By-pass drilling closed
6 Coolant flow back to radiator

Fig 5 Thermostat operation (typical)

9 Any air which collects at high points in the system (i.e. radiator feed pipe) is bled back to the top of the header tank (Fig 6) via the constant bleed pipework (4).

10 A connection from the coolant pump inlet is taken to the base of the header tank.

11 A belt driven fan draws warmed air from the transmission compartment and discharges it into the engine compartment.

12 The expulsion of air from the transmission compartment causes a reduction of air pressure within the compartment. The pressure drop induces fresh ambient temperature air to be drawn in via the air inlet louvres, through the radiator and charge air cooler matrices, around the gearbox and through the fan.

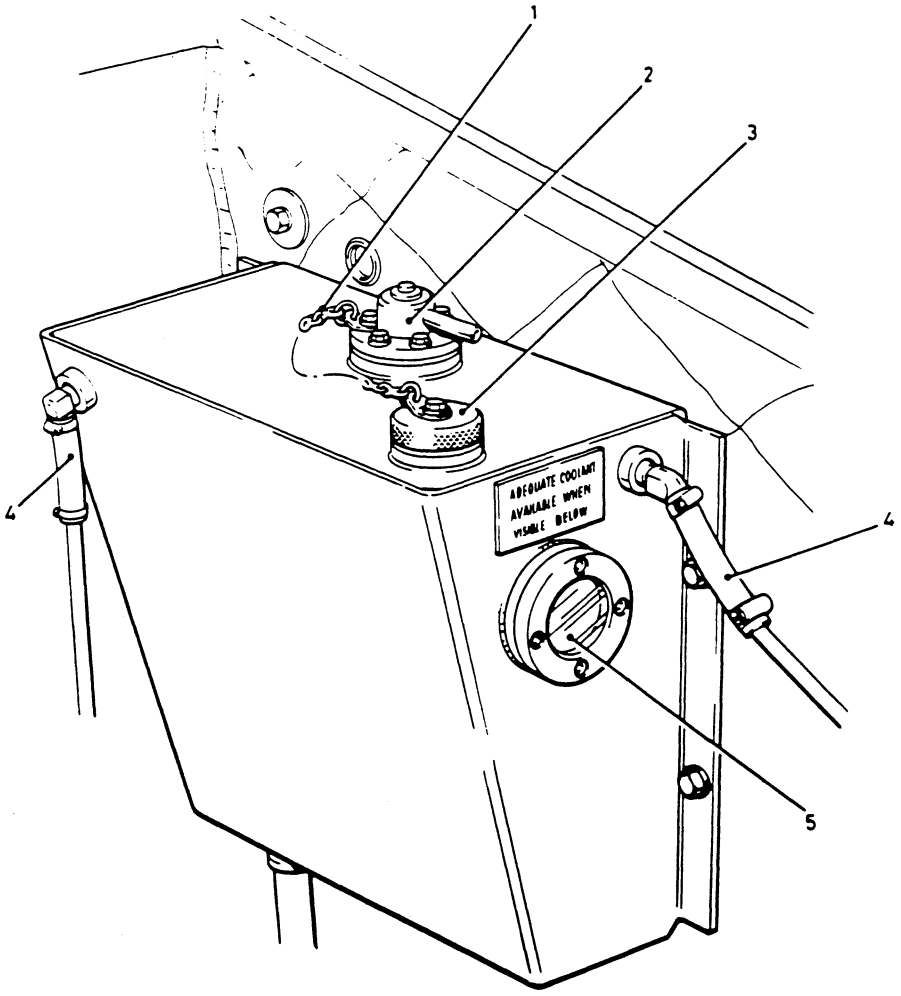
13 The warmed air passes through the engine compartment before being discharged to atmosphere via the air outlet louvres.

COOLANT HEADER TANK

14 The coolant header tank is fitted at the top rear left corner of the engine compartment. It incorporates a screwed filler cap (Fig 6 (3)) retained by a chain (1), a pressure vacuum relief valve (PVRV) (2) and a sight glass (5) for checking of the coolant level.

15 The capacity of the header tank allows for the expansion of coolant, when the system is filled to the bottom of the filler neck. The expansion compartment is otherwise sealed by the pressure vacuum relief valve (2) which is secured to a flange at the top of the tank.

16 The system head is maintained via the feed hose at the base of the tank. The filler cap (3) when closed completely seals the header tank, hence when the coolant increases its volume due to heating, excess coolant will flow from the system through the feed hose into the header tank, increasing the air pressure therein. The pressure relief valve of the PVRV (2) will regulate the rising air pressure, venting excess air to atmosphere. The process is reversed during cooling, a depression in the header tank due to the contraction of coolant, causes the vacuum relief valve of the PVRV to admit air.



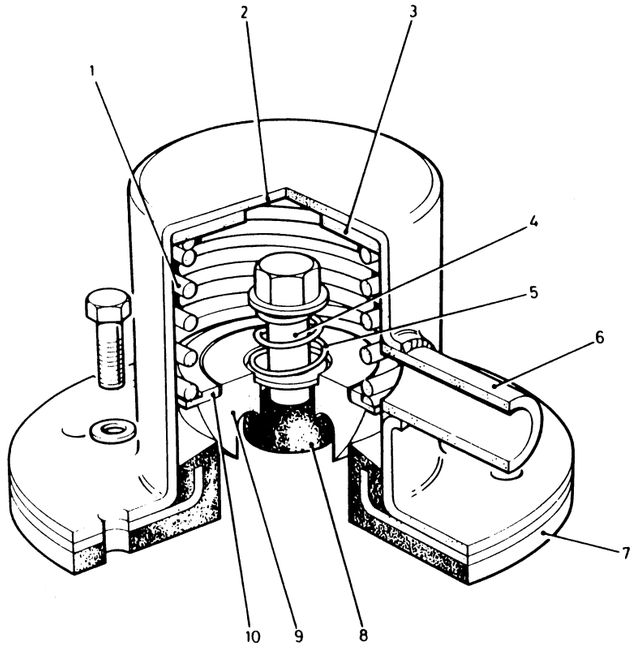
5153C

1 Chain
2 Pressure vacuum relief valve
3 Screwed filler cap
4 Constant bleed pipes
5 Sight glass

Fig 6 Coolant header tank

17 The filler cap (Fig 6(3)) is provided for topping up the cooling system as required. Any air trapped within the radiator and associated pipework is bled back for release at the top of the header tank via the constant bleed connections (4). Two bleed screws on the radiator and one on the coolant pipe behind the radiator are provided for manual release of any air trapped in the system.

18 The PVRV assembly is shown sectionalized in Fig 7. The pressure relief valve (9) is constrained on its seat by the spring (1), the vacuum valve (8) is fitted centrally in the pressure vacuum relief valve and is constrained by the spring (5). Valve operating pressures (with respect to atmospheric pressure) are relief 104 kN m^2 (15 lbf in^2) for the pressure relief and -6.9 kN m^2 (-1.0 lbf in^2) for the vacuum. Air is released or admitted via the vent (6).



5174D

1 Spring
2 Relief valve assembly
3 Spacer washer
4 Vacuum valve stem
5 Spring
6 Vent
7 Base plate
8 Vacuum valve
9 Pressure relief valve
10 Spring seat

Fig 7 Pressure vacuum relief valve

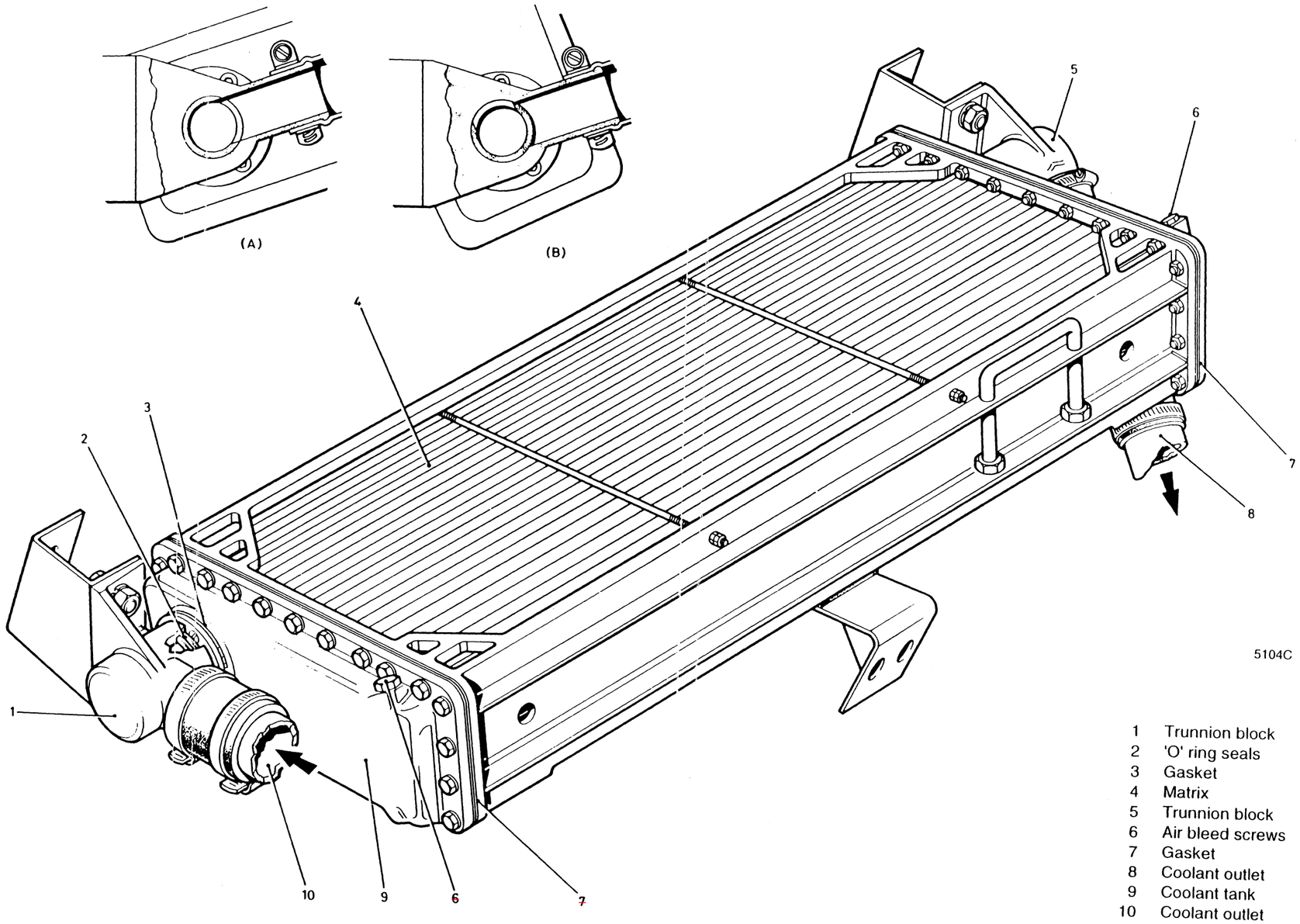
Engine oil cooler

19 The engine oil cooler is a full flow, 7 plate type cooler. Oil flows through a cast passage in the cooler cover and through the element where it is cooled by engine coolant flowing past the plates of the element.

Radiator

20 The radiator (Fig 8) is positioned horizontally and transversely in the transmission compartment immediately below the air inlet louvres. It is supported between two trunnion blocks (1) and (5) which, via internal passageways, allow the flow of coolant in and out of the radiator. The trunnion joints are sealed by 'O' rings (2) which locate in annular grooves in the trunnion blocks and bear on the outer surfaces of the trunnions. The trunnion blocks are similar, each having an inlet/outlet port which aligns with a side aperture in the trunnion as in (A) to allow the passage of coolant. This arrangement ensures full flow under operating conditions, but when the radiator is raised for access to the transmission compartment, the aperture in each trunnion is completely misaligned (B), thus blocking the coolant flow. The engine must not be run in these circumstances.

21 The radiator comprises of a single pass matrix (4) which is an assembly of finned tubes and side plates. The tube ends are brought out through and soldered to the brass end plates which also act as mounting plates for the two coolant tanks (9). The coolant tanks are bolted one to each end plate with a gasket (7) interposed for sealing; each tank is provided with an air bleed screw (6) and a tapped collar for fitment of a trunnion. Each trunnion is secured to the tank by three screws, the joint is sealed by a gasket (3). The radiator trunnions and radiator coolant tanks are handed.



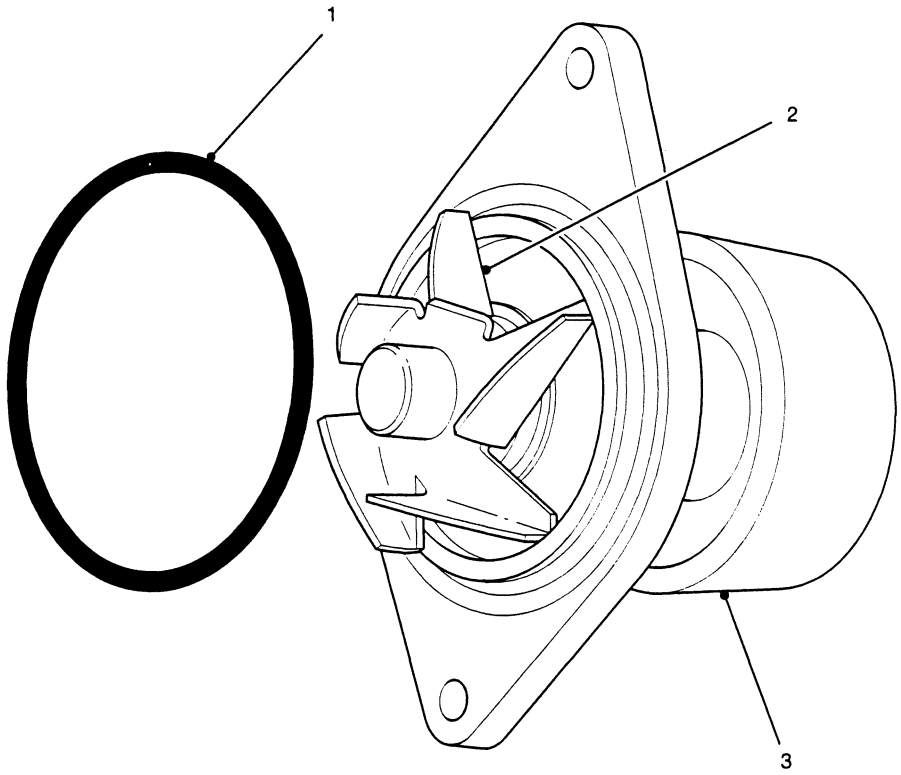
5104C

1 Trunnion block
2 'O' ring seals
3 Gasket
4 Matrix
5 Trunnion block
6 Air bleed screws
7 Gasket
8 Coolant outlet
9 Coolant tank
10 Coolant outlet

~~Fig 8~~ ~~Radiator and trunnions~~

Coolant pump

22 The integral coolant pump (Fig 9) is of the centrifugal type with the inlet and by-pass lines as internal parts of the cylinder block. It is fitted with a seal (1) and secured by two hex head screws and is driven by a drive belt, tensioned by an automatic adjuster.



1 Seal
2 Impeller
3 Pulley

Fig 9 Coolant pump

Gearbox oil heat exchanger

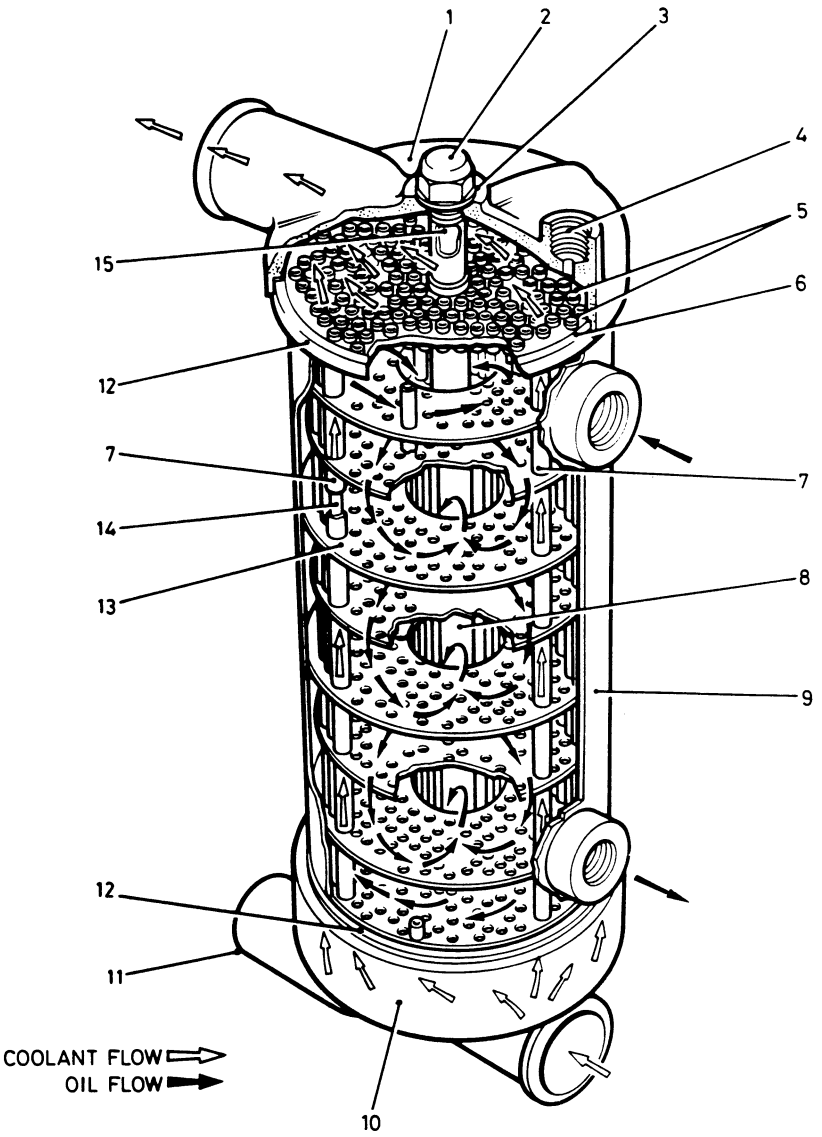
23 The gearbox oil heat exchanger (Fig 10) is vertically mounted in the front right hand side of the engine compartment with two oil connections protrude through into the transmission compartment. The two coolant connections are at the top and bottom of the unit.

24 The heat exchanger comprises of coolant tubes (5) which pass through and are soldered to top and bottom collector plates (12). Intermediate baffle plates (13) are held suitably spaced by hollow spacer tubes (7) which slide over the coolant tubes (14). The gearbox oil unit (9) is enclosed by a tubular body in which oil inlets and outlets are fitted.

25 The tie rod (15) passes through the inlet end cover (10), the gearbox oil unit (9) and the outlet end cover (1). A cap nut (2) with a sealing washer (3) beneath, is screwed to each end of the tie rod which clamps the whole unit together. Gaskets (6) ensure no leaks from coolant or oil.

26 The coolant passes through the tubes arranged in a stack, while the gearbox oil passes through the space between the tubes. By this arrangement, the gearbox oil will remain at a constant temperature.

27 A further coolant connection at the base of the unit is connected to the coolant drain block (11).



5106D

1	Outlet end cover	9	Gearbox oil unit
2	Cap nut	10	Inlet end cover
3	Sealing washer	11	Coolant drain block
4	Bleed point	12	Collector plate
5	Coolant tube	13	Intermediate baffle and tube support plate
6	Gasket	14	Coolant tubes
7	Spacer tube	15	Tie rod
8	Tie rod sleeve		

Fig 10 Gearbox oil heat exchanger

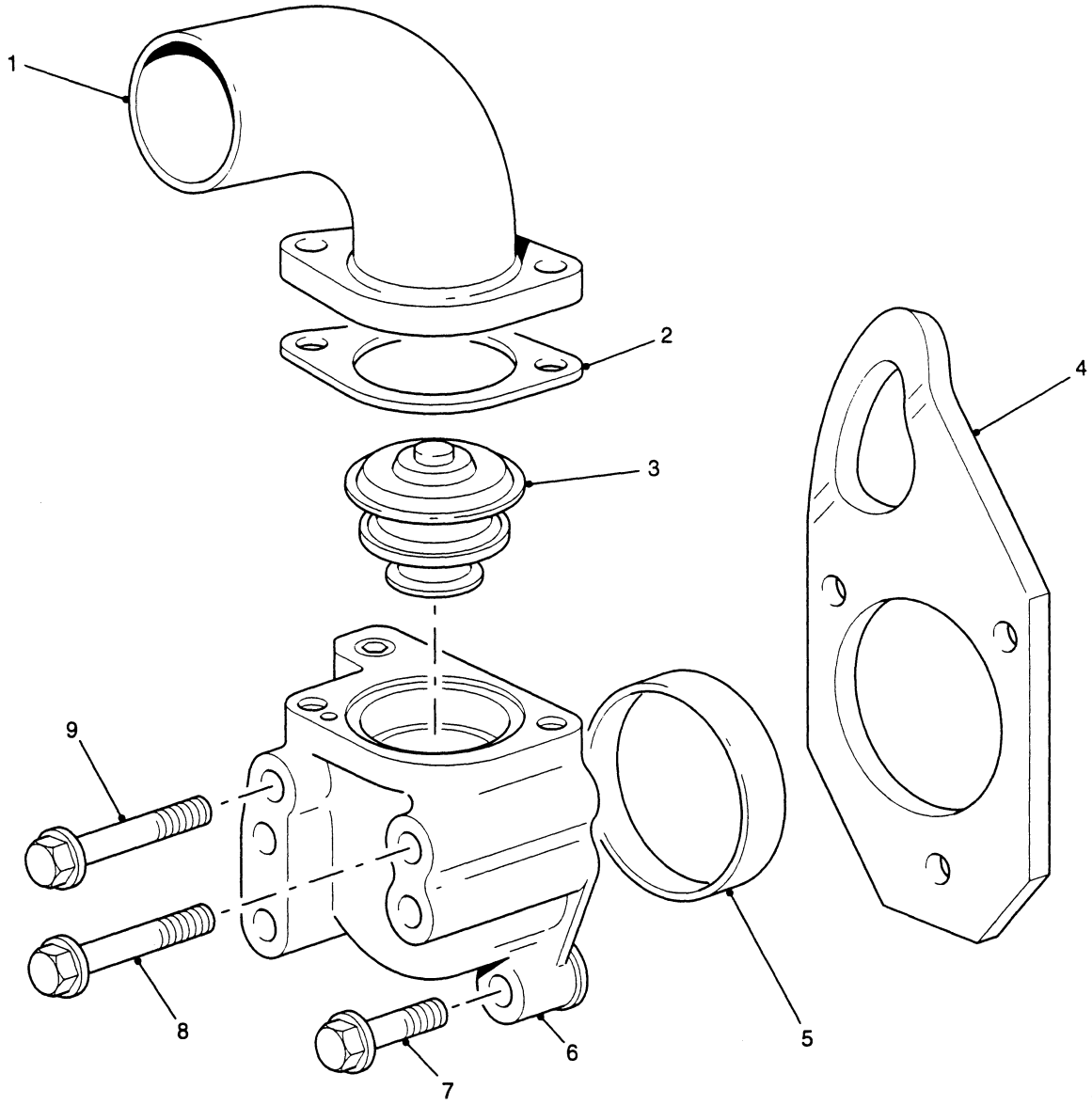
Thermostat

28 A wax element thermostat (Fig 11(3)) is fitted in the thermostat housing (6). The thermostat is retained by trapping the outer flange of the thermostat between a recess in the top of the thermostat housing (6), and an outlet pipe (1) with gasket (2). Three bolts (7, 8 and 9) secure the thermostat housing and the engine lifting bracket (4) to the cylinder head.

29 The thermostat is set to commence opening at 83 deg C (181 deg F) and be fully open at 95 deg C (203 deg F).

30 When the thermostat is open, the coolant is directed through the radiator.

31 When the thermostat is closed, the coolant is directed via the by-pass, back to the inlet side of the coolant pump.



1 Outlet pipe
2 Gasket
3 Thermostat
4 Engine lifting bracket
5 Seal
6 Thermostat housing
7 Bolt
8 Bolt
9 Bolt

Fig 11 Thermostat

~~Fan~~

32 The cooling fan (Fig 12) is mounted on the engine/transmission bulkhead and comprises a fan cowling (2), impeller assembly (1) and pulley (15) mounted on a single steel shaft (14).

33 The impeller is an alloy casting in which nine vanes are constituted to provide an axial to radial type airflow through the cowling. The impeller is bolted (25) to a hub ring (19) which in turn is keyed (11) to a steel shaft (14). The shaft is supported in two bearings in a sleeve bearing assembly (18), which is housed in the hub of the fan cowling. The sleeve bearing assembly incorporates a roller bearing (16) at the pulley (drive) end and a ball bearing (5) at the fan end. Both bearings are pre-packed with lubricant, seals (4 and10) and sealing rings (6 and 7) retain the lubricant and prevent ingress of dirt and moisture.

34 The fan cowling (2) is an alloy casting with five radial arms supporting the bearing hub and a flanged periphery for mounting the fan. The supporting arms are streamlined to prevent resistance to airflow, the fixing holes in the mounting flange have thread inserts.

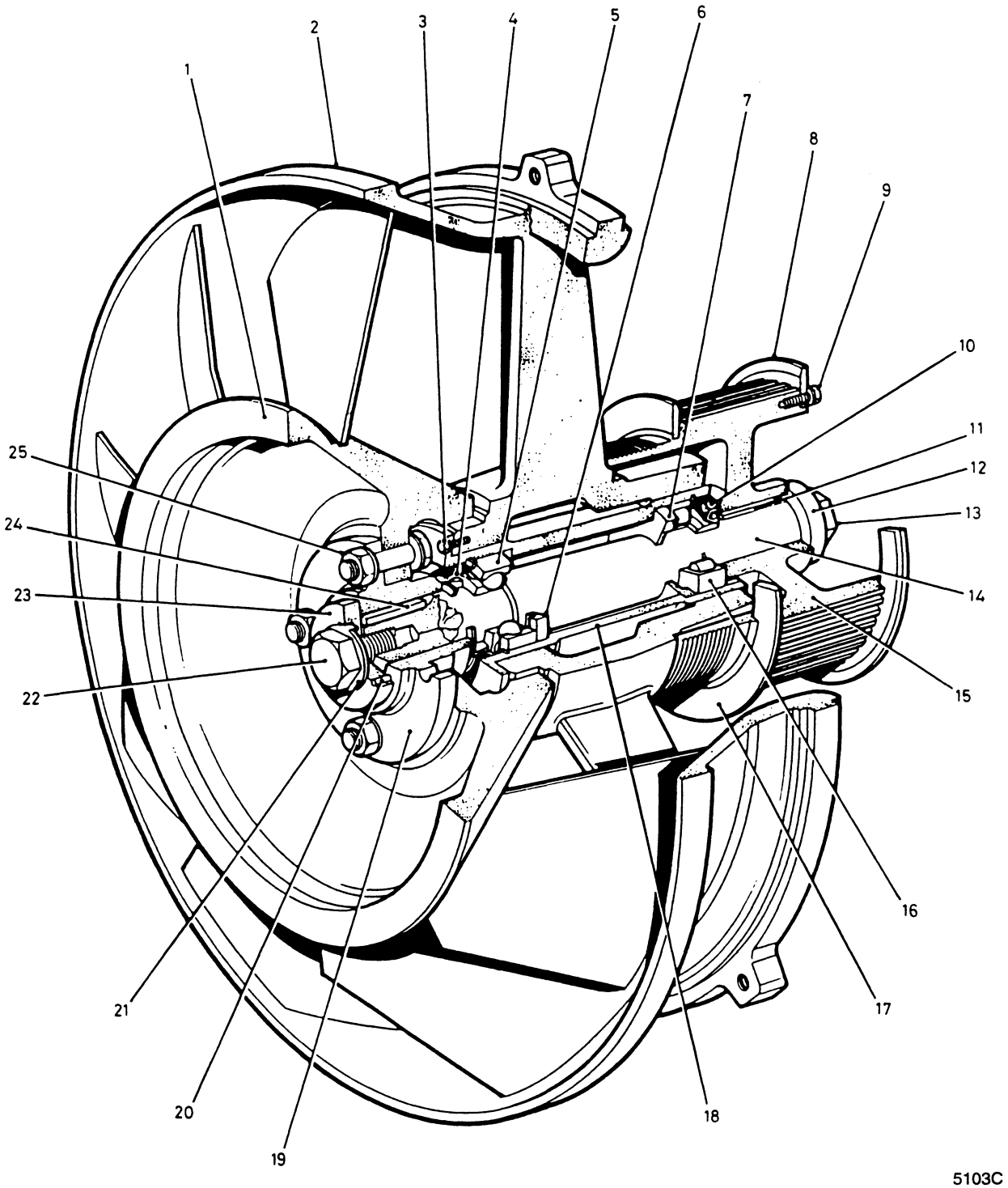
35 Drive to the impeller is applied via a steel pulley (15) which is coupled to a similar pulley on the engine drive coupling by an internally toothed drive belt. The drive belt is retained on the pulley by an inner retaining flange (17) and a removable outer retaining flange (8) which provides ease of belt removal. A further pulley surface; integral with the drive pulley on the inboard side, provides drive to the alternator via a multigroove belt.

36 Retaining plates (12 and 23) secure the fan and pulley at both ends of the shaft. The retaining plates are dowelled (20) in position and the securing screws (13 and 22) are locked with tab washers (21).

37 The fan assembly is mounted on a removable panel on the bulkhead between the transmission and engine compartments. It is fitted in slotted holes to allow for belt adjustment and an adjusting bolt is positioned near the top of the fan in the gearbox compartment.

38 The fan forces air from the transmission compartment into the engine compartment. This creates a depression in the transmission compartment causing air to be drawn in through the radiator and charge air cooler matrices.

39 The air in the engine compartment is discharged through the air outlet louvres.



1	Impeller	9	Screw	18	Sleeve bearing assembly
2	Fan cowling	10	Seal	19	Hub ring
3	Screw	11	Key	20	Dowel
4	Seal	12	Retaining plate	21	Tab washer
5	Ball bearing	13	Screw	22	Screw
6	Seal ring	14	Shaft	23	Retaining plate
7	Seal ring	15	Pulley assembly	24	Key
8	Retaining flange (removable)	16	Roller bearing	25	Bolt
		17	Retaining flange		

Fig 12 Cooling fan

CHAPTER 4

TRANSMISSION

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INTRODUCTION

1 The power of the engine is transmitted through a main drive coupling (Fig 1) and through the gears to the final drives. The main drive coupling incorporating a flexible coupling and a constant velocity joint, is bolted to the engine flywheel and to the centrifugal clutch of the gearbox.

GEARBOX

2 The ATL T303 gearbox combines the Wilson epicyclic train system with Merritt steering principles and provides seven gears, both forward and reverse. The gears are engaged hydraulically by applying oil operated brake bands and clutches to the gear trains.

3 Gear change is determined by an electronic controller located in the commander's compartment, which sends signals to an electro-hydraulic valve block mounted on the gearbox. Solenoid operated valves on the valve block admit pressurised hydraulic oil to the appropriate brake bands and clutches to engage the chosen gear. The controller receives signals from an electro-magnetic speed sensor, the driver's gear selector and microswitches on the throttle linkage which indicate whether the vehicle is coasting or driving. Selection of forward and reverse is by a control lever located in the driver's compartment.

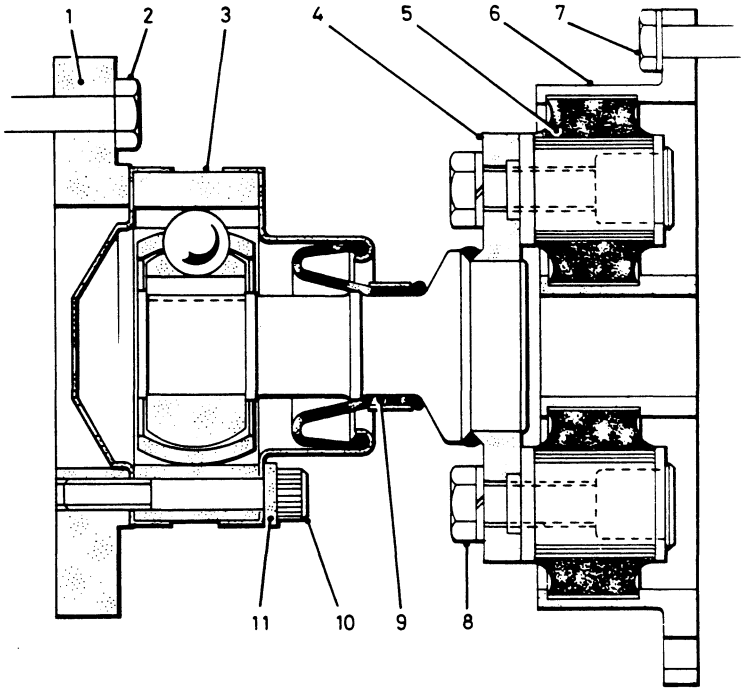
4 Hydraulic pressures for gear engagement, generated by the main oil pump, are available whenever the engine is running. Thus the take-up of drive from rest is confined to the centrifugal clutch. Lubrication pressures are available from start up.

5 The tow start pump, which is isolated during normal operation, provides sufficient hydraulic pressure for gear engagement during tow starting.

NOTE

Neutral must be selected before any towing operation (other than for tow starting) commences. If the vehicle is to be towed with a defective gearbox, the final drive input shafts must be disengaged.

6 Incorporated in the input to the transmission is a free wheel device which allows a mechanical drive to the engine for tow starting operations. In normal driving, the free wheel device is in the free wheel mode.



5091D

1 Coupling/gearbox adaptor
2 Adaptor/gearbox bolts
3 Constant velocity joint
4 Main drive coupling shaft assembly
5 Rubber insert
6 Engine flywheel coupling
7 Coupling/flywheel bolts
8 Spindle to engine flywheel coupling bolts
9 Rubber boot
10 Coupling to adaptor mounting bolts
11 Locking plate

Fig 1 Main drive coupling

Transmission

7 The transmission comprises:

7.1 An input bevel cluster and sliding sleeve providing both forward and reverse in all gears.

7.2 Four epicyclic trains and two multi-plate clutches providing seven gear ratios and neutral.

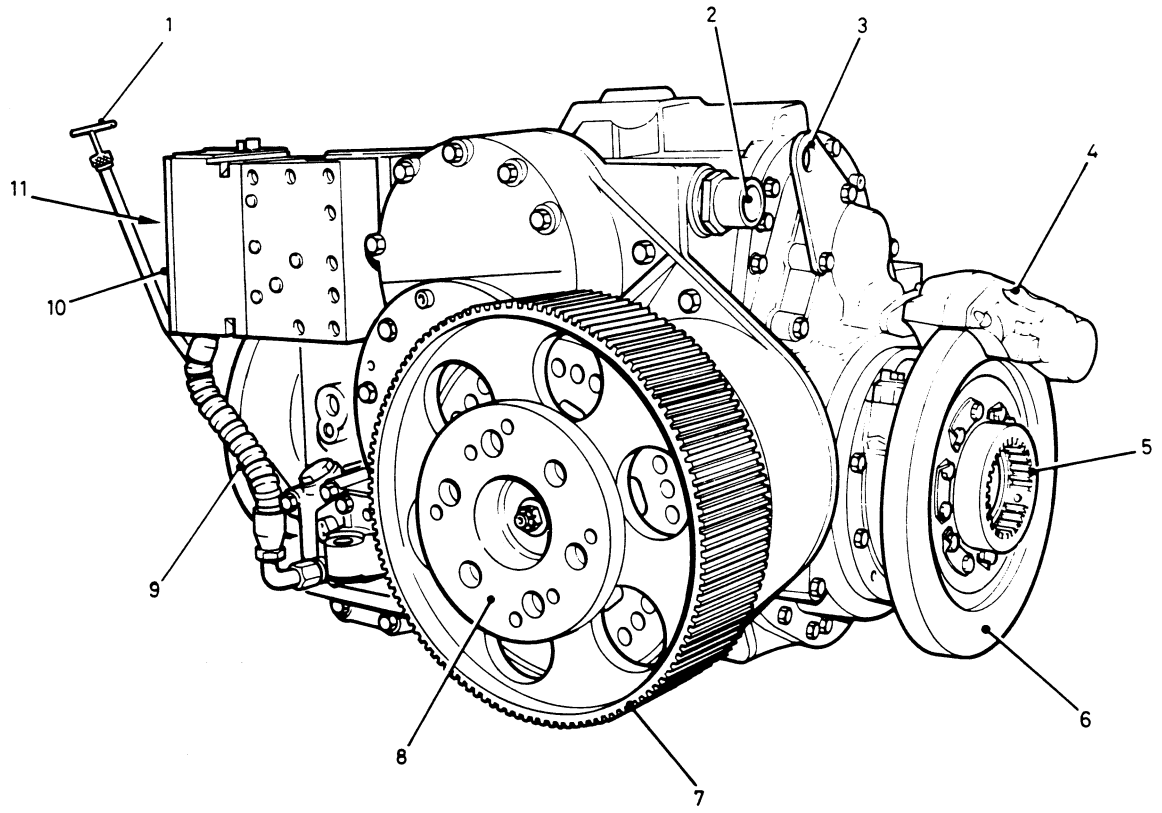
7.3 Two epicyclic trains forming the output gears.

7.4 A differential which, when steering, allows one track to speed up proportional to the decrease in speed of the other.

7.5 Two steering trains, for transmitting the drive from the differential to the sun wheels of the output gears.

7.6 Two hydraulically operated steering brake calipers (Fig 2(4) and (11)) control the differential.

8 The epicyclic gears, forward and reverse bevel gears, input bevel gear and differential are assembled in the two halves of a vertically split alloy gearcase. The brake band operating cylinders are bored horizontally in each half of the casing, giving eight cylinders in two rows of four.



5080D

1 Dipstick
2 Breather/filler connection
3 Lifting eye
4 RH steering brake caliper
5 RH output coupling
6 RH steering disc
7 Toothed belt drive pulley
8 Input coupling
9 Electro-hydraulic valve block oil feed
10 Electro-hydraulic valve block
11 LH steering brake caliper (hidden)

Fig 2 Three quarter view of gearbox

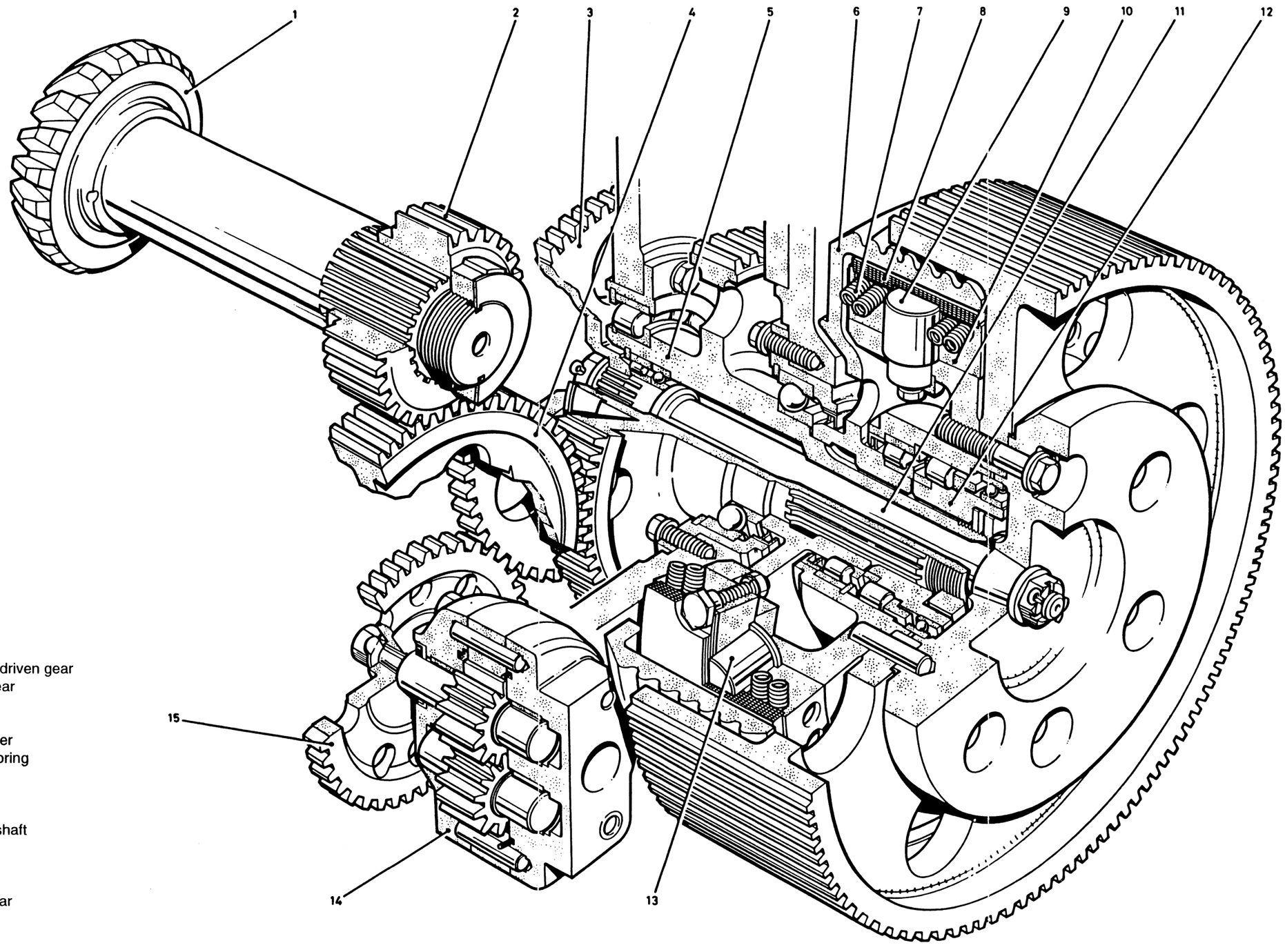
Centrifugal clutch

9 Projecting radially from the centrifugal clutch inner member are the six driving pins (Fig 3(9)), each carrying a clutch shoe (10) fitted with a clutch shoe liner (8). Four garter extension springs (7) pass through each of the shoes.

10 The clutch outer member (6) is splined to the input gearshaft (5) in front of the free wheel assembly (12).

11 The input gearshaft meshes with an idler gear (4) which, in turn, meshes with the spiral bevel pinion driven gear (2) splined to the spiral bevel pinion (1).

12 The input gearshaft is hollow and located centrally within it is a solid pump driving gearshaft (11). On its inner end is splined the oil pump driving gear (3) which drives the main oil pump (14) through the oil pump driven gear (15).



1 Spiral bevel pinion
2 Spiral bevel pinion driven gear
3 Oil pump driving gear
4 Idler gear
5 Input gearshaft
6 Clutch outer member
7 Garter extension spring
8 Clutch shoe liner
9 Driving pin
10 Clutch shoe
11 Pump driving gearshaft
12 Freewheel
13 Drive pin
14 Main oil pump
15 Oil pump driven gear

Fig 3 Three quarter rear cutaway part view of gearbox

Clutch action

13 When the engine is running below clutch pick-up speed, the four garter extension springs (7) restrain the clutch shoes (10) from moving out due to centrifugal force and so prevents clutch engagement. When the engine is accelerated above pick-up speed (750/900 rev/min) the restraining force of the garter extension springs is overcome by the centrifugal force acting on the clutch shoes which move outwards causing the clutch linings (8) to make contact with the clutch outer member (6) and permit a smooth take up of the drive.

Freewheel

14 Incorporated in the clutch hub is a freewheel (12) formed with ramps and steel rollers, which is splined to the rear end of the input gearshaft. In the normal direction of drive the device is freewheeling. When the vehicle is being tow started, the rollers ride up the ramps, lock the device and force rotation of the engine. It also has the same effect on the overrun, giving braking assistance from the engine.

Directional gears

15 The directional gears, which are controlled by the driver operating the transfer lever, comprise a cluster of two bevel gears (Fig 4(21 and 25)) in constant mesh with the input bevel gear. The directional gears are supported on bearings housed in the casing and retained by bronze half caps. A forward/reverse sliding sleeve (20) is splined to the hollow differential primary shaft (26) which carries the drive to the differential. The directional gears being meshed with the input bevel will be driven in opposite directions. The direction of rotation of both the gear and steering trains can be reversed by engaging the forward/reverse sliding sleeve with either of the forward/reverse bevel gears.

Differential

16 The differential (30) is of the spur gear type and comprises three pairs of planet gears (28), so arranged in the housing that one pinion of each pair meshes with the differential sunwheel (31) at the left, while the other meshes with a sunwheel at the right. The differential gearwheel (29) bolted to the differential housing, transmits the drive to the change speed gears via the input driving gear (7) integral with the high speed clutch (8).

Half shafts

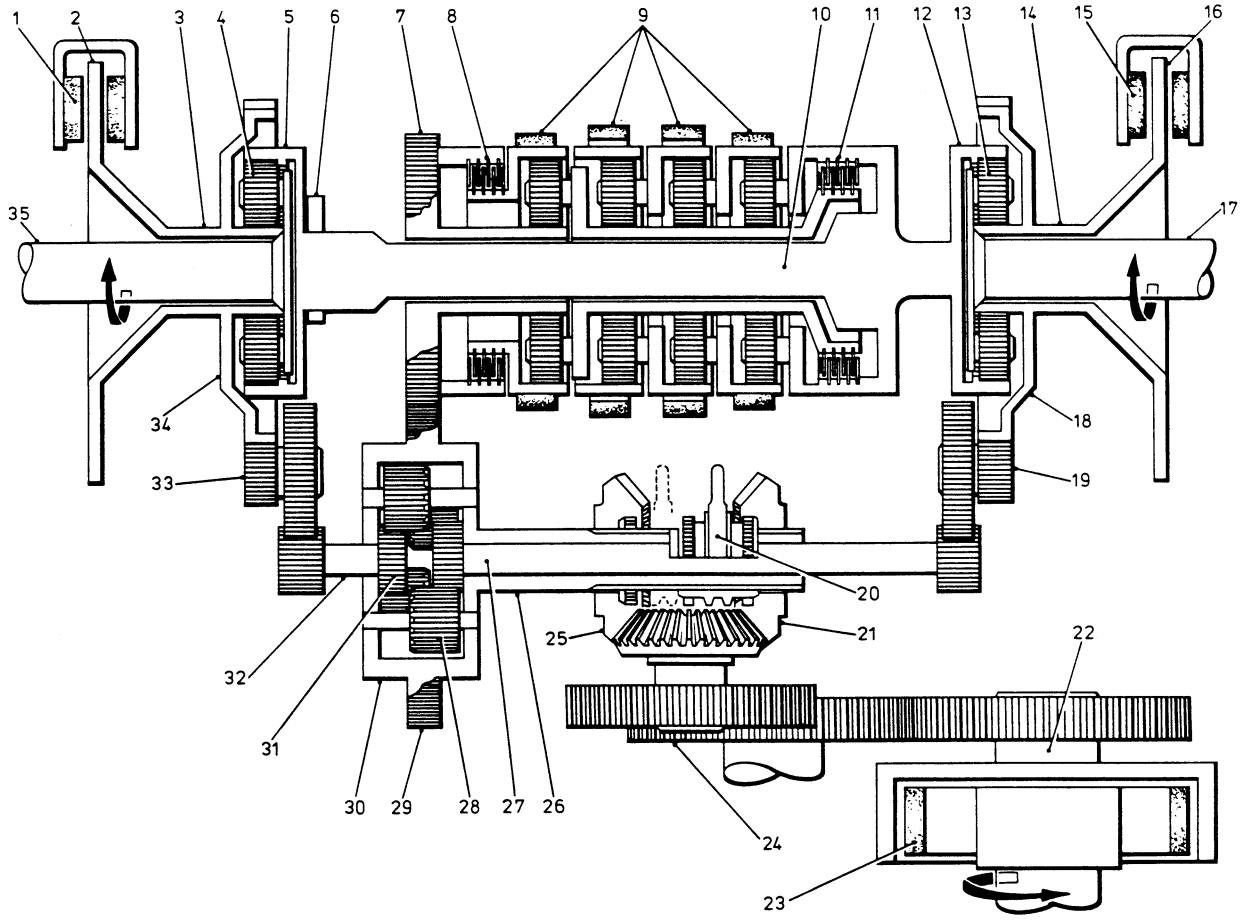
17 The two half shafts (27 and 32) are splined into differential sunwheels at one end, and carry the steering pinions at the other. When steering, one half shaft is stopped through the braking of the steering brake disc (2 or 16), and differential action causes the speed of the other to double.

Gear trains

18 The drive to the gear trains is received from the differential gearwheel (29) which meshes with integrally cut input driving gears (7) of the driving member of the high speed clutch (8). The driven member forms the low speed annulus.

19 The lowest gear of the seven speed gearbox is 1st with the others numbered 2nd to 7th. First, 2nd and 3rd gears are obtained by coupling each annulus respectively to the low speed train of gears and 4th, 5th and 6th obtained by coupling annuli 1st, 2nd and 3rd with the high speed clutch (8). Seventh speed is obtained by connecting both high speed and 7th speed clutches (see Para 21).

20 The hub of the high speed clutch (8) and the four sunwheels are interconnected through the low speed planet carrier and rotate on bearings on the secondary shaft (10). Output to the secondary shaft in gears from 1st to the 6th is from the 1st gear planet carrier which is splined to the drum of the 7th speed clutch, the drum being splined to the secondary shaft. Output to the secondary shaft in the 6th gear is from both the 1st gear planet carrier and the sunwheel. Splined to each end of the secondary shaft are the annuli of the epicyclic trains.



2198D

1	LH steering brake	18	RH steering brake driving gear
2	LH steering brake disc	19	RH steering idler gear
3	LH steering coupling	20	Forward/reverse sliding sleeve
4	LH planet gears	21	Forward drive bevel gear
5	LH annulus gear	22	Input gearshaft
6	Tow start pump cam	23	Centrifugal clutch
7	Input driving gear	24	Input idler gear
8	High speed clutch	25	Reverse drive bevel gear
9	Epicyclic brake bands	26	Hollow differential primary shaft
10	Secondary shaft	27	RH half shaft
11	7th speed clutch	28	Differential planet gear
12	RH annulus	29	Differential gearwheel
13	RH planet gear	30	Differential
14	RH steering coupling	31	Differential sunwheel
15	RH steering brake	32	LH half shaft
16	RH steering brake disc	33	LH steering idler gear
17	RH output shaft and planet carrier	34	LH steering brake driving gear
		35	LH output shaft and planet carrier

Fig 4 Diagrammatic layout of gearbox

21 The gears are obtained by directing fluid under pressure to pistons to engage brake bands or clutches in pairs as follows:

21.1 1st - Low speed and 1st/4th brake bands (Fig 5(a))
21.2 2nd - Low speed and 2nd/5th brake bands
21.3 3rd - Low speed and 3rd/6th brake bands
21.4 4th - High speed clutch and 1st/4th brake bands (Fig 5(b))
21.5 5th - High speed clutch and 2nd/5th brake bands
21.6 6th - High speed clutch and 3rd/6th brake bands
21.7 7th - High speed and 7th speed clutches

Brake bands and clutches

22 Brake bands for low speed, 1st, 2nd and 3rd gear trains are applied to the respective annulus of each train. Each brake consists of two separately opposed bands. Each epicyclic brake band (Fig 4(9)) is applied hydraulically by a pair of opposed pistons. The diameters of the pistons vary, the largest piston being required for the 1st - forward/reverse - gear brake because the greatest torque reaction occurs in this gear. The inherent tension in the brake carrier when the hydraulic pressure is released is sufficient to disengage the brake band from the annulus.

23 The high speed and 7th speed clutches (8 and 11) are applied hydraulically by oil pressure ducted to pistons to operate the pressure plates. Each clutch consists of pairs of steel and sintered bronze faced steel plates splined internally or externally alternately to the driving and driven members. Eight small springs and ball valves ensure the disengagement of the clutch plates when not in use. The ball valves are inserted, diametrically opposed, into each clutch housing. When oil is admitted to the housing at clutch engagement, the pressure of the oil pushes the balls on to their seats, closing off the ports. When the oil pressure is released the balls are unseated by centrifugal force allowing the escape of oil and permitting complete and rapid disengagement of the clutch.

GEAR SELECTION

24 Gear selection is achieved by admitting hydraulic oil to brake bands and clutches. The flow of oil is controlled by six solenoid operated valves mounted on a valve block which is bolted to the gearbox. Electrical signals to operate the solenoids are produced in the gear change controller and depend on the speed of the vehicle, and on various operational parameters.

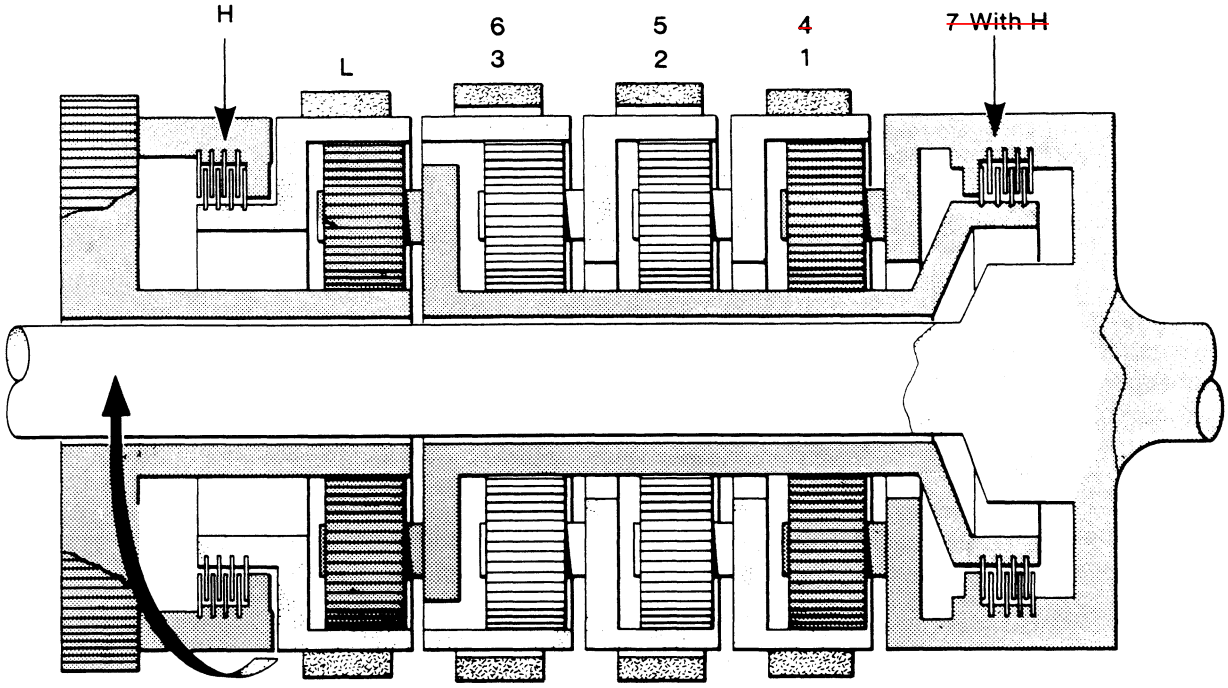
25 In the event of an electrical failure rendering the automatic gear select system inoperative, either 1st or 4th gear can be selected by opening the appropriate solenoid valves mechanically. This facility is contolled by a lever operated by the driver.

First gear

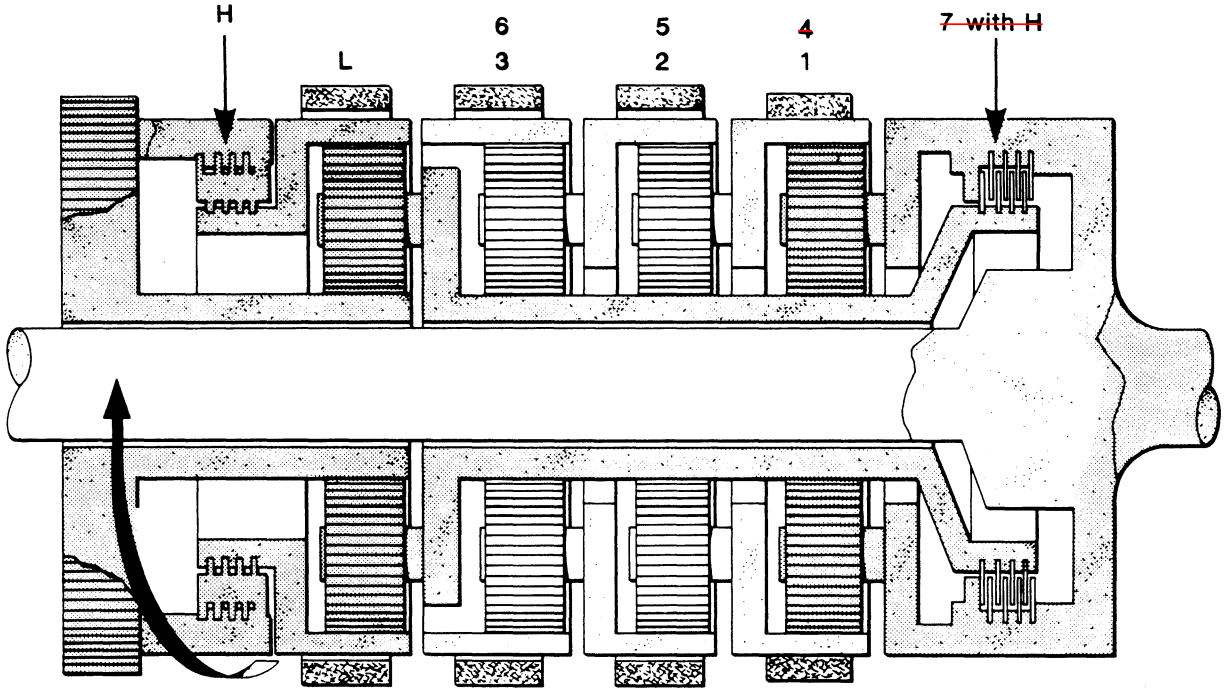
26 When first gear is selected, the high speed clutch driven member provides a drive to the low speed sunwheel, and with the low speed brake band engaged, ie annulus stationary (Fig 5(a)), an initial gear reduction is obtained, the drive being taken from the low speed planet carrier. As the sunwheels of 1st, 2nd and 3rd gears are interconnected, the drive passes to the 1st gear sunwheel. Because the 1st gear annulus is held stationary, it provides a further reduction in the gear ratio. The 1st gear planet carrier takes the drive to the secondary shaft via the 7th gear drum providing a gear reduction ratio of 15.32:1.

Second gear

27 With second gear selected, the high speed clutch driven member is providing the input device, the initial reduction is obtained by holding the low speed gear train stationary. The drive is thus taken to the sunwheels, and by holding the 2nd gear annulus stationary the drive is transmitted to the planet carrier at a further reduction. The output from this train is from the 2nd gear planet carrier to the 1st gear annulus, 1st gear planet carrier, and the 7th gear drum giving a reduction ratio of 6.66:1.



(a) 1st gear engaged



(b) 4th gear engaged

~~5081C~~

Fig 5 Gear engagement

Third gear

28 When third gear is selected, input drive is from the high speed clutch driven member to the low speed gear train and then to the sunwheels. By holding the 3rd gear annulus stationary, a further reduction is obtained. The output from this train is from the 3rd gear planet carrier through the 2nd and 1st gear trains to the 7th gear drum and secondary shaft providing a ratio of 4.77:1.

Fourth gear

29 When fourth gear is selected (Fig 5(b)), the low speed brake band is disengaged and the high speed clutch engaged, locking it to the low speed annulus. Thus the low speed annulus and sunwheel are driven by, and at the same speed as the high speed clutch, thereby raising the gear ratio. As the low speed planet carrier drives all the sunwheels, by braking the 1st annulus, a gear will be obtained with a reduction ratio equal to the 1st gear train which is 2.83:1.

Fifth and six gear

30 With the high speed clutch and low speed gear train locked and turning as one, 5th or 6th gear ratio is obtained by braking the annuli of the gear selected giving progressively higher ratios, as for 2nd and 3rd gears (Para 27 and 28). The gear ratios obtained are 5th gear 1.56:1 and 6th gear 1.18:1.

Seventh gear

31 Seventh gear is obtained by engaging both the high speed and 7th speed clutches to provide a straight through drive from the input gear to the secondary shaft. Engaging the high speed clutch connects the low speed annulus and sunwheel to the clutch, and engaging the 7th speed clutch connects both the 1st gear sunwheel and planet carrier to the clutch. The gear ratio for 7th gear is 0.75:1.

Neutral

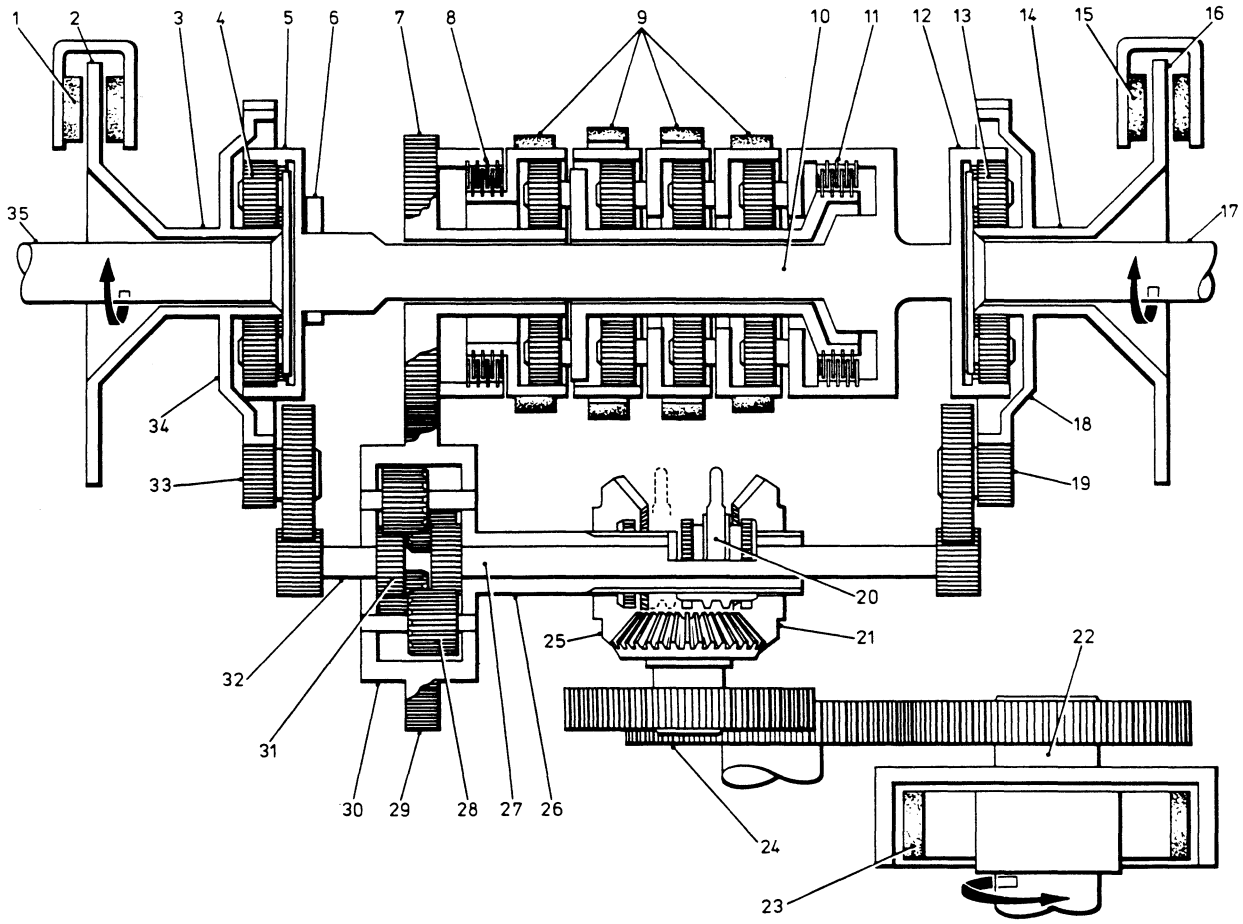
32 In normal operation neutral is obtained by closing the solenoid valves so that no clutches or brakes are energised. This allows the gears to rotate idly and transfer no drive to the output. Neutral steering is possible under these conditions. If, however, the forward/reverse lever is moved to the central position the sliding sleeve will be disengaged. The directional gears will be driven on the layshaft. There will be no drive to gear or steering trains and no output from the gearbox and, therefore, no neutral steering.

Output gears

33 The output gears comprise two epicyclic trains (Fig 6(3,4,5 and 12,13,14)), one at each side of the casing, for transmitting the drive to the output shafts (17 and 35). The two annulus gears (5 and 12) are splined to the ends of the secondary shaft (10), the RH annulus (12) also having external splines for engagement with the drum of the 7th speed clutch. There are three planet gears (4 and 13) in each set, each pinion running on roller bearings.

Operation

34 When the vehicle is in forward gear and moving straight, each steering coupling (3 and 14) is driven at a constant ratio of the engine speed in an anti-clockwise direction, while each output annulus gear (5 and 12) is driven at a varying speed by the secondary shaft (10) in a clockwise direction. The annulus gear speed always exceeds the sunwheel speed. Each output shaft (17 and 35) is, therefore, driven in a clockwise direction at a speed equal to annulus speed minus sunwheel speed.



2198D

1	LH steering brake	18	RH steering brake driving gear
2	LH steering brake disc	19	RH steering idler gear
3	LH steering coupling	20	Forward/reverse sliding sleeve
4	LH planet gears	21	Forward drive bevel gear
5	LH annulus gear	22	Input gearshaft
6	Tow start pump cam	23	Centrifugal clutch
7	Input driving gear	24	Input idler gear
8	High speed clutch	25	Reverse drive bevel gear
9	Epicyclic brake bands	26	Hollow differential primary shaft
10	Secondary shaft	27	RH half shaft
11	7th speed clutch	28	Differential planet gear
12	RH annulus	29	Differential gearwheel
13	RH planet gear	30	Differential
14	RH steering coupling	31	Differential sunwheel
15	RH steering brake	32	LH half shaft
16	RH steering brake disc	33	LH steering idler gear
17	RH output shaft and planet carrier	34	LH steering brake driving gear
		35	LH output shaft and planet carrier

Fig 6 Diagrammatic layout of gearbox

Steering trains

35 Two identical spur gear trains situated in the gear case end covers form the steering trains. Each train comprises a pinion formed integrally with a differential half shaft (27 and 32), an idler gear and pinion (19 and 33) and a steering brake driving gear (18 and 34) which is splined to a steering coupling (3 and 14).

36 The two integral idler gears, comprising a wheel and pinion (19 and 33) are supported on a pin by rollers. The wheel meshes with the differential half shaft (27 and 32) while the idler pinion meshes with the steering brake driving gear (18 and 34).

37 The steering trains transmit the drive from the differential (30) through the half shafts (27 and 32) to the steering couplings (3 and 14). The steering couplings, in straight ahead and reverse operations, are driven at the same speed, which is a constant ratio of the engine speed, and in the same direction as the differential shaft pinion. In steering operations, one steering train is stopped, by applying the steering brake, with the result that the speed of the opposite steering coupling is increased to twice its former speed.

Steering brakes

38 The steering brakes are situated at the sides of the gearbox; each brake consists of a steering disc (2 and 16)) driven by the appropriate driving gear (18 and 34), and a hydraulically operated steering brake (1 and 15) bolted to the gearbox casing. A pair of steering brake pad assemblies comprising friction linings bonded to backing plates are contained in each assembly.

PRINCIPLES OF OPERATION

NOTE

In the following paragraphs, reference to clockwise or anti-clockwise means as viewed from the right hand side (See Fig 8).

Vehicle moving forward - straight

39 When 2nd gear is engaged and forward direction selected with the transfer lever and with the engine running above idling speed, there is a drive from the input coupling through the input gears to the differential housing. The drive is then through a pair of spur gears to the change speed gear trains, which drive the secondary shaft, and therefore the output annular wheels, in a clockwise direction.

40 Another drive through the differential half shafts and steering trains causes the output sunwheels to rotate in an anti-clockwise direction at a constant ratio of the engine speed.

41 Since the speed of the output annular wheels is greater than that of the sunwheels, each output shaft is driven in a clockwise direction at a constant ratio of the engine speed.

42 At each upward gear change, the drive is transmitted through the corresponding gear trains in the change speed gears. This results in an increase in speed of the output annular wheels at each step, while the speed of the output sunwheel remains at a constant ratio of the engine speed. As the annular wheel speed is increased, the output shaft speed and consequently the vehicle speed is increased.

Vehicle moving in reverse - straight

43 Reverse direction is obtained by moving the transfer lever to the reverse position which in turn moves the sliding sleeve in mesh with the reverse drive bevel pinion which reverses the drive throughout the gearbox as for Para 39 to 42, so that the final rotation of the output annular wheels are in an anti-clockwise direction.

Vehicle moving forward - steering

44 If the vehicle is moving forward and the right steering lever is pulled back (Fig 7 and 8), so stopping the left steering disc, the immediate effect is to stop the output sunwheel, steering train, and the differential half shaft at the left side, and cause the left output shaft to speed up. Due to the action of the differential gears the right side differential half shaft is speeded up to twice its former speed, resulting in the right output sunwheel also being driven at twice its former speed, and the annular wheels rotating at the same speed as formerly. Since the sunwheel speed is now twice its former speed, the speed of the right output shaft has been reduced by the same amount that the opposite shaft has been increased.

45 Therefore, when the right steering lever is applied, the speed of the left track is increased and that of the right track reduced by a similar amount, causing the vehicle to turn to the right. Conversely, when the left steering lever is applied, the vehicle is caused to turn to the left.

46 As the speed of the sunwheels is at a constant ratio to the engine speed and that of the annular wheels dependent upon the gear engaged, the difference in speed of the output shafts becomes less in each higher gear. The size of the turning cycle, therefore, increases as higher gears are engaged.

Vehicle moving in reverse - steering

47 When the left steering lever is applied, the right output sunwheel is stopped and this causes the left sunwheel to be driven at twice its former speed, while the speed of the annular wheels remain unchanged. The annular wheels rotate anti-clockwise. The left output shaft is driven in an anti-clockwise direction at a reduced speed and the right output is driven in the same direction at an increased speed.

48 Therefore, when the vehicle is moving backwards and the left steering lever is applied, the right track is speeded up and the left track slowed down by equal amounts. Conversely, when the right steering lever is applied the left track is speeded up and the right track slowed down. The result is that the rear of the vehicle turns to the side of the applied steering lever.

Vehicle stationary - neutral turn - forward engaged

49 When the vehicle is stationary, with the engine idling, neutral selected, and transfer lever to forward, no steering will result from the application of a steering lever, since the engine speed is not high enough to give a drive through the centrifugal clutch.

50 When a neutral turn is required, it is necessary to accelerate the engine to engage the centrifugal clutch. There is then a drive through the differential and steering trains to the output sunwheels, which are driven in an anti-clockwise direction. Since the weight of the vehicle holds the output shafts and the planet carriers stationary, the output annular wheels are allowed to idle.

51 When the left steering lever is applied, the right steering disc and the right output sunwheel are held. Under conditions of equal resistance to the tracks the right output shaft rotates in a clockwise direction, receiving its drive from the left steering train via the secondary shaft.

52 Due to the action of the differential, the speed of the left sunwheel is doubled so that the annular wheel speed is now less than the new speed of the left sunwheel. Consequently, the left output shaft rotates in the same direction as the left sunwheel, ie anti-clockwise. When either steering lever is applied the track on the same side as the applied steering lever moves backwards and the track on the opposite side moves forward at the same speed, causing the vehicle to pivot on its centre with the front of the vehicle turning towards the applied lever.

53 It has been assumed so far that there is an equal resistance to each track, but conditions may be that one track is on hard ground, and the other on soft; in which case that track offering the greater resistance would be held, as would the output shaft at that side of the transmission.

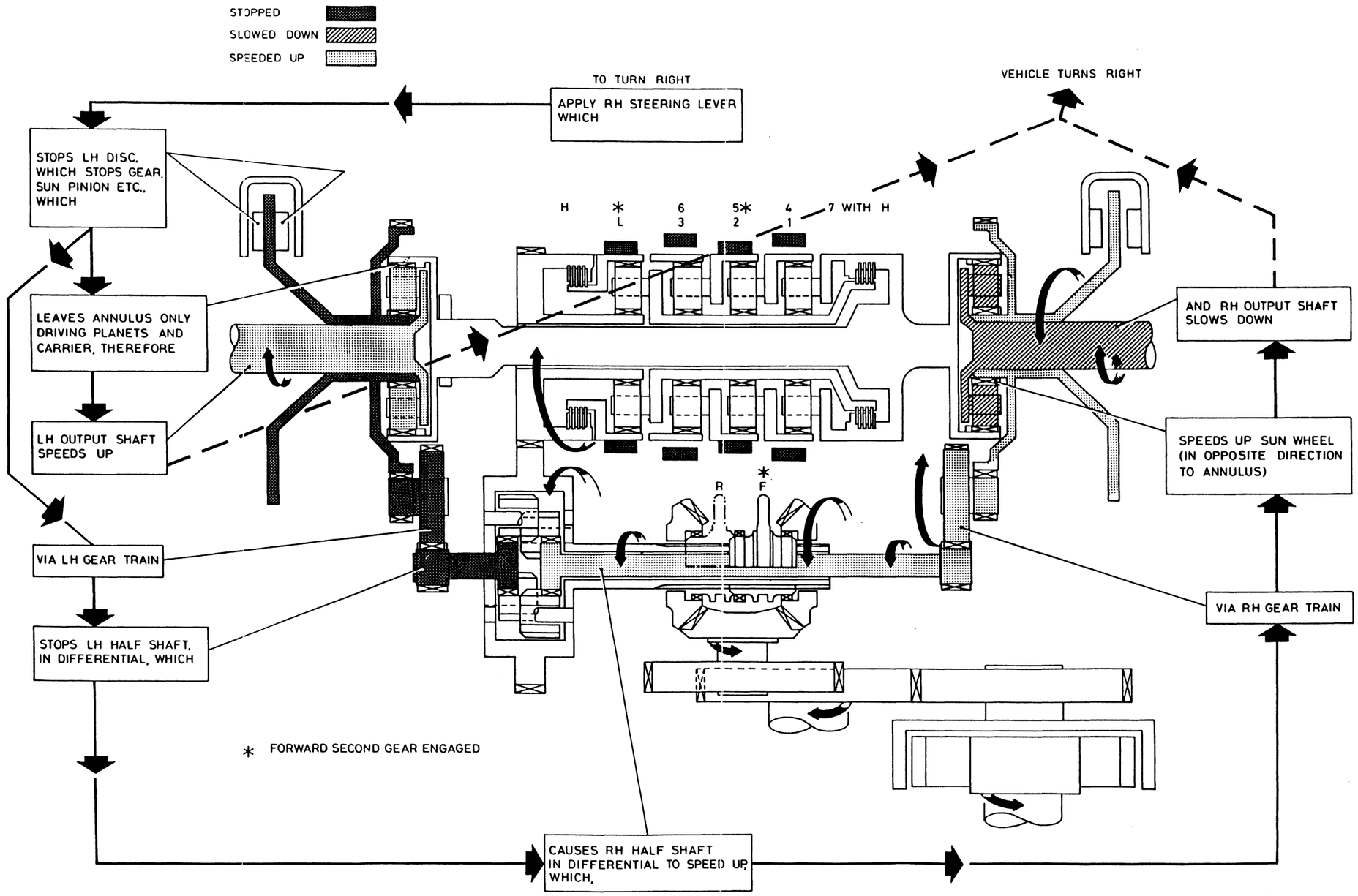


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Fig 7 Steering operation - gearbox

Equal resistance to both tracks

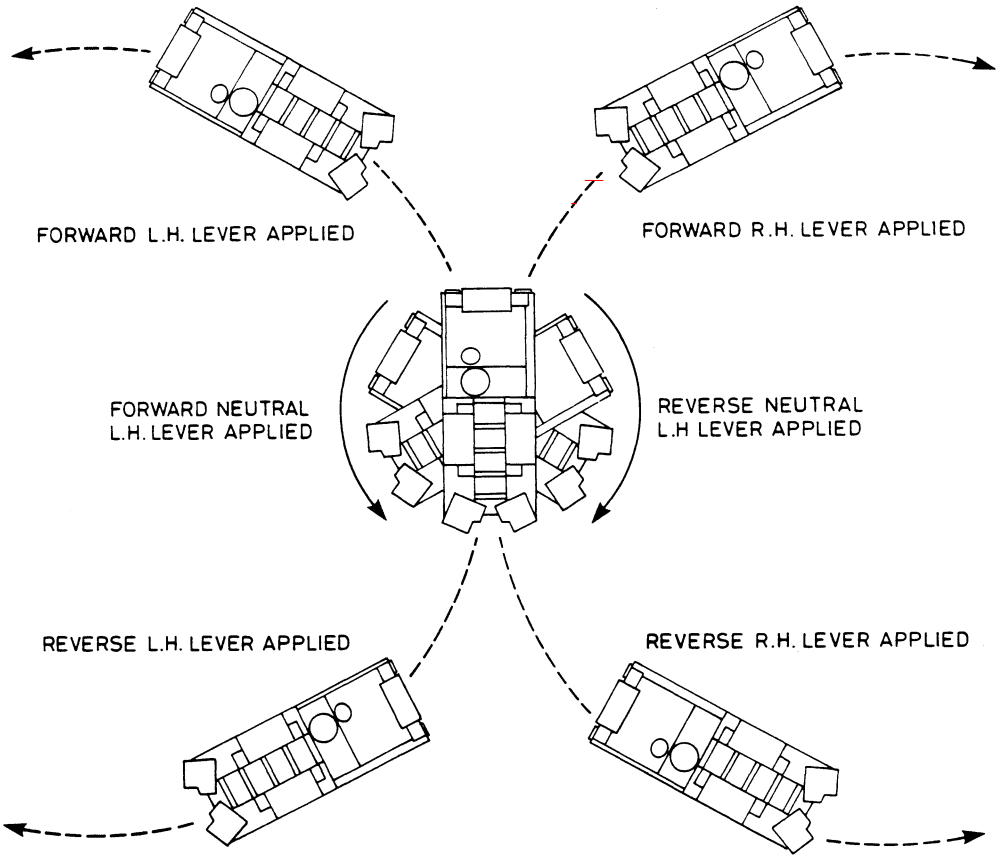


Fig 8 Steering operation

54 When the left steering lever is applied and the right track is held, as in Para 51, the whole epicyclic gear train at the right side is stationary. The differential action which causes the left sunwheel to double its former speed, as the left annular wheel is stationary the left sunwheel drives the left output shaft anti-clockwise at twice its former speed. Therefore, when the left steering lever is applied and the right track is held, the left track moves backwards.

55 Should the right steering lever be applied when the right track is held, a differential drive would be set up. The left sunwheel would be held and the right sunwheel, rotating at twice its former speed, would drive the annular wheels at twice their former speeds. Consequently, the left output shaft would be driven clockwise by the left annular wheel at twice its former speed. Therefore, when the right steering lever is applied and the right track is held, the left track moves forward.

56 Conversely, when the right steering lever is applied and the left track is held, the right track is driven backwards. When the left steering lever is applied the right track is driven forward.

Vehicle stationary - neutral turn - reverse engaged

57 Steering in neutral with the transfer lever to reverse, will produce the opposite reaction to that just described. The front of the vehicle will turn in the opposite direction to the applied lever, ie if the left steering lever is applied the front of the vehicle will turn to the right, conversely, if the right lever is applied the vehicle will turn to the left.

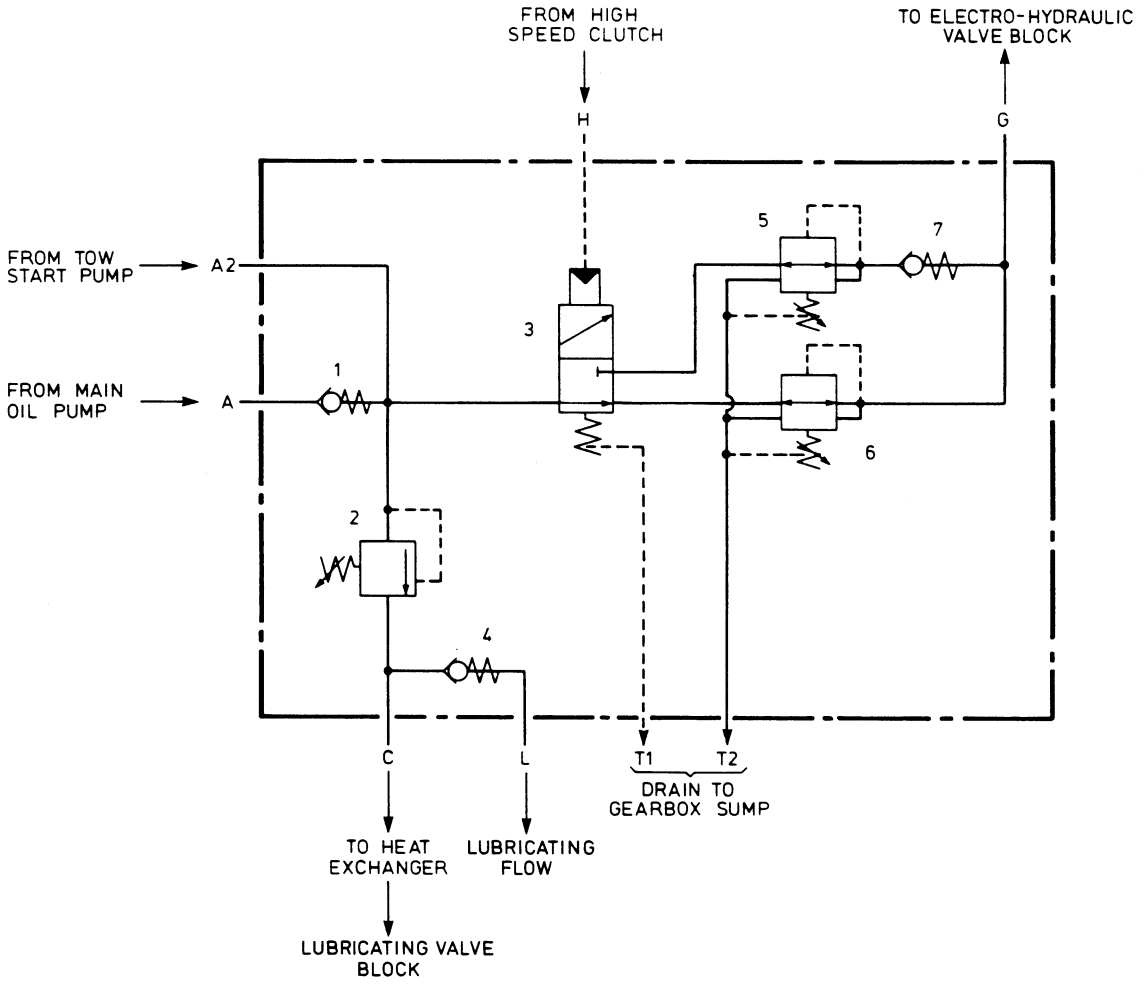
HYDRAULIC AND LUBRICATION SYSTEM

General

58 The hydraulic and lubrication system (Fig 10) supplies oil pressure for hydraulic control and for lubrication of the gears and bearings. Pressure is supplied by the main oil pump mounted in the bottom of the front half of the casing. Oil pressure for gear engagement during tow starting is provided by the tow start pump.

Main oil pump assembly

59 The main oil pump assembly is driven in a constant direction by the oil pump driving gear on the pump driving gear shaft which passes through the hollow input gear shaft and is in operation all the time the engine is running. The pump draws oil from the gearbox sump and delivers it via the gearbox oil filter to the pressure regulating block. From the pressure regulating block the oil is distributed to the electro-hydraulic valve block and to the lubricating valve block via the heat exchanger.



1 Check valve
2 Relief valve
3 Pilot operated diverter valve
4 Check valve
5 Pressure regulating valve
6 Pressure regulating valve
7 Check valve

Fig 9 Pressure regulating block - circuit diagram

Pressure regulating block

60 The pressure regulating block (Fig 9 and 10) receives oil from the oil pump via the gearbox filter and distributes it: some fed continuously to the tow start pump, some to the electro-hydraulic valve block and some to the lubricating valve block via the heat exchanger.

61 The high speed/low speed control valve is controlled by the fluid pressure from the high speed clutch. When low speed gears are selected, fluid is directed to the low speed pressure regulating valve which controls the pressure to port G at 945 lbf/in^2. A non return valve ensures that this pressure is not fed back to the output of the high speed pressure regulating valve. When high speed gears are selected, the fluid pressure, via the high speed clutch, operates the flow control valve which now directs the flow to the high speed pressure regulating valve which controls the pressure to port G at 345 lbf/in^2. Thus the low speed gears have high pressure, the high speed have low pressure.

62 Oil fed through a system relief valve incorporated in the circuit leaves the regulating block and flows through the heat exchanger to the lubricating valve block. When the pressure existing in the circuit exceeds 150 lbf/in^2, the by-pass valve lifts, allowing oil to pass direct to the lubricating valve block.

63 All valve cartridges are preset at the manufacturing stage and are not adjustable. Repair is by replacement only.

Lubricating valve block

64 The lubricating valve block (Fig 10) houses the lubricating valve which controls the oil pressure in the lubrication system to 50 lbf/in^2 nominal. The valve receives oil under normal operating conditions via the heat exchanger or direct from the pressure regulating block when the by-pass valve is lifted. When 50 lbf/in^2 in the circuit is exceeded, the valve lifts to open channels to the ancillary fittings. Should the oil reach an excessive pressure, the valve opens a further amount and uncovers a port which allows oil to flow to the sump. In this way oil at excessive pressure is prevented from reaching the running gear. Oil passes through a restriction to feed the ancillaries. In restricting the supply to the ancillaries an adequate supply to the running gear is assured: however, oil is fed continuously to the secondary shaft irrespective of the position of the valve.

Tow start pump

65 The tow start pump (Fig 10) is driven by a cam on the left hand steering annulus. The pump is of the reciprocating piston type incorporating a ball type non-return inlet valve. Normally, oil from the pressure regulating block prevents operation of the pump by holding the piston rod clear of the cam. However, when the vehicle is being tow started, the tow start pump will deliver oil via the pressure regulating block to the electro-hydraulic valve block at sufficient pressure to engage the gear selected and so turn the engine via the free wheel device.

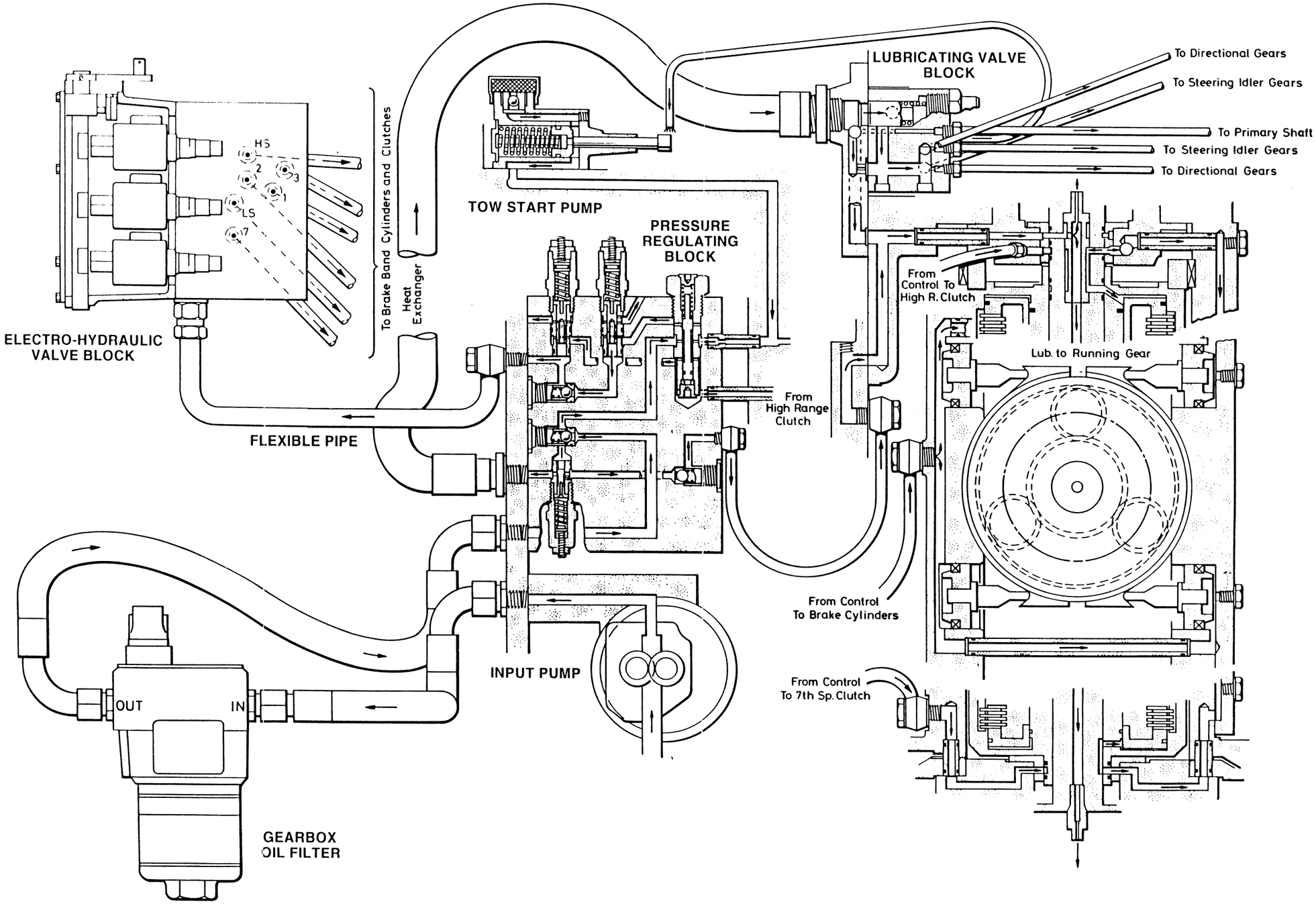


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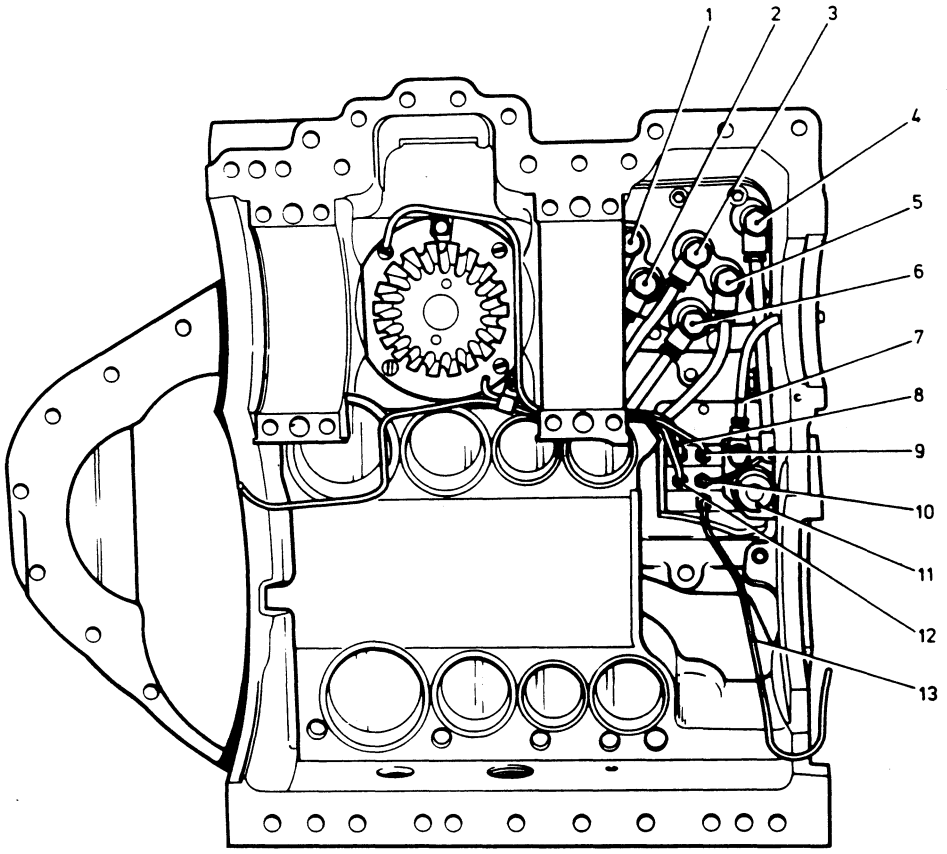
Fig 10 Hydraulic and lubricating system



2320D

1 To 3rd/6th brake pistons
2 To 1st/4th brake pistons
3 To 2nd/5th brake pistons
4 To high speed clutch
5 To low speed brake pistons
6 To 7th speed clutch
7 To differential
8 To RH bevel gear
9 To LH bevel gear
10 To RH idler gears
11 Lubricating valve
12 To LH idler gears
13 To tow start pump cam

Fig 11 High pressure and lubricating pipes

ELECTRO-HYDRAULIC VALVE BLOCK

General

66 The electro-hydraulic valve block (Fig 12) houses the solenoid valves that direct hydraulic oil pressure to the brake bands and clutches within the gearbox to determine which gear is engaged.

67 The valve block comprises a manifold (1) which is secured to the gearbox with cap screws. Internal drillings in the manifold correspond with ports (7) in the gearbox mating face. O ring seals ensure oil tight joints.

68 Six solenoid valves (4) are mounted on the manifold. The valves control hydraulic oil pressure between the supply port and the drillings that communicate with the gearbox. Bolted to the manifold is a housing (6) that surrounds the valves and forms a mounting for the camshaft (5) and actuating arm (3) that operate certain valves mechanically in the event of power failure. The housing also carries the socket (2) through which electrical connections are made with the solenoid valves. A cover screwed to the outer end of the housing prevents the ingress of dirt.

Operation

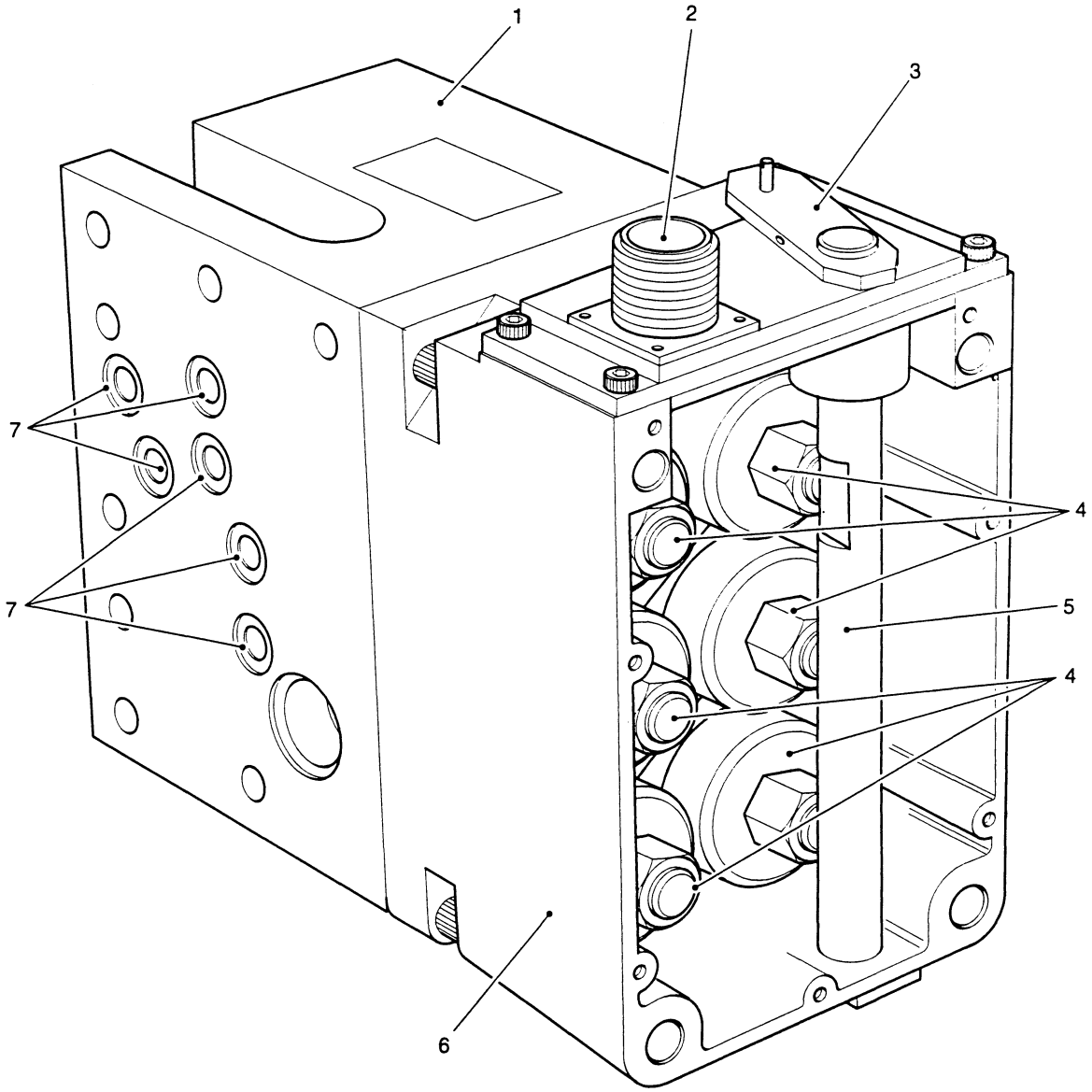
69 Hydraulic oil is supplied to the electro-hydraulic valve block by the main oil pump via the pressure regulating block. The oil enters the valve block through an external port P (Fig 13). From port P, internal drillings carry the oil to port 3 on each of the six solenoid valves.

70 With the valves in the de-energised state ports 1 and 2 are connected, forming a return path from the brake band pistons and the clutches to the reservoir in the bottom of the gearbox via port T. Thus, with no valves energised, no brake bands or clutches are operative and the gearbox remains in neutral.

71 When a gear selection is demanded by the electronic controller, electrical signals energise the appropriate solenoid valves, causing port 3 to be connected to port 2. Hydraulic oil pressure is now transmitted from the supply port P via the energised valves to the selected clutch and brake band, and the required gear is engaged.

72 In emergency manual override no valves are energised electrically. Cams on the shaft allows the mechanical operation of either the 1st speed brake and low speed clutch valves or the 1st speed brake and high speed clutch valves, engaging 1st or 4th gear respectively.

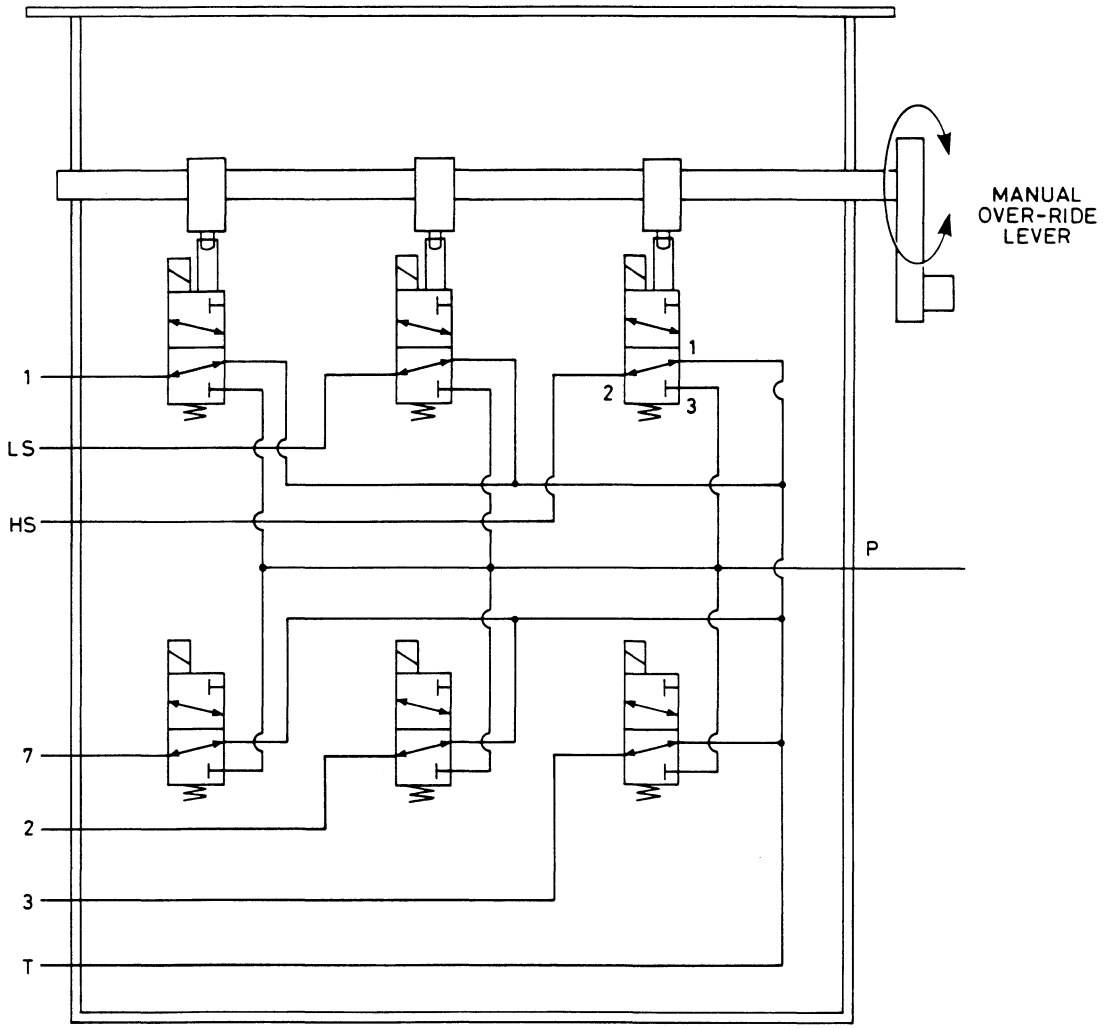
73 When solenoid valves are mechanically operated, a reed switch closes to connect a +24V supply to each solenoid, to prevent any attempt to energise the solenoids electrically.



5078C

1	Manifold	5	Camshaft
2	Socket (for electrical connector)	6	Housing
3	Actuating arm	7	Ports
4	Solenoid valves		

Fig 12 Electro-hydraulic valve block



LS - Low Speed
HS - High speed
P - Hydraulic oil supply port
T - Hydraulic oil return

5079C

Fig 13 Electro-hydraulic valve block - hydraulic circuit

FINAL DRIVES

General

74 The final drive assemblies (Fig 14) are mounted one each side of the gearbox and transmit the drive to the tracks. The two assemblies are similar except for handing differences, also the left final drive houses a speedometer sensor. The final drive gear ratio is 3.667:1.

Description

75 The sunwheel housing (Fig 14 (37)), stub axle (7) and final drive hub casings form oil reservoirs for the lubrication of the gears and bearings. The stub axle casing incorporates filler/level plugs at 3 o'clock and 9 o'clock and has a drain plug (26) in the bottom of the casing, the sunwheel housing has a speedometer sensor (3) (LH only) and a breather pipe (5) fitted in the top.

76 The inboard end of the input shaft (41) has external teeth which engage with the teeth of the gearbox output shaft and is held in mesh by the input shaft plunger. Along this shaft is an annular groove which accommodates a seal (36), while the outboard end of the shaft is splined to the sunwheel shaft (31).

77 From there the drive is transmitted to the epicyclic reduction gears (28, 32 and 33) through to the final drive hub (9). The sprocket wheels (10) bolted to the hub carry the drive to the sprocket ring (20) and then to the tracks.

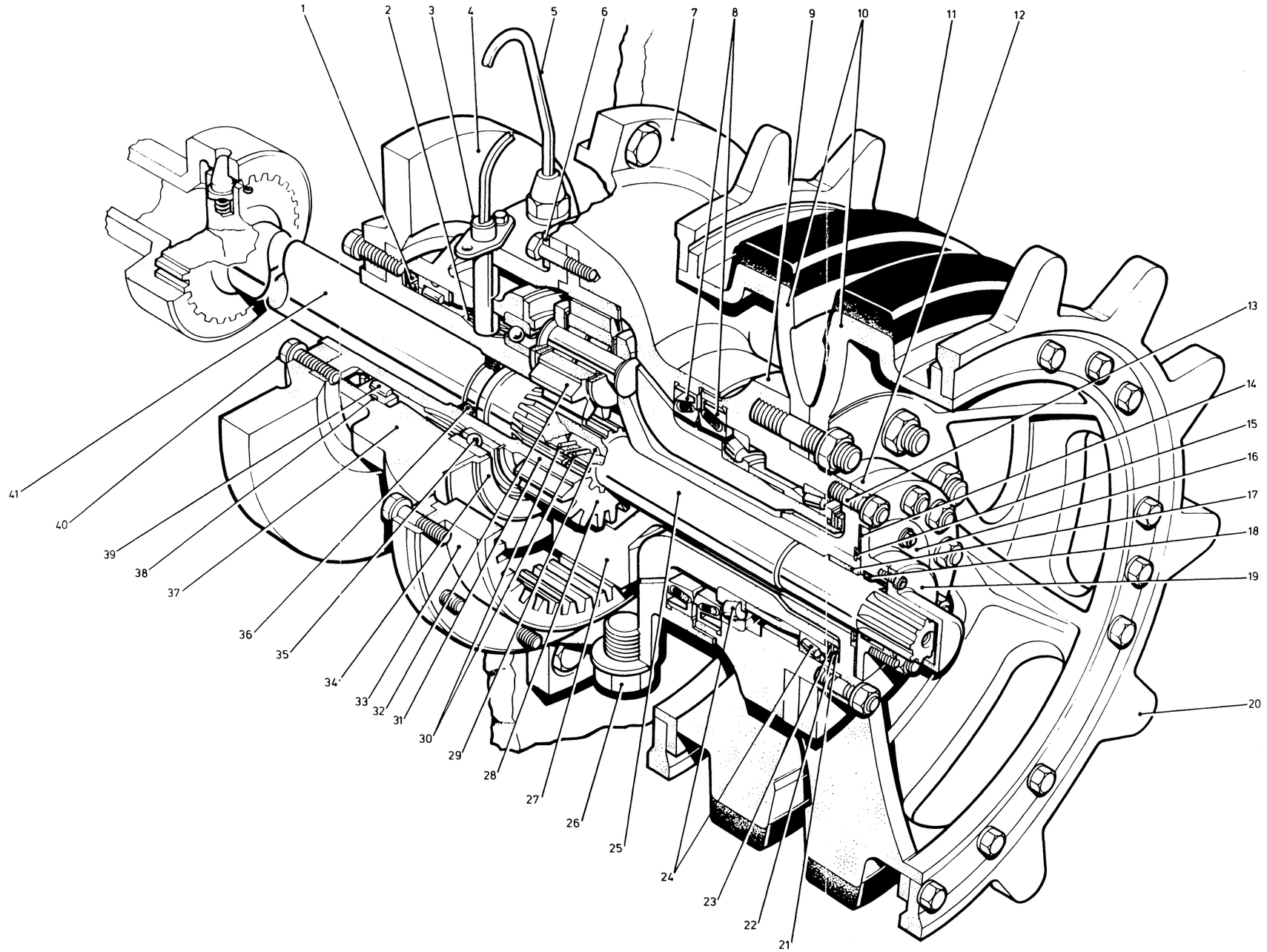
78 The sunwheel shaft (31) is supported at one end by a needle roller bearing (39) and at the other by a ball bearing (35) held by a race retainer (34) and secured to the sunwheel housing (37) by six screws locked with wire. The outer race of the needle roller bearing contains an annular groove (38) with which it is located in the sunwheel housing by two grub screws. A lip seal (1) is fitted to retain the oil and protect the needle roller bearing from the ingress of dirt or water. Cut into the sunwheel shaft are a number of teeth (2) which are sensed by the speedometer sensor.

79 The main brake disc (4) is bolted to the sunwheel shaft which drives the sunwheel (28) and planet gears (32) which, because the annulus (33) is bolted between the sunwheel housing (37) and the stub axle (7), rotates the planet carrier (27) at a reduced speed. The drive plate (12) is splined to the planet carrier, retained by a circlip (15), and carries the drive to the hub (9) which is bolted to it. Twelve studs (13) are fitted to locate the drive plate and assist in resisting shock loads.

80 The final drive hub (9) runs on taper roller bearings (24) carried on the stub axle, and is secured to the stub axle by a hardened ring (23) placed beneath a bearing retainer nut (21) locked by a tab washer (22). An oil sealing arrangement of two seal rings (8) ensures an oil tight seal between the hub and the stub axle. The sprocket wheels (10), bolted to the hub, carry the drive to the sprocket ring (20) and finally through the tracks. Rubber tyres (11) are fitted to the sprocket wheels to reduce the exterior noise factor by keeping the tracks from bedding on the root surfaces of the sprocket teeth.

NOTE

Should it be necessary to tow the vehicle with a defective gearbox, the end cap (19) should be removed, the input shaft plunger depressed and the input shaft (41) disengaged from each side of the gearbox. If it should be too difficult to move the input shaft manually, a threaded hole in the output end of the propeller drive shaft (25) will permit an extractor to be used.



1 Lip seal
2 Speedometer sensing teeth
3 Speedometer sensor
4 Main brake disc
5 Breather pipe
6 Spreader ring
7 Stub axle
8 Seal rings
9 Hub
10 Sprocket wheels
11 Rubber tyre
12 Drive plate
13 Stud
14 End plate gasket
15 Circlip
16 End plate
17 Bush
18 Lip seal
19 End cap
20 Sprocket ring
21 Retainer nut
22 Tab washer
23 Hardened ring
24 Taper roller bearings
25 Propeller drive shaft
26 Drain plug
27 Planet carrier
28 Sunwheel
29 Locating pin
30 Spring pins
31 Sunwheel shaft
32 Planet gear
33 Annulus
34 Race retainer
35 Ball bearing
36 Seal
37 Sunwheel housing
38 Needle bearing locating groove
39 Needle roller bearing
40 Brake disc securing bolt
41 Input shaft

5324B

Fig 14 Final drive assembly

CHAPTER 5

DRIVER CONTROLS, INCLUDING MAIN AND PARKING BRAKES

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INTRODUCTION

1 This chapter gives a technical description of the driver controls for the steering system, gear change mechanism, engine and braking systems fitted in the driving compartment of the Carrier, full tracked, vehicle launched scatterable mine system (VLSMS) `Shielder'.

STEERING SYSTEM

General

2 The steering system (Fig 1) is typical of the Merritt system in that disc brakes control a pair of epicyclic gear trains interconnected through a differential in the gearbox output drive. The brakes are hydraulically operated by two hand operated steering levers, one for each brake. Each brake consists of a steering brake disc bolted to a sunwheel coupling and straddled by a hydraulically operated brake caliper.

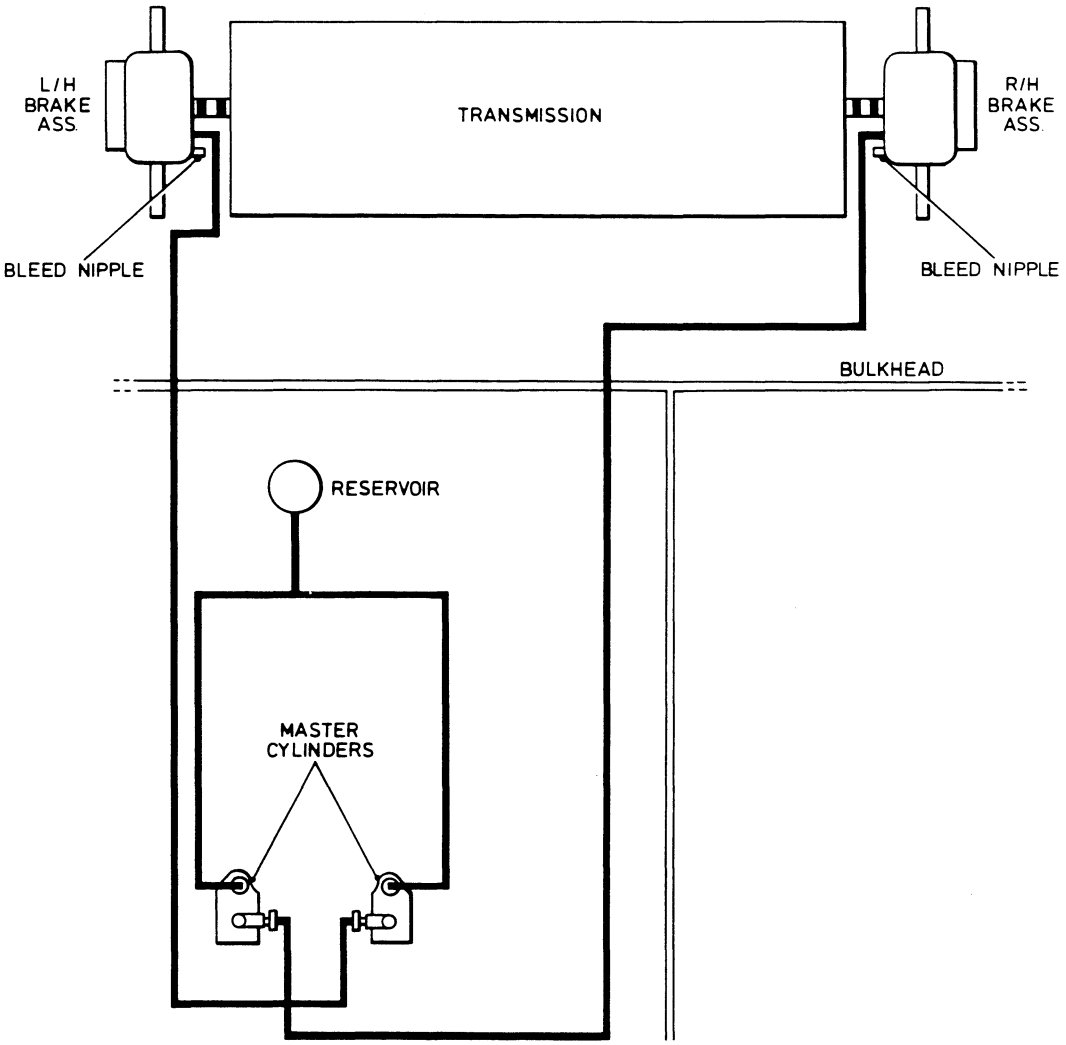


Fig 1 Steering hydraulic system - diagrammatic

Steering lever assembly

3 The two tubular steel steering lever assemblies (Fig 2(4)) are mounted on a common pivot bolt (12) located in a cast steel mounting bracket which is secured to the hull floor. A handle (1) is fitted to the top of each lever. The handles have moulded hand grips which incorporate controls for the vehicle horn, turn indicators and headlight dip/main.

4 The base of each lever shaft is secured to a cast steel lever which is connected to and applies mechanical advantage through a fork end (10) against a push rod (14). The push rod operates a master cylinder (18, 19), each cylinder operating a separate steering brake circuit (Fig 1). Outlets (Fig 2(21)) from each cylinder transmit fluid to the brake calipers. A common reservoir located on the driver/transmission bulkhead feeds both cylinders.

5 Each lever is held in a forward OFF position by a return spring (13) and is pulled back against this spring to operate its corresponding master cylinder. Adjustment for the return position of each lever is obtained using the adjustable stop screws (8).

Operation

6 When a steering lever is operated, (by pulling back hard on the appropriate handle) the push rod, acting against the return spring moves a piston along the bore of the master cylinder (18 or 19) which pressurizes hydraulic fluid in the pipes to the caliper causing the brake pads in that caliper to clamp the disk on the opposite side of the vehicle to that of the operated lever.

7 A mechanical interlock in the form of an interlock pin (25) housed in the lever mounting bracket (17) prevents simultaneous operation of both steering levers. When a lever is pulled, the interlock pin engages in a countersunk hole bored in the other lever which is then locked to the mounting bracket housing.

Steering brake calipers

8 The steering brake calipers (Fig 3) which are handed, consist of two separate halves, bolted together and located astride each steering disc. Within each brake caliper are four identical pistons (9), two on each side of the caliper which, when the appropriate steering lever is operated, clamp the brake pads (3) to lock the steering disc. Each side of the caliper is machined to form two enclosed cylinders. A recess (8) in each cylinder bore ensures that hydraulic fluid is always behind the pistons. A piston seal (7), recessed in each cylinder bore, ensures an oil tight chamber for the fluid to operate the cylinders. A piston end seal (6) prevents the ingress of dirt and moisture.

9 Hydraulic fluid enters the caliper through a hose (4) and passes to each side through internal ducts and on to the pistons to apply the brake. When pressure is released, a running clearance exists between the brake pads and discs. Bleed nipples (5) are fitted to each caliper for bleeding air from the system.

Steering operation

10 In straight ahead driving, both steering discs run freely between the brake pads. When a steering lever is operated the opposite steering brake disc is clamped between the brake pads, which stops the output sunwheel connected to the disc. The vehicle is therefore steered to the same side as the operated lever.

KEY TO FIG 2

1 Handle
2 Bolt
3 Nut
4 Steering lever assemblies
5 Split pin
6 Spring
7 Nut
8 Adjustable stop screw
9 Push rod pin
10 Fork end
11 Spring end cap
12 Lever pivot bolt
13 Return spring
14 Push rod
15 Spring end cap
16 Mounting bracket securing bolt
17 Mounting bracket
18 RH master cylinder
19 LH master cylinder
20 Inlet from reservoir
21 Outlet to brake calipers
22 Master cylinder fixing screws
23 Nut, pivot bolt
24 Bush
25 Interlock pin

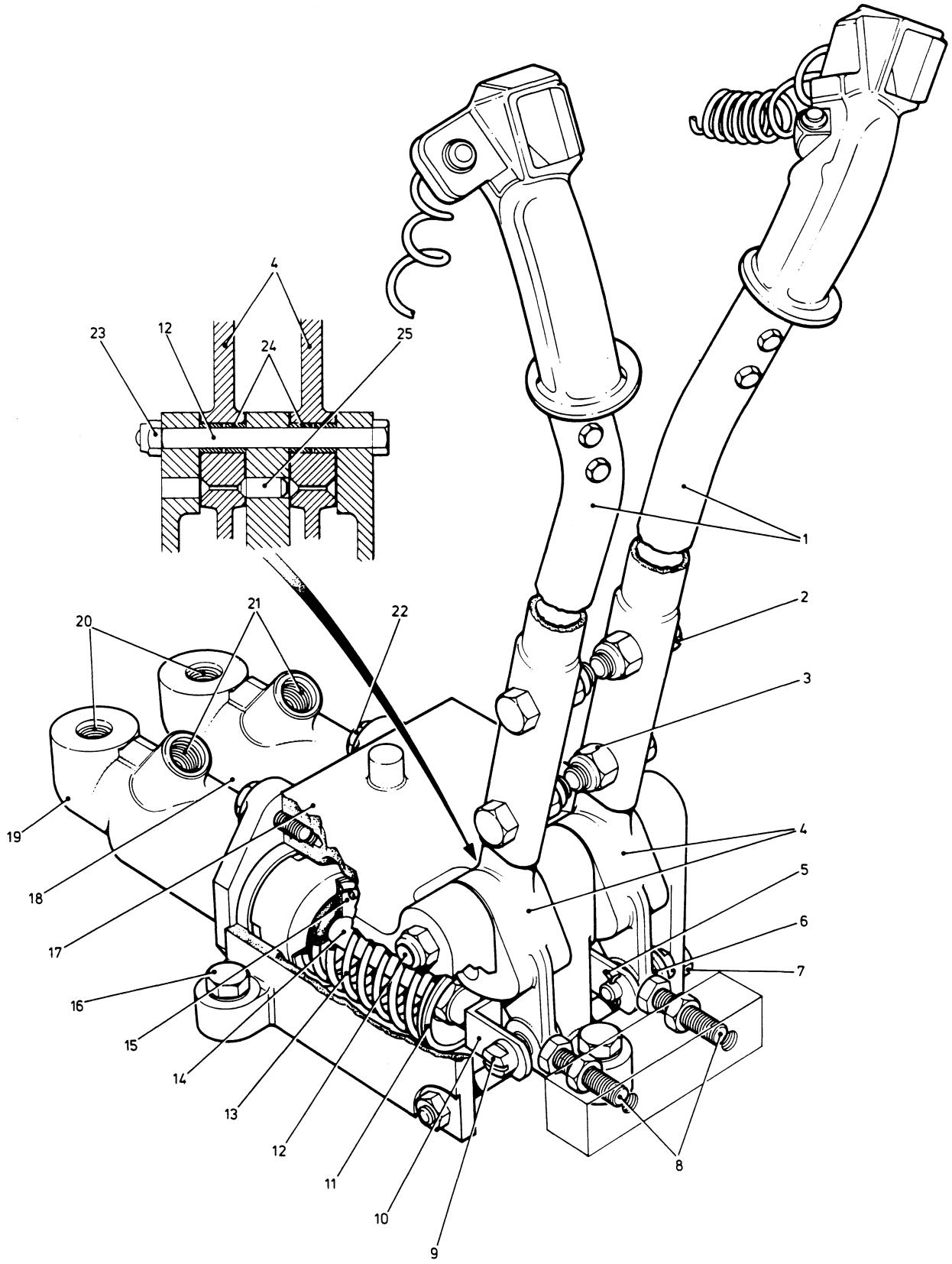
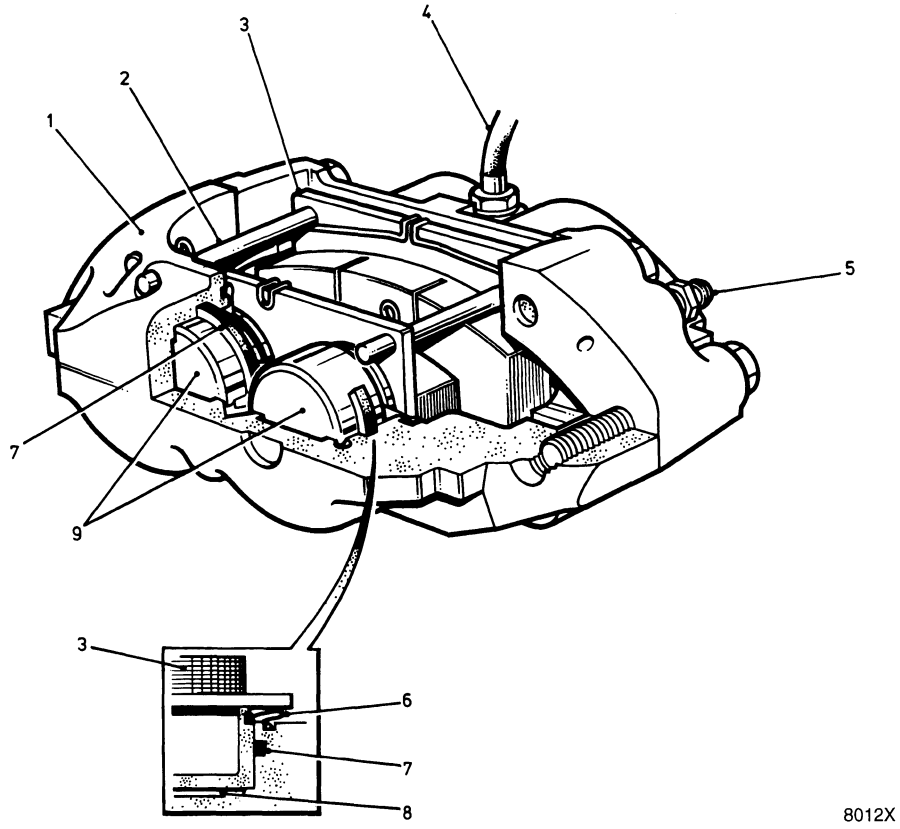


Fig 2 Steering lever assembly



1 Caliper
2 Brake pad retaining pin
3 Brake pad
4 Flexible hose
5 Bleed nipple
6 End seal
7 Piston seal
8 Recess
9 Piston

Fig 3 Steering brake caliper

GEAR CHANGE MECHANISM

General

11 The Shielder vehicle has an epicyclic gearbox that has seven gears in both forward and reverse directions. The gears are engaged/disengaged by the application/release of hydraulically operated brake bands and clutches to the gear trains.

12 Hydraulic fluid is admitted to the clutches and to the pistons that apply the brake bands via a valve block mounted on the outside of the gearbox. The six valves within the block are operated by solenoids that are controlled by electrical signals from a microprocessor control panel located in the commander's compartment.

13 An interconnection diagram of the automatic gear select system is shown in Fig 4.

14 The microprocessor control panel accepts inputs from the driver's gear selector, a speed probe mounted on the left hand gearbox output casing, the parking brake micro switch, coast switches connected to the throttle linkage and up/down demand switches on the driver's gear change pedal. Power supplies for the microprocessor control panel are obtained from the vehicle electrical system distribution panel via the auto power interface box.

15 Electrical signals from the microprocessor control panel are routed to the gearbox valve block and to a solenoid connected to the throttle linkage.

16 The driver's gear selector (Fig 5) comprises a pedestal mounted lever positioned on the drivers compartment/engine compartment bulkhead to the right hand side of the driver. Micro-switches inside the pedestal are closed or opened by the lever (2) that moves within a gate on top of the pedestal (3). A plate (1) secured to the pedestal indicates the position of the lever for each mode of operation.

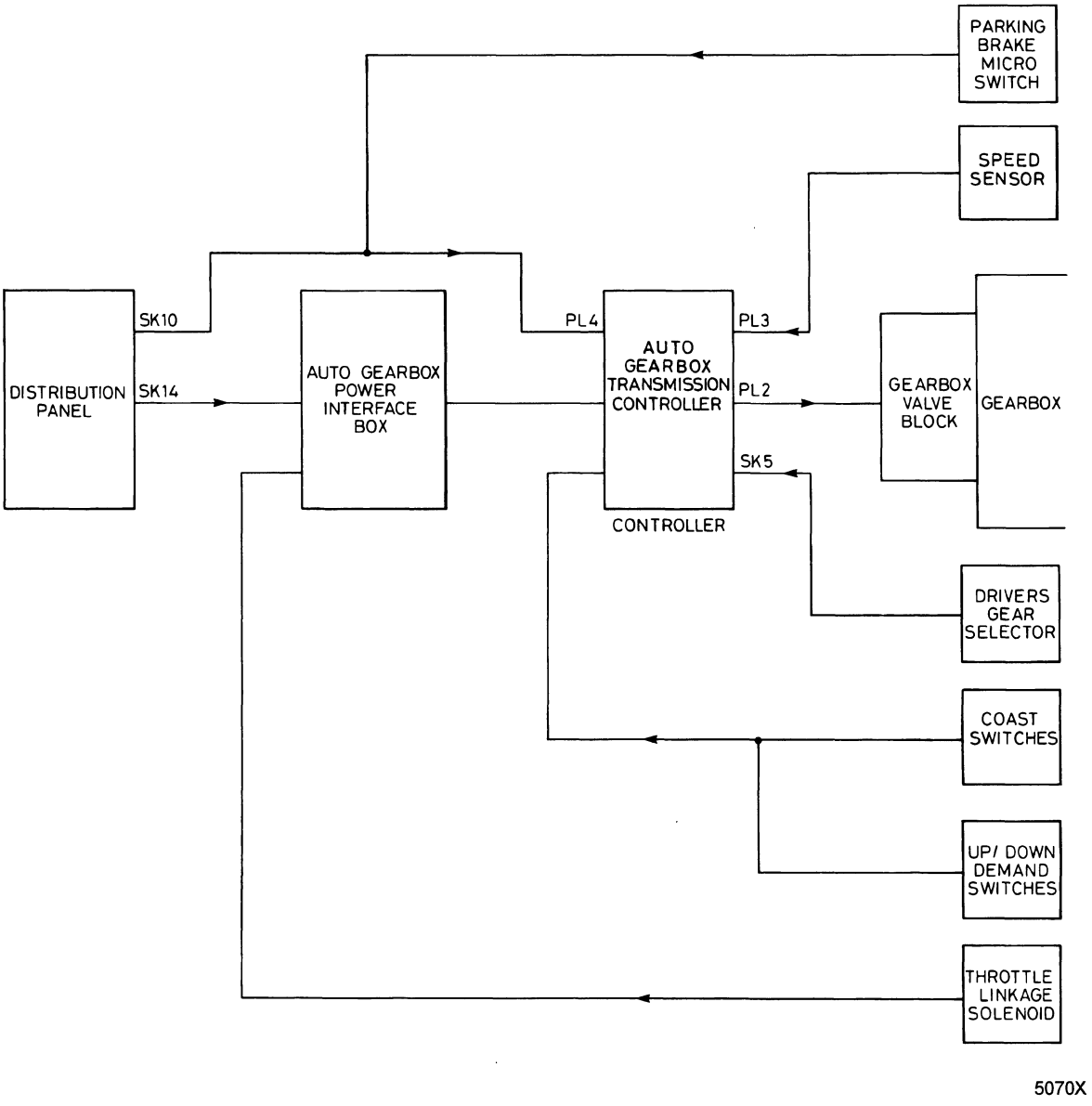


Fig 4 Auto gear select system block diagram

Gear selection

Automatic mode

17 When the vehicle is stationary with the engine running and the parking brake applied, setting the driver's gear selector to 'A' (Auto) causes 2nd gear to be engaged. As the vehicle moves off and the road speed increases, the gears change up in the sequence 2nd to 7th. The speed at which each gear change occurs is determined by the microprocessor control panel having regard to the throttle demand as monitored by the coast switches. The higher the throttle demand, the higher the speed at which gear changes occur.

18 At each gear change an electrical signal is sent by the microprocessor control panel via the auto power interface box to a solenoid connected to the throttle linkage. This causes the engine speed to reduce (known as `throttle dip') as the gear upshifts to synchronise the engine speed with the new demand imposed by the higher gear ratio. The purpose of throttle dip is to give a smoother gear change whilst ensuring that traction is not lost.

19 If, when the vehicle is moving, the driver selects `H' (Hold) on the gear selector, up gear changes are inhibited.

20 As the vehicle road speed decreases, the coast switches on the throttle linkage indicate to the microprocessor control panel that the throttle is closed, ie the vehicle is coasting, or open, ie the vehicle is pulling. At speeds determined by the microprocessor control panel the gears change sequentially down to 5th gear if the vehicle is coasting, and remain in 5th gear until the vehicle is almost at a standstill at which point 2nd gear is engaged. If the vehicle is pulling the gears change sequentially down to 2nd gear and remain in 2nd gear until either the vehicle stops or increases speed.

21 First gear is not available in automatic mode.

22 To ensure smooth gear changes without loss of tractive effort, a throttle dip system is incorporated. As the microprocessor control panel demands an up change, a signal is sent to a solenoid attached to the throttle linkage. This causes the throttle to close momentarily to allow the engine speed to fall, thus synchronising the engine speed to the new gear ratio. On down changes the microprocessor control panel causes the gear change to pause in neutral allowing time for the engine speed to increase before the lower gear is engaged.

23 Inadvertent application of the parking brake while the vehicle is moving initiates downchanges until either the brake is released or the vehicle comes to rest.

Protected manual mode

24 When the vehicle is stationary with the engine running and the parking brake applied, setting the driver's gear selector to 'M' (Manual) causes 2nd gear to be engaged. Should additional manoeuvrability be required, 1st gear can be selected by operating the gear selector pedal.

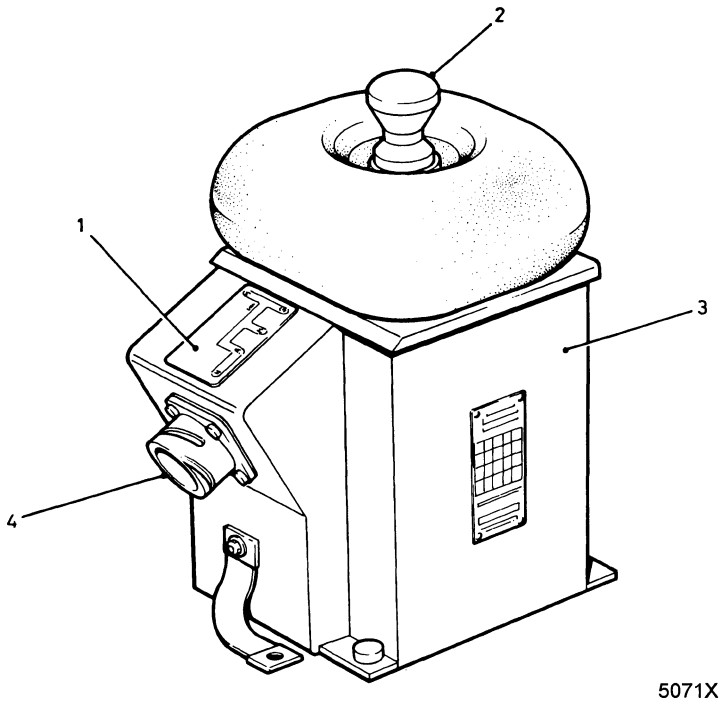
25 As the vehicle moves off and the road speed increases, the gears change up in the sequence 2nd to 7th at the instigation of the driver who uses the gear selector pedal to input Up/Down demand signals to the microprocessor control panel. Each gear has an associated road speed window. If a gear change is demanded outside of the window, the gear change is disallowed and the existing gear held.

Emergency manual override

26 In the event of a failure in the automatic gear selector system, a lever on the gearbox valve block can be used to select either 1st or 4th gear by mechanical operation of the solenoid valves. This lever is connected by cable to an emergency gear selector lever located in the driver's compartment adjacent to the parking brake lever. An electric interlock switch is incorporated between the emergency gear selector lever and the automatic transmission controller to prevent any possible damage to the transmission as a result of the gear selector lever not being in the neutral position before an emergency gear is selected.

Tow start mode

27 In order to tow start a vehicle, `TS' (Tow start) is selected on the driver's gear selector. The gear selector must be lifted over a detent to prevent inadvertent selection of `TS'. Below a pre-determined road speed, neutral is selected. When the road speed rises above the pre-determined threshold, 4th gear is selected.



1 Gear position indicator plate
2 Lever
3 Pedestal
4 Electrical connector

Fig 5 Driver's gear selector lever

FORWARD/REVERSE LEVER

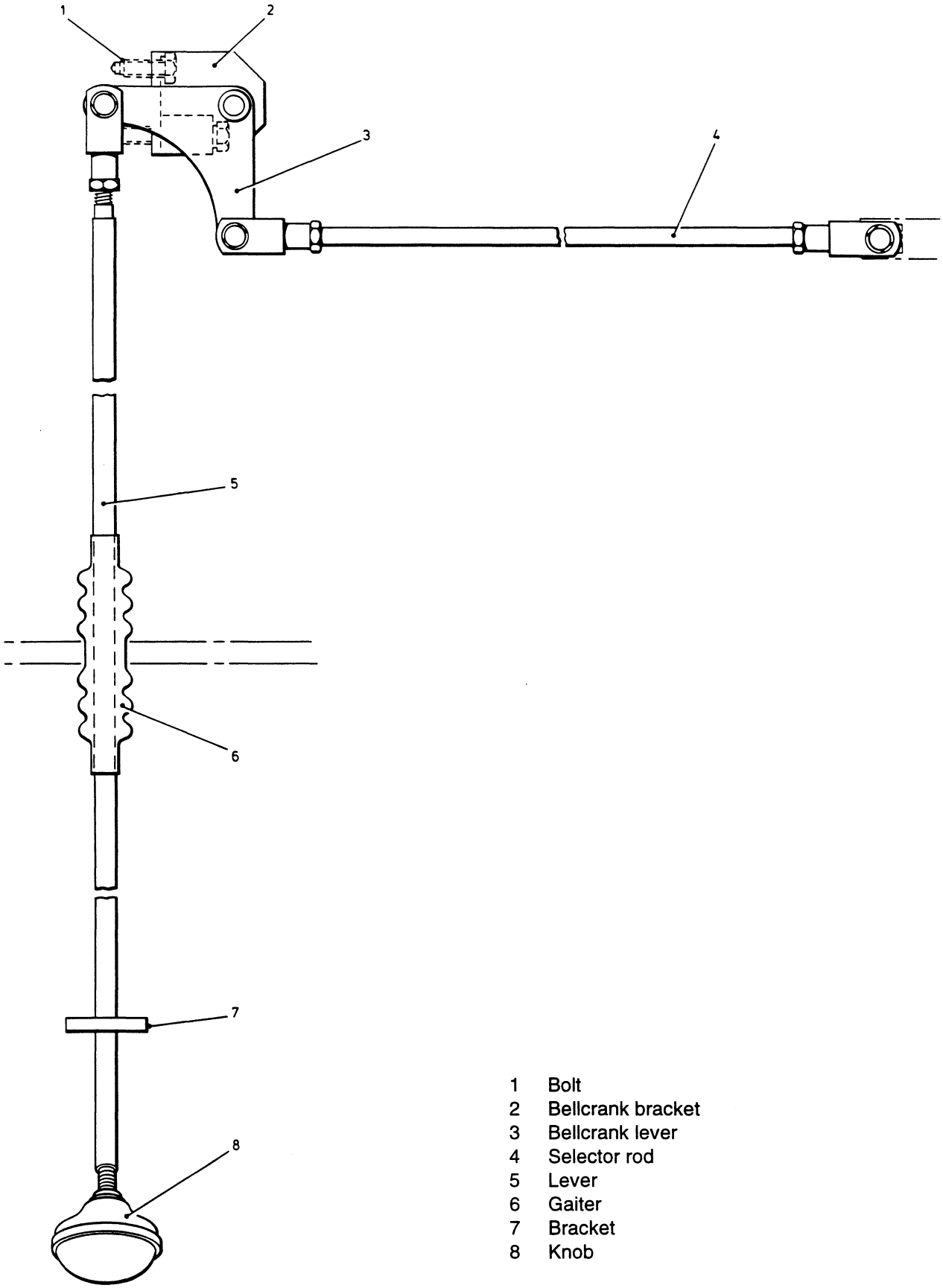
28 The forward/reverse control lever (Fig 6) is located in the driver's compartment on the left hand sponson.

29 The lever (5) is connected to the selector rod (4) in the gearbox assembly via a bell crank lever (3) and pin, and when moved from the neutral position will select forward when pulled back or reverse when pushed forward. The bellcrank lever is pivoted on a bracket (2) mounted on the left hand sponson in the transmission compartment. The lever (5) passes through the transmission/driver's compartment bulkhead and is supported by a bracket (7). A gaiter (6) provides an NBC seal.

ENGINE CONTROL

Accelerator pedal

30 The accelerator pedal is of the hinged type. It is bolted to the transmission bulkhead and is connected to the fuel injection pump by a cable linkage. A hand throttle linkage, connected to the cable through the accelerator pedal bracket, facilitates manual control of the engine speed. The hand throttle control is located to the right of the driver on the engine/driver's compartment bulkhead.



1 Bolt
2 Bellcrank bracket
3 Bellcrank lever
4 Selector rod
5 Lever
6 Gaiter
7 Bracket
8 Knob

~~2251C~~

Fig 6 Forward/reverse lever

BRAKING SYSTEMS

General

31 The main braking system which is used for slowing and stopping the vehicle, is a pedal operated hydraulic disc brake type. A brake disc bolted to the sunwheel shaft on each final drive unit is driven by the final drive input shaft. The parking brake is used for holding the vehicle stationary.

Main brakes

32 A main brake caliper (Fig 7) straddles each main brake disc and is attached by bolts from outside the hull side plates. Each disc is bolted to the final drive sun wheel shaft and rotates with it. Within each brake caliper are four identical pistons (9), two on each side of the caliper which, when the brake pedal is operated clamp the brake pads (4) to the disc to slow or stop the vehicle. Each side of the caliper is machined to form two enclosed cylinders, each having a pimple (7) to which the pistons abut when fully home. The chambers thus formed ensure that hydraulic fluid is always behind the pistons. A piston seal (8), recessed in each cylinder bore, ensures an oil tight chamber for the fluid to operate the pistons.

33 Hydraulic fluid enters the caliper through a flexible hose (10) and via internal drillings to the closed ends of all four pistons. A bleed nipple (3) fitted to another drilling enables air to be bled from the system.

34 The footbrake pedal (Fig 8) is of the hinged type. The pedal lever (14) is located via a pivot pin (13) to the mounting bracket (1), which is secured to the hull floor. The end of the pedal lever is secured to the master cylinder push rod (7) via a fork end (9) and push rod pin (10). The helical return spring (6) holds this lever mechanism back via a seating washer. Depression of the pedal acts against the push rod and moves a piston along the bore of the master cylinder (4) which pressurizes hydraulic fluid in the pipes to the main brake caliper via the outlet (5). Fluid in the master cylinder is maintained from a reservoir (Fig 9(28)) located on the driver/transmission bulkhead.

Operation

35 When the footbrake pedal (Fig 8) is operated the helical spring (6) is compressed and the push rod (7) moves the master cylinder piston along its bore, which pressurizes the hydraulic fluid in the pipes to the main brake calipers. The pressure causes the brake caliper pistons (Fig 6(9)) to press against the brake pads (4) which clamp the main brake discs, causing the vehicle to slow or stop. Upon releasing the pedal, the helical spring returns the pedal to its adjustable stop. With the brake system not pressurized there is a running clearance between the brake pads and the discs.

36 The brake light switch (Fig 9(13)) is mechanically operated when the footbrake pedal is depressed. An adjustable stop is provided to adjust pedal return travel.

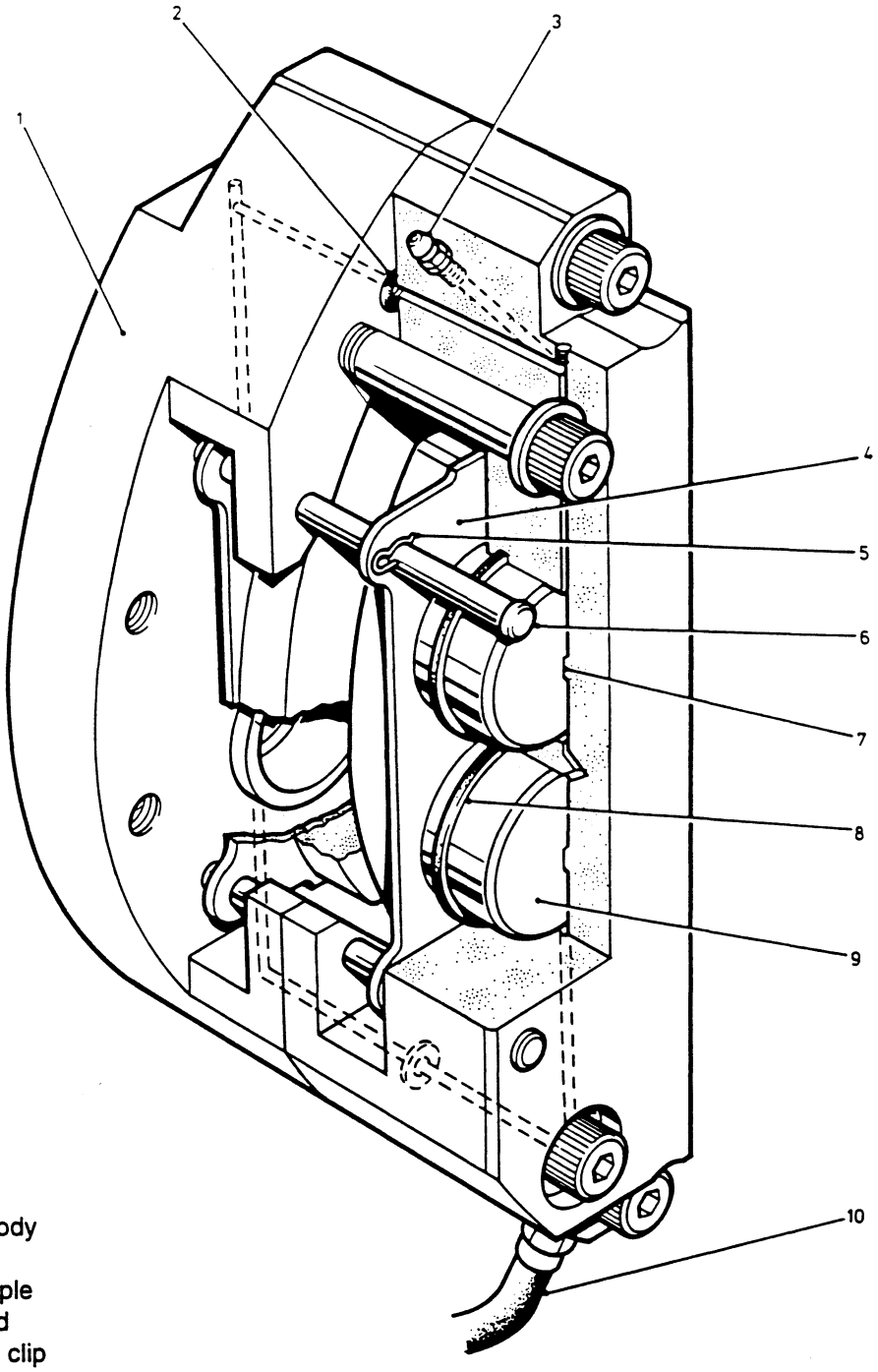
Parking brake

37 Each parking brake consists of a caliper (Fig 9(7)) with pads faced with friction material which are brought into contact with faces of the main brake disc (9).

38 The parking brake cables (3) connects the brake calipers to the parking brake lever (1) via a cable pulley (2), which ensures that an equal pull is applied to each caliper, and thus an equal braking force at each side of the vehicle.

39 The parking brake is applied by moving the hand operated lever (1) backwards. This action pulls the brake cable which moves the brake pads into contact with the discs.

40 A brake release spring (6) ensures that the brakes return to the off position when the parking brake lever is released.



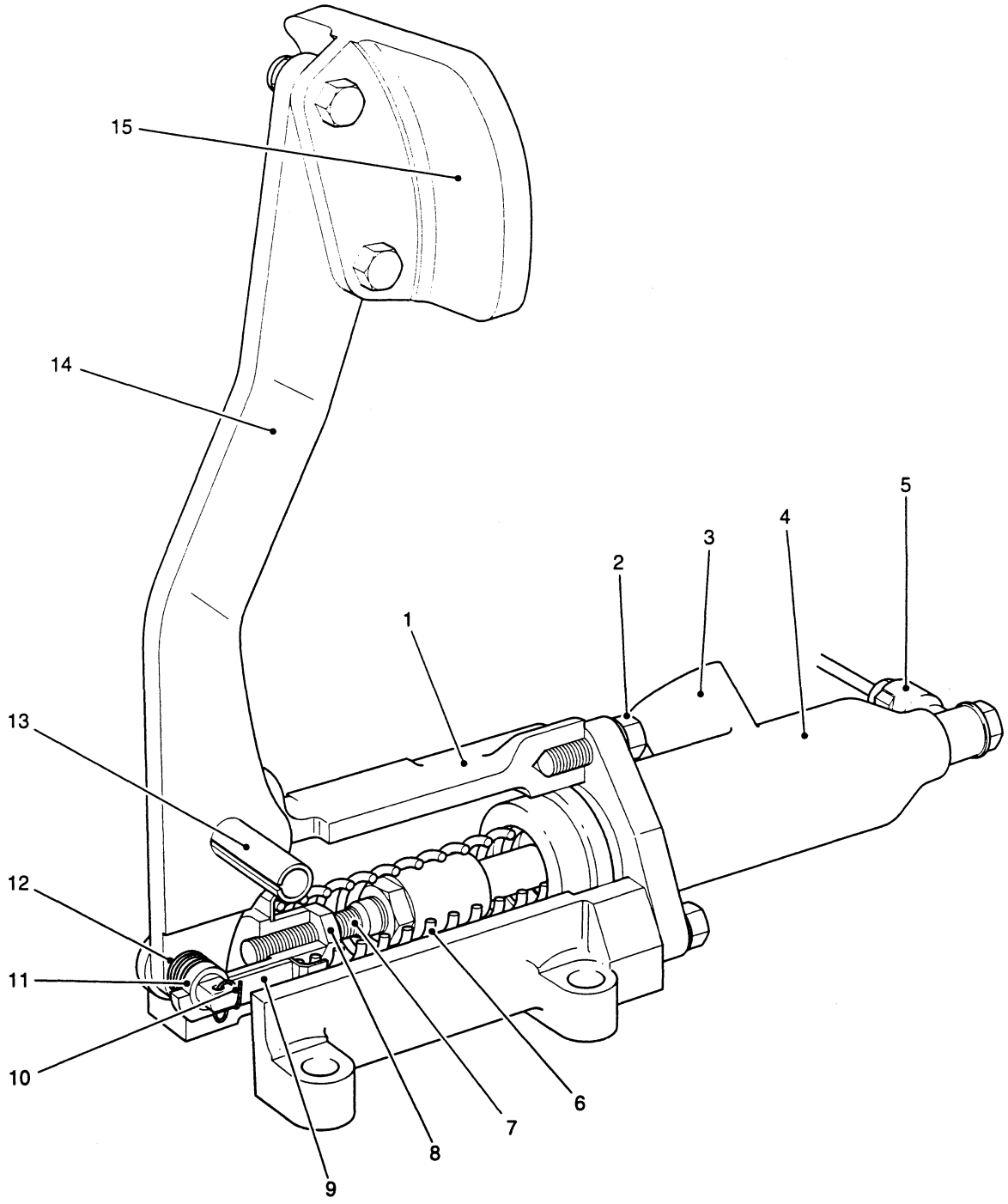
1 Caliper body
2 Seal ring
3 Bleed nipple
4 Brake pad
5 Retaining clip
6 Brake pad retaining pin
7 Pimple
8 Piston seal
9 Piston
10 Flexible hose

Fig 7 Main brake caliper

Operation

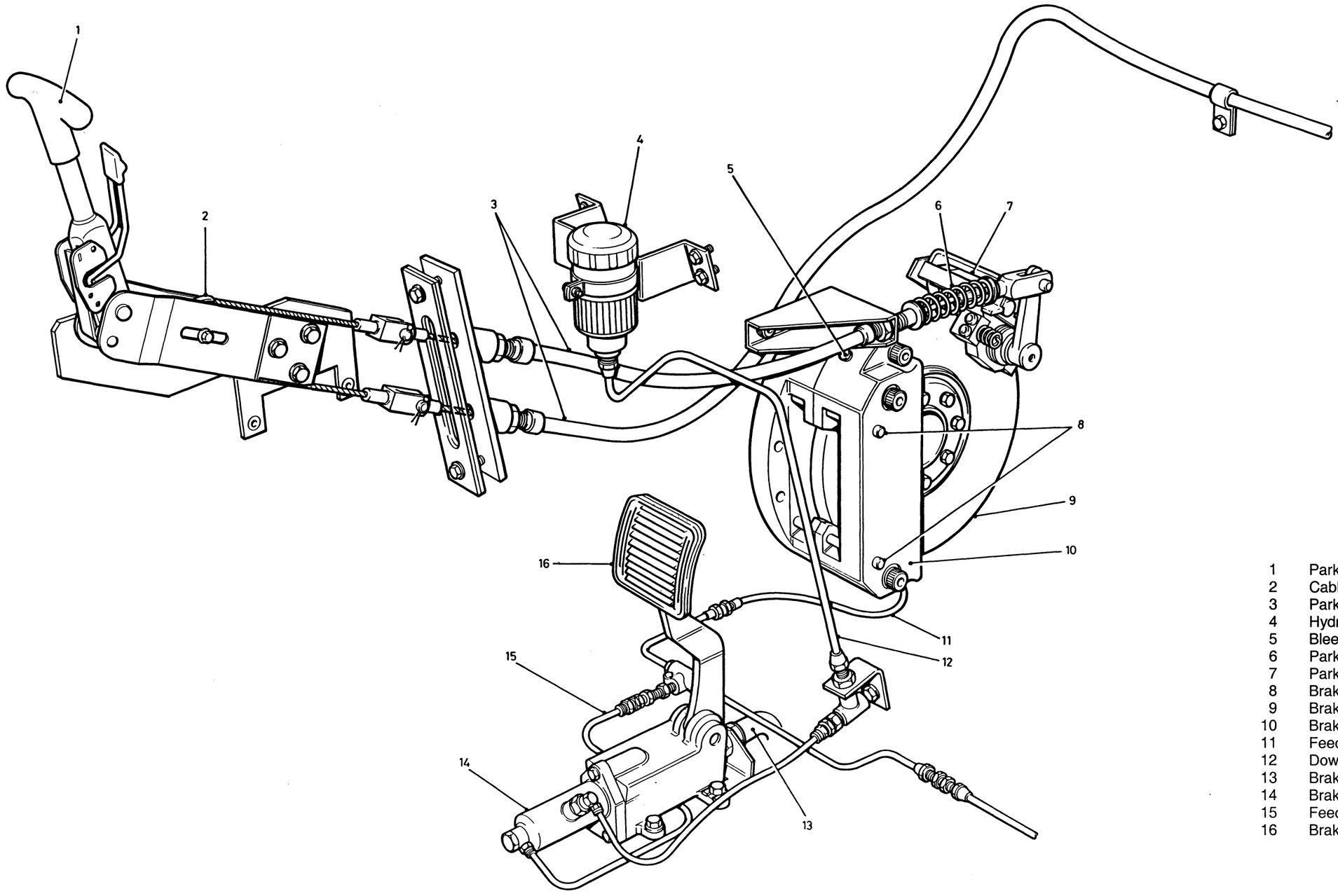
41 The parking brake lever (Fig 9 (1)) is mounted above the left hand side sponson in the driver's compartment. The lever is pulled backwards to apply the brake and is held in the ON position by the locking lever.

42 The parking brake is released by depressing the locking lever and pushing the parking brake lever forwards.



1	Mounting bracket	9	Fork end
2	Fixing screw	10	Push rod pin
3	Fluid inlet from reservoir	11	Spring
4	Master cylinder	12	Split pin
5	Fluid outlet to caliper	13	Pivot pin
6	Helical spring	14	Pedal lever
7	Push rod	15	Pedal pad
8	Locknut		

Fig 8 Footbrake pedal assembly



1 Parking brake lever
2 Cable pulley
3 Parking brake cables
4 Hydraulic fluid reservoir
5 Bleed nipple
6 Parking brake release spring
7 Parking brake calliper
8 Brake pad retaining pins
9 Brake disc
10 Brake calliper
11 Feed hose to calliper
12 Down pipe from fluid reservoir
13 Brake light switch
14 Brake master cylinder
15 Feed pipe from master cylinder to callipers
16 Brake pedal

5121x

Fig 9 Main and parking brakes

CHAPTER 6

SUSPENSION AND TRACKS

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Sprockets and tracks
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5 Sprocket wheels
7 Track support rollers
8 Tracks
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13 Idler wheel cranked arms and pivot brackets
15 Idler wheels
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INTRODUCTION

1 This chapter gives a technical description of the suspension system and tracks fitted to the Carrier, full tracked, vehicle launched scatterable mine system (VLSMS) 'Shielder' vehicle.

2 The following terms are used to locate items of suspension on the vehicle:

2.1 Left and right hand sides (LH and RH). The sides as viewed from the rear of the vehicle looking toward the front of the vehicle.

SPROCKETS AND TRACKS

General

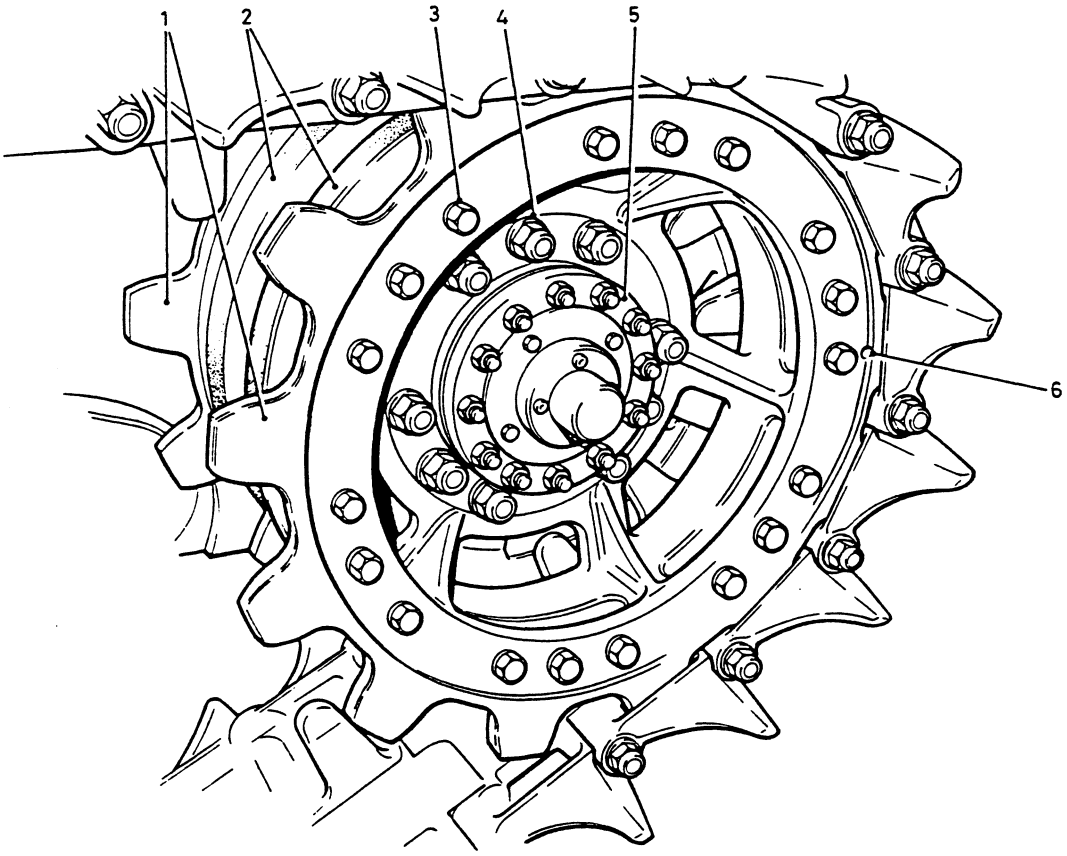
3 The track on each side of the vehicle is tensioned by a cranked idler wheel actuated by a hydraulic track tension ram. The rams are operated by pumping grease (to increase track tension) via a nipple and charge valve incorporated in each of the ram cylinders.

4 The tracks utilise rubber padded alloy steel track links with rubber insert track pin bushes. Each track is driven by sprockets fitted to each of the final drive hubs. Each track is supported by two track support rollers along its top run.

Sprocket wheels

5 The sprocket wheels (Fig 1) are bolted to each of the final drive hubs (5) with interposed shimming, to ensure alignment with road wheels. Each sprocket comprises two identical rubber-tyred track support wheels (2) and two identical sprocket rings (1). The sprocket rings and track support wheels are bolted (3) together to form two halves of the drive sprocket, the drive sprocket halves are then secured onto the sprocket hub studs incorporated in the final drive unit using drive sprocket to hub securing nuts (4).

6 Each sprocket ring has sprocket teeth wear indicators incorporated and is also marked with a datum hole (6) to ensure alignment of the inner and outer sprocket teeth.

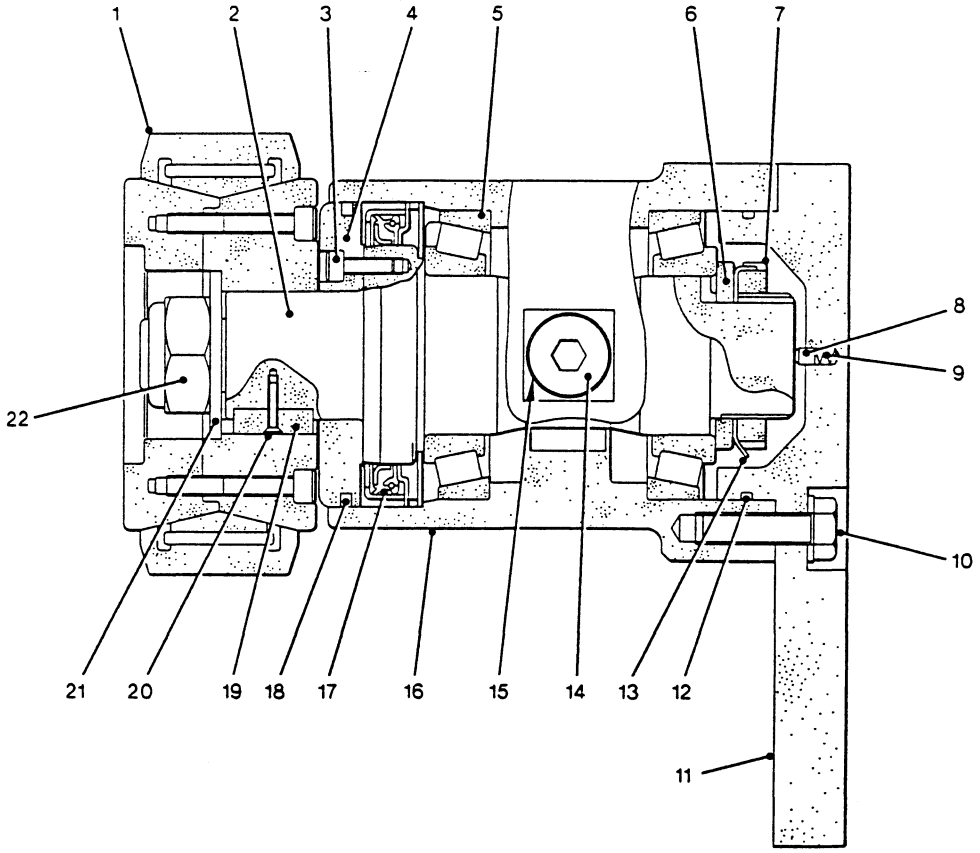


1 Sprocket rings
2 Track support wheels
3 Sprocket ring securing bolts
4 Drive sprocket to hub securing nuts
5 Final drive hub
6 Datum hole

Fig 1 Sprocket wheels

Track support rollers

7 Four track support rollers (Fig 2), two each side of the vehicle, are provided to support the top run of the track. Each roller has a mounting plate (11) by which it is secured to the hull of the vehicle. Hexagon head screws (10) secure the mounting plate to a bearing housing (16) in which taper roller bearings (5) carry a spindle (2). The spindle is retained by a keyed washer (6), lockwasher (13) and locknut (7). A spring loaded carbon brush (8) is incorporated at the inboard end of the spindle to eliminate the build up of static charges. A scotseal (17) is located at the outboard end of the spindle, to prevent the leakage of oil. An end cap (4) incorporating laminar rings (18) is fitted to the spindle to prevent the ingress of dirt and/or debris and is secured by socket head screws (3). The tyred roller (1) is located by a key (19) which is located and held onto the spindle (2) by a countersunk head screw (20) and is secured by a washer (21) and nut (22).



1	Roller	12	O-ring seal
2	Spindle	13	Lockwasher
3	Socket head screw	14	Plug
4	Endcap	15	Sealing washer
5	Taper roller bearing	16	Bearing housing
6	Keyed washer	17	Scotseal
7	Locknut	18	Laminar rings
8	Brush	19	Key
9	Spring	20	Countersunk head screw
10	Hexagon head screw	21	Washer
11	Mounting plate	22	Nut

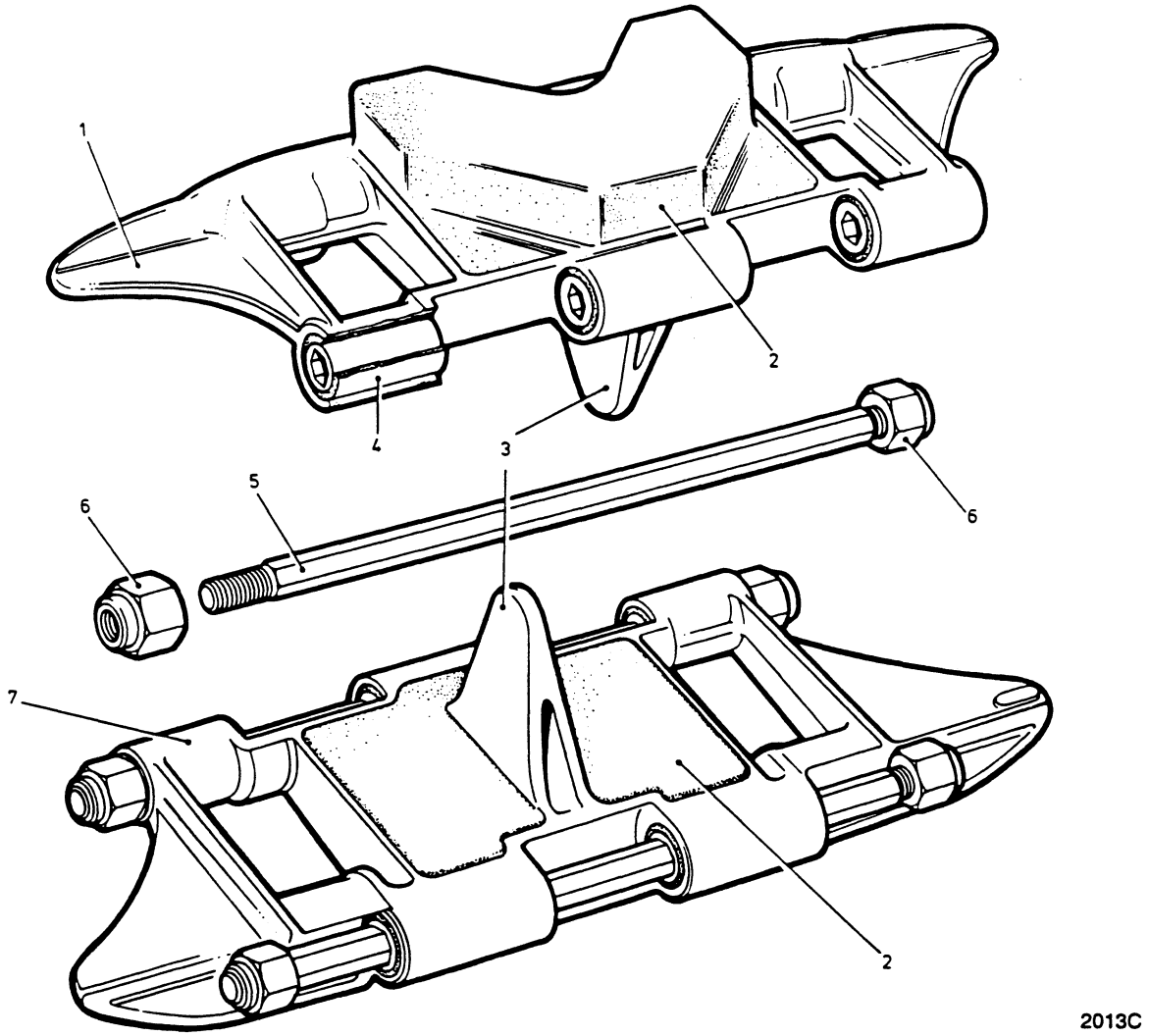
Fig 2 Track support roller

Tracks

8 The tracks are constructed from track links and track pins, as in Fig 3. The track links (7) are steel alloy castings with bonded rubber pads (2) and resilient track pin bushes (4). The bush inner sleeves are hexagonal in section and are installed in the castings in a position which produces a 13 degree angle between the links when assembled. The use of hexagonal track pins (5) and resilient track pin bushes obviates frictional wear on pins and greatly reduces noise level in traction. The method of track link joining reduces stressing (in either direction about the axis of the pin) of bush rubber inserts during flexing of the track when in motion. When the track is wrapped around the sprocket, such that the angle between adjoining track links is 167 degrees, the stresses in the associated track pin bush rubber inserts are zero. It follows that in this position the bush inner sleeves will be aligned to permit withdrawal and insertion of the track pin (5).

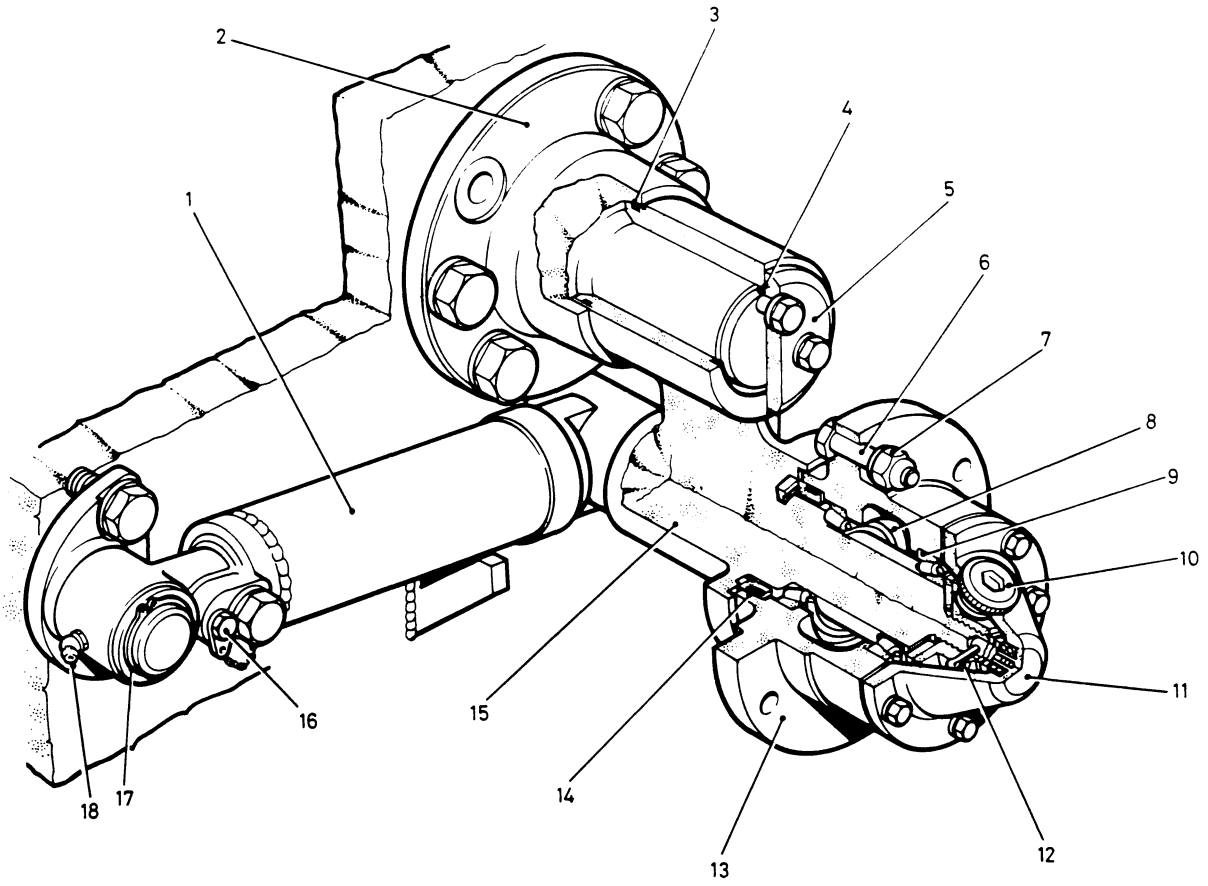
9 A horn (3) on each track link centralises the tracks on the road wheels, idler wheels and sprocket wheels and locates the track preventing track throw.

10 The nuts (6) securing the track pins are self-locking and equal amounts of thread should protrude through each nut to ensure that the track pins are centralised.



1 Spud
2 Rubber pad
3 Horn
4 Resilient bush
5 Track pin
6 Nut
7 Link

Fig 3 Track link



3726D

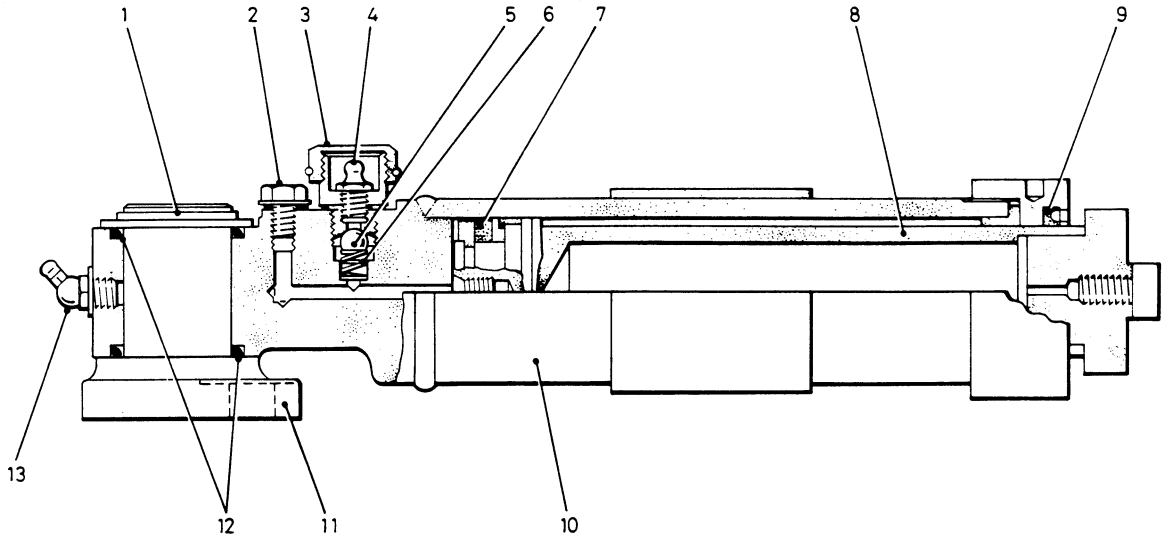
1	Track tension ram	10	Filler plug
2	Idler pivot bracket	11	Hub cap
3	Seal	12	Split pin
4	Seal	13	Idler wheel hub
5	Idler wheel crank retaining plate	14	Seal assembly
6	Wheel securing bolt	15	Idler wheel cranked arm
7	Wheel securing nut	16	Grease release plug
8	Roller bearing	17	Circlip
9	Bearing outer race	18	Grease nipple

Fig 4 Track tensioner arrangement

Track tension rams

11 The track tension rams (two per vehicle) are fitted as shown in Fig 4. The track tension ram (1) acts on the idler wheel cranked arm (15) exerting a force proportional to the pressure of grease in the cylinder (Fig 5 (10)). Grease is injected into the cylinder (to increase track tension) via the nipple (4) and charge ball valve and spring (5 and 6). The grease is retained in the cylinder by a distributor seal (7). When it is required to slacken the track (achieved by reducing grease pressure) remove the plug (2) and release the grease. A scraper ring (9) at the ram end of the cylinder prevents the ingress of dust and moisture.

12 The track tension ram is retained on the pivot bracket by a circlip (1). Two seals (12) prevent the ingress of dust and moisture to the pivot bracket shaft.



4388D

1	Circlip	8	Piston
2	Plug	9	Scraper ring
3	Cap	10	Cylinder
4	Nipple	11	Pivot bracket
5	Ball (valve assembly)	12	Seal
6	Spring (valve assembly)	13	Lubricating nipple
7	Distributor seal		

Fig 5 Track tension ram

Idler wheel cranked arms and pivot brackets

13 The idler wheel cranked arms (Fig 4 (15)) are steel alloy and differ from road wheel axle arms in that the stub axles (and ram tensioner extensions) are integral with the cranked arms. The two seals (3 and 4) prevent the ingress of dust and moisture.

14 The pivot bracket (2) is flange mounted to the hull side plate. The cranked arm is retained on the pivot bracket by the retaining plate (5).

Idler wheels

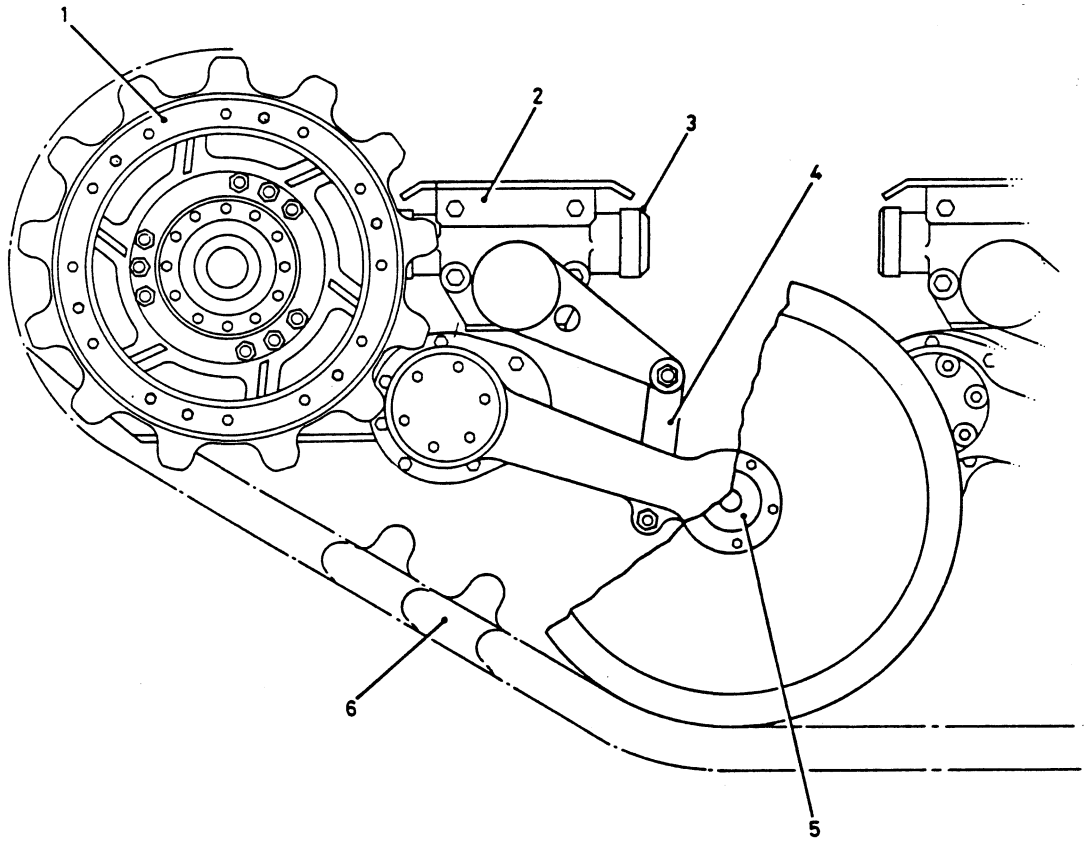
15 The idler wheels are of steel formed in two pieces which on assembly form a Vee shaped groove in the centre of the rim, creating clearance for the track horns and providing axial location of the track. The rim is braced with webbed spokes. The wheels are secured to the hubs by bolts and self-locking nuts.

SUSPENSION AND ROAD WHEELS

General

16 The suspension (Figs 6 and 7) utilises torsion bars giving independently sprung road wheels. Each road wheel consists of two identical wheel discs. The discs are mounted on a hub which rotates about a stub axle fitted to the trailing end of a forged aluminium trailing axle arm.

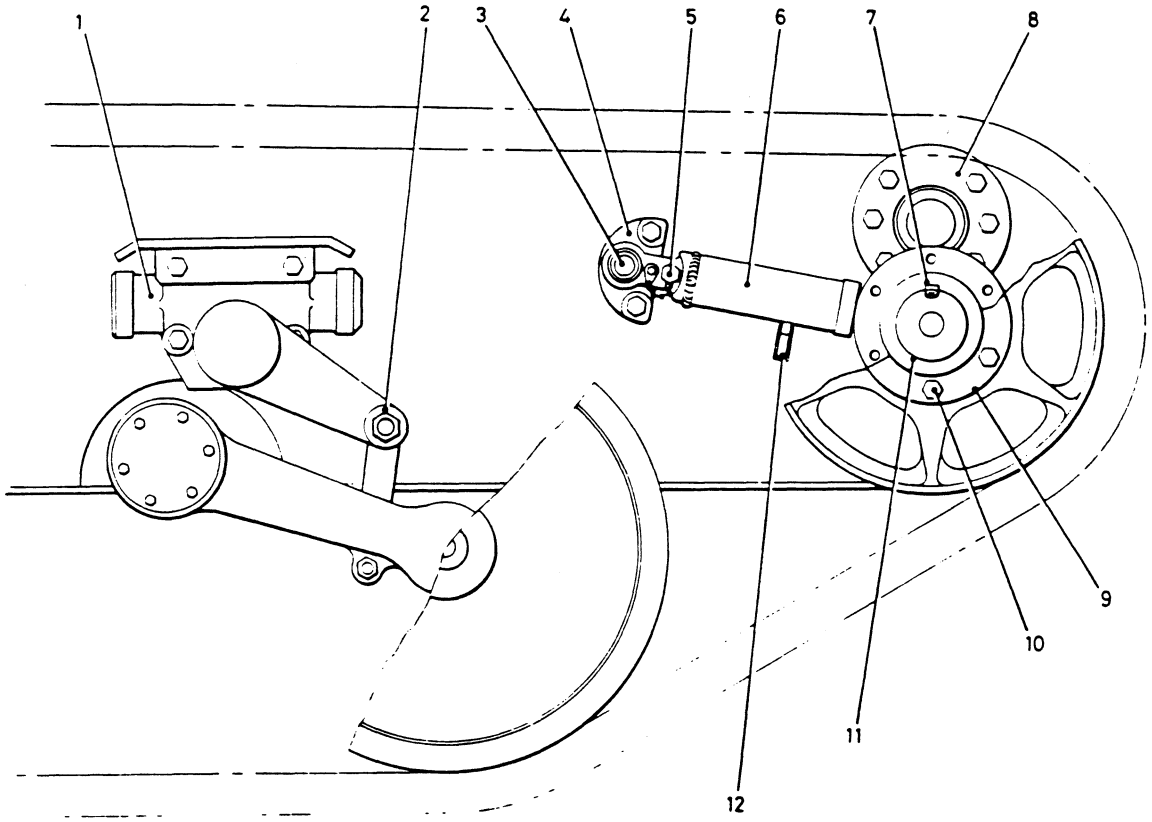
17 Motion of an axle arm about a pivot bracket is controlled by a torsion bar. The bar is flange fitted to the axle arm with its other end anchored in a housing which is integral with the axle arm of the opposite wheel station. The loading of each torsion bar is subject to a maximum as imposed by track contacting the underside of the sponson in bump and the static setting angle (rest position) when in rebound. Six hydraulic type suspension dampers (Fig 6 (3) and Fig 7 (1)) are incorporated at the two front and the rear wheel stations either side of the vehicle. The road wheel hubs (Fig 6 (5)), idler wheel hubs and axle arm bearing housings are filled with oil. Access plugs for replenishment purposes are provided.



5048C

1 Sprocket wheel
2 Damper guard
3 Suspension damper
4 Link arm
5 Road wheel hub
6 Track link

Fig 6 Suspension arrangement (front)



3210C

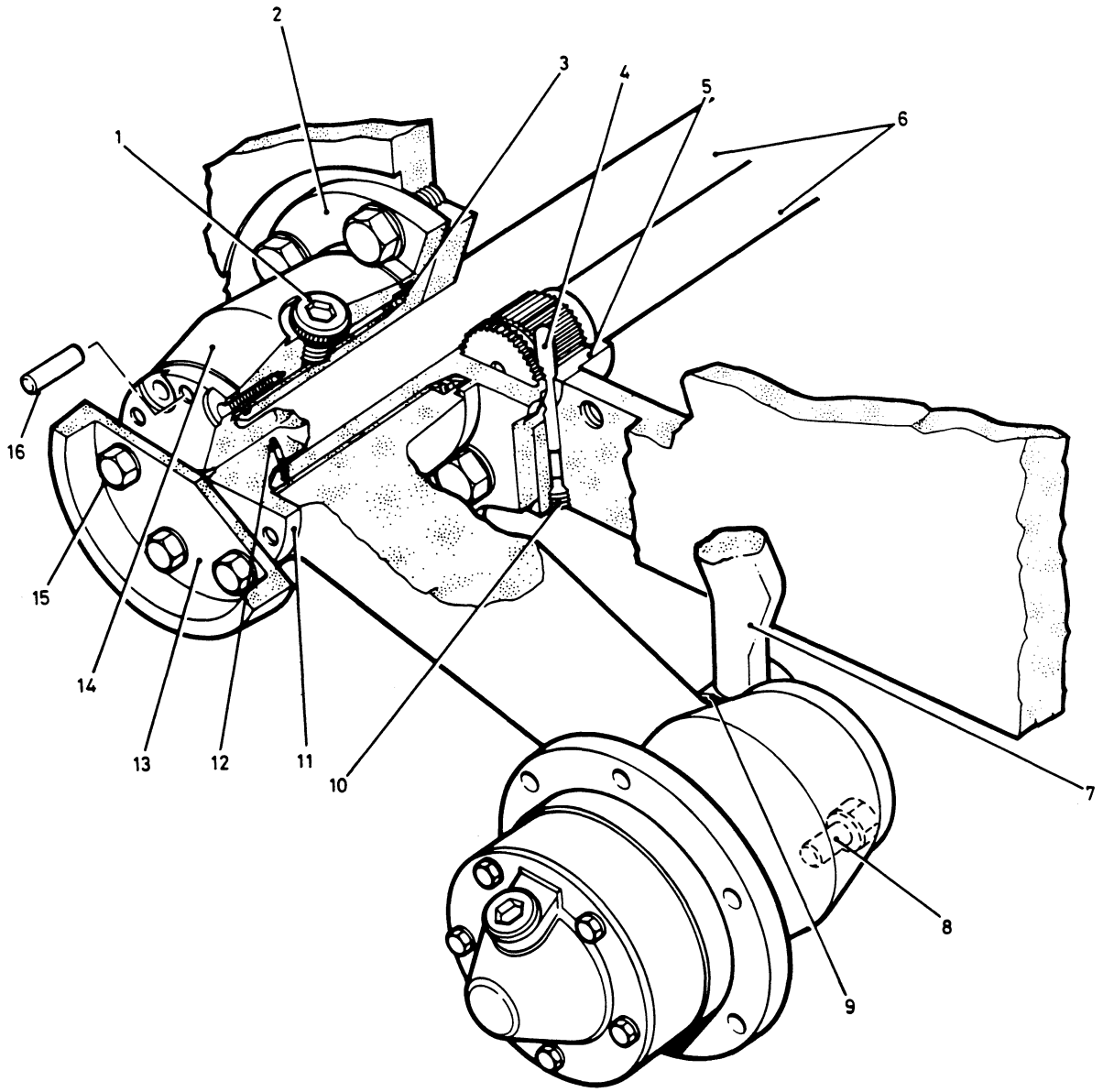
1	Suspension damper	7	Filler/level plug
2	Link arm	8	Idler pivot bracket
3	Pivot point	9	Idler wheel
4	Pivot bracket	10	Wheel nut
5	Nipple (covered)	11	Wheel hub
6	Track tension ram	12	Ram stop

Fig 7 Suspension arrangement (rear)

Torsion bars

18 The torsion bars (Fig 8 (6)) are flanged (11) at one end and are machined with splines at the other. The flanged end is secured to the axle arm by six screws (15) and six dowels (16). The splined end is anchored within the pivot arm securing bracket on the opposite side of the vehicle by a pin (4) engaging tangentially in an annular groove in the splines. The pins are interference fits in the housing and an extractor is required to withdraw them. The front wheel station axle arms are protected by guards (13).

19 The bars are handed and are stamped `R.H.' or `L.H.' with an arrow showing the direction of pre-set on the outer face of the flange. When installed in the vehicle, the arrows on the bars fitted to the right hand side of the vehicle will indicate clockwise, and on the left side, anti-clockwise.



5000C

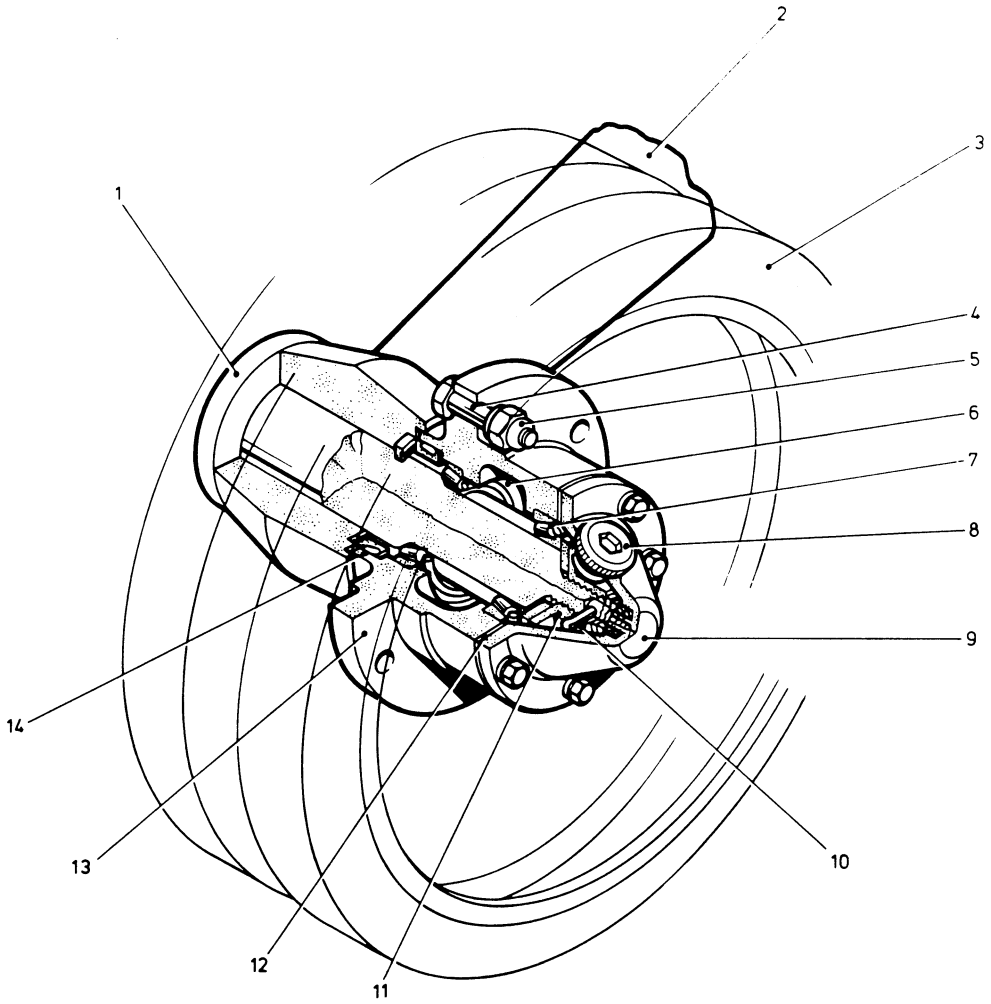
1	Filler plug	10	Set screw plug
2	Pivot bracket	11	Torsion bar flange
3	Seal	12	'O' ring seal
4	Torsion bar locating pin	13	Axle arm guard
5	Torsion bar housing	14	Axle arm
6	Torsion bars	15	Torsion bar securing screw
7	Suspension damper link arm	16	Torsion bar dowels
8	Stub axle securing screw		
9	Axle arm/suspension damper link arm ball joint		

Fig 8 Axle arm and torsion bar arrangement (front wheel station)

20 A location mark in the form of a `D' is stamped on the outer flange of the torsion bar adjacent to one of the dowel holes. This enables the torsion bar to be correctly aligned with the axle arm, to give the correct suspension height setting for the vehicle.

Axle arm assemblies

21 The assemblies incorporate aluminium alloy axle arms that are bushed at one end and fitted at the other with steel stub axles for the mounting of wheel hubs. The stub axle and the two bearing bushes are interference fits in the axle arm (Fig 8 (14)), the stub axle is also secured by two screws (8). The axle arms at the two front and the rear wheel stations on each side are drilled to accept ball joints (9) which are part of the lower end of the suspension damper link.



2182D

1	Stub axle	8	Filler plug
2	Axle arm	9	Hub cap
3	Wheel	10	Split pin
4	Wheel securing bolt	11	Extended washer nut
5	Wheel securing nut	12	Gasket
6	Roller bearing	13	Wheel hub
7	Bearing outer race	14	Seal assembly

Fig 9 Wheel hub

22 The bushed end (pivot end) of each axle arm accommodates a seal (3) fitted to prevent leakage of bearing bush lubricating oil. An oil filler plug (1) is provided.

23 Tapped holes and dowels at the pivot end of the axle arm provide for the fitting of torsion bars (6). The axle arm assemblies are held in position on the axle arm pivot brackets by the torsion bars which are themselves retained by the locating pins (4) in the opposite wheel stations.

Axle arm pivot brackets

24 The axle arm pivot brackets (2) are flange mounted to the hull side plates where they function as mounting pivots for the respective axle arms while providing anchorage for torsion bars in opposite wheel stations. An annular groove at the outer end of the pivot pin provides for the fitting of a seal (3) to prevent oil escaping via the torsion bar/axle arm joint.

25 The joints between the axle arm pivot brackets and hull side plates are sealed with jointing compound to prevent moisture entering the torsion bar housing.

Wheel hubs

26 The road and idler wheel hubs (Fig 9) are aluminium alloy castings with machined centres that accommodate two taper roller bearings and an oil seal. The bearing outer races (7) of the roller bearings are interference fits in the wheel hubs (13), the inner races (with rollers) (6) are a push fit on the stub axle. Bearing preload is governed by the degree of tightness of the extended washer nuts (11). The nuts are secured by split pins (10).

27 The bearings are lubricated by oil. A filler plug (8) in the hub cap (9) facilitates the introduction of oil and a seal assembly (14) prevents leakage from the inboard end of the hub.

28 The wheel hub assembly (13) comprises three elements, an iron facing ring which is cemented to the axle arm and gives a mating surface for the second element, a specially shaped sealing ring which is held in position by the third element, a synthetic rubber `O' ring. The `O' ring is fitted to exert radial pressure inward on the seal and mate with a machined surface on the hub.

29 To eliminate the possibility of static charges in the wheels a spring-loaded carbon brush and rubbing pad are incorporated as a low resistance path between the wheel and the stub axle.

30 A gasket (12) is fitted between the hub and the hub cap.

Suspension dampers

31 The suspension incorporates six dampers (Fig 10), three either side operating on the two front and the rear wheel stations. The dampers are bolted to the hull side plates and connected to the axle arms by a link incorporating ball joints at each end. The suspension dampers are of the double acting lever type. Guards to protect the dampers from track whip are incorporated at all the damper mountings.

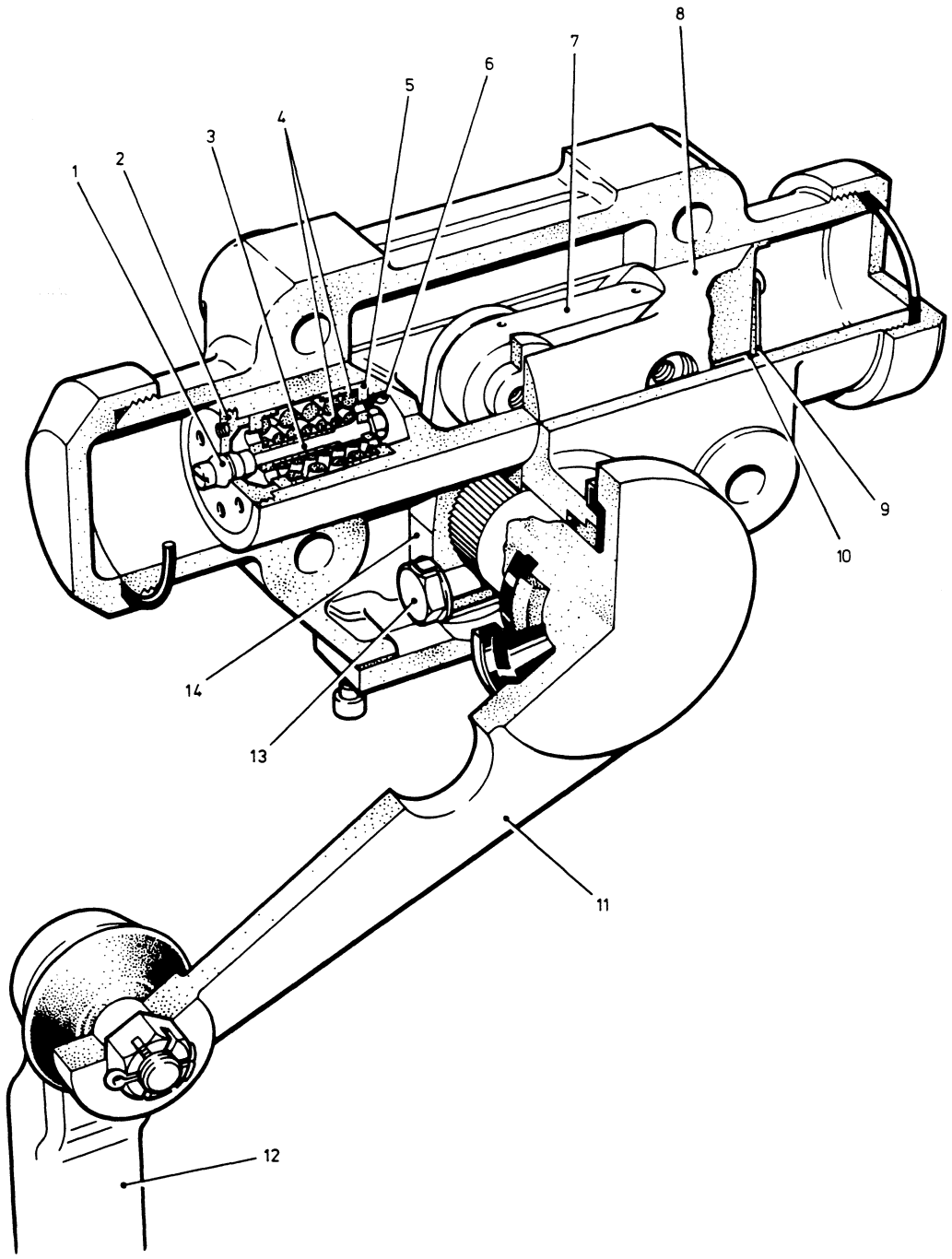
32 The link (12) transmits wheel movement from the axle arms to the pivoting damper arm (11). A lever (14) is clamped by a pinch bolt (13) to the splined shaft of the damper arm. The upper end of the lever is a fork end and is connected via a rod (7) to a double ended piston (8).

33 When the road wheel rises, the arm rotates clockwise and moves the piston to the right, compressing the fluid in the right hand cylinder. An oilway (6) is drilled from the right hand end of the piston to connect with the damping cartridge (1 to 5). The pressure of the fluid passing through the damping cartridge also forces the inner cup (5) to the left compressing the two springs (4) and carrying the rod (3) with it. This rod has a tapered plug (1) at its outer end and this plug moves out of the metering orifice in the piston plate (2), progressively allowing the piston to move faster. As the pressure drops the springs force the tapered plug back into the piston plate.

34 When the wheel moves down, the arm rotates anti-clockwise and the piston (8) moves to the left, compressing the fluid in the left hand cylinder. Fluid passes through the holes in the piston plate (2), again compressing the two springs (4) carrying the rod and tapered plug (1) out of the metering orifice in the piston plate (2), through the damping cartridge and via the oilway (6) to the right hand cylinder. As the pressure drops the springs force the tapered plug back into the piston plate. Any leakage past either end of the piston into the central linkage and reservoir area is relieved via a drilling to the right hand cylinder. This drilling is closed by a spring blade valve (10) supported by a stop plate (9) except when reservoir area pressure exceeds that of the right hand cylinder.

Road wheels

35 All the road wheels are identical and therefore interchangeable. Each wheel is an aluminium alloy wheel disc with a steel wheel rim rivetted to the disc. Bonded to the wheel disc and rim is a solid rubber tyre. The wheels are fitted in pairs on each of twelve road wheel hubs with a locking ring interposed to ensure that the mounting bolts do not rotate. Road wheels are shimmed to align with the sprocket assembly.



2191C

1	Tapered plug	8	Piston
2	Piston plate	9	Stop plate
3	Rod	10	Spring blade valve
4	Springs	11	Arm
5	Cup	12	Link
6	Oilway	13	Pinch bolt
7	Rod	14	Lever

Fig 10 Suspension damper

CHAPTER 7

HULL AND FITTINGS

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GENERAL

1 The hull forms the main frame of the vehicle and is a [redacted] to the crew and internal components. The internal side and top surfaces of the driving and commander's compartments are lined as appropriate with insulating material, to reduce heat transfer, provide bump protection and minimise condensation.

2 The transmission, engine and driver's compartments (Fig 1(1, 2 and 6) are formed by two bulkheads, one pair (7 and 10) fitted transversely, the other (9) longitudinally. Access is gained to the engine and transmission compartments via hinged louvres which are secured in the open position by straps anchored to the hull top plate and having a snap hook at the free end. Access is gained to the driving compartment (6) via the driver's hatch, and to the commander's compartment (3) via the commander's cupola.

3 The vehicle has front and rear stowage compartments (8) and (5) and various fittings on the hull exterior provided for the stowage bins, pioneer tools and vehicle spares.

TRANSMISSION COMPARTMENT

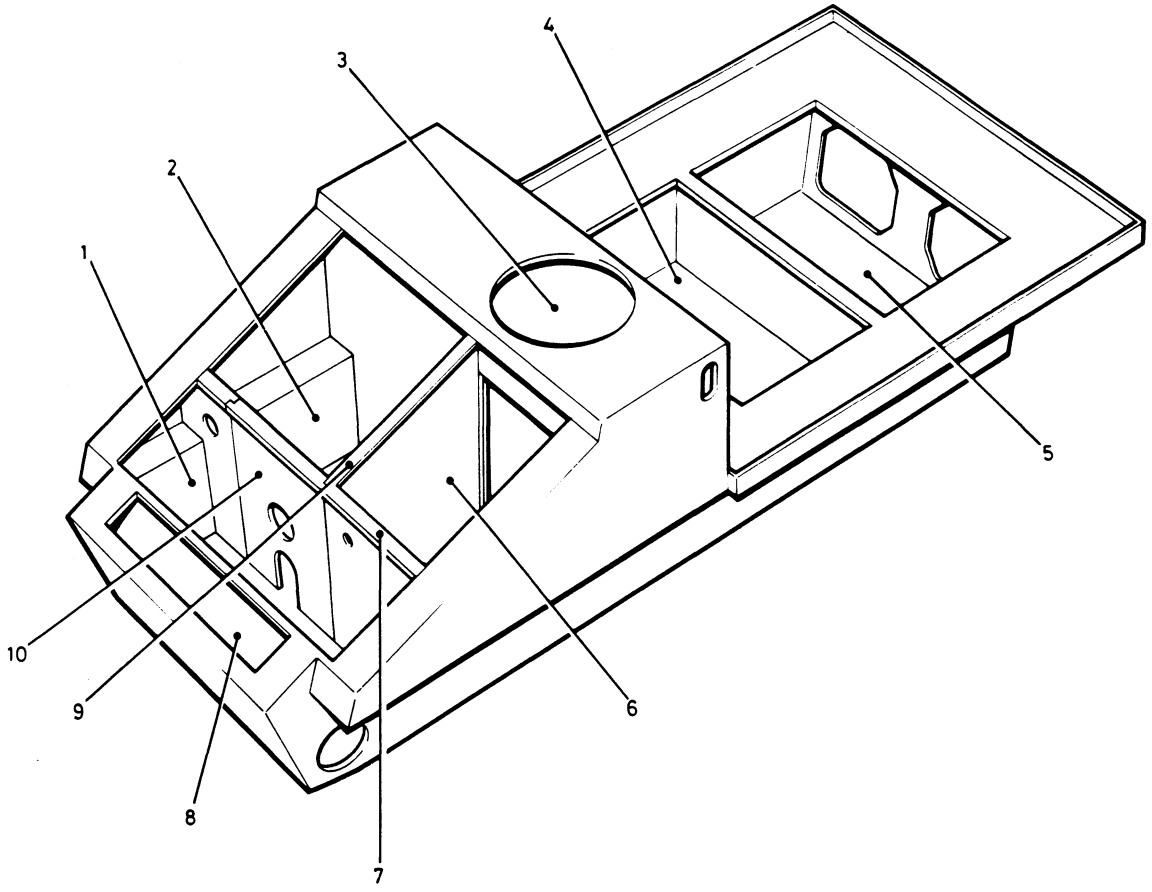
4 Inside the transmission compartment (1) are housed the gearbox, the gearbox oil filter, transmission drive shafts, the engine cooling system radiator and the induction system charge air cooler. The gearbox sits on a pair of lined trunnion support blocks welded to the compartment floor and retained by a pair of lined top caps around the output casings, which are bolted to these blocks. The trunnion top caps are serial numbered and should not be divorced from the vehicle. The rear of the gearbox is bolted to a third block welded to the compartment floor adjacent to the vehicle centre line.

5 An oil drain access plate is fitted to the underside of the hull. A final drive is bolted to the outside of each of the hull sideplates, each is connected to the gearbox by a drive shaft. A hull drain valve is fitted to the compartment floor and is foot operated by the driver. In the bulkhead between the transmission and engine compartment (10) are apertures for the cooling fan, engine/transmission drive shaft, alternator drive, gearbox oil filler and charge air cooler connections.

ENGINE COMPARTMENT

6 Four threaded bosses (welded assemblies), welded to the hull floor provide means of securing the engine. Two brackets welded to the top of the hull sponson on the right of the compartment provide means of securing the engine air filter. Forward of the air filter position, also on the hull sponson are two locating bosses and a mounting bracket which provide for the fitting of the vehicle alternator.

7 A hole in the hull sideplate to the rear of the engine compartment (2) is provided for the engine exhaust system. The walls are covered with heat insulating material which reduces heat transfer to the driving and commander's compartment. An engine oil/fuel drain access plate and coolant drain block sealing plug are fitted to the underside of the hull.



5186D

1	Transmission compartment	6	Driving compartment
2	Engine compartment	7	Driver/transmission bulkhead
3	Commander's compartment	8	Front stowage compartment
4	Fuel tank compartment	9	Longitudinal bulkhead
5	Rear stowage compartment	10	Engine/transmission bulkhead

Fig 1 Hull

DRIVING COMPARTMENT

8 In the floor of the driving compartment (Fig 1(6)), welded to the hull, is a raised platform with threaded bosses and fixtures for securing the steering and braking control mechanisms and a driver's floor plate. To the left of the compartment above the hull sponson are fixture points for the vehicle batteries, the driver's instrument panel and distribution panel and for the transmission forward/reverse control lever. Located in the driver's cover plate are the driver's hatch, the driver's periscope and wiper motor.

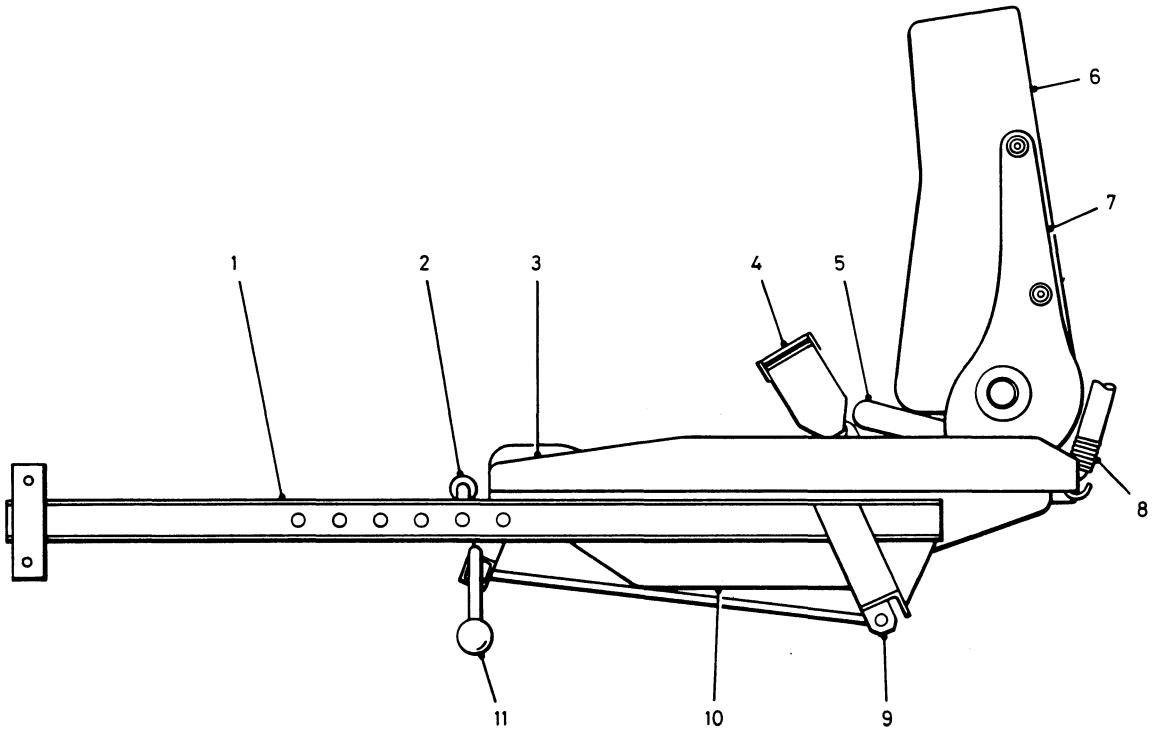
Driver's seat

9 The driver's seat assembly comprises a seat cushion (or squab) (Fig 2(3)) with a tilting backrest.

10 The seat assembly is supported in the seat rails (1) by four rollers. The seat can be adjusted forwards and backwards along the rails. The seat rails are fixed at the front end to two pivot brackets, one on the hull sideplate and one on the driving compartment/engine compartment bulkhead and at the rear end by the two locating pins (9) locating in two brackets fixed either side of the driving compartment. The rear brackets support the seat in a lowered position (for driving with the driver's hatch closed) or in an elevated position (for driving with the driver's hatch open and in the head out position).

11 Movement of the driver's seat is effected when control levers (2) and (11) are operated to release the locating pins. The seat can then be moved in a longitudinal direction by manual effort, and in an up or down direction by the influence of the elastic cords (8) or the driver's body weight respectively.

12 The backrest tilt mechanism utilizes torsion bar type springing to push the backrest forward when the backrest release lever (5) is operated. The backrest is removable to permit emergency removal of the driver.



3868D

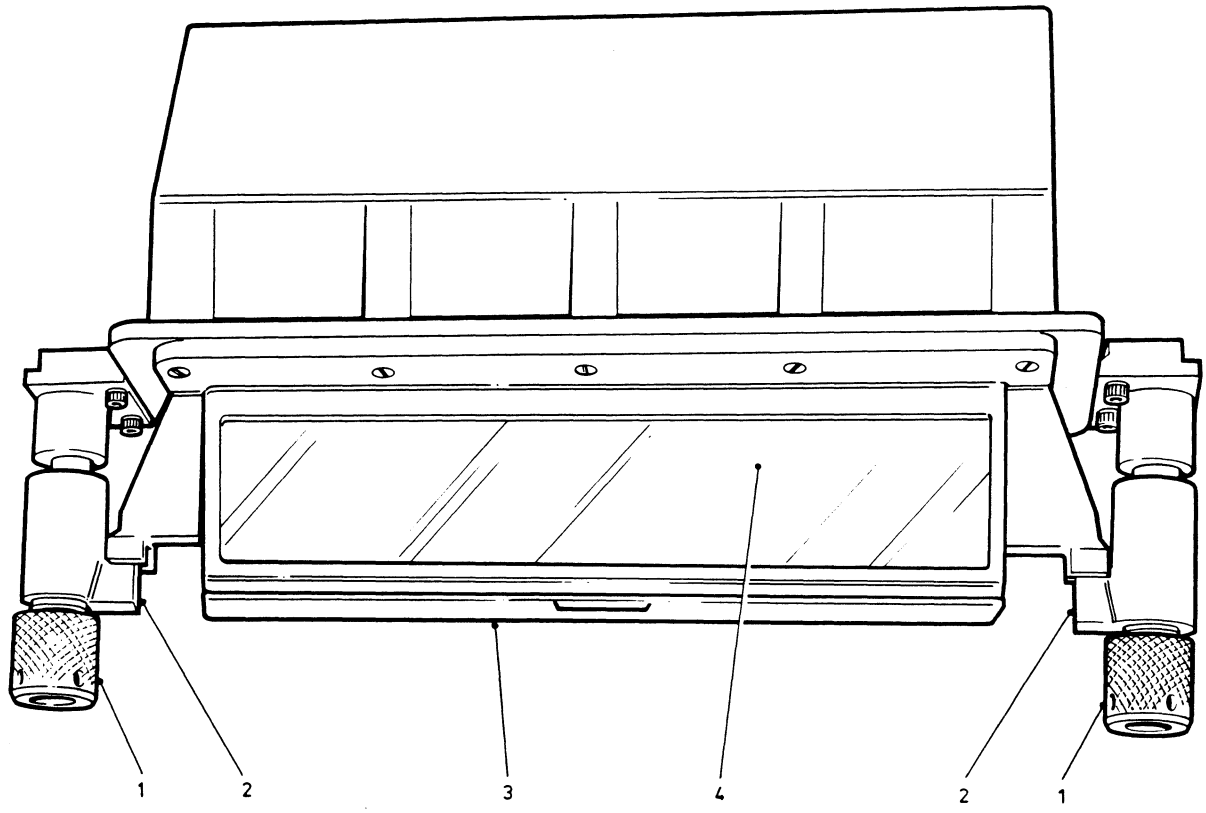
1 Seat rail
2 Longitudinal adjustment lever
3 Seat squab
4 Seat belt
5 Backrest release lever
6 Backrest
7 Backrest tilt mechanism
8 Elastic cord assembly
9 Locating pin
10 Seat pan
11 Height adjustment lever

Fig 2 Driver's seat

Driver's periscope day sight

13 The driver's periscope day sight (Fig 3) is mounted in the driver's cover plate forward of the driver's hatch. The periscope is a simple unity power instrument comprising an upper and a lower prism. Both prisms are encapsulated in synthetic rubber and mounted in aluminium castings. The two piece construction of the periscope allows the upper or lower prisms to be replaced independently, in the event of damage. An air gap is formed when the two case assemblies are screwed together. This ballistic gap prevents damage to the lower prism and the crew should the upper prism be hit by small arms fire or shell splinters. The incident face of the upper prism is inclined forward at an angle of 267mils to the vertical to minimise reflections from the sun and sky. The periscope is sealed, dessicated and filled with dry nitrogen. A metal spring operated folding blind is provided which gives protection against nuclear flash and the necessary blackout facility, at night, when closed down or tactical.

14 An electric wiper mechanism is provided for wiping the window during adverse weather conditions. A screen washer system is incorporated for cleaning the window under dry conditions. The driver's periscope may be removed and replaced by the driver's night sight L16A1. (See EMER INSTRUMENTS C270 for a technical description of the night sight).



3059D

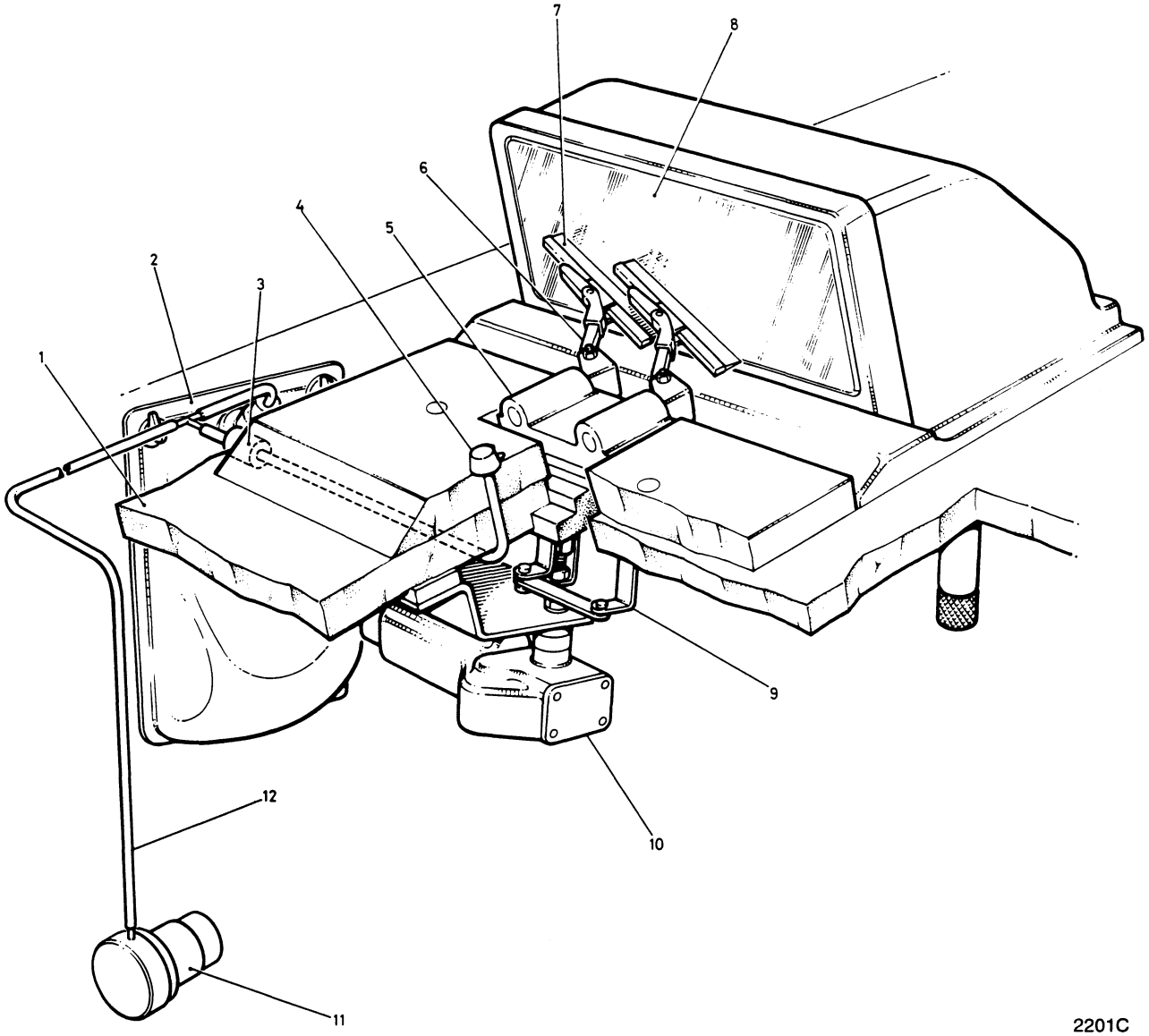
1 Knurled clamping nut
2 Supporting lugs
3 Protective cover
4 Periscope

Fig 3 Driver's periscope day sight

Driver's periscope wiper/washer system

15 The wiper mechanism (Fig 4) comprises two bevel drives both incorporated in a bracket (5) which is secured to the top plate by two screws. It is driven by a motor (10) which is controlled by a switch on the driver's instrument panel. The motor is coupled to the wiper mechanism by a worm and pin engagement, the drive by the two bevel drives which are mechanically linked. The two wipers and wiper arm assemblies (6) are identical, each employing a spring wiper blade (7) to ensure contact pressure between wiper and wiped surface.

16 The screen washer system consists of a jet adaptor (4) screwed into the driver's cover plate (1), a foot operated pump (11) above the driver's left foot, a plastic bag container (2) fitted to the engine compartment bulkhead, transparent interconnection nylon tubing (12) and non-return valve (3).



1 Drivers cover plate
2 Plastic bag container
3 Non-return valve
4 Jet adaptor
5 Wiper mechanism bracket
6 Wiper arm assembly
7 Wiper blade
8 Driver's vision periscope
9 Wiper mechanism
10 Motor
11 Foot operated pump
12 Nylon tubing

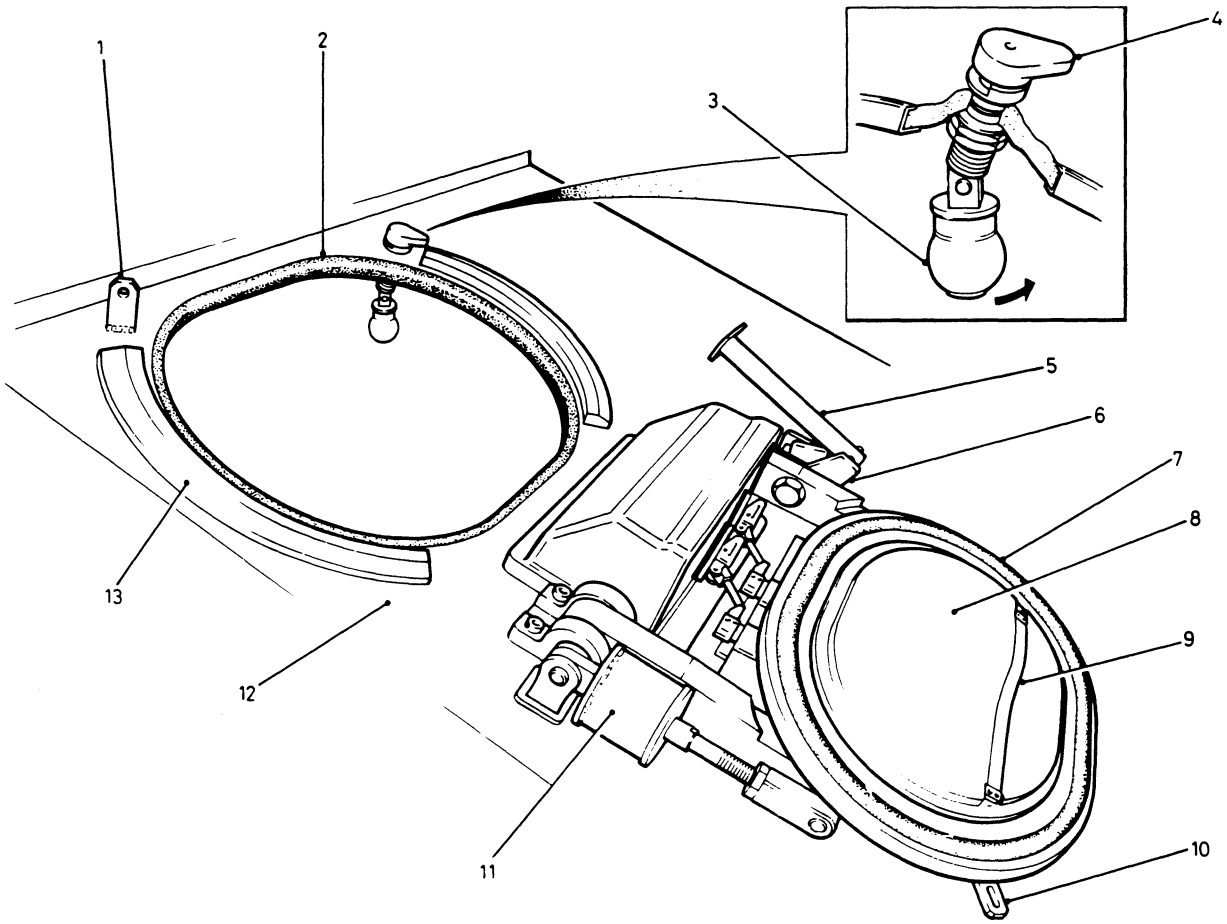
Fig 4 Driver's washer/wiper system

Driver's hatch

17 Access is gained to the driving compartment via the driver's hatch (Fig 5) which is sealed (7) to the drivers cover plate (12) when closed. The hatch is hinged at the front. The inside surface is padded (8). The weight of the hatch is counter-balanced by a spring equilibrator (11).

18 The hatch is secured when open by a locking mechanism (6) and in the closed position by a locking handle (3) located in the drivers cover plate. A securing hasp (10) and eye (1) is provided to padlock the hatch when required.

19 Ballistic strips (13) positioned either side of the hatch opening provide ballistic cover for the hatch seals.



5090D

1 Securing eye
2 Sealing and protection collar
3 Locking handle
4 Catch
5 Release lever
6 Locking mechanism
7 Seal
8 Padding
9 Hatch strap
10 Securing hasp
11 Equilibrator
12 Drivers cover plate
13 Ballistic strips

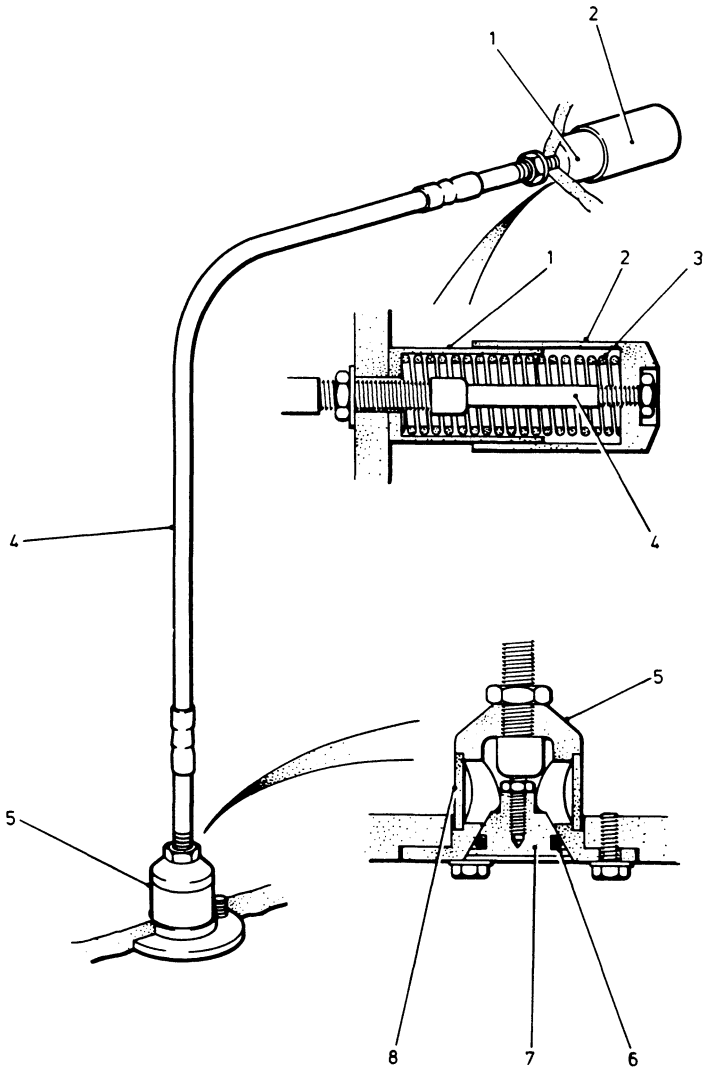
Fig 5 Driver's hatch

HULL DRAIN VALVE

20 The cable controlled foot operated hull drain valve (Fig 6), operated by a push knob above the driver's left foot, is provided to drain accumulated water from the transmission compartment.

21 The drain valve comprises a conical valve head (7) with an 'O' ring seal (6) which seals against a face in the valve body (5). The flanged face of the body is secured by three screws to the underside of the vehicle hull. A perforated sleeve screen (8) around the lower end of the body prevents fouling of the valve seating. One end of the Bowden cable assembly outer sleeve is screwed into the housing of the valve body (5) and secured by a locknut. The inner cable is screwed into the valve head (7) and retained by a locknut.

22 The other end of the cable outer sleeve is fitted through the driver/transmission compartment bulkhead plate into a spring cup (1) and retained by two washers and locknuts. The inner cable is screwed into the recessed head of the control knob (2) and locked by a nut. A helical coil compression spring (3). Located under the control knob and housed in the spring retaining cap, returns the valve to the closed position when the control knob is released.



2120C

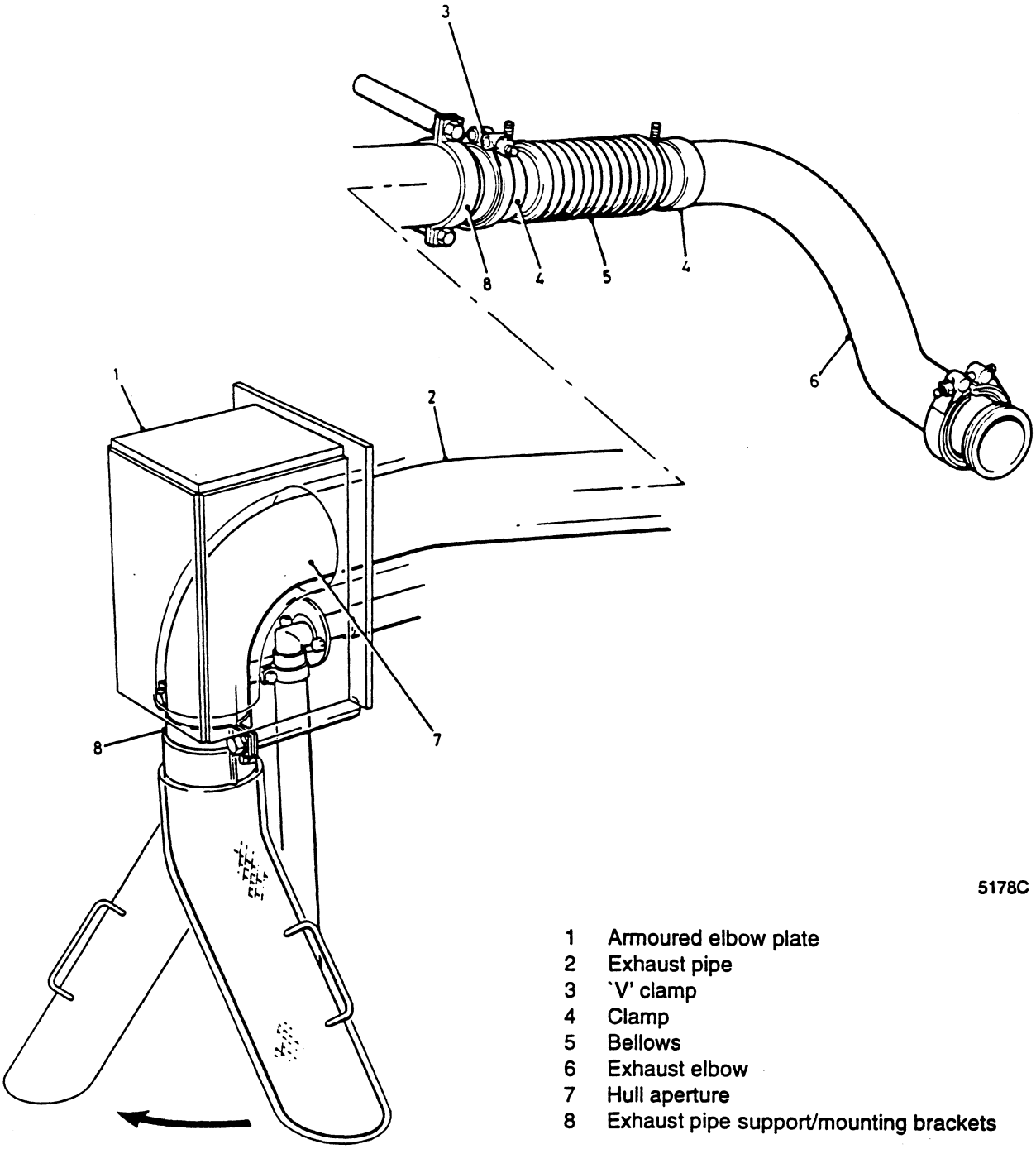
1 Spring cup
2 Control knob
3 Spring
4 Control cable
5 Valve body
6 'O' ring seal
7 Valve head
8 Screen

Fig 6 Hull drain valve

EXHAUST SYSTEM

General

23 Exhaust gases from the engine are directed through an exhaust manifold to the turbine side of the turbocharger. Gases discharged from the turbine are passed via an expansion bellows to the exhaust pipe which exits the rear of the engine compartment at the top right hand corner and runs down inside an external side stowage bin to the tailpipe. The tailpipe has two positions, inboard (pointing forward) for normal operating/running conditions, and outboard (at right angles to the vehicle) for when the vehicle is under camouflage, or when the tailpipe is to be fitted with an exhaust extractor.



1 Armoured elbow plate
2 Exhaust pipe
3 'V' clamp
4 Clamp
5 Bellows
6 Exhaust elbow
7 Hull aperture
8 Exhaust pipe support/mounting brackets

Fig 7 Exhaust pipe and fittings

Exhaust pipes and fittings

24 The turbocharger is bolted direct to the exhaust manifold. An exhaust elbow (Fig 7(6)) is connected at one end to the outlet of the turbocharger and at the other end to a stainless steel bellows (5), and is secured by a steel clamp (4). The outlet of the bellows connects to a coupling and is secured by a second steel clamp (4). The coupling connects to the exhaust pipe (2) and is secured by a `V' clamp (3). The exhaust pipe (2) exits the engine compartment via an aperture (7) in the hull sidewall.

25 An armoured elbow plate (1) attached to the hull protects the aperture. The exhaust pipe support and mounting brackets (8) are bolted to the engine compartment interior rear bulkhead, and the external hull sidewall.

COMMANDER'S COMPARTMENT

26 The commander's compartment has a flat roof plate with the commander's cupola mounted on interface features machined into the plate. An emergency escape hatch is located in the hull floor beneath the commander's seat.

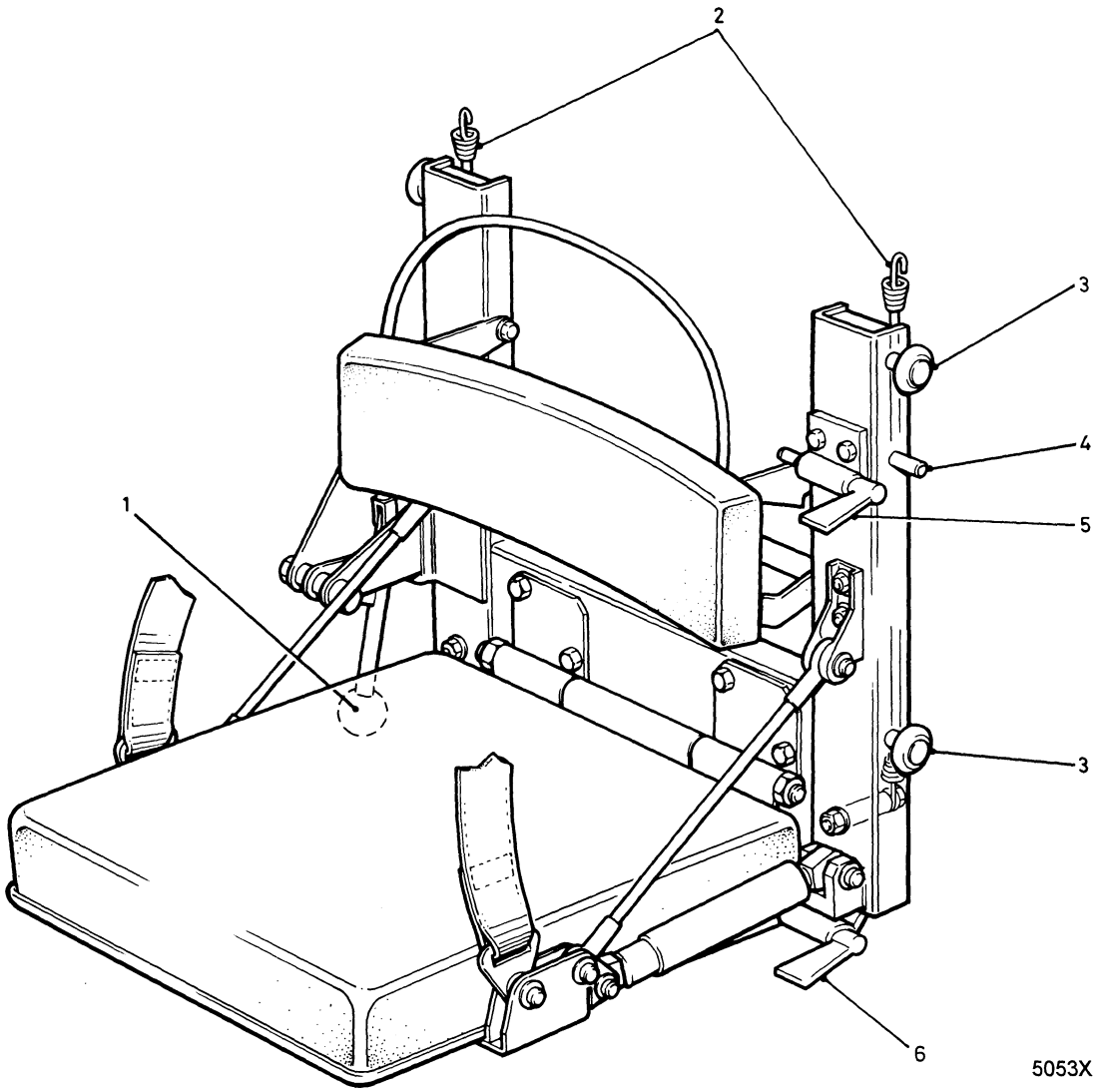
Commander's seat

27 The commander's seat (Fig 8) comprises a two position backrest and a tilting squab mounted on a frame which carries the mechanism for controlling the vertical height of the seat. The frame has four guide wheels (3) fitted to its vertical members, the wheels engaging with two vertical rails secured to the rear wall of the crew compartment. Locating pins (4) fitted to the frame locate in holes in the rails to lock the position of the seat in the vertical plane.

28 A height adjustment lever (1) fitted to the right hand side of the seat is coupled to locating pins by a flexible control cable. Operating the lever causes the locating pins to disengage from the vertical rails, leaving the seat free to move. Upward movement is effected by the tension in two elastic cords (2) which connect the seat frame to the crew compartment wall. Downward movement is caused by the body weight of the occupant of the seat.

29 The two position padded backrest has an upper and a lower locating position, and is locked into its selected position via a locking spring bolt (5), the backrest should be in the upper position for seat lowered, or in the lower position for seat raised. The seat squab can be tilted into the vertical position to create more free space within the crew compartment. The squab is moved manually and is held in the upright position by two gas springs fitted one either side of the squab. When the squab is in the horizontal position it is locked into position via a locking spring bolt (6). The weight of the occupant is supported by two flexible cables fitted between the sides of the squab and the seat frame.

30 The reel type inertia seat belts fitted to the commander's seat are of the automotive lap/shoulder type. The seat belt inertia reels are mounted at the top of the hull and the fixed ends of the harnesses are attached to the seat frame. A seat belt socket is attached to the lap seat belt on the right hand side of the seat, and a seat belt fastener attached to the lap seat belt on the left hand side of the seat. The belts are pulled from the reels, over the shoulders, and when the tongue of the fastener is pulled across the lap and inserted into the socket, will lock into position. The tongue of the fastener and the belt socket can be adjusted along the lap belts to give a comfortable position. When the belts are released, the reels will tension the belts. Any sudden pull on the belts will lock the reels so that the belts will secure the commander. By lifting the release flap on the belt socket the tongue of the lap belt is released and the belts will rewind onto the reels.



1 Height adjustment lever
2 Elastic cords
3 Guide wheels
4 Locating pins
5 Backrest locking spring bolt
6 Seat locking spring bolt

Fig 8 Commanders seat

FRONT STOWAGE COMPARTMENT ACCESS COVERS

31 The front stowage compartment has two hinged access cover assemblies, which are retained in position by a saddle plate/hand knob assembly. A locking facility is incorporated via a staple and hasp.

REAR STOWAGE COMPARTMENT DOORS

32 The hull rear stowage doors comprise of [redacted] When the doors are closed, the joints are sealed by synthetic rubber seals which are attached to each door.

33 Handles fitted to both doors control a simple blade retaining latch, and are locked for security using a chain and padlocks.

CUPOLA

General

34 The vision cupola (Fig 9) is mounted on the vehicle roof and provides the mount for the vision periscopes for use by the vehicle commander. It consists of a fixed base ring and an [redacted] which rotates on a crossed roller bearing type race.

35 The spring assisted cupola hatch can be locked in the closed position (from inside), or opened up and retained by a catch (14) in the vertical or horizontal position.

36 The cupola can be slewed by slewing handles, bolted to the rotatable casing, through 170 degrees to allow all round vision for the commander. A locking handle (11) retains the cupola in any required position. A series of five x1 magnification periscopes No. 42, Mk 3 and a wide angle periscope No. 44, Mk 4 give the commander a view of the surrounding terrain.

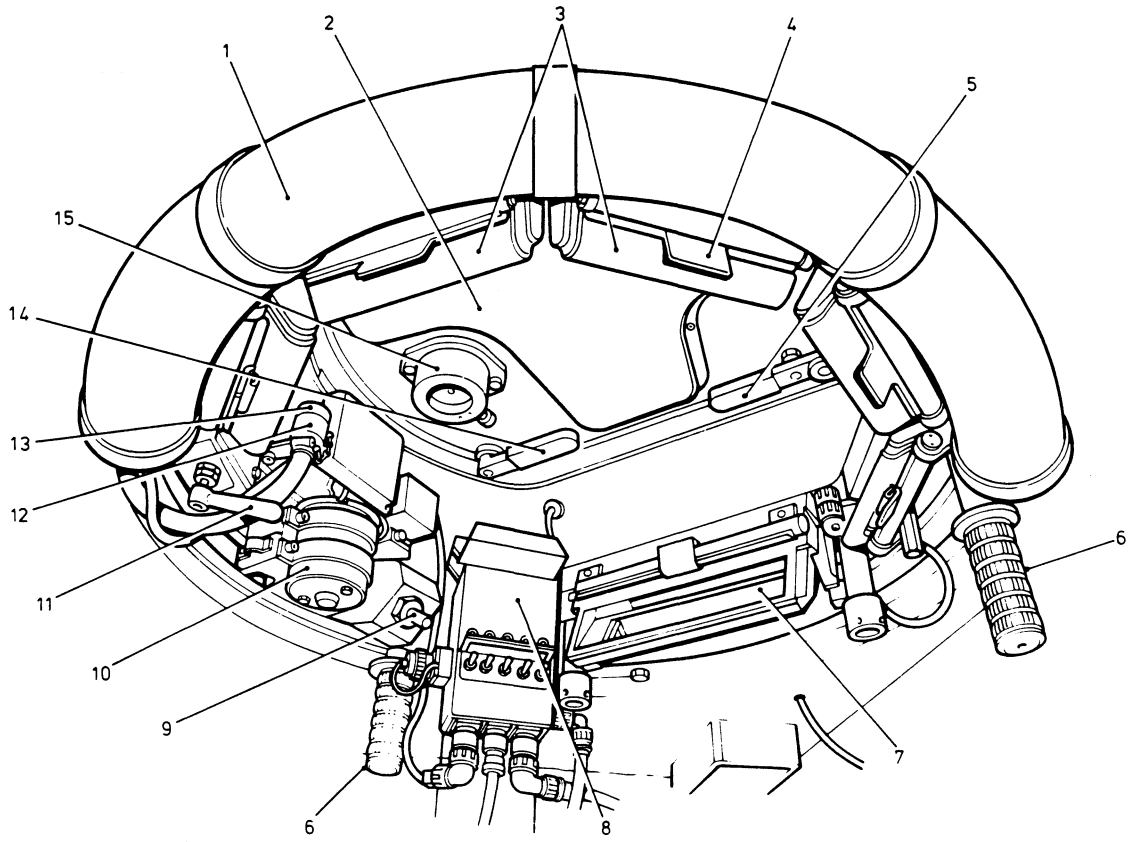
Cupola bearing

37 The cupola bearing (Fig 10) has an outer split ring (8) and (10) which is bolted to the roof plate, and an inner ring (12) which supports the cupola. The load is transmitted by steel balls (4), which are caged by interlocking plastic mouldings (6), while free to roll on the mating surface of the inner and outer steel wires (5). The steel wires are located in grooves in the inner and outer rings, the assembly is secured by screws (1) which hold the two halves of the outer ring together. The assembly also includes dowel pins for locating the ring halves together, and shims for bearing clearance adjustment purposes.

38 The cupola's rotating torque is determined by fitting a brass shim (9) between the upper (10) and lower (8) outer bearing rings which are bolted together. The inner bearing ring is attached to the lower outer bearing ring which, in turn, is bolted to the vehicle roof with an interposing sealing compound. A notch mark machined in the periphery of all three rings (bearing upper, lower and inner) provides the facility for correct hole alignment.

39 The inner bearing ring (12) has a machined groove which houses the cupola sealing ring (11). The sealing blade of the ring contacts the ground face of the upper outer bearing ring, thereby providing an efficient seal which protects the cupola bearing from dust and water, and also prevents ingress of NBC particles to the vehicle interior via the cupola rotating parts.

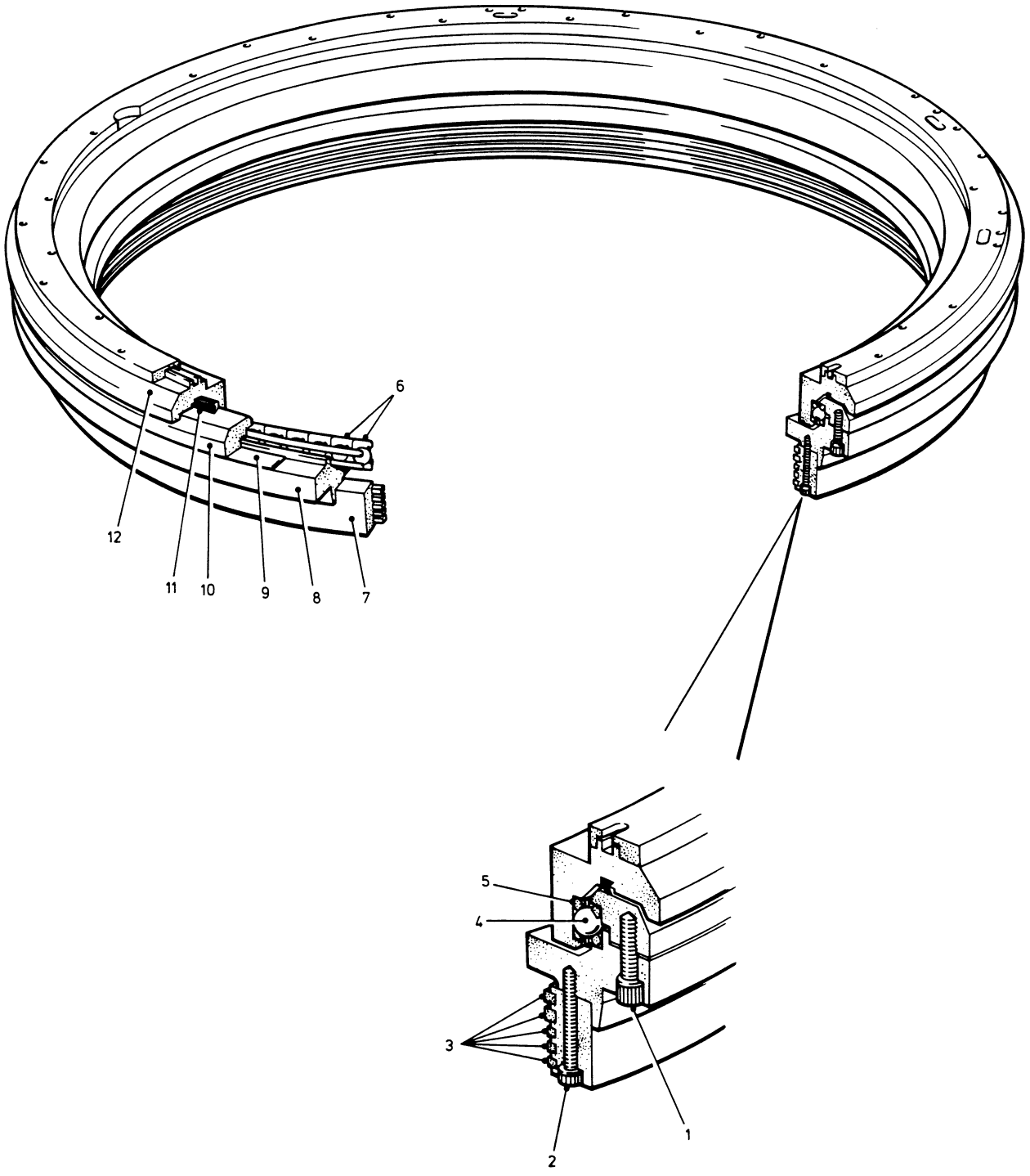
40 An epoxy resin 'slip ring' (7) with five brass tracks (3) is screwed (2) to the lower outer bearing ring. The tracks are connected to the vehicle electrical system and provide the electrical connection via the cupola services switch box for the cupola electrical services and interface to the hatch safety switch. Guards are fitted to the cupola to protect and cover the brass tracks.



2170D

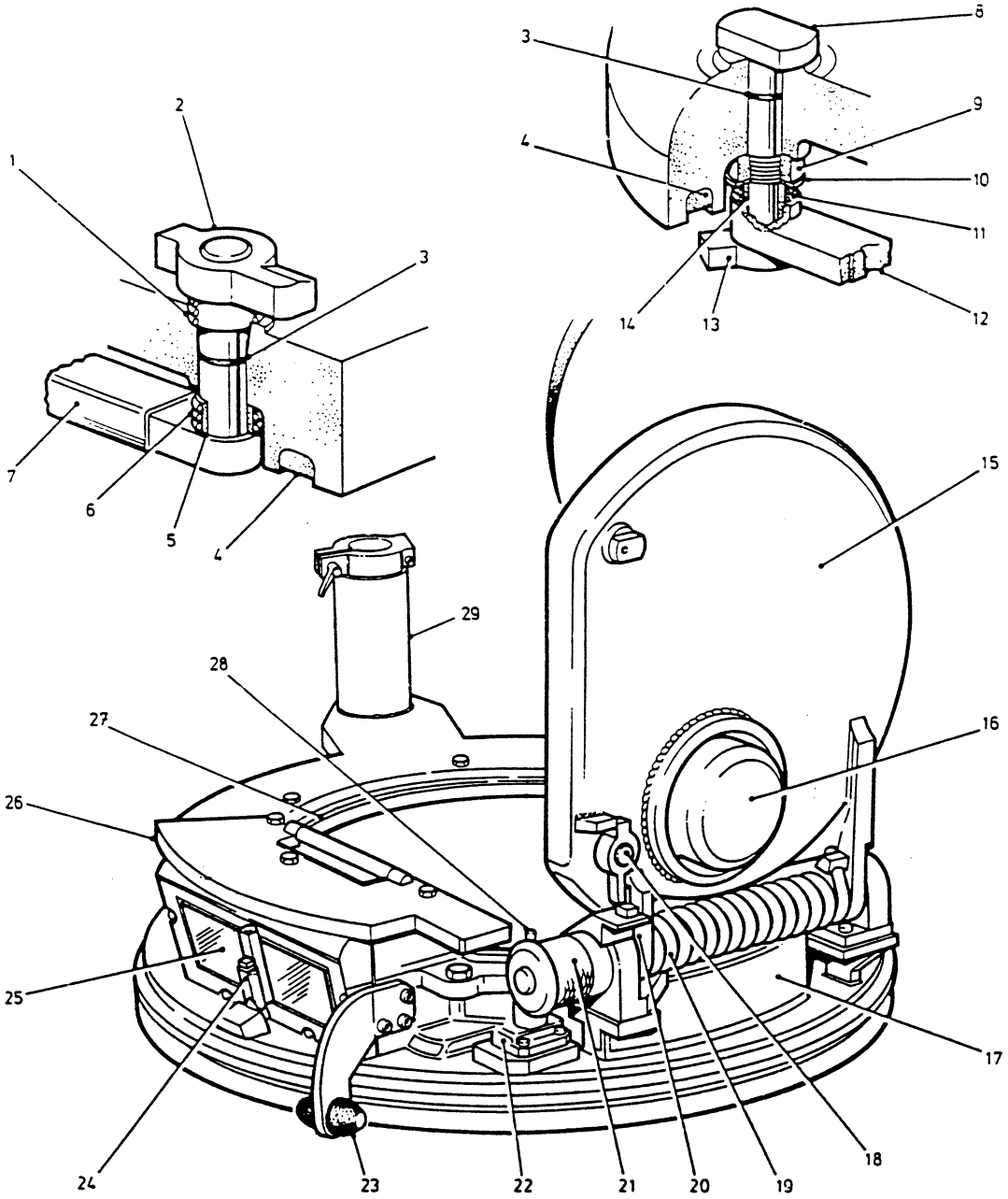
1 Screen washer reservoir
2 Access hatch
3 Vision periscopes
4 Blackout blind
5 Hatch locking handle
6 Slewing handle
7 Commander's periscope
8 Cupola services switch box
9 Screen washer button
10 Wiper motor
11 Cupola locking handle
12 Filler - screen washer reservoir
13 Filler bung
14 Hatch retaining catch
15 NBC relief valve

Fig 9 Cupola (interior view)



1	Screw	7	Slipring
2	Screw	8	Lower outer bearing ring
3	Brass tracks	9	Brass shim
4	Steel balls	10	Upper outer bearing ring
5	Steel wires	11	Sealing ring
6	Interlocking plastic mouldings	12	Inner bearing ring

Fig 10 Cupola bearing



1 Spring
2 Hatch retaining catch
3 'O' ring seal
4 Seal
5 Bush
6 Spring
7 Handle
8 Bolt
9 Nut
10 Washer
11 Spring
12 Clip
13 Handle
14 Sleeve
15 Hatch
16 Pressure relief valve
17 Casing
18 Hatch catch
19 Torsion spring
20 Stop arm
21 Stop arm adjuster
22 Transfer gearbox assembly
23 Bump stop
24 Wiper
25 Commander's periscope
26 Boot plate
27 Landing strip
28 Hatch closed switch
29 GPMG pintle mount

Fig 11 Cupola (exterior view)

Cupola casing

41 The circular [redacted] Fig 11(17)) is suitably machined to mount the cupola hatch and to accept the vision periscopes, the GPMG pintle mount (29) and the various functional equipments disposed around the casing wall. The casing is capped-off by a boot plate (26) (providing protective cover for the sights) which is bolted directly to the casing, a section of the boot plate being raised on pillars to cover the Commander's periscope sight No 44, Mk 4.

Cupola hatch

42 The domed side hinged [redacted] atch (Fig 11(15)) affords an exit/access facility for the commander. The opening and closing of the hatch is assisted by a large coiled torsion spring (19).

43 The spring, fitted between the bushed hatch hinge lugs, relieves some of the effort required to move the hatch. The spring fits over, and is retained by the sleeved hinge pin. The tails of the spring engage in an eccentric bush fitted in the hatch rear lug and a recess in the hatch hinge bracket respectively to give the required torque reaction.

44 The hatch is opened by turning the handle (13) against the force of a torsion spring (11) to disengage the handle's tongue from a slot in the casing wall. The hatch can be retained in the vertical or horizontal open position, by the engagement of the spring-loaded, hatch catch (18) with the stop arm (20), the position of which is controlled by the adjuster (21).

45 The hatch (15) is locked in the closed position, from inside, by turning the lever handle (7) into a slot in the casing wall. The hatch cannot be locked or released from outside without the aid of a suitable tool. A hasp is provided for padlocking the hatch from the outside when closed.

46 The hatch closes onto a landing strip (27) on the cupola casing and is sealed by a half round rubber seal (4), in the grooved hatch rim. 'O' ring seals (3) fitted to the hatch retaining catch shaft and bolt shaft prevents entry of dirt and moisture and aids NBC sealing.

47 A simple flap type air pressure relief valve (16) is located in the cupola hatch. The valve relieves the pressure build up which occurs when the vehicle is operated 'closed-down' with the NBC equipment operating. The outlet from the valve is protected by a domed armour cowl. For details of the valve, see Chap 9.

48 The inside of the hatch is padded to minimise injury to the crew and to afford protection from solar heat. A switch (28) is mounted adjacent to the wiper transfer gearbox assembly to sense the hatch open or shut.

Periscope window washing system

49 The periscopes are each provided with an individual wiper arm and washer jet.

50 The window washing system is a simple manual, press to operate system which stores the water in a circular shaped plastic reservoir container. The container (Fig 12(33)) is supported by clamp rings (32) and support straps (29) secured by fixing bolts to the underside of the cupola casing. A short plastic filler tube (24) connects a spigot (25) at one end of the container and to a spigot on a filler body and is secured by hose clips (26) at each end. The filler body is fitted with a 'bung' type rubber filler plug (27). A chain to retain the plug is secured by rings (28) to both the plug and the support plate. A 'draw-off' tube (23) is fitted, via a spigot and hose clip, to the reservoir immediately below the filler tube connection.

51 The water is drawn from the reservoir by a push button type pump (22) which is bracket mounted on the cupola casing. Water distribution to each sighting station is achieved by a continuous plastic tube (31) routed around the cupola casing wall, and is broken by 'Tee' pieces which direct the water to the window jets (30).

1 Drive pinion
2 Drive crank
3 Helical drive rack (primary)
4 Motor
5 Transfer gearbox
6 Locknuts
7 Spring
8 Screw
9 Top cover
10 Upper gearwheel
11 Thrust bearing
12 Dowel
13 Lower gearwheel
14 Thrust bearing
15 Bridge housing
16 Bush
17 Spring seat
18 Support tube
19 Main helical drive
20 Commander's wiper arm
21 Commander's wiper blade
22 Push button type pump
23 Draw-off tube
24 Filler tube
25 Spigot
26 Hose clip
27 Filler plug
28 Ring
29 Support strap
30 Window jet
31 Plastic tube
32 Clamp ring
33 Container
34 Wheelbox housing
35 Arm
36 Blade
37 Drive wheel
38 Wiper arm clamp
39 Wiper arm drive shaft

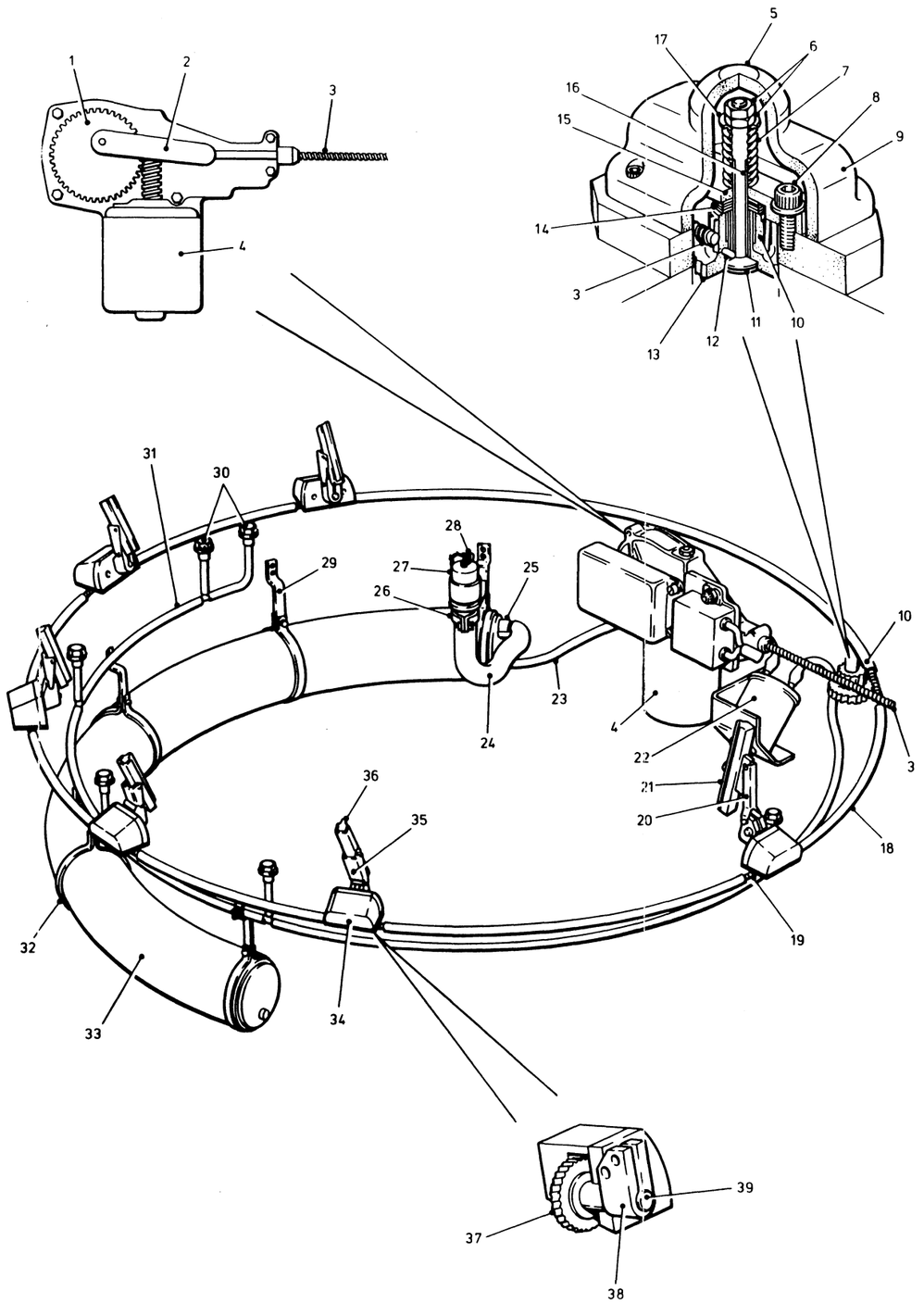


Fig 12 Washer/wiper system

Periscope window wiper system

52 The six bladed wiper system is driven by a single speed 24V 6W electric motor via a single flexible helical drive. The motor and its drive unit are bracket mounted to the cupola casing wall, and retained by two metal clamps. The motor is energized by a switch positioned on the cupola services switch box.

53 The motor (Fig 12(4)) is a single speed, double brush commutator motor which has its parking switch removed. The motor worm drive output shaft engages with the drive pinion (1) to which is fitted an offset peg. Pivoting from the peg is the drive crank (2) which has the wire wound helical primary drive rack (3) attached to its free end. As the drive pinion rotates, driven by the motor, the drive crank causes the helical drive to reciprocate within its guide tube. The helical drive rack is supported by, and terminates at, the drive output transfer gearbox (5).

54 The drive output transfer gearbox assembly (located in a housing formed in the top of the cupola rotating casing) incorporates a clutch mechanism to safeguard the wiper motor circuit from a current surge should one or more of the wiper arms encounter an obstruction. Should the wipers be obstructed, the upper gearwheel (10) driven by the motor will still operate, but the lower gearwheel (13) driving the wiper arm wheel boxes via the flexible helical drive shaft, will separate by the clutch action. An audible clicking noise may be heard when this takes place. When the obstruction is removed, the drive between the two gearwheels will be resumed when the two dowels align with their matching grooves and the spring (7) forces the two gearwheels back together.

55 The wheelbox housings (34) fitted are the same for all six positions. The gear assemblies drive the wiper arms (35) and wiper blades (36). The commander's wide angle periscope is provided with a longer wiper arm (20) and blade (21) to cover the larger window area.

56 Within the drive transfer gearbox are two gearwheels which are positioned by two dowel pins forming the clutch mechanism previously described. The dowels (12) soldered across the grooved boss face of the lower gearwheel (13), fit matching grooves across the upper gearwheel (10) boss face. Both upper and lower gearwheels are centred on a flanged sleeve bearing bush (16) which is brazed and centred in a supporting bridge housing (15). A stepped shaft at one end and threaded at the other fits through the centre bearing bush. Thrust bearings (11) and (14) are located between the shaft flange, lower gearwheel face and the flange face of the central bearing bush. A helical compression spring (7), fitted over the top end of the protruding bearing bush is retained by a spring seat (17) located on the shaft and is secured and tensioned by two locknuts (6). The whole transfer gear assembly is geared to a helical drive rack (3), and as both gearwheels normally operate as one, the top or output gearwheel drives the main helical driveshaft, housed in the support tubes (18).

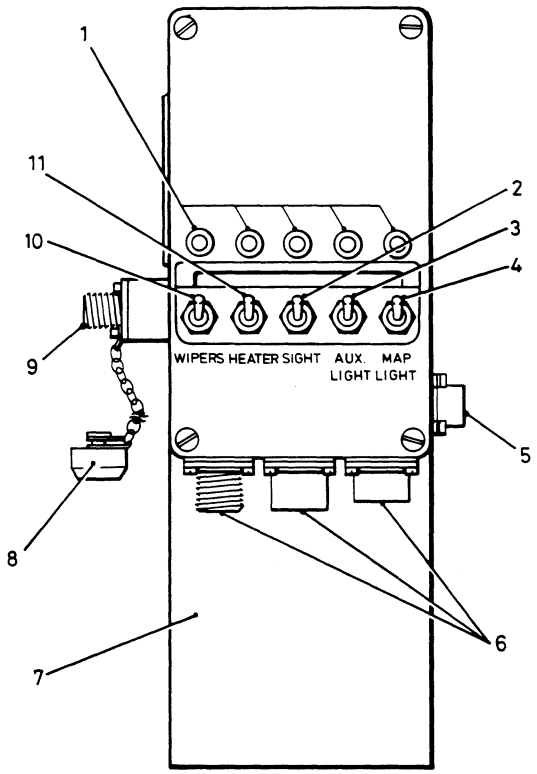
57 The helical drive support tubes are securely clamped by the six wheelbox housings (34), disposed at the vision stations around the cupola wall, and secured by fixing screws to the rotatable casing. Each wheelbox supports in two bushes the wiper arm drive shaft (39) and its drivewheel (37). As the helical driveshaft slides back and forth within the guide tubes and wheelboxes, the drive is transmitted by the drive wheels to the shafts which hold the clamp (38) on wiper arms (35) with their wiper blades (36). The wheel boxes are packed with grease.

Cupola services switch box

58 The cupola services switch box (Fig 13) mounted on the cupola wall adjacent to the commander's main periscope provides the mounting facility for all the cupola electrical services controls. The controls include, ON/OFF toggle switches for the wipers (10), sight illumination (2), sight heater (11), auxiliary light (for beacon) (3) and map light (4). Each switched circuit is protected by a circuit breaker incorporated in its associated switch mechanism. A green indicator LED mounted above each switch provides indication of when a circuit is in operation. A shield fitted just above the toggle switches prevents inadvertent switching on. A dummy receptacle (5) mounted on the side provides stowage for a blanking plug or connector when not in use.

59 Five pick-up brushes, two power and three for the hatch open/closed sensor, are mounted behind the switch box. Each spring loaded brush contacts the appropriate cupola brass slip ring track to provide the required electrical transfer. The brush holders are affixed within the epoxy resin brush mounting block, which is screw retained to the switch box. Plastic screw cap covers retain each brush holder and give access to the brushes for checking and renewal.

60 The electrical connections mounted on the underside of the switch box provide connecting points for the output cables which connect with the beacon light socket, sight heater, wiper motor and the hatch safety switch. The connections are protected by a shield (7) to prevent damage to the sockets when the cupola is installed. A 3-pin screw-in type connector socket (9) on the side of the casing provides for mounting and supplying a map light for the commander. When not in use protective cover (8) must be fitted.



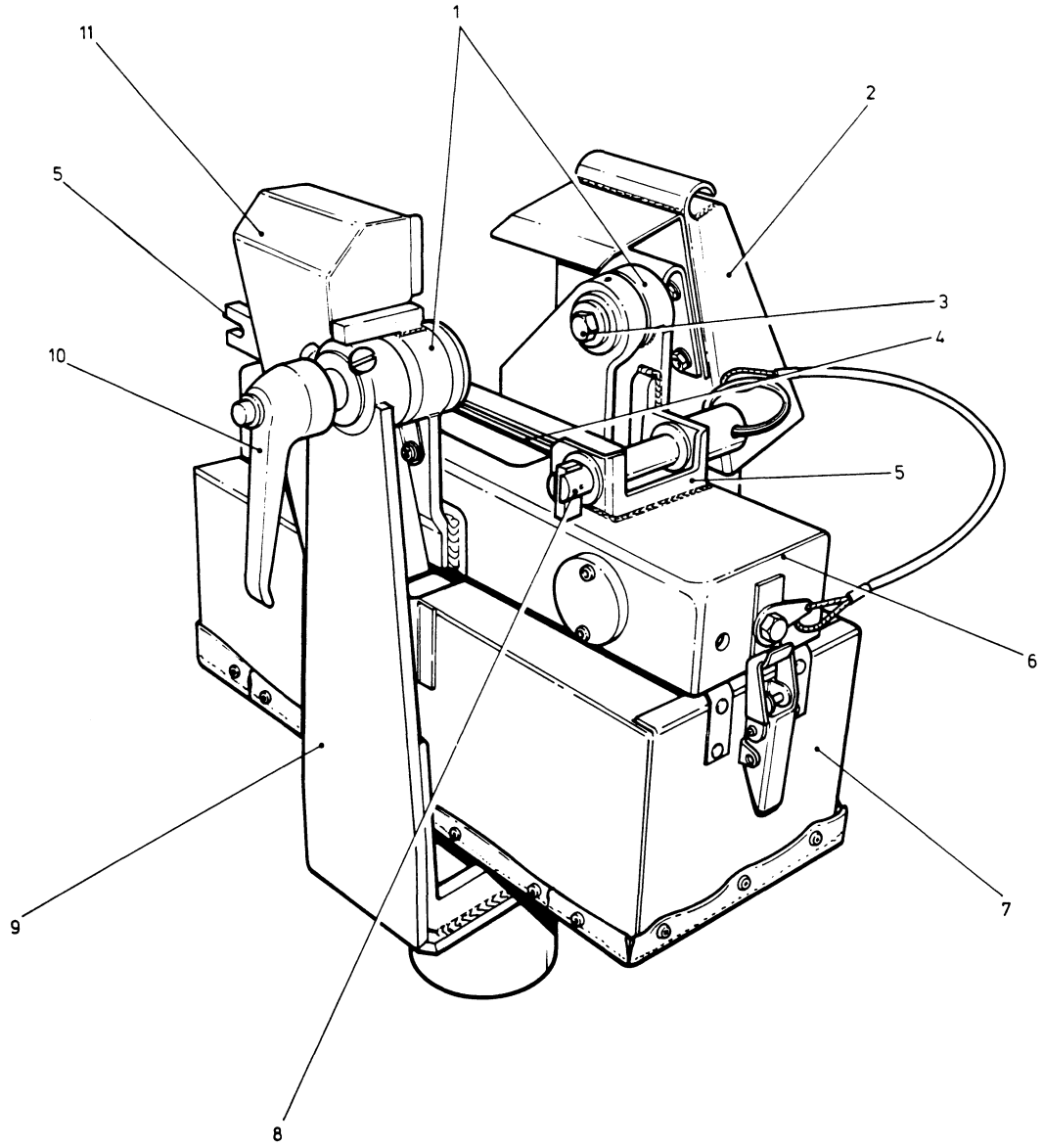
2078D

1 LED indicators
2 Sight illumination switch
3 Auxiliary light switch
4 Map light switch
5 Dummy receptacle
6 Supply connections
7 Shield
8 Protective cover
9 Map light socket
10 Wiper switch
11 Sight heater switch

Fig 13 Cupola services switch box

Buffered machine gun mount

61 The buffered machine gun mount (Fig 14) fits into the clamp on the GPMG pintle mount. Journals fitted to the top of the cradle carry the machine gun cradle, which consists of inner (4) and outer (6) channels. Anti-vibration mounts are fitted between these channels to buffer the firing reaction of the machine gun. The machine gun cradle is able to move in elevation and a locking handle allows the cradle to be fixed in elevation. The GPMG is fitted onto the mountings (5) and secured by a locking pin (8). The right hand journal carries an ammunition box bracket and an ammunition guide. Spent cases are collected in a case (7) clipped to the underside of the machine gun mount. A canvas cover is provided to protect the mount when the GPMG is not fitted.



1 Journals
2 Ammunition box bracket
3 Screw
4 Inner channel
5 Mountings
6 Outer channel
7 Case
8 Locking pin
9 Cradle
10 Locking handle
11 Clip chute

Fig 14 Buffered machine gun mount

FIRE FIGHTING EQUIPMENT

62 The fire fighting equipment comprises an installed fire detection system in the engine and transmission compartments; a fixed, manually operated fire suppression system for the engine and transmission compartments, and a detection and automated fire suppression system for the fuel tank compartment. Four portable fire extinguishers are also provided, two mounted inside and two mounted outside the vehicle.

Fire detection system

63 The engine and transmission compartments share a fire detection system comprising of a firesense detector element, connected to a fire warning control circuit. The fire warning control circuit located in the distribution panel provides control of an audio alarm (fire warning horn) located in the driver's compartment, and warning lights on the driver's instrument panel. The firesense detector element is fitted around the engine and transmission compartment walls, and connected to the control circuit via a firesense responder unit situated below the driver's engine access panel.

64 In the event of an engine or transmission fire, or damage occurs to the firesense detector element, the firesense responder unit activates, the fire warning horn sounds immediately, the fire warning light on the instrument panel illuminates, and the central warning light flashes. Operation of the horn cancel switch on the driver's switch panel terminates the horn sound, but the warning lights will continue to show. The warning lights will remain in continuous operation whenever the vehicle master switch is set to 'ON'. The fire detection system resets itself after the fire is extinguished and the firesense element has cooled down, or been replaced. For a detailed description of the control circuit refer to Chap 8. In the event of a fuel tank compartment fire, the fuel tank compartment fixed fire extinguisher is automatically activated by an Infra-red flame detector mounted in the fuel tank compartment.

Fixed fire suppression system

65 The fixed twin fire extinguishers for the engine and transmission compartments are operated manually in the event of an engine or transmission fire, by twisting and pulling one of the three "Tee shaped" operating handles (Fig 15 (4,6 or 9)) provided on the vehicle. The operating handles are located; one internally, on the driver's compartment rear bulkhead, and two externally, one on either side of the commander's compartment.

66 The fixed fire suppression system for the engine and transmission compartments consists of two manually operated 2 kg (4.4 lb) HRD Dry powder extinguishers (5) mounted on the LIP interface box in the commander's compartment. The extinguishers are connected by piping to four discharge nozzles in the engine compartment, and two discharge nozzles in the transmission compartment. The discharge nozzles in the engine compartment are located, two above the engine and two below, all four nozzles are angled to discharge onto the engine, and the two nozzles in the transmission compartment are angled to discharge onto the transmission and brakes.

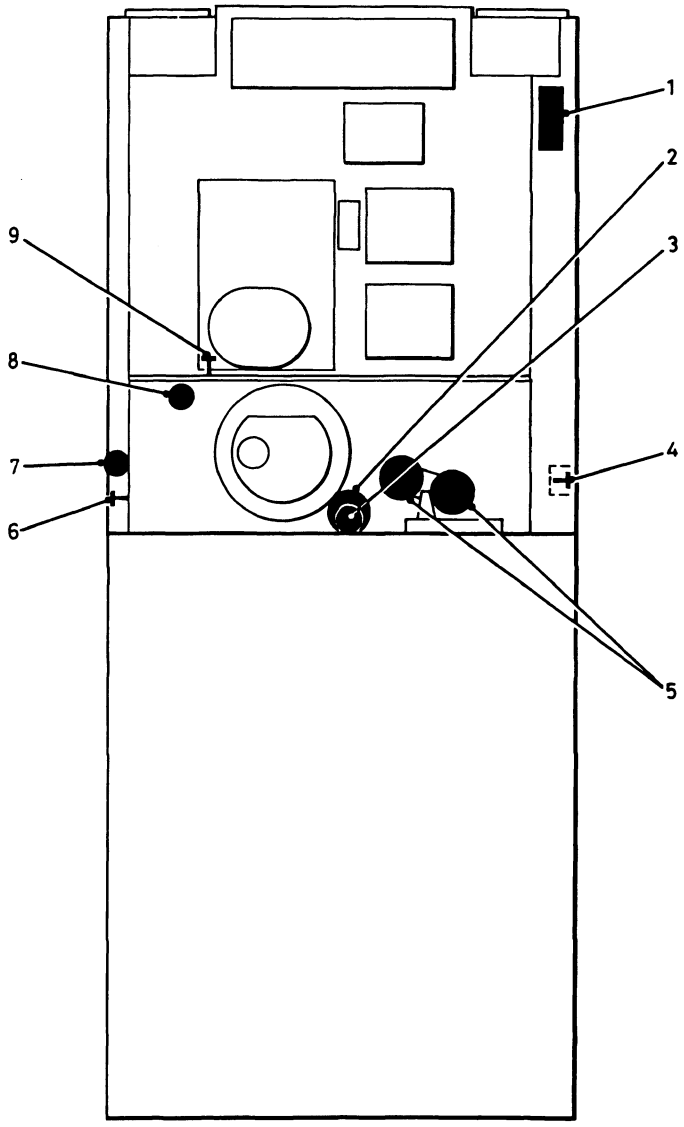
67 The fuel compartment fixed fire suppression system incorporates a 1.5 kg (3.3 lb) FE-36 extinguisher (2) mounted on the commander's compartment rear bulkhead which is connected by an elbow and piping to a conical discharge nozzle in the fuel tank compartment. A press to test button/visual indicator that indicates system faults and also system serviceability, is mounted in its own fire test box, located close to the commander's control box in the commander's compartment. Within the fuel bay there is a fire detection unit, this unit is a dual channel IR Detector for fire and explosion detection and is mounted next to the fuel tank. Additional circuits are included for activating an Electro Explosive Device (EED) and for continuity monitoring of the EED and the pressure switch housed in the extinguisher. When a fire or an explosion is detected, a relay is energised within the unit routing the supply voltage to the EED housed in the extinguisher. Energy from the supply is used to detonate the EED activating the extinguisher.

68 The fuel bay fire detection unit has built in circuits, which continuously monitor the condition of the pressure switch, and the EED mounted in the extinguisher unit. If either of these devices is detected as open circuit (including interconnecting cabling), the fault output is activated and the red press to test LED will illuminate indicating that the extinguisher is unserviceable. If when pressed, the red press to test button illuminates, the system is serviceable, if there is no illumination, there is a fault with either; the system wiring control unit extinguisher monitoring circuits or the indicating LED.

69 The fixed fire extinguishers (Fig 16) consist of two main parts, the discharge manifold mechanism assembly (2) and the extinguisher container (3), the two being screwed together. The twin extinguishers for the engine and transmission compartments are each fitted with an internal contents gauge (1).

Portable fire extinguishers

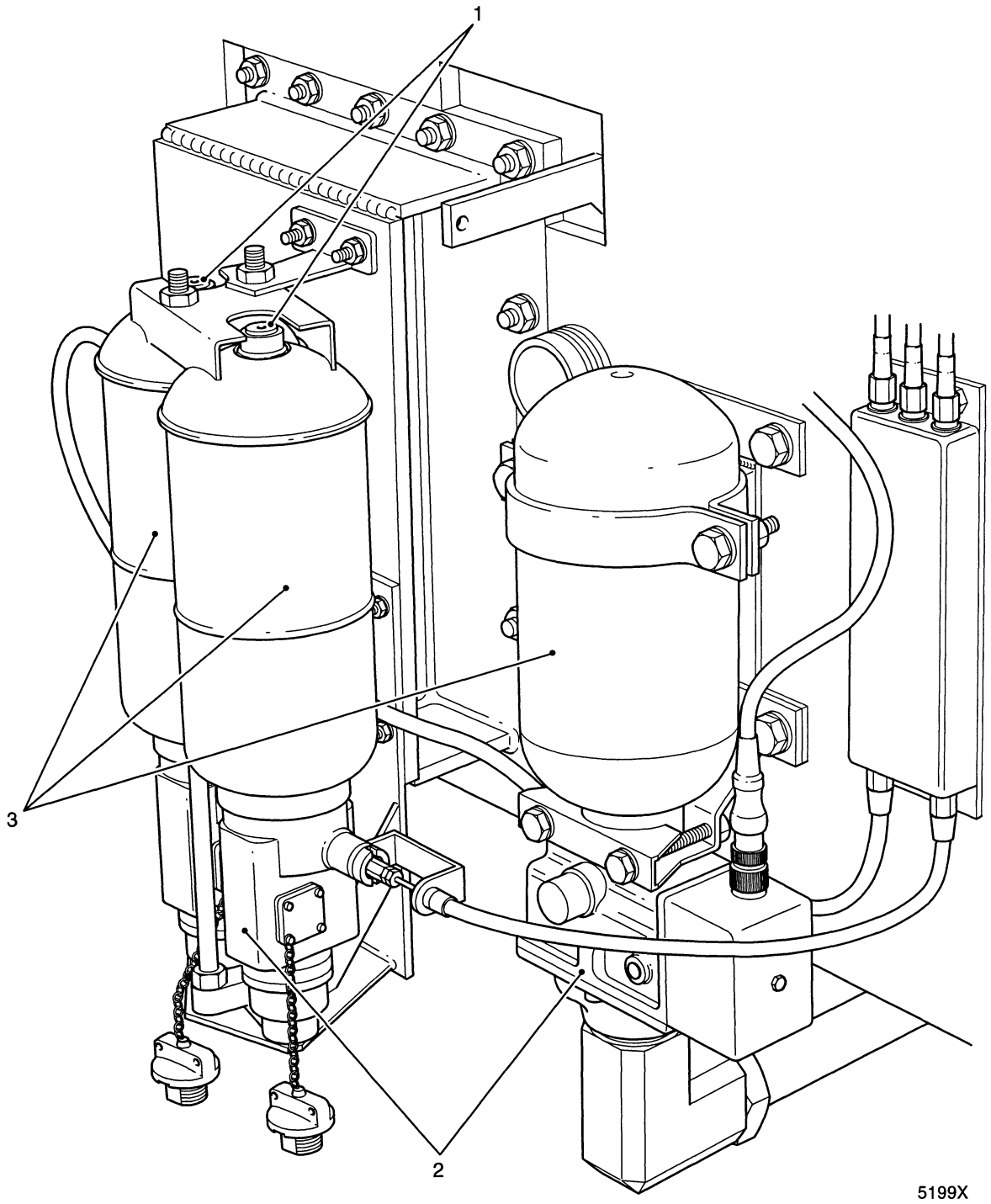
70 There are four portable fire extinguishers mounted on the vehicle (Fig 15), two 2.0 kg BCF extinguishers (3 and 8) are mounted internally, one mounted centrally on the commander's compartment rear bulkhead, and the second mounted on the commander's side of the bulkhead between the commander's and driver's compartments. The second two 2.0 kg Dry powder extinguishers (7 and 1) are mounted externally, one mounted on the exterior side wall of the commander's compartment, and the second mounted on the front RH side stowage bin, forward of the antenna base.



5194X

1 Portable fire extinguisher (externally mounted)
2 Fixed fire extinguisher (fuel compartment)
3 Portable fire extinguisher (internally mounted)
4 RH 'T' pull handle (externally mounted)
5 Fixed twin fire extinguishers (engine and transmission compartments)
6 LH 'T' pull handle (externally mounted)
7 Portable fire extinguisher (externally mounted)
8 Portable fire extinguisher (internally mounted)
9 'T' pull handle (internally mounted)

Fig 15 Location of fire fighting equipment



1 Internal contents gauge
2 Discharge manifold mechanism
3 Extinguisher container

Fig 16 Fixed fire extinguishers

SMOKE GRENADE DISCHARGERS

General

71 There are two multi-barrel smoke grenade dischargers (Fig 17); one fitted on each side of the vehicle at the top of the front sloping plate. They are mounted in a position such that the grenades are capable of generating a smoke screen in an emergency, [redacted] over the frontal aspect of the vehicle. The dischargers are operated electrically from firing buttons, one for each discharger located on the commander's control box.

Description

72 Each discharger consists of a base plate (4) and four discharger barrels (1). The barrels are fitted with a male adaptor (2) which forms part of the electrical jack-type connection with the self-projecting grenade. There is a drain hole (3) at the lowest point in each barrel.

73 The base plate cover (7) incorporates the electrical connection socket (6) and the resistor block (5) which houses four resistors, one for each barrel firing circuit.

74 The barrels are covered by the issued rubber caps to prevent the dislodgement of the loaded grenades and to prevent water, mud and dust entering the discharger barrels.

75 A two way double pole in-line filter is connected to each discharger firing circuit at the point of entry into the vehicle hull. In the event of Electro-magnetic pulses (EMP) or Radio Frequency Interference (RFI) being present on the firing line, in either direction, the filters will bleed these to the outer skin of the vehicle.

76 The dischargers are connected electrically to the firing button switch situated on the commander's control panel in front of the commander's position.

77 To protect the firing circuit from inadvertent operation by the crew, a double pole SAFE/ARM switch is provided on the commander's control box in close proximity to the firing buttons.

78 The electrical circuit for the dischargers is protected by one of the circuit breakers on the distribution panel. It is identified as INSP SKT SMOKE.

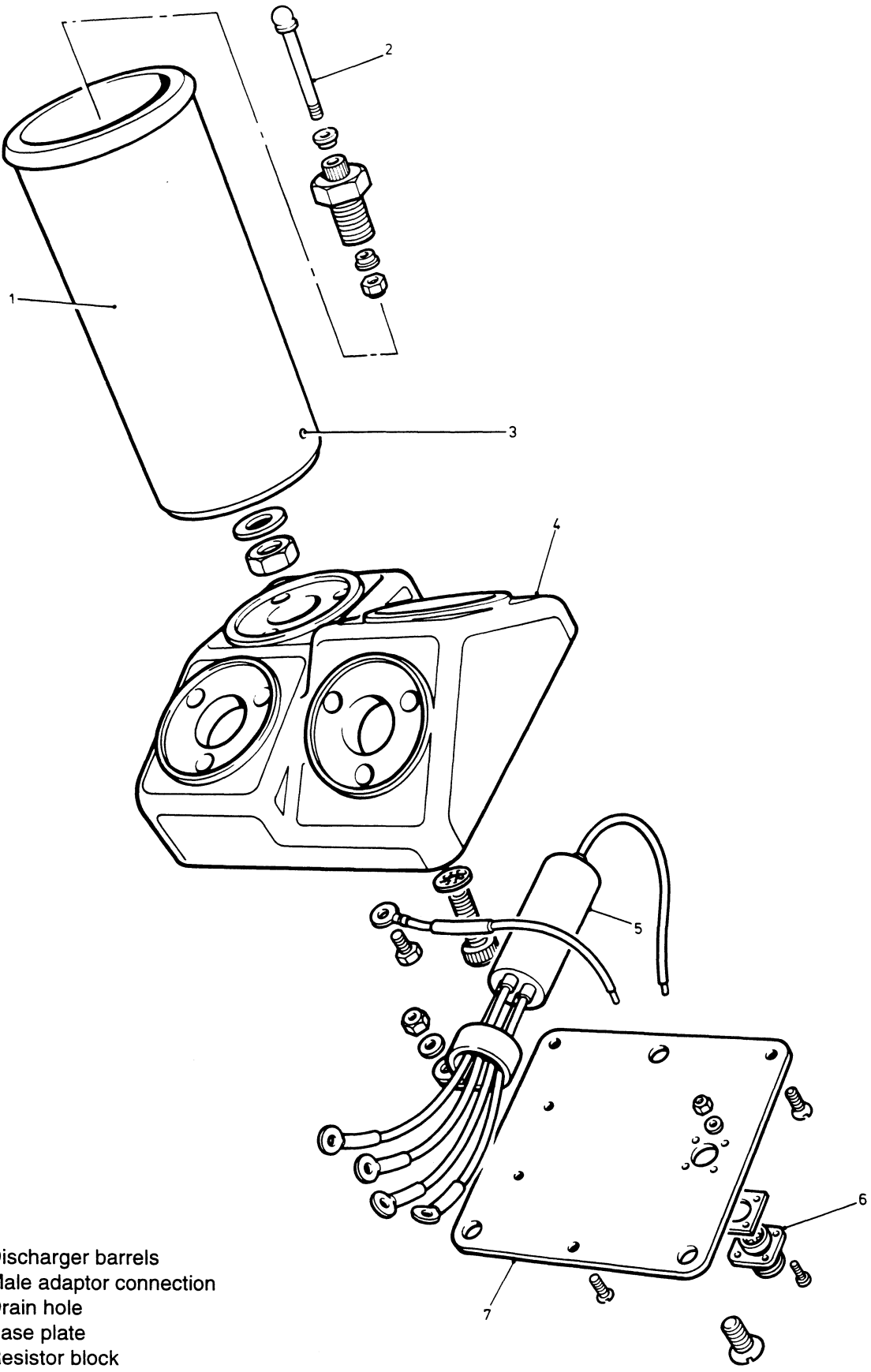
EMERGENCY ESCAPE HATCH

General

79 An emergency escape hatch, located beneath the commander's seat, is installed in the hull floor plate to enable the crew to exit the vehicle under emergency conditions. The escape hatch assembly is protected by a simple cover plate, which is retained by a single spring loaded retaining bolt. The emergency escape hatch can be opened from inside the vehicle, by using the release handle, or from outside the vehicle, by using one of the two emergency escape hatch removal tools, retained externally, (one each side) on the rear wall of the crew compartment.

Description

80 The emergency escape hatch consists of an oval plate, with four sliding bolt mechanisms under spring tension controlled by a central control handle, a woven lifting strap, and a chain retained locking T-bar (for use when the escape hatch is being refitted).



1 Discharger barrels
2 Male adaptor connection
3 Drain hole
4 Base plate
5 Resistor block
6 Electrical connection socket
7 Base plate cover

2204C

Fig 17 Smoke grenade discharger

CHAPTER 8

ELECTRICAL

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9 General
10 Operation
Distribution panel
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26 Circuit protection
27 Sockets and connections
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54 Turnlights
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GENERAL

1 This chapter details the vehicle electrical system for Shielder. The vehicle electrical system comprises three main distribution circuits: automotive systems, crew services, radio circuits and mine launcher system. This chapter describes the automotive circuits, crew services circuits and power distribution to the radio circuits. The technical description for the radio circuits are given in AESP 5820-F-210-302. The mine launcher system is described in AESP 1095-G-100-302.

2 Two sets of batteries are provided, each set consisting of two identical 12V batteries connected in series. One set supplies the automotive system, crew and mine launcher system, the other set supplies the radio circuits, crew heater and interior lighting. In addition, the hull installation includes an inter-vehicle connection (IVC) socket to accept the supply from an external 24V battery system, should the vehicle batteries be in a discharged state.

3 The main power source with the engine running is derived from an alternator with rectified output. The alternator has a dual output facility (220A max) which ensures complete isolation of the automotive electrics from the circuits of the crew services, radio circuits and mine launcher system. All systems are nominal 24V dc (nominal 28V dc with alternator running).

4 All circuits within the vehicle use an all insulated negative return system. Where screened cables are fitted the screen is attached to the chassis. The isolated hull effectively creates a Faraday cage. This is necessary for maintaining an insulated environment for the mine launcher system, isolating its control circuits from sources of interference and Electro Magnetic Conductance (EMC).

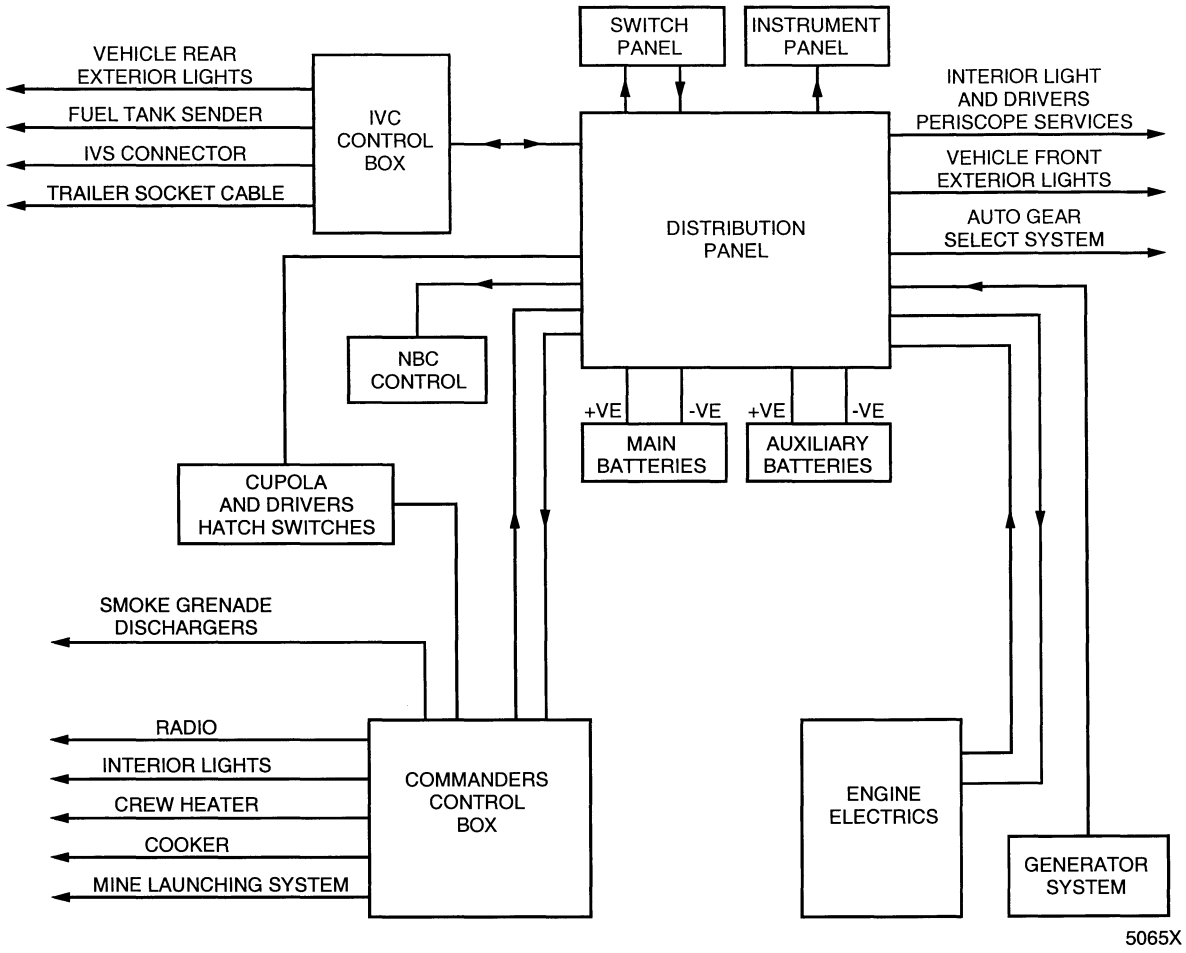

Fig 1 Vehicle electrical system - schematic

5 A schematic layout of the vehicle electrical system is shown in Fig 1. Control and distribution of power to all vehicle services is provided via the distribution panel. The driver's switch and instrument panels mounted on the front of the panel provide control of the automotive systems, external lights and driver's periscope sight. The commander's control box mounted in the crew compartment provides control of crew services, smoke dischargers and distribution of power to the radio circuits. Power to the cupola is routed via sliprings in its mounting to the cupola services box, controlling distribution to all its services.

BATTERIES

6 The batteries are 12V (Armasafe type UK6TNMF) with a capacity rating of 120 Ah. The batteries are arranged in two sets of two and are located at the left hand side of the driver=s compartment, below the distribution and instrument panels.

7 Battery terminals are of the standard polarized type for use with split clamp connectors. The positive terminal is fitted with a brown plastic collar and the negative terminal with a blue plastic collar. The cells are vented by means of a common vent block at the top of the battery. The vent block has two outlets suitable for the attachment of plastic tubing. Where one outlet only is utilized, the other is sealed by a plastic cap. Plastic tubing is used in conjunction with each of the battery vent systems to allow breathing of the batteries and the liberation of cell gases via breathers fitted on the vehicle exterior. The externally fitted breathers each incorporate a flame trap to prevent damage to batteries should escaping gases ignite and are located on the left hand roof slope plate, to the left of the driver=s hatch.

INTER-VEHICLE CONNECTION

8 An inter-vehicle connection (IVC) socket is provided in the external services box at the left hand side of the vehicle, for connection of an external 24V battery supply. The socket supply is routed internally via an isolation relay to the main power lines on the left hand side of the vehicle. The relay can be activated by a control switch labelled `IVC' on the distribution panel. When not in use the socket must be covered by the captive screw-on cap.

GENERATING SYSTEM

General

9 The generating system (Fig 2) comprises an alternating current (ac) alternator No. N1328-1 with integral rectifier and regulatory circuitry. The system provides power for charging the vehicle batteries and for heavy duty services such as cooker and NBC system. The alternator has a dual output (220A max), isolating the automotive electrics from the crew services and radio electronics. The current output from the alternator is limited by its self regulating characteristics, the system is further protected by an electronic load dump, limiting peak transient voltages during battery-less operation.

Operation

10 The alternator is of the self excitation type, externally energised via the engine oil pressure switch.

11 When the engine power on switch is in the POWER ON position, the battery charge light illuminates via RLQ1.

12 As soon as the engine has started, the build up of oil pressure in the engine activates the oil pressure switch, energising relay RLP. The generating system is energised via RLP2.

13 As the alternator output rises above approximately 17V, the auxiliary output 'A' goes high, energising relay RLQ, switching off the battery charge light.

14 Should the engine oil pressure fall below the preset value while the engine is running, the oil pressure switch will be de-activated. Relay RLP will be cut off, de-energising the generating system, illuminating the battery charge light and also the master warning light (not shown).

DISTRIBUTION PANEL

General

15 The distribution panel is located in the driver's compartment on the hull left sponson mounted above the batteries. The panel houses the power control, indicator, fire warning, turnlight, cooking vessel and NBC relays and associated circuitry, and also provides power distribution via various plugs and sockets. The panel is mounted in a splash proof [redacted] secured to the vehicle by four shockproof mounts. The driver's instrument and switch panels are mounted on the front of the distribution panel. The instrument panel is mounted on quick release catches and wired to the distribution panel via a flexible curly extension cable, allowing the panel to be removed and mounted outside the driver's hatch, for using during 'head up' driving conditions.

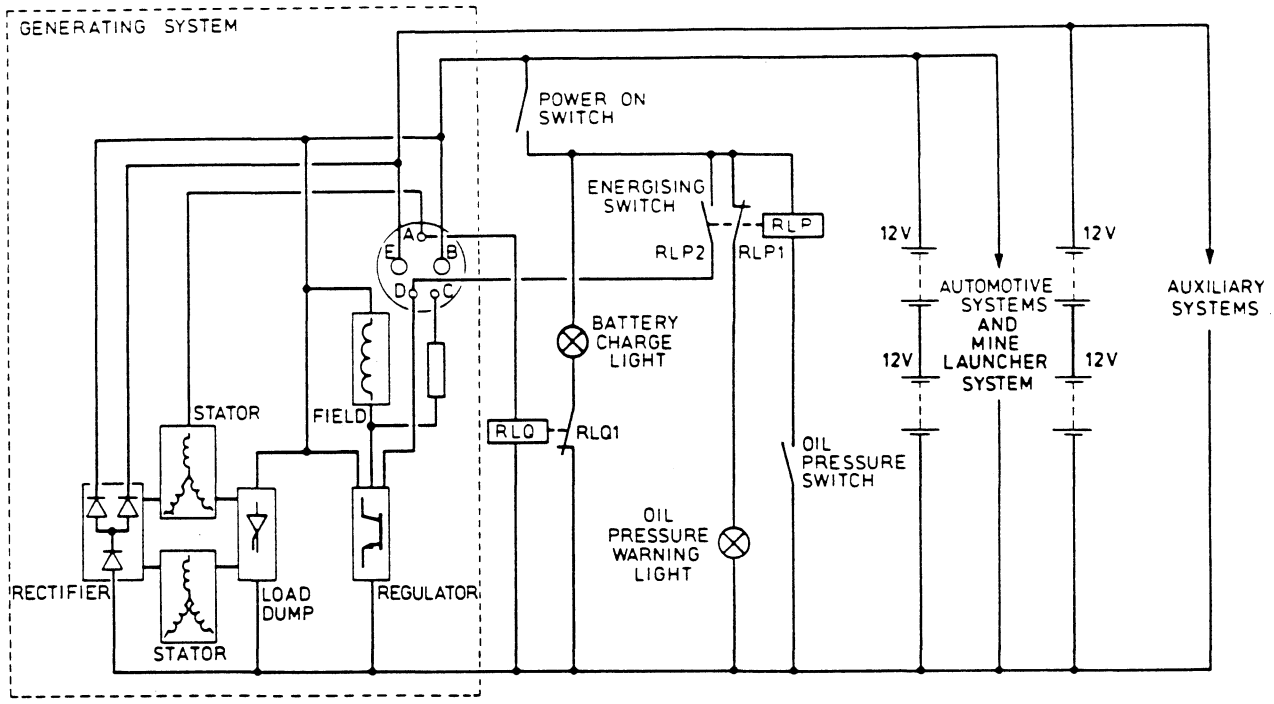

Fig 2 Generating system - schematic

Power distribution

16 Control of power distribution is provided via five isolation relays A, B, C, D, G mounted within the casing of the distribution panel, refer to (Fig 3). A further relay for the control of the IVC supply is housed in the IVC control box at the lower of the left hand side of the commander's compartment. The relays are energised from the power control switches mounted on the front and left hand side of the panel.

Power control switches

17 The vehicle master switch enables isolation of the batteries from all vehicle circuits. When in the closed position, power is provided to the control relays and switches from the battery positive lines via diodes D1 and D3.

18 Closing of the vehicle master switch energizes relay A closing its contacts and enabling power from the automotive batteries to the vehicle systems for starting the engine. The relays B and C are also energized. Relay B brings the auxiliary batteries on line, providing power to the radio system, interior lights and crew heater. Relay C is available should a third set of batteries be installed.

19 The emergency start switch energizes relay D connecting all batteries to the vehicle positive line (B) for emergency starting of the engine should the automotive batteries be in a discharged state.

20 The IVC switch energises the IVC relay enabling power from an external 24V battery source to be fed into the vehicle system. The IVC indicator lamp, located adjacent to the switch position, will be illuminated when power is present in the circuit.

21 Power to the environmental control system (ECS) (NBC unit and crew heater) and the cooker supply is controlled via two isolation relays E and F. The relays are energized via the 'alternator only' relay 'Q', ensuring that power to these systems is enabled only whilst the alternator is on line. The cooker relay 'E' is further controlled by a remote connection to the coil via the cooker socket. Further distribution and circuit protection for these circuits and for the internal lighting and smoke grenade discharger circuits is provided via the commander's control box.

22 Other circuits housed in the distribution panel include those for the automotive system, and internal and external lighting systems, these are described fully in subsequent paragraphs. A central warning system provides indication to the drivers of any major faults in the system, this along with the fire warning system is described later in this publication.

23 Two inspection sockets provide a 24V dc outlet for use with inspection and test equipment. One is mounted in the left hand side of the distribution panel, the other is located in the engine compartment mounted on the front right side of the engine block on the hour meter bracket. The circuit is protected by a 10A circuit breaker labelled INSP SKT on the panel front.

24 Two horns are fitted in the vehicle. A vehicle horn, located in the left hand side of the transmission compartment, is activated by a push-to-make switch on the right hand steering lever. The horn circuit is protected by a 5A circuit breaker labelled HORN. The second horn, a fire horn, located in the driver's compartment, is activated via the fire detection system for the engine and transmission compartments.

Relays and connections

25 The main power control and isolation relays (Fig 4 (3,4,9,10,25 and 26)) are mounted in the base of the distribution panel. The main power connections from the battery supplies are made to the panel via single terminal 'Sotax' connectors. The automotive batteries are connected (23) to the underside of the panel and the crew and radio batteries are connected (27) to the lower left side. Power from the generating system is fed to a socket (7) on the right hand side above the starter motor connections. Heavy current connections between relays and sockets are made using insulated copper bus strips bolted to the terminals. A connection board (11) mounted above, carries a further seven low current switching relays for control of the turnlights, headlight beams, fire warning system, oil pressure switch and alternator charge. The board also carries the start relay (20), turnlight flasher unit (22) and main connector block (19).

Circuit protection

26 Nineteen circuit breakers (2 and 5) fitted along the top edge of the distribution panel provide for protection of the main circuits within the panel. The circuit breakers are of the thermal break, push to reset type and are labelled according to the circuit protected.

Sockets and connections

27 The position and labelling of sockets and plugs is as shown in Fig 5. The main power connections are made via single terminal 'Sotax' connectors, identified brown positive and blue negative. Ancillary connectors are of the multi-pin screw locking type. The inspection socket located at the top left side of the panel provides a 24V dc outlet for test and inspection equipment.

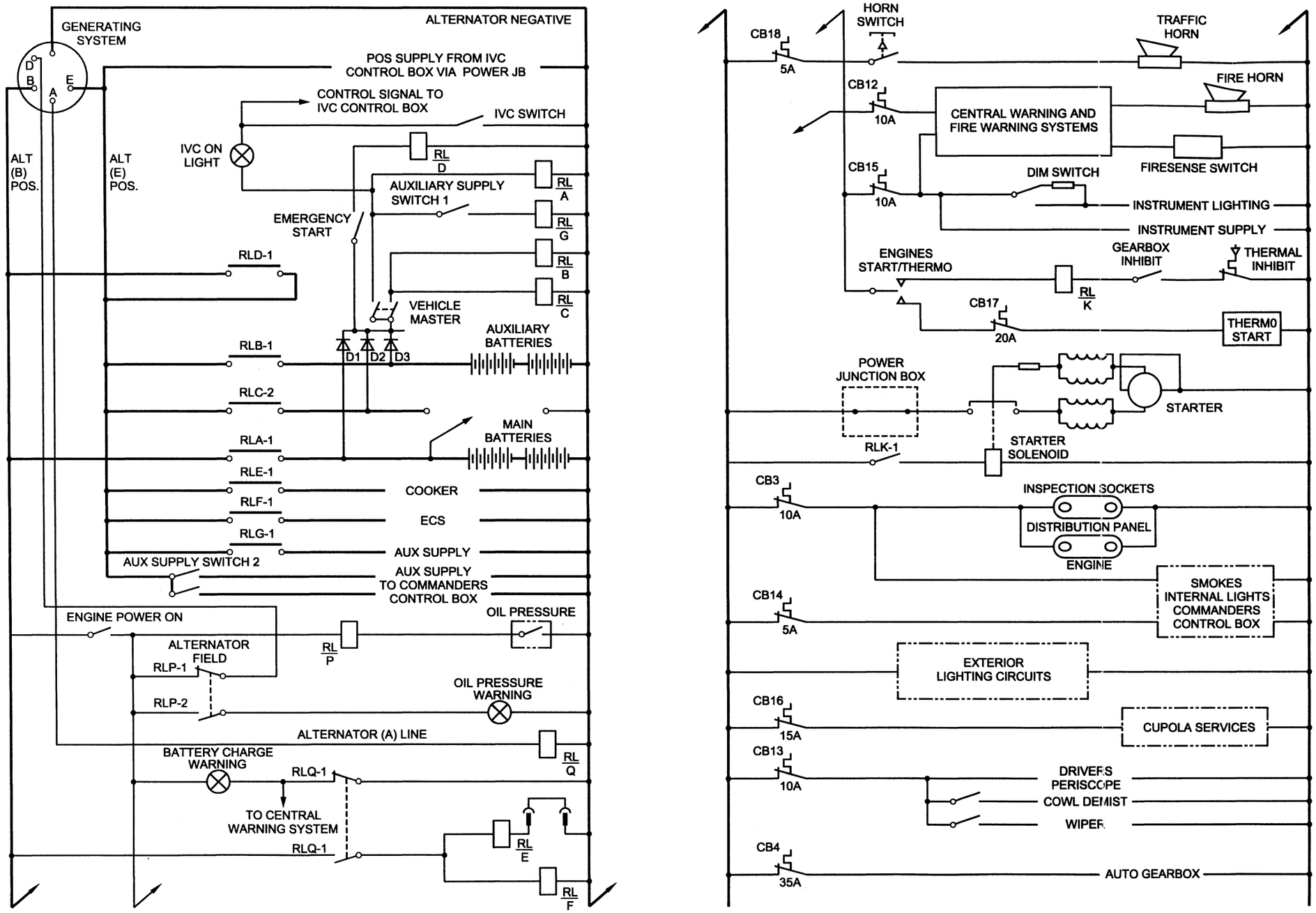

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Fig 3 Distribution panel circuit - schematic

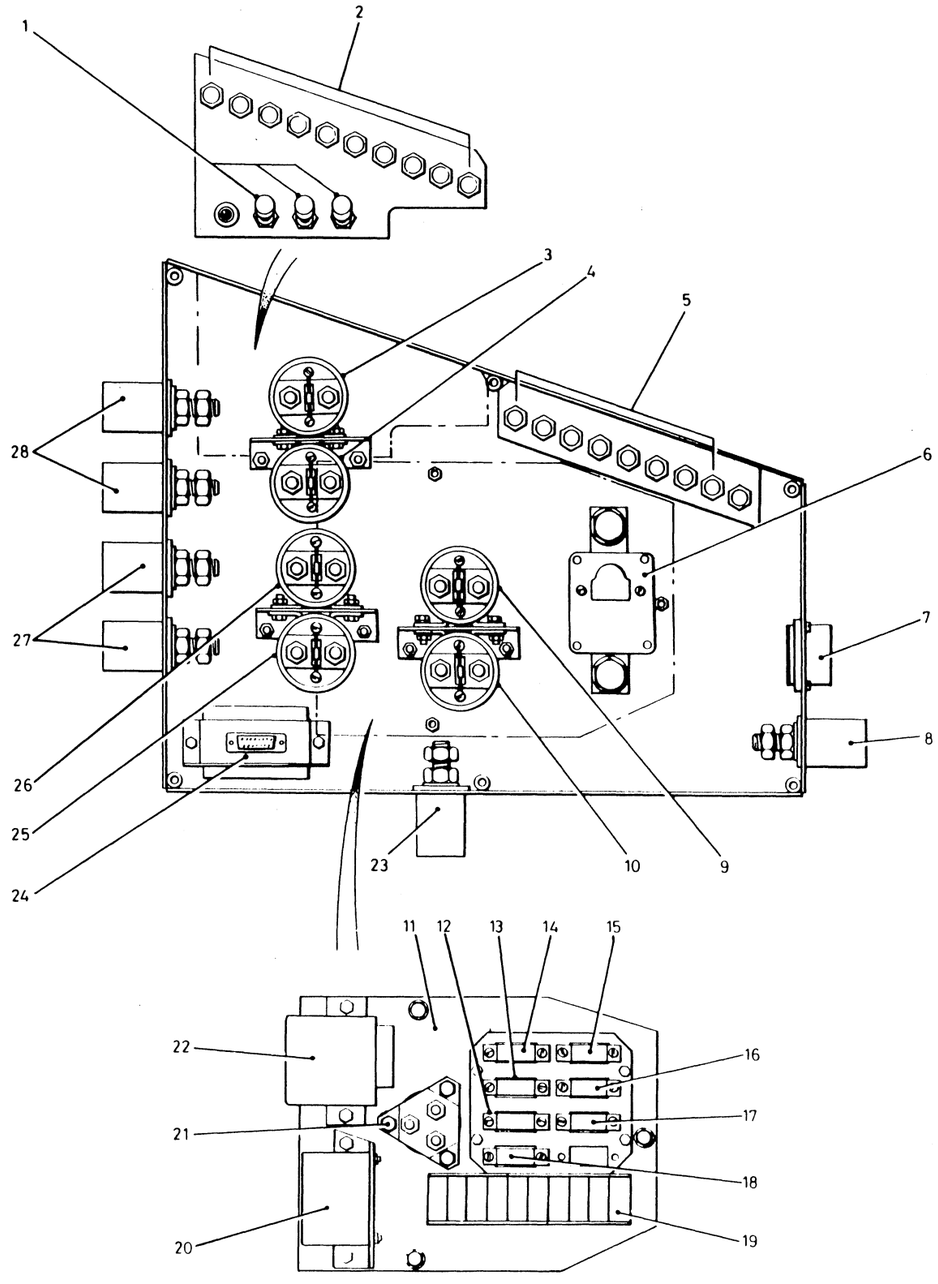

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Fig 4 Distribution panel - internal layout

KEY TO FIG 4

1 Power control switches
2 Circuit breakers (block 1)
3 ECS isolation relay
4 Cooker isolation relay
5 Circuit breakers (block 2)
6 Emergency start relay
7 Alternator socket
8 Starter motor connections
9 Auxiliary supply relay
10 Automotive battery relay
11 Connection board
12 Fire cancel relay
13 Oil pressure relay
14 Turnlight switch relay (RH)
15 Turnlight switch relay (LH)
16 Alternator 'A' line relay
17 Fire horn relay
18 Headlight dip relay
19 Main connector block
20 Start relay
21 Diode panel
22 Flasher unit
23 Automotive battery connections
24 Central warning unit
25 Auxiliary battery relay
26 Relay (not used)
27 Battery supply connections
28 Bus bar connections

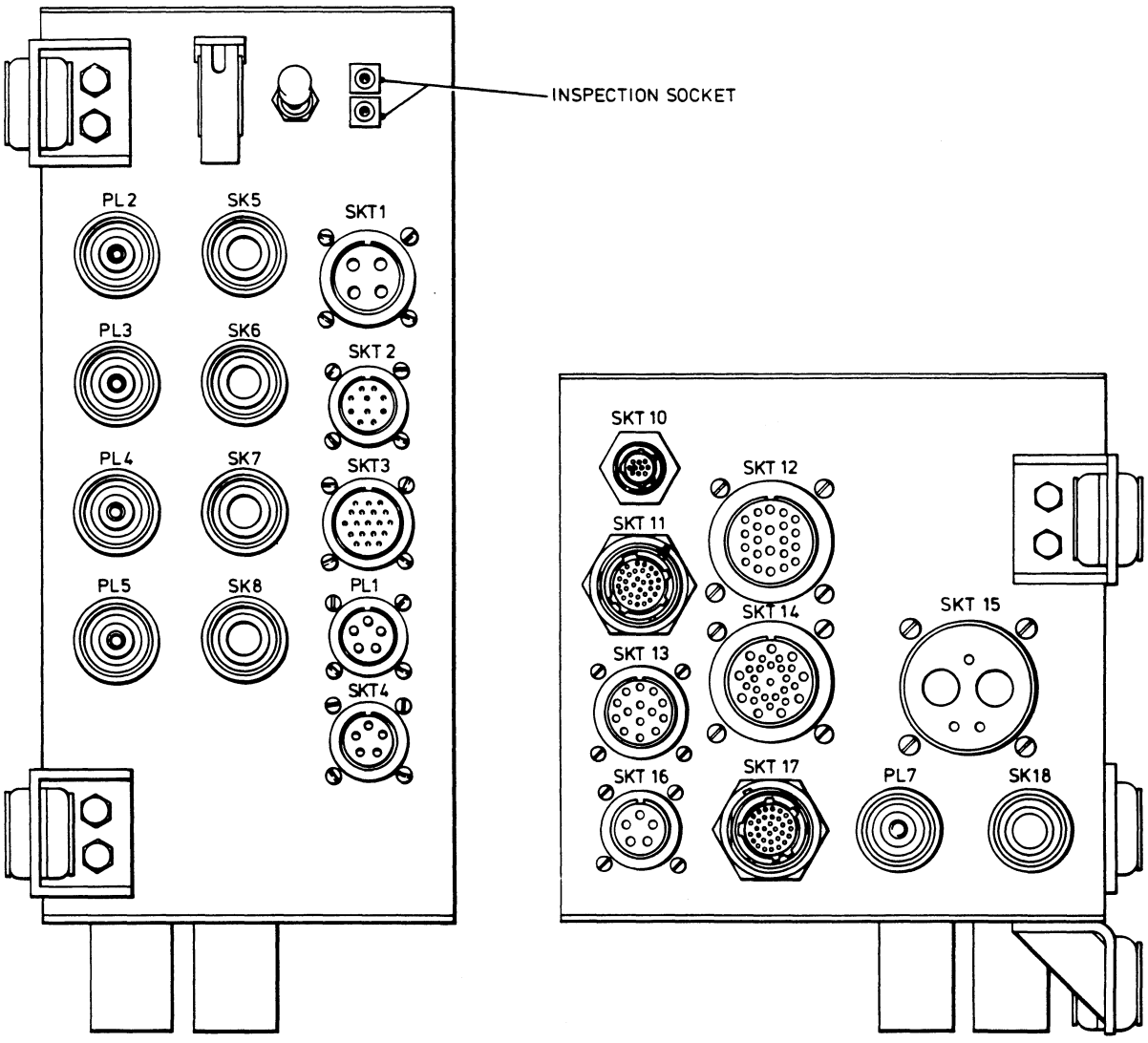

Fig 5 Sockets and connectors

COMMANDER'S CONTROL BOX

General

28 The commander's control box (Fig 6) is located at the front of the crew compartment below the cupola housing. The control box houses controls for the environmental control system, smoke grenade dischargers and interior lighting system. Power distribution is provided via various plugs and sockets in the control box case.

Circuit protection

29 Seven circuit breakers (CB) are provided for protection of various distribution circuits in the panel. These are one 60A CB for the cooker supply, three 5A CB and one 15A CB for the radio circuits, a 100A CB for further radio circuits, and a 25 A CB for the heater unit. The circuit breakers are of the thermal break, push-to-reset type and are labelled according to the circuit protected.

INSTRUMENT PANEL

30 The instrument panel (Fig 7) is located in the driver's compartment above the left hand sponson, mounted on the front of the distribution panel. Wiring from the panel is routed directly to the distribution panel via a 'curly cord' cable, from the socket at the right hand end to socket 11 on the distribution panel The instrument panel is secured by quick release fittings allowing removal and repositioning of the panel on a mounting plate outside of the driver's hatch, for use during 'head up' driving conditions. The instrument panel consists of a splash proof metal casing onto which is mounted a machined aluminium fascia which houses the instrument dials and warning lights.

31 All wiring connections from the instruments to the transducers and probes etc are connected via the distribution panel. The instrument dials are individually illuminated, power to this circuit and to the instruments is enabled when the vehicle master switch is set ON and the 'engine power on switch is in the POWER ON position. The circuit is protected by a 10A circuit breaker labelled INS on the distribution panel.

Oil pressure gauge

32 A pressure transmitter unit located on the engine adjacent to the oil filters provides an electrical signal to the oil pressure gauge. The gauge provides a reading corresponding to the value of the engine oil pressure.

Fuel gauge circuit

33 The fuel gauge employs a conventional bi-coil fuel gauge mounted on the instrument panel, and a float actuated variable resistor mounted in a sealed case and fitted to the fuel tank. Movement of the float causes the resistance to vary between 10 to 350 ohms, and the subsequent voltage changes are extended to the fuel gauge to give indications between empty and full.

Speedometer circuit

34 The speedometer reading is obtained from a remote speed probe housed in the left hand final drive. The probe outputs electrical pulses corresponding to the rotational speed of the drive shaft. The instrument reading is in direct proportion to the frequency of the pulses which are in turn dependent upon vehicle speed. When the vehicle power is switched OFF, the speedometer needle may not zero, however, the meter will zero when power is switched on again. An odometer mounted in the lower speedometer face provides a reading of total distance travelled in km.

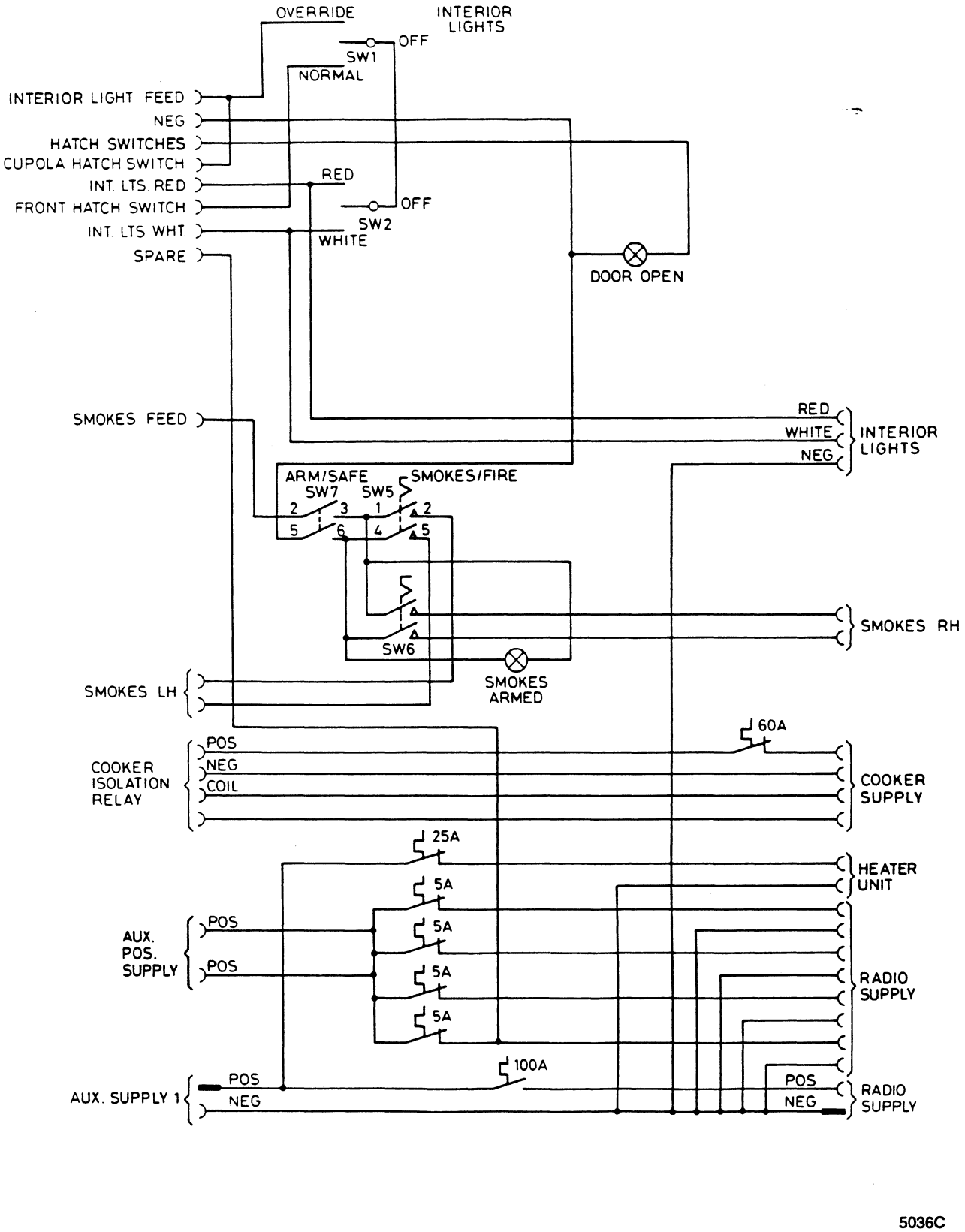

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Fig 6 Commander's control box - schematic

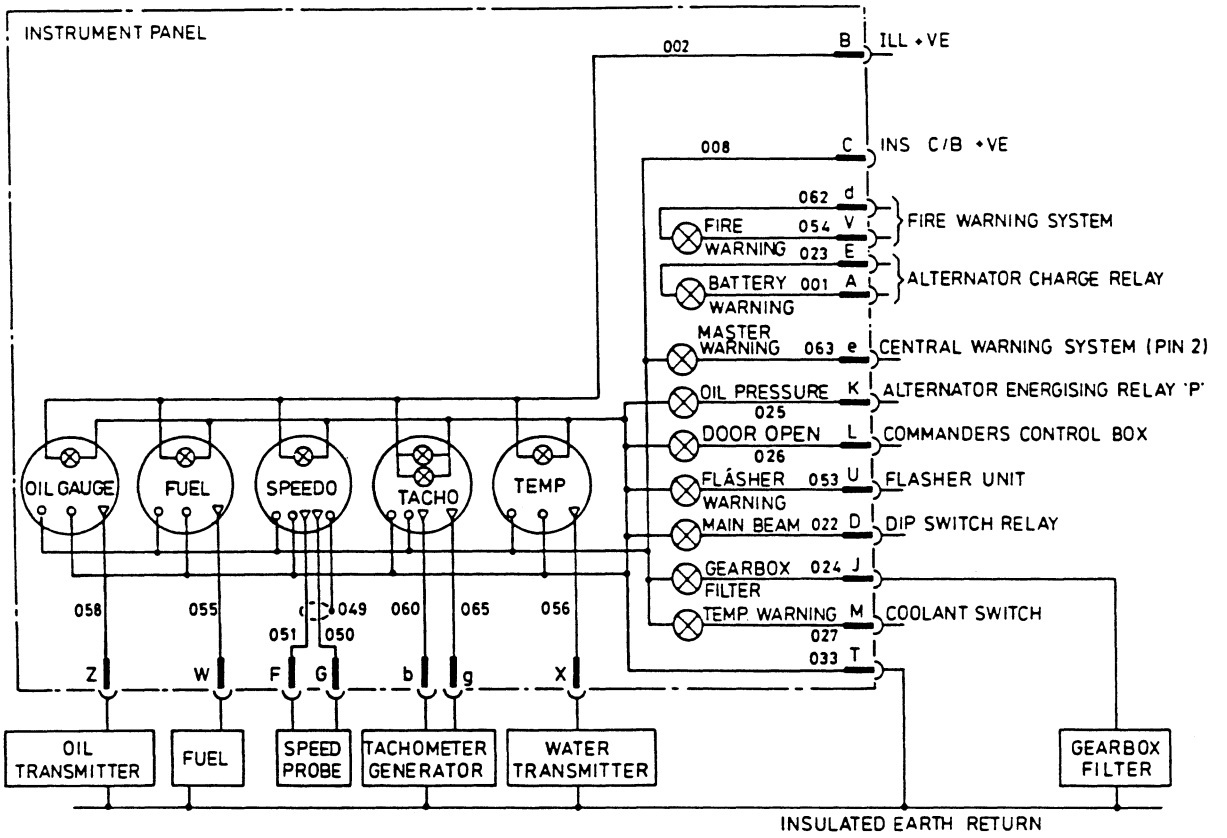

Fig 7 Instrument panel - schematic

Tachometer circuit

35 The tachometer circuit employs a pulse detector mounted adjacent to the flywheel. The detector monitors the speed of rotation of the flywheel and indicates the engine speed in revolutions per minute on a gauge mounted on the instrument panel.

Temperature gauge circuit

36 A semiconductor temperature measuring device located on the cylinder head at the flywheel end of the engine provides a resistance value proportional to the coolant temperature level. The subsequent voltage changes are extended to the panel mounted temperature gauge which gives the temperature reading in degrees C.

Warning lights

37 A number of warning lights are provided, located on the panel fascia, to alert the driver to various faults and conditions in the automotive systems. The application of each of the lights is as described in the appropriate circuit application outlined in the subsequent sections of this chapter.

DRIVER'S SWITCH PANEL

38 The driver's switch panel is located in the driver's compartment above the left sponson, mounted on the distribution panel below the instrument display. The panel consists of a splash proof metal case on the front of which are mounted switches for the control of the automotive systems. All wiring connections to the engine circuits are made via the distribution panel, connections being made through two sockets at the right end of the switch panel to sockets 16 and 17 (Refer to Fig 5) on the distribution panel. The switches are of the two and three position toggle types with the exception to the hazard warning switch which is a self illuminating 'push on-push off' type. Several of the key function switches are of the 'gated pull to unlock' type to prevent accidental switching.

CENTRAL WARNING SYSTEM

39 The purpose of the central warning system (Fig 8) is to immediately draw the attention of the driver to:

39.1 A malfunction in certain of the automotive systems, namely engine oil pressure, alternator and gearbox filter.

39.2 An outbreak of fire in the engine/transmission compartment.

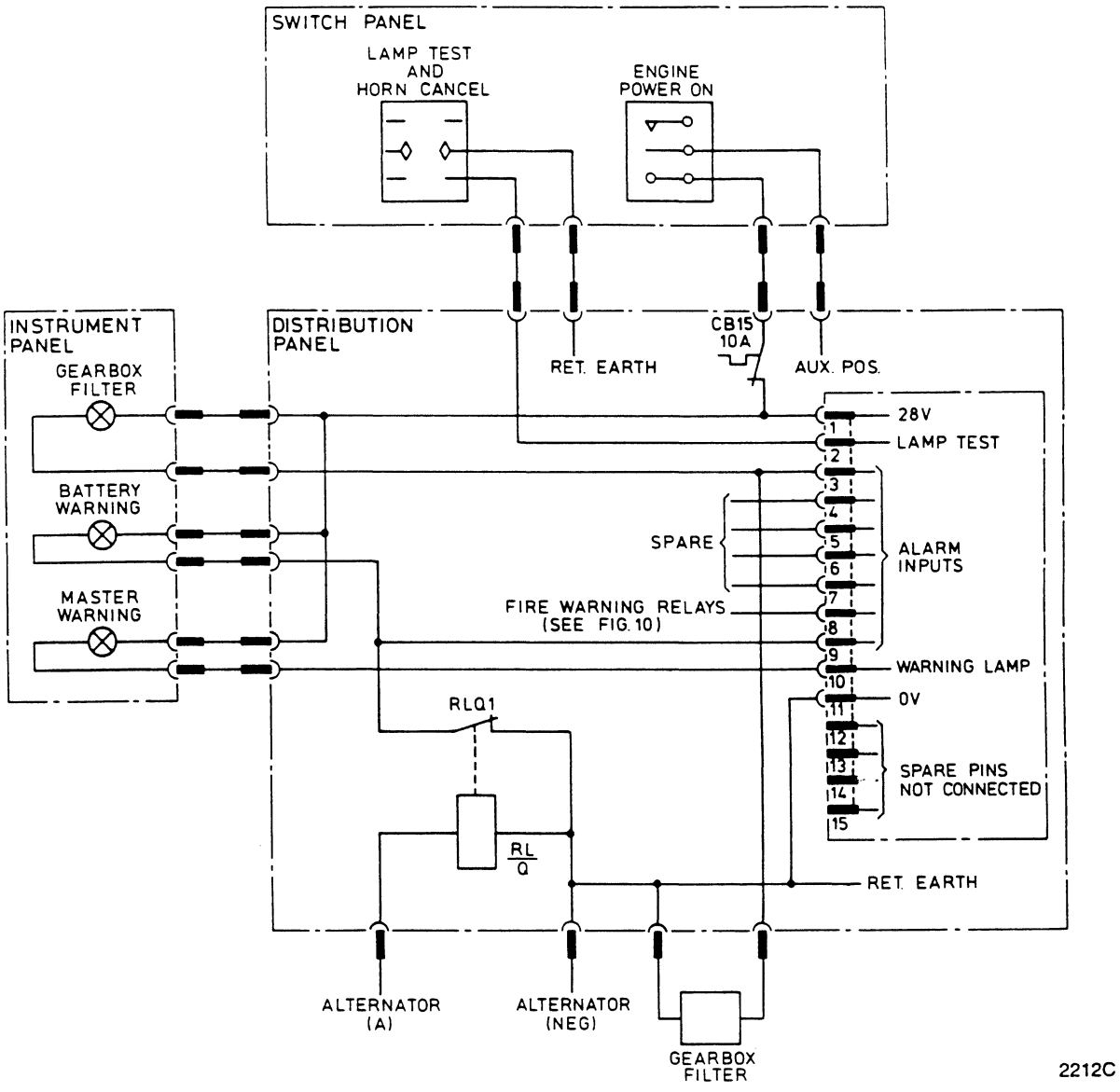

Fig 8 Central warning system - schematic

40 In each case, the occurrence is signalled by the intermittent flashing of the master warning light on the driver's instrument panel, and also for the case of 39.2 a fire horn is sounded.

41 A schematic outline of the system is shown in Fig 8, digital integrated circuitry within the warning unit is not shown. A logic 'O' (represented by 0V) applied to any one of the alarm inputs, will activate the unit, causing the red master warning light to flash. A lamp test facility enables the master warning, gearbox filter and fire warning lights to be tested; switching the 'lamp test and horn cancel' switch on the driver's switch panel to the down position, takes pin 2 of the unit to 0V, and activates the unit. The circuit is protected by a 10A circuit breaker labelled INS on the distribution panel.

Alternator

42 The negative side of the 'battery warning' light provides the input to alarm input pin 9 of the warning unit. When the alternator is not charging, relay 'Q' remains in the normally closed contact position as shown. The negative side of the 'battery warning' light is held at 0V and the light is illuminated, pin 9 of the warning unit is taken to logic '0' (0V) activating the unit and causing the master warning light to flash. As the alternator reaches optimum charge (engine speed 600 rpm) the output line 'A' is switched to a 'high' state and relay 'Q' is energised, the negative side of the 'battery warning' light is cut off, extinguishing the light and resetting the warning unit.

Engine oil pressure

43 The generating system is energised via the engine oil pressure switch. If the engine oil pressure drops below a safe operating level the alternator is de-energized causing the 'battery warning' light to illuminate, and activate the central warning unit as previously described.

Gearbox filter

44 The gearbox oil filter is fitted with a 'pressure drop' indicator switch, should the filter become restricted, the subsequent pressure drop across the filter body closes the switch contacts. The negative side of the gearbox filter warning light is shorted to 0V, illuminating its lamp and applying logic 'O' to pin 3 of the central warning unit. The warning unit is activated causing the master warning light to flash.

FIRE WARNING SYSTEM

45 The fire warning system (Fig 9) operates when the firesense element detects a fire in the engine or transmission compartments, or sustains damage. The firesense element consists of a metal capillary tube filled with gas under pressure. One end of the tube is sealed, the other end terminated in a switch box containing two pressure operated switches, one normally closed and the other normally open. In the event of a fire, the pressure in the tube increases and closes the normally open switch, initiating a fire warning. Damage to the tube allows the gas pressure to fall, opening the normally closed switch and causing an alarm to be given. The fire warning light is illuminated and relay 'N' is energized, contact 'RLN1' closes and the fire horn will sound. Operation of the horn cancel switch energizes relay 'M', contacts 'RLM1' change over, de-energizing relay 'N' and cancelling the horn. In each case a logic 'O' (0V) is applied to the alarm input, pin 8, of the central warning unit, and the master warning light flashes in the manner previously described.

46 Operation of the horn cancel switch does not cancel the fire warning light or reset the central warning unit to cancel the master warning light. These lights will remain on until the firesense element is replaced.

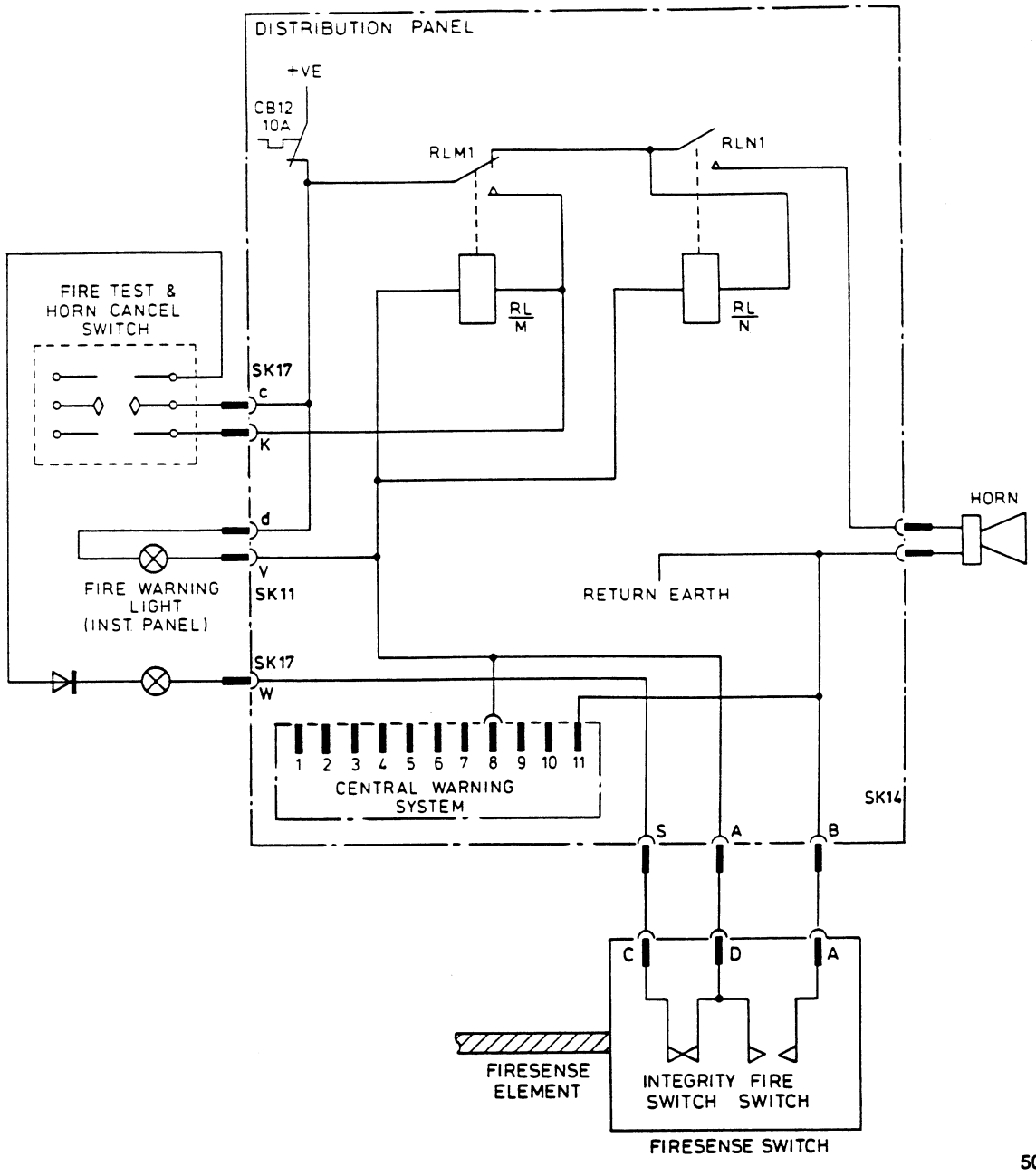

Fig 9 Fire warning system

INTERIOR LIGHTS

47 Three interior lights (Fig 10) are provided, two in the crew compartment and one in the driver's compartment.

48 The interior lights are identical, each being individually controlled by a rotary dimmer switch incorporated in the light unit base. Each fitting houses two lamps, one with white and one with a red lens fitted. The lights are switched between red and white settings via the 'INT. LIGHT' selector switch (SW2) on the commander's control box. Power to the lights is controlled via the three position 'ON/OFF/OVERRIDE' switch (SW1) in conjunction with the 'door closed' switch on the commander's and driver's hatches. The door open lights on the instrument panel and commander's control box are activated when either the commander's or driver's hatches are open.

49 The door switch positions are as follows, and have the following effect on the interior lights:

49.1 Position with either hatch open.

OFF - lights 'OFF'
NORM - lights 'OFF'
OVERRIDE - lights 'ON'

49.2 Position with both hatches closed.

OFF - lights 'OFF'
NORM - lights 'ON'
OVERRIDE - lights 'ON'

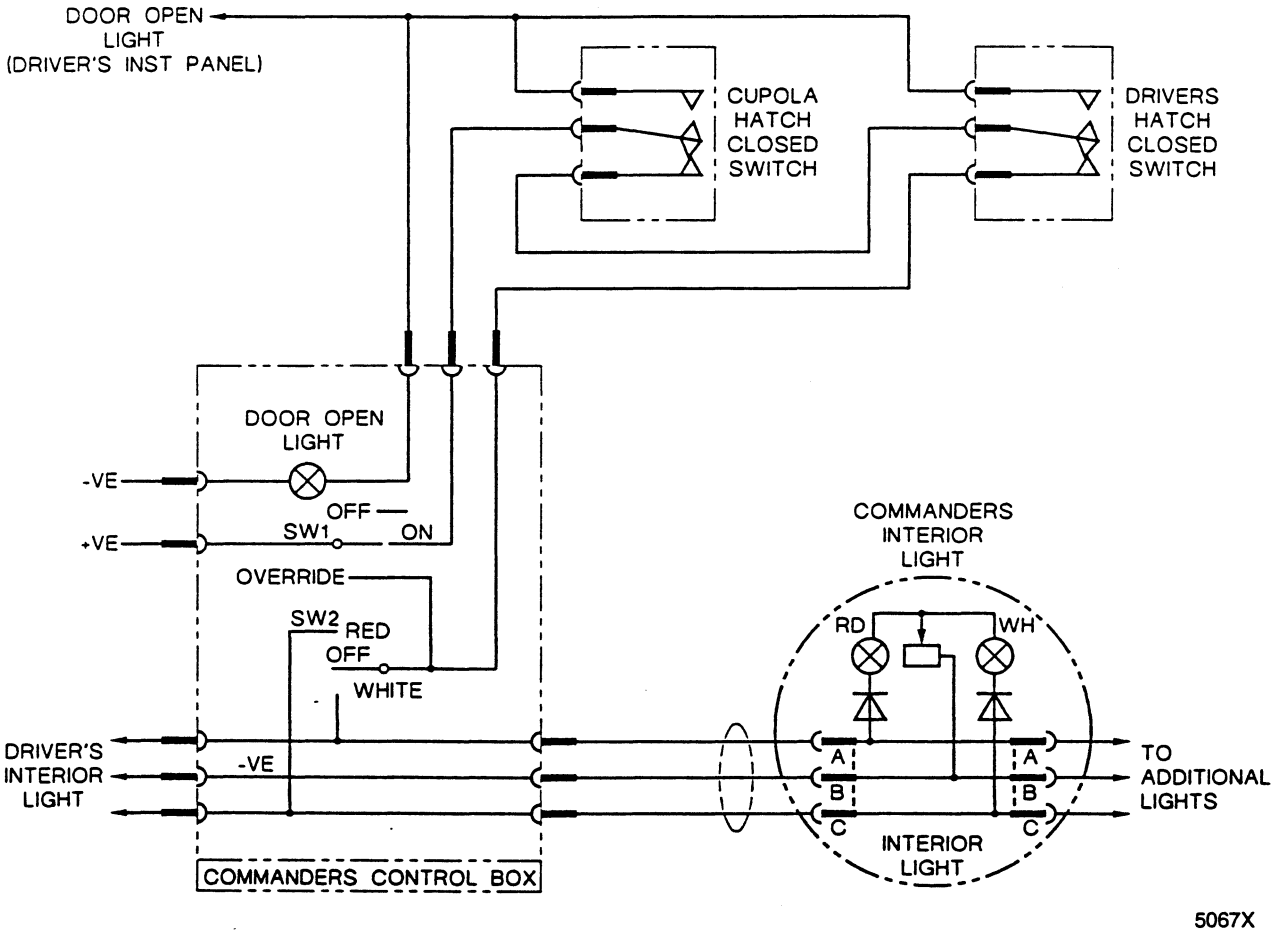

Fig 10 Interior lighting - schematic

EXTERIOR LIGHTS

50 The exterior lights (Fig 11) comprise two head lights, two front side lights, two rear tail lights, two rear stop lights, one rear fog light, one reversing light, a rear registration plate light, a convoy light and four turn lights which are also hazard warning lights.

51 The lights are controlled by switches on the driver's switch panel. The convoy switch has three positions OFF, CONVOY, SIDE & CONVOY. In the OFF position power is enabled to all lighting circuits, in the convoy positions all external lights are extinguished except for the convoy lights and side lights (if selected). The external light switch has three positions OFF, SIDE, SIDE & HEAD. The circuits are protected by individually identified circuit breakers located on the distribution panel.

52 With the light switch in the SIDE & HEAD position, operation of the dip switch, located on the left steering lever, energizes relay 'L', switching the head lights from DIP to MAIN BEAM, subsequent operation of the dip switch switches the head lights from MAIN BEAM to DIP and vice versa.

TURNLIGHT AND HAZARD WARNING LIGHTS

53 The turnlight and hazard warning light circuit (Fig 12) provides control, for the operation of the four vehicle turnlights. Power to the circuit is routed via the convoy switch, allowing the circuit to be isolated during convoy driving. The circuit is protected by a 5A circuit breaker, labelled as FLASHER on the distribution panel.

Turnlights

54 The turnlight switches are mounted on the left and right hand steering levers, providing control of the left and right hand flasher relays 'H' and 'J' respectively. The relays are configured to introduce a latching effect, such that the operation of only one set of turnlights at a time is possible, preventing all the lights operating simultaneously when both turnlight buttons are pressed. The flasher driver, is a self contained unit incorporating transistorised circuitry for high performance and reliability. The flasher driver unit (when activated by a turnlight switch or the hazard warning switch) produces output pulses to the appropriate turnlights. A further output from the flasher unit drives the 'turnlight indicator' lamp on the instrument panel when the unit is operating.

Hazard warning lights

55 The hazard warning lights switch, mounted on the switch panel, is wired into the circuit such that when the switch is operated the flasher relays are overridden, and flashing of each of the four turnlights occurs simultaneously.

56 A warning light incorporated in the translucent switch button also flashes to indicate that the hazard warning system is in operation.

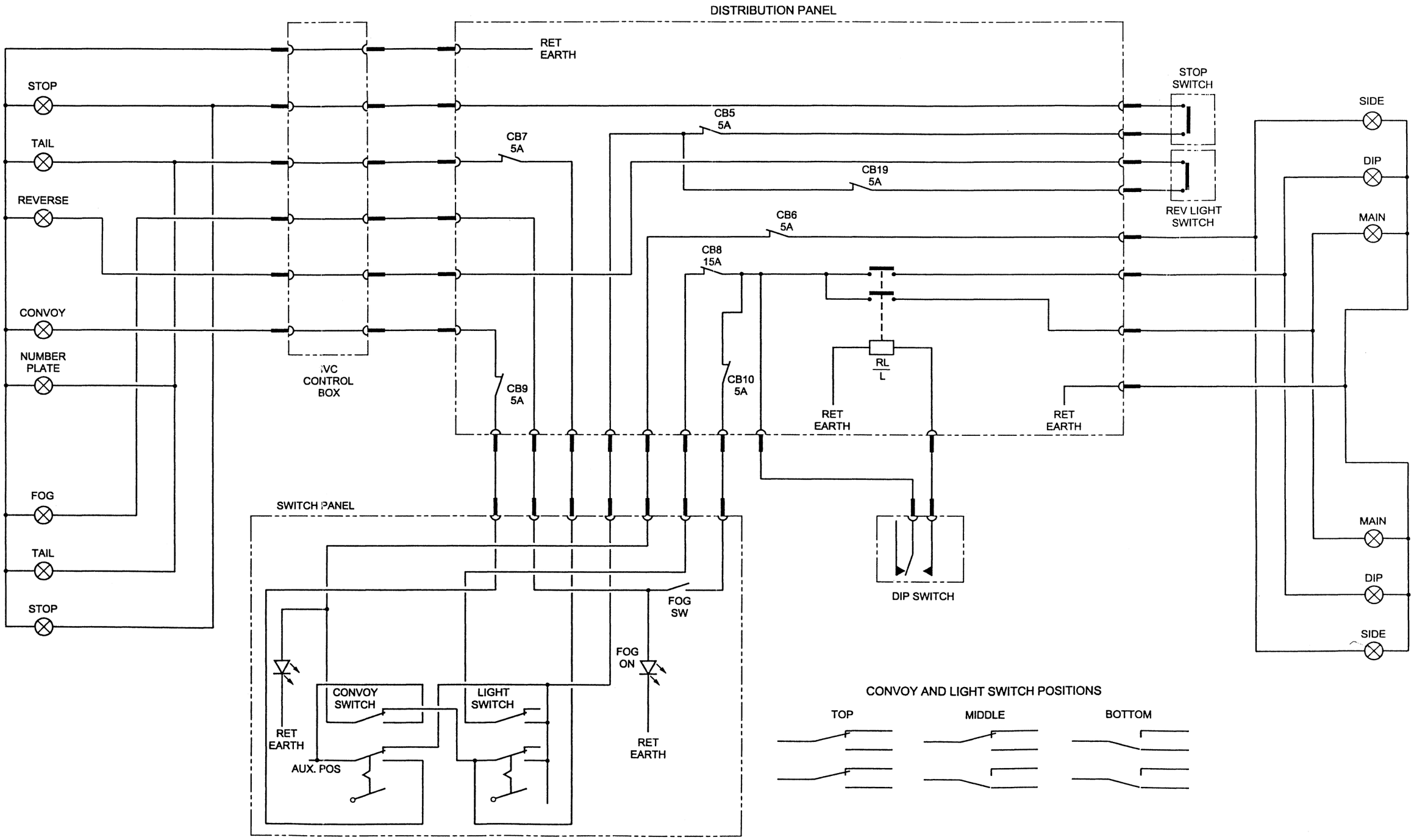

Fig 11 Exterior lighting circuit - schematic

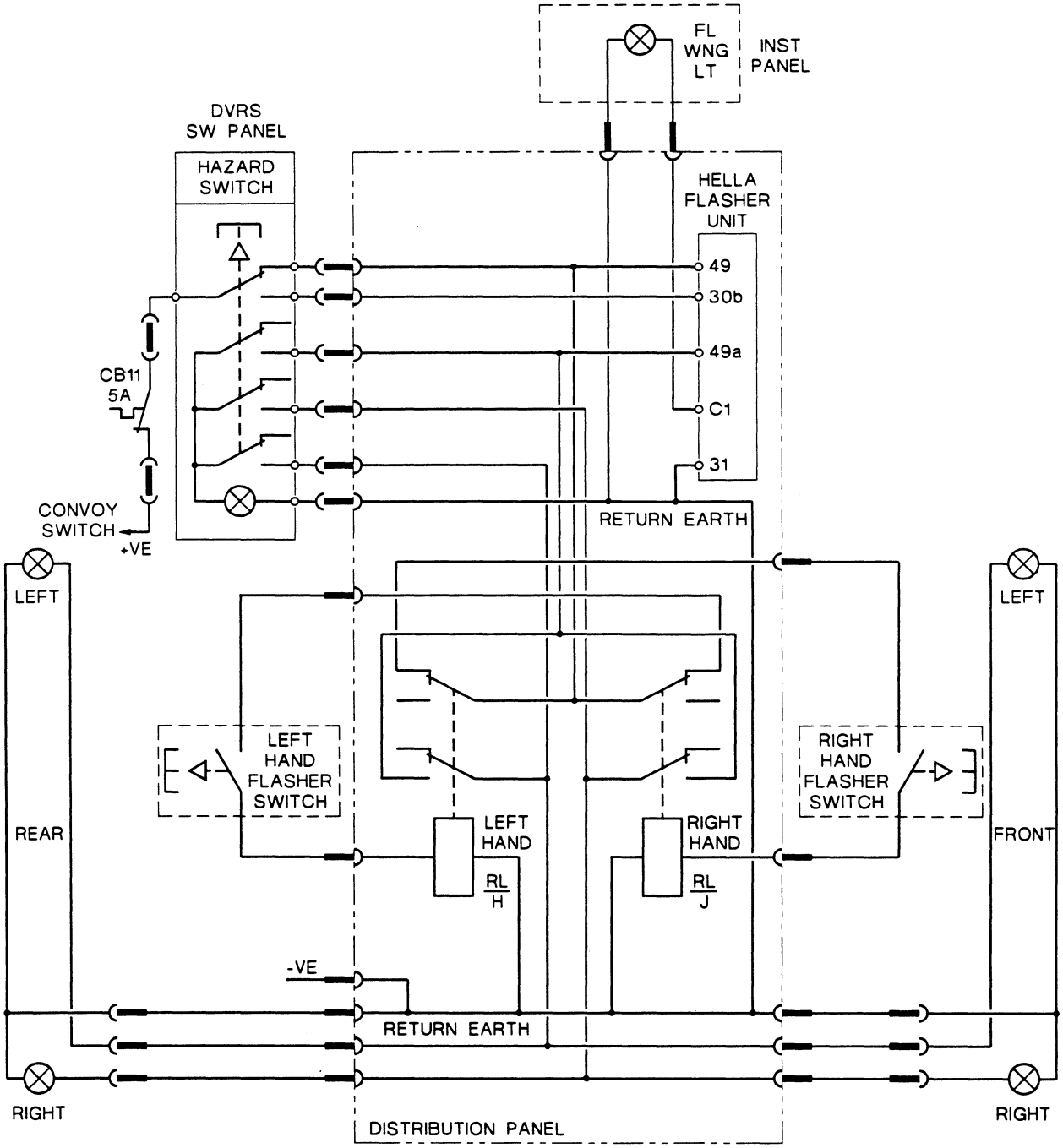

Fig 12 Turnlight and hazard warning lights - schematic

SMOKE GRENADE DISCHARGER SYSTEM

General

57 The smoke grenade discharger system comprises a control circuit, housed in the commander's control box, and two smoke grenade dischargers No. 12 Mk 2 (Fig 14). A schematic layout of the system is shown in Fig 13. The circuit is protected by a 10A circuit breaker labelled SMOKE on the distribution panel (the circuit breaker is also shared by the inspection sockets circuit).

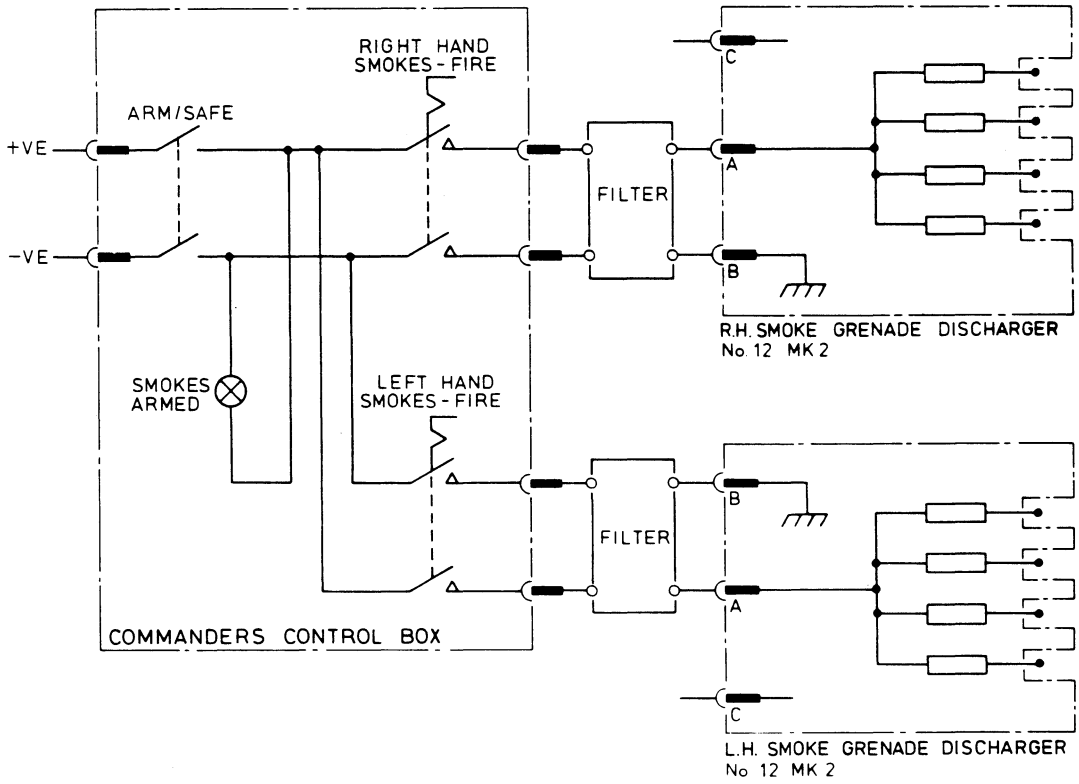

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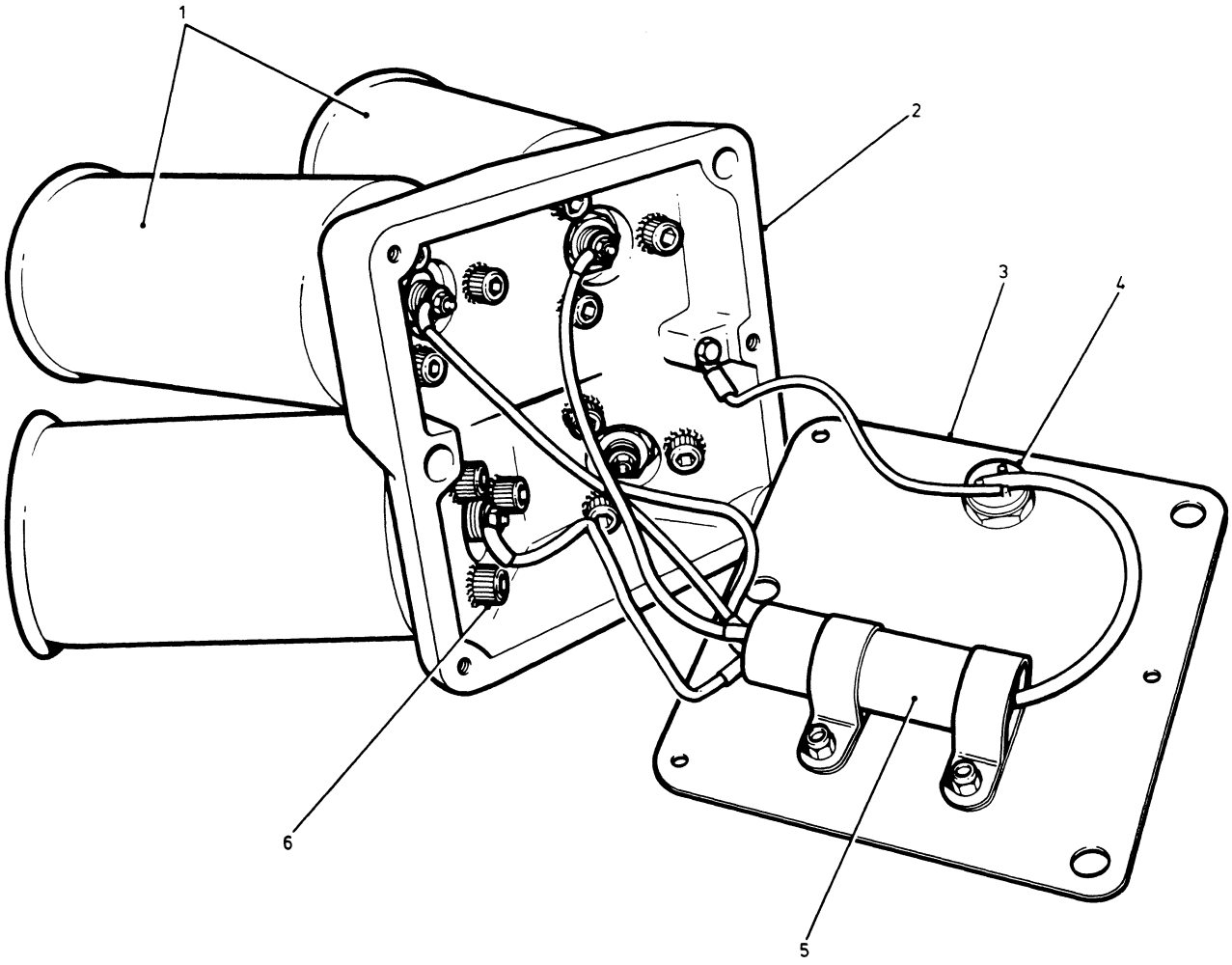
Fig 13 Smoke discharger system - schematic

Control circuit

58 Power to the control circuit (Fig 13) is fed from the distribution panel via a dual pole isolation switch labelled 'ARM, SAFE' on the commander's control box. In the 'SAFE' position all supplies to the circuit are isolated, a light labelled 'SMOKES' on the control box, illuminates when the switch is set to 'ARM'. Two spring loaded toggle switches enable separate firing of the left and right hand dischargers. The firing current is applied to each discharger barrel via a load resistor; the load resistors form an equalisation network which ensure continuity of discharge of all four grenades during firing. In line filters are located in both firing circuits to reduce the effects of electrical interference, caused during the discharge of grenades, and protect against Electro Magnetic Pulse (EMP) effects.

Smoke grenade discharger No 12 Mk 2

59 The alloy smoke grenade dischargers (Fig 14) each have four discharger barrels (1) mounted on a barrel asssembly (2). The barrels are splayed to give a wide area of coverage. Each barrel is secured to the barrel assembly by the securing screws (6). The barrel assembly is closed by a base plate (3) on which is mounted a resistor block (5).



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1 Discharger barrels
2 Barrel assembly
3 Base plate
4 Connector
5 Resistor block
6 Screw

Fig 14 Smoke grenade discharger No 12 Mk 2

CUPOLA DISTRIBUTION SYSTEM

60 The 24V electrical power supply from the distribution panel to the cupola is brought in via slip rings embodied in the cupola race ring, to the cupola services switch box. The circuit is protected by a 15A circuit breaker labelled CUPOLA on the distribution panel.

Cupola services switch box

61 The cupola services switch box has switches and outlet connectors for the control and distribution of the various services. It also provides a housing for the brushgear in contact with the cupola slip ring.

62 Cupola services brushgear comprises four spring loaded carbon brushes located in brush holders and connected in pairs for improved contact with the positive and negative slip rings. The holder is secured, by four screws, to the inside of the box so that the brushes protrude at the back, the joint between holder and box being sealed by a gasket. The brushes are secured in the holders by screw-on end caps. A further six carbon brushes of similar type are provided for connection of the weapon system interlock to the hatch switch.

63 Mounted on the switch box front panel are five toggle type circuit breaker switches and five LED's, these have circuit applications as shown in Fig 15. The toggle switches are identical single pole ON/OFF type and labelled according to circuit application. The integral circuit breaker is reset by setting the switch OFF then ON.

Sight wiping

64 The six periscopes that provide all round vision for the commander each have a wiper unit which is geared to a common drive system. The motor is controlled via the switch labelled SIGHT WIPERS on the cupola services switch box. The drive motor assembly includes a filter unit for the suppression of radio interference signals.

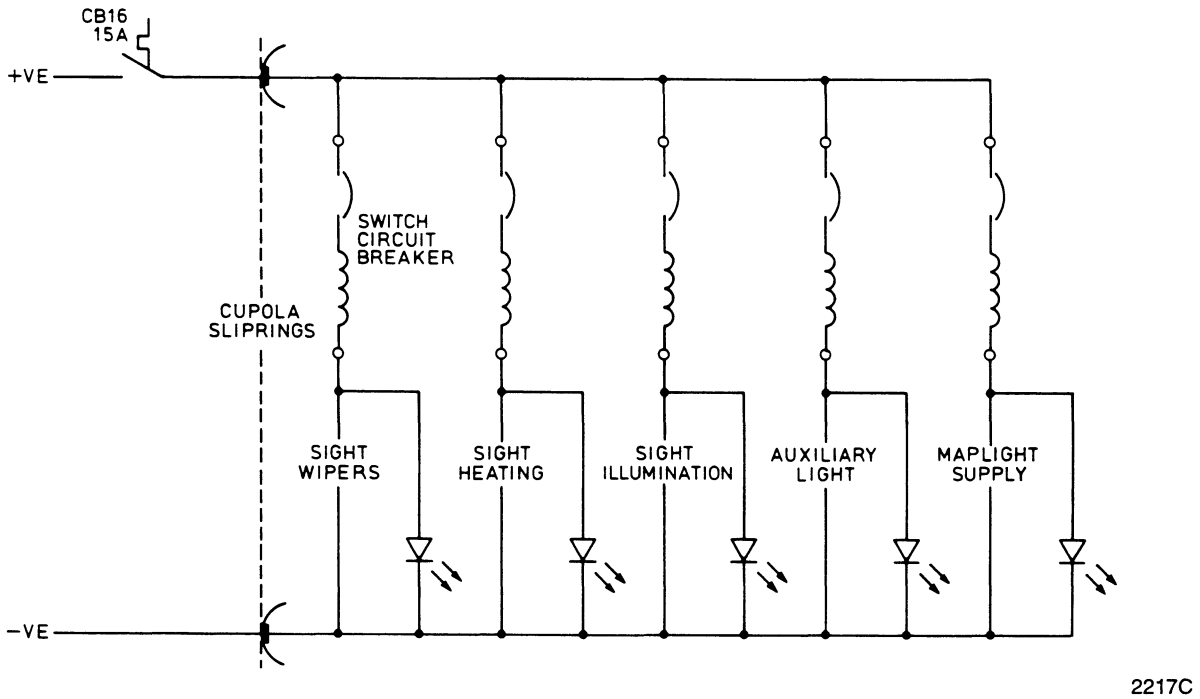

Fig 15 Cupola services - schematic

Sight heating

65 The window of the sight protector is heated by a conductive thermal coating connected by spring plungers located in a block fitted to the protector body. The sight protector circuit includes a terminal board and a thermostat, the supply is via a switch labelled SIGHT HEATING on the cupola services switch box.

Auxiliary light

66 The auxiliary light switch provides supply to a connection socket on the cupola exterior for connection of the beacon light unit. The beacon light unit, which is mounted on the vehicle roof, incorporates a motor driven reflector for rotating of the light beam.

Commander's map light

67 A 3-pin plug on the side of the cupola services switch box provides for mounting and supplying a map light for the commander. The circuit is controlled by the switch labelled MAPLIGHT SUPPLY on the cupola services switch box. When not in use the plug outlet is protected by a screw-on captive cover.

ENGINE ELECTRICS

General

68 The engine electrics are supplied via the engine power on switch, and comprise the starter circuits together with various warning lights (battery charge, oil pressure and coolant temperature).

Starter circuit

69 The starter circuit (Fig 16) utilizes a Starter Motor No 4 Mk 2 which is fitted with a solenoid and internal thermal overload switch. The other components are a start relay housed in the distribution panel, and power on and engine start switches located on the driver's switch panel. To energize the starter motor to start the engine, the vehicle master switch must be in the 'ON' position, the Driver's Gear Selector must be set to the START position, the engine power on switch in the 'POWER ON' position and the engine start switch placed in the 'START' position. The starter relay 'K' is energized, operating the solenoid switch in the starter motor.

70 The solenoid contact operation is in two stages. Initially, a torque limiting resistor limits the motor current until it is engaged in the flywheel. The second contact then closes, shorting out the resistor, allowing the motor to apply full torque to the engine.

71 If the engine is in gear or the starter motor has overheated, the earth return to the start relay coil is disconnected. The starter relay remains de-energized isolating the solenoid which inhibits operation of the starter motor.

Thermostart

72 The thermostart unit, located on the inlet manifold, may be used during cold start conditions to warm the engine prior to starting. Setting the engine start switch to the THERMO position activates the unit which warms air drawn through the induction manifold by burning a small quantity of diesel fuel, ignited by an electrically heated element. The switch is held in this position for 8-10 seconds, released and then placed in the START position, starting the engine as previously.

Battery charge warning light

73 The battery charge warning light will illuminate when the vehicle master switch is set to 'ON' and the engine 'power on' switch is in the POWER ON position, providing visual warning that the vehicle electrical system is energized. The light should extinguish when the engine is started indicating an output from the alternator, should the warning light glow while the engine is running there is no alternator output.

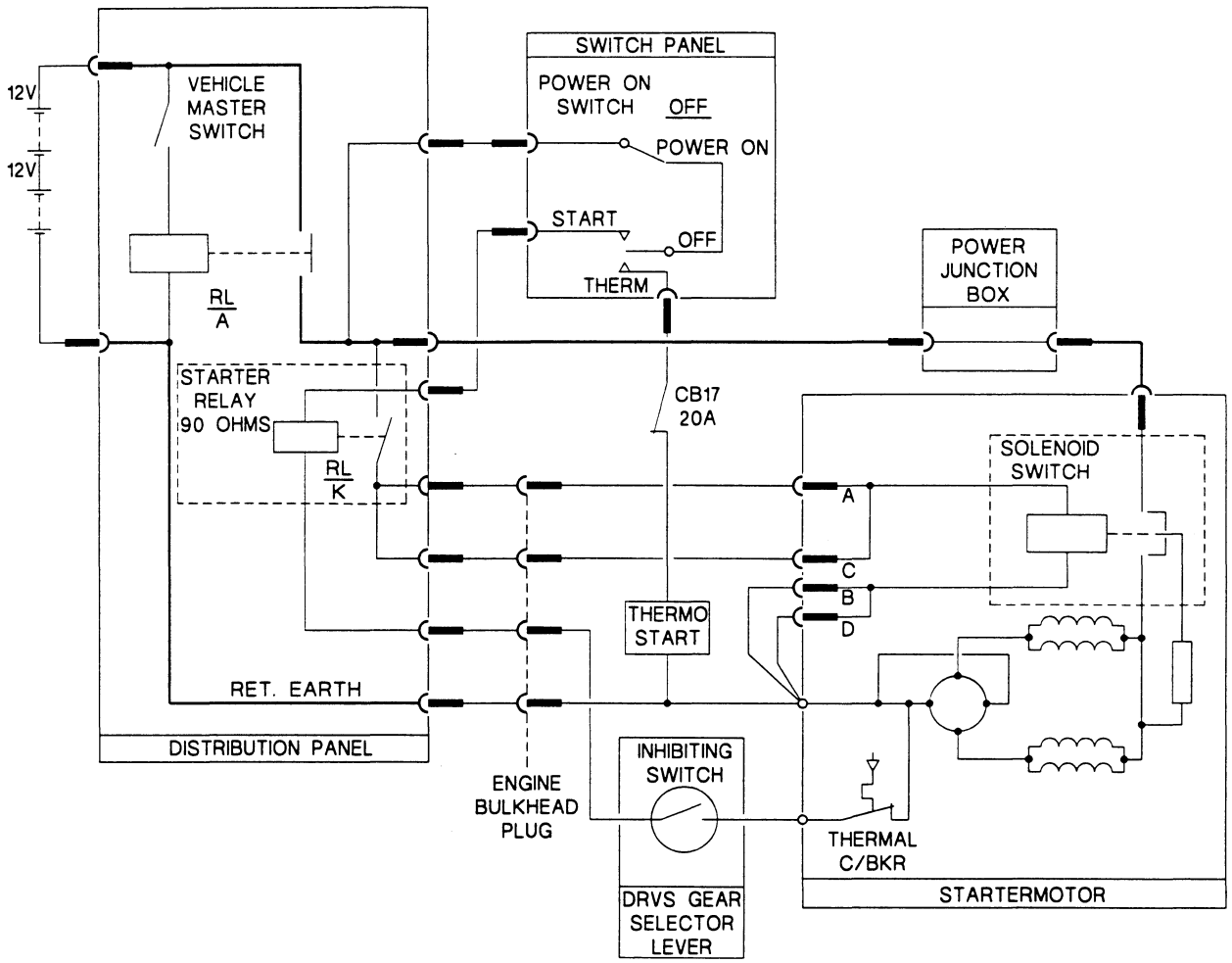

Fig 16 Starter circuit - schematic

STARTER MOTOR

General

74 For details of the starter motor No 4 Mk 2, refer to EMER, Power O, 322/4.

CHAPTER 9

ENVIRONMENTAL CONTROL SYSTEM

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13 Pack casing
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15 Second stage air filtration (particulate filter)
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23 Reset switch
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INTRODUCTION

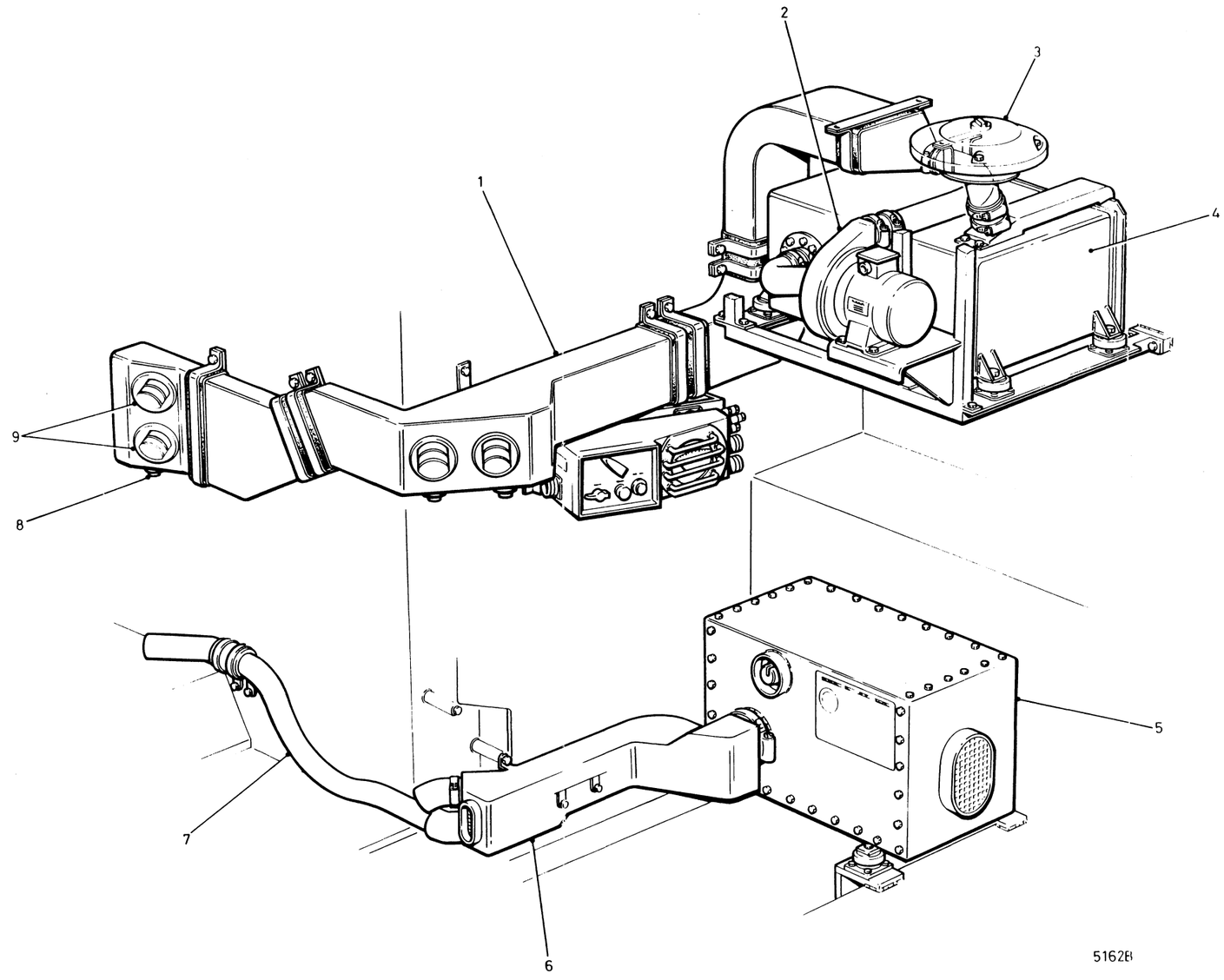
1 The Environmental Control System (ECS) fitted to the Shielder vehicle, provides protection in hostile Nuclear, Biological and Chemical (NBC) environments and also provides crew comfort. The system comprises two main units: NBC air filtration system (NBC pack), and a separate crew heater providing complementary heating or ambient airflow when required.

2 A general layout of the system is shown in (Fig 1). The NBC pack (4) draws in air from outside the vehicle through an armoured inlet valve (3) situated on the RH side of the roof plate. The air passes through various specialised filters in the pack to remove foreign particles, vapours and hostile contaminants. Airflow is controlled via the NBC pressurising fan (2), the outlet of which is fed directly to the air ducting (1).

3 Filtered/clean air from the NBC pack is directed throughout the crew compartments via air ducting. The ducting provides each crew member with a supply of filtered air via a diffuser outlets (9), each diffuser is circular in form incorporating movable flaps which open or close the outlet. Also incorporated in the air ducting are respirator outlets (8) for each crew member.

4 The crew heater (5) provides heating or ambient airflow for the vehicle interior by distributing hot air or ambient air (when required) to the crew positions. Airflow from the heater assembly is directed throughout the crew compartments, via a combination of ducting (6) and pipework (7).

5 Operation and servicing of the ECS is straightforward, with filters for the NBC filtration system being changed from outside the vehicle via a hinged armour plate hull access door, located behind a stowage bin on the RH side of the vehicle.



1 NBC air ducting
2 NBC pressurising fan
3 Armoured inlet valve
4 NBC pack assembly
5 Heater assembly
6 Heater air ducting
7 Heater air pipework
8 Respirator outlet
9 Diffuser outlet

5162B

Fig 1 ECS arrangement - NBC and heater

NBC AIR FILTRATION SYSTEM

General

6 The NBC air filtration system is provided to protect the crew should the vehicle be exposed to NBC conditions.

7 The system functions by drawing air into the vehicle via a 3 stage air filtration pack and circulating the filtered air at a pressure sufficient to ensure an adequate airflow throughout the vehicle interior. The airflow is promoted by a separate motor driven fan having its inlet connected to the air filtration pack and its outlet to the air ducting channels. A control box for controlling fan speed (and hence airflow rate) is incorporated. Air pressure within the vehicle is regulated by an air pressure relief valve located in the commanders cupola. A monitoring system enabling routine `in situ' checking of filters in the air filtration pack is embodied.

8 The system is energized from the alternator 'E' line, the circuit being controlled by a 'generator only' relay in the distribution panel (Chap 8). The circuit is protected by a 35A circuit breaker labelled NBC. The NBC system is provided for operational use only and must not be operated solely for ventilation purposes.

CAUTION

EQUIPMENT DAMAGE. When carrying out functional tests the NBC system must not be operated in a vicinity in which painting is taking place, or where vapours from solvents such as Benzine, or CTC, etc are present. Such vapour can seriously shorten the life of the filters.

9 Under full NBC protection, i.e. with the vehicle operating under `closed down' conditions, the NBC pack is operative, drawing filtered air into the vehicle interior. The air inside the vehicle is pressurized by the NBC fan. A pressure relief valve in the cupola hatch maintains the correct over pressure level. This ensures that clean air is forced out through any defective seal, preventing contaminated air entering the vehicle interior.

NBC air filtration pack No. 1 AM 85V

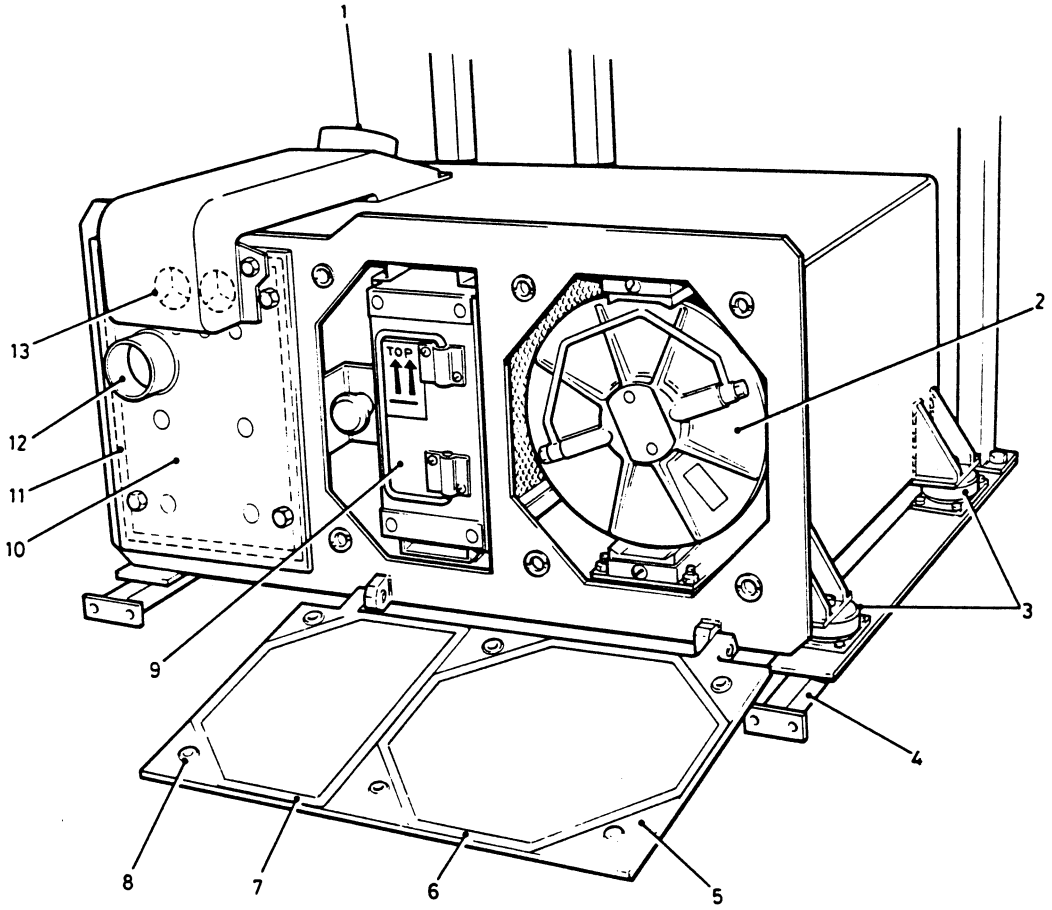
Mounting details

10 The NBC pack (Fig 2) is located internally, above the sponson on the RH side plate in the commander's compartment. It is supported at each corner by anti-vibration mounts (3) which are fitted between the base of the pack and the NBC mounting frame assembly (4). Bolts passing through the mounting frame secure the NBC pack in its correct position in the vehicle.

11 The NBC pack is positioned with its filter cornpartments opening to the exterior of the right hand side of the vehicle. An hinged armour plate door fitted to the hull exterior protects and provides access to the NBC components.

Pack internal sealing

12 Sealing during pack assembly is of a high degree to ensure that an extraneous intake of air or the by-passing of filters does not occur, sealant being employed wherever the fitting of internal components has necessitated drilling of the outer casing and interstage bulkhead plate. Silicone grease is employed to prevent the sticking of seals between facing surfaces of filters and filter housings. It is important that the procedure for resealing be adhered to.



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1	Air inlet spigot	6	Seal (third stage filter)	10	Cover plate
2	Third stage filter unit	7	Seal (second stage filter)	11	Seal (cover plate)
3	Anti-vibration mounts	8	Quick release fixing	12	Scavenge fan outlet spigot
4	Mounting frame assembly	9	Second stage filter unit	13	First stage filter unit
5	Filter access door				

Fig 2 NBC pack No. 1 AM 85V

Pack casing

13 The sheet metal fabricated casing is of welded construction, and incorporates three compartments (one for each filtration stage). The casing has two apertures for access to the second (9) and third (2) stage filter units, each aperture being closed by a single door (5) hinged at the bottom. The door has quick release fixings (8) and is fitted with seals (6) and (7) to ensure leakproof joints when the door is closed. A third aperture, sealed by a bolted on plate (10) with a seal (11) is provided to facilitate major servicing. The casing is machined to provide for the installation of hardware for accommodation of the various filters. On the top of the casing, a spigot (1) connected to a detachable ducting, is coupled to an inlet valve to form the air inlet for the NBC pack. Positioned at the rear of the casing a spigot locates with a pipe which provides for the air outlet from the pack to the fan inlet, and at the front of the casing a smaller hose spigot (12) provides for the evacuation (via the scavenge fan) of dust particles extracted by the first stage filter unit (13).

First stage air filtration (inertial separator)

14 The first stage air filtration unit (Fig 3) is designated 'Inertial Separator Unit'. The unit is housed in the left hand upper compartment of the NBC pack casing and comprises two sets of inertial tubes (3), mounted into a substantial steel housing (2), which act as tunnels for incoming air, spiral vanes (4) inside the tubes impart a rotary motion to the air flow. Heavy dust particles in the air stream are flung outwards under the influence of centrifugal forces. The air in the centre of the tubes thus depleted of heavy particles passes to the second filter stage via conical tubes (1) while the contaminated dust particles are deposited in the bottom of the housing (2) below the inertial tubes. The housing is scavenged by a motor-driven scavenge fan (9) and the dust particles are dispersed via a scavenge outlet spigot (6). The scavenge fan motor is fed via a plug and socket connection at the rear of the NBC pack, with its circuit being protected by a 10A fuse.

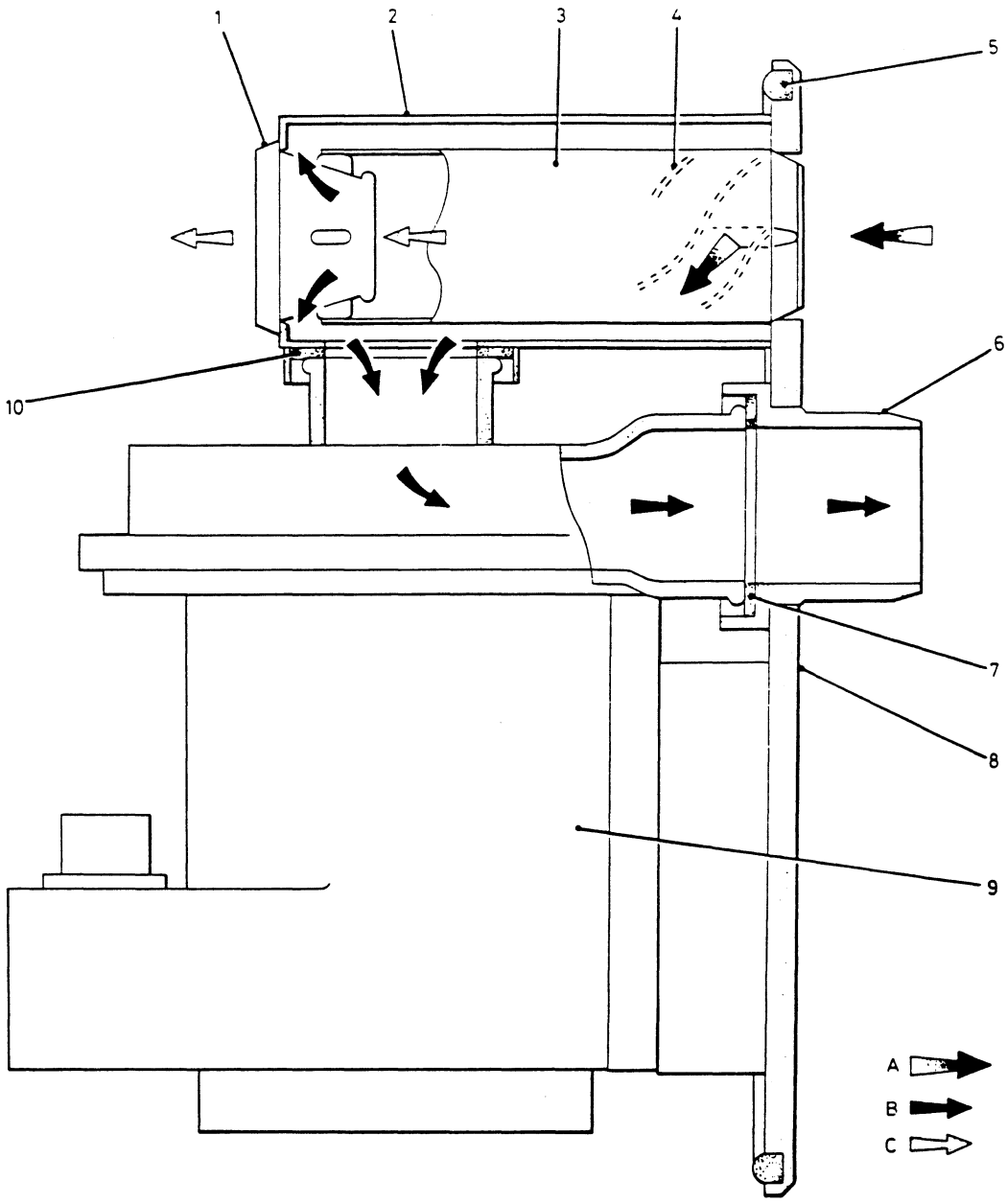
Second stage air filtration (particulate filter)

15 The second stage air filtration unit is located in a compartment in the centre of the pack casing and is designated 'Filter Particulate Ultra-High Efficiency, No. 1 AM 85V'. The filter (Fig 4) is removable; when installed in the pack it is secured by a rod operated over centre clamping device. The method of sealing its coupling with the third stage filter is by the use of an expanded silicone rubber seal (1) secured around the outlet edges of the filter.

16 The filter is a sealed unit which must be handled with care to avoid damaging the glass fibre filtration material inside, and the seal around the outlet. The filter cannot be cleaned, and if damaged cannot be repaired; damaged or clogged filters must therefore, be replaced. A fold-flat handle (2) at the front of the filter facilitates handling.

Third stage air filtration (anti-vapour filter)

17 The third stage air filtration unit (final stage) is accommodated in the right hand compartment of the NBC pack and embodies a single filter to cope with the airflow requirement. The filter which is designated 'Filter-Anti-Vapour No. 5, Mk 4' is mounted on a spigot positioned in the rear of the compartment as shown in Fig 5. The mounting spigot (4) has an external thread for filter attachment, and a hollow centre for the passage of air. Air from the filter is routed to the outlet at the rear of the NBC pack. An 'O' ring seal (3) seated in a groove in the facing of the spigot base, seals the joint between mating surfaces to prevent `filter by-passing' when the filter is screwed onto the spigot. The filter requires to be hand-tightened only to effect the necessary seal. Top and bottom clamps to prevent the filter unscrewing are provided, they comprise of an adjustable clamping device (1) which is operated by turning a clamping screw (2).

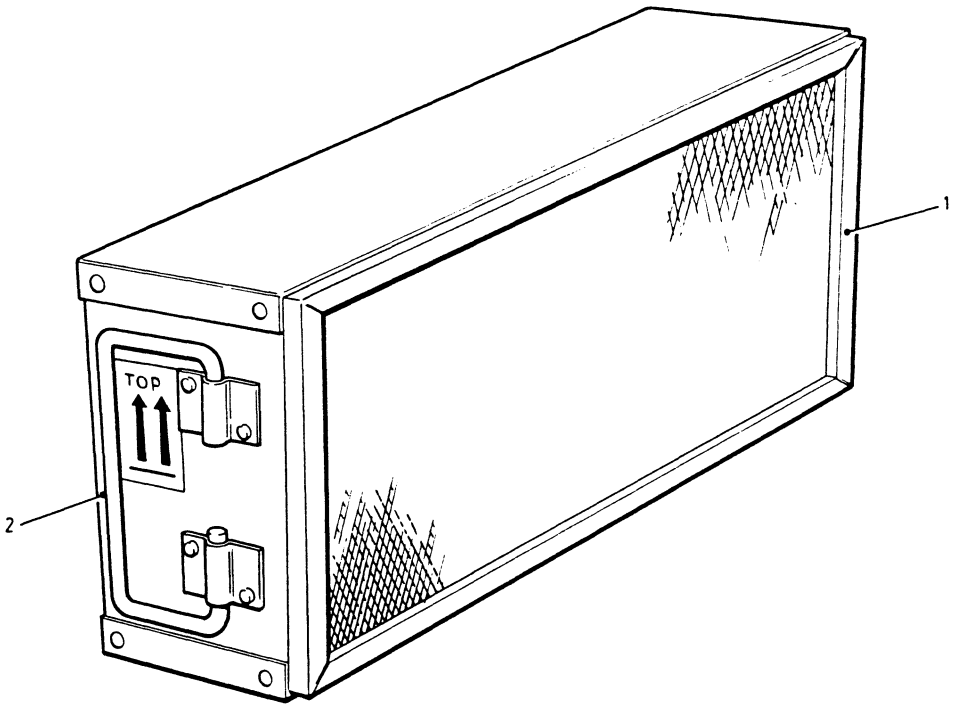


5191C

A Unfiltered air intake
B Extracted heavy dust particles
C First stage filtered air

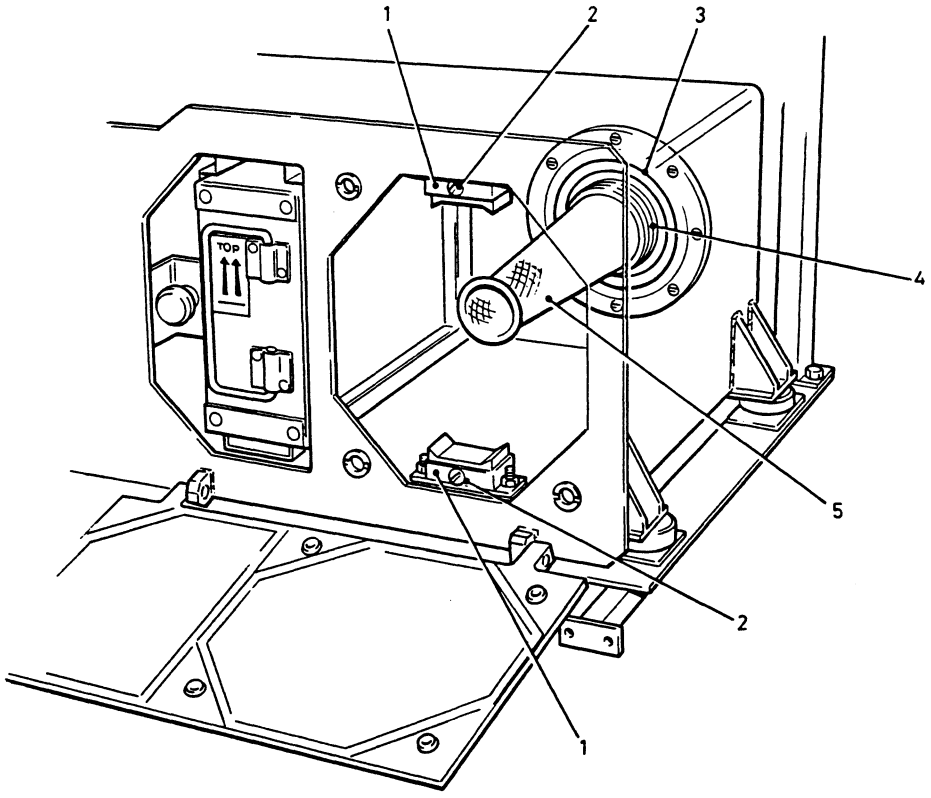
1 Conical tube
2 Housing
3 Inertial tube
4 Spiral vanes
5 Cover plate seal
6 Scavenge outlet spigot
7 Fan outlet seal
8 Cover plate
9 Scavenge fan
10 Fan inlet seal

Fig 3 Inertial separator unit and flow diagram (first stage filter)



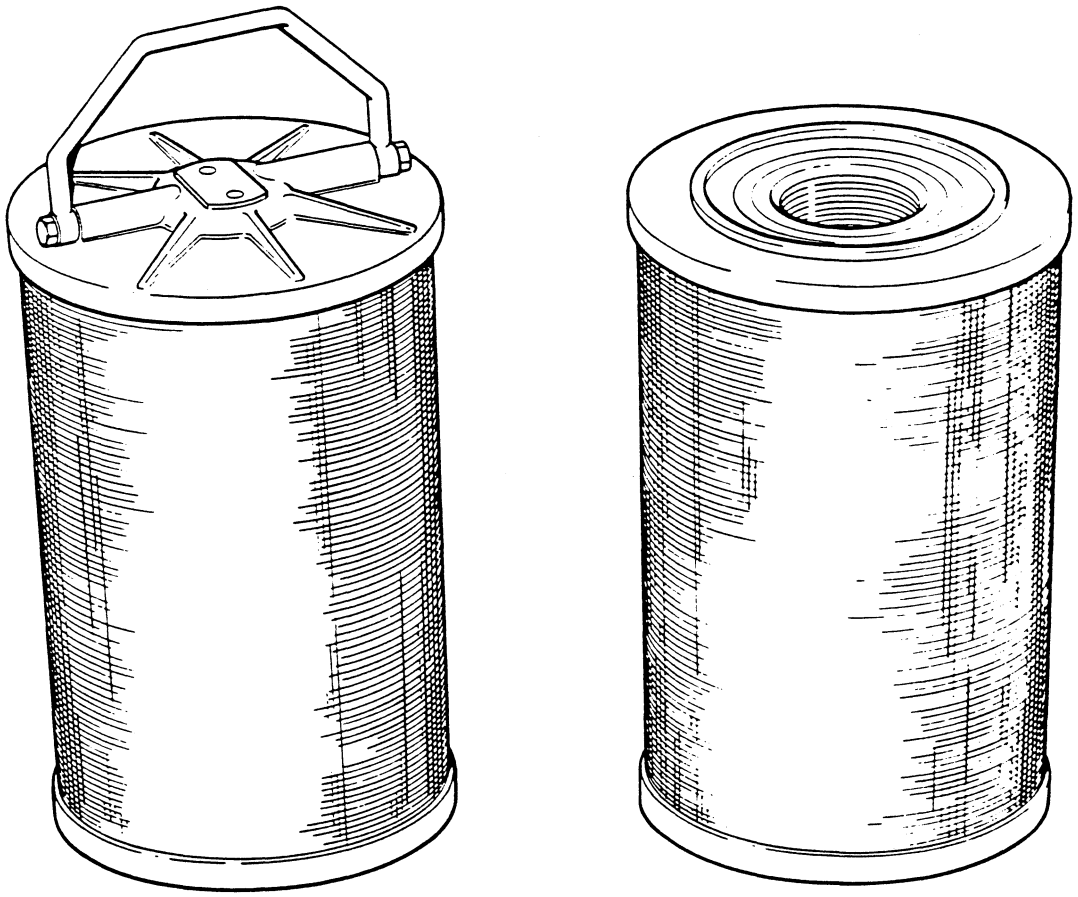
1 Seal
2 Handle

Fig 4 Filter particulate ultra high efficiency No. 1 AM 85V (second stage filter)



1 Clamping device
2 Clamping screw
3 `O' ring seal
4 Filter mounting spigot
5 Perforated cone

Fig 5 Filter mount and clamping arrangement (third stage filter)



5168C

Fig 6 Filter anti-vapour, No. 5, Mk 4 (third stage filter)

18 The filter (Fig 6) derives its anti-vapour properties from the use of activated charcoal, the charcoal is packed between inner and outer finely perforated sleeves capped at each end. One end cap has a centrally disposed air passage which is threaded for filter mounting purposes, the other end cap has a carrying handle which is also used for hand-tightening when fitting the filter to the mount. The direction of air flow through the filter when in use is radially inwards through the outer perforated sleeve, there being a tendency for the flow to be distributed throughout the filtration media due to the presence of the perforated cone (Fig 5 (5)).

19 The filter cannot be cleaned and if classified as unserviceable, following checks as outlined in Category 601, must be replaced.

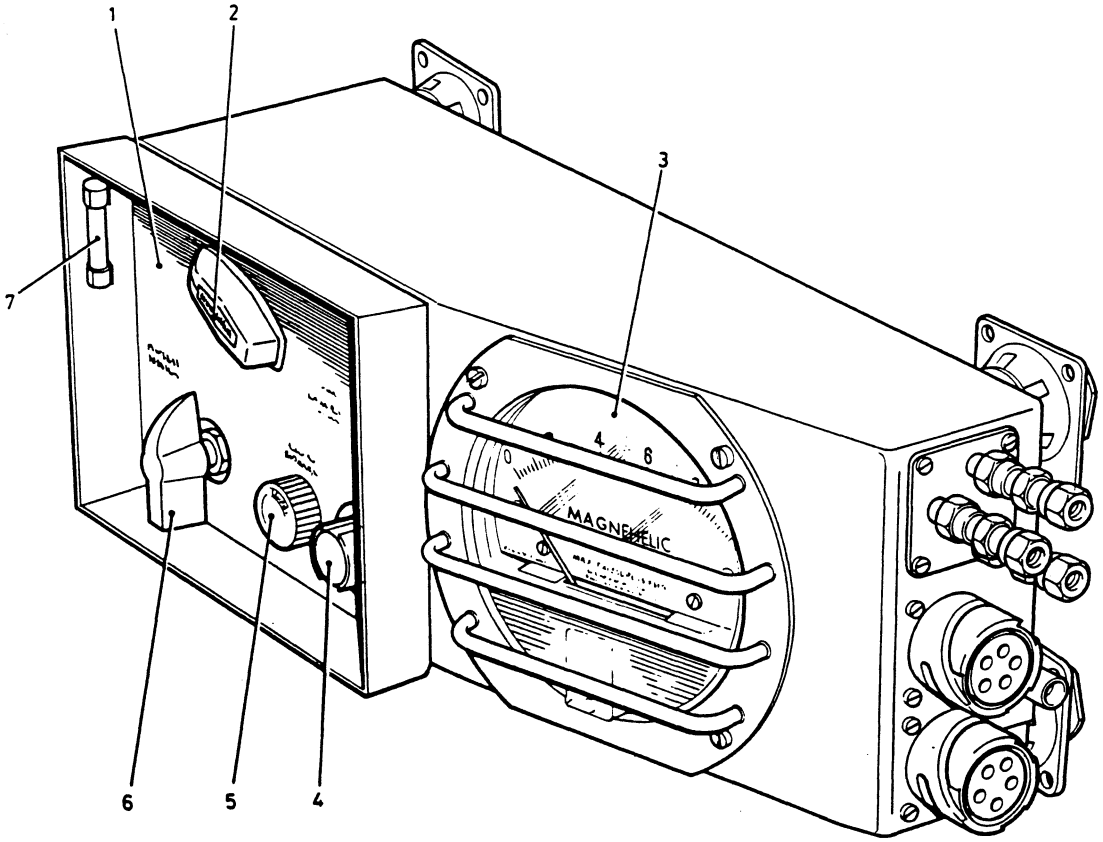
NBC Fan No. 10 Mk 1

20 The NBC fan is of unit construction comprising a centrifugal fan and 24V d.c. drive motor. The unit is mounted at the rear of the NBC pack with its inlet connected to the pack by a pipe and short flexible hoses. The fan outlet is connected to the driver's and commander's outlet air ducting also by a pipe and short flexible hoses. The hose connections are secured by hose clips.

21 The drive motor is rated as having an output capability of approximately 0.31 kW (0.42 hp) at 11,500 rev/min, input power is supplied via a plug connector incorporated in the motor frame. The circuit is fused (at the driver's distribution panel) and includes a speed control (on the system control box) for variation of airflow.

NBC control box

22 The NBC control box (Fig 7) provides for control and functional testing of the air filtration system, and is mounted forward of the NBC pack casing in a position accessible to the commander. The controls are mounted on a suitably inscribed control panel (1) and consists of a manual reset switch button (4), a fan speed selector switch (6), a rotary valve control knob (2) and a scavenge fan cartridge type fuse holder and fuse (5). A spare fuse (7) for the scavenge fan circuit is provided and housed in retaining clips at the top LH corner of the control panel. To the side of the control panel a differential pressure gauge (3) is mounted. Inside the control box there is fitted a power supply relay and a resistor board. Electrical and pneumatic connections are located at the sides of the control box.



5184C

1 Control panel
2 Rotary valve control knob
3 Differential pressure gauge
4 Manual reset switch button
5 Scavenge fan fuse
6 Off/fan speed selector switch
7 Spare 10A fuse

Fig 7 NBC control box

Reset switch

23 The reset switch functions to isolate the NBC system fan drive motors if the supply current is suddenly interrupted. Such interruption would, in the main, be due to stoppage of the vehicle engine since the NBC supply circuit is dependent upon there being an output from the vehicle alternator (Chap 8) and in such circumstances the supply could be restored (in the absence of the reset switch) simply by restarting and running the engine. This would mean, however, subjecting the alternator to an instantaneous load on starting, which, depending on the setting of the fan speed selector, could be such as to cause drive belt slippage and possible damage. The reset switch prevents this occurrence by remaining open to break the supply circuit to the power supply relay which in turn provides power to both fan drive motors, meanwhile the alternator can accelerate to its 'on line' speed free of the motor load, and the fan speed selector can be reset to the OFF position in readiness for restarting the NBC fan. The reset switch must be closed manually to restore NBC system power supply to the fan motor circuits, thereafter, acting as a circuit 'latch', it remains closed until some change (as already described) in supply conditions occurs. The latch circuit is not deactivated by switching the fan speed selector switch to OFF, systems in the control box therefore remain live and available until the vehicle supply is switched OFF.

24 The switch incorporates a solenoid to hold the contacts in the closed position against the action of a spring, the solenoid is energized by the supply voltage via the closed contacts. The switch is of the press to reset type, having a white translucent cap which encloses a warning lamp fitted in the push button. The lamp is wired so that it illuminates when the power supply is available but not selected, and extinguishes when the switch is latched (NBC selected).

Fan speed selector switch

25 This is an Off/6-position, rotary type switch, wired in conjunction with the resistor bank inside the box, to provide an Off position plus six fan speeds as a means of varying the airflow rate, each position being identified by a number inscribed on the control panel, number 1 being the lowest fan speed position. At positions 1 to 6 a second circuit on the switch energises the power supply relay which then supplies power to both fans and the NBC fan speed control circuit. The scavenge fan runs at constant speed irrespective of speed selector position.

26 The switch has an index type control knob fitted to the operating spindle and is secured to the control panel by a nut screwed on the switch stem.

Resistor board

27 The resistor board comprises nine 1.5 ohm resistors soldered to tags on the insulating board to form a resistor chain. With intermediate tappings for variation of the NBC fan drive motor field current. The board is secured by screws to two brackets welded to the inside of the control box.

Rotary valve

28 The rotary valve is for use when checking air pressures at various stages in the air filtration system. The pressures to be checked are those across the second stage of air filtration and that within the vehicle interior. Selection is made by turning the valve to one of two positions as identified by markings on the control panel face. The air pressure in the region thus selected is then directed to the gauge at the side of the panel. The circuit (Fig 8) utilizes colour coded nylon tube connectors with threaded adaptor type terminations which enable leak-proof connections to be made.

29 The rotary valve ports are arranged in two banks designated A and B, each port being identified by a number stamped on the body.

Power supply relay

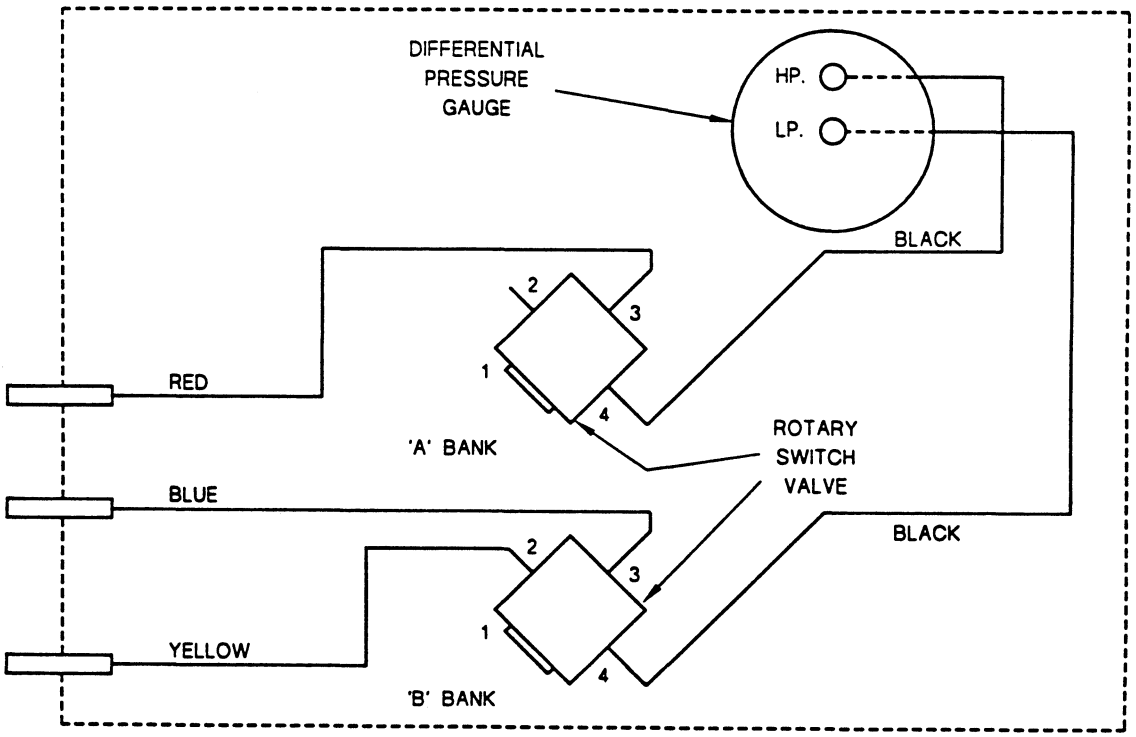
30 The power supply relay controls the input to the NBC equipment. The relay winding is connected in series with the reset relay and fan speed selector switch, the circuit is energized only when there is an output from the vehicle generating system. The relay contacts are of the single, 30 amp current carrying capacity type, they are enclosed by a dust cover which can be removed for checking the contacts. The relay is secured by two screws to a bracket welded to the control box base.

Fuse unit

31 The fuse unit accommodates a cartridge type fuse for the scavenge fan in the cyclone unit. The 10 amp anti-surge fuse is gripped at one end within a moulded cap (fuse carrier) which can be unscrewed for removal from the fuse unit body by hand, a synthetic rubber sealing ring is incorporated.

Control box external connectors

32 The NBC power supply harness from the vehicle electrical system is connected into the control box by means of a fixed socket on the side of the control box adjacent to the control panel. At the other side of the box are two fixed sockets, the upper socket is for connection of the NBC fan unit and the other is for connection of the cyclone unit scavenge fan. Above these are three pneumatic connectors for attachment of nylon tube connectors, two from the NBC pack filtration stage check points and the other (coloured yellow) from a small adaptor, the 'ambient pressure inlet air tap', which is situated towards the rear and above the NBC pack, in the roof plate of the vehicle.



5172X

Fig 8 Rotary valve connections

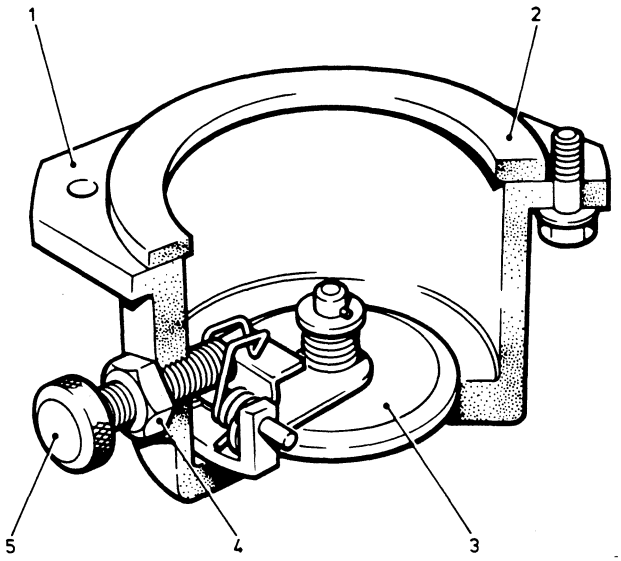
Air pressure relief valve No. 5, Mk 1

33 The air pressure relief valve (Fig 9) functions to maintain a level of air pressure when over atmospheric pressure is generated within the vehicle by the NBC fan when operating under `closed down' conditions. Pressure inside the vehicle varies with the fan speed selector switch setting and an air leakage factor, which is dependent upon the efficiency of vehicle sealing and setting of the air pressure relief valve. The leakage factor is largely governed by the amount by which the valve can open to increase the airflow rate. In installations having highly efficient sealing (hatch sealing, etc) the valve opening parameter must tend toward maximum in order to establish the required airflow conditions. The air pressure relief valve is therefore adjusted `in situ', the correct setting being obtained by metering a flow of air into the closed down vehicle and adjusting the valve until the air pressure is within a specified level.

34 The differential pressure gauge measures the difference in pressure across the filtration stages as designated on the control panel adjacent to the rotary valve control knob, and the air pressure inside the closed down vehicle relative to atmospheric according to whichever is selected on the rotary valve. The gauge is calibrated to give positive readings of pressure in inches (water gauge) and has two ports, one identified LP and the other HP. An adjustment screw for zeroing the instrument is accessible from the front of the gauge, but normally not touched unless it is certain that there is no pressure difference between LP and HP connections (i.e. as when terminal ports are open to atmosphere). The gauge is secured to the box face by four screws.

35 Once obtained, the correct setting must not subsequently be disturbed as it is vital to the operation of the NBC system. Replacement of a faulty air pressure relief valve should be carried out only in suitably equipped workshops.

36 The valve is fitted in the cupola hatch, the outlet in the armour plate being protected by a cowl. It comprises a hinged disc valve assembly (3) which is constrained in the absence of pressure potential by a light spring to seal off the aperture in the valve body (1). The adjusting screw (5) determines the amount by which the valve can open, a locknut (4) is provided for securing the screw in position. The valve is secured to the cupola hatch by four screws, with sealing gasket (2) interposed.



2154D

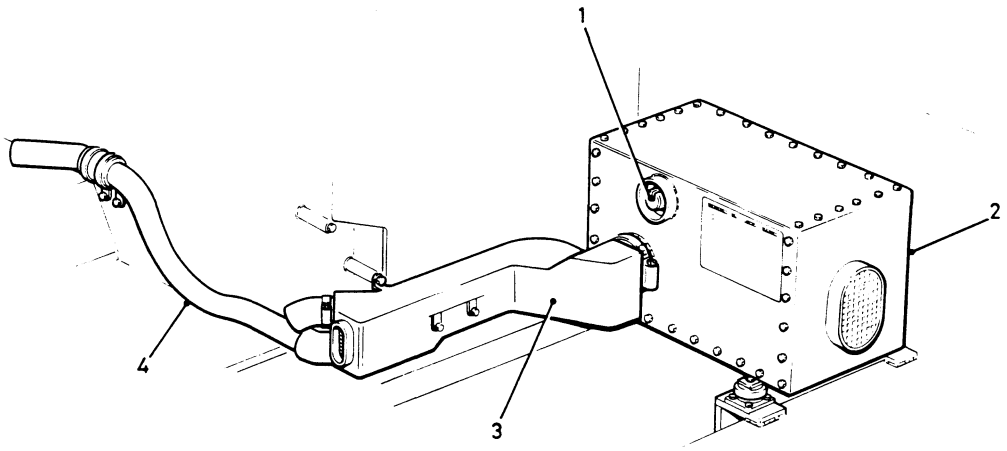
1 Relief valve body
2 Gasket
3 Disk valve assembly
4 Locknut
5 Adjusting screw

Fig 9 Air pressure relief valve No. 5, Mk 1

CREW HEATER

37 The crew heater unit assembly (Fig 10 (2)), which provides supplementary heating or ambient airflow for the vehicle interior, is located inside the vehicle, on the right hand side and slightly above floor level of the commander's compartment. The heater unit itself, is housed in a fabricated steel casing of riveted construction and bolted directly to the base of the casing. The heater unit comprises an integrated fuel fired burner/combustion chamber, heat exchanger, outer casing housing, motor driven blower, intake and exhaust pipes, ignition and fuel control systems, and a separate actuating/control switch unit (1), mounted on the front face of the fabricated casing.

38 The heat exchanger houses an ignition glow plug, a safety thermal cutout switch and a flame sensor. The combustion chamber, forms an integral part of the heat exchanger assembly, and has an exhaust outlet connection which is part of the heat exchanger. A combustion air blower unit draws combustion air via a silencer from an air inlet, thus providing an isolated combustion system.



5200D

1 Actuating/control switch unit
2 Heater unit assembly
3 Heater air outlet ducting
4 Heater pipework

Fig 10 Crew heater unit assembly

39 Combustion air intake and exhaust pipework is routed from the bottom of the heater unit along the right hand side plate of the commander's compartment and into the engine compartment. A protective heat shield covers the pipework within the compartment. Combustion air is drawn from the engine compartment where the intake pipework is terminated, the exhaust outlet is further routed inside the engine compartment to an exit point situated beneath the engine exhaust exit at the top right hand corner.

40 The combustion chamber/burner fuel supply is drawn from the vehicle fuel tank by a separate electrically driven fuel metering pump, the pump contains an in-line gauze filter to prevent the ingress of dirt into the system. The pump is controlled by an electronic pulse generator which drives the pump at three speeds dependent upon heat demand, resulting in the following fuel consumptions.

40.1 Approximately 0.15 l/hr for the low setting on actuating/control switch.

40.2 Approximately 0.34 l/hr for the medium setting on actuating/control switch.

40.3 Approximately 0.58 l/hr for the high setting on actuating/control switch.

41 A fuel line directs the fuel into the combustion chamber where it is ignited by the ignition glow plug. Air flow for both heating and combustion air is controlled by the electric blower motor unit which is mounted at the front end of the combustion chamber. The heating air blower fan is directly driven from the motor front spindle and the combustion air blower fan is driven from the motor rear spindle.

42 The outer casing upper and lower housings enclose both the heat exchanger and the combustion chamber. They serve to guide the heating air and provides attachments for the inlet and outlet heater hoods. A removable protective cap plate is mounted externally on the upper outer casing housing and houses the PCB/temperature control sensor and the ignition glow plug assembly. The heater air outlet ducting (3) and pipework (4), routes heated or ambient air to the crew positions.

43 The heater actuating/control switch (Fig 11) is located on the front face of the fabricated steel casing assembly. It comprises, an On-Off switch with control features for the heating capacity and ambient airflow, a red light for illumination, and a green operating pilot light, which also flashes in the event of the heater overheating. Electrical power is distributed to the heater control circuit by a 25A circuit breaker in the commander's control box.

Mode of Operation

44 The heater is started by turning the actuating/control switch control knob (4) to segment marked 4, The green operating pilot light (2) illuminates, after about 3 seconds the blower and ignition glow plug are switched on, after 33 - 70 seconds the fuel pump is switched on, and the fuel is ignited in the combustion chamber. Once a stable flame has been obtained, the glow plug switches off. Ambient airflow throughout the vehicle is achieved by turning the actuating/control switch control knob to the blue field (1).

Regulation in heating operation

45 Once the intake/compartment temperature (10°-30° C) has been reached at the actuating/control unit, the heater switches to the 'LOW' setting and continues to run at low blower motor speed. If the heating capacity in the 'LOW' control setting is insufficient, the heater switches to the 'MEDIUM' setting. The blower will continue to operate at low speed. In most cases, the LOW/MEDIUM/HIGH settings at low speed will provide the required heat. If the heating capacity in the 'MEDIUM' setting is insufficient, the heater switches to the 'HIGH' setting. This entails full speed for the blower motor. If even less heating capacity is needed than the heater supplies in the 'LOW' setting, the heater switches to the 'OFF' setting. Restart is in the 'MEDIUM' setting at low blower motor speed. When the heater is finally switched off, the operating pilot light goes out and the blower continues to run until it cools down, this continued operation lasts about 4 - 5 minutes.

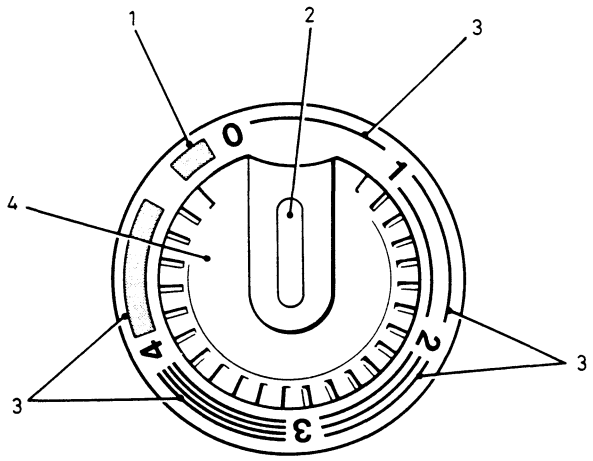
46 The combustion flame is monitored by the flame sensor, and the maximum permitted temperature by the safety thermal cut-out switch, both of which affect the actuating/control unit, which switches off the heater in the event of possible faults.

47 If the heater does not ignite within 90 seconds of the start of fuel pumping, start up is repeated. If the heater still does not ignite after a further 90 seconds, fault shutdown follows. If the heater flame goes out by itself during operation, a restart follows first. If the heater fails to ignite within 90 seconds of fuel pumping being switched on, or it does ignite but then goes out within 10 minutes, fault shutdown follows. The fault shutdown feature can be cancelled out by briefly switching the heater off and then back on again.

48 In the event of the heater overheating, the safety thermal cut-out switch reacts, the fuel supply is interrupted, and fault shutdown follows. If overheating is the cause of a fault shutdown, the actuating/control switch unit pilot light will flash steadily. Once the cause of the overheating has been eliminated, the heater can be restarted by switching the heater off and back on again.

49 When the heater is started the function of the blower motor is checked once. If it does not start, the heater will undergo fault shutdown. During operation, the blower motor is monitored in cycles (4 mins). If the motor speed is below the permitted limit, fault shutdown follows.

50 When the heater is switched off, the glow plug is switched on during the delayed shutoff period for about 30 seconds (after glow) in order to clean it of combustion residues.



5179D

1 Blue field (ventilation only)
2 Green pilot light
3 Red field (heating/temperature control)
4 Control knob

Fig 11 Actuating/control switch unit

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Title of AESP: Carrier, Full Tracked, Vehicle Launched Scatterable Mine System (VLSMS), 'Shielder' - Technical Description

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* Action is being taken to:

  * (i) Revise the AESP
  * (ii) Amend the AESP

* No action is considered necessary for the following reasons:

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AESP Form 10

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