ELECTRICAL AND MECHANICAL ENGINEERING REGULATIONS

(By Command of the Army Council)

WHEELED VEHICLES

V 622

SCOUT CAR, LIAISON, FERRET, MK 1

SCOUT CAR, RECCE, FERRET, MK 2

TECHNICAL HANDBOOK-
TECHNICAL DESCRIPTION

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SCOUT CAR, LIAISON, FERRET, MK 1
SCOUT CAR, RECCE , FERRET, MK 2

TECHNICAL HANDBOOK - TECHNICAL DESCRIPTION

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GENERAL DESCRIPTION

1. Ferret scout cars are armoured four-wheeled drive road and cross-country vehicles. The Mk 1 liaison vehicle (Fig 1 and 2) has an open roof and carries a crew of three, whilst the Mk 2 reconnaissance vehicle (Fig 3 and 4) is fitted with a rotating turret and carries a crew of two.

2. Of welded construction the hull consists of a fighting compartment and an engine compartment and is waterproofed for fording.

3. For the driver's use are three observation flaps at the front of the hull. A splinter-proof glass screen for use in the centre flap opening gives the driver maximum observation during an approach march. The screen has to be removed before the flap can be closed. Each of the front flaps is fitted with a periscope for observation purposes when the vehicle is closed down. At the rear of the hull are two flaps and at each side visors fitted with splinter-proof screens.

4. The Mk 1 liaison vehicle carries a .303 in. Bren machine gun which can be mounted on the hull roof. The roof opening is closed when required by a canvas cover.

5. The turret of the Mk 2 reconnaissance vehicle is of welded construction and carries a mounting for a .30 in. Browning machine gun.

6. A smoke grenade discharger is mounted on each of the two front wings.

7. Power is supplied by a 6-cylinder water cooled B60 No.1, Mk 3A or Mk 6A engine which is of unit construction with a fluid flywheel and gearbox.

8. The engine cooling system, which is pressurized to 10 lb/sq.in., embodies a gilled-tube radiator and a 12-bladed fan.

9. Engine power is transmitted through the fluid flywheel to a pre-selective 5-speed gearbox. The gearbox drives an attached transfer box which is coupled by propeller shafts to bevel boxes which drive the road wheels through reduction gears in each hub.

10. Independent suspension is employed for each road wheel through a helical spring and wishbone type arms and hydraulic shock absorbers.

11. Hydraulic two leading-shoe brakes are fitted on each of the four wheels. The handbrake operates all brakes mechanically whilst the footbrake operates them through the hydraulic system.

12. Divided-disc road wheels are fitted with cross-country run-flat tyres which permit a limited amount of running after having been punctured.

13. Steering is effected through a recirculating ball type mechanism.

14. The negative earth return electrical system is 24 volt. Two 12 volt batteries, connected in series, are housed in metal containers, one on each side of the gearbox.

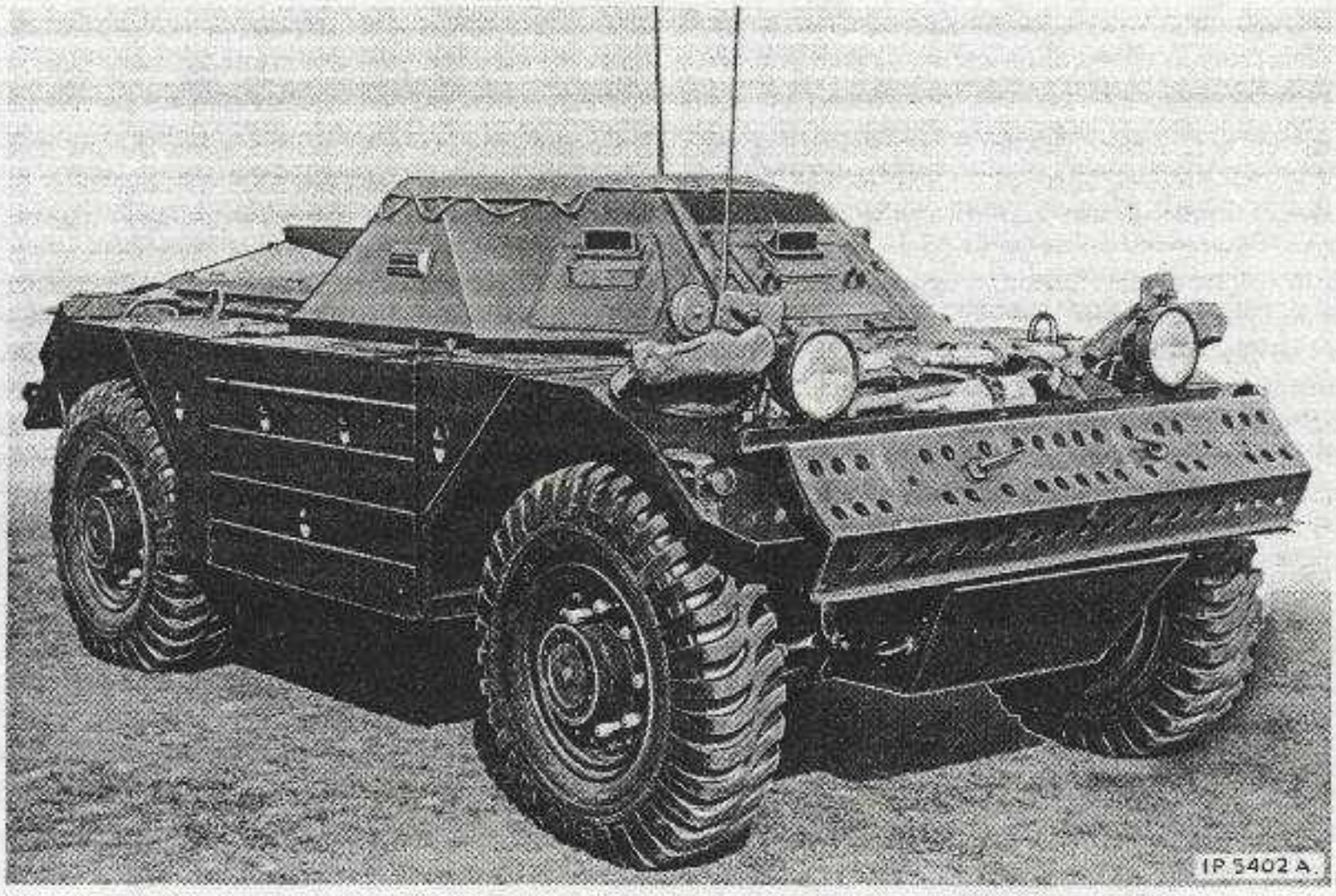


Fig 1 Three-quarter front right view of Mk 1 liaison vehicle

Fig 2 Three-quarter rear left view of Mk 1 liaison vehicle

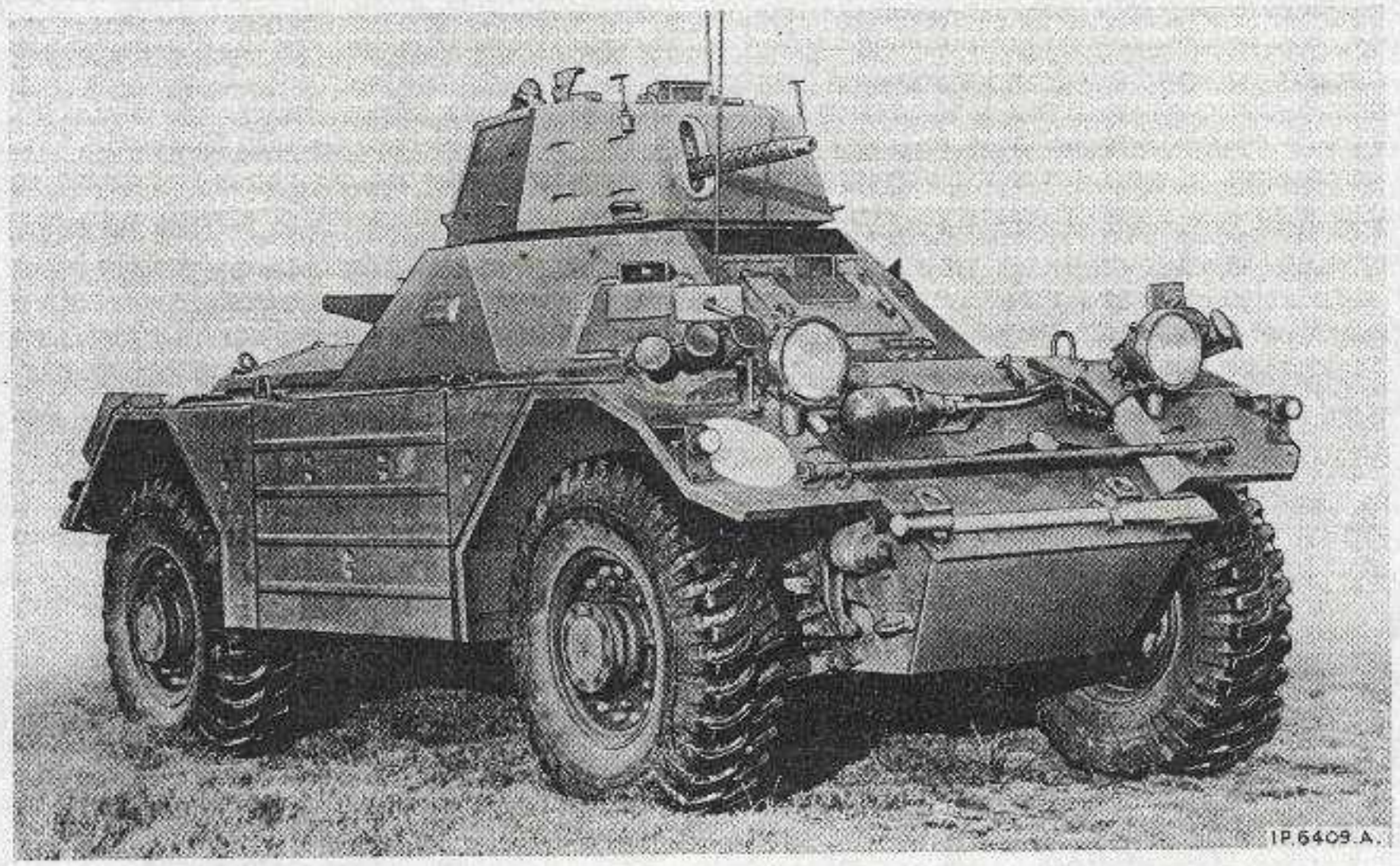


Fig 3 Three-quarter front right view of Mk 2 reconnaissance vehicle

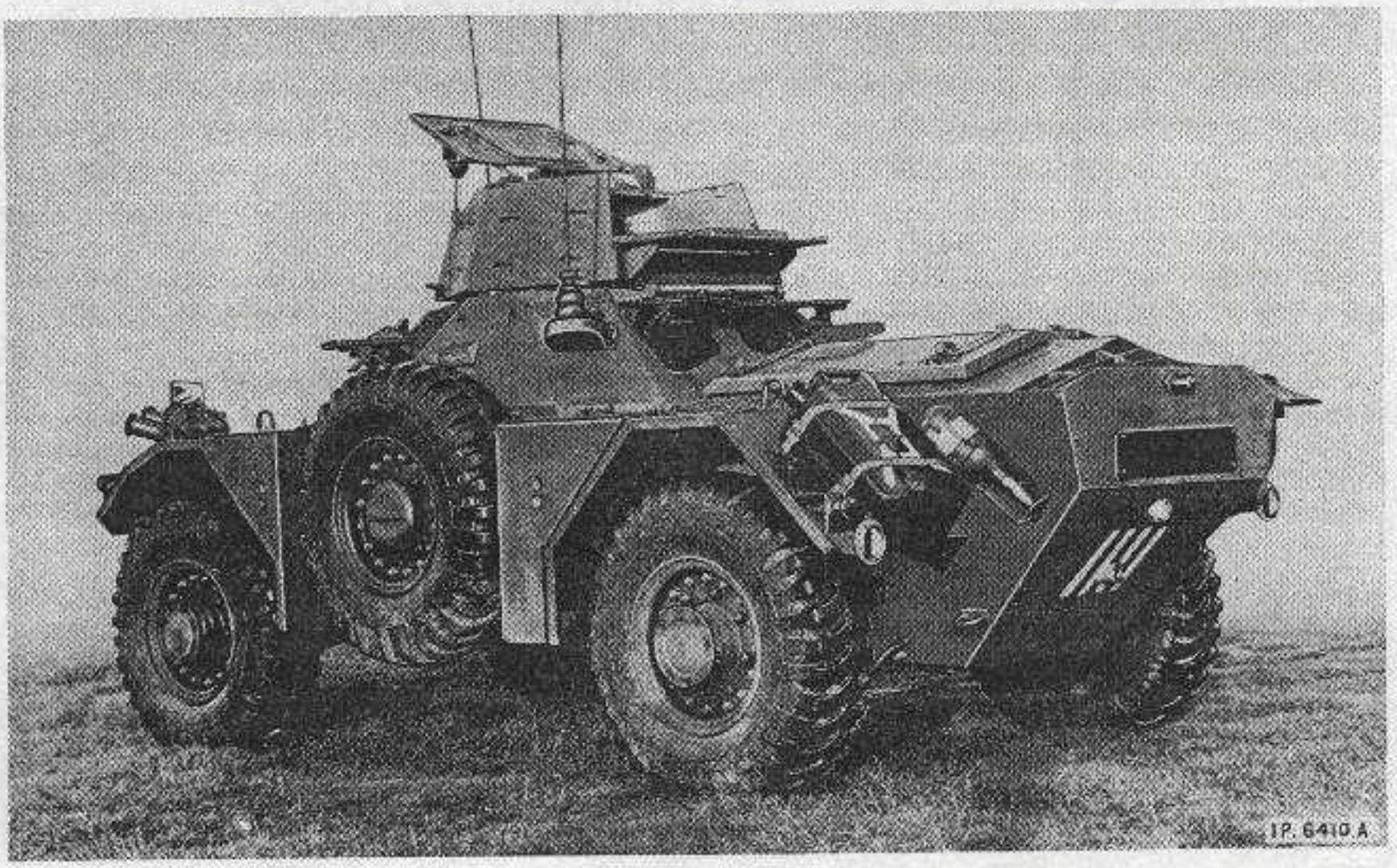


Fig 4 Three-quarter rear left view of Mk 2 reconnaissance vehicle

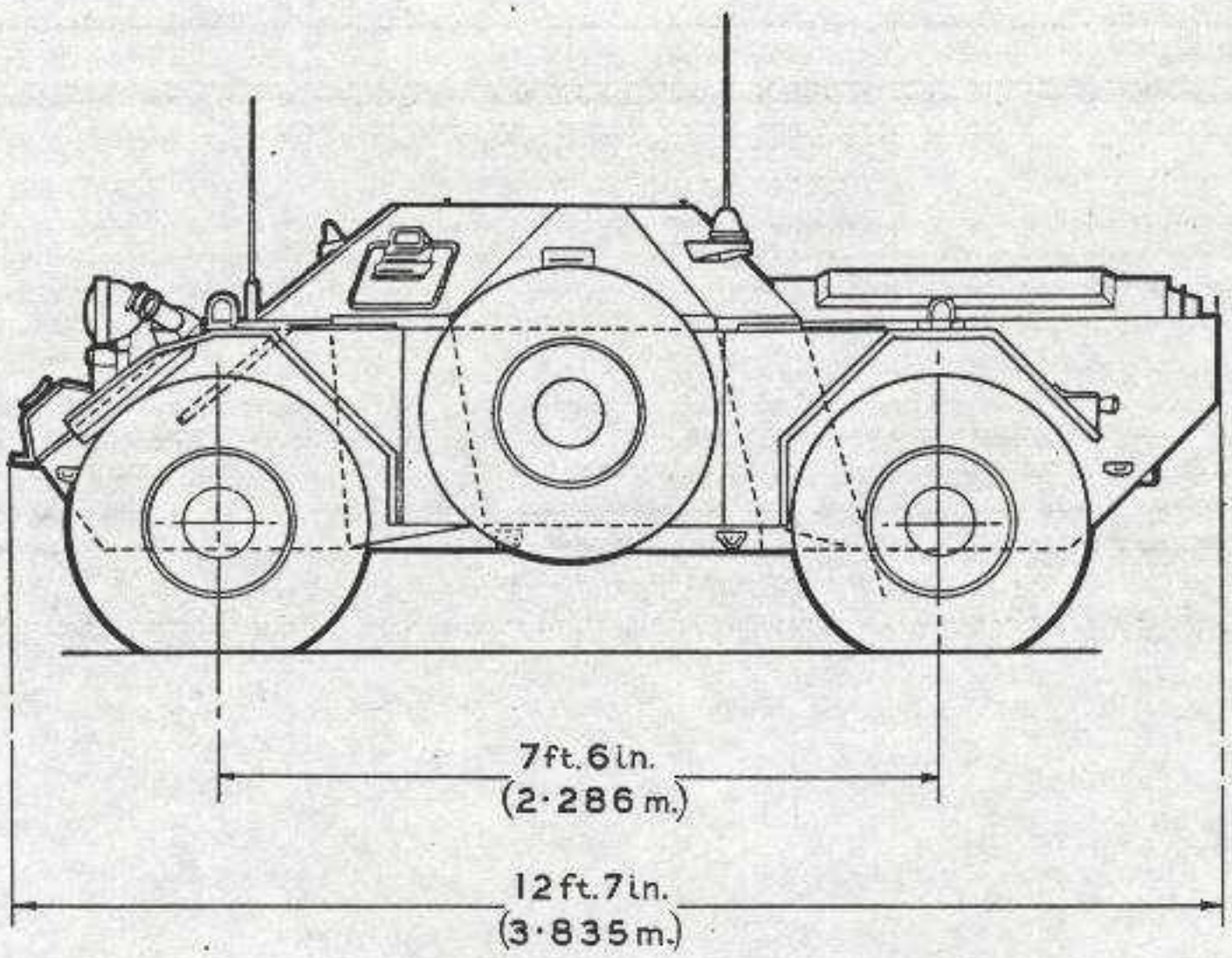
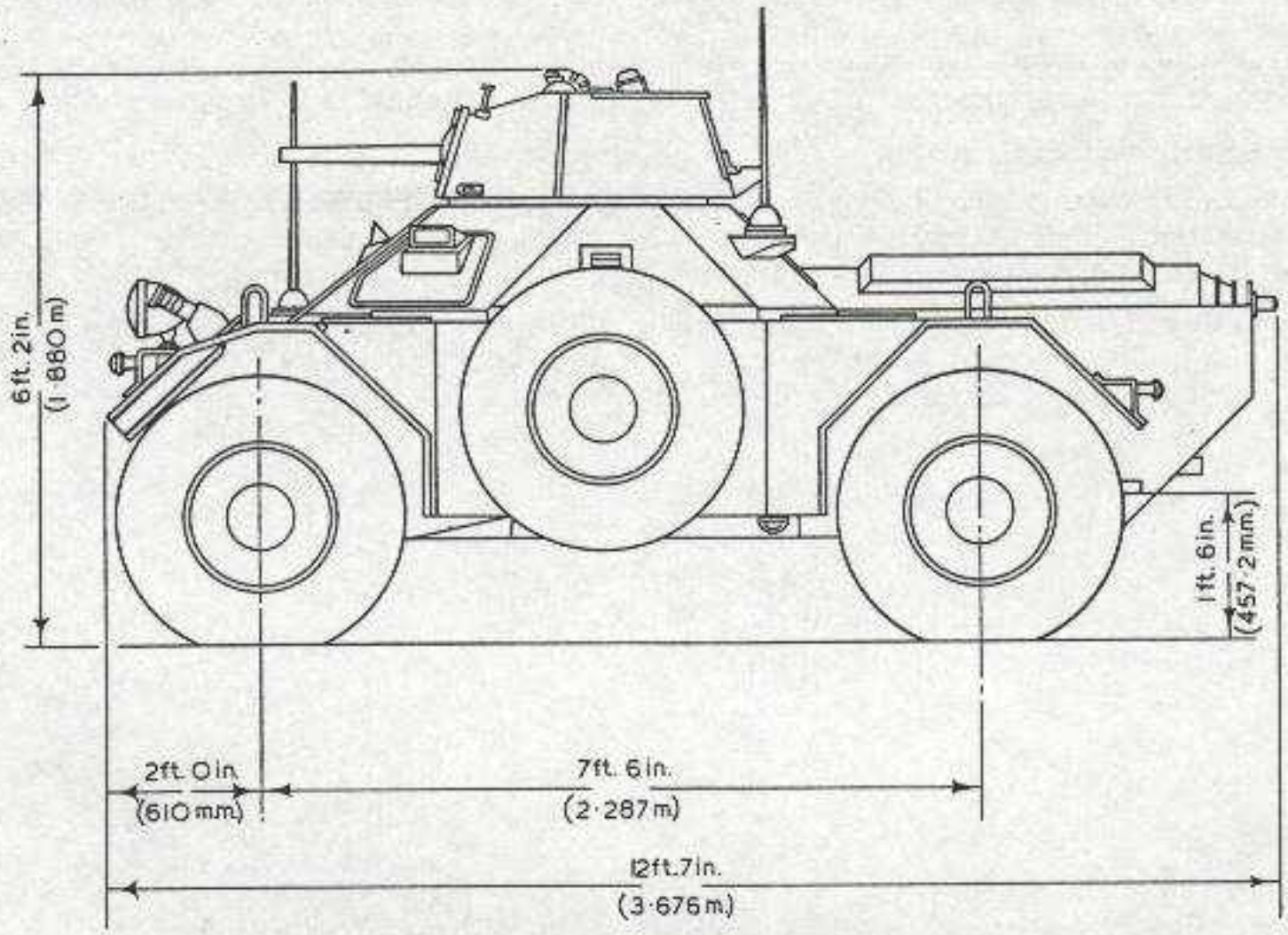


Fig 5 Vehicle dimensions - Mk 1 liaison vehicle



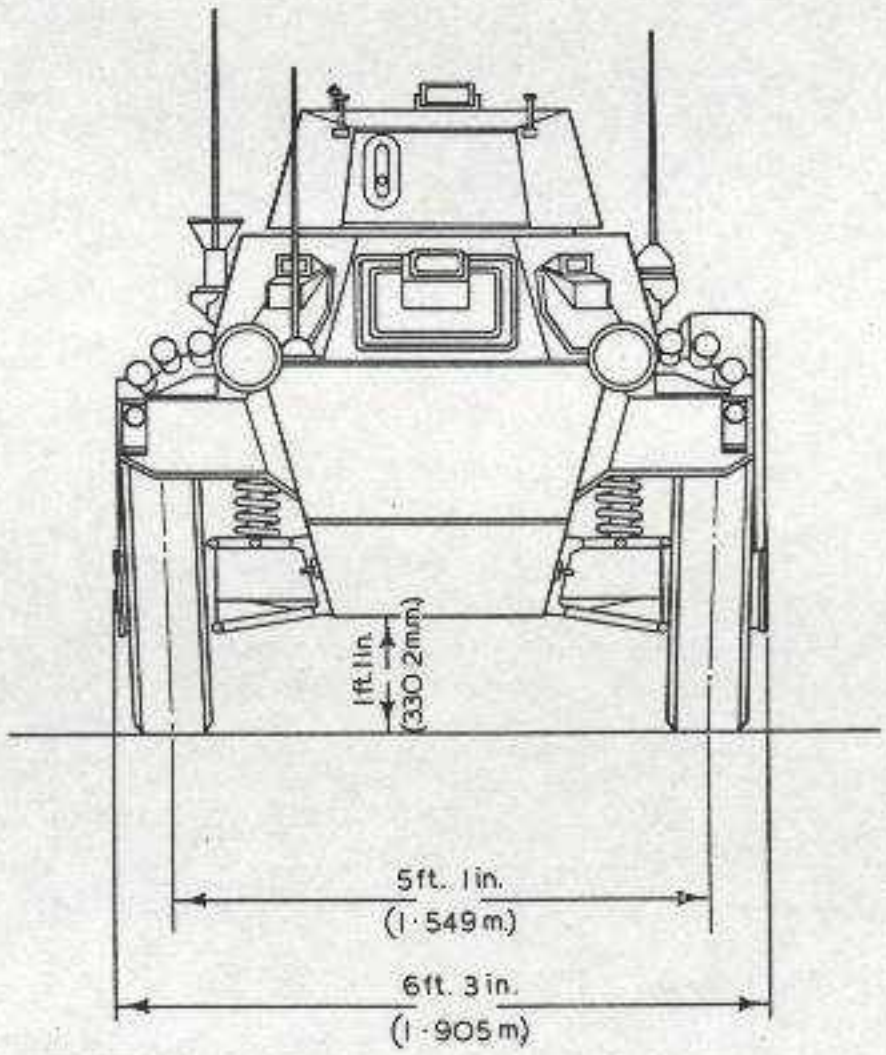


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Fig 6 Vehicle dimensions - Mk 2 reconnaissance vehicle

TECHNICAL DATA

DIMENSIONS

Liaison vehicle, Mk 1 - see Fig 5
Reconnaissance vehicle, Mk 2 - see Fig 6

WEIGHTS

Liaison vehicle, Mk 1		
Unladen - less all items shown under laden weight		
Total	3 tons 1 cwt	(6,832 lb, 3,099 kg)
Laden - including crew, armament, ammunition, fuel, oil, water, stowage and all equipment		
Front axle	1 ton 16 cwt	(4,032 lb, 1,828 kg)
Rear axle	2 tons 1 cwt	(4,592 lb, 2,083 kg)
Total	3 tons 17 cwt	(8,624 lb, 3,911 kg)
Reconnaissance vehicle, Mk 2		
Unladen - less all items shown under laden weight		
Total	3 tons 11 cwt	(7,952 lb, 3,444 kg)
Laden - including crew, armament, ammunition, fuel, oil, water, stowage and all equipment		
Front axle	1 ton 19 cwt	(4,368 lb, 1,981 kg)
Rear axle	2 tons 6 cwt	(5,152 lb, 2,337 kg)
Total	4 tons 5 cwt	(9,520 lb, 4,318 kg)

SHIPPING TONNAGE

Liaison vehicle, Mk 1	9 tons 13½ cu.ft.
Reconnaissance vehicle, Mk 2	12 tons 2 cu.ft.

BRIDGE CLASSIFICATION 4

FORDING DEPTH

Unprepared	3 ft 0 in.	(0.914 m)
Prepared	5 ft 0 in.	(1.524 m)

ENGINE

Type	B60, No.1, Mk 3A or Mk 6A
Cylinders	6 in line
Bore	3.5 in. (88.9 mm)
Stroke	4.5 in. (114.2 mm)
Capacity	259.78 cu.in. (4.256 litres)
Maximum brake horse power (net)	98 at 3,750 r.p.m.
Maximum torque (net)	195 lb-ft at 2,000 r.p.m.

ENGINE LUBRICATION - external

Oil tank	Incorporated with engine mounting
Oil cooler	Still tube
Oil filter	Full flow element type

Rectifier

292. The rectifier is of the germanium type, see Table 2, and is fitted to the cut-out base. As stated in the previous paragraph the rectifier is connected in series with the cut-out pull-in coil and the relay contacts, thus preventing current from the battery from flowing through the pull-in coil of the cut-out, should the relay be closed, which would result in demagnetization. The relay prevents a permanent reverse voltage from being applied to the rectifier and cut-out coil, thus preventing reverse current from flowing through the coil when the generator voltage falls substantially below battery voltage.

293. Shunted across the rectifier is a 95 ohm resistor (9) which permits a small discharge through the cut-out pull-in coil. These ampere-turns are added to those of the series coil and accelerate the opening of the cut-out to give a clean break. This resistor is also fitted to the underside of the cut-out base.

Switch and fuse assembly

294. The switch and fuse assembly is fitted to one end of the generator panel (Fig 47) and comprises a switch and fuse base (5) and a fuse cover (1).

Switch and fuse base

295. Four screws and spring washers secure the base to the panel. Fitted to the top-side of the base are two fuses and, to the underside, a 1-way switch and a 2-way switch, both of the strip type. The fuses are of 25A (No.23 S.W.G. tinned copper wire) and 5A (No.35 S.W.G. tinned copper wire) rating; they are connected in the main charging circuit and the indicator lamp circuit respectively. Spare fuse wire is carried round each fuse holder and the fuse rating is engraved on each holder and on the base so that there should be no mistake when renewing fuses. Prior to the introduction of MOD. No.5 the fuse wire was No.21 and No.30 S.W.G. tinned copper respectively. Access to the fuses is obtained by removing the fuse cover (1).

296. The 1-way switch (Fig 51(2)) consists of a pre-set beryllium copper contact spring (5) fitted with a silver contact to mate with a silver coated copper contact plate (1) riveted to the base. These contacts are closed when the switch is in the free position. The 2-way switch is similar but the contact spring (6) is fitted with a double-sided contact to mate with another base contact plate and, when the switch is operated, with a contact spring (5) fitted above but insulated from it. Both switches are operated by a plunger (4) made of insulating material located in the centre of the base.

Fuse cover

297. The fuse cover (Fig 52(1)) is an alloy casting with a centrally disposed diaphragm assembly to operate the switch plunger. Four screws and spring washers secure the cover to the generator panel. The beryllium cobalt copper diaphragm (3) is cup-shaped and is soldered to a brass support. Four screws secure a clamping plate (4) and the diaphragm support to the cover. Fitted in the diaphragm cup is a brass buffer plate (7) followed by a helical spring (6) and a brass operating stud (5) the stem of which protrudes through the clamping plate. Fitted in the cover at the other side of the diaphragm is a plunger (8) made of insulating material which touches the switch plunger.

Operation

298. The small generator fording cap locates over the end of the operating stud and the larger cap screws on a brass adaptor screwed and pin dowelled to the fuse cover. This presses the smaller cap against the operating stud to flex the diaphragm which in turn pushes the diaphragm and switch plungers to operate the switches. Adjustment is made by means of shims (2) which together with a gasket are fitted between the diaphragm support and the cover.

299. With the fording caps in position on the generator panel the base contacts of the two switches are open circuited and the indicator lamp and its fuse are connected to the generator positive connection via the top contacts of the 2-way switch. When the caps are removed the 2-way switch operates to break this circuit and to connect the indicator lamp to earth. The lamp lights and gives visual warning to the driver. The 1-way switch closes and brings into circuit the limitation shunt coil of the regulator which limits the generator output to 6A as described under "Regulator". The caps should not be removed from the panel in this vehicle, see para 235.

Suppressor capacitors

300. The two suppressor capacitors are of the bushing type and are connected in the generator field and armature leads; they are of 0.1 and 0.25 μF capacity respectively.

Plug and socket connectors

301. There are two plug and two socket connectors to the panel. Socket (Fig 47(12)) receives the generator plug. Plug (16) receives the vehicle battery and ignition socket. Plug (13) is the output connection for charging radio batteries when fitted, and socket (14) is the connection for a battery thermal switch (see para 276). Plug (13) and socket (14) are not normally used in this installation and are therefore fitted with waterproof protection caps (15) and (17).

General

302. Sealing is effected by fitting sealing rings and seals to the various covers. Seals are treated with silicone sealing compound on assembly.

303. Two plugs are fitted to the front cover to permit the usual waterproof test to be made.

304. The design of the regulator is such that the panel must be mounted with the axis of the carbon pile horizontal and there must be no restriction to air circulating through the cooling fins.

305. When the main fuse blows the cut-out opens due to reverse current flowing through the generator field and associated shunt circuits via the cut-out series coil (Fig 43). These circuits will also complete the indicator lamp circuit and the lamp will light to show that the generator has ceased to charge. With the cut-out closed the lamp is short-circuited.

Modifications

306. A modification record plate is fitted to the panel and the approved modifications are listed in Table 1.

Mod. No.	*Detail*
1	Introduction of stabilizing windings in the regulator current unit.
2	Regulator top cover plate secured by six bolts instead of four.
3	Fitting an insulating washer between the voltage regulator ballast resistor and the support plate.
4	Addition of non-magnetic shim to the pole face of the cut-out to prevent the armature sticking and to reduce risk of failure through vibration, para 288.
5	Fuse wire No.23 and No.35 S.W.G. supersedes No.21 and No.30 S.W.G. tinned copper, para 295.
6	Cut-out series turns increased from $3\frac{3}{4}$ to $14\frac{3}{4}$ to prevent cut-out failure due to vibration and to minimize danger of demagnetization due to external faults.
7	Introduction of Araldite bonded rectifier superseding solder bonded type to prevent failure when operating under high ambient temperatures.

Table 1 Modifications of generator panel No.2, Mk 1

GENERATOR PANEL No.2, MK 2/1 - FV175871 (Fig 53 and 54)

307. Generator panel No.2, Mk 2/1 is an alternative to the No.2, Mk 1 and is very similar to it.

308. The regulator and the two resistors are identical but the introduction of the stabilizing windings in the current unit is identified by the erasure of No.2 from the modification record plate.

Cut-out base assembly (Fig 55)

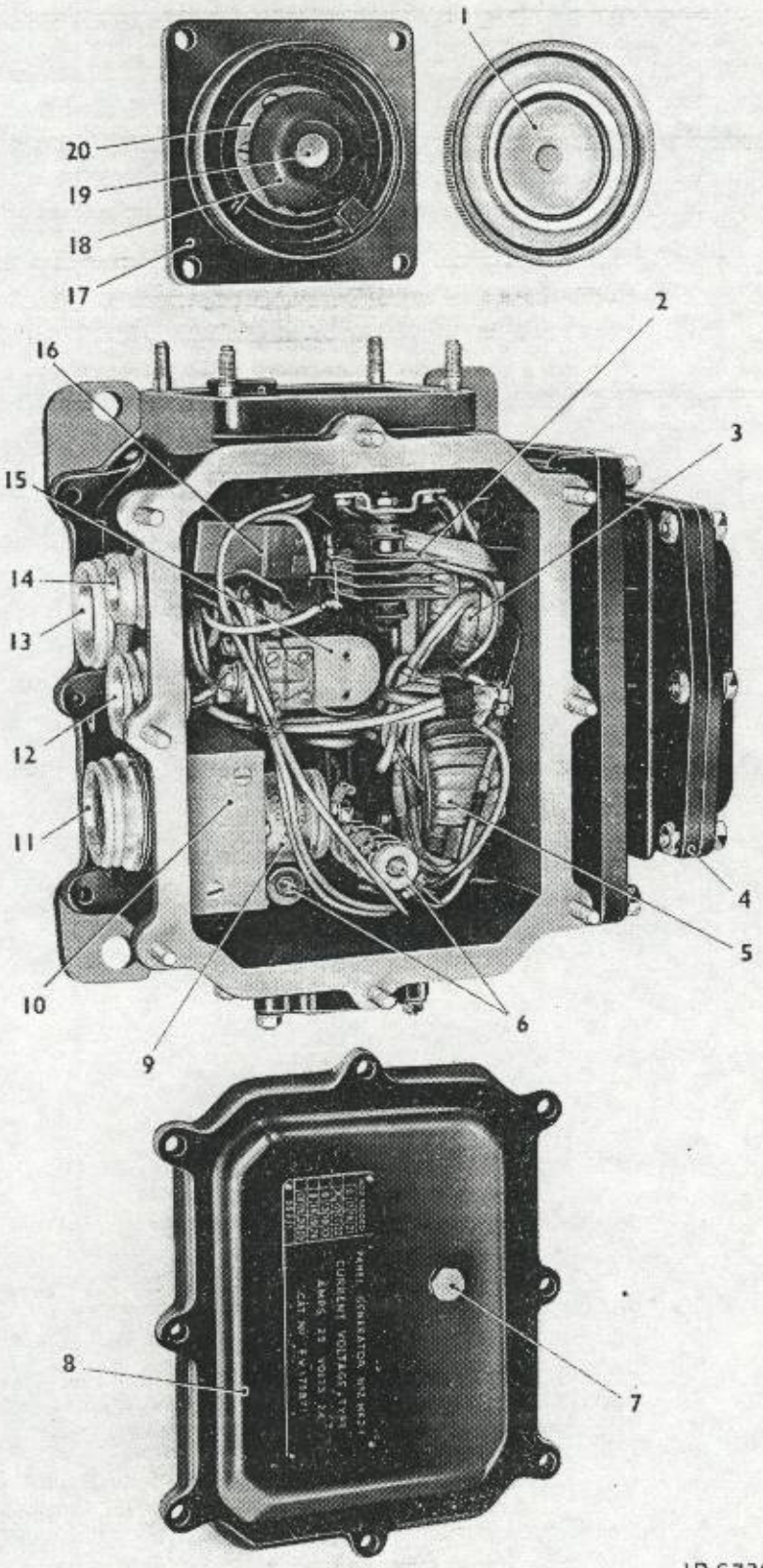
309. The cut-out base assembly comprises a cut-out (1) relay (2) two resistors, two bushing capacitors (4) and (5) and a screening box. The rectifier (3) is fitted adjacent to the base.

Cut-out

310. The cut-out is of the normal open type and is not polarized. It consists of three coils - shunt, series and auxiliary - wound on one former and mounted on an angle frame along the top of which is fixed the armature hinge spring. A stop plate fitted above the armature controls its upward movement.

311. The cut-out is fitted with two pairs of contacts - main and a spring type secondary. The moving contacts are attached to the armature. The stationary contacts are fitted to, but insulated from, the frame. They are adjustable. A pressure spring fitted to the armature controls its operating voltage, and an adjusting screw is provided to vary the spring pressure.

312. The shunt coil has a resistance of 278 $\pm$ 13 ohms and is connected across the generator terminals (Fig 43). The series coil consists of a few turns of heavy gauge wire connected in the generator positive lead and in series with the cut-out contacts. The auxiliary winding has a resistance of 1.77 $\pm$ 0.17 ohms, and is connected in series with a metal rectifier and with the contacts of a relay across the positive connections of the generator and of the vehicle battery.



1 Fording caps

2 Rectifier

3 Current unit

4 Regulator assembly

5 Voltage unit

6 Resistors

7 Waterproof test plug

8 Front cover

9 Capacitor

10 Screening box

11 Generator connection socket

12 Radio battery connection plug

13 Vehicle battery and ignition connection plug

14 Battery thermal switch connection socket

15 Cut-out

16 Relay

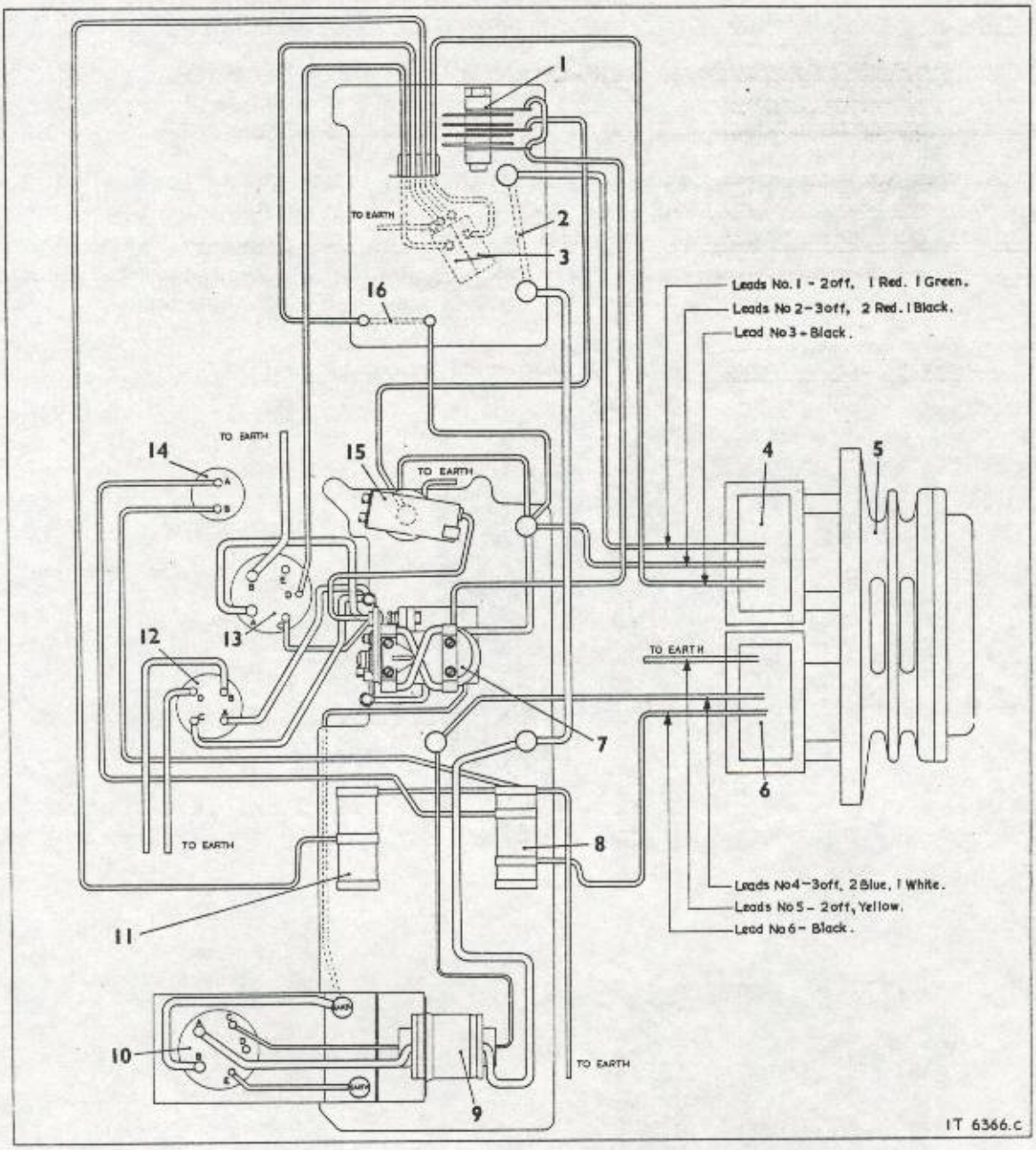
17 Fuse cover

18 Rubber moulding

19 Guide

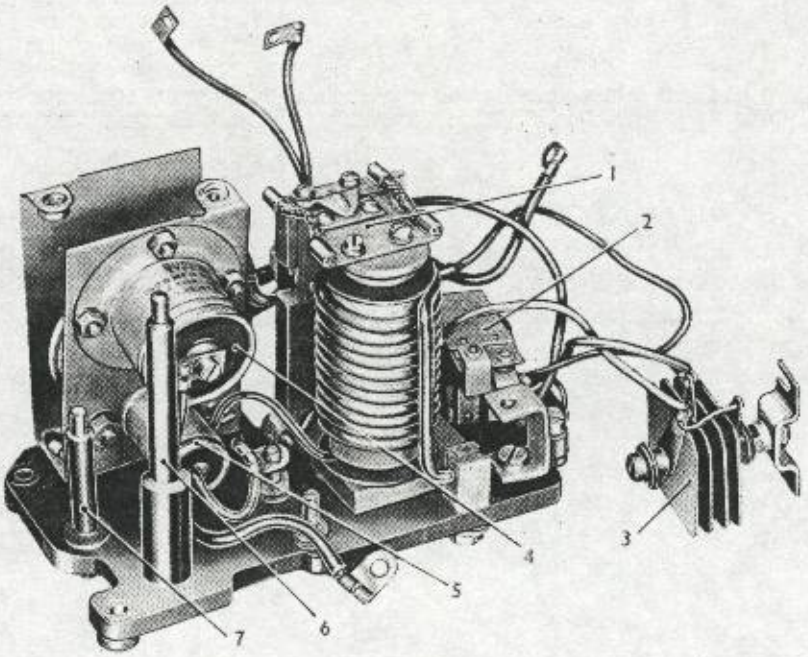
20 Clamp plate

Fig 53 Generator panel No.2, Mk 2/1



1 Rectifier
2 Main fuse
3 Microswitch
4 Current unit
5 Carbon pile regulator
6 Voltage unit
7 Cut-out
8 Voltage ballast resistor
9 0.1 μF capacitor
10 Generator connection socket
11 Current limitation trimmer resistor
12 Radio battery connection plug
13 Vehicle battery and ignition connection plug
14 Battery thermal switch connection socket
15 Relay
16 Warning lamp fuse

Fig 54 Generator panel No.2, Mk 2/1 wiring diagram



1 Cut-out
2 Relay
3 Rectifier
4 0.25 μF bushing capacitor
5 0.1 μF bushing capacitor
6 Ballast resistor pillar
7 Trimmer resistor pillar

Fig 55 Cut-out base assembly - generator panel No.2, Mk 2/1

313. The cut-out is set to cut-in at 27.5-28.0V, and to cut-out at a reverse current of 2A at 27.0V.

Relay

314. The relay is similar to that fitted to the Mk 1 panel. Its coil has a resistance of 200 ± 10 ohms and is connected across the generator terminals. The relay operates to close its contacts when the generator voltage reaches 16-18V and opens when the generator voltage falls to 6.0-8.0V. It is fitted to prevent a permanent current leakage through the rectifier when the cut-out is open.

Operation

315. As the generator commences to rotate and the voltage builds up, the relay closes to complete the circuit of the cut-out auxiliary winding. The rectifier prevents a reverse current flowing through this winding which would hinder the closing of the cut-out.

316. When the generator voltage exceeds that of the vehicle battery, forward current flows through the cut-out auxiliary winding and helps the cut-out shunt winding to close the cut-out. The secondary contacts close first and connect the generator to the radio battery plug; closing the main contacts connects the generator to the vehicle battery and short circuits the auxiliary winding.

317. As the generator voltage drops when slowing down, reverse current flows through the cut-out series winding to cause the cut-out to open and isolate the generator from the batteries. When the generator volts drop to 6.0-8.0V the relay opens to isolate the rectifier and the cut-out auxiliary winding from the battery.

Switch and fuse assembly

318. The switch and fuse assembly (Fig 56) has the same operational function as that fitted to the Mk 1 panel but is different in detail.

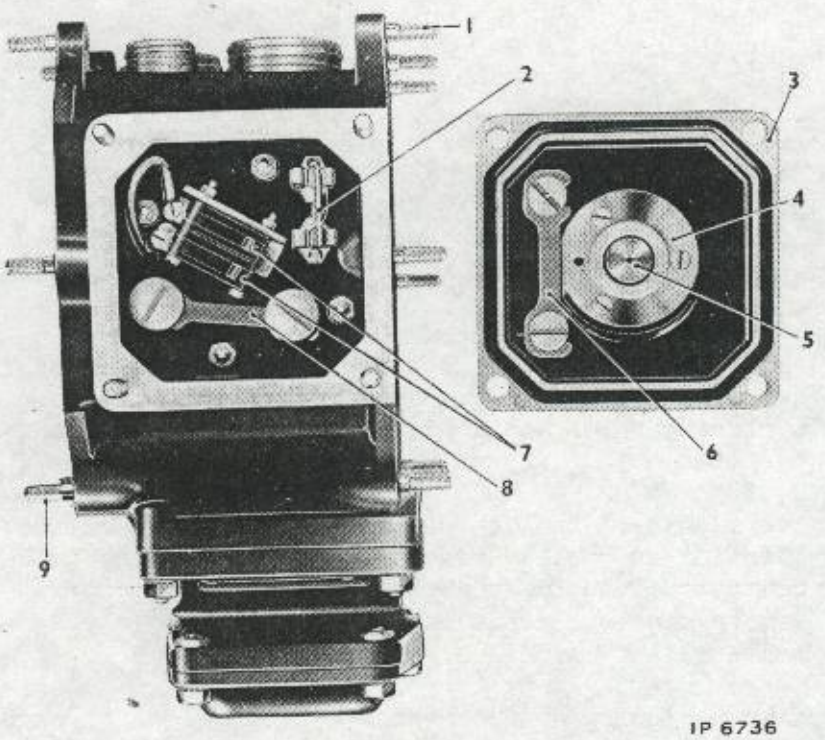
Switch and fuse base

319. The base is secured to the panel by four screws with shakeproof washers and nuts, and is fitted with two fuses and two micro switches (7) on its topside. The main fuse (8) is a 50A strip fuse (10 sec fusing rating) and the warning lamp fuse (2) is rated at 5A (No.30 S.W.G. tinned copper wire).

Fuse cover

320. The fuse cover (3) is located on four studs to which it is secured by nuts and shakeproof washers. Fitted to this cover is a plunger assembly, which operates the micro switches, and three spare main fuses (6); spare fuse wire for the indicator lamp circuit is wrapped round the fuse holder.

321. The plunger assembly (Fig 57) consists of a spring-loaded guide (2) with a rubber cup-shaped moulding (3) bonded to it, an over-run spring (7) and a plunger (8) located in the bore of the guide. The moulding is secured to the outer face of the fuse cover by a clamp plate (4) and six countersunk head screws. The moulding supports the guide, which slides in the fuse cover, and also seals the unit. Three countersunk head screws secure a retainer (6) to the inner face of the fuse cover to restrict the plunger travel.



1 Backplate stud
2 Warning lamp fuse
3 Fuse cover
4 Retainer
5 Plunger
6 Spare main fuse
7 Micro switches
8 Main fuse
9 Front cover stud

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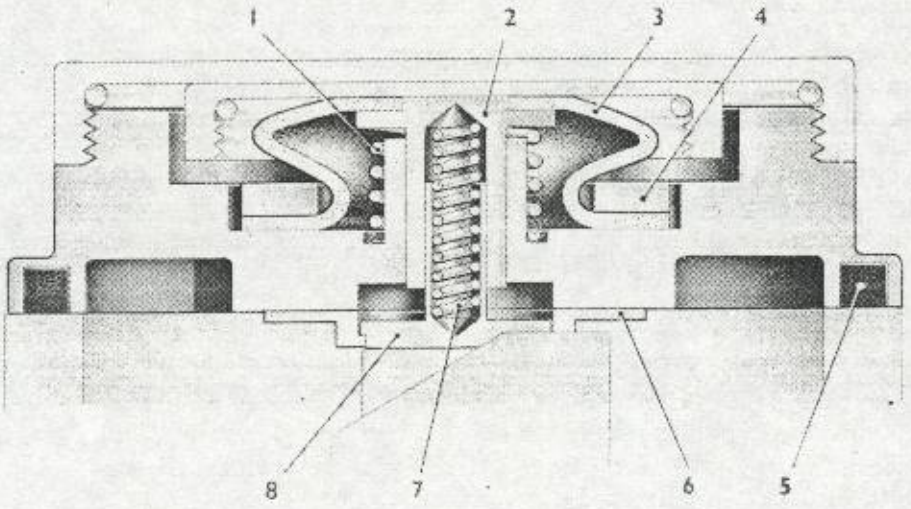
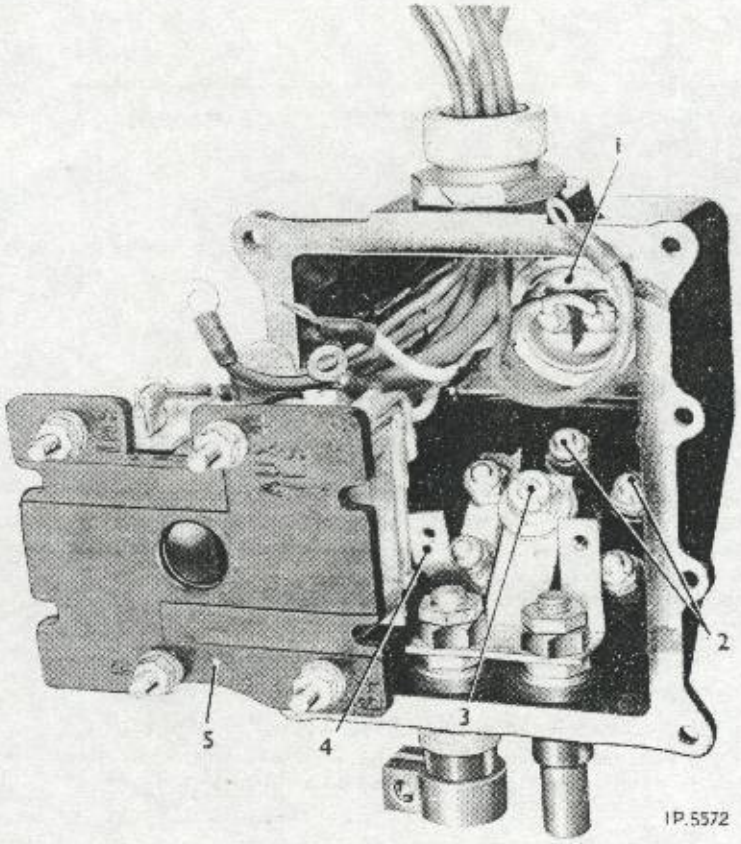
Fig 56 Switch and fuse assembly - generator panel No.2, Mk 2/1



1 Guide return spring
2 Guide
3 Rubber moulding
4 Clamp plate
5 Seal
6 Retainer
7 Overrun spring
8 Plunger

Fig 57 Fuse cover - generator panel No.2, Mk 2/1



1 Inspection lamp socket
2 Studs securing inter-vehicle starting socket
3 Positive terminal of inter-vehicle starting socket
4 Inter-vehicle starting socket negative connector
5 Circuit breaker base assembly

Fig 58 Distribution box No.1, Mk 1 with base removed and circuit breaker base withdrawn

Operation

322. When the fording caps are fitted to the panel the guide is pressed inwards against the effort of the return spring and this movement is transmitted to the plunger via the over-run spring and so operates the switches. The over-run spring permits the follow through of the guide without damage to the switches. When the caps are removed the return spring pushes the guide outwards to release the pressure from the switches. The effect of these switch operations is as described for the Mk 1 panel in para 299.

Plunger assembly, early panels

323. On panels not incorporating MOD. No.3, the plunger assembly consists of a spring-loaded rubber diaphragm fitted on one side with a spring-loaded, flat-headed screw which operates the switches, and with an operating stud on the other side. The switch operating screw and a spring and buffer plate are housed in a sleeve fixed to the diaphragm. The screw is captive and spring-loaded to permit follow-through of the diaphragm without damage to the switches.

Modifications

324. A modification record plate is fitted and the approved modifications are listed in Table 2.

Mod. No.	*Detail*
1	Connections from cut-out to vehicle and radio batteries reversed.
2	Introduction of stabilizing windings in the regulator current unit.
3	Fuse cover modified incorporating an improved switch plunger assembly.
4	Earth leads taken to common earth point to improve suppression.
5	Sealing gasket grooves transferred to lids to facilitate production.
6	Fitting of protection caps for radio battery and battery thermal switch outlets.
7	Regulator top cover plate secured by six bolts instead of four.
8	Glossy finish of panel changed to matt black to promote cooler running of regulator.
9	Earth leads of vehicle and radio battery plugs shortened to reduce radio interference

Table 2 Modifications of generator panel No.2, Mk 2/1

DISTRIBUTION BOX No.1, MK 1 - FV157930

325. The distribution box (Fig 58) is of cast aluminium waterproof construction consisting of a base and a body clamped together by nuts and shakeproof washers fitted to eight base studs. A rubber seal is fitted to the mating face of the base. A plug and washer are fitted in the body to permit the application of the standard waterproof test.

326. The battery and generator cables are connected to the box from whence voltage is distributed to the various electrical components. The positive battery cable is fitted with a shrouded socket which fits on a heavy-duty plug B+ embodied in the box. A clamp fitted round the socket secures it to the plug. The shroud prevents short circuiting the battery should the cable be disconnected from the box. A similar

arrangement but reversed i.e., with a heavy-duty shrouded socket S+ fitted to the box, is used to connect the starter motor positive cable to the box.

327. The box is fitted with two earthing studs to one of which is connected the battery and starter negative cables and to the other the negative lead from the windscreen wiper socket, and an earthing braid which is connected, together with the negative lead from the wireless set junction box, to a vehicle earth stud located just forward of the generator panel.

328. Leads for other connections to the box are brought out through a rubber bung located in a gland fitted to the top of the box. These leads are terminated by nipple connectors.

329. The box is secured by nuts and washers fitted to the two earthing studs and by bolts with nuts and washers fitted to two clearance holes.

330. Incorporated in the box are an inspection lamp socket (1) an inter-vehicle starting socket and a circuit breaker base assembly (5). Protecting covers secured by chains are supplied for the sockets when they are not being used or when fording.

Inter-vehicle starting socket

331. The inter-vehicle starting socket is fitted to assist in starting the engine when the batteries become discharged. It consists of two concentric contact sleeves; the inner is positive and insulated, the outer is negative and earthed.

332. The positive contact consists of a tinned brass socket in which is located a funnel-shaped beryllium-copper contact sleeve. The outer face of the sleeve is flanged to seat on the face of the socket to which it is secured by an endplate and four screws. Eight slots cut in the funnel end of the sleeve ensure a good spring connection. The socket incorporates a screwed stem (3) to which is secured a connecting link from the battery positive terminal.

333. The positive contact assembly is located inside a bakelite cup-shaped moulding over which fits the tinned brass negative contact sleeve fitted with six studs (2) for mounting to the box. An insulating washer is fitted between the positive contact endplate and the turned-over end face of the negative contact sleeve. A sealing gasket is fitted between the mating faces of the negative sleeve and the box.

Circuit breaker base assembly

334. Four screws with plain and shakeproof washers secure the circuit breaker base assembly (Fig 59) in the box. Fitted to the base are two circuit breakers, one, type QA3, is rated at 30A and the other, type QA5, at 10A. Circuits protected by these units are enumerated in para 237.

Circuit breakers

335. Each circuit breaker (Fig 60) consists of two contacts connected in series with the circuit it is protecting. One contact is mounted on a bi-metal strip (3) and the other on a spring-loaded hinged armature (2) which forms part of the magnetic circuit of a fairly high resistance (178 ohm $\pm$ 7%) coil (1) connected across the contacts.

336. The bi-metal strip together with a stop (4) are riveted to an angle bracket (16) which is secured to one pole piece (13) of the unit by two screws. The top of the bracket is drilled and tapped (20) to receive a terminal screw. Bushes and washers insulate the bracket from the pole piece. The stop is shaped to limit both the upward and the downward movement of the strip.

COOLING SYSTEM

Radiator	Gilled tube
Fan	12 blades
Circulation	Thermo-siphon, impeller assisted

FUEL SYSTEM

Fuel filter	Element type
Air cleaner	190 c.f.m.

FLUID FLYWHEEL (COUPLING) ... Open circuit type

GEARBOX ... 5-speed pre-selective type

GEARBOX RATIOS

	Early Mk 1 liaison vehicles	Later Mk 1 liaison vehicles and all Mk 2 reconnaissance vehicles
1st	5.666 : 1	6.046 : 1
2nd	4.170 : 1	4.381 : 1
3rd	2.375 : 1	2.437 : 1
4th	1.527 : 1	1.569 : 1
5th	1 : 1	1 : 1

TRANSFER BOX

Type	Spiral bevel and helical gears incorporating differential and sliding dog for forward and reverse.
Ratio	1.347 : 1

BEVEL BOXES

Type	Spiral bevel
Ratio	1.923 : 1

HUB REDUCTION GEAR

Type	Epicyclic
Ratio	2.400 : 1

OVERALL RATIOS (engine to roadwheels)

	Early Mk 1 liaison vehicles	Later Mk 1 liaison vehicles and all Mk 2 reconnaissance vehicles
1st	35.225 : 1	37.580 : 1
2nd	25.924 : 1	27.240 : 1
3rd	14.765 : 1	15.150 : 1
4th	9.493 : 1	9.754 : 1
5th	6.217 : 1	6.217 : 1

MAXIMUM SPEEDS - based on later vehicle ratios

1st	9.6 m.p.h.	(15.4 km.p.h.)
2nd	13.23 m.p.h.	(21.3 km.p.h.)
3rd	23.8 m.p.h.	(38.3 km.p.h.)
4th	36.34 m.p.h.	(58.5 km.p.h.)
5th	58 m.p.h.	(93.3 km.p.h.)

1 Circuit breaker
Type QA3 (30A)

2 Circuit breaker
Type QA5 (10A)

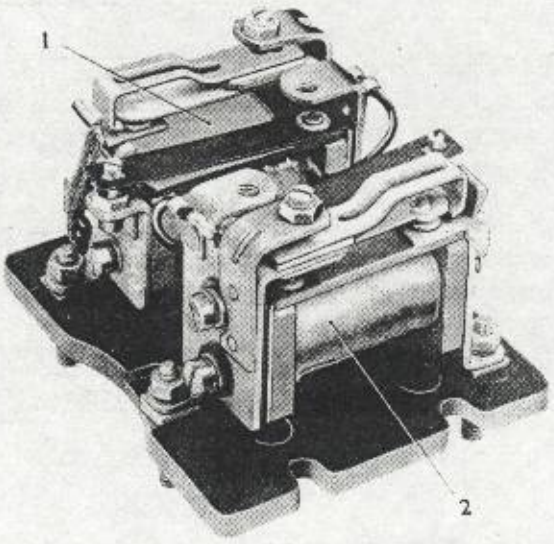


Fig 59 Circuit breaker base assembly - distribution box No.1, Mk 1

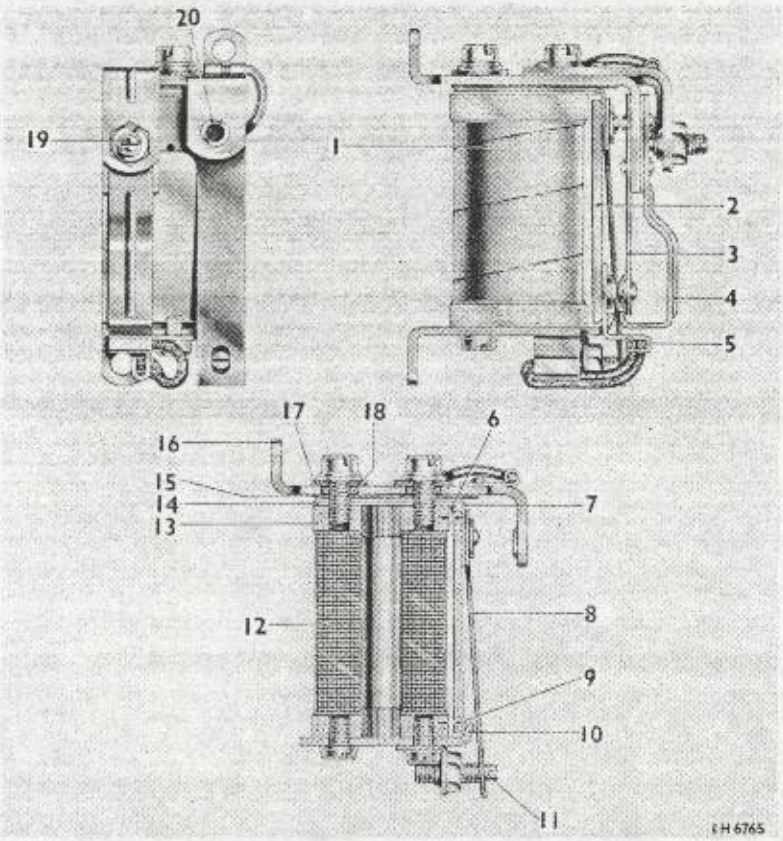
337. The armature (2) and control spring (8) are riveted to an angled hinge piece (7) which is secured by the two screws securing the bi-metal strip assembly but, in this instance, the armature assembly is not insulated from the unit. A flexible connection is soldered to tags fitted to the armature and to the unit, the armature tag (5) being secured by the contact rivet. The control spring is of the strip type; its free end is slotted to rest on the shoulder of an adjusting screw (11) which screws into a fixed bracket. The pressure is adjusted so that the armature will pull in from its stop when 8.5-9.0V is applied to the coil; in this position the bi-metal strip should be just clear (0.002 in. approx.) of its stop. The armature stop (10) is fitted to the unit adjacent to the free end of the armature, the upward movement of which it is shaped to restrict.

338. The 30A unit has gaps of 0.002-0.004 in. and 0.041-0.043 in. between the core and the back and front of the armature respectively. The 10A unit has equivalent gaps of 0.002-0.004 in. and 0.029-0.031 in. They may be adjusted respectively by moving the armature and the armature stop plate after slacking off the fixing screws.

339. The contacts are set to have a gap of 0.007 in.-0.008 in. when the armature is held down on to the core. Adjustment is effected by a screw (19) which presses on top of the bi-metal strip stop.

340. Under normal working conditions the coil is short-circuited by the contacts. When a fault occurs the current through the contacts increases, the bi-metal strip is heated and bends away from the armature thus separating the contacts. The coil is therefore connected directly in series with the fault and the fault current is reduced to safe limits. The current through the coil creates a magnetic field which attracts and holds the armature to the coil pole pieces. Since no current is now carried by the bi-metal strip this cools down and resumes its normal position, but does not make contact because the armature carrying the second contact is held down by the coil. This condition remains until the fault is cleared when the current will be reduced and the armature released. In heavily loaded circuits a normal current may be sufficient to hold the armature to the pole pieces and in this case the armature will not be released until the circuit is switched off.

341. The 30A unit will carry 35A continuously for 15 minutes without operating but will operate within 15-50 seconds when 60A is passed through it. The 10A unit will carry 11A for 15 minutes but will operate within 10-25 seconds when 20A is passed.



1 Coil
2 Armature
3 Bi-metal strip
4 Bi-metal strip stop
5 Armature connection tag
6 Hinge gap
7 Armature hinge
8 Control spring
9 Armature gap
10 Armature stop
11 Pressure adjusting screw
12 Coil
13 Pole piece
14 Distance piece
15 Insulator
16 Angle bracket
17 Insulating washer
18 Insulating bush
19 Contact gap adjusting screw
20 Terminal plate

Fig 60 Circuit breaker - distribution box No.1, Mk 1

SWITCHBOARD No.1, MK 1 - FV157924

342. The switchboard (Fig 61) is a flange-mounted, waterproofed unit. It houses an ignition (control) switch (6) starter switch (8) lamp switch (7) panel lamp switch (5) oil pressure warning lamp (9) and a main indicator lamp (2) which, except the panel lamp switch, are fitted to a bakelite base located in a die-cast housing (4) by two dowel pins and secured by three screws. Six studs with nuts and spring washers are fitted to the back of the body for securing a cover and gasket.

343. The back cover (1) is fitted with two cable entries each comprising a sealing ring, tag washer, gland, washer and locking ring, and with a plug and washer to permit the standard waterproof test to be applied.

Ignition switch

344. LOCK, OFF and ON are the three positions of the combined magneto and coil ignition switch (6) which is fitted with a barrel type lock. With the ignition key inserted in the lock the switch can be turned to any position. If the key is removed when the switch is in the LOCK position the switch cannot be moved. If the key is withdrawn when the switch is in the OFF or ON position the switch can be turned only to the ON or OFF position. The key is not intended to be turned and no attempt should be made to turn it.

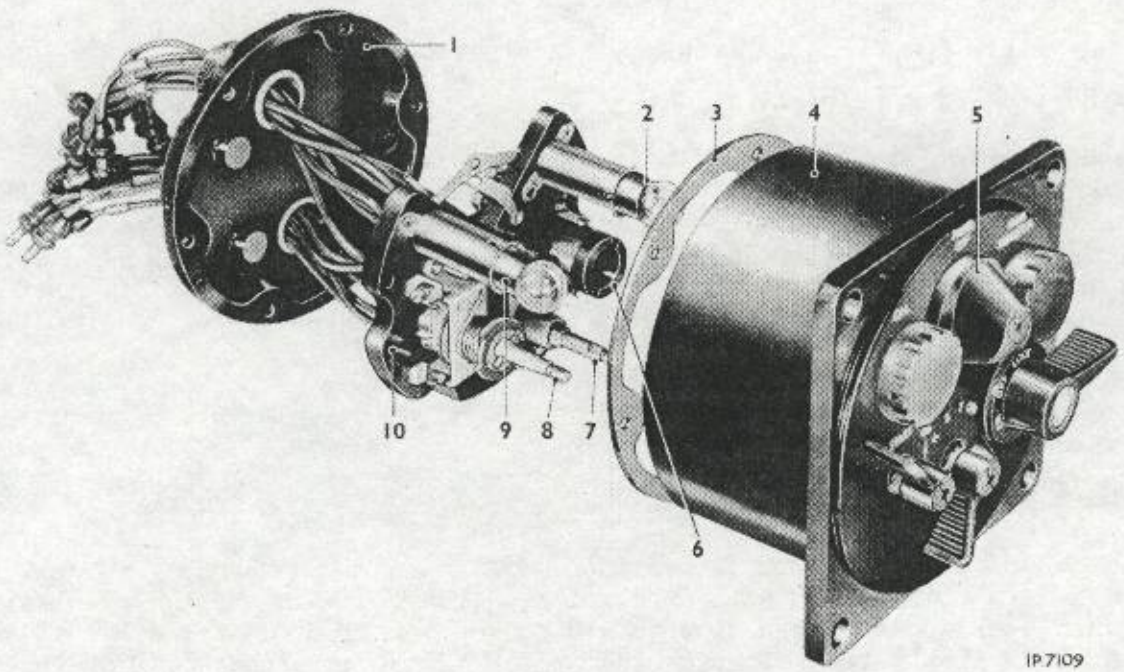
345. The switch comprises a bakelite rotor with a moulded-in brass slipring which wipes three vertical contacts (two long, one short) fixed to the base. The short contact is connected to earth and the other two are magneto L.T. connections. The slipring is stepped in width and does not completely encircle the rotor. This section of the switch is not used in this installation.

346. The underside of the rotor is slotted to engage a contact plate fitted with two brass spring-loaded contacts and a centrally disposed pivot pin which is located in a hole in the switchboard base. The base is fitted with two diametrically opposite contact bushes in which the contacts locate when the switch is ON. Four dimples machined in the base locate the contacts in the OFF and LOCK positions of the switch. This section of the switch constitutes the coil ignition switch.

347. A spring ring retains the switch handle in a brass bush which is secured to the housing by a nut. Waterproofing is effected by sealing rings and washers. Two projections on the handle engage a spring plate and also slots cut in the top of the rotor; complete rotation is prevented by the projections abutting a fixed locking plate. A helical spring fitted between the plate and the rotor maintains pressure on the coil ignition contacts.

348. The switch is assembled so that when the switch is OFF, the rotor slot is horizontal, the wide section of the slipring is engaging the earth contact and the narrow section the two magneto contacts. The coil ignition contact plate is located in the two vertically disposed dimples. In the ON position the magneto contacts are isolated from each other and the coil ignition contact bushes are bridged by the contact plate.

349. With the switch in the ON position battery current is fed from the switch to the ignition circuit and also through the distribution box 10A circuit breaker to the engine electrical auxiliary equipment, i.e., to the starter switch, main indicator lamp, coolant thermometer, fuel gauge, oil pressure switch and instrument panel lamp (Fig 66).



1	Cover	6	Control switch
2	Indicator lamp	7	Lamp switch
3	Gasket	8	Starter switch
4	Housing	9	Oil pressure warning lamp
5	Instrument panel lamp switch	10	Base assembly

Fig 61 Switchboard No.1, Mk 1

Starter switch

350. The starter switch (Fig 61(8)) is of the spring-loaded semi-rotatable type consisting of a rotor fitted with two contact drums which wipe three spring contacts. The drums are in contact with each other, but are insulated from the spindle by bushes and washers. One drum is shaped to cover the bottom of the rotor assembly and has a centrally disposed protrusion which forms a bearing for the rotor. This bearing locates on a spring-loaded plunger fitted to the base, and the centre of the rotor locates in a U-shaped support.

351. Fitted to the rotor beneath the support is an index plate shaped to engage a pin riveted to the support so as to limit the rotor movement. Located on the support is a helical return spring and supporting collar and fitted to the square-sectioned rotor spindle above the collar is another index plate followed by a plain washer and a securing pin. The ends of the spring are anchored in holes in the support and index plate. Alternative holes for the spring are provided but usually the spring is fitted to exert the maximum return effort to the switch.

352. The rotor spindle passes through a hole in the housing, the hole being sealed by two sealing washers and a plain washer; a spring ring retains the washers in position in the housing. The switch handle is secured to the spindle by a special screw.

353. The three contacts are connected to the vehicle supply via the ignition switch and 10A circuit breaker, to the starter solenoid and to the ignition side of the ballast resistance respectively. With the switch operated the contacts are connected, the starter solenoid is energized and the ignition ballast resistance short-circuited (Fig 45).

Lamp switch

354. The lamp switch (Fig 61(7)) is similar to the starter switch but is not spring-loaded. It controls the external lamps and has positions, OFF, T, S and H.

355. The rotor bearing engages a bearing bush which is connected to the AUX+ terminal, this terminal being connected to the vehicle supply via the 30A circuit breaker located in the distribution box. The three fixed contacts are connected to terminals T, S and H respectively.

356. The switch positions are determined by a steel ball located in a hole in the support plate. The ball engages one of four holes in the index plate. A spring plate bolted to the support presses against the ball.

357. Turning the switch to the T position energizes the convoy lamp. Advancing the switch to the S position brings into circuit the side lamps, tail lamps and the number plate lamp. The final position H of the switch brings the headlamps into circuit and all external lamps are then energized (Fig 62).

Instrument panel lamp switch

358. The remaining switch (Fig 61(5)) controls the instrument panel lamp. It is of the rotating type and is a combined off and five position dimmer switch which enables the driver to vary the intensity of panel lamp illumination to suit operational requirements.

359. This switch (5) consists of a body, rotor and cover with operating knob. The moulded cylindrical body is wound externally with Glowray resistance wire (500 ohms) which is tapped at three points giving 82, 114, 100 and 204 ohms between sections. The base of the body is fitted with a ring of six equally-spaced numbered contacts, the first five of which are connected to the sections of the resistance; No.6 contact is the off position of the switch. No.1 contact is fitted with an extended tag which is connected to the instrument panel lamp. Centrally disposed is a combined contact and terminal stud to which the vehicle supply is connected. This contact is bridged to one of the six contacts by a contact piece fitted to the bakelite rotor.

360. Fitted in the cover and retained by a spring ring is a spindle dog insulation assembly consisting of a bakelite moulding with a spindle, which carries the operating knob, and two driving pins moulded in position. The pins engage holes in the rotor and are of different diameters to ensure correct assembly. A helical spring fitted between the cover and the rotor maintains contact between the rotor and the base. Located radially in the moulding is a spring-loaded steel ball which engages one of six equally-spaced holes in the cover to locate the six switch positions.

361. Two screws with nuts and washers secure the cover to the body and two screws with washers secure the switch to the switchboard housing. The sealing of the spindle and the fixing of the knob are similar to those described for the starter switch.

Warning lamps

362. The oil pressure warning lamp (9) and the main indicator lamp (2) are energized from the vehicle supply via the ignition switch and the distribution box 10A circuit breaker. The first of these is connected in series with the engine oil pressure switch and is fitted with an amber window. The switch is pressure operated; with no, or low, oil pressure its contacts are closed and the warning lamp is alight. When the pressure reaches 3-12 lb/sq.in. the contacts separate and the light goes out. The switch is described in EMER Power S 522. The main indicator lamp, fitted with a red window, is connected to the generator positive terminal via the generator panel. The pins of each bulb fit in slots cut in a resiliently mounted sleeve and the bulb is pressed against a spring-loaded centre contact by the plastic window which screws into the faceplate of the switchboard. A felt disc fitted inside the window protects the bulb and waterproofing is effected by a rubber sealing ring.

363. The main indicator lamp lights when the ignition is switched on, the circuit being from the battery positive terminal through the ignition switch, circuit breaker, lamp, generator panel, generator and then to the battery negative terminal (Fig 46). As the engine picks up in speed, the generated voltage rises and neutralizes the battery voltage thus causing the lamp to go out gradually and so indicating that the generator is delivering its voltage. When the engine slows down, the cut-out opens and the lamp lights again and remains alight until the ignition is switched off. The indicator lamp will not light until the cut-out opens since, with the cut-out closed, the lamp is short-circuited. In addition to the circuit breaker the main and indicator lamp fuses are both in circuit. If the main fuse blows, the warning lamp will light to indicate this (para 305). The lamp will also light if the fording caps are removed from the generator panel (para 299).

INSTRUMENT PANEL No.1, MK 1 - FV157927 (Fig 63)

364. The instrument panel is a totally enclosed unit, housing the speedometer (5) tachometer (1) coolant temperature gauge (3) and the fuel gauge (2). A panel lamp is fitted to illuminate the instrument scales. A combined switch and resistance unit

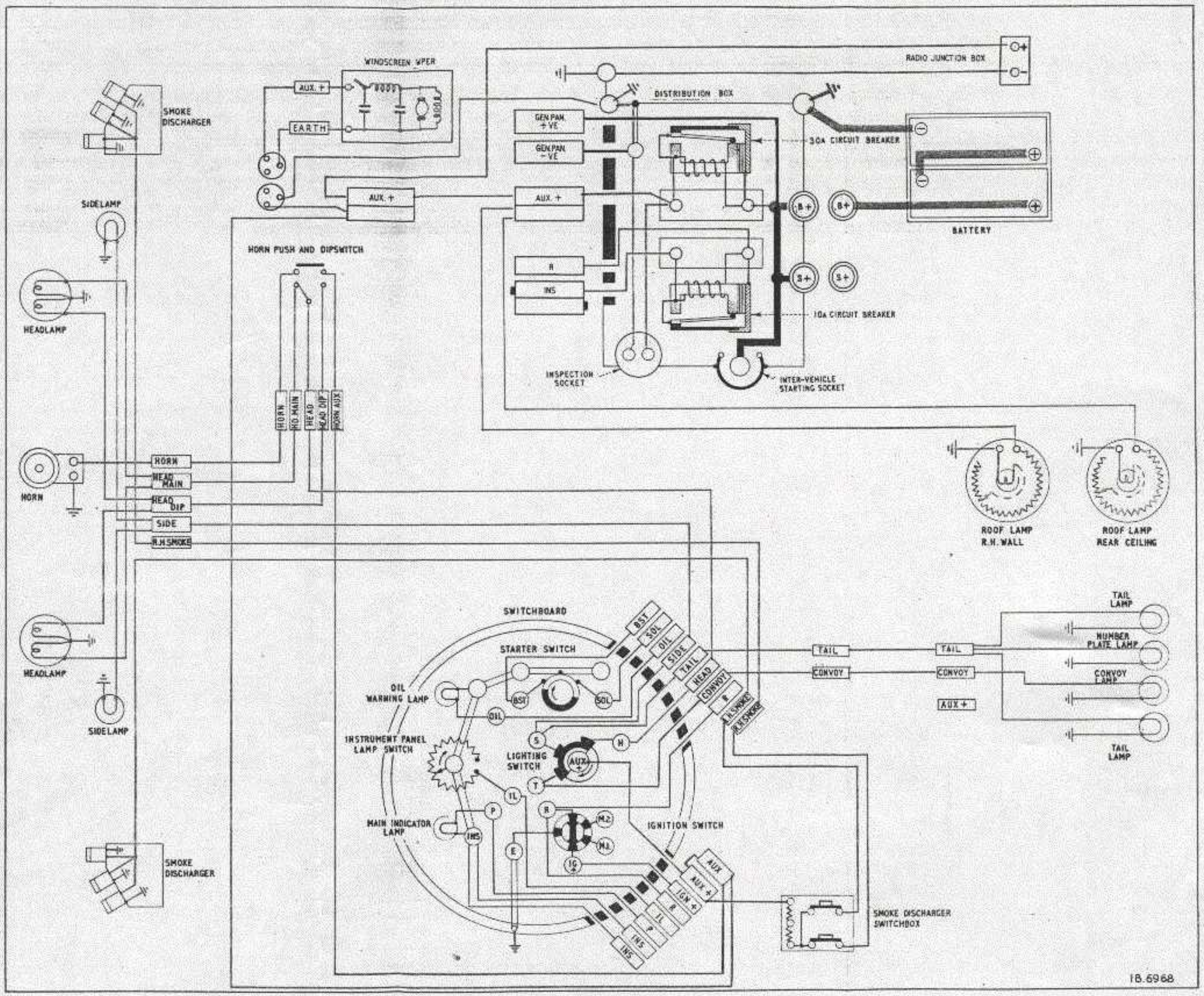
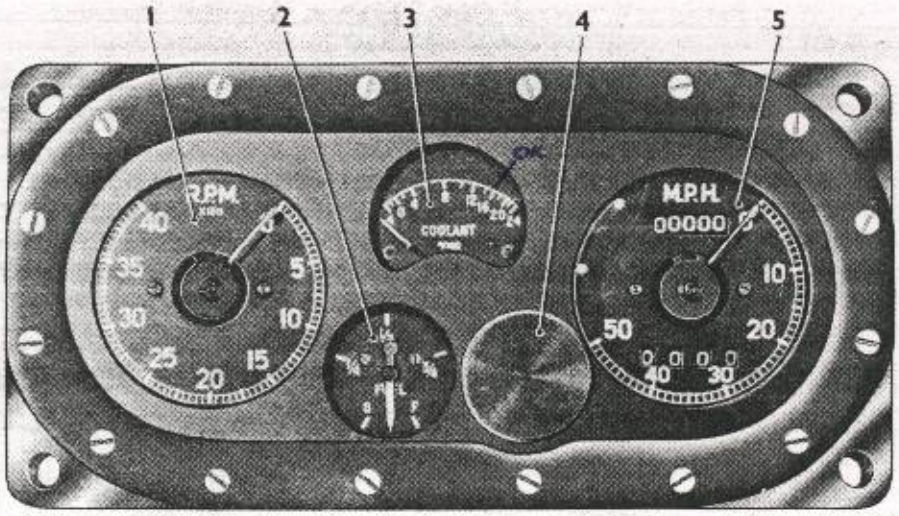


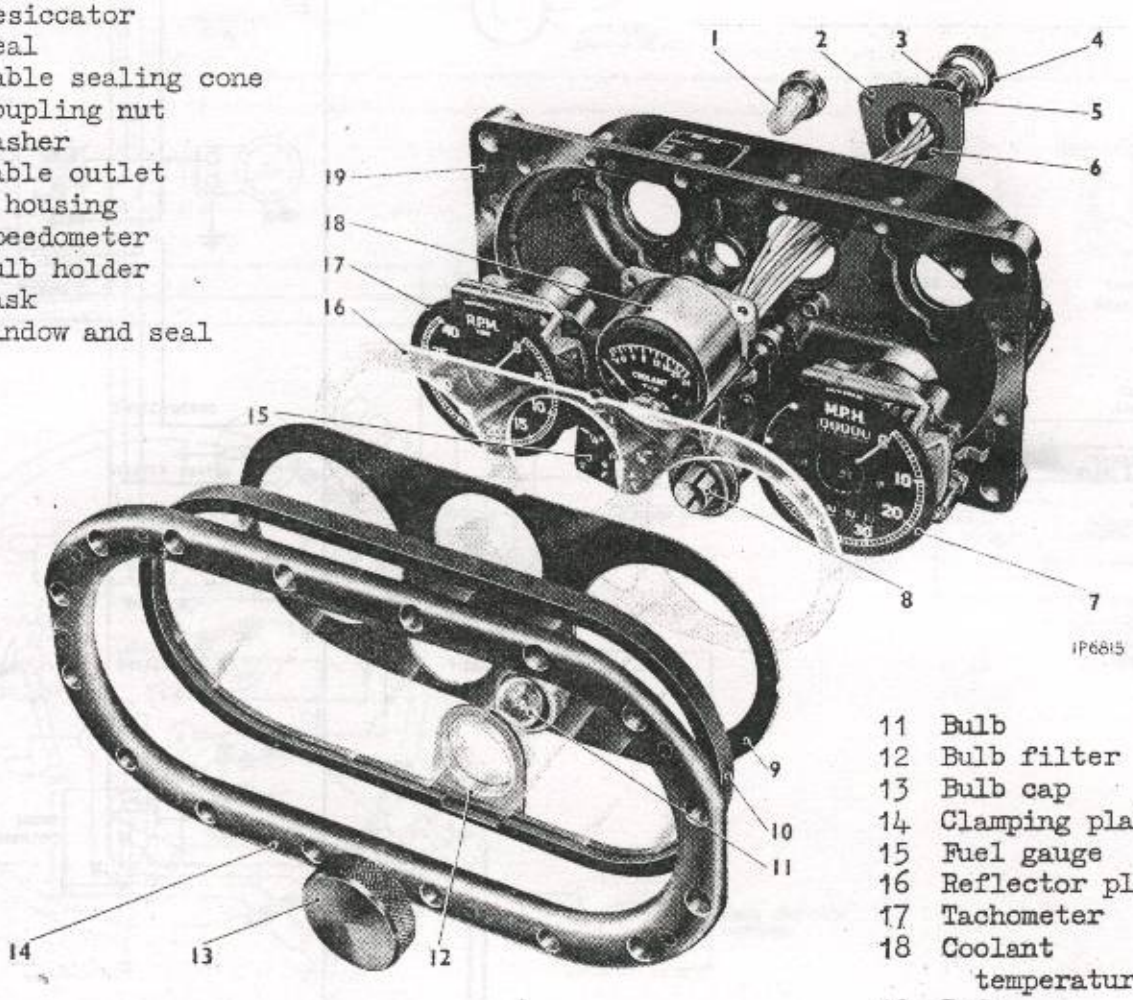
Fig 62 Lighting and auxiliaries wiring diagram (red)



IP5575

1 Tachometer
2 Fuel gauge
3 Coolant temperature gauge
4 Panel lamp cap
5 Speedometer

Fig 63 Instrument panel No.1, Mk I



IP6815

1 Desiccator
2 Seal
3 Cable sealing cone
4 Coupling nut
5 Washer
6 Cable outlet housing
7 Speedometer
8 Bulb holder
9 Mask
10 Window and seal

11 Bulb
12 Bulb filter
13 Bulb cap
14 Clamping plate
15 Fuel gauge
16 Reflector plate
17 Tachometer
18 Coolant temperature gauge
19 Body

Fig 64 Exploded view of instrument panel No.1, Mk I

fitted to the switchboard controls the lamp and permits the intensity of the illumination to be varied to suit operational requirements. To absorb moisture, a desiccator is fitted to the back of the board.

Speedometer

365. The drive to the speedometer is via an angle drive gearbox secured to the back of the instrument panel immediately behind the speedometer. The gearbox driven gear shaft directly engages the speedometer driving spindle while coupled to the lower end of the gearbox driving gear shaft is a flexible drive cable which is coupled at its other end to the speedometer drive incorporated in the transfer box (see para 119).

366. At the top of the speedometer (Fig 64(7)) is a total mileage indicator, which records up to 99,999 miles before returning to zero. At the bottom is a trip mileage indicator, which records up to 999.9 miles before automatically returning to zero. A flexible trip operating shaft connected to the trip mileage indicator permits the indicator to be turned to its zero position when desired. The trip reset knob is located adjacent to the horn push and dipswitch. The speedometer records up to 50 m.p.h. The decimal figures of the trip mileage indicator and the pointer tip are coloured red.

367. The instrument is of the magnetic type working on the eddy current principle. A magnet assembly is revolved by the speedometer cable which induces eddy currents in an aluminium drag element carrying the pointer assembly. These currents produce a magnetic field which links with the original field and opposes the relative positional change and hence the drag element and pointer tend to follow the movement of the magnet assembly. The movement of the pointer assembly is retarded by a hairspring, a steady condition being reached when the hairspring and magnetic torques balance; the magnetic torque is proportional to the speed. The two mileage indicators are driven from the rotating magnet assembly through a gear train.

368. For the speedometer to record 30 m.p.h. its shaft must rotate at 400 r.p.m. Other readings are proportional. For every 800 revolutions of the speedometer shaft one mile is indicated on the counter.

Tachometer

369. The tachometer (17) is of the magnetic type and driven from the rear end of the engine camshaft by a connecting flexible shaft. The scale is graduated from 0-40 and the reading must be multiplied by 100 to give the engine speed in r.p.m.

370. The unit works on a similar principle to the speedometer (para 367). It is calibrated for a drive of 1/4 engine speed, i.e., 1,000 r.p.m. of the shaft shows 40 on the indicator.

Coolant thermometer

371. The coolant thermometer comprises two units, a gauge (18) and a bulb (Fig 65) connected electrically.

1 Shroud
2 Bulb
3 Sealing washer
4 Plug

Fig 65 Thermometer bulb

372. The indicator dial is graduated from -4 to 24 and the indicated reading must be multiplied by 10 to give the coolant temperature in degrees Fahrenheit. The indicator has a double pivot moving coil element with two windings connected in a ratiometer circuit with a temperature sensitive resistance element contained in the bulb which is fitted in the front of the engine cylinder head on the exhaust side.

373. The value of the current through the two windings determines the position of the pointer. One indicator coil winding is in series with the battery and earth and the second is in series with the battery, the bulb element and earth (Fig 66). The bulb resistance element is a wire wound combination of Nickel wire (6 ft approx) and with a short length (6 in.) of Eureka wire attached. Its resistance increases as its temperature rises. The variation in resistance alters the balance of the currents in the two coil windings and the pointer therefore takes up a position corresponding to the temperature of the bulb.

374. Since the temperature indication depends upon the ratio of the currents in the two windings it is independent of voltage variation. Similarly the symmetrical arrangement of the circuit renders the indication free from errors due to changes in ambient temperature.

375. The current consumption is approximately 40 mA.

Fuel gauge

376. The fuel gauge consists of two units: the indicator in the instrument panel, and the tank unit No.2, Mk 2 - FV59266.

377. These units are fitted to indicate the quantity of fuel in the tank. They are connected together by three wires and work on the Desynn principle.

378. The tank unit (Fig 67) consists of a transmitter operated by the rise or fall of a float arm due to alteration in the level of the fuel in the tank. The transmitter comprises a uniform circular resistance (6) tapped at three equally-spaced points. Two contacts bear on the resistance at diametrically opposite points; they are mounted on sliders (4) which are insulated from each other and from the unit and are connected to the vehicle supply (Fig 66). The sliders are linked mechanically, via a driving lever (Fig 67(2)) to a shaft which is rotated by the rise and fall of the float. This motion is transmitted by a pinion (10) fitted to the bottom of the shaft which engages a spiral contrate gear (9) cut on the face of the float arm carrier. This gear is designed in conjunction with the shape of the fuel tank to give the shaft and transmitter the necessary rotation to suit the standard indicator. The gear is pinned to a sleeve type bearing and is carried by a spindle with a screw thread at one end and a head with a screwdriver slot at the other. The spindle is positioned in the gear housing to give a backlash of 0.010 in.-0.015 in. between the pinion and gear. It is locked by a Simmonds nut and at the head by a solder seal.

379. The indicator consists of a small iron stator carrying a star-connected three-phase distributed windings. Accurately balanced and supported in bronze bearings, is a 2-pole permanent magnet rotor which is free to move within the stator field and which carries the indicator pointer.

380. The transmitter tappings are connected to the indicator winding (Fig 66) thus: the position of the transmitter contacts determines the distribution and strength of the currents flowing in the indicator windings. The resultant magnetic field, and therefore the position taken up by the rotor and pointer, aligns itself with the position of the transmitter contacts. The direction and disposition of the magnetic field is independent of the applied voltage and therefore variation in voltage does not affect the indicator reading.

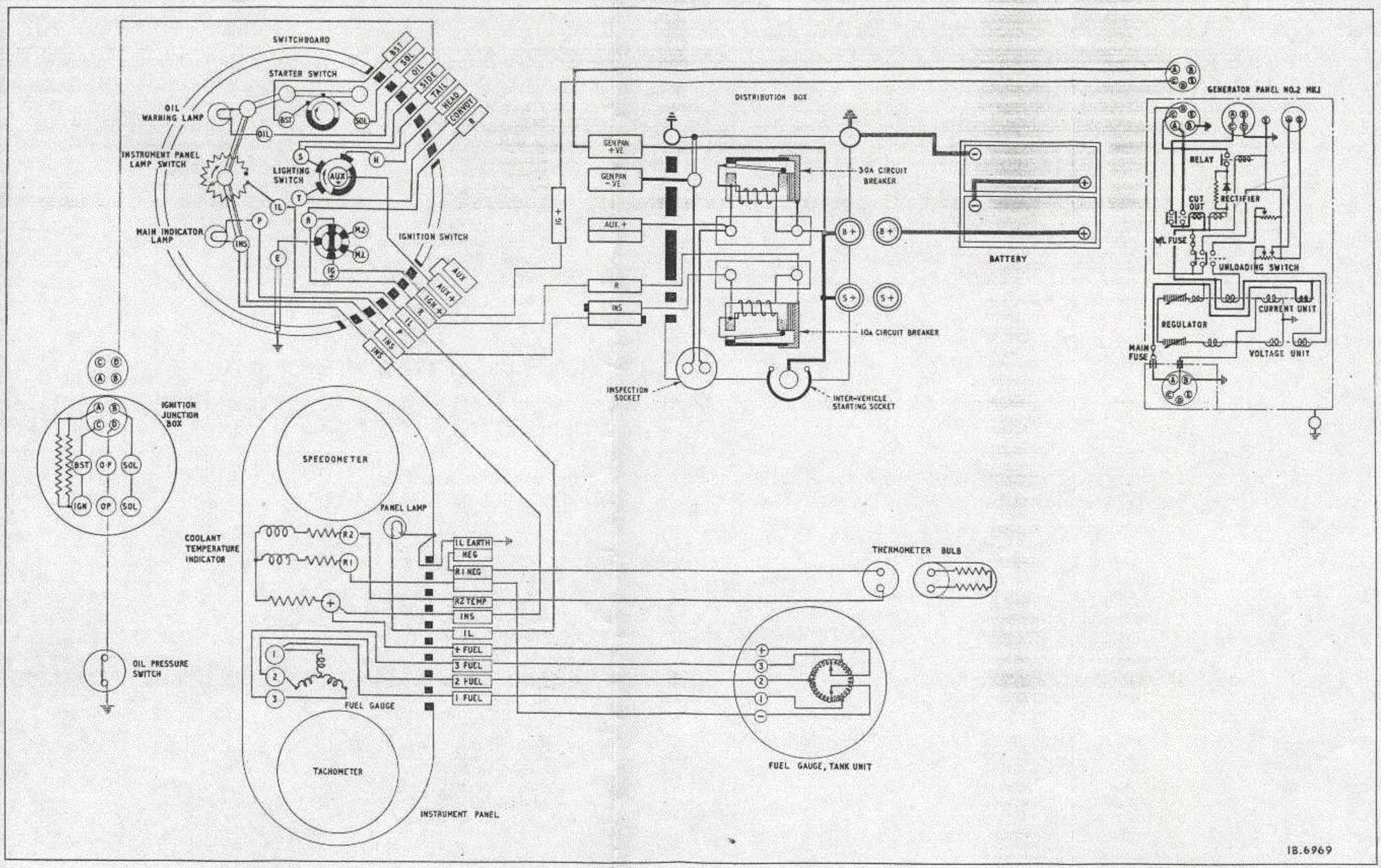


Fig 66 Instruments wiring diagram (red)

PERFORMANCE

Average safe road speed	45 m.p.h.	(72.4 km.p.h.)
Average safe cross-country speed	25 m.p.h.	(40.2 km.p.h.)
Maximum gradient climbable	24 deg	(1 in 4 approx.)
Range of road operation	190 miles	(305.7 km)
Range of cross-country operation	100 miles	(161 km)
Road fuel consumption	9 m.p.g.	(3.2 km.p.litre)
Cross-country fuel consumption	5 m.p.g.	(1.7 km.p.litre)
Approach angle - front	60 deg	
Departure angle - rear	50 deg	
Ditch crossing - with channels	4 ft 0 in.	(1.22 in.)

NETT POWER/GROSS WEIGHT RATIO

Liaison vehicles, Mk 1	24.9 b.h.p./ton
Reconnaissance vehicles, Mk 2	22.6 b.h.p./ton

MAXIMUM TRACTIVE EFFORT - 100% efficiency

5th gear	221 lb/ton
1st gear - early vehicle ratios	1,235 lb/ton
1st gear - later vehicle ratios	1,275 lb/ton

SUSPENSION

Type	Fully independent wishbone	
Springs	Single coil spiral	
Wire dia	1.03 in.	(26.16 mm)
Number of coils	12.5	
Effective number of coils	11	
Mean dia of coil	3.9 in.	(99.06 mm)
Rate	2,485 lb/in.	
Free length	17.35 in.	(4.406 m)
Static length	15.75 in.	(4.000 m)
Closed length	12.875	(3.27 m)
Shock absorbers	Double acting hydraulic - telescopic	

BRAKES

Foot	Hydraulic, 2 leading-shoe	
Hand	Mechanical, 2 leading-shoe	
Diameter of shoes	13 in.	(330 mm)
Width of shoes	$2\frac{1}{2}$ in.	(63.5 mm)
Braking area	230 sq.in.	(1,484 sq cm)

STEERING

Type	Recirculating ball	
Number of turns of steering wheel lock to lock	$3\frac{3}{4}$ approx.	
Front wheel toe-in	1/8 in.	(3.175 mm)
Turning circle at full lock - right and left	38 ft.	(11.582 m)

ROADWHEELS

Type	Divided disc
Size	6.50 x 16.00

TYRES

Size	9.00 x 16
Pressures	See EMER Vehicles General 0 761

1 Float
2 Driving lever
3 Gasket
4 Slider
5 Locating pin
6 Toroidal resistance
7 Driving pin
8 Float arm stop
9 Spiral contrate gear
10 Pinion

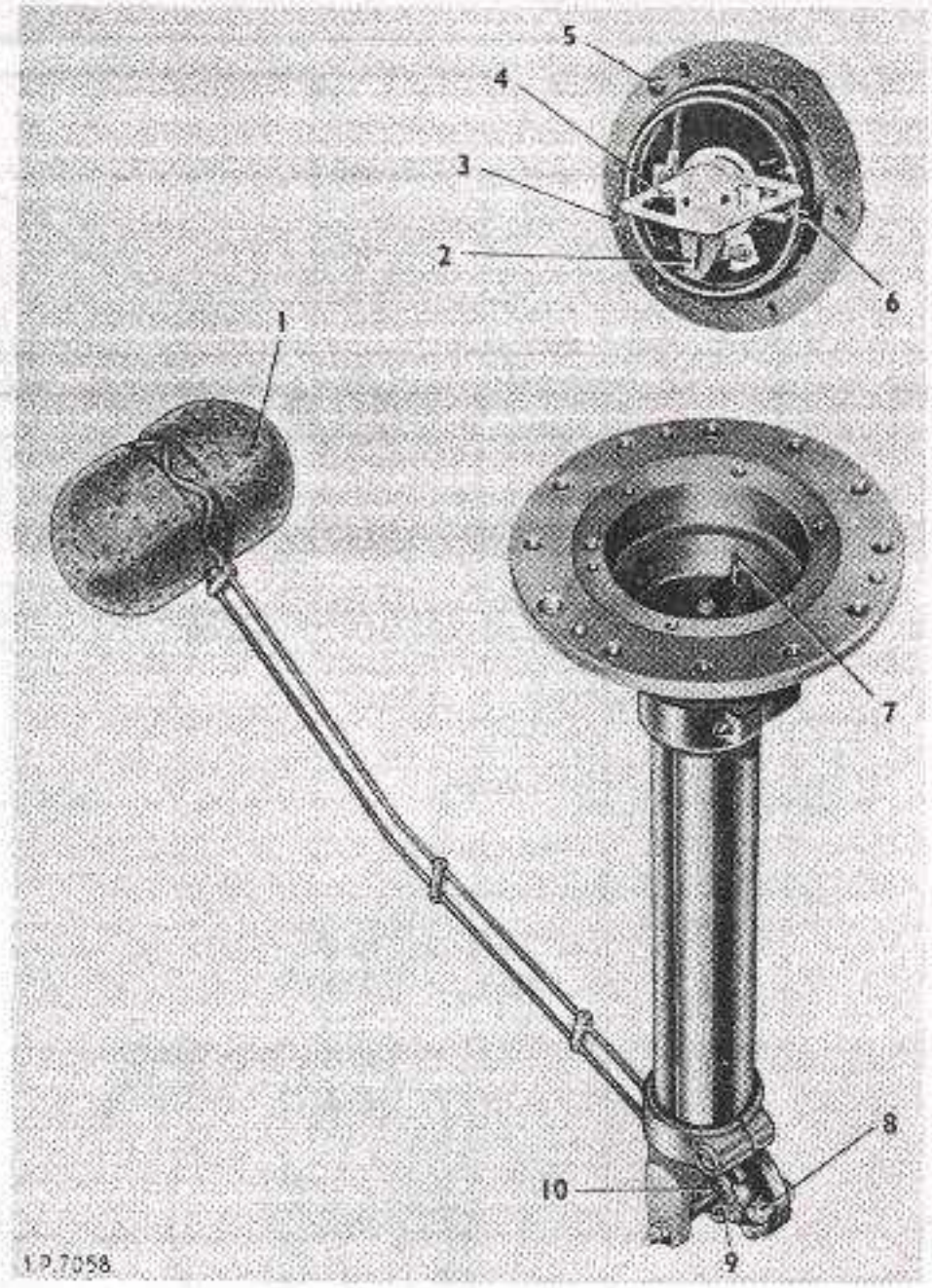
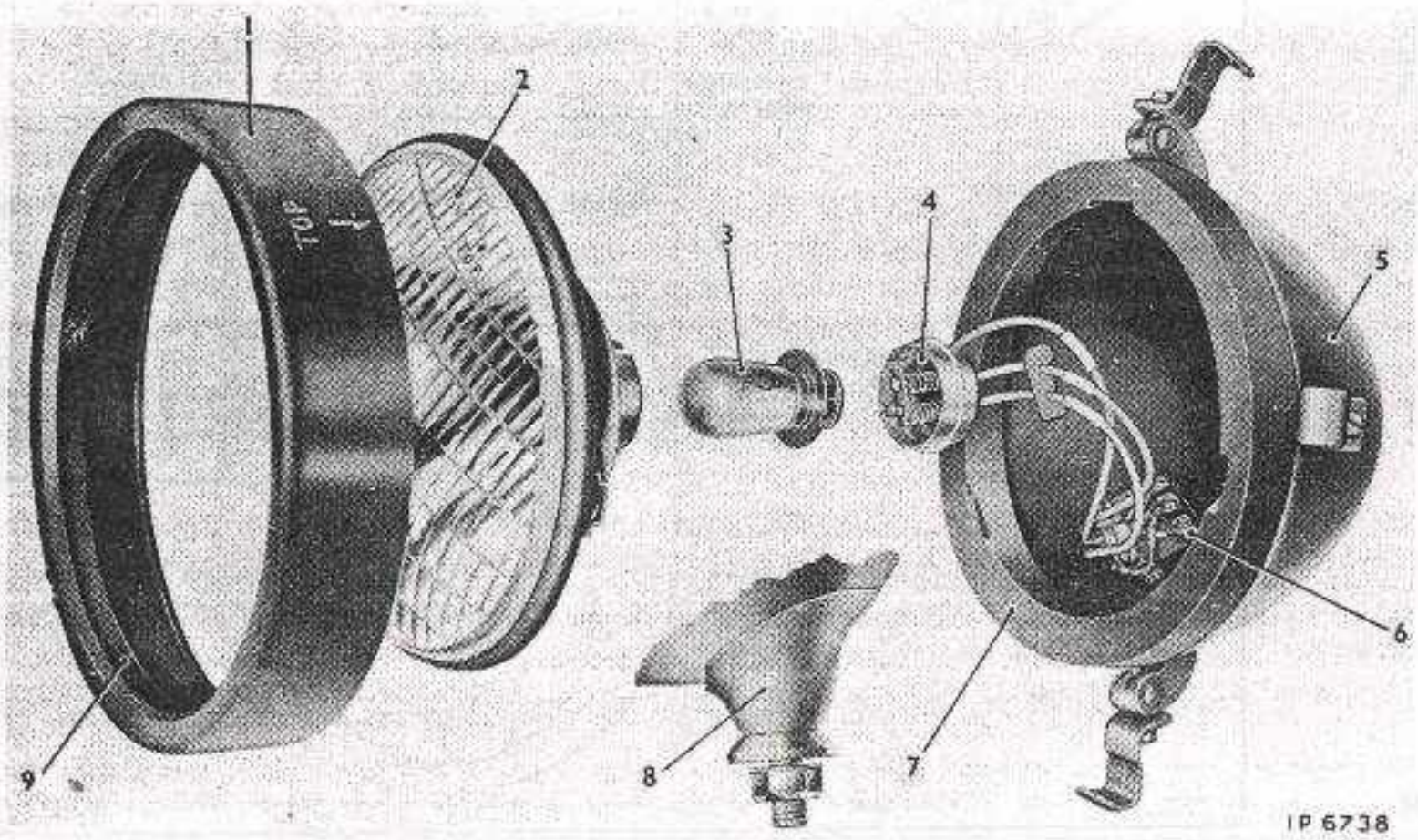


Fig 67 Fuel gauge tank unit



1 Rim
2 Light unit
3 Bulb
4 Adaptor
5 Body
6 Terminal block
7 Rear gasket
8 Stem mounting
9 Front gasket

Fig 68 Headlamp No.2, Mk 1

Panel lamp

381. The pins of the centre contact bulb locate in slots cut in a spring-loaded holder (Fig 64(8)) and the bulb is pressed against a spring-loaded centre contact by a brass cap (13) screwed on the front of the panel. Interposed between the bulb and the cap is a phosphor-bronze spider which prevents damage to the bulb. Waterproofing is effected by means of a sealing ring fitted to the cover.

HEADLAMP No.2, MK I - FV157970 (Fig 68)

382. The two headlamps are of the stem mounted prefocus type working on the double-dipping system of headlight control, i.e., operation of the dipswitch changes the light beams of both lamps from the normal to the dipped position or vice versa. Each lamps consists of a rim (1) a light unit (2) with a specially designed bulb (3) an adaptor (4) and a body (5).

383. The bulb is of the double filament type to provide the dipping facilities and it can be fitted in one position only in the light unit. This position is determined in the design of the lamp to give correct focusing for both main and dip filaments.

384. The light unit comprises a combined reflector and front lens assembly constructed to ensure that the lens is permanently sealed to the reflector, thus effectively barring the entrance of dust, dirt and moisture. The lens is of the block pattern. It is divided into a large number of small rectangular zones, each zone being optically formed into a combination of a cylindrical lens or flute and a prism. The horizontal spread of the light is controlled by the lenses while the prisms deflect the light downwards resulting in a powerful beam with a flattish top. The whole of the optical figuring is formed on the inner surface of the glass.

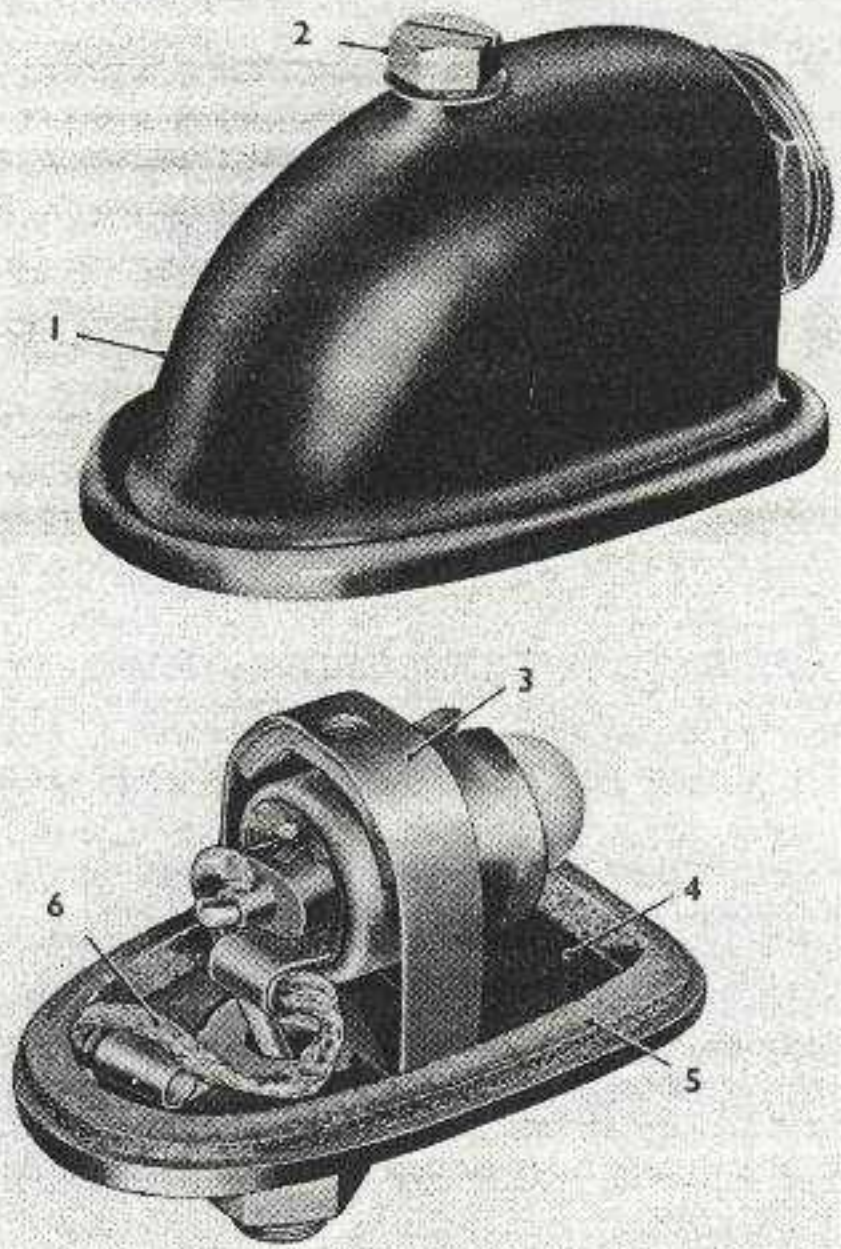
385. The bulb is fitted with an accurately positioned seating flange which locates against an internal flange formed in a cup secured to the back of the light unit. The seating flange is slotted to engage a key formed lengthwise in the bore of the cup.

386. The adaptor consists of a sleeve which houses an insulated moulding fitted with two spring-loaded contacts to which the lamp cables are soldered. These contacts engage the bulb contacts. A clip riveted to the sleeve secures a nipple fitted to an earth lead. Three unequally spaced keys formed in the bore of the sleeve engage slots cut in the light unit cup to locate and secure the adaptor to the cup.

387. Fitted inside the body is a three-way terminal block (6) to which the three adaptor cables and the two vehicle cables are connected. The centre earth terminal is connected to one of the terminal block securing screws. Vehicle cables enter the lamp through a rubber sealing cone secured by a coupling nut to a gland located at the back of the body.

388. The light unit is fitted between two sealing gaskets (7) and (9) located in the rim, this sub-assembly being clamped to the body by four clips and swivel bolts. When required a black-out mask may be fitted to the lamp by means of these clips and bolts.

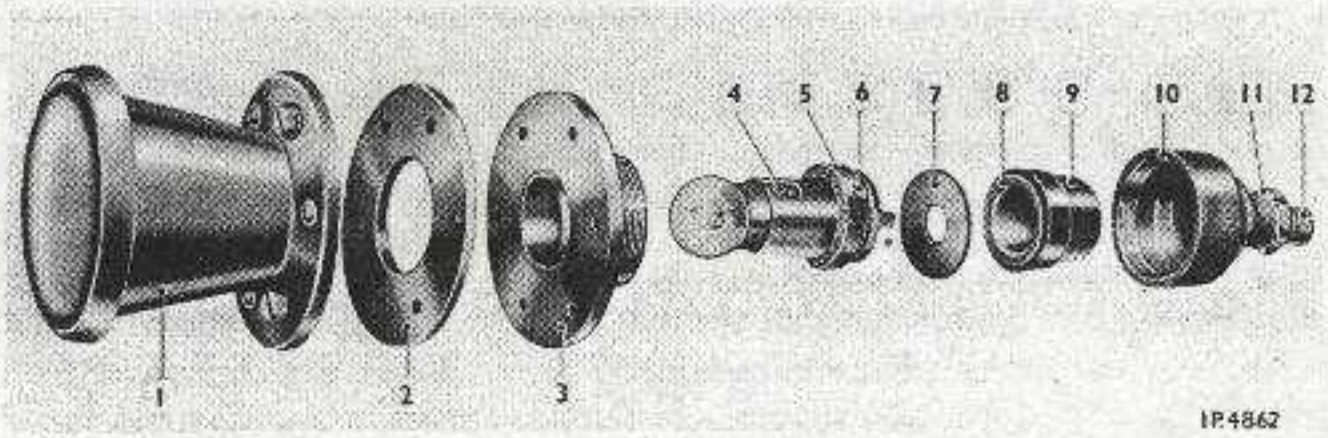
389. To ensure correct assembly the light unit, rim and rear gasket (7) are marked TOP and the light unit carries a direction arrow, all of which must line up with each other. The rear gasket is slotted to locate three unequally spaced clips fastened to the light unit.



1 Cover
2 Securing screw
3 Bracket
4 Body
5 Gasket
6 Earth connection

Fig 69 Side lamp No.1, Mk 1

IP4971A



IP4862

1	Front cover	5	Rubber mounting	9	Rubber mounting
2	Gasket	6	Earthing ring	10	Locking ring
3	Backplate	7	Insulating washer	11	Gland nut
4	Bulb holder	8	Bulb holder cup	12	Ferrule

Fig 70 Side lamp No.2, Mk 1

390. A ball and socket joint is used to connect the body of the lamp to the mounting stem (8) an arrangement which permits the light beam to be directed as required when the stem securing nut is slackened off.

SIDE LAMP No.1, MK I - FV157922 (Fig 69) (Fitted to the 1st 200 vehicles)

391. These stem-mounted waterproofed lamps are of the 2-piece type comprising a body with stem and bulb holder and a cover. A bracket riveted to the body carries the rubber-mounted centre contact bulb holder; the earth connection is effected by a terminal secured to the bulb holder case.

392. The cover (1) is secured by a bolt (2) which screws into a stiffening-piece located behind the bulb holder bracket (3). The cover carries the window assembly consisting of a three-lamination transparent celastoid, the centre lamination having a double matt finish and the two outer ones double polished.

393. Waterproofing is effected by means of gaskets fitted to the window, cover securing screw, and between the cover and body.

SIDE LAMP No.2, MK I - FV159932 (Fig 70) (Fitted to the 201st and subsequent vehicles)

394. These side lamps comprise a waterproofed assembly consisting primarily of front cover (1) backplate and bush (3) and an adaptor assembly.

395. The centre contact bulb holder (4) is mounted in a rubber bush (5) which locates against a seating in the bore of the backplate bush. A locking ring (10) screws on the bush to clamp an insulating washer (7) and a rubber mounted cup (8) against the back of the bulb holder.

396. The earth connection is effected by an earthing ring (6) located against the flange of the bulb holder; projections on the ring are bent over the bulb holder rubber mounting to contact the bore of the backplate bush.

397. Six tapped holes are provided in the backplate; three are used for securing the front cover and gasket and three for securing the lamp to its mounting. The front cover is conical and fitted with a diffused crystal window.

TAIL LAMP No.2, MK I - FV14932

398. These lamps are similar to the No.2, Mk 1 Side lamp and differ only as regards the red window fitted.

NUMBER PLATE LAMP No.1, MK I - FV14933

399. The number plate lamp is similar to the side lamp No.2, Mk 1 but the cylindrical front cover has a 180 deg light aperture. Fitted on the cover is a light shield with two light apertures: one of 180 deg as in the cover and diametrically opposite this a 3/8 in. diameter hole. The shield is slotted to engage a locating peg fitted to the cover and the shield may be rotated on the cover, within the limits set by the peg, to give full or restricted illumination. A spring is fitted between the light shield and the end of the cover.

CONVOY LAMP No.2, MK 2 - FV157969 (Fig 71) **or**
CONVOY LAMP No.2, MK 4 - FV229537

400. Convoy lamp No.2, Mk 2 is a stem-mounted unit consisting primarily of a body and a rubber mounted bulb holder.

401. The centre contact bulb holder (4) is mounted in a rubber bush (5) which locates against a seating in the bore of the body stem. The end of the holder is flanged to form a seating for an earthing ring (7) and the bush. Projections on the ring are bent over the bush to contact the bore of the body. Located against the back of the bulb holder is a rubber sleeve (8) followed by a felt cable sleeve (10) the assembly being clamped together by a locking ring (9) which screws on the stem of the body.

402. The body (6) is mushroom shaped with a screwed brass cap (1) and seating ring (2) centrally disposed in the front of its head. The rim of the body head is fitted with a segmentally shaped plain glass window (13) to permit illumination of the convoy markings and diametrically opposite this window is a small ruby lens (3) which permits a spot of red light to be visible to a vehicle driver following too closely in convoy. A cap (12) fitted to the back of the body head is spun over to retain the window.

403. Convoy lamp No.2, Mk 4 is very similar to the No.2, Mk 2 to which it is an alternative. The felt cable sleeve (10) is replaced by a friction washer, a cover and a screwed bush, thus permitting an appropriate cable conduit to be screwed on to the lamp. The shape of the bulb holder rubber bush and rubber sleeve is slightly different. A hole is provided in the back face of the body to permit the lamp to be dowelled in position, thus facilitating the changing of a bulb.

ROOF LAMP No.6, MK 1 - FV157965 (Fig 72)

404. Each lamp is mounted on a felt pad and secured by a centrally disposed felt bush and bolt (12); the pad and bush are secured to the vehicle plate and lamp base respectively by Bostik C compound.

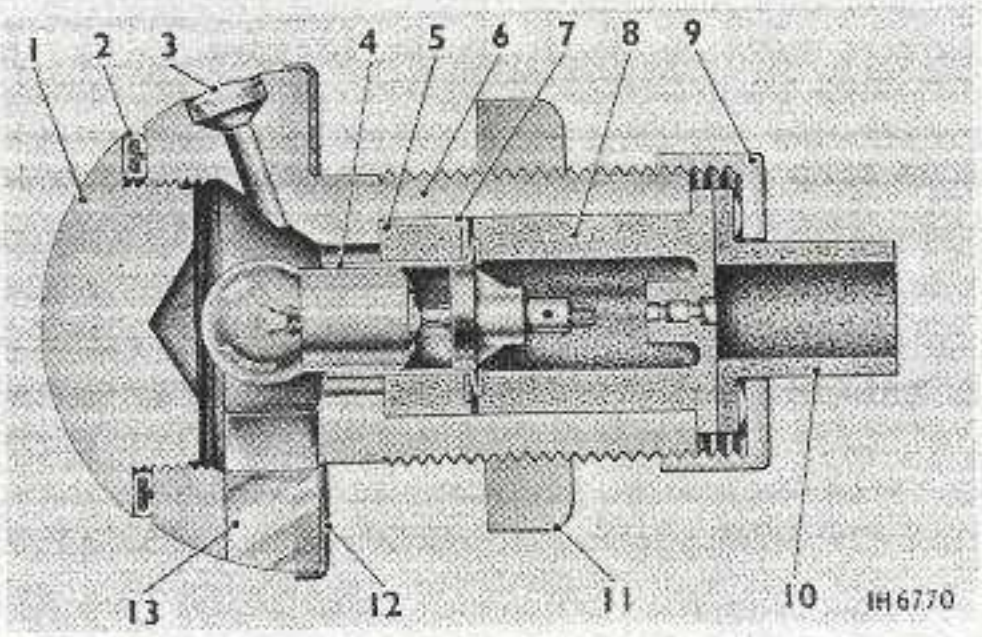
405. The lamp is circular and consists of a switch and a variable resistance which permits illumination intensity to be varied to suit requirements. It comprises two major sub-assemblies: a base (13) with handle (10) and switch contact piece (9); and a body (1) with resistance unit (6) shield (3) and bulb, the two sub-assemblies being secured together by three screws.

406. The switch has 74 deg of rotation, the first 14 deg of movement being from the OFF to the DIM position. It has a contact piece (9) which wipes the resistance and is engaged by a spring-loaded plunger (5). The pins of the bulb locate against the back of the body; slots for the pins are provided in the body to permit the fitting and removal of the bulb. The bulb centre contact engages a contact piece (4) connected to the switch plunger.

407. The bulb shield (3) is of the cowl type; its periphery has a series of holes spaced to permit an all round light cut-off of 15 deg as required. To identify this positioning, letters are embossed on the body (1) and a pointer (2) is attached to the shield.

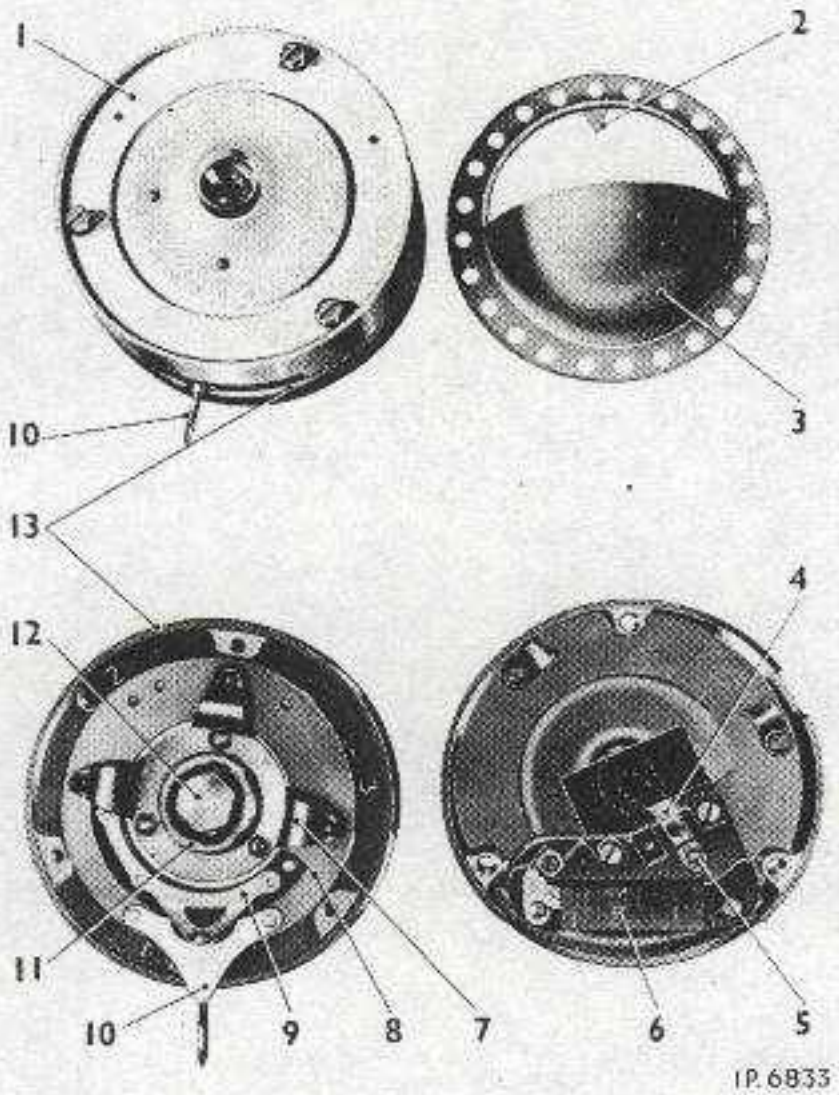
HORN No.1, MK 1 - FV157950 (Fig 73)

408. The horn is a waterproofed high-frequency model of normal design, consisting of an electro-magnet the operating coil (10) of which is connected in series with a contact breaker and with the horn push.



1 Cap
2 Seating ring
3 Ruby lens
4 Bulb holder
5 Rubber bush
6 Body
7 Earthing ring
8 Rubber sleeve
9 Locking ring
10 Felt cable sleeve
11 Locking nut
12 Retaining cap
13 Window

Fig 71 Convoy lamp No.2, Mk 2



1 Body
2 Pointer
3 Bulb shield
4 Contact piece
5 Contact plunger
6 Resistance unit
7 Switch retaining spring
8 Switch
9 Contact piece
10 Switch handle
11 Cupped washer
12 Securing bolt
13 Base

Fig 72 Roof lamp No.6, Mk 1

409. The contact breaker is operated by the electro-magnet armature (4) which together with a diaphragm (5) and a tone disc piston comprise the vibrating assembly. To damp arcing a metallized paper capacitor (3) is connected across the contacts. The contact breaker assembly is centrally disposed on a plate, one end of which is fixed and the other end tapped to receive an adjustment screw entered from the outside of the body; a control spring is fitted on the screw between the bracket and the body.

410. Adjustment of the horn is effected by turning the screw which varies the position of the contact breaker relative to the armature. To assist in this adjustment the underside of the screw head is serrated to give a ratchet effect. When correctly adjusted, the maximum current taken is 3A.

411. The vibrating assembly is supported by the diaphragm which, together with packing washers, is clamped between the body (1) of the horn and a front cover (6). The assembly vibrates at a very high frequency and the movement of the tone disc piston in the bore of the front cover gives the warning note.

412. A cable nipple is fitted to the end of the two vehicle horn connections, the conductors being bared for a short distance and bent round the bottom of the nipple. The nipples fit in the bore of terminal pillars fitted to the horn body. A nut, fitted to a stud centrally positioned between the pillars, presses an insulating plate against the flanges of the nipples to clamp the conductors between the nipples and the bore of the terminal pillars.

413. The vehicle cables enter the horn through a water excluding rubber seal held in position by a clamp plate and nut fitted to the stud mentioned above.

HORN PUSH AND DIPSWITCH No.1, MK 1 - FV157943 (Fig 74)

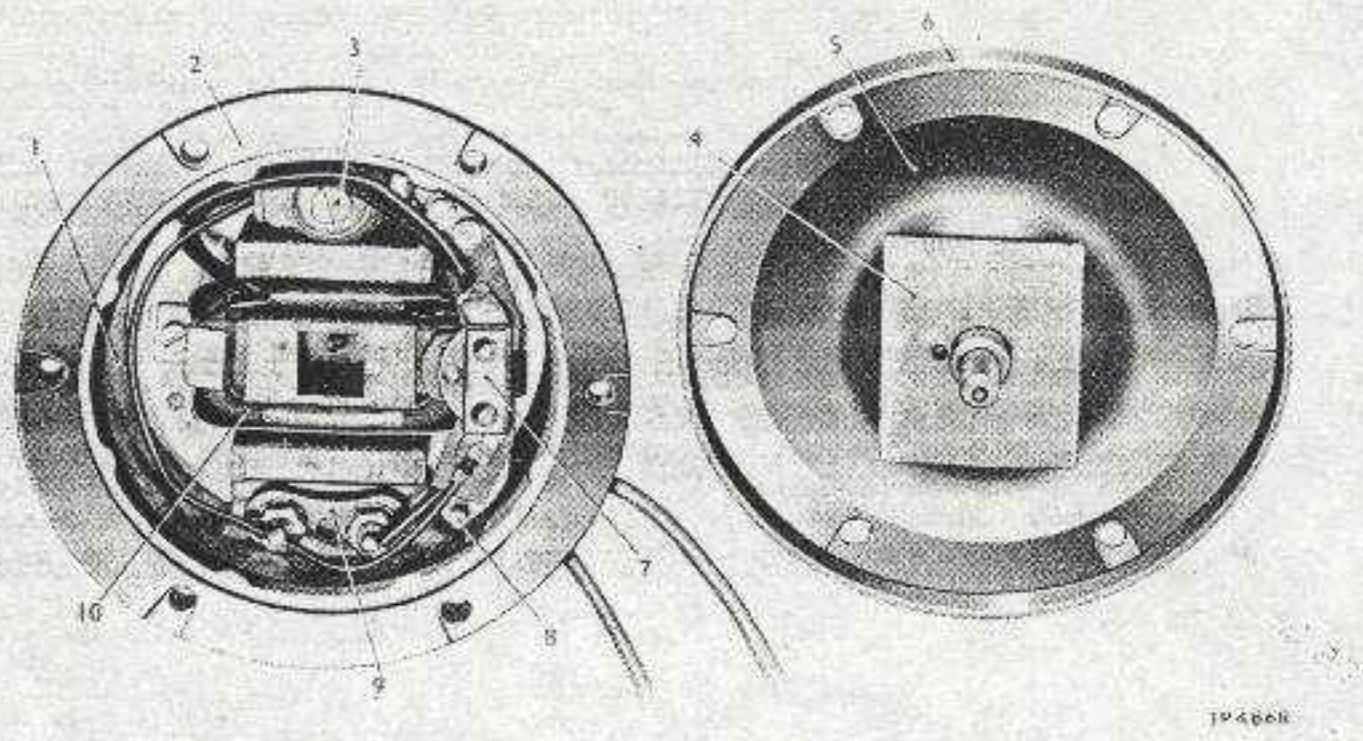
414. The horn push and dipswitch comprise a centrally disposed push button for operating the horn and a 2-position switch which brings either the main or the auxiliary (dip) filaments of the headlamp bulbs into circuit. The dipswitch is operated by turning a knurled cylindrical knob. A metal cover which screws on to the body is provided for fording purposes. When the switch is in use the cover is stowed loose in one of the vehicle lockers.

415. The dipswitch (8) locates in the body (7) followed by the freely mounted dipswitch knob (9) and a mounting plate (2) for the horn contact set (10). Two screws secure them to the body, the knob being free to rotate.

416. The dipswitch is of the 2-way toggle type with the toggle arm (3) projecting to locate in a slot cut in the switch knob so that turning the knob operates the switch.

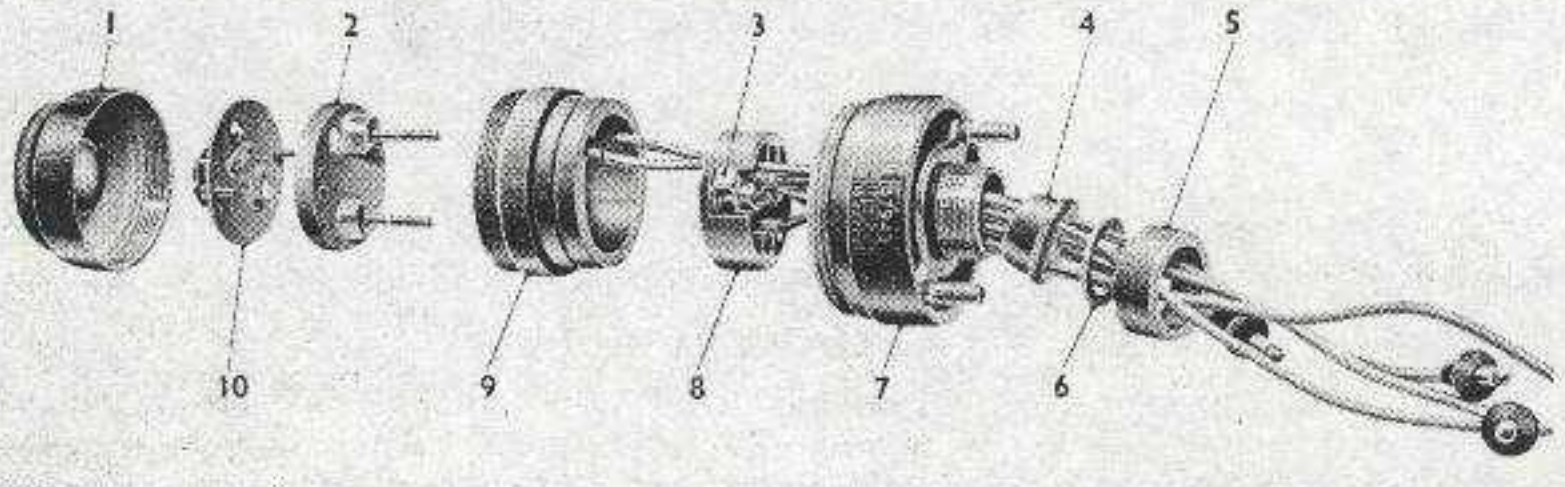
417. The horn contact set is of the simple spring strip type operated by the push button.

418. Originally two screws secured the button and cover assembly (1) and the contact set (10) to the mounting plate (2). To render the switch splashproof when its cover is removed the button and cover assembly have been redesigned. In the case of these switches the button and cover assembly is screwed on to the knob and two screws with shakeproof washers secure the contact set to the mounting plate. This modification is indicated by the erasure of No.1 from the modification record plate.



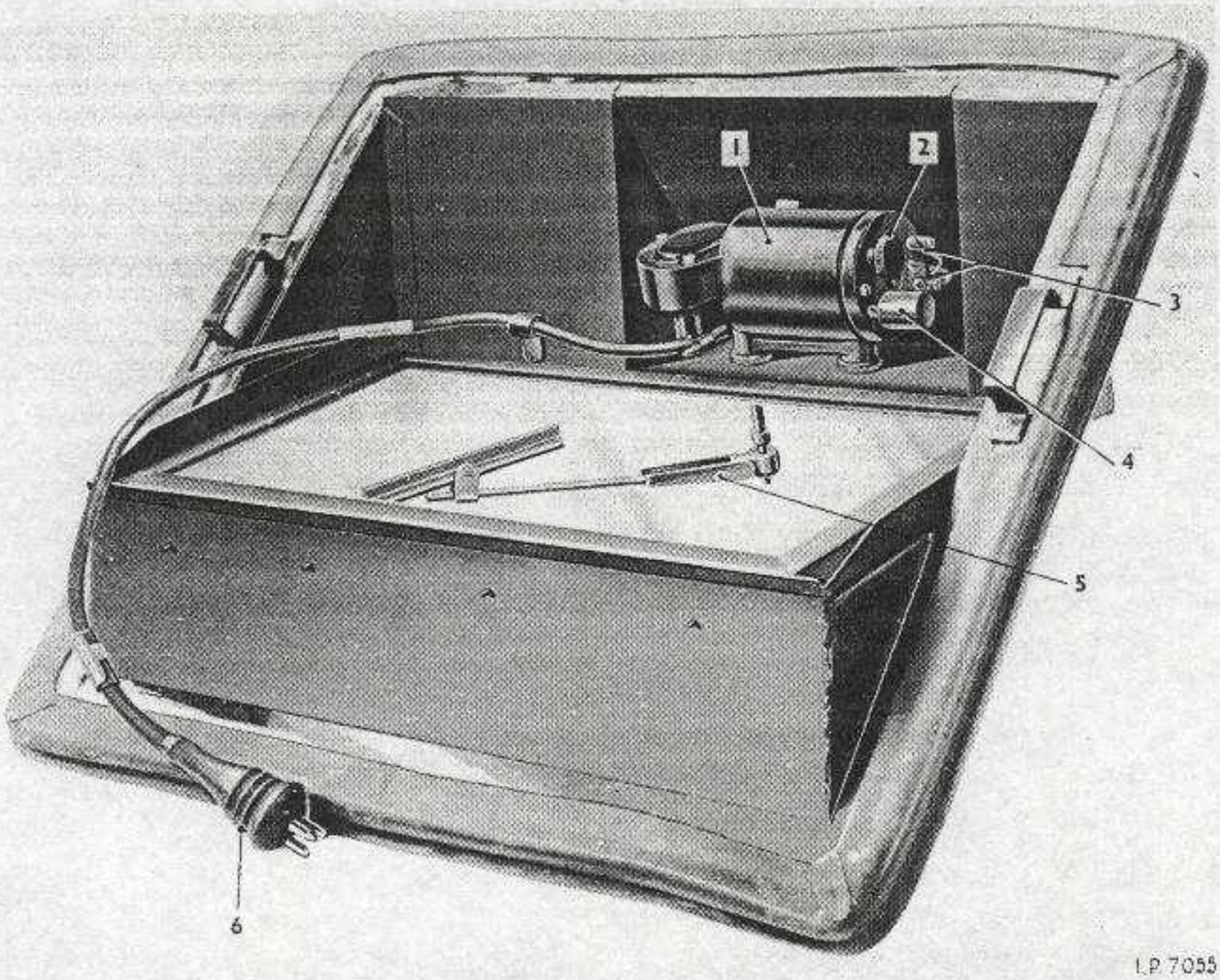
1 Body
2 Diaphragm packing washer
3 Capacitor assembly
4 Armature
5 Diaphragm
6 Front cover
7 Contact breaker assembly
8 Adjusting screw
9 Terminal assembly
10 Coil

Fig 73 Horn No.1, Mk 1



1 Button and cover assembly
2 Contact set mounting plate
3 Toggle arm
4 Cable gland
5 Gland nut
6 Washer
7 Body
8 Dipswitch
9 Dipswitch knob
10 Horn contact set

Fig 74 Horn push and dipswitch No.1, Mk 1



I.P.7055

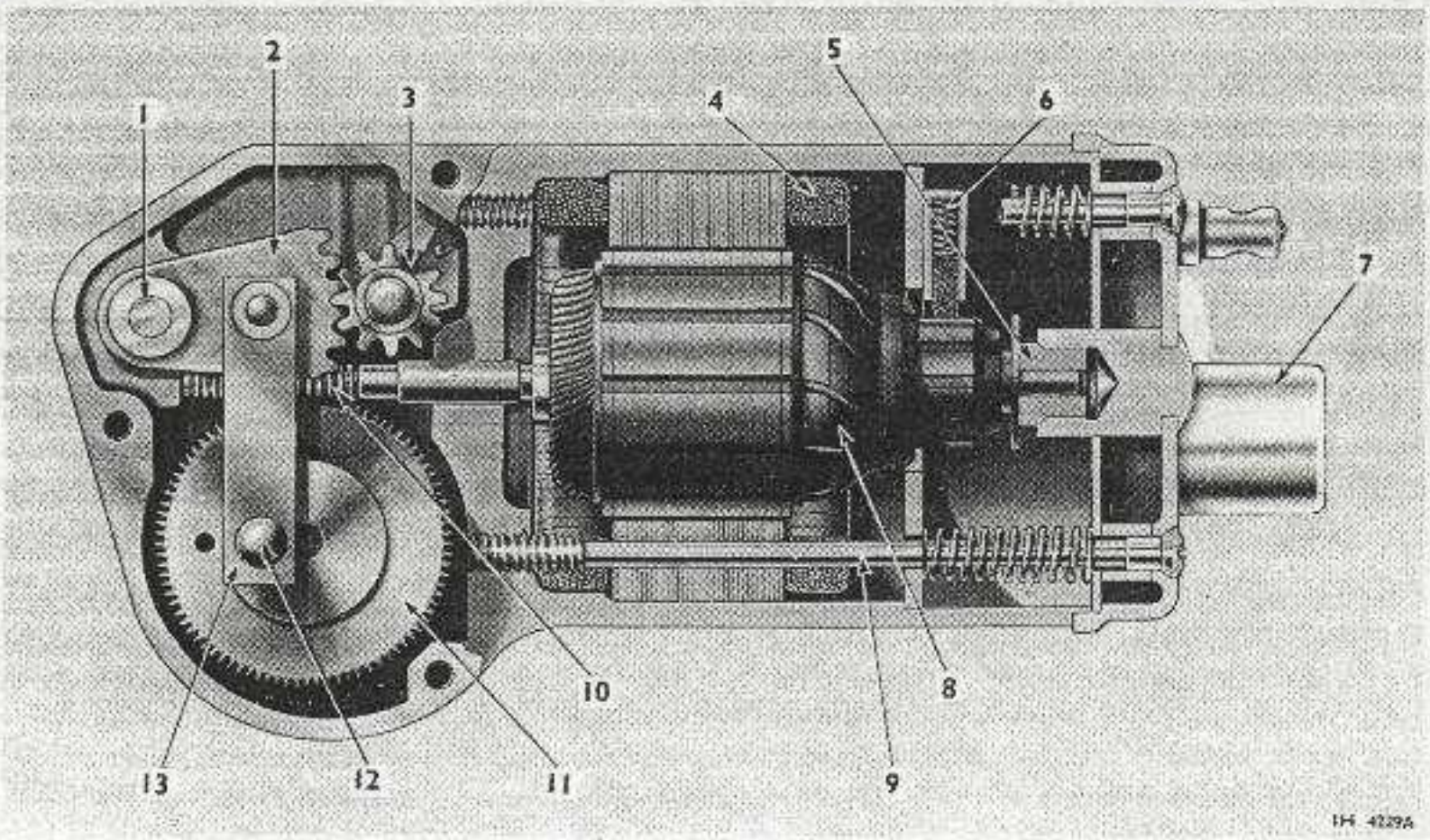
1 Windscreen wiper 3 Terminals 5 Wiper arm
2 Switch knob 4 Capacitor 6 Shrouded plug

Fig 75 Driver's screen

WINDSCREEN WIPER (C.A.V. type BWN24/56)

419. The windscreen wiper is fitted to the driver's screen (Fig 75) and is suppressed to prevent interference to wireless reception. It embodies its own switch (2) and is fitted with $2\frac{1}{4}$ ft of 3-core rubber covered cable which terminates in a 3-pin plug (6). The plug is moulded into a rubber casing which is integral with the cable covering. The cable from pins 2 and 3 (green and red) are soldered together at the windscreen wiper end. When in use the plug fits into a 3-pin rubber shrouded socket located behind and to the left of the driver above the smoke discharger switchbox.

420. The windscreen wiper (Fig 76) consists of a small shunt motor geared down considerably to drive an arm, carrying a 5 in. blade, through a 120 deg wiping angle.



1 Segment pivot
2 Toothed segment
3 Wiper arm pinion
4 Field coil
5 Bearing bush
6 Brush and spring
7 Capacitor
8 Armature
9 Switch cover screw
10 Armature shaft worm
11 Worm wheel
12 Crankpin
13 Connecting rod

Fig 76 Windscreen wiper

Gearing

421. A worm (10) cut on the end of the armature shaft engages a worm wheel (11) fitted with a crankpin (12). A pivoted toothed segment (2) is also fitted with a pin, the two pins being linked together by a connecting rod (13). The teeth of the segment mesh with a pinion (3) secured to the wiper arm. As the armature rotates, an oscillating motion is imparted to the arm and blade through the toothed segment.

422. To help in the correct assembly of the gearing a mark is made on the boss of the pinion which must coincide with the centre tooth gap of the segment. The worm wheel and the segment are carried on eccentric bearing pins which permit adjustment of the backlash of the respective gears. Grubscrews fitted at right angles to the pins lock them in position.

Armature

423. The armature is carried by self-lubricating type bearing bushes fitted in the body and in the commutator end (C.E.) cover. A thrust washer is fitted to the C.E. of the shaft and the driving end abuts a pivot screw fitted to the body which is set to give an armature endplay of 0.05 mm-0.10 mm (0.002 in.-0.004 in.).

CAPACITIES

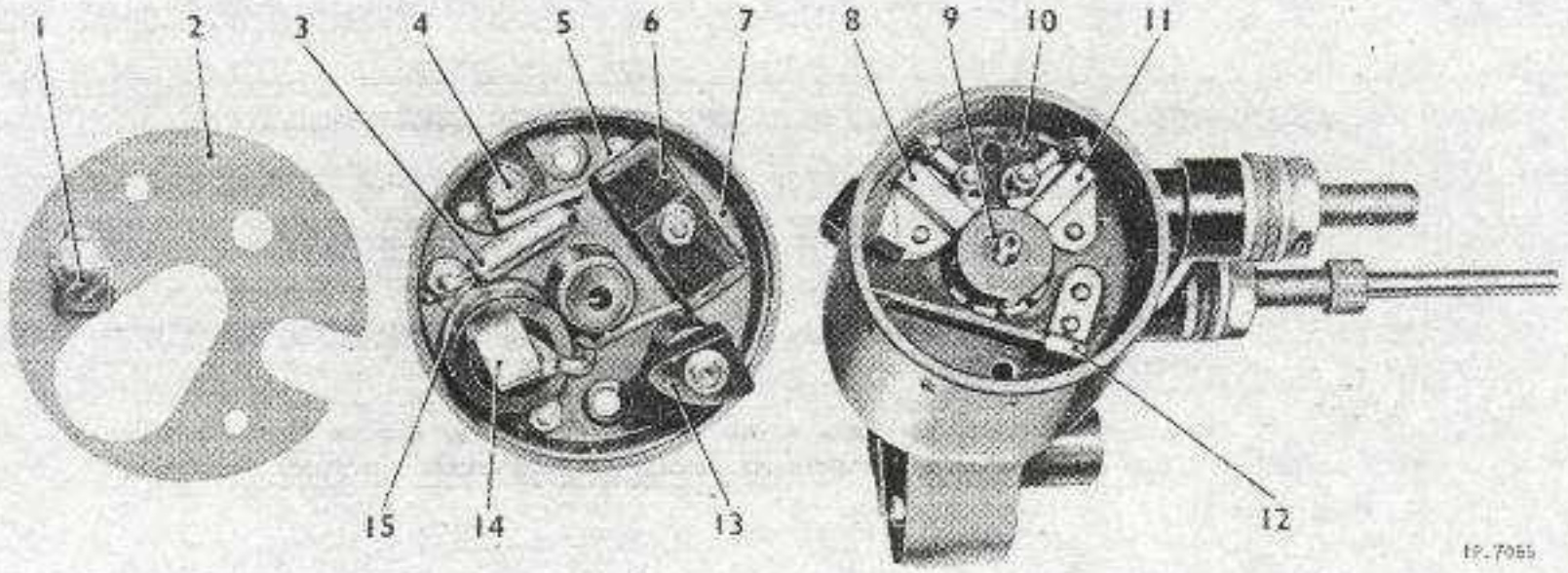
	Imperial	*U.S.A.*	*Metric litres*
Engine lubrication system (dry sump)	3 gal	3½ gal	13.64
Engine cooling system	4½ gal	5½ gal	20.46
Fuel tank - total	21 gal	25¼ gal	95.5
Fluid flywheel (coupling)	9¾ pints	11¾ pints	5.54
Gearbox	1¼ gal	1½ gal	5.7
Transfer box	6 pints	7¼ pints	3.41
Inner tracta joint housings including bevel boxes - each	3 pints	3½ pints	1.7
Outer tracta joint housings including road wheel hubs - each	1½ pints	1¾ pints	0.85
Brake fluid supply tank	1¼ pints	1½ pints	0.71
Air cleaner	4 pints	5 pints	2.28
Steering cross-shaft bevel box - lower	1½ pints	1¾ pints	0.85
Steering bevel box - upper	1½ pints	1¾ pints	0.85

ELECTRICAL EQUIPMENT

System	24V, current-voltage control, negative earth
Battery (2 off)	
Type	No.2, Mk 1 - FV157937
Voltage	12V
Capacity	60 Ah
Generator	No.2, Mk 1 - FV175843 or No.2, Mk 2 - FV175866
Generator panel	No.2, Mk 1 - FV175848 or No.2, Mk 2/1 - FV175871
Starter	No.1, Mk 1 - FV135333 or No.1, Mk 2 - FV141546 or No.1, Mk 2/1 - FV157939

PROTECTIVE DEVICES

Type	*Location*	*Circuits*	*Rating*
Fuse, No.23 S.W.G. tinned copper	Generator Panel No.2, Mk 1	Generator	25A
Fuse, No.35 S.W.G. tinned copper	Generator Panel No.2, Mk 1	Indicator lamp	5A
		OR	
Fuse, special strip type	Generator Panel No.2, Mk 2/1	Generator	50A (10 sec fusing)
Fuse, No.30 S.W.G. tinned copper	Generator Panel No.2, Mk 2/1	Indicator lamp	5A
Circuit breaker	Distribution Box	Indicator lamp, oil pressure warning, instrument panel lamp, starter switch, coolant thermometer and fuel gauge.	10A
		Lamps, horn, smoke dischargers, windscreen wiper and wireless set junction box.	30A



1	Negative brush holder contact	6	Choke	12	Switch contact blade and plate
2	Contact plate	7	End cover	13	Switch cam
3	0.001 μF capacitor	8	Positive brush holder	14	Switch plate contact
4	Positive terminal	9	Thrust washer	15	1.0 μF capacitor
5	Negative terminal	10	Brush gear base		
		11	Negative brush holder		

Fig 77 Commutator end and cover of windscreen wiper

Brush gear base assembly

424. The bakelite brush gear base (Fig 77(10)) locates against a seating in the body. Riveted to it are two brush holders (8) and (11) and the switch plate with contact spring blade (12).

Commutator end (C.E.) cover assembly

425. Fitted to the C.E. cover (7) is a switch knob, the positive (4) and the earthed negative (5) terminals, the wireless interference suppression units and a contact plate. The switch knob is moulded to a spindle fitted with a cam (13) at its other end which locates against the switch blade. When the knob is turned to the ON position the cam presses the blade against the adjacent brush holder (8).

426. The suppression components comprise a 1.0 μF capacitor (15) and a 0.001 μF capacitor (3) both connected across the wiper terminals with a choke (6) connected in the positive lead between the two capacitors.

427. The contact plate (2) locates against a seating in the end cover. It has a spring contact (1) soldered to it which contacts the negative brush holder (11). A similar contact (14) fitted to the top of the 1.0 μF capacitor contacts the switch plate.

428. Two screws secure the brush gear base and end cover to the body. Compression springs fitted on the screws between the brush gear base and the end cover press these two items against their seatings.

HULL

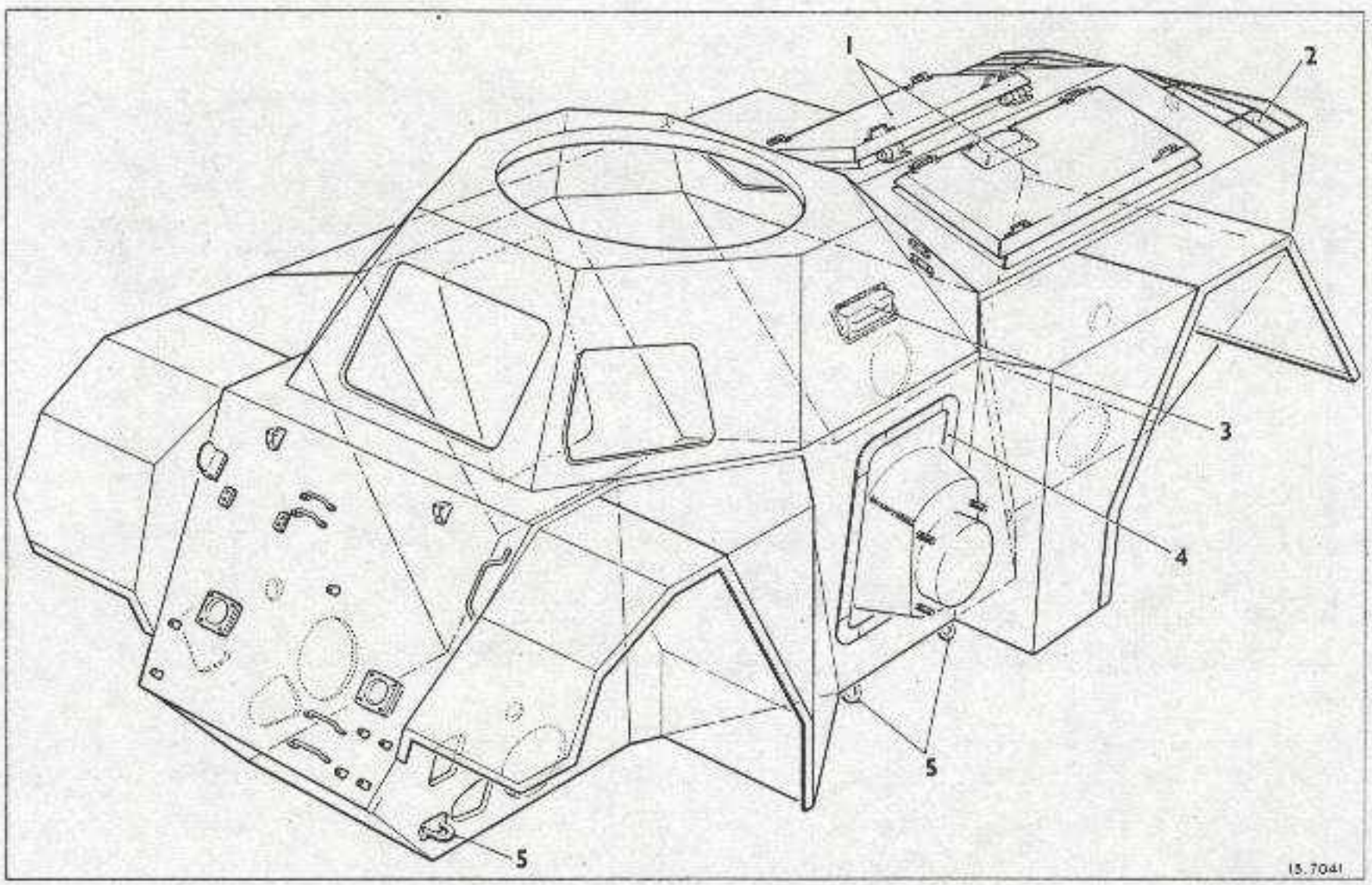
GENERAL

429. The hull (Fig 78) is constructed from steel armour plates welded together to form a box-like structure which is divided by a bulkhead into engine and crew compartments. The bottom plate (Fig 79) is provided with drain plugs and apertures which afford access for draining the internal units. The apertures are sealed with cover-plates secured by bolts.

430. The crew compartment of the Mk 1 liaison vehicle (Fig 80) is open at the top and is provided with a canvas cover, whilst the Mk 2 reconnaissance vehicle (Fig 81) has a roof plate with a mounting ring for a turret, details of which are given under para 439.

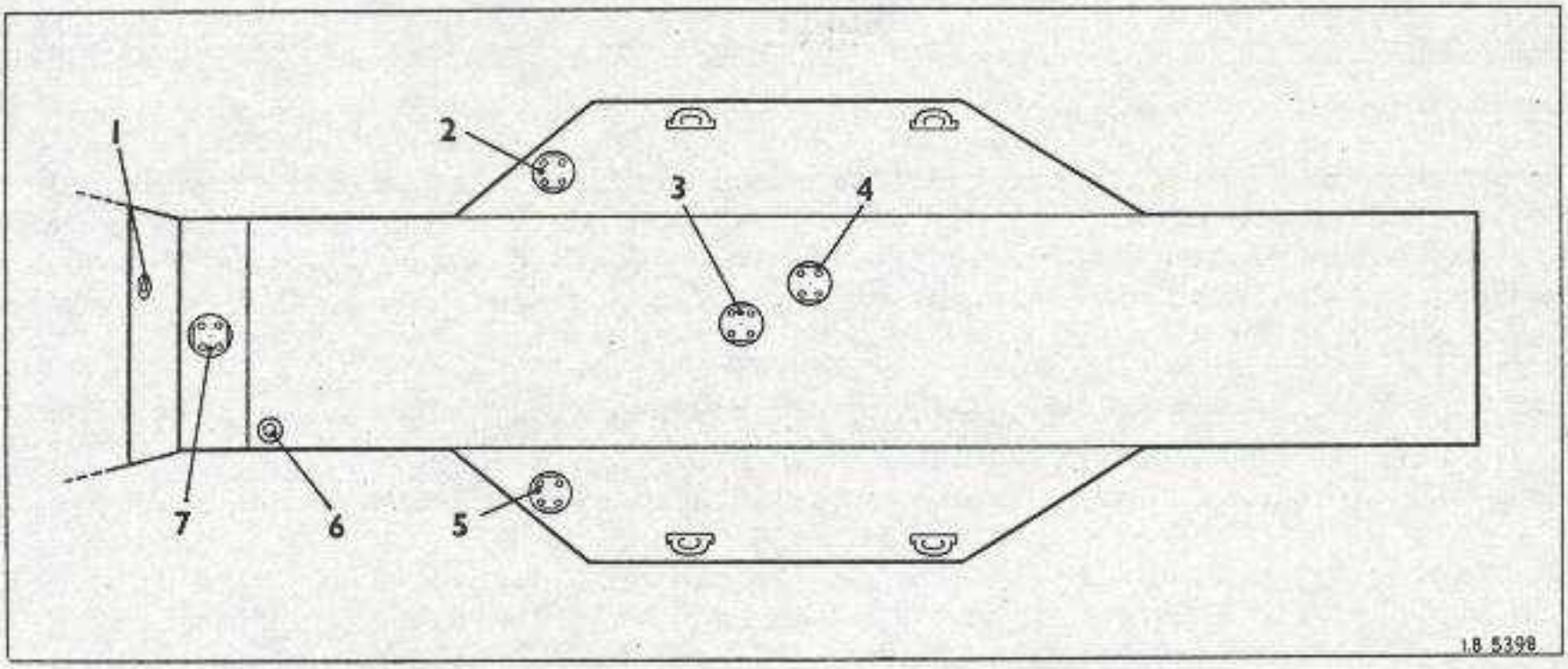
431. The engine compartment is fitted with two hinged access covers (Fig 80(8)) which are dished to form air louvres so that air can be drawn into the engine compartment by the cooling fan and expelled through louvres (9) on the rear of the hull.

432. A driver's hinged escape hatch is fitted to the front of the hull. A hinged visor flap (Fig 82(24)) located on the escape hatch is fitted with a periscope housing (25) and is spring-loaded to retain it in the open position. Two similar visor flaps are fitted, one on each side of the driver's escape hatch. Provision is made for fitting a windscreen with wiper in the front hatch aperture when required.



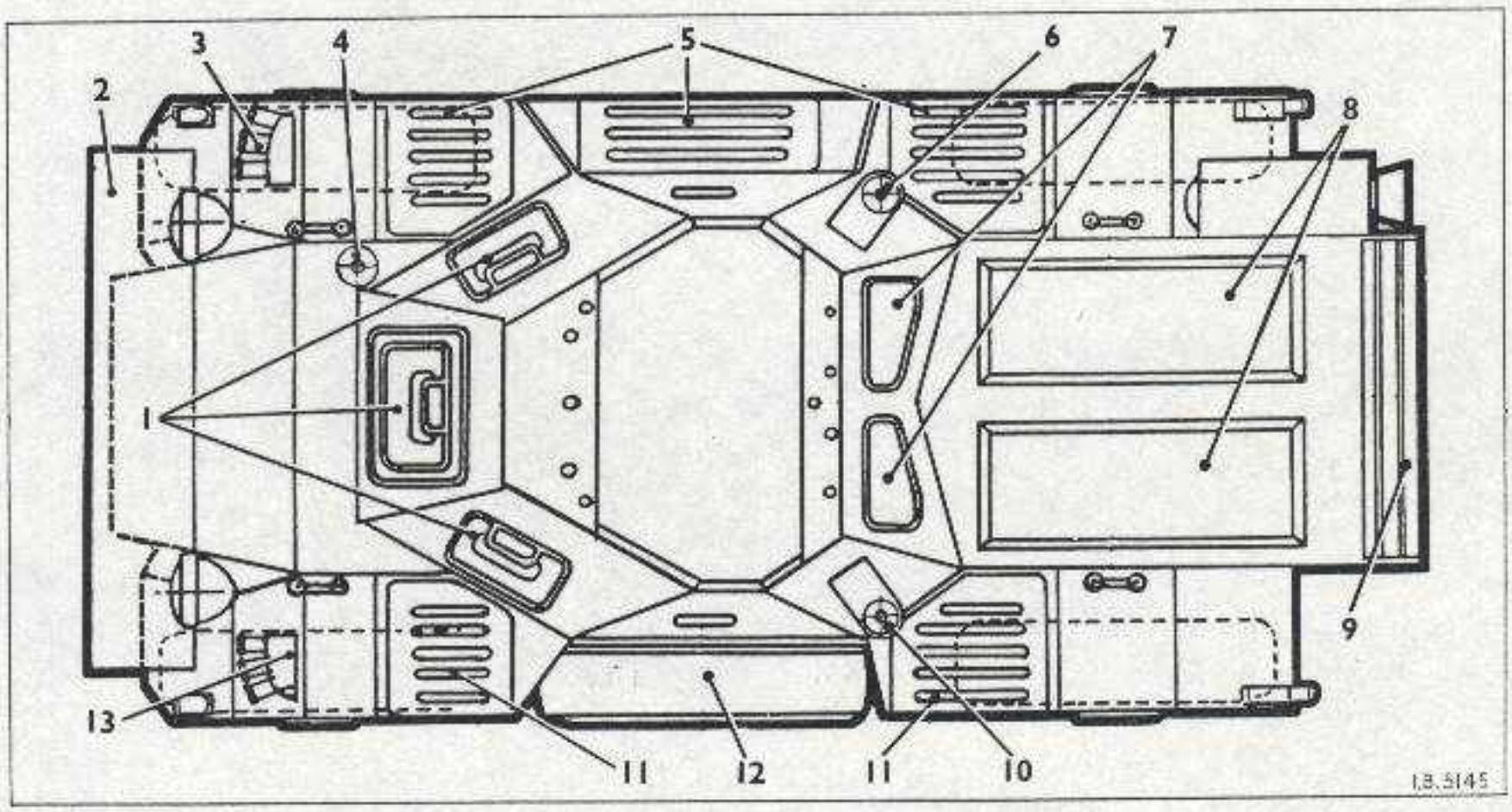
1 Engine covers
2 Air louvres
3 Side visor
4 Side escape hatch
5 Lashing eyes

Fig 78 Hull



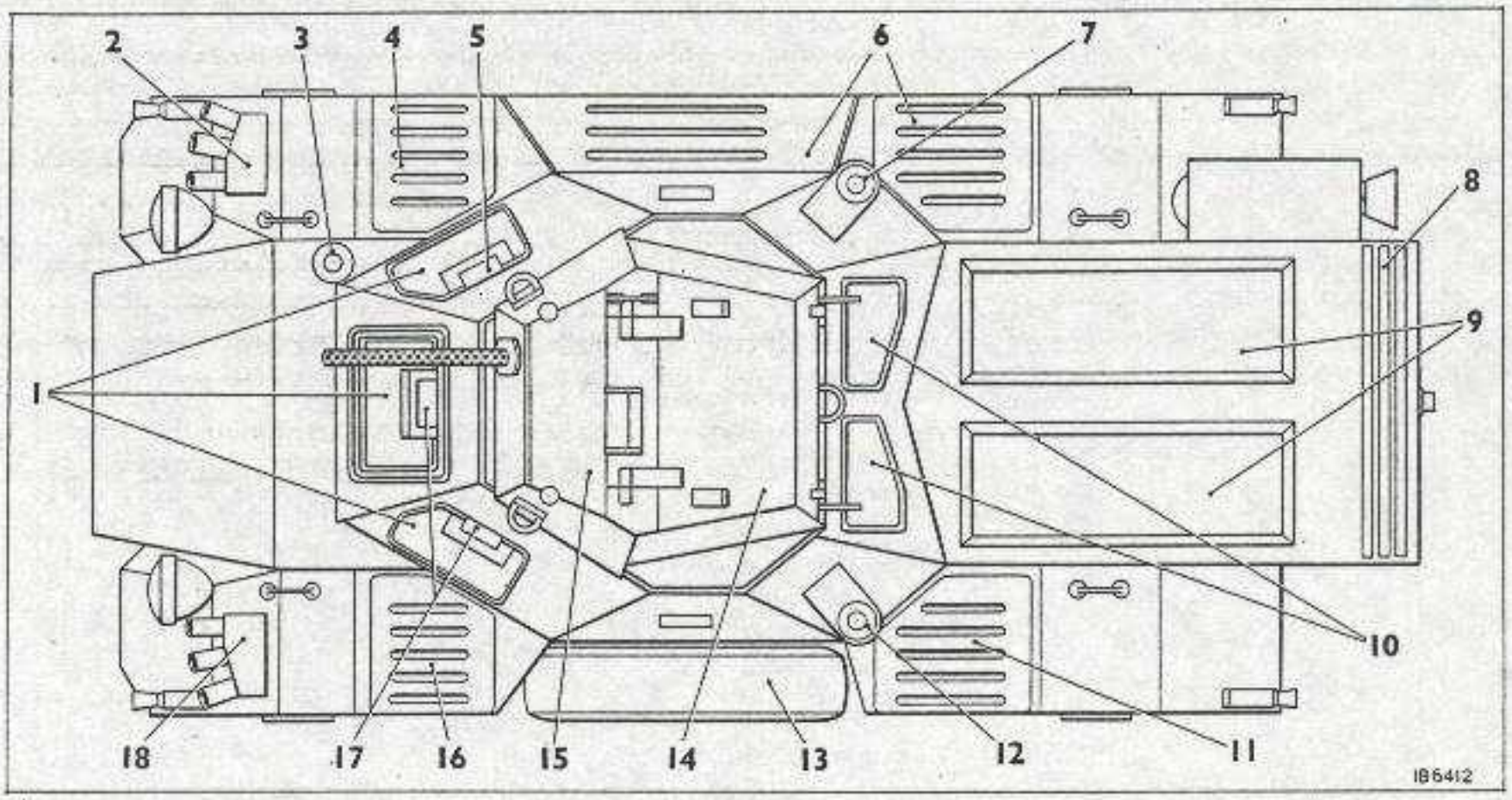
1 Coolant drain access plug
2 Fuel drain plug access plate
3 Gearbox drain plug access plate
4 Transfer box drain plug access plate
5 Fuel drain plug access plate
6 Hull drain plug
7 Engine oil tank drain plug access plate

Fig 79 Drain access plates and plugs



1 L.H. smoke dischargers
2 Driver's flaps
3 Sand channels
4 R.H. smoke dischargers
5 Aerial base
6 Stowage containers
7 Aerial base
8 Rear observation flaps
9 Engine covers
10 Air louvre
11 Aerial base
12 Stowage containers
13 Spare wheel

Fig 80 Plan view of Mk I liaison vehicle



1	Driver's flaps	7	Aerial base	13	Spare wheel
2	Smoke discharger	8	Air louvre	14	Turret door
3	Aerial base	9	Engine covers	15	Turret
4	Stowage container	10	Rear observation flaps	16	Stowage container
5	Periscope	11	Stowage container	17	Periscope
6	Stowage containers	12	Aerial base	18	Smoke discharger

Fig 81 Plan view of Mk 2 reconnaissance vehicle

433. Two hinged flaps (Fig 80(7)) are provided at the rear of the hull and side visors, fitted with splinter-proof glass screens, are provided, one at each side of the hull. Two jettison type escape hatches are provided, one at each side of the hull.

434. The floorboards and covers (Fig 83) are secured with screws or by nuts on studs welded to the hull bottom plate.

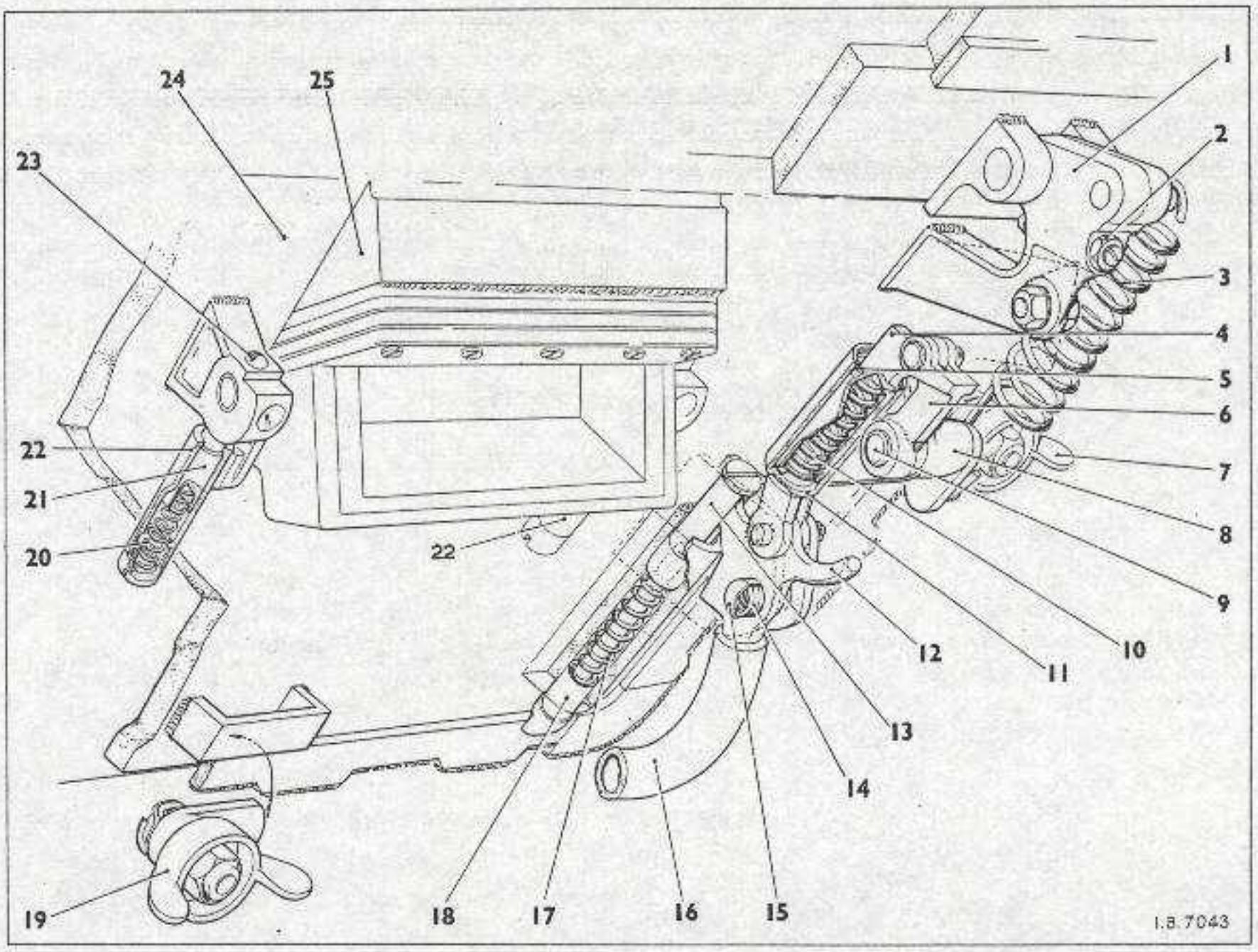
435. Four lashing eyes (Fig 78(5)) are fitted to the sides of the hull and four to the bottom centre plate. Trunnion brackets for attachment of the transfer box mountings are welded on each side of the bottom plate and at the rear end, a trunnion bracket is also fitted for the engine mounting.

436. External stowage containers are fitted behind each front wheel, in front of each rear wheel and on the right-hand escape hatch.

SEATS

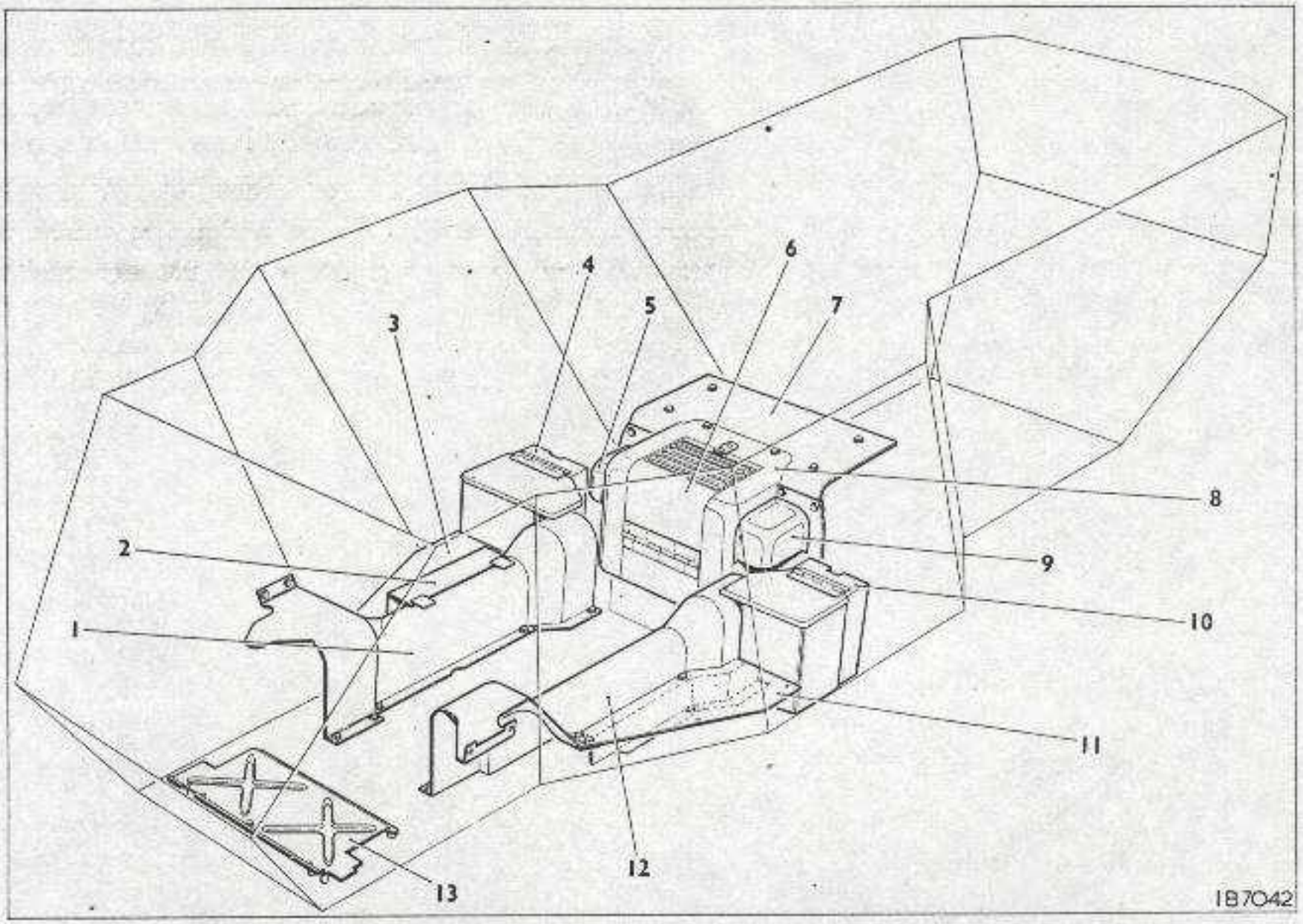
437. The driver's seat (Fig 84) is mounted on runners and can also be adjusted for height. The gunner's seat (Fig 85) is mounted on runners secured to the cover over the transfer box and can be raised, or lowered, to one of two positions.

438. Additional hinged seats are mounted on the side escape hatches and stowage bins in the Mk 1 liaison vehicle.



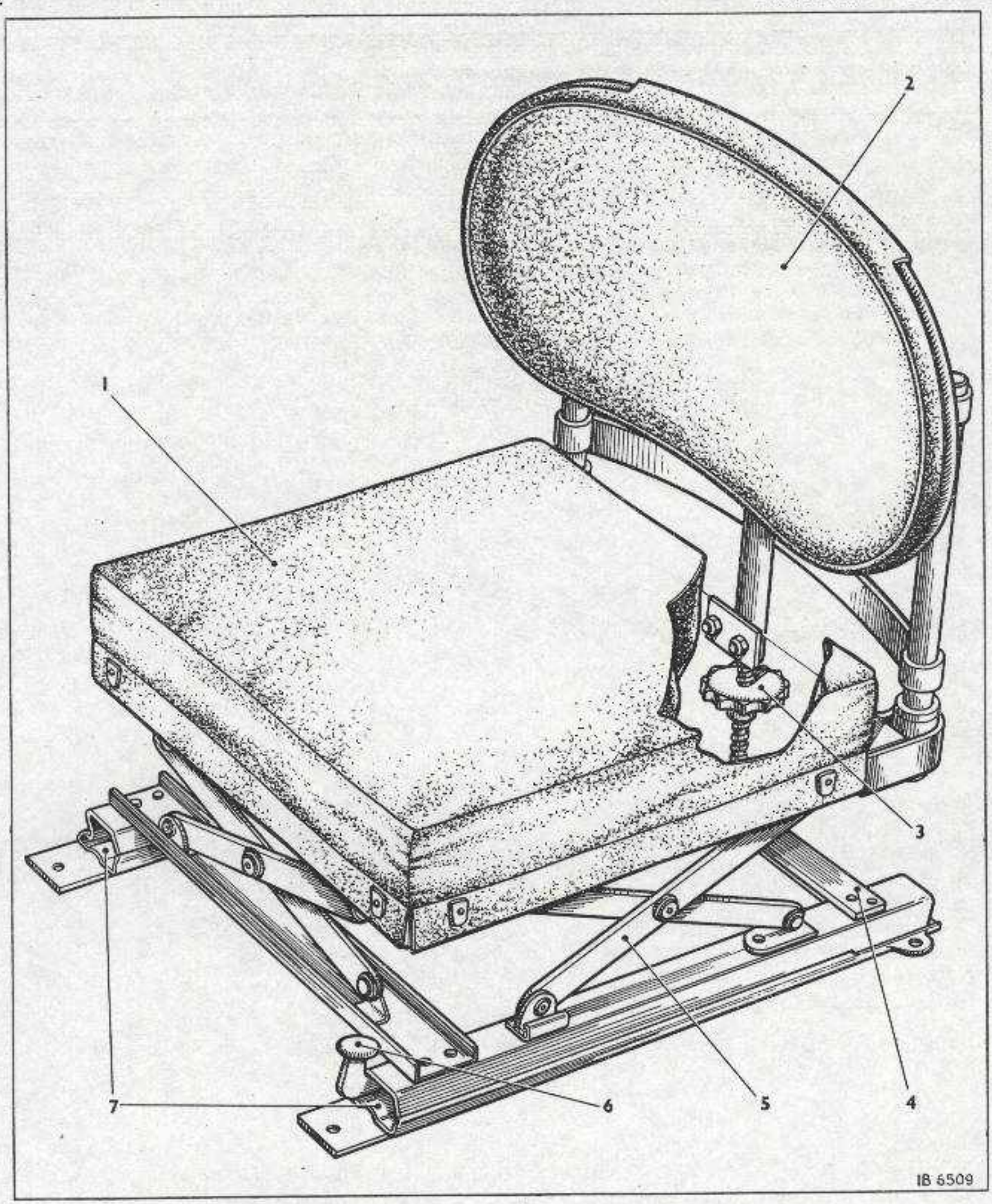
1 Flap hinge
2 Adjusting screw
3 Flap control spring
4 Male tubular link
5 Circlip
6 Solid link
7 Escape hatch locking catch
8 Solid link stud
9 Joint pin
10 Tubular link spring
11 Female tubular link
12 Catch release lever
13 Flap catch latch
14 Release lever friction spring
15 Friction spring thimble
16 Operating handle
17 Flap catch spring
18 Flap snap catch
19 Flap locking catch
20 Periscope locking plunger spring
21 Periscope locking plunger
22 Periscope locking handle
23 Periscope locking handle screw
24 Flap
25 Periscope housing

Fig 82 Driver's front visor flap



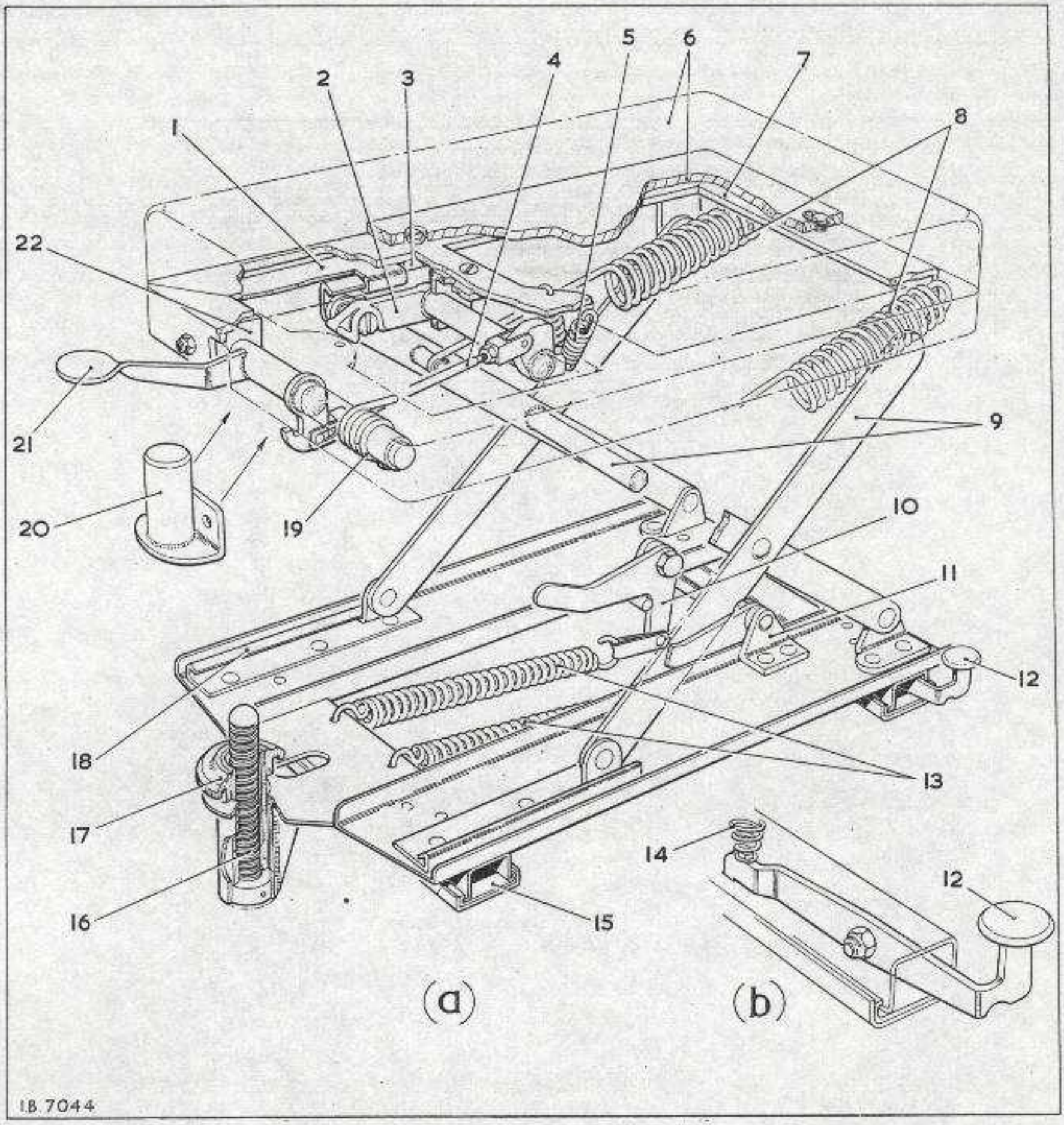
1 Right propeller shaft tunnel
2 Speedometer cable guard
3 Right hull floorplate
4 Right lower seat, including bin (Mk 1 Liaison vehicle only)
5 Right transmission cover
6 Transmission cover door
7 W/T set support and transmission cover
8 Top transmission cover
9 Left transmission cover
10 Left lower seat, including bin (Mk 1 Liaison vehicle only)
11 Left hull floorplate
12 Left propeller shaft tunnel
13 Driver's floorplate

Fig 83 Floor plates and covers



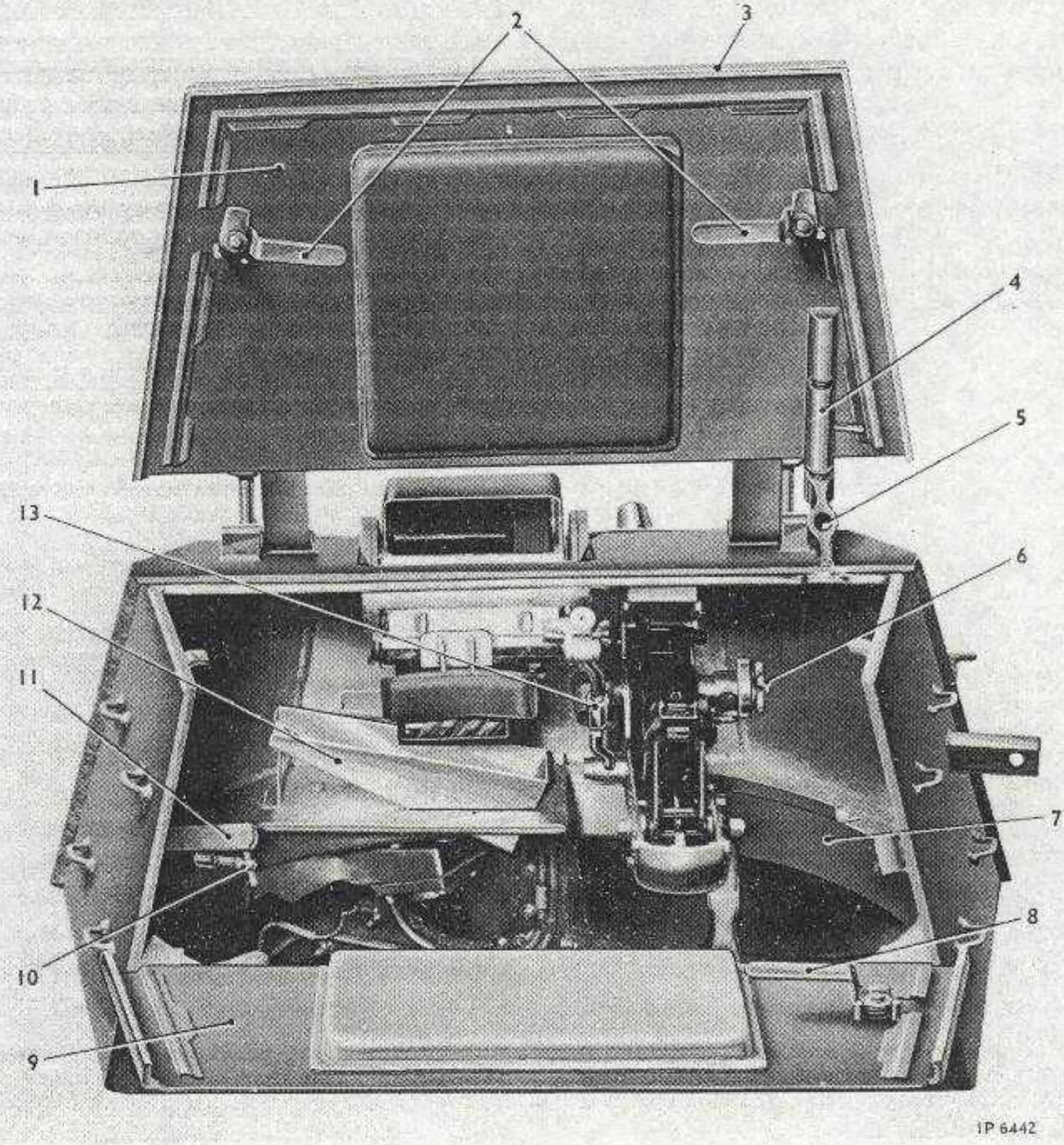
1 Cushion
2 Backrest
3 Vertical adjustment nut
4 Frame
5 Support
6 Horizontal adjustment lever
7 Guide rails

Fig 84 Driver's seat



1	Top slide rail	10	Starter lever	18	Bottom slide rail
2	High catch	11	Starter bracket	19	Spinner catch return spring
3	Limit stop	12	Fore and aft catch lever	20	Spindle bracket and protecting tube
4	High catch connecting rod	13	Starter springs	21	Spinner catch and operating lever
5	Double tension spring	14	Bottom catch compression spring	22	Spinner catch bar bracket
6	Cushion and board	15	Guide rail and channel		
7	Seat frame	16	Vertical adjustment spindle	(a)	Arrangement of seat
8	Main lift tension springs	17	Vertical adjustment spinner	(b)	Detail of catch lever
9	Cross levers and torsion bar				

Fig 85 Gunner's seat



1 Roof door
2 Roof door catch handles
3 Lip
4 Roof door retaining bolt
5 Socket bracket
6 Elevating clamp
7 Mounting ring
8 Rear door catch handle
9 Rear door
10 Locking pin
11 Traversing handle
12 Ammunition tray
13 Sight linkage

Fig 86 Turret open

TURRET

GENERAL

439. A turret is provided on the Mk 2 vehicle to give overhead protection to the gunner. It can be traversed manually through 360 deg and is provided with a friction brake operated in conjunction with the traversing handle.

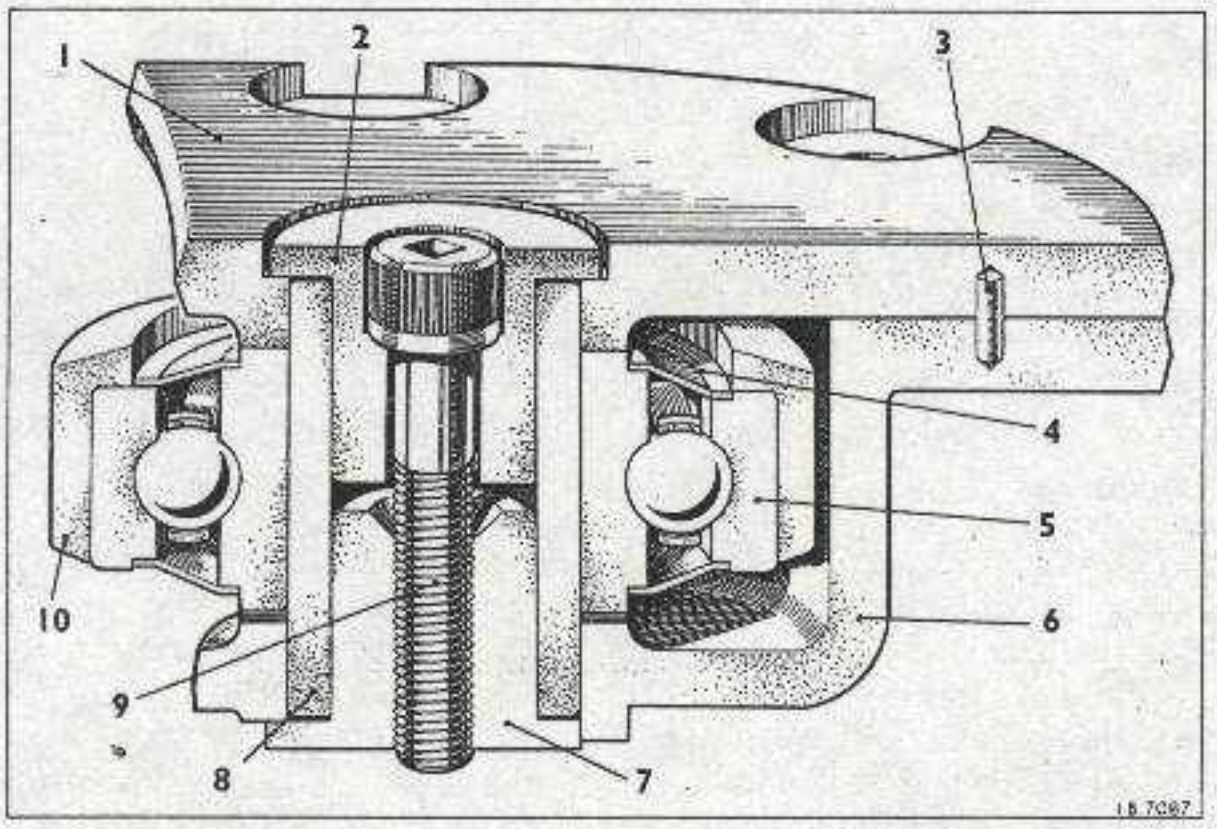
TURRET (Fig 86)

440. The turret is fabricated and has, bolted to it, a mounting ring (7) which accommodates three equidistant ball bearings on which the turret rests and rotates.

441. The bearings (Fig 87) are held between an inner (6) and outer (1) housings bolted to the hull. The outer housing is recessed to hold a plain bearing (2) through which an Unbrako socket-headed screw (9) passes and screws into a tapped bearing (7) located in the inner bearing. The bearings are held apart by a sleeve (8) on which fits a ball bearing (5). Around the ball bearing is a tapered collar (10) which fits into an annular groove cut in the mounting ring and on which the turret rests. The annular groove in conjunction with the bearing mounted collar prevent any possibility of the turret lifting. Shims are placed between the inner housing and the underside of the ball bearing to eliminate endplay in the housing.

442. The turret front plate (Fig 88(4)) is sloped rearwards and, to accommodate the MG barrel, has cut in it on the R.H. side a slot of sufficient length to permit maximum elevation and depression of the gun.

443. The turret roof plate is in two parts, the rear portion being hinged to form the roof door (Fig 86(1)). The door has three open positions at approximately 40 deg 80 deg and 170 deg in any of which it is secured by a spring-loaded bolt (4) which enters the appropriate socket (5) on the fixed portion of the roof plate. When fully open, rubber buffers (Fig 88(3)) on the door rest on adjustable stops (1) secured to the front side plates.



1 Outer housing
2 Plain bearing
3 Dowel
4 Grease retaining plate
5 Bearing
6 Inner housing
7 Tapped bearing
8 Sleeve
9 Unbrako socket headed screw
10 Collar

Fig 87 Race ring bearing

BULBS

Lamp	*Volts*	*Watts*	*Type*	*Inter-service Part No.*
Head	26	50/50	British pre-focus	X954508
Side	26	6	S.C.C.	X952236
Tail	26	6	S.C.C.	X952236
Number plate	26	6	S.C.C.	X952236
Convoy	26	6	S.C.C.	X952236
Roof	26	6	S.C.C.	X952236
Instrument panel	26	6	S.C.C.	X952236
Indicator	26	6	S.C.C.	X952236
Oil pressure warning	26	6	S.C.C.	X952236
Inspection	26	6	S.C.C.	X952236

ENGINE

15. The engine installed in Ferret scout cars is the B60, No.1, of which two versions are applicable viz. the Mk 3A and the Mk 6A. These engines are similar, the Mk 3A having B.S.F. and the Mk 6A U.N.F. threaded items. B series engines are dealt with in general in EMER Power S 522 and B60 engines in particular in EMER Power S 522/2.

ENGINE MOUNTING

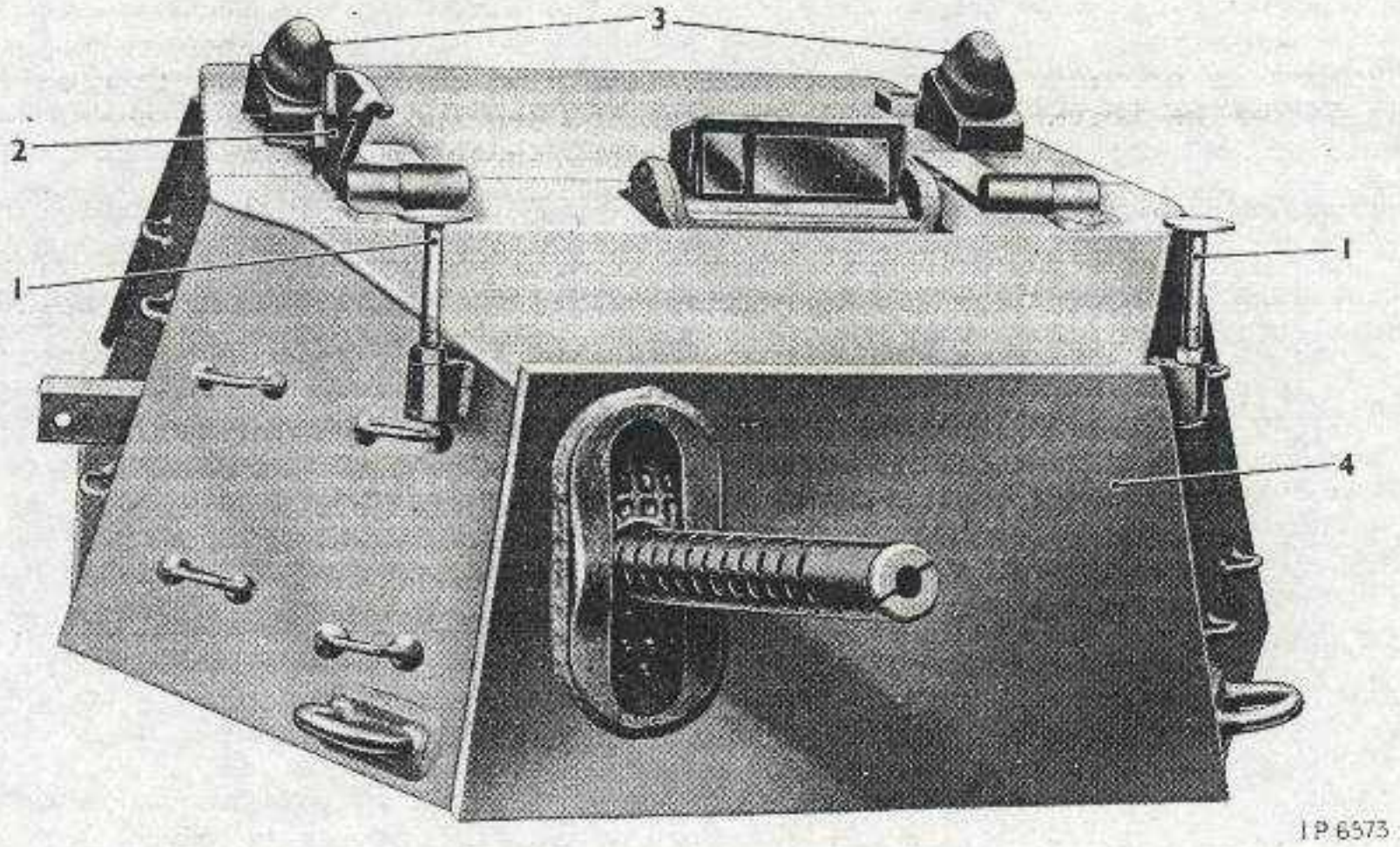
16. This mounting is incorporated with the oil tank - para 18. The mounting comprises two support tubes (Fig 9(1) and (2)) the rear ends of which are bolted, through flanged sockets (7) to the oil tank (5); whilst the opposite flanged ends are bolted to a mounting plate (8) secured between the engine flywheel housing and gearbox. The mounting plate is attached, through rubber buffer pads (9) to two brackets (steady plates) (10) secured to the hull. A plate (12) formed with two feet is secured between the engine timing cover and cylinder block. The feet rest on rubber blocks (3) which in turn rest on faces formed on the oil tank, the feet and blocks being secured by set-bolts screwed into the tank. The tank is supported by an angle bracket (6) bolted to the hull.

ENGINE LUBRICATION

17. The engine lubrication system (Fig 7) is fully described in EMER Power S 522 with the exception of the oil tank and oil cooler which are incorporated in the system when the engine is installed in the vehicle. Also, in this installation, the oil returned from the generator gearbox is taken direct to the oil tank and not the engine sump.

OIL TANK

18. The oil tank forms part of the engine mounting - para 16. The tank (Fig 9(5)) is a saddle type aluminium alloy casting to which an adaptor cover plate (13) incorporating unions for the pipe connections, and inspection covers (14) are fitted. The tank is provided with an extended filler pipe with a clip-on cap (18) a dipstick tube with a push-in type dipstick (17) an extended breather pipe and breather (11), and a drain plug located in the base of the tank.



1 Door stop
2 Socket bracket
3 Buffer
4 Front plate

Fig 88 Turret closed

444. The rear door (Fig 86(9)) is hinged at the bottom, and, when lowered, can be utilized as a seat. It is secured in this position by a hand operated catch (8). This same catch is also used to lock the door in the closed position in conjunction with a lip (3) on the underside of the roof door.

445. The turret can be locked in the travelling position, i.e., 12 o'clock, by a spring-loaded plunger (10) which engages in a recess in the turret mounting plate. The plunger is housed in a sleeve which is secured to the turret ring and is disengaged by a turn of the plunger handle, clock- or anti-clockwise, causing a peg to ride up the sleeve inclines. It is held in position by the peg resting in a groove cut in the sleeve flats.

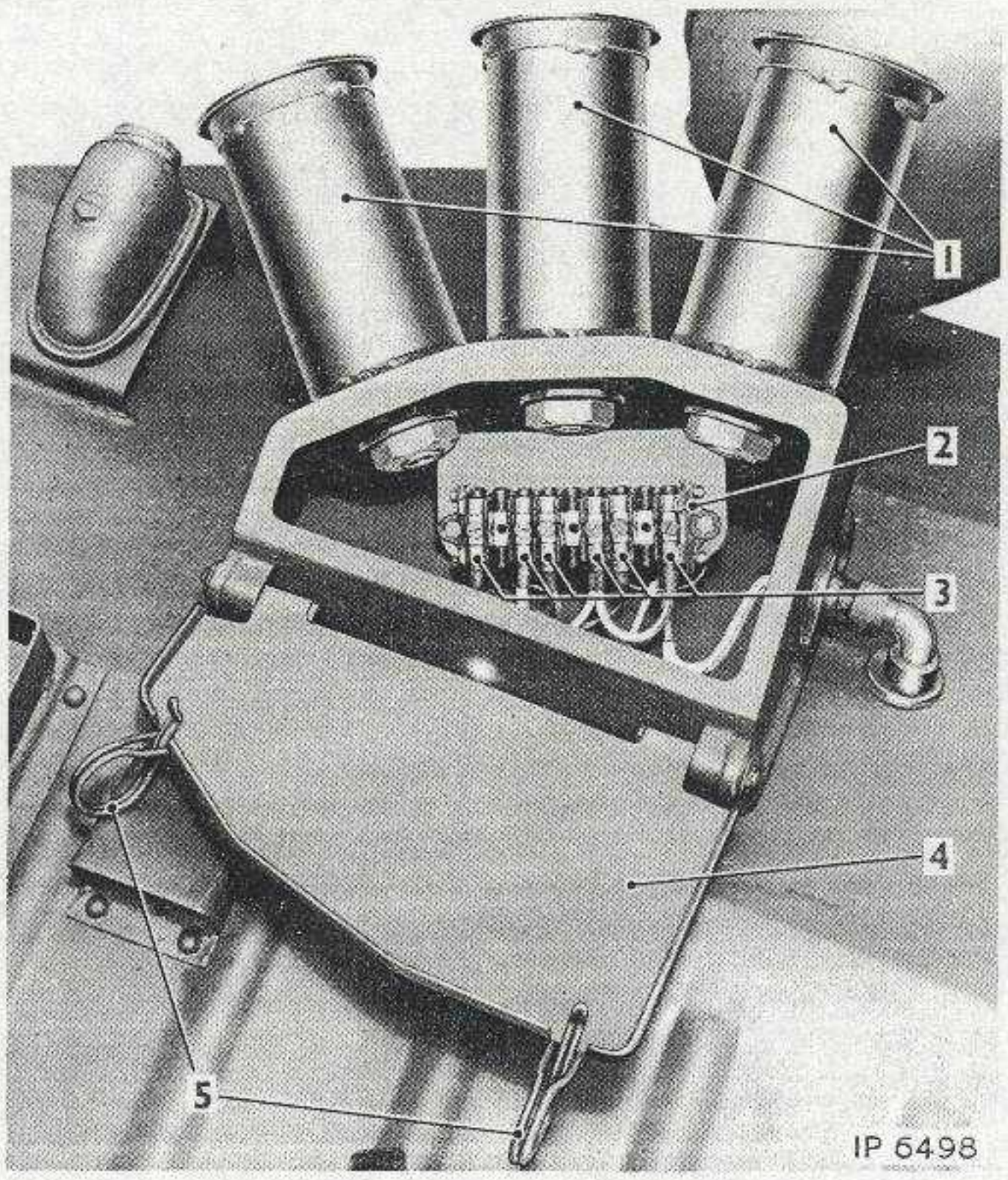
446. A friction brake operated by the traversing handle (11) is provided for damping the turret traverse when travelling. It consists of a ferodo block let into the turret sill and put under pressure by a cam on the underside of the spring-loaded traversing handle. The ferodo block rests on the hull mounting plate and the requisite friction between the rotating turret and non-rotating hull is applied by varying the downward pressure of the traversing handle. When the turret is not being traversed the helical spring forces the cam into contact with the ferodo block and automatically ensures the braking of the turret.

ARMAMENT

MULTI-BARREL SMOKE DISCHARGERS No.3, MK I (Fig 89)

447. The dischargers are issued in pairs, right and left, and fitted on the front wings to cover the front of the vehicle.

448. They are fired electrically from inside the vehicle, the current being supplied from the 24V vehicle batteries. The circuit (Fig 62) is earth return, via the 30A circuit breaker located in the distribution box, the earth return terminal being located on the discharger bracket.



1 Barrels
2 Terminal block
3 Contacts
4 Cover
5 Spring clips

Fig 89 Multi-barrel smoke dischargers

449. Each discharger has three barrels (1) attached to the bracket assembly. The barrels are mounted in line at an angle of 45 deg elevation to the base of the bracket and are spread laterally from each other to give a spread angle of 40 deg when fired. Maximum range is approximately 60 yards.

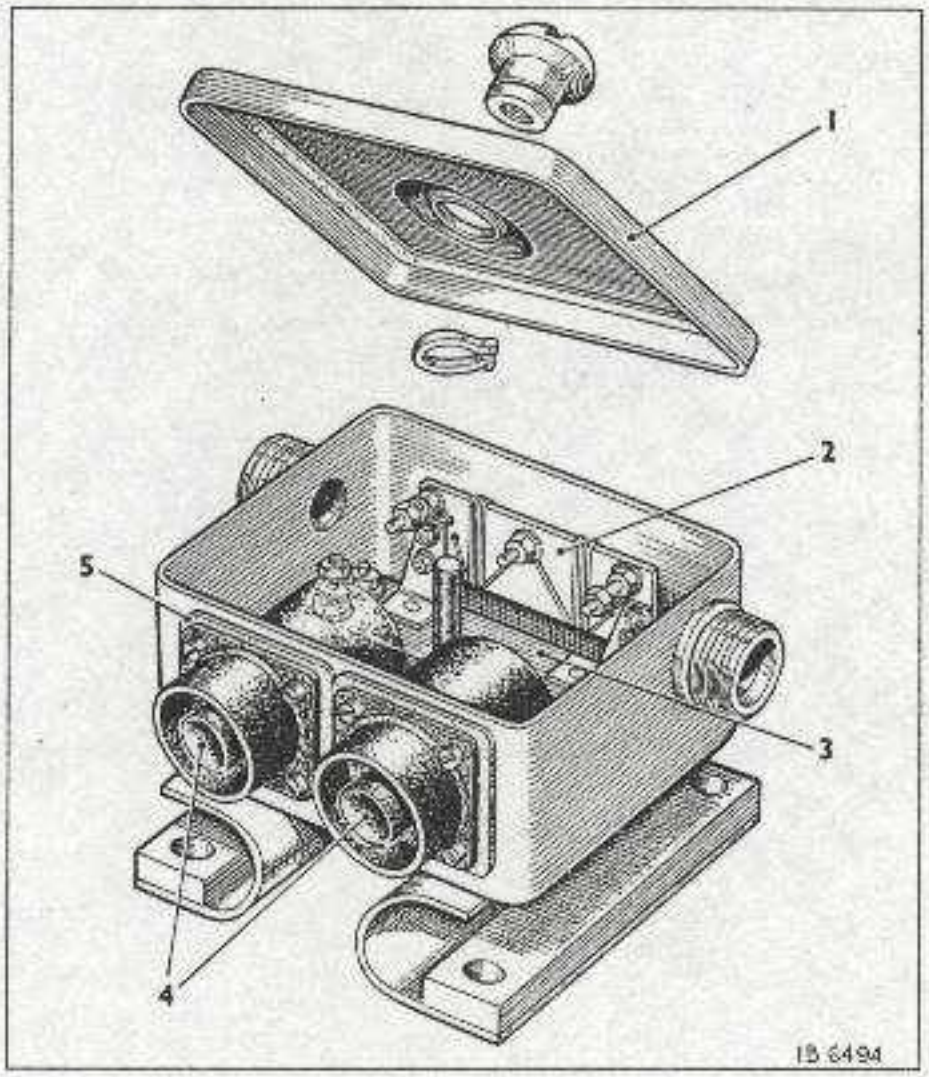
450. Around the barrel mouth is a safety flange to prevent the grenade being loaded with the lever outside the barrel. Vents in the bottom of the barrels act as drain holes for water entering the barrels.

451. The bracket assembly contains the terminal block (2) which carries three pairs of contacts (3) for the leads of the Fuze, Electric, F103. The contacts are wired in series with the push button firing box.

452. The bracket assembly is screwed to the wings and carries a hinged cover (4) to protect the electrical components from the weather. The cover is secured in position by two spring clips (5).

FIRING BUTTON BOX (Fig 90)

453. The firing button box is located on the right-hand wall inside the vehicle and houses a limiting resistor (2) and two switches (4) which complete the circuit to the electric fuze. The spring-loaded type moulded switches are secured to the side of the firing button box by Parker Kalon screws.



1 Lid

2 Resistor unit

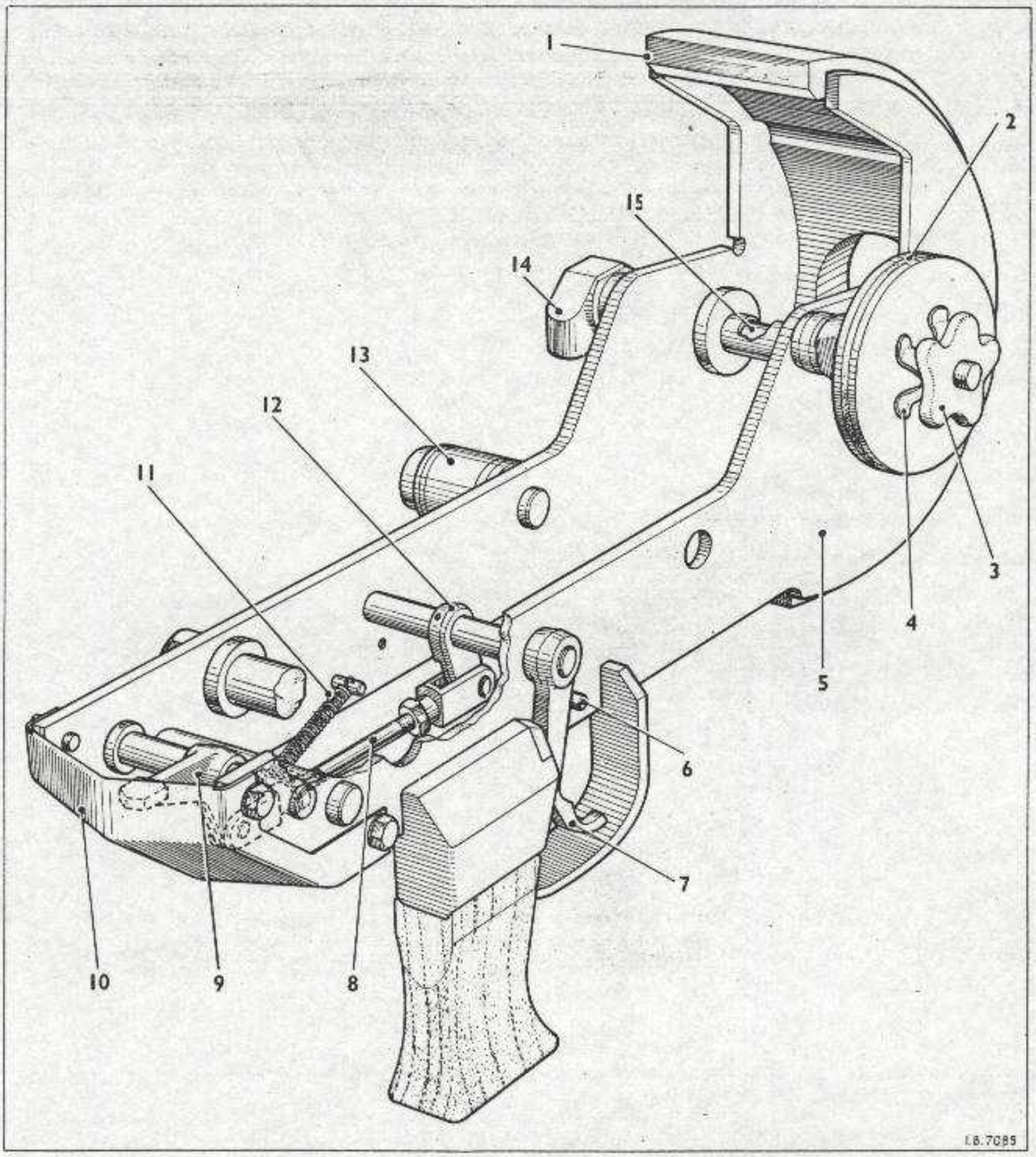
3 Terminal block

4 Push button

5 Gasket

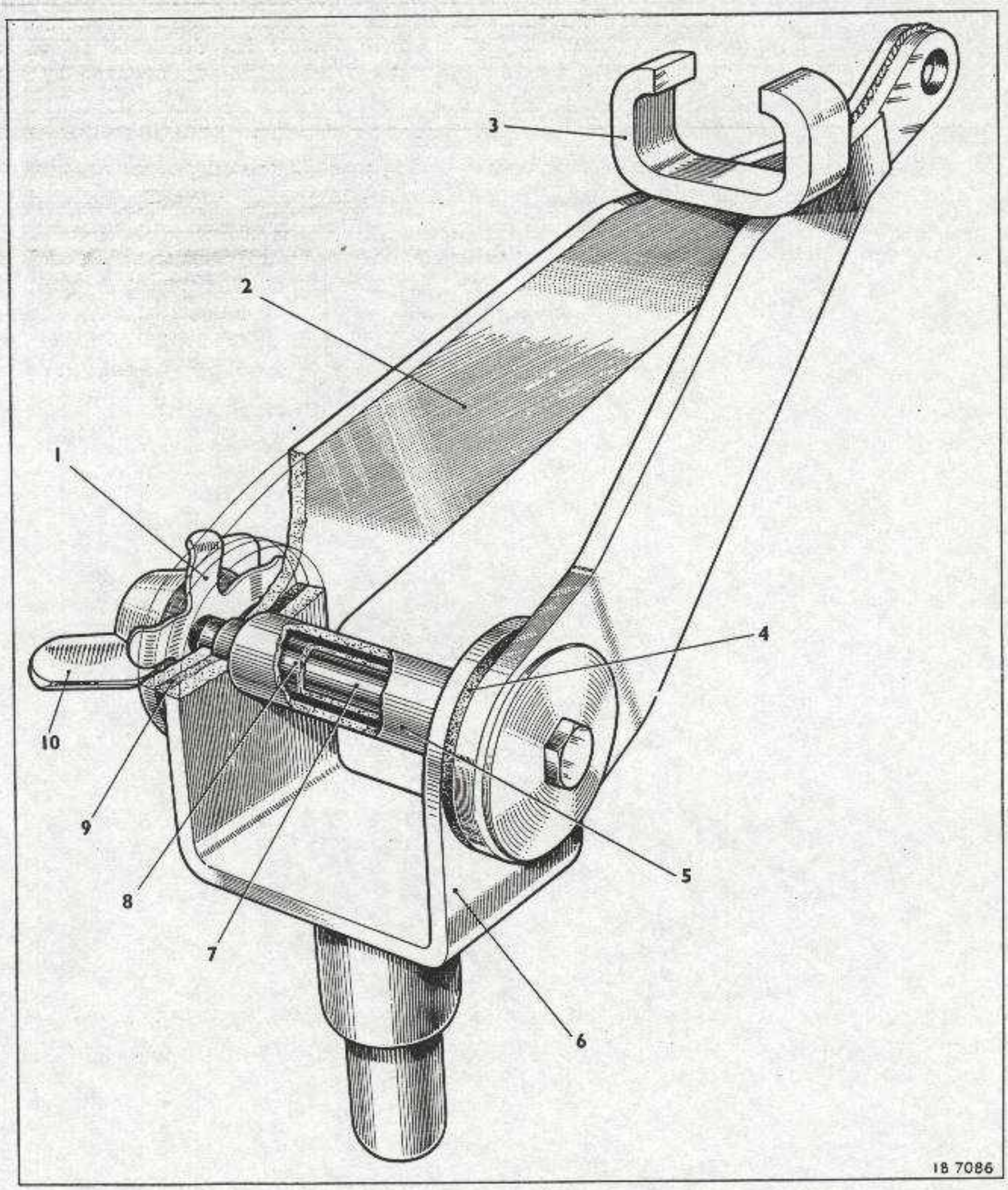
Fig 90 Firing button box

454. The resistor unit is mounted on a terminal block (3) and consists of 36 turns of No.28 S.W.G. Eureka wire having a resistance of 8 ohms. It is centre tapped for use where a 12V supply is provided. With the 24V vehicle supply the resistor is connected in series with the incoming supply. The box is closed by a lid (1) secured by spring clips.



1	Mantlet	6	Stop pin	11	Spring
2	Friction disc	7	Trigger	12	Trigger lever
3	Hand nut	8	Adjusting rod	13	Sight linkage
4	Spider spring	9	Firing lever	14	Capsquare
5	Cradle	10	Guard plate	15	Bolt

Fig 91 Mounting, Browning .300 in. MG No.4, Mk 1



1	Spider spring	6	Fork
2	Carrier arm	7	Bolt
3	Clip	8	Bush
4	Friction disc	9	Friction disc
5	Spacer	10	Wingnut

Fig 92 Bren MG mounting of Mk I vehicle

MOUNTINGS

MOUNTING, BROWNING, ·300 in. MG, No.4, MK I (Fig 91)

General

455. The mounting is designed to hold a .300 Browning MG and give an elevation of 45 deg and a depression angle of 15 deg. To prevent the rear of the vehicle being hit by its own fire at extreme angles of depression, a stop rail is provided on the hull to limit the depression to approximately 10 deg in this direction. It is held to the turret front plate by trunnions secured by capsquares to a bracket welded to the front plate.

Description

456. The cradle (Fig 91(5)) consists of two side plates held together by transoms and tie-plates. On the front of the cradle is a semi-circular mantlet (1) which covers the slot in the turret front plate at all firing angles.

457. Incorporated in the right trunnion is a friction elevating clamp which can be set to suit the gunner's requirement. The clamp consists of a trunnion pin welded to the cradle over which fits an oil retaining bronze bush and capsquare (14). The capsquare secures the cradle to the mounting lugs welded to the turret. Two trunnion plates, the inner being secured to the end of the capsquare by a dowel and screws, have between them a friction disc (2) which is compressed between the two plates by a spider spring (4) fitted between the outer plate and hand-nut (3). To centralise the mounting in the turret aperture, washers of various thicknesses are provided and placed between the trunnion pin flange and capsquare.

458. Welded to the left cradle plate is a pin which supports one end of the sight linkage (13).

459. The rear end of the cradle carries the MG firing mechanism linkage. The linkage is adjustable and consists of a trigger (7) which is pinned to a trigger shaft secured between the cradle side plates. To prevent the trigger from being carried too far forward by its return spring (11) a stop pin (6) is fixed to the right side plate.

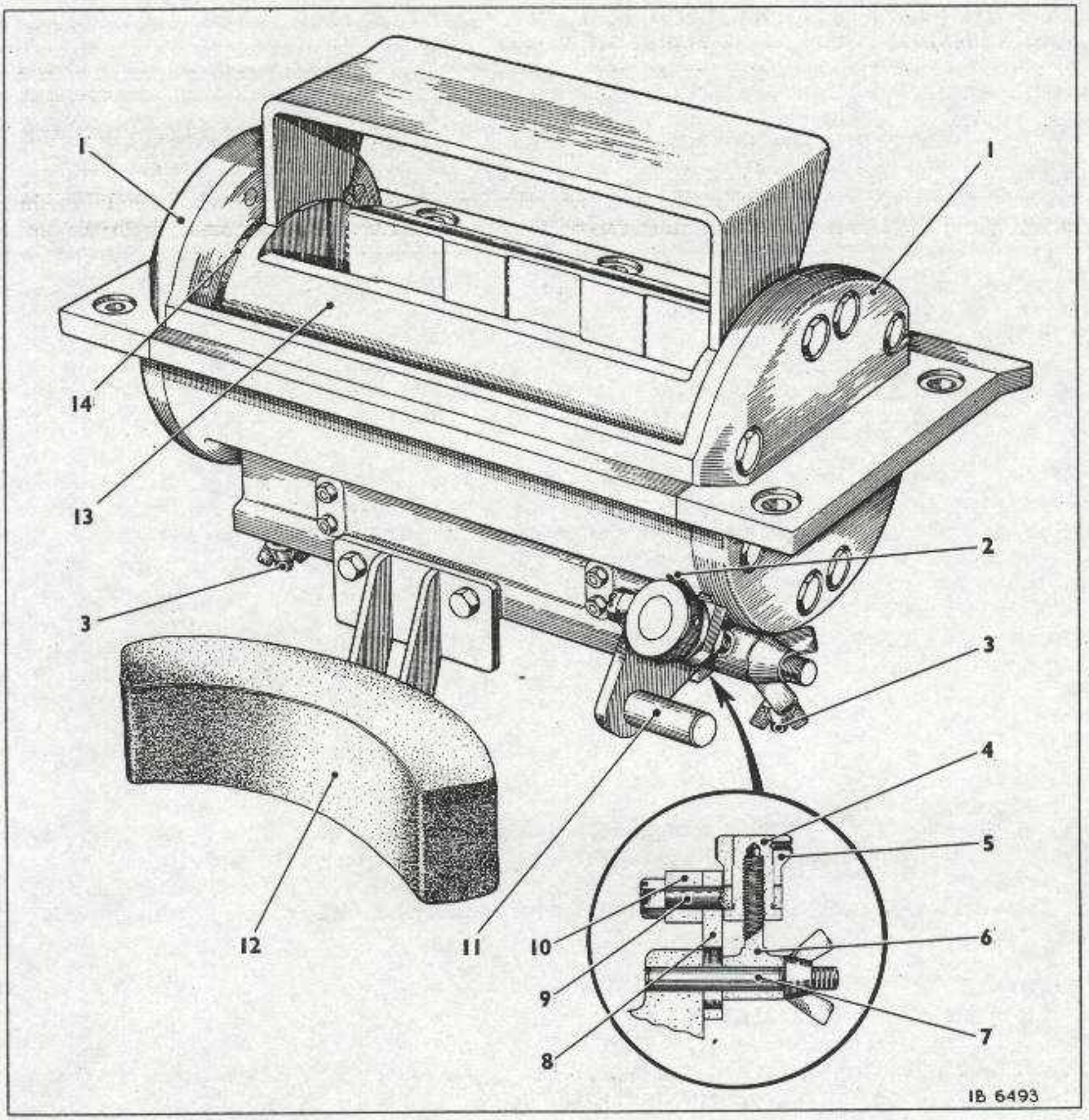
460. Midway along the trigger shaft is pinned a trigger lever (12) to which is connected the adjustable connecting rod (8). The other end of the rod is secured to the bell-cranked firing lever (9). The firing lever is pinned to the centre of the firing lever shaft which is held between the cradle side plates by collars allowing a rotational movement of the shaft without endplay.

461. Immediately behind the trigger is a mounting block welded to the right cradle side plate to which is secured a wooden handgrip.

BREN MG MOUNTING - MK I VEHICLE (Fig 92)

462. The Mk 1 vehicle has no turret but is provided with a removable MG mounting on the hull to take a Bren MG.

463. The mounting consists of a pintle welded to a fork (6) which fits into a socket on the hull. Held to the fork by a friction assembly is a carrier arm (2) which has a clip (3) welded to the top and a hole for a fixing bolt at the front to secure the MG in position.



1	End cap	6	Adjusting eyebolt	11	Linkage pin
2	Clicker spring	7	Pintle	12	Brow pad
3	Sight securing bolts	8	Control arm	13	Periscope housing
4	Adjusting barrel	9	Barrel eyebolt	14	Felt ring
5	Barrel head	10	Boss		

Fig 93 Mounting, sight, A.F.V., No.12, Mk I

464. The friction assembly consists of two friction discs (4) one on each side of the fork, placed under pressure by a disc washer on one side and a spider type spring (1) on the other. Passing through the assembly is a pivot bolt (7) with a wingnut (10) at one end by which the necessary pressure is applied. When not in use the mounting is stowed in the vehicle.

MOUNTING, SIGHT, A.F.V. No.12, MK I (Fig 93)

General

465. The mounting is made up of two main assemblies, the mounting bracket and the periscope housing (13). The mounting bracket is built up of two parts, each bolted to the turret roof plate in such a manner as to allow a small amount of end float for the fitting of the periscope housing. Felt strips fitted in each part of the bracket bear against the periscope housing and prevent the ingress of dirt or moisture into the turret.

466. The periscope housing is positioned by trunnions which permits the sight to be elevated or depressed to the limits of the MG mounting.

467. An adjustable sighting linkage connects the periscope housing to the MG mounting.

Mounting bracket

468. The mounting bracket is in two halves bolted to the turret roof plate. Each half has a groove cut along its length to house a felt strip which bears against the periscope housing and seals the aperture between the housing and bracket.

469. The ends of the bracket are closed by end caps (1) bolted to the bracket and are recessed in the centre to accommodate the housing trunnion bearings. Felt rings (14) positioned by the end caps, are placed between the end caps and periscope housing (13) to prevent metal-to-metal contact between the bearing faces, thus eliminating wear and at the same time allowing easy rotation of the housing in the bracket.

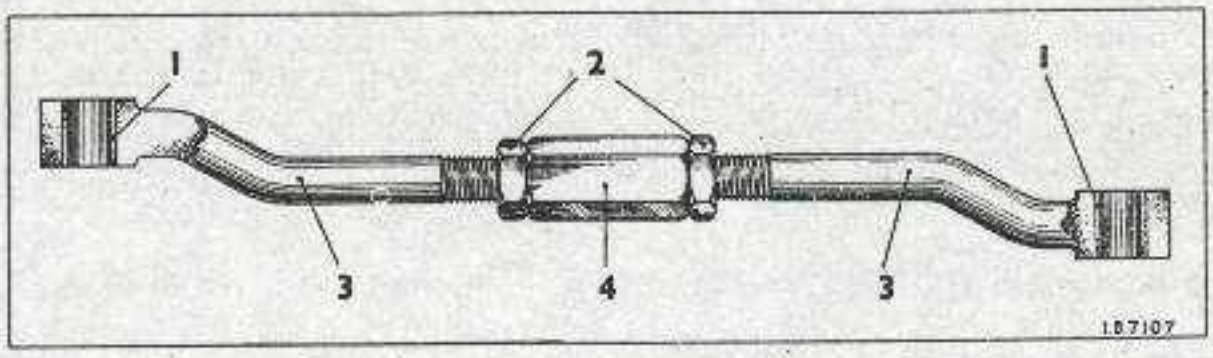
Periscope housing

470. The periscope housing is held in position by trunnions and is allowed free rotational movement of 45 deg elevation and 15 deg depression.

471. Fixed to the inside of the housing are two leaf springs which bear against the sight and prevent any play of the sight when mounted in its housing. A pintle (7) welded to the bottom of the housing receives the eyebolt (6) of the adjusting mechanism. Lugs are also formed on the bottom of the housing for the reception of the sight securing bolts (3).

Adjusting mechanism

472. The adjusting mechanism consists of a control and clicker mechanism. The control arm (8) is loosely hung on the right-hand trunnion and has welded to it a hollow boss (10) in which the barrel eyebolt (9) is secured. A pin (11) is also welded to the control arm on which the sight linkage is hung. The pintle (7) of the periscope housing passes through the slot in the control arm which limits the amount of adjustment that can be given to the sight by the adjusting mechanism. It also forms the support for the adjusting eyebolt (6).



1 Bush
2 Locking nuts
3 Link
4 Turnbuckle

Fig 94 Periscope linkage

473. The adjusting barrel (4) screws on to the adjusting eyebolt. It is flanged at the bottom and fits in the barrel eyebolt with its flange in contact with the bottom of the barrel eyebolt. The barrel is threaded at the top for the reception of the barrel head (5) which screws on to within 0.005 in. of the barrel eyebolt and is secured by a grubscrew.

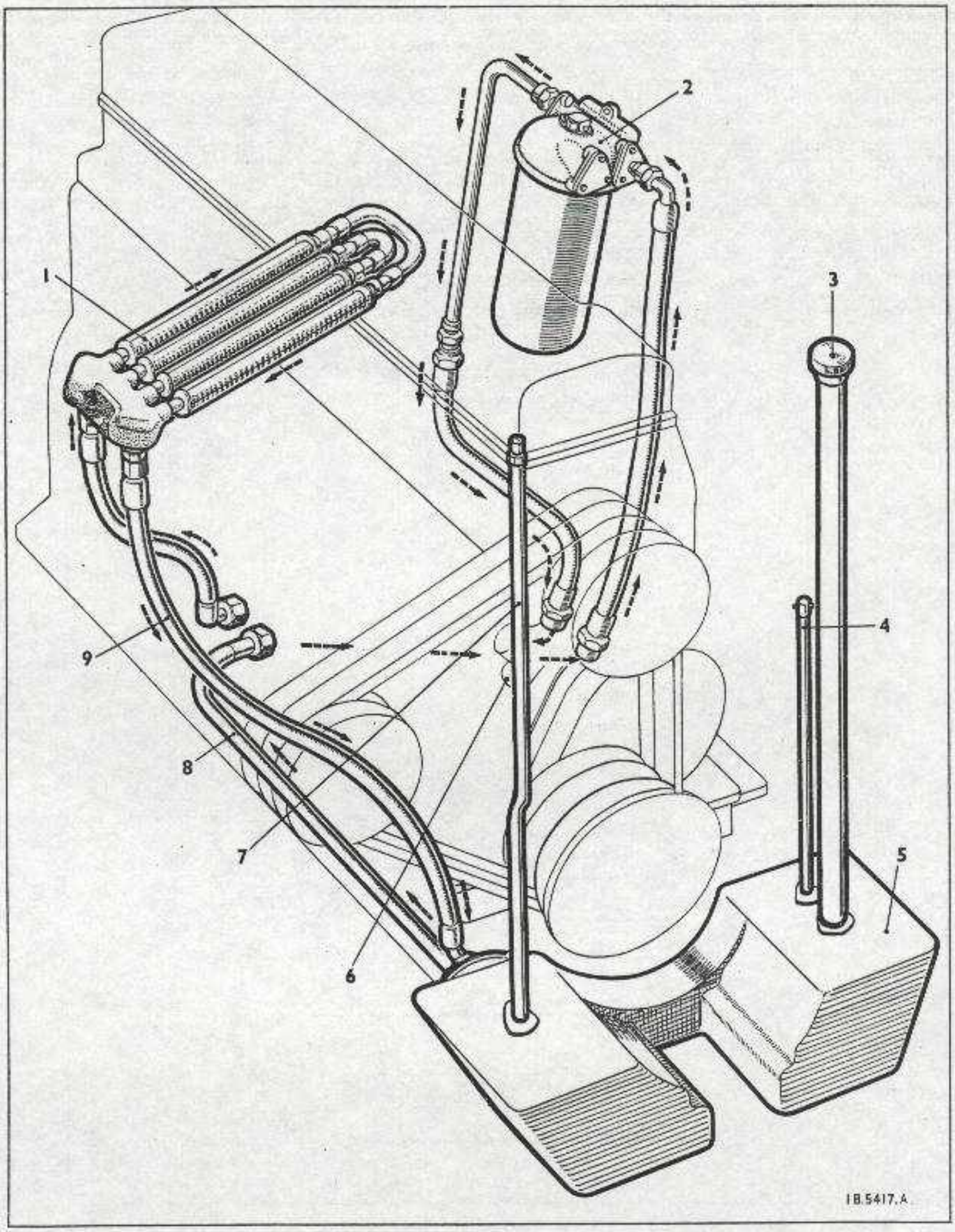
474. As the barrel eyebolt and, therefore, the barrel cannot move longitudinally, rotation of the barrel head causes the adjusting eyebolt to move in or out of the barrel. This action alters the position of the sight in the mounting bracket without movement of the gun allowing gun and sight to be adjusted to each other in elevation.

475. The adjustment is maintained by a spring-steel clicker (2) screwed to the barrel eyebolt engaging in serrations in the barrel head.

Sight linkage (Fig 94)

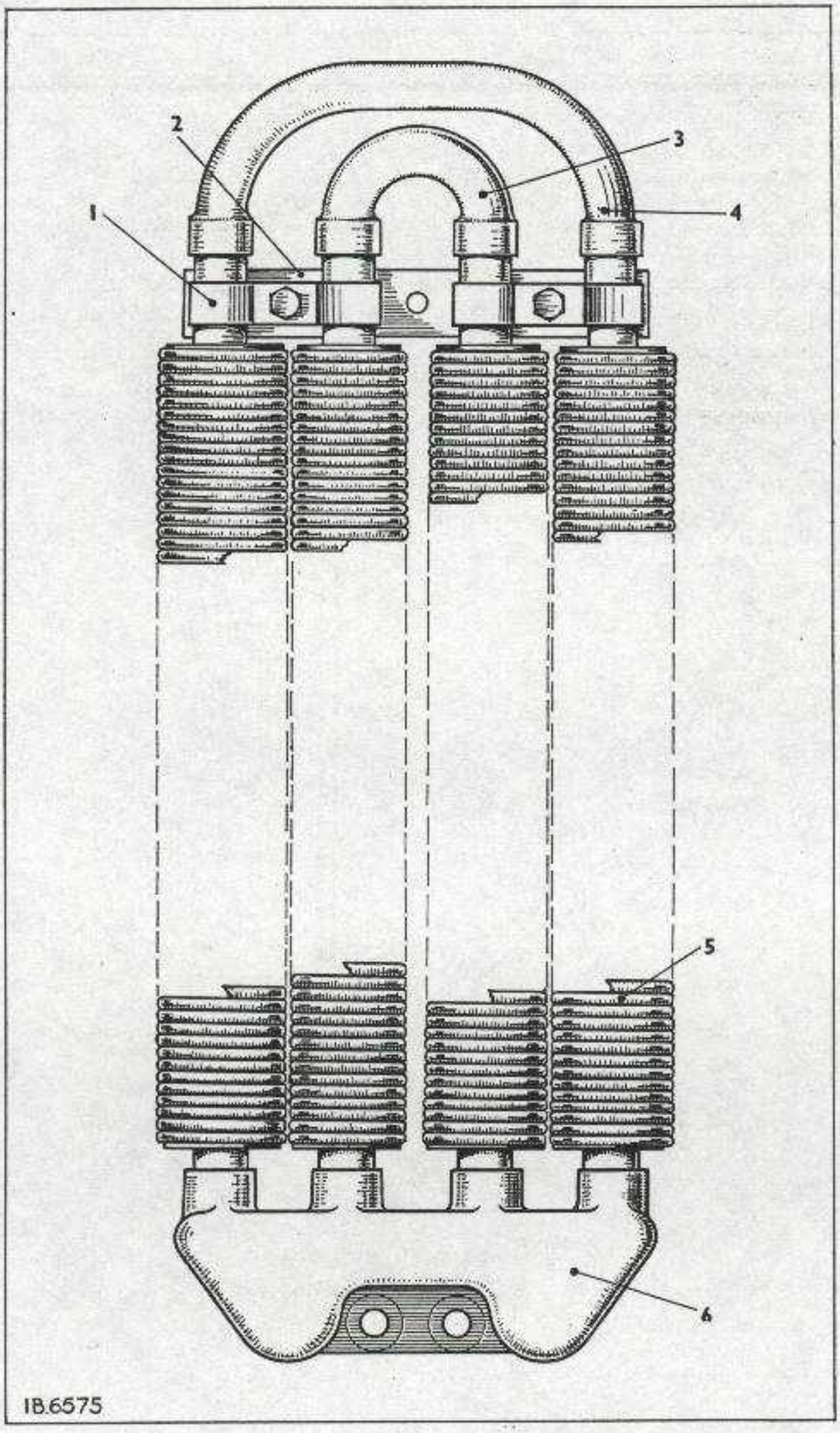
476. The sight linkage is a single adjustable link connecting the periscope housing to the MG cradle. The length of the linkage can be altered to adjust for parallelism between the axis of the bore and the line of sight in the vertical plane by a turnbuckle (4) which is locked by two locking nuts (2).

END



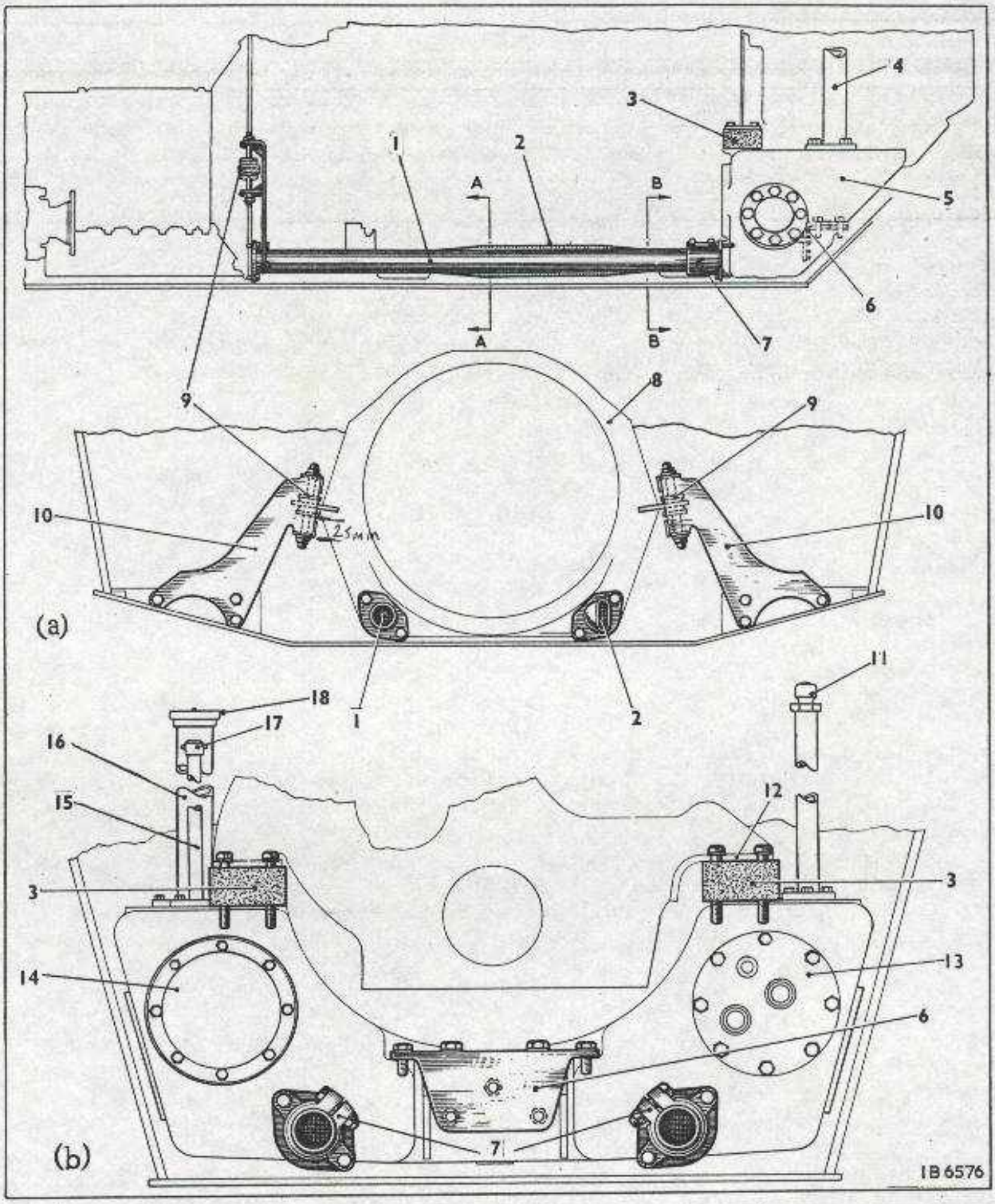
1	Oil cooler	4	Oil tank dipstick	7	Oil tank breather pipe
2	Oil filter	5	Oil tank	8	Oil tank delivery pipe
3	Oil tank filler cap	6	Oil pressure relief valve	9	Oil tank return pipe

Fig 7 Engine lubrication system



1 Clip
2 Plate
3 Small joiner tube
4 Large joiner tube
5 Still tube
6 Header

Fig 8 Oil cooler



1 Left support tube
2 Right support tube
3 Rubber block
4 Breather pipe
5 Oil tank
6 Oil tank support bracket
7 Support tube socket
8 Front mounting plate
9 Rubber buffer pads
10 Steady plate
11 Breather
12 Rear mounting plate
13 Adaptor coverplate
14 Inspection coverplate
15 Dipstick tube
16 Oil filler tube
17 Dipstick
18 Filler cap
(a) Section AA
(b) Section BB

Fig 9 Engine mountings and oil tank

OIL COOLER

19. The oil cooler (Fig 8) comprises a non-ferrous cast header (6) formed with two separate internal chambers. The ends of four still tubes (5) are fitted into the header so that two communicate with each chamber. The opposite ends of the two outer tubes are connected by a large joiner tube (4) and the ends of the inner tubes by a second small joiner tube (3). The tubes are secured to a plate (2) by clips (1). Two unions are screwed into the header. Each communicates with one of the chambers for connection of the delivery and return oil pipes. From the delivery pipe the oil passes through one of the unions into the chamber to which it connects, thence through the two coupled tubes into the other chamber and return pipe connected to the other union. It is immaterial to which unions the delivery and return pipes are connected since a circuit through the cooler is completed either way. Cooling action is effected as the oil passes through the still tubes.

OIL FILTER

20. The oil filter is described in EMER Power S 522.

COOLING SYSTEM

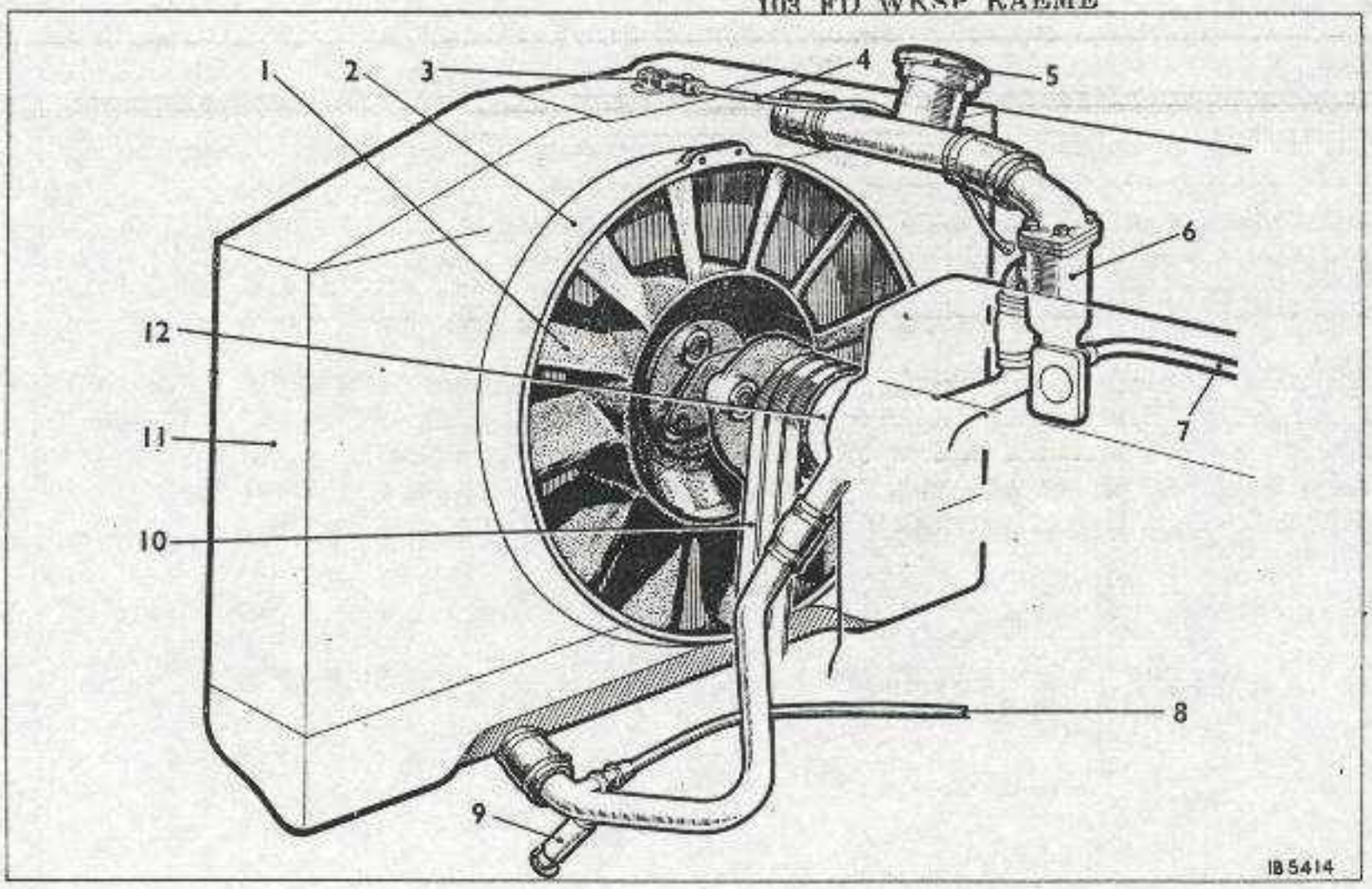
GENERAL

21. The cooling system (Fig 10) is sealed and pressurized to 10 lb/sq.in., so raising the boiling point to 239.5 deg F. Pressure is controlled by a relief valve (3) located on the top of the radiator. Coolant circulation is assisted by an impeller pump (12). The coolant passes from the bottom of the radiator through the pump into the gallery (Fig 13(9)) fitted in the cylinder block. From the gallery it is discharged into the cylinder block, cylinder head (12) and induction manifold jackets (1) then past a thermostat-controlled valve (2) into the top of the radiator or, when the valve is closed at low temperatures, back through the pump.

22. A temperature gauge (5) on the vehicle instrument panel is operated by a unit screwed into the cylinder head. A 12-bladed fan is driven by "vee" belts from the pump pulley which is itself belt driven by the crankshaft pulley.

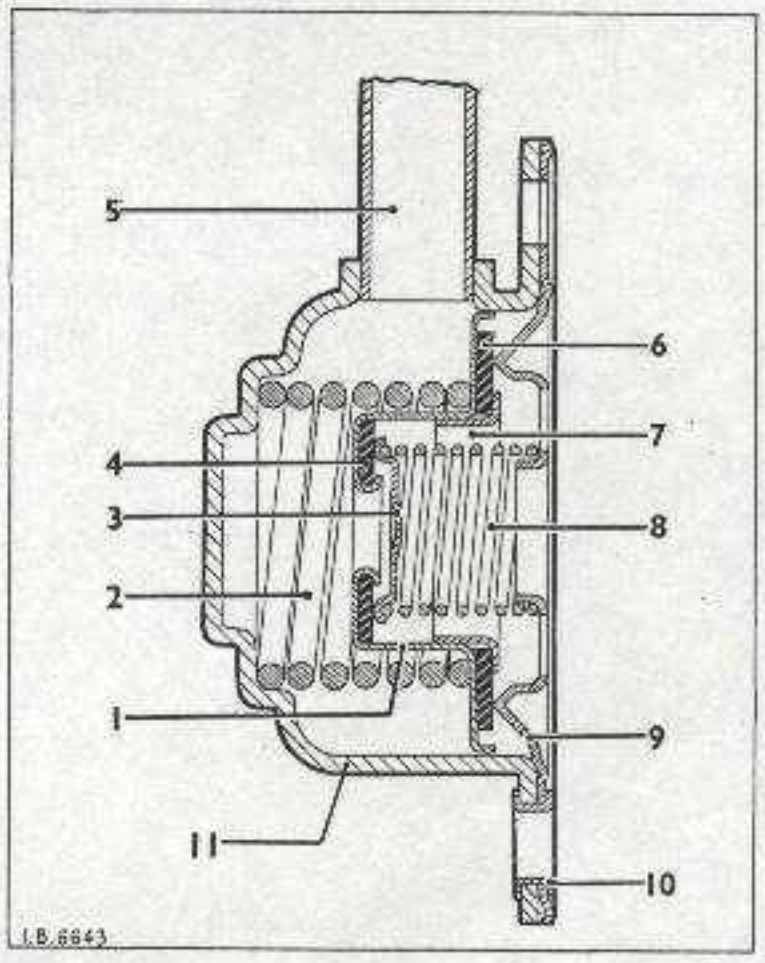
FAN AND COWL (Fig 12)

23. The fan cowl (2) is an aluminium alloy casting which houses the 12-bladed aero-foil fan (1). The centre of the fan cowl is recessed with six holes drilled and counterbored for mounting the fan shaft (6). The steel shaft is formed with a flange which registers in the cowl recess. The fan hub (4) houses two roller bearings (7) which are positioned by distance sleeves (8) and (9). The bearings are held in position by a centre bolt (10) passing through the centre of the shaft, with a retaining cap (11) at the end. An oil seal (5) is fitted in the fan at the flange end of the shaft. The fan is secured to the hub by four setscrews, locked by tab-washers, and two bolts which also secure one of two flexible couplings (3). The couplings, each of which has four equi-distant holes fitted with rubber bushes, are inter-connected by a coupling flange (12). The outer coupling is coupled to the coolant pump through which the fan is driven.



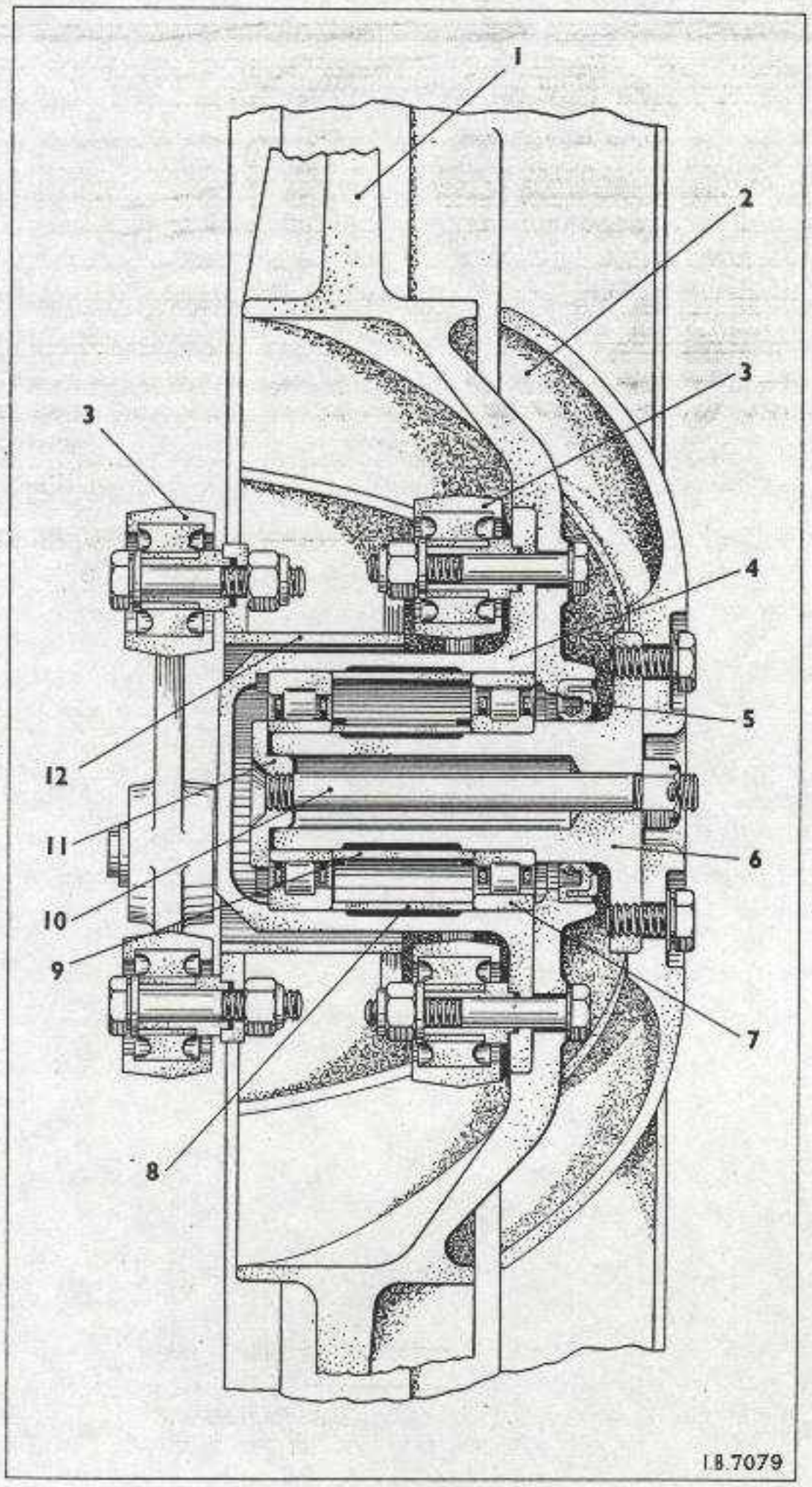
1 Fan
2 Fan cowl
3 Pressure relief valve
4 Relief valve outlet pipe
5 Radiator filler cap
6 Thermostat housing
7 Induction manifold jacket connecting pipe
8 Cylinder block drain pipe
9 Coolant drain
10 Fan driving belts
11 Radiator
12 Coolant impeller

Fig 10 Cooling system layout



1 Pressure valve
2 Pressure valve spring
3 Vacuum valve
4 Vacuum valve seat
5 Overflow pipe
6 Pressure valve seat
7 Seat retainer
8 Vacuum valve spring
9 Closing plate
10 Hollow rivet
11 Body

Fig 11 Radiator relief valve



1 Fan

2 Fan cowl

3 Flexible coupling

4 Fan hub

5 Oil seal

6 Fan shaft

7 Roller bearing

8 Large distance sleeve

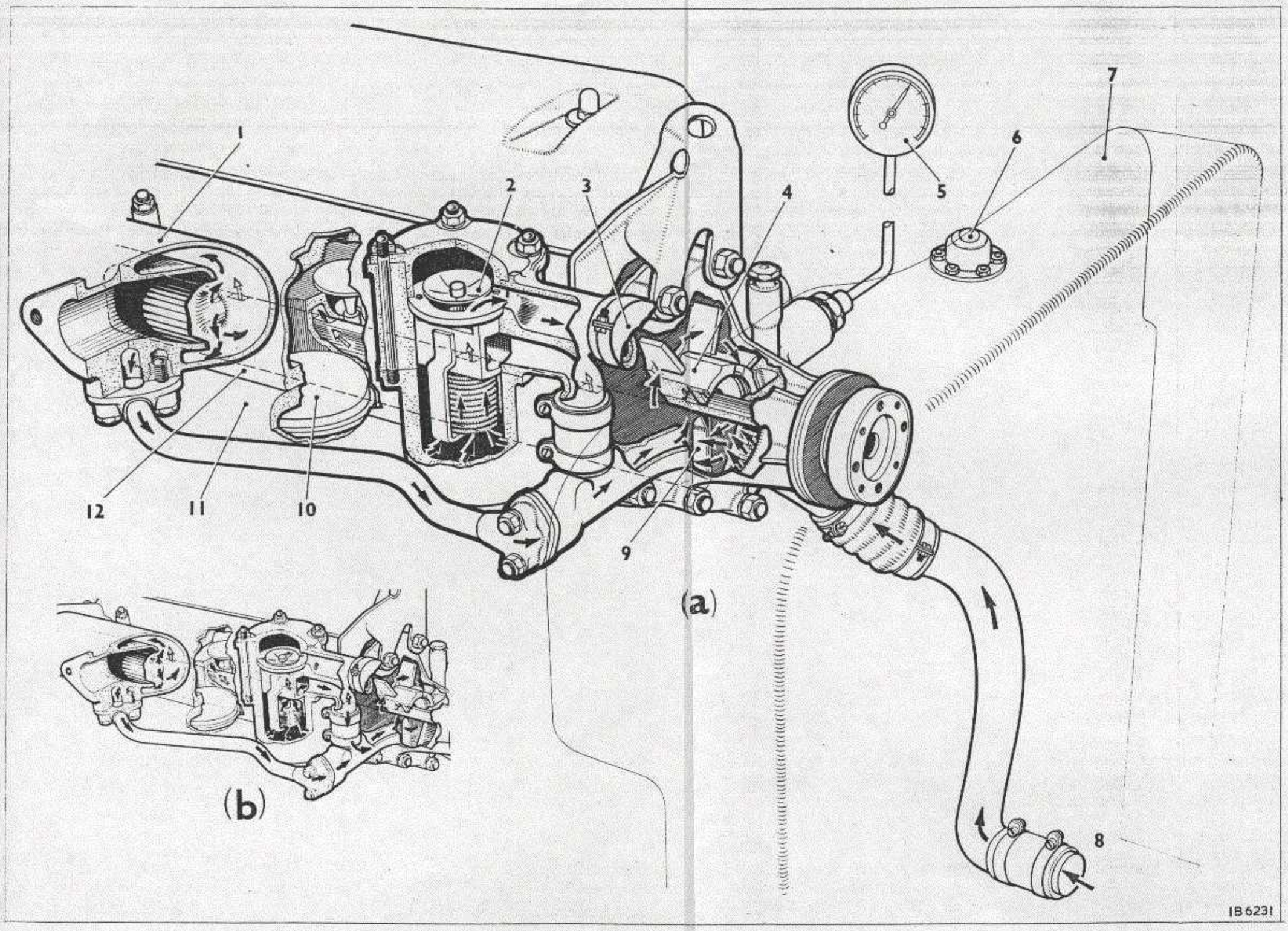
9 Small distance sleeve

10 Centre bolt

11 Retaining cap

12 Coupling flange

Fig 12 Fan and fan cowl



1 Induction manifold
2 Thermostat
3 Radiator inlet
4 Coolant pump
5 Temperature gauge
6 Pressure relief valve
7 Radiator
8 Radiator outlet
9 Coolant gallery
10 Piston
11 Cylinder block
12 Cylinder head
(a) Coolant circuit - thermostat open
(b) Coolant circuit - thermostat closed

Fig 13 Engine coolant flow

RADIATOR

24. The radiator is a gilled-tube type having a frontal area of 2.7 sq.ft. The brass tubes have copper gills with a disposition of 9 gills per inch. The upper and lower tanks are of brass. The lower tank is fitted internally with four brass stiffeners and has external reinforcement terne plates sweated on the lower corner at each side. These plates are spot welded to terne side support plates the lower ends of which are also sweated to the lower tank and the opposite ends to the upper tank. The inlet pipe is sweated in the upper tank whilst the outlet pipe, which is a bronze casting, is riveted and sweated to the lower tank. A steel retaining bracket is riveted on each of the two side support plates and an angle stiffener bracket is sweated on the top of the upper tank. A mounting flange, provided with studs, is riveted and sweated on the top of the upper tank for fitting a pressure relief valve.

25. The relief valve (Fig 11) comprises a body (11) into which an outlet (overflow) pipe (5) is sweated. A pressure valve (1) is fitted with a large synthetic rubber seat (6) which is retained by a pressed-in flanged sleeve and a second smaller vacuum valve seat (4) which is retained by a swaging formed on the valve. A closing plate (9) provided with inlet holes and having a valve seating and central swaging formed on it, is secured to the body by hollow rivets (10). The pressure valve seat rests on the seating formed on the closing plate and the valve is loaded by a large spring (2) compressed between the body and valve. A vacuum valve (3) seats on the vacuum valve seat in the pressure valve and is loaded by a small spring (8) compressed between the closing plate and vacuum valve.

26. When the pressure in the radiator reaches approximately 10 lb/sq.in., the pressure valve (1) is lifted away from its seating against the reaction of the spring (2) and the excess pressure in the form of steam or water passes out through the outlet (overflow) pipe (5). When the pressure has again fallen to less than 10 lb/sq.in., the valve is closed by the spring (2). Should the pressure in the radiator fall to approximately 1 lb/sq.in. below atmospheric, the vacuum valve (3) is forced off its seat against the reaction of the spring (8) and air passes into the radiator until the pressure is normal, when the valve again closes.

COOLANT PUMP

27. For description see EMER Power S 522.

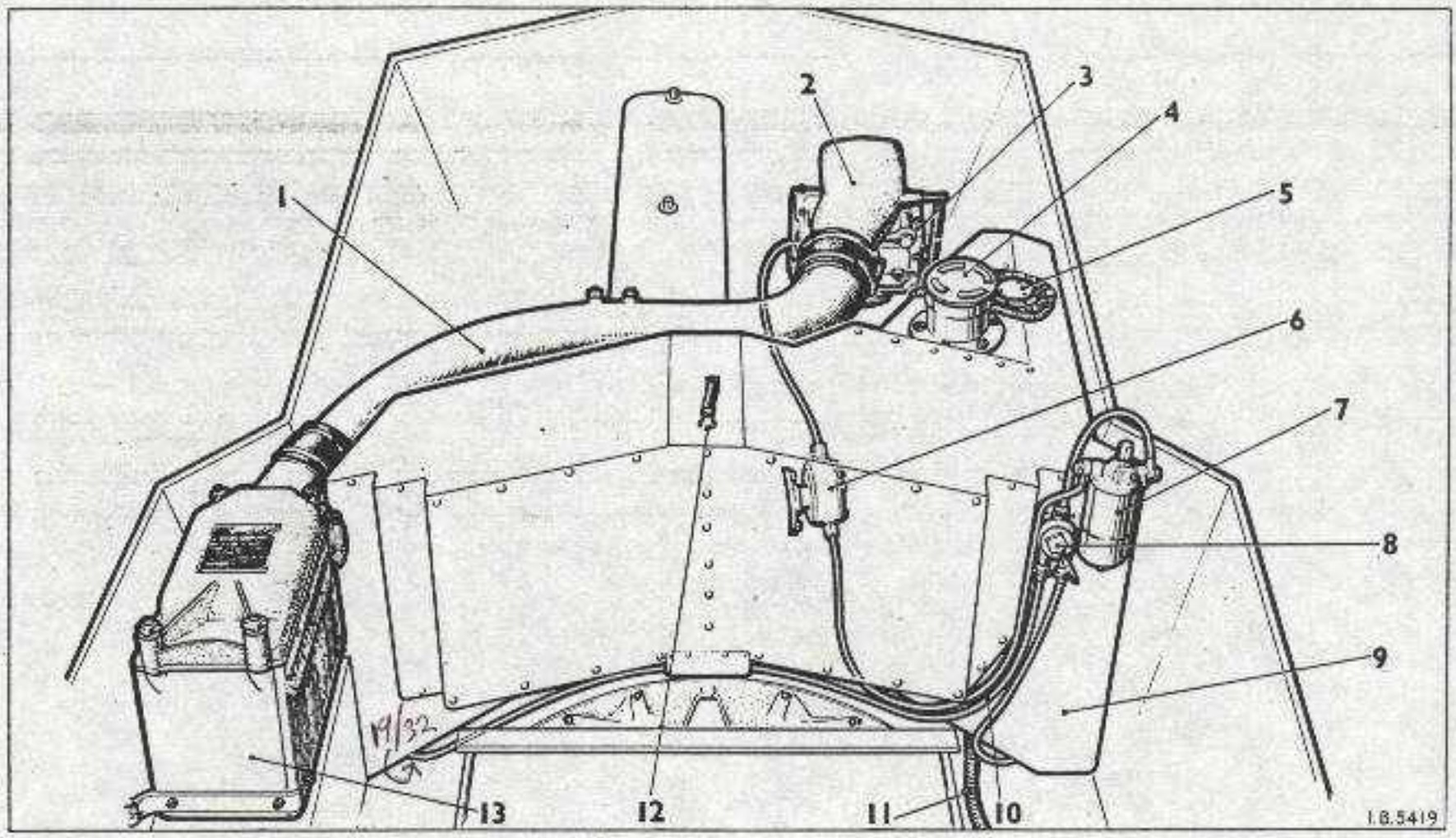
THERMOSTAT

28. For description see EMER Power S 522.

FUEL SYSTEM

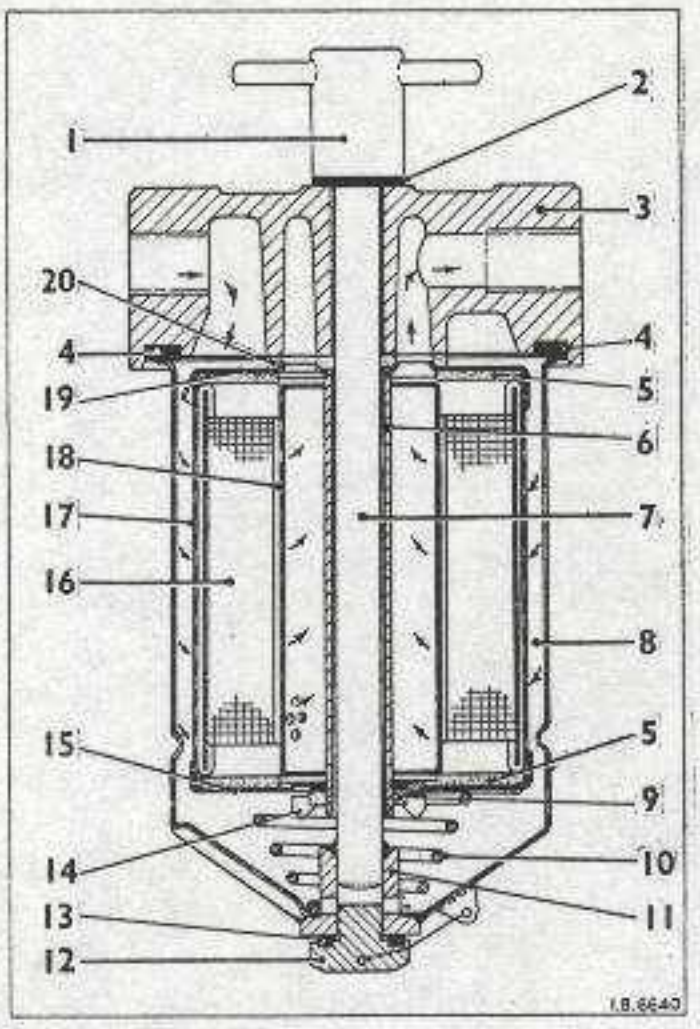
GENERAL

29. Fuel is carried in a 21 gallon tank (Fig 14(9)) affording a main supply of 18 gallons and a reserve of 3 gallons. Fuel drawn through a two-way tap (8) and a filter (7) is fed to the carburetter (3) by an engine mounted mechanically operated pump (6). Air to the carburetter is taken through an air cleaner (13) and inlet pipe (1).



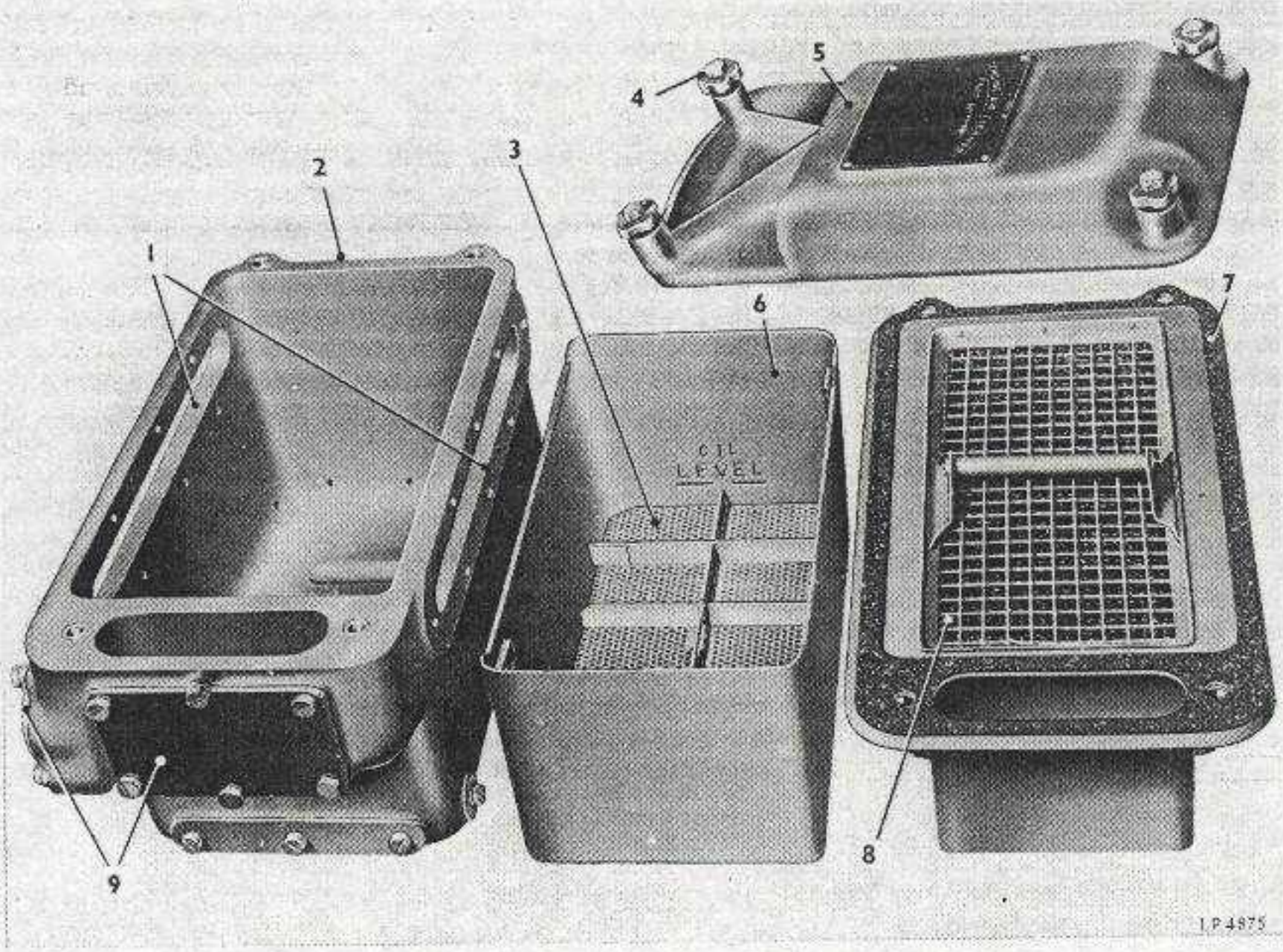
1 Air inlet pipe
2 Air horn
3 Carburetter
4 Fuel filler cap
5 Fuel gauge unit
6 Fuel pump
7 Fuel filter
8 Fuel tap
9 Fuel tank
10 Fuel suction pipes
11 Fuel gauge cable conduit
12 Fuel tank breather pipe
13 Air cleaner

Fig 14 Fuel system layout



1 Wingnut
2 Sealing washer
3 Head
4 Rubber gasket
5 Felt washer
6 Centre tube
7 Centre bolt
8 Bowl
9 Sealing washer
10 Spring
11 Adaptor
12 Drain plug
13 Fibre washer
14 Element wingnut
15 Lower end cap
16 Element
17 Outer case
18 Inner case
19 Upper end cap
20 Cork gasket

Fig 15 Fuel filter



1 Air intake slots
2 Body
3 Damper
4 Captive screw
5 Top cover
6 Oil container
7 Gasket
8 Element
9 Blanking plates

Fig 16 Air cleaner

FUEL TANK

30. The fuel tank is constructed of riveted terne sheet, shaped to fit the front end of the engine compartment. The lower portion of the tank is arched so that it straddles the engine flywheel housing. The fuel in the lower R.H. portion of the tank formed by the arch is used as the reserve, whilst the fuel in the remainder of the tank is the main supply. A drain plug, and an adaptor for connecting the appropriate fuel pipe, are fitted in the bottom of each portion of the tank on either side of the arch. Baffle plates are fitted inside to minimuze surge. Stiffening plates and bolts are fitted in the tank for mounting purposes, and stiffening plates with screwed holes are provided for fitting the filler neck and electrical fuel gauge unit. The seams, mounting bolts, stiffening plates and adaptors are sweated after fitting and the bolt heads are covered by dished plates riveted and sweated to the tank. A breather pipe (Fig 14(12)) a screw-on type filler cap (4) and a filler pipe filter are provided. The tank is supported and retained by rubber bonded support plates and torsion units.

FUEL FILTER (Fig 15)

31. The fuel filter comprises three main components, the head, the bowl and the element. The head (3) is an aluminium alloy casting which incorporates the inlet and outlet ports and mounting flange. An air release plug is screwed into a drilled hole communicating with the inlet port. The pressed-steel bowl (8) has an internally screwed drain plug adaptor (insert) (11) and centre bolt (7) welded centrally to the base. The rim of the bowl abuts a synthetic rubber gasket (4) cemented in a recess in the head and the bowl is retained by a wingnut (1) with sealing washer (2) screwed on to the centre bolt. The star-section element (16) is made up from nylon, or organdie, covered with fine galvanized wire mesh and is contained between a perforated outer case (17) and similar inner case (18) which are also covered with wire mesh. The cases are clamped between two end-caps (15) and (19) the upper of which has a perforated centre-tube (6) attached to it. The tube passes through the lower cap and the whole assembly is retained as one unit by a wingnut (14) with a rubber sealing washer (9) which screws on to the centre-tube. Felt washers (5) form seals between the cases and end-caps. The upper cap has two crescent-shaped ports which communicate with the outlet port in the head, whilst a cork gasket (20) forms a seal between the remainder of the cap and head. A conical spring (10) retains the element assembly against the head. The adaptor (11) in the base of the bowl has radial ports to allow the fuel to drain when the drain plug (12) and washer (13) are removed. Fig 15 shows the passage of the fuel through the filter.

CARBURETTER

32. For description see EMER Power S 522.

FUEL PUMP

33. For description see EMER Power S 522.

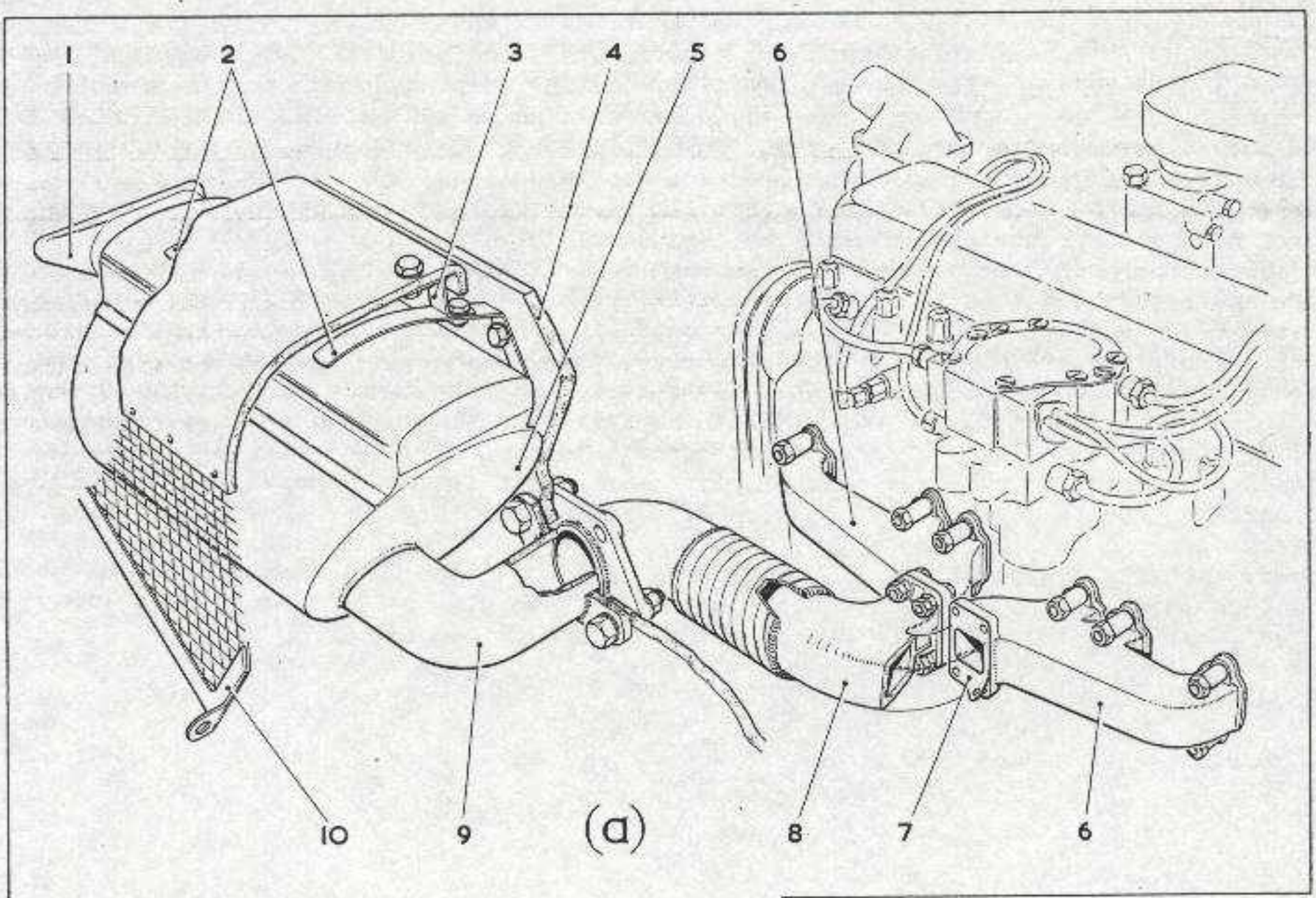
AIR CLEANER - Type 190 c.f.m. (Fig 16)

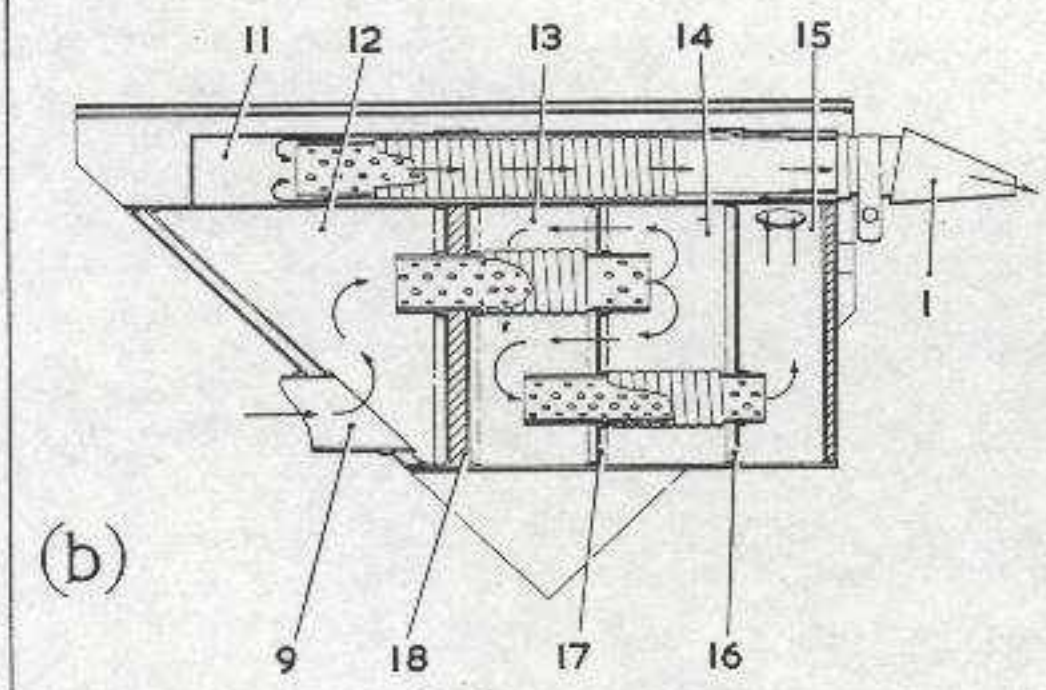
34. The air cleaner is an oil bath type comprising a body, oil container, damper, element and cover. The aluminium alloy cast body (2) has two longitudinal slots (1) for the air intake and two air outlets at one end for connecting to the carburetter. These outlets are fitted with blanking plates (9) one of which is discarded to suit the particular installation required. The pressed-steel oil container (6) has two internal handles at opposite corners and has the oil level mark on the inside at each end. Housed in the oil container is the perforated damper (3) provided with longitudinal and transverse spacing strips on each side to retain it mid-way between the bottom of the oil container and element. The element (8) is formed of knitted steel wire held by lateral stiffening wires in a sheet aluminium flanged casing. The aluminium alloy top cover (5) is provided with four captive bolts (4) for securing it, and the element, to the body. Gaskets (7) are cemented to the upper and lower faces of the element casing flange for sealing purposes.

EXHAUST SYSTEM

35. The exhaust system consists of a branch pipe (Fig 17(8)) connecting the engine manifolds (6) to a silencer (5).

36. The branch pipe is made up of a malleable cast-iron "Y" piece welded to a short length of flexible metal pipe which in turn is welded to a flanged elbow pipe. The "Y" piece is connected to the manifolds by bolts and twin locknuts whilst the elbow





I.B. 7045

1 Fish-tail outlet
2 Silencer bracket
3 Silencer guard bracket
4 Hull side plate
5 Silencer
6 Engine exhaust manifold
7 Gasket
8 Exhaust branch pipe
9 Silencer inlet pipe
10 Silencer guard
11 Upper chamber
12 1st compartment
13 2nd compartment
14 3rd compartment
15 4th compartment
16 3rd wall
17 2nd wall
18 1st wall
(a) General arrangement
(b) Gas flow through silencer

Fig 17 Exhaust system

pipe is connected to the silencer, through a hole in the hull side plate (4) by bolts, nuts and shakeproof washers. Gaskets (7) are fitted between the branch pipe flanges, manifolds and silencer flange.

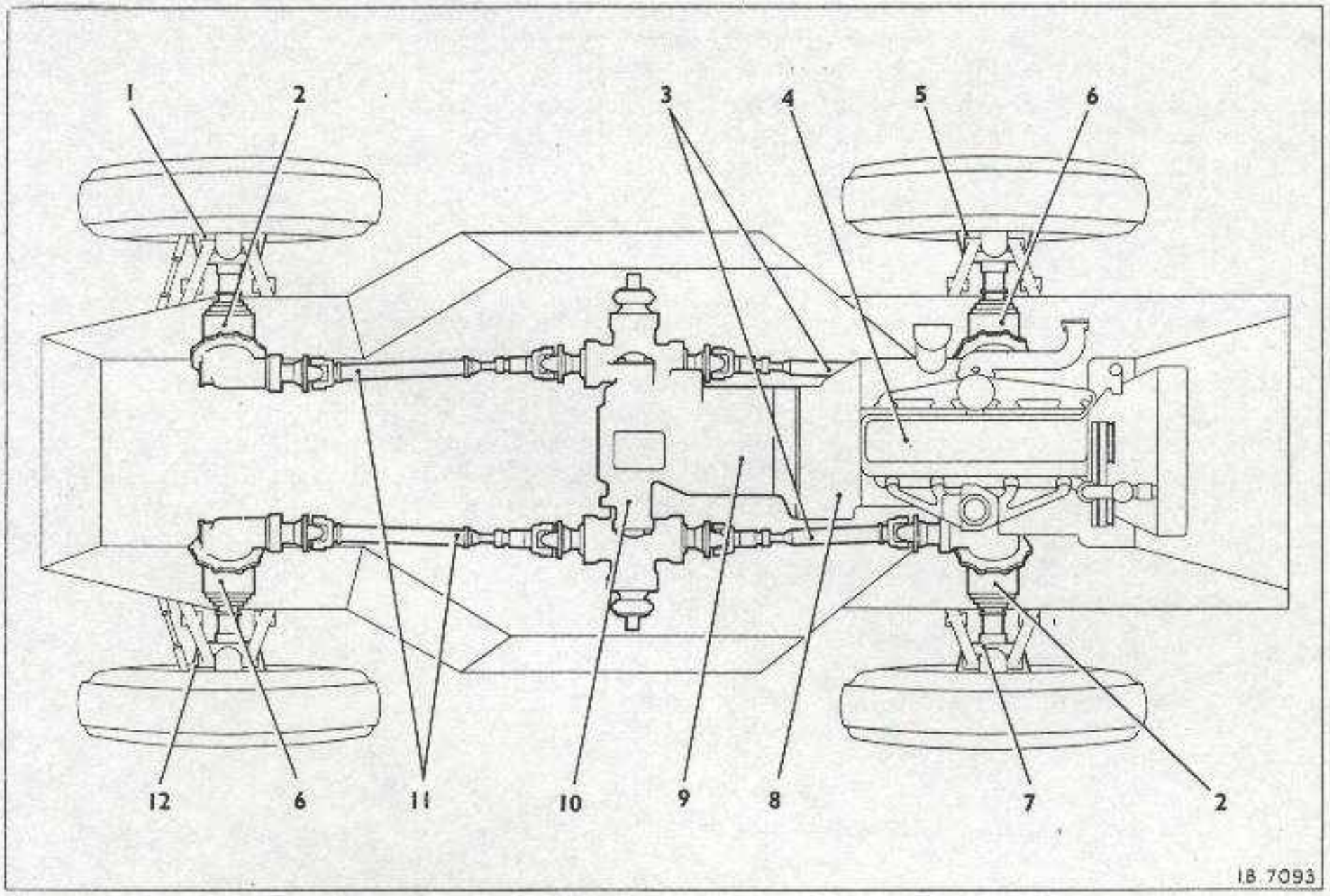
37. The silencer (5) which is of welded construction, is cylindrical in shape with cavity section end plates and has a built-on upper chamber (11) which houses the outlet pipes. The front end plate is sloping and has the flanged inlet pipe (9) attached to it. The main cylindrical portion is divided into four compartments by three walls. The front (first) wall (18) is made up of two sections with a cavity formed in between, whilst the remaining two walls (16) and (17) are single section. The front wall and rear end plate cavities are packed with asbestos. Five elements, each of which is made up of an open-ended perforated steel tube with a length of unlagged flexible metal pipe fitted over the centre portion, are welded in holes cut in the walls. Three of these elements are mounted in the upper portion of the front and centre (second) walls forming a communication between the first compartment (12) and third compartment (14) whilst the two remaining elements are mounted in the lower portion of the centre and rear (third) walls forming a communication between the second compartment (13) and fourth compartment (15). The centre wall (17) has four holes drilled through it which form a communication between the second and third compartments. Two longer elements, similar to those already described, are housed in the built-on upper chamber with the rear ends protruding through the end plate. These ends are fitted with a fish-tail (1) which forms the exhaust outlet. A large hole forms a communication between the fourth compartment (15) and upper chamber (11).

38. In operation, the exhaust gases pass through the inlet pipe (9) into the first compartment (12) then through the three upper elements into the third compartment (14) from which they pass into the second compartment (13) through the holes in the centre wall (17) then through the two lower elements into the fourth compartment (15). From this compartment the gases then pass into the upper built-on chamber in a reverse direction to the inner ends of the two long elements, through which they pass to the fish-tail and atmosphere. The result of directing the exhaust gases through the elements and compartments in the silencer is, in effect, the absorbtion of the noise set up by the ignited gas in the engine cylinders by changing the natural resonant frequencies.

TRANSMISSION

GENERAL

39. Power from the engine (Fig 18(4)) is taken forward through a fluid flywheel (8) to a five-speed pre-selector gearbox (9). At the front of and forming a unit with the gearbox is a transfer box (10) which contains a forward and reverse mechanism and a differential drive. Four bevel gears in the transfer box connect via universal joints with propeller shafts (3) and (11); each propeller shaft drives, through a second universal joint, a bevel box (2) and (6) connected to each road wheel hub (1) (5) (7) and (12). Housed in each bevel box and road wheel hub are constant velocity tracta joints which form a flexible drive to the epicyclic reduction gears contained within the hub.



1	Front R.H. road wheel hub	7	Rear L.H. road wheel hub
2	Front R.H. and rear L.H. bevel boxes	8	Fluid flywheel
3	Rear propeller shafts	9	Gearbox
4	Engine	10	Transfer box
5	Rear R.H. road wheel hub	11	Front propeller shafts
6	Front L.H. and rear R.H. bevel boxes	12	Front L.H. road wheel hub

Fig 18 Transmission layout

FLUID FLYWHEEL

DESCRIPTION

40. The fluid flywheel, or coupling, is of the open circuit type and is contained within a bell housing at the rear of the crankcase.

41. Three main components comprise this flywheel: the front casing, which is bolted to the crankshaft and also carries the starting ring; the rear casing which is bolted to the front casing and is the driving member; the runner, or driven member, which is splined to the input shaft of the gearbox (gearbox driving shaft).

42. The bell housing is located on two hollow dowels and secured to the crankcase by two bolts in conjunction with six studs fitted to the housing. At the opposite end, two solid dowels and sixteen studs are fitted to the housing for the location and attachment of the gearbox front cover and the gearbox support plate. Four bolts are used, in addition, to secure the front cover to the support plate. Screwed into a boss at the top of the front cover is an engine timing pointer which is used in conjunction with timing marks engraved on the periphery of the rear casing.

Note: *Six pre-production Mk 1 vehicles (Nos. 32-BA-75 to 32-BA-80 inclusive) were fitted with a flywheel bell housing for use in conjunction with an engine starter type 524SGR41B/3 having a non-standard fixing flange. Further reference to this subject is made in the paragraphs dealing generally with the electrical equipment.*

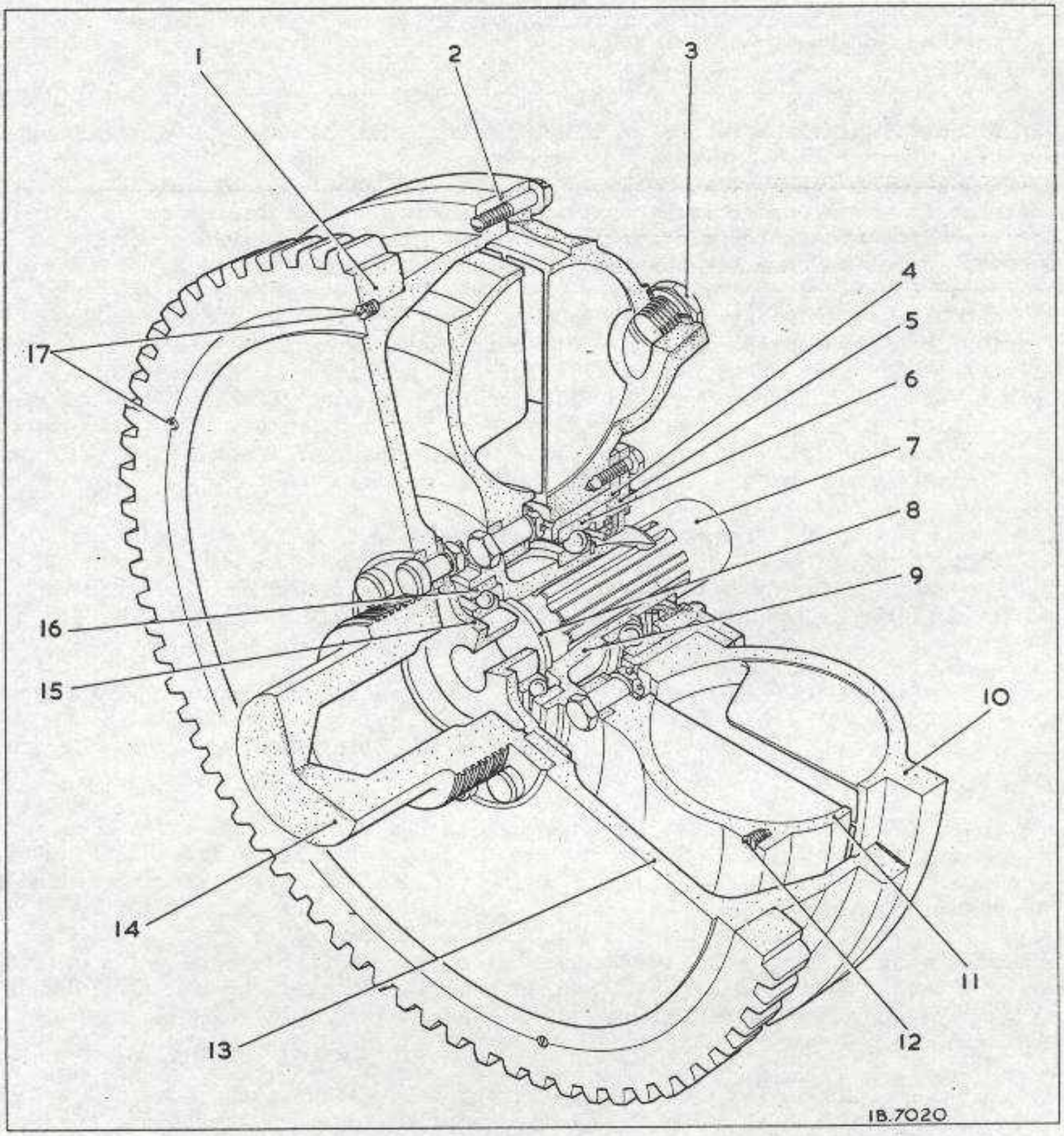
43. A late modification of the gearbox front cover provides for a guard over the aperture giving access to the flywheel plugs. This front cover guard (Fig 21(2)) has been designed to prevent loose parts falling into the housing and is of wire mesh construction reinforced by a riveted-on frame through which pass two bolts securing the whole.

44. Projecting from the crankcase into the bell housing is the engine crankshaft, (Fig 19(14)) the end of which is flanged. Secured to this flange by special bolts, slotted nuts and split pins are the front casing (13) and the front bearing centre (15). Shrunk on to the front casing is the starting ring (1) which is also pegged by grub screws (17) for further security. The rear casing is flanged and spigoted to the outer rim of the front casing and held there by bolts. A fibre joint (2) is fitted between the two casings and shakeproof washers are fitted under the hexagonal heads of the bolts except in late flywheels where these washers are replaced by lock plates linking two bolts.

45. Two plugs (3) each sealed by a copper or copper asbestos washer (see notes following this para) are screwed into the rear casing at 180° to each other and either is utilized as a filler or a drain plug when in the appropriate position. The oil (OM-13) in the flywheel has reached its correct level when filling, when it flows from the bottom of the filler orifice, provided that this orifice is at top dead centre. It should be noted that a new type of plug is now fitted to fluid flywheels. This plug, Part No.FV51972, replaces the plug with the square hole in the centre of its head. Instead of the square hole, the new plug has a tapped hole for use with extracting spanner FV55683 to ensure that the plug is not inadvertently dropped into the housing.

Notes:

1. *There are three known types of washer in use on fluid flywheel plugs. These types are as follows:-*
   - *(a) Rolled-in copper asbestos washer (commercial pattern), having a hole with two flats.*



1 Starting ring
2 Joint
3 Flywheel plug
4 Bearing housing
5 Oil seal housing
6 Rear casing bearing
7 Gearbox driving shaft
8 Runner hub insert
9 Runner hub
10 Rear casing
11 Runner
12 Balancing plug
13 Front casing
14 Engine crankshaft
15 Front bearing centre
16 Runner pilot bearing
17 Grubscrews

Fig 19 Fluid flywheel

(b) Rolled-in copper asbestos (Pt. No. FV50203) having a circular hole with four V-shaped tangs projecting inwards. This is the original pattern.

(c) Rolled-out copper washer (Pt. No. FV51892). This is the latest pattern.

2. In future, all commercial pattern washers will be discarded. Washer (Pt. No. FV50203) will be fitted until stocks are exhausted and, thereafter, washer (Pt. No. FV51892) will be fitted.

46. The rear casing or driving member (10) is bowl-shaped with recesses formed in the bowls. These recesses are sub-divided into compartments when the component is cast. Prior to initial assembly the casing is tested for dynamic balance, balancing screws being fitted where and as required. These screws will be replaced in later flywheels by lead fillings to facilitate the fitting of the linked lock plates described in para 44.

47. The rear casing is supported by a ball bearing (6) mounted on a runner hub (9) retained by a circlip. The bearing is held in a bearing housing (4) which, together with an oil seal housing (5), is bolted to the rear casing. The oil seal housing retains an oil seal which is held in position by a backing washer and an outer circlip. The oil seal, comprising a sharp-lipped spring-loaded rubber ring, is fitted with the lip turned inwards to prevent oil leakage. The backing washer has a conical boss at one side for mating with the back of the sealing member and is selected according to the thickness between its parallel faces to give slight axial pressure to the oil seal. It is available in three thicknesses i.e., 0.120 in., 0.130 in., and 0.145 in. respectively.

48. Being the driven member, the runner (11) is splined to the gearbox driving shaft via the runner hub (9). This runner hub is fixed to the runner by means of eight bolts, a washer plate, slotted nuts and split pins. As with the rear casing, plugs (12) in the runner are used to achieve correct balance; similarly, the member is bowl-shaped with compartments, or cells, formed by vanes. Support for the shaft is given by a pilot ball bearing (16) that fits between a front bearing centre (15) bolted to the front casing and the runner hub.

Note: *Early production Mk 1 vehicles were fitted with a B60, No.1, Mk 3A engine. When fitting a B60, No.1, Mk 6A engine as a replacement it is first essential to modify the existing front bearing centre to eliminate interference with the crankshaft spigot in accordance with Whld. Veh. V 627 Mod. Inst. No.3.*

OPERATION

49. The fluid coupling is completely automatic in action and, when filled to its correct level with oil, forms a flexible coupling between the engine and the gearbox which will transmit from no power at engine tick-over to 98% power at maximum r.p.m.

50. When the rear casing (driving member) is rotated by the engine its vanes carry the fluid around with them; the fluid is thus subjected to centrifugal force and is flung outwards from the wheel. Consequently it shoots into the corresponding cells of the runner (driven member), impinging on the sides of its vanes. This impact, directed at a tangent, causes the driven wheel to turn in the same direction as its neighbour. When the engine is idling and the vehicle is at rest with the brakes applied, the energy imparted to the fluid is negligible. If the brakes are released the vehicle will barely creep forward but as the engine is accelerated the fluid will exert a progressively greater pressure on the vanes of the driven member and therefore a greater proportion of the drive will be transmitted. On further increase of speed more energy is passed to the driven member until eventually driving and driven members rotate approximately as one.

GEARBOX

51. The gearbox is of unit construction with the transfer box (Fig 20) and provides five speeds which, through the medium of the transfer box, may be used in either a forward or a reverse direction. Early type gearboxes, i.e., those fitted in early production Mk 1 vehicles, give higher "indirect" gear ratios than those given by the late type (see page 11). Except for this difference in ratios, altered to improve the performance of the vehicle, both types of gearbox are basically similar in principle and construction.

Note: *The gears are commonly spoken of as "Emergency low, 1st, 2nd, 3rd and top" but herein they are referred to as "1st, 2nd, 3rd, 4th and top" (or "5th") in conformity with the gear positions as engraved on the selector gate and the designations given in the vehicle Parts List.*

RUNNING GEAR

52. The gearbox casing is integral with that of the transfer box. The running gear is of conventional design and comprises an epicyclic gear train which gives four reduction gear ratios, a plate clutch which provides direct drive (for 5th gear) and a gear type oil pump which ensures adequate lubrication of revolving parts.

Driving shaft

53. The gearbox input or driving shaft (Fig 21(4)) is driven by the fluid flywheel and is supported on a ball bearing (55) at the flywheel end. The outer race of the bearing is held in a housing (66) and the inner race is backed by an adjusting washer (54). A locking nut (62) screws on to the outer end of the shaft and is secured with a lockring. This nut bears against a distance piece (60) carrying the oil pump driving gear which is sandwiched between the nut and the inner race of the ball bearing. On earlier types of gearbox (see para 94) no distance piece is fitted and the nut simply abuts the driving gear. Security of the ball bearing outer race is obtained by attaching an oil pump body (56) to a gearbox front cover (69) by long screws which first pass through an oil pump body cover (58). The oil seal, held in the latter cover, fits around the driving shaft nut and serves to prevent oil escape from the pump.

Clutch

54. The top gear clutch sliding member (51) rides by means of a bush (67) on the driving shaft. Superimposed between the sliding member and an actuating ring (68) is an angular-contact ball thrust bearing (52) and a thrust ring (53). It should be noted that this bearing should have its outer race fitted with the deepest flange towards the direction from which the thrust will occur, in this instance where the thrust ring bears firmly upon it.

55. There are four outer clutch plates (8) and five inner plates (7) held apart by six return springs (6) and plungers (5). This multi-plate clutch provides a straight-through drive for 5th (or top) gear and is operated in the same manner as the brake bands which engage the other four gears.

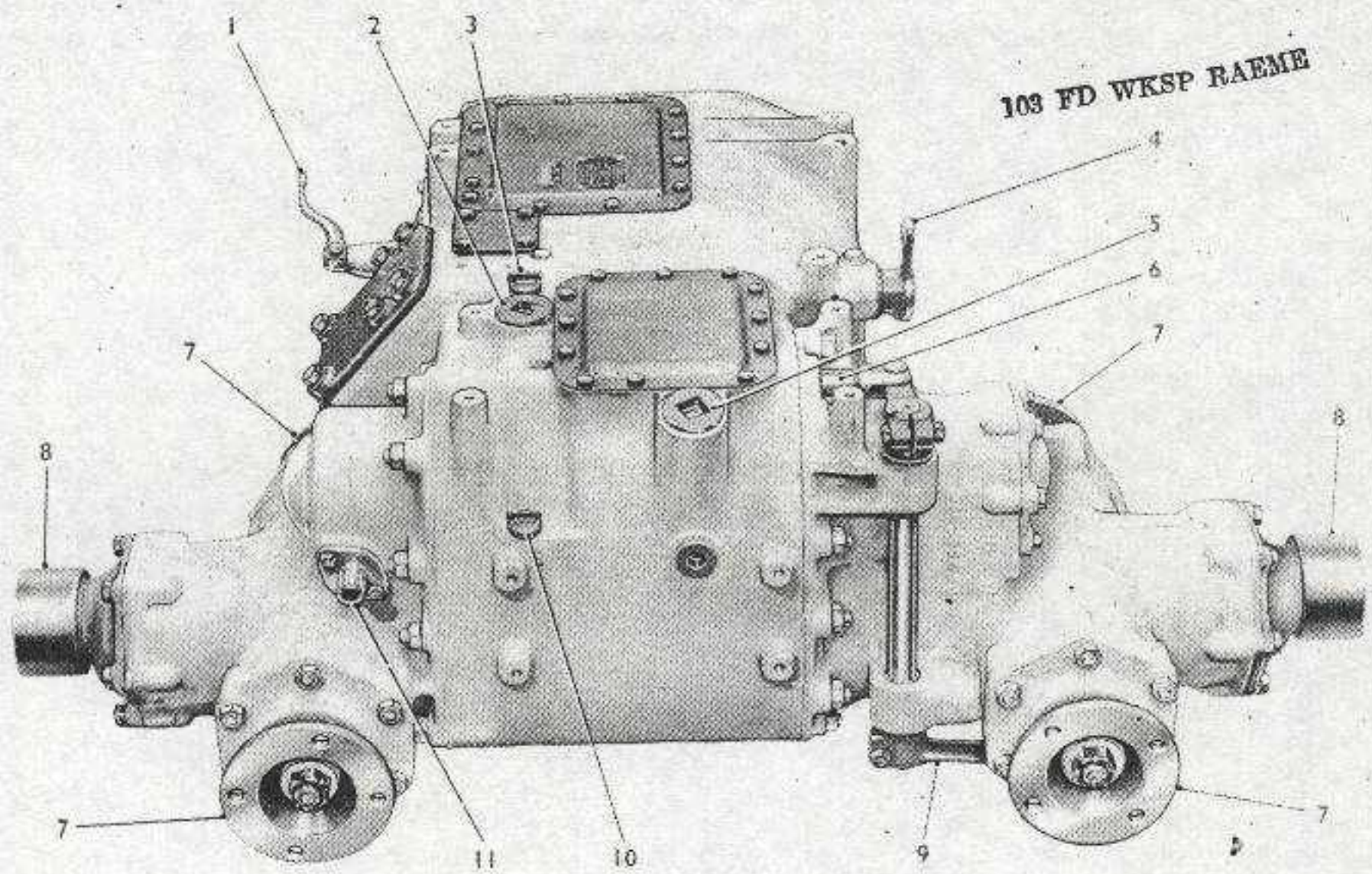
Gear trains

56. The 1st speed brake drum (17) is held within a ball bearing (20) which fits between the drum and an oil seal housing (34). The input gear bearing housing (31) is slightly recessed to receive the bearing. Between the oil seal housing and the outer race a running gear adjusting washer (35) is inserted. This washer is supplied in three thicknesses to permit adjustment of the running gear end float.

57. The following floating bushes are fitted: 1st speed sun wheel bush (37); 1st speed carrier bush (39); 2nd speed brake drum bush (41); 4th speed carrier bush (45); 3rd speed brake drum bush (48); 4th speed sun wheel bushes (46) and (50).

58. A support washer (44) is fitted between the 2nd and 3rd speed carrier plates and a thrust washer (42) is fitted between the driving and driven shafts. The planet gears run on roller bearings.

59. The 1st speed sun wheel (38) and the 2nd speed planets and carrier assembly (15) are splined to the driven shaft (23). A double sun wheel (43) splined to the driving shaft drives both the 2nd speed planets and carrier assembly (15) and the 3rd speed planets and carrier assembly (12). As indicated in para 57 the 4th speed sun wheel runs on two flanged bushes.



1 Gearbox selector lever
2 Gearbox oil filler plug
3 Gearbox oil dipstick
4 Busbar outer operating lever
5 Transfer box oil filler plug
6 Forward/reverse selector shaft
7 Coupling flange
8 Cover and mounting bracket
9 Bottom selector lever
10 Transfer box oil dipstick
11 Speedometer drive bracket

Fig 20 Gearbox and transfer box - front view

Driven shaft and transfer box input bevel pinion

60. The driven shaft rotates on bushes (18) and (19) fitted between it and the driving shaft. At its outer end the driven shaft is externally-splined to receive the shaft portion of the transfer box input bevel pinion (28) which is supported by opposed taper roller bearings (27). Between the inner races are fitted a spacer (30) and shims (26) selected to give a bearing pre-load of 0.000 to 0.002 in. A nut (24) threaded on to the pinion shaft and locked with a tabwasher secures the whole assembly together. The two outer races of the roller bearings are separated by shoulders formed on the input gear bearing housing (31) the outer race at the inner end being held by an oil seal housing (34); this housing is pegged to the bearing housing.

Key to Fig 21 (opposite)

1 Timing pointer
2 Front cover guard
3 Top gear outer member
4 Driving shaft
5 Return spring plunger
6 Return spring
7 Inner clutch plate
8 Outer clutch plate
9 Gearbox top cover
10 4th speed brake band
11 3rd speed brake drum (part of 4th speed planets assembly)
12 4th speed annulus (part of 3rd speed planets assembly)
13 3rd speed brake band
14 2nd speed brake band
15 2nd speed planet carrier (part of 2nd speed planets assembly)
16 1st speed brake band
17 1st speed brake drum (part of 1st speed planets assembly)
18 Driven shaft front bush
19 Driven shaft rear bush
20 1st speed brake drum bearing
21 Circlip
22 Oil seals
23 Driven shaft
24 Input pinion locknut
25 Input pinion lockwasher
26 Input bevel pinion shims
27 Taper roller bearing
28 Transfer box input bevel pinion
29 Input pinion insert
30 Input bearing spacer
31 Input gear bearing housing
32 "O" packing - 4.750 in. x 0.210 in.
33 "O" packing - 3.850 in. x 0.210 in.
34 Oil seal housing
35 Running gear adjusting washer
36 Input gear bearing housing shims
37 1st speed sun wheel bush
38 1st speed sun wheel
39 1st speed carrier bush
40 2nd speed brake drum
41 2nd speed drum bush
42 Sun wheel thrust washer
43 2nd and 3rd speed sun wheel
44 3rd speed carrier plate washer
45 4th speed carrier bush
46 Sun wheel rear bush
47 4th speed sun wheel
48 3rd speed brake drum bush
49 4th speed brake drum
50 Sun wheel front bush
51 Top gear sliding member
52 Thrust bearing
53 Top gear thrust ring
54 Driving shaft adjusting washer
55 Driving shaft bearing
56 Oil pump body
57 Oil pump driven gear
58 Oil pump body cover
59 No.3 Woodruff key
60 Distance piece
61 Driving shaft nut lockring
62 Driving shaft nut
63 Oil seal
64 No.5 Woodruff key
65 Oil pump driving gear
66 Driving shaft bearing housing
67 Top gear sliding member bush
68 Top gear actuating ring
69 Gearbox front cover
70 Oil pump driving gear

(a) Sectional arrangement showing late type oil pump

(b) Part section showing early type oil pump driving gear

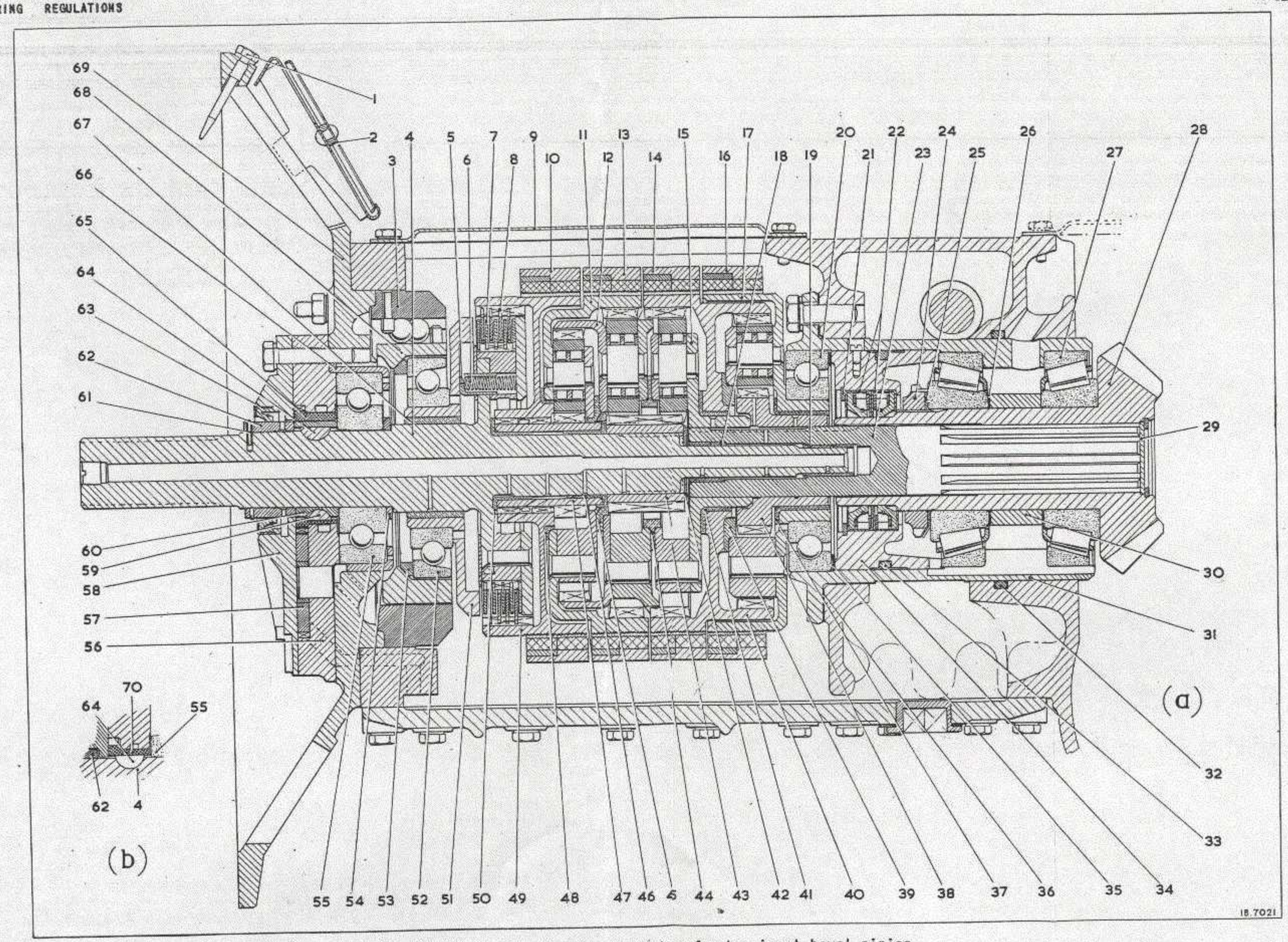


Fig 21 Gearbox running gear and transfer box input bevel pinion

61. Two oil seals (22) are fitted face to face around the input bevel pinion shaft and "O" packings (32) and (33) are inserted respectively in annular grooves in the gearbox casing and the oil seal housing. Between the gearbox casing and the input gear bearing housing, shims (36) are fitted. These shims are supplied in various thicknesses to enable the bevel pinion to be correctly meshed.

Operation

62. With this arrangement of compound epicyclic gearing torque conversion only takes place when a member of any one train is locked by holding the corresponding brake drum with a brake band anchored to the gearbox casing, thus providing a reaction point or fulcrum. At the output end is a single epicyclic train which determines the reduction for 1st speed. Intermediate speeds are obtained by driving the epicyclic trains at various rates, thus reducing the reduction until, for top gear, a clutch prevents relative rotation of parts and the whole assembly revolves together.

63. The compound gear train, as shown in Fig 21(a) consists of four simple trains. The 2nd speed train is the basic train, the purpose of the others being to govern the speed and direction of rotation of the 2nd speed annulus which also forms the 2nd speed brake drum.

64. The 2nd speed drum (40) is connected to the 3rd speed planet carrier plate which is integral with the 4th speed annulus (12) whilst integral with the drum is the 1st speed annulus. The second speed drum, except when held by the brake band (14) must rotate at the speed and in the direction which result when one of three other brake bands (16) (13) or (10) is applied.

65. The gearbox output is transmitted to the transfer box input bevel pinion through the driven shaft (23) which splines into the bore of the 2nd speed planet carrier (15) and also into the bore of the 1st speed sun wheel (38).

66. With 1st gear engaged the 1st speed brake drum (17) (and hence the planet carrier) is held by the brake band (16). As the driving shaft rotates, it turns the 2nd and 3rd speed sun wheel (43) which in turn drives the 2nd speed planets. These planets turn their carrier and, therefore, the gearbox driven shaft in the same direction as the driving shaft but at a much reduced speed, owing to the action of the 1st speed train which causes the 2nd speed annulus (integral with the 1st speed annulus) to turn in the direction opposite to that of the driving shaft. The reduction ratio in this gear is 6.046 : 1 (earlier type 5.66 : 1).

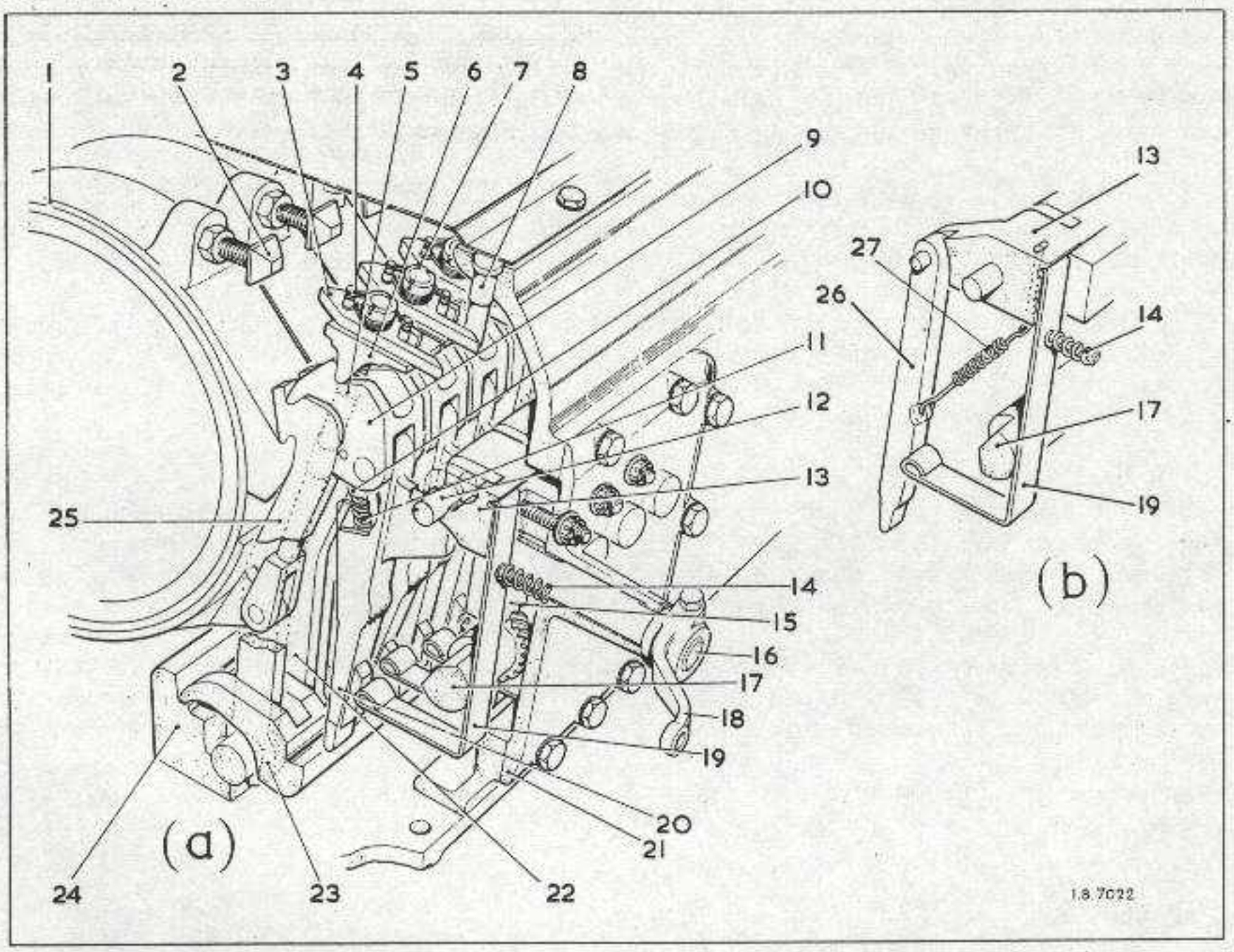
67. For 2nd gear, the 2nd speed brake band (14) is applied and this holds the 2nd gear brake drum (40) stationary. The driving shaft drives the 2nd and 3rd speed sun wheel (43) which rotates the 2nd speed planets and, because the 2nd speed annulus is locked by the brake drum, the 2nd speed planet carrier turns at a higher speed than in 1st gear and hence the gearbox driven shaft also. The reduction ratio in 2nd gear is 4.381 : 1 (earlier type 4.17 : 1).

68. In 3rd gear, the 3rd speed brake drum (11) (and hence the 3rd speed annulus) is held stationary by the brake band (13). The driving shaft rotates the 2nd and 3rd speed sun wheel and therefore the 3rd speed planets. As the 3rd speed planet carrier revolves, it rotates the 2nd speed annulus and the 2nd speed planet carrier is turned at a higher speed than in 2nd gear and hence the gearbox driven shaft also. The reduction ratio in 3rd gear is 2.437 : 1 (earlier type 2.375 : 1).

69. The 4th gear is obtained by applying the brake band (10) thus holding stationary the drum (49) and hence the 4th speed sun wheel (47). Because of the intermeshing

between the 3rd and 4th gear train, the 3rd speed carrier revolves faster than when 3rd gear is engaged and therefore the speed of 2nd speed planet carrier is increased and also that of the gearbox driven shaft. The reduction ratio in this gear is 1.569 : 1 (earlier type 1.527 : 1).

70. Top gear is obtained by engaging the plate clutch, all the brake bands being disengaged. This locks the driving shaft to the 4th speed brake drum and causes all the members of the compound gear train to rotate as a whole and so give direct drive to the gearbox driven shaft.



1	Brake band	16	Selector quadrant shaft
2	Adjuster screw	17	Selector camshaft
3	Adjuster ring	18	Selector lever
4	Adjuster spring	19	Cam following plate
5	Pull-rod	20	Operating strut
6	Adjuster table	21	Selector cover
7	Pull-rod nut	22	Rear hook
8	Adjuster tail pin	23	Busbar
9	Thrust pad	24	Busbar fulcrum bracket
10	Operating strut plunger	25	Front hook
11	Operating strut spring	26	Neutral strut
12	Locking bar plunger	27	Neutral strut spring
13	Selector locking bar		
14	Spring	(a)	General arrangement
15	Quadrant (integral with shaft (16))	(b)	Part-view showing neutral strut

Fig 22 Selector gear and brake band operating gear

BRAKE BANDS AND OPERATING GEAR

71. The gearbox components are controlled through the medium of a pre-selector mechanism operated by a lever mounted near the driver's seat. When the lever is moved it operates a camshaft in the gearbox, the position of the camshaft determining which gear will be engaged when the gear change pedal is depressed. The gear is not changed until the pedal is depressed and then released.

72. The downward pedal movement releases the gear in operation whilst on the spring-actuated return stroke a locking bar engages the mechanism brought into position by the selector lever and permits it to apply the necessary pressure to contract the brake band of that gear. The brake bands each comprising an external and an internal band are of conventional design as shown in Fig 21 and 22 and each brake band is applied in a similar manner to any other in the gearbox.

73. Each brake band is applied when a strut (Fig 22(20)) having a thrust pad (9) pinned to its upper end is lifted by a busbar (23) which is controlled by a powerful spring (para 78) and is connected by linkage to the gear change pedal (para 105).

74. Fig 23(a) shows the position of the busbar after depressing the gear change pedal. This allows the lower end of the strut corresponding to the selected gear to engage in the groove in the busbar. Fig 23(b) shows the position of the busbar after releasing the gear change pedal, the brake band now being applied.

75. Each brake band has an auto-adjuster to maintain the correct clearance between the brake band and the drum. When the strut is lifted to apply the brake band the adjuster moves towards the adjuster screw (Fig 22(2)). As the brake band wears slightly the movement of the strut increases causing the adjuster ring (3) to strike the adjuster screw and be deflected in a counter-clockwise direction. In this direction the spring (4) slips round the pull-rod nut (7). When the gear change pedal is next depressed, the adjuster moves away from the brake band and the other end of the adjuster ring strikes the tail pin (8) which deflects the ring in a clockwise direction. The spring now tightens on the nut which screws down on the pull-rod (5) a small amount.

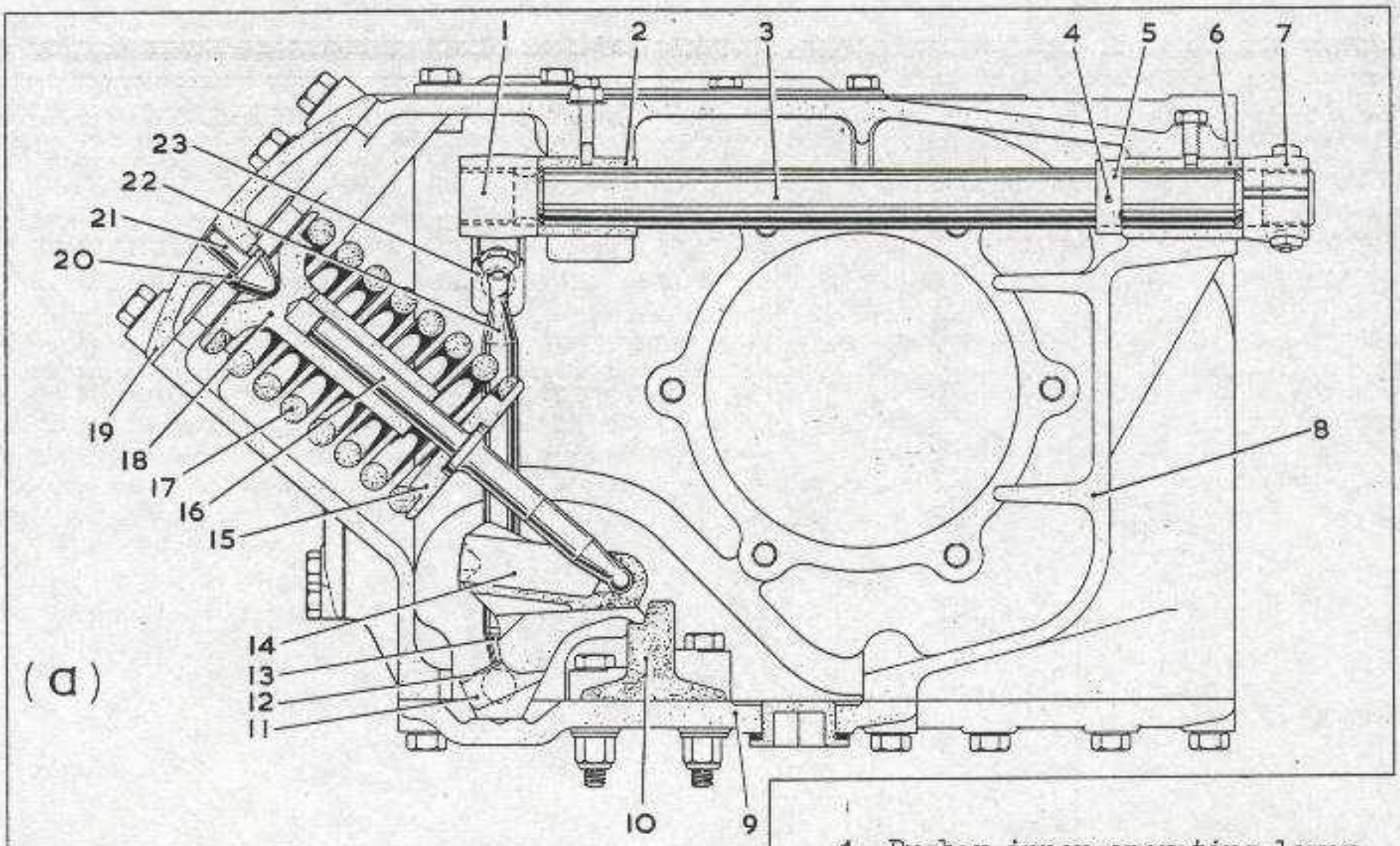
76. The adjuster will continue to operate as described until the brake band clearance is correct; the adjuster ring then just touches the adjuster screw and the action ceases.

TOP GEAR CLUTCH

77. Top gear (5th) is engaged by the busbar lifting a strut in exactly the same manner as described for the other gears but, instead of tightening a brake band, the strut lifts a pin which is attached to the clutch actuating ring (Fig 28(68)). The ring has spiral grooves. There are corresponding grooves in the outer member (3) and steel balls working in the grooves cause the rotary motion given to the actuating ring to be converted to endwise movement. This is transmitted to the sliding member (51) which presses the clutch plates together. The clutch has an automatic adjuster similar to that described for each brake band.

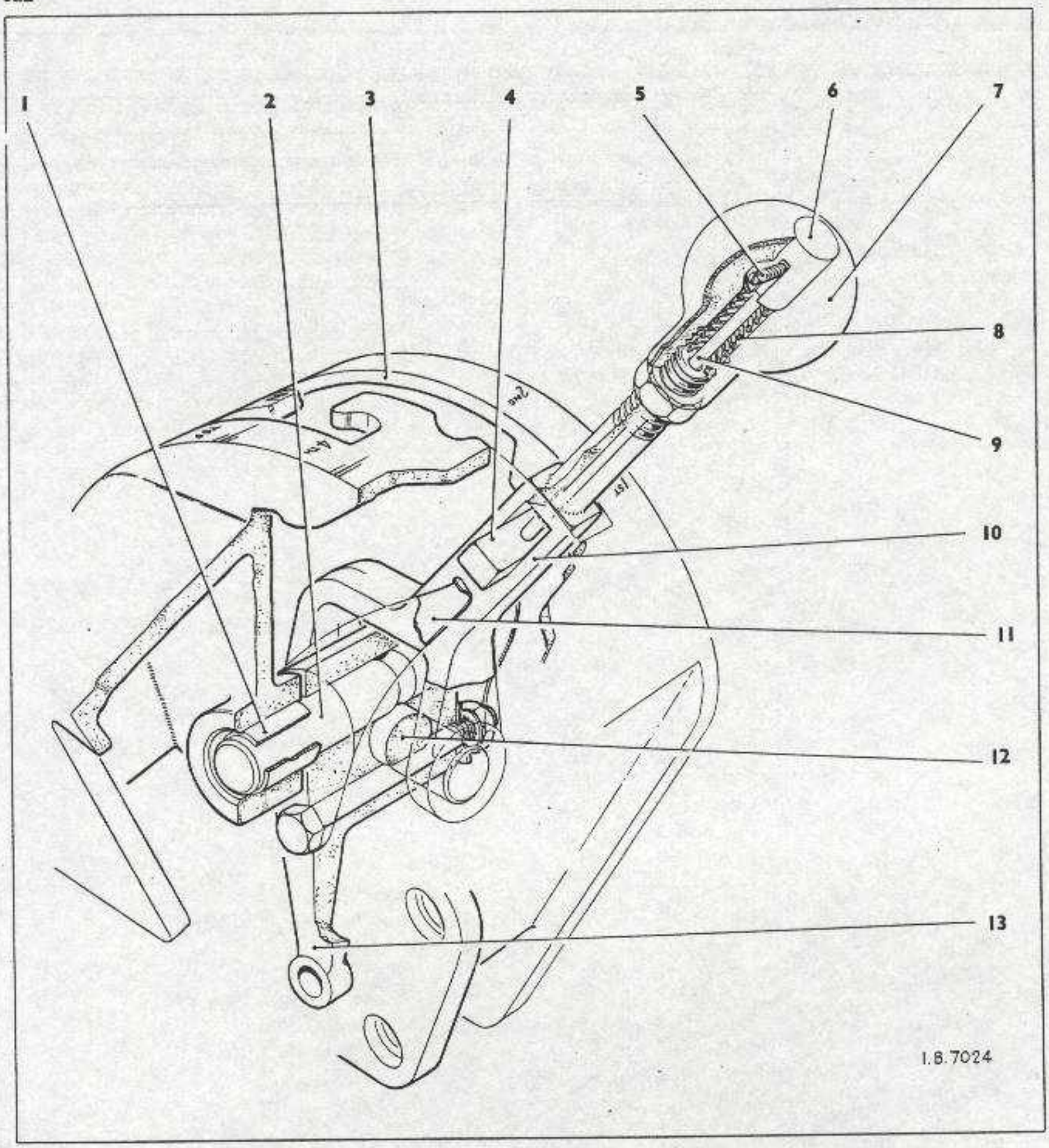
BUSBAR SPRING GEAR

78. The arrangement of the spring gear is shown in Fig 23, the gear change pedal being connected by linkage to the busbar outer operating lever (7) serrated and clamped to the cross-shaft (3). The cross-shaft is support in two bushes located in the casing by dowel-end screws. A collar secured by a Mills pin prevents endwise movement. At its inner end, an inner lever (1) is serrated and clamped to the shaft; the ball ends of a



1 Busbar inner operating lever
2 Cross-shaft inner bush
3 Busbar operating cross-shaft
4 Mills pin
5 Collar
6 Cross-shaft outer bush
7 Busbar outer operating lever
8 Gearbox and transfer box casing
9 Gearbox bottom cover
10 Busbar fulcrum bracket
11 Busbar
12 Rod retaining plate
13 Busbar operating rod
14 Busbar bucket
15 Spring guide collar
16 Spring inner guide
17 Busbar spring
18 Spring outer guide
19 Spring cover
20 Ball pin adjusting washer
21 Ball pin
22 Busbar operating sleeve
23 Sleeve retaining plate
(a) Gear change pedal depressed
(b) Gear change pedal released

Fig 23 Busbar spring gear



1 Oil retaining bronze bush
2 Selector lever spring pivot pin
3 Selector gear gate
4 1st speed stop
5 1st speed stop grubscrew
6 1st speed stop button
7 Selector lever knob
8 1st speed stop spring
9 1st speed stop rod
10 Selector gear lever
11 Selector lever R.H. control spring
12 Selector lever pivot pin
13 Selector operating lever

Fig 24 Selector gear lever and gate assembly - three-quarter front view

busbar operating sleeve (22) and rod (13) fit into hollows formed respectively at the end of this lever and at an outer position on the busbar.

79. When the pedal is fully depressed, the busbar (11) is held down against a stop on the gearbox bottom cover (9) the pedal pressure being opposed by the force of the spring (17). Although the spring is fully compressed and exerting maximum force, the effective arm of the spring force about the busbar pivot is very short, owing to the busbar bucket (14) having swung into abutment at its lower end with the busbar. As a result the pedal pressure necessary to balance the force is not excessive.

80. When the pedal is released, the spring force acting through the bucket causes the busbar to rise to the position shown in Fig 23(b). Although the spring force decreases as the busbar rises, owing to the spring extending, this decrease is more than compensated for by the increase in the effective arm of the spring force, except for a brief period just before the lower end of the bucket swings away from the busbar. Thus, the moment of the spring force causing the busbar to rise increases and with it the force applied to the strut.

SELECTOR GEAR

81. The selector gear (as illustrated in Fig 22) is of modified design, incorporating a neutral strut (see para 90 to 92) and comprising a toothed quadrant (15) which is meshed with a spiral gear integral with the selector camshaft (17) which carries one cam for each gear and an additional cam for neutral.

82. The selector camshaft is mounted in a bearing at each end. For each cam there is a cam following plate (19) which has a coil spring (14) behind it. An interlocking device for preventing two gears being engaged at the same time is formed by a locking bar (13) having five slots and housing a row of four plungers (12) through which projections on the five operating struts (20) have to pass. Sufficient end movement is provided to allow only one strut to pass at a time.

83. The quadrant is integral with the shaft (16) which is mounted in two bushes pressed into the cover (21) and has a lever (18) keyed and clamped to its outer end.

84. When the selector gear lever of the selector gear control is placed opposite any gear marked on the gate, that gear will be engaged when the gear change pedal is fully depressed and then released. In operation, the camshaft is turned so that the affected cam following plate is pushed towards the strut (20) by its spring. This pushes the strut against the busbar (23) but as the busbar is already held up by the busbar spring no action takes place.

85. As soon as the gear change pedal is depressed the busbar is depressed and the cam following plate is then able to push the strut so that it rests over the groove in the busbar. When the gear change pedal is released the busbar rises and lifts the strut with it. This applies the brake by lifting the thrust pad (9) which is connected to the lower end of the brake band by means of a pull-rod (5). The top end of the brake band is held by two hooks (22) and (25).

86. When the gear change pedal is depressed for the next change of gear the disengaging spring-loaded plunger which is fitted inside the strut forces the strut away from the busbar. The cam following plate is, at this period, held out of the way by the camshaft.

87. Let it be assumed that 1st gear is engaged and the selector gear lever is moved to the 2nd gear position. This causes the camshaft to be rotated until the lower point

of the 2nd gear cam is opposite the cam following plate, which pushes the 2nd gear strut against the busbar. At the same time, the 1st gear cam following plate is forced away from the 1st gear strut.

88. When the gear actuating pedal is fully depressed the 2nd gear strut enters the groove in the busbar while the 1st gear strut is flicked clear of the busbar by the spring-loaded plunger incorporated in the strut. On releasing the pedal the busbar spring lifts the busbar and the 2nd gear strut so tightening the brake band and engaging 2nd gear.

89. From the foregoing it should be fully understood why it is so essential to depress the gear actuating pedal FULLY when changing gear. The selection and engagement of top gear is carried out in exactly the same manner, except that a clutch is engaged instead of a brake band being applied.

90. With the modified design of selector gear neutral is obtained by the busbar being held right down by the neutral strut (26). This ensures a greater clearance between the 4th gear brake band and drum and in the top gear clutch and so reduces the drag in neutral.

91. Early type gearboxes were fitted with a selector gear of conventional design and therefore did not incorporate the neutral strut, while the camshaft had five cams in all, one for each gear. These gearboxes were so timed that, when neutral was selected, two struts (i.e., 4th and 5th) were pushed into the busbar when it was depressed to its lowest position by the gear actuating pedal. The plungers on the locking bar are of such a length that only one slot at a time can be filled by the projection on the back of a strut. Consequently, when the gear change pedal was released, the two struts were prevented from passing through the correspoinding slots and rising high enough to tighten the 4th gear band or compress the top gear clutch. As neither the brake band nor the top clutch was applied, the gearbox was left in neutral.

92. In all early type gearboxes the selector gear of conventional design will be replaced by the modified design on vehicle overhaul, in accordance with Wheeled Vehicles V 627 Mod. Inst. No.15.

LUBRICATION SYSTEM

93. The gearbox has an oil capacity of 10 pints. It is fitted with a combined dip-stick and breather and a filler plug, both of which are accessible after opening a hinged cover under the gunner's seat.

94. The lubrication system is pressure fed by a gear type oil pump. In earlier types the driving gear is keyed directly to the shaft but in the later types of gearbox a different arrangement is adopted. A distance piece is fitted between the driving gear and the shaft; this distance piece is keyed to the shaft and the driving gear is in turn keyed to the distance piece. Woodruff keys are used in both cases and, during assembly, the driving gear must be a good sliding fit on the shaft. The front shaft nut in this instance clamps the distance piece between itself and the inner race of the driving shaft and thus does not bear directly upon the oil pump driving gear.

95. The pump draws oil from the gearbox casing and discharges it into an axial hole in the driving shaft whence it is distributed through radially drilled holes to the various bushes and gears. The oil then finds its own level in the gearbox casing to be recirculated by the pump. Two oil pressure relief valves, each loaded by a spring, are housed in the oil pump body behind a cover.

Warning: *Should the vehicle be towed with the engine stationary, the gearbox in neutral and the transfer box engaged, some parts of the gearbox will be running at high speed although the oil pump will not be working. Under these conditions there is a definite risk of gearbox overheating and seizure. To avoid this, the transfer box must also be placed in neutral when the vehicle is being towed; it is not sufficient to place the gearbox in neutral.*

SELECTOR GEAR CONTROL

DESCRIPTION

96. The selector gear lever (Fig 24(10)) operates in a gate (3). This gate is secured by studs welded to the hull at the right of the driver's seat. The lever pivots on two pins; one, the selector lever spring pivot pin (2) and the other the selector lever pivot pin (12). By means of the first of these two pins the lever can be moved in a forward or rearward direction or, by use of the second, tilted sideways into either slot of the gate.

97. The spring pin is mounted in two oil-retaining bronze bushes pressed into bosses formed on the flanks of the gate and supports, in addition to the selector gear lever, a selector operating lever (13) together with a R.H. control spring (11) at one side and a similar L.H. spring at the other. Both springs are secured by a bolt which passes through the selector operating lever (13). This lever operates the linkage. When a gear in either slot of the gate is selected, one control spring bears firmly upon the selector gear lever thereby jamming it against the side of the slot. In neutral gear the lever is clasped firmly between the two control springs.

98. The 1st speed stop (4) fits into a slot in the selector gear lever and is screwed on to one end of a rod (9) which is free to slide in the centre of the lever shaft. At its top end the rod screws into a button (6) loaded by a small coil spring (8). A deep projection cast on the gate prevents the lever being moved to the 1st gear position unless the thumb button is first depressed.

99. The gate is engraved with the following gear positions: 1st, 2nd, 3rd, 4th, T and N (T = top, N = neutral).

100. An adjustable control rod is pin-jointed to the selector operating lever at one end and to an idler lever (Fig 25(3)) at the other end. The idler lever pivots by means of an oil-retaining bronze bush on a pin welded at one end to a bracket and fitted at the other end with a collar, secured by a Mills pin, for retaining the lever.

101. From the second eye end of the idler lever another adjustable control rod is connected to the outer arm of a bell-crank lever (4) which pivots by means of two oil-retaining bronze bushes on a pin welded to the hull structure. This lever also is retained on its pin by a collar secured by a Mills pin. The inner arm of the bell-crank lever is pin-jointed to a short adjustable control rod which is attached to the gearbox selector lever (5).

Notes:

1. *The arrangement at the rear end of the selector gear control as shown in Fig 25 is that applicable to the modified gearbox selector gear incorporating a neutral strut. In this arrangement the gearbox selector lever and the inner arm of the bell-crank lever (Pt. No. FV51866) project rearwards when in neutral. When 1st gear is selected the gearbox selector lever is moved to its highest position.*

2. With the conventional selector gear as fitted in early gearboxes (see para 90), the gearbox selector lever and the inner arm of the bell-crank lever (Pt. No. FV50266) project forwards when in neutral. When 1st gear is selected, the gearbox selector lever is moved to its lowest position.

OPERATION

102. The selector gear lever does not engage the gear and the position of the lever is no indication that the gear is engaged in the gearbox. When the lever is moved it operates the gearbox camshaft upon the position of which depends which gear will be engaged when the gear change pedal is depressed.

103. It is most important that, before the engine is started, the selector lever is moved to the neutral position and the pedal operated. The pedal should be operated even if the lever is in the neutral position.

104. When any gear is being engaged the lever should be moved to the required position before the change is made. The lever may be left in position for the next change for any length of time.

GEAR CHANGE PEDAL AND LINKAGE

DESCRIPTION

105. The pedal (Fig 25(14)) is welded to a tubular shaft which also carries at its left-hand end an integral linkage operating lever. This pedal assembly is free to pivot on a solid shaft which is held in brackets (13) bolted to the hull, the shaft being secured to the bracket at one end with a Mills pin. Two oil retaining bronze bushes, pressed into the ends of the tube, support the pedal assembly.

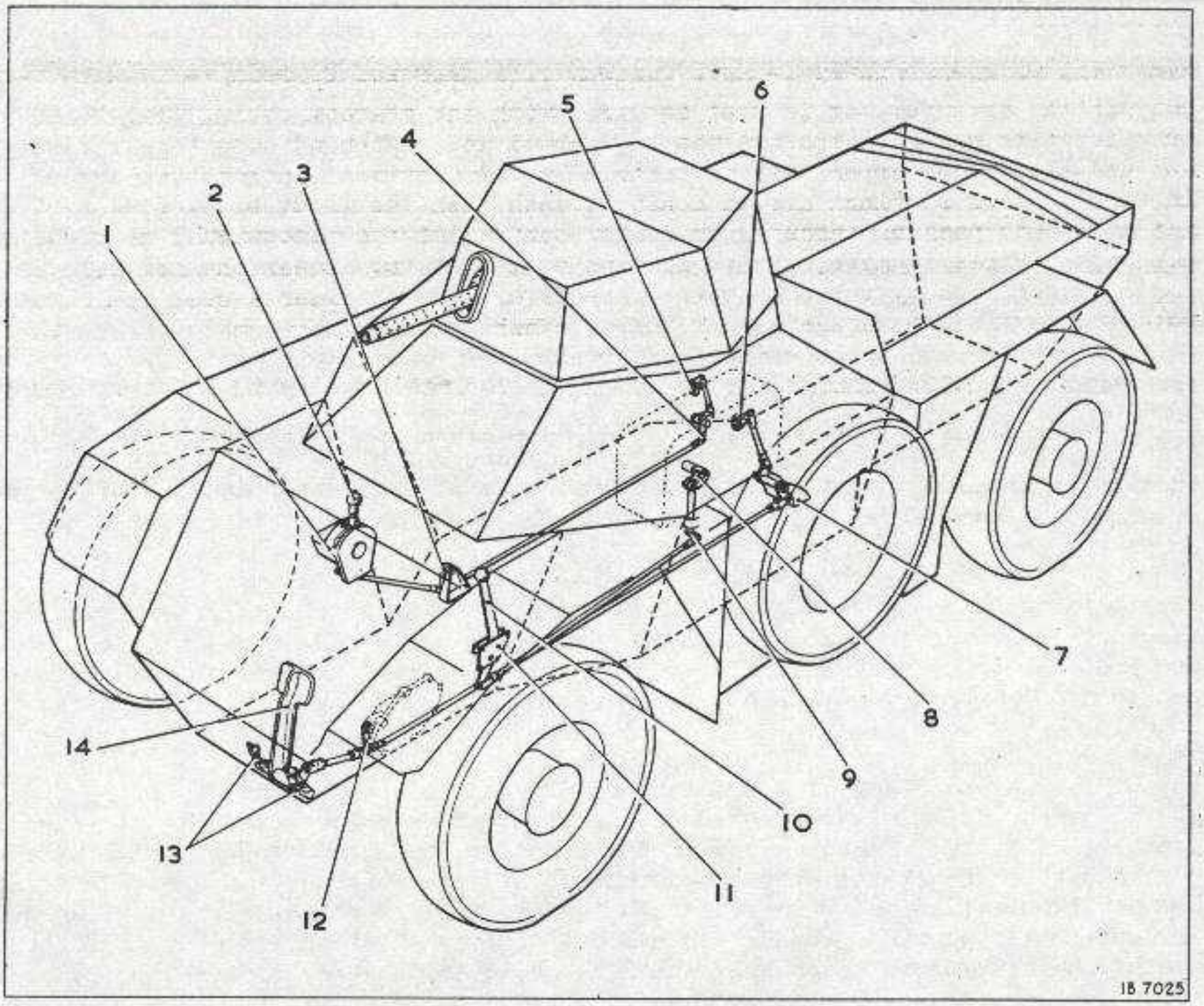
106. A short adjustable rod is connected to the pedal lever and an idler lever (12) respectively. The idler lever is free to move by means of an oil-retaining bronze bush on a shaft held in a bracket bolted to the left-hand bevel box; the shaft is secured with a Mills pin.

107. From the second eye connection on the idler lever a longer rod, also having forked ends, is linked to a bell-crank lever. The bell-crank comprises a tubular member with levers integral at each end. It pivots by means of two oil retaining bronze bushes on a short shaft which is held in a bracket (7). The bracket is bolted to the floor of the hull and a Mills pin secures the shaft rigidly to it. From the bell-crank lever another adjustable rod is linked to the gearbox busbar outer operating lever (6) (see also Fig 23(7)).

108. Split-pinned joint pins and fork-ends with locknuts provide means of attachment for all the control rods. The pedal and bell-crank lever are set to angular dimensions measured through the centre of the busbar outer operating lever (i.e., 5° below the horizontal when the pedal is down and 47° above it when the pedal is up) the rods being adjusted to give an equal swing of the idler lever about a vertical centre line.

OPERATION

109. This is as described in para 78.



1 Selector gear gate
2 Selector gear lever
3 Selector gear control idler lever
4 Selector gear control bell-crank lever
5 Gearbox selector lever
6 Gearbox busbar outer operating lever
7 Gear change control bell-crank lever bracket
8 Transfer box forward/reverse top selector lever
9 Transfer box forward/reverse bottom selector lever
10 Forward/reverse control hand lever
11 Forward/reverse control hand lever plate
12 Gear change control idler lever
13 Gear change control pedal brackets
14 Gear change pedal

Fig 25 Gearbox and transfer box controls arrangement

TRANSFER BOX

DESCRIPTION

110. The transfer box is of unit construction with the gearbox (Fig 20). The main body of the transfer box is cast integral with the gearbox casing (Fig 26(60)) and is provided with studs to receive the right-hand and left-hand output gear casings (59) and (24). In the upper half of the box, two directional spiral bevel gears supported in taper roller bearings are in constant mesh with the input bevel pinion (7). A mainshaft (8) passing through the hollow centres of the directional gears carries a sliding dog free to move on that portion of the shaft between the gears. This sliding dog is controlled by the forward/reverse lever in the driver's compartment and can be actuated at will to engage either one or other of the directional gears.

111. When the dog engages a gear the motion of that gear is imparted to the mainshaft which in turn drives (through the medium of a double-helical gear train at the right-hand end of the shaft) a bevel differential assembly which divides the drive and directs it at each side to an output spiral bevel pinion that is in constant mesh with two output bevel gears.

112. Both output gear casings are machined metal castings, the left-hand casing (24) being the longer of the two. Each is secured to the studs on the main body by plain nuts and shakeproof washers. The bevel pinion cover at the end of each output casing incorporates a bracket (trunnion) which serves to mount the complete transmission assembly.

113. The right-hand end of the mainshaft drives the speedometer. In the main body an oil filler and dipstick are provided. A breather is incorporated in the dipstick assembly; air pressure developed in the transfer box through operation of the gears is equalized through connecting passages and then vented through the breather to atmosphere. Lubrication is by the oil bath method, the oil reaching the various gears, ball and roller bearings, by splash and oil mist. An oil drain plug is fitted to the base of the box and is accessible through a hole in the underside of the hull after a drain plug coverplate (Fig 79(4)) has been removed.

114. One directional bevel gear is mounted in the right-hand side of the main body. This gear is supported by opposed taper roller bearings (Fig 26(3)) carried in a flanged bearing housing (6) the flange being drilled and counterbored for eight socket-headed screws which secure the housing in the main body.

115. Between the bearing housing flange and the face of the casing where it abuts, shims (5) are fitted to ensure correct meshing of the gear with the input pinion. These shims are supplied in four thicknesses ranging from 0.002 in. to 0.025 in. The cups of the bearings fit against abutments machined in the housing, while a spacer and shims (12) as required separate the cones. A locknut (13) fits on the shaft of the bevel gear which is externally threaded to receive it; when tightened this nut bears against a lockwasher which bears on the inner cone of the outer bearing thereby securing the gear against axial movement, the shims (12) having been selected to give a bearing pre-load of 0.000 in. to 0.002 in.

116. Identical otherwise in method of assembly, the other directional bevel gear is mounted in the output gear casing (24) at the left-hand side.

117. The mainshaft passes through the hollow shafts of the directional bevel gears and is supported at the left-hand end by a roller bearing (16) and a ball bearing (17) which are held apart by an inner and an outer spacer. Being shouldered, the mainshaft is

positively held in these bearings, its abutment being clamped against the inner race of the roller bearing by the tightening of a slotted nut (20) which bears upon a washer (21) against the inner race of the ball bearing. The nut is locked by split-pinning. This double bearing can adjust itself to deflections of the shaft and, having to carry a radial load without much thrust, the inner races are clamped as described to prevent them jarring loose.

118. The splined centre portion of the mainshaft carries a sliding dog (9) which is toothed at each end. Engaging in a groove cut round the centre of the dog is a fork (11) which is part of the forward/reverse mechanism. The teeth of the dog engage with corresponding teeth in either of the bevel gears, the dog being slid along to engage it with the right-hand gear if FORWARD is selected or the left-hand gear if REVERSE is chosen. Selection of neutral on the forward/reverse lever places the dog in the midway position with neither gear in engagement. The end teeth of the sliding dog are cut with 6° reverse lead in order to prevent disengagement.

119. The right-hand end of the mainshaft is splined to carry a staggered double-helical gear (58) which meshes with a driven gear (39) of similar pattern on the differential assembly. The mainshaft helical gear is held in position at one end by a sleeve (57) which abuts the dog-splines on the mainshaft and, at the other end, by the inner race of a roller bearing (56). This roller bearing which has a single-lip outer race is mounted in the right-hand output gear casing and supports the right-hand end of the shaft. Keyed to that portion of the mainshaft beyond the roller bearing is the speedometer gear (55). This gear (a worm driving a worm wheel) bears against the inner race of the mainshaft right-hand bearing and is held there by a thick washer, slotted nut and split pin. The speedometer pinion, i.e., the worm wheel, abuts a thrust pad and runs in a shouldered bush pressed into a bracket (40) which is secured by a pair of nuts screwed down on studs, the bracket being positioned to bring the oil hole at the inner end uppermost.

120. The differential casing (32) and (36) is supported in roller bearings (31) and (48) one in each output gear casing. The outer races of these bearings have single lips. The differential casing is stepped down at both ends to mount the inner races of these bearings, the reduced diameters thereby affording positive location of the casing between bearings spaced at opposite ends. At the right-hand end, the double-helical gear driven by the mainshaft gear is splined to the casing.

121. The differential casing is made up in two parts, a long portion (36) (mounting the helical gear) and a much shorter part (32). Four holes arranged radially around the casing joint in the same plane as the joint, accommodate the differential cross-pin or spider (33) which is clamped into position when the casing is assembled. Eight bolts, nuts and split pins are used for holding together the two parts of the casing.

122. Each arm of the cross-pin carries a bush. On the bush rides a bevel pinion (35). A dished thrust washer (34) is fitted between the head of the pinion and the casing to prevent "picking up". Both long and short casings receive in floating bushes the differential bevel gears. These gears are driven by the four pinions.

123. Each output bevel pinion (49) is supported in an identical manner by opposed taper roller bearings (50) which are a press-fit within a flanged housing (54) which fits inside the output gear casing. The cups are separated by a shoulder machined in the housing and the cones by a spacer. Shims (53) are available in three thicknesses for insertion at the outer ends of the spacers to give a bearing pre-load of 0.000 in. to 0.002 in. The shaft of the output bevel pinion projects through the bearings and its end is externally-threaded to take a nut (52) which when tightened bears upon its lockwasher which bears against the cone of the outer bearing.

124. The housing accommodating these bearings is secured to the casing by nuts and hexagon-headed screws which also secure a cover (23) over the end of the casing. This cover incorporates a bracket or trunnion for mounting the transfer box and, indeed, the whole front end of the combined transmission and power unit installation. Caps fit over the mounting trunnions at both sides. The trunnions are held in a Metalastic rubber bush. Shims (41) are provided for fitment between the bearing housing and the casing to permit adjustment of the backlash between the output bevel gear and the output pinion.

125. Each output bevel pinion drives two output bevel gears (44) positioned respectively forward and aft and at right angles to the output shaft (differential halfshaft). These bevel gears are supported by opposed taper roller bearings (43) and (47) carried in a housing (46) and fitted with spacer and shims in a like manner to that used in the case of the output bevel pinion. The end of each output bevel gear shaft is splined to receive a coupling flange (25) which is secured with a slotted nut and split pin. Within a housing (42) retained by nuts and shakeproof washers on studs, an oil seal is fitted.

Key to Fig 26 (opposite)

1 Gearbox oil dipstick
2 Gearbox oil filler plug
3 Taper roller bearing - 65 mm x 120 mm x 1.142 in.
4 Transfer box top cover
5 Forward/reverse bearing housing shims
6 Forward/reverse bearing housing
7 Input bevel pinion (gearbox output pinion)
8 Mainshaft
9 Sliding dog
10 Forward/reverse bevel gear
11 Selector fork
12 Forward/reverse bevel gear shims
13 Forward/reverse gear locknut
14 Circlip
15 Selector shaft
16 Roller bearing - 40 mm x 90 mm x 23 mm
17 Ball bearing - 40 mm x 90 mm x 23 mm
18 Mainshaft cover
19 Top selector lever
20 Slotted nut - 5/8 in. UNF
21 Mainshaft washer
22 Transfer box oil filler plug
23 Cover and mounting bracket
24 L.H. output gear casing
25 Coupling flange
26 Selector spring plug
27 Detent ball
28 Selector spring
29 Bottom selector lever
30 Selector lever shaft
31 Roller bearing - 55 mm x 100 mm x 21 mm
32 Short differential casing
33 Differential cross-pin
34 Differential pinion thrust washer
35 Differential pinion
36 Long differential casing
37 Differential gear
38 Differential gear thrust washer
39 Differential casing helical gear
40 Speedometer drive bracket
41 Output bearing housing shims
42 Oil seal housing
43 Taper roller bearing - 1.5 in. x 3.75 in.
44 Output bevel gear
45 Output bevel gear shims
46 Output gear bearing housing
47 Taper roller bearing - 1.625 in. x 3.75 in.
48 Roller bearing - 2.1/4 in. x 4.1/2 in. x 7/8 in.
49 Output bevel pinion
50 Taper roller bearing - 1.8125 in. x 3.750 in. x 1.094 in.
51 Output shaft (differential half shaft)
52 Output pinion locknut
53 Output bevel pinion shims
54 Output pinion bearing housing
55 Speedometer gear
56 Roller bearing - 30 mm x 90 mm x 23 mm
57 Sleeve
58 Mainshaft helical gear
59 R.H. output gear casing
60 Gearbox and transfer box casing

(a) Three-quarter front broken perspective view
(b) Part-view showing selector shaft detent ball

103 FD WKSP RAEME

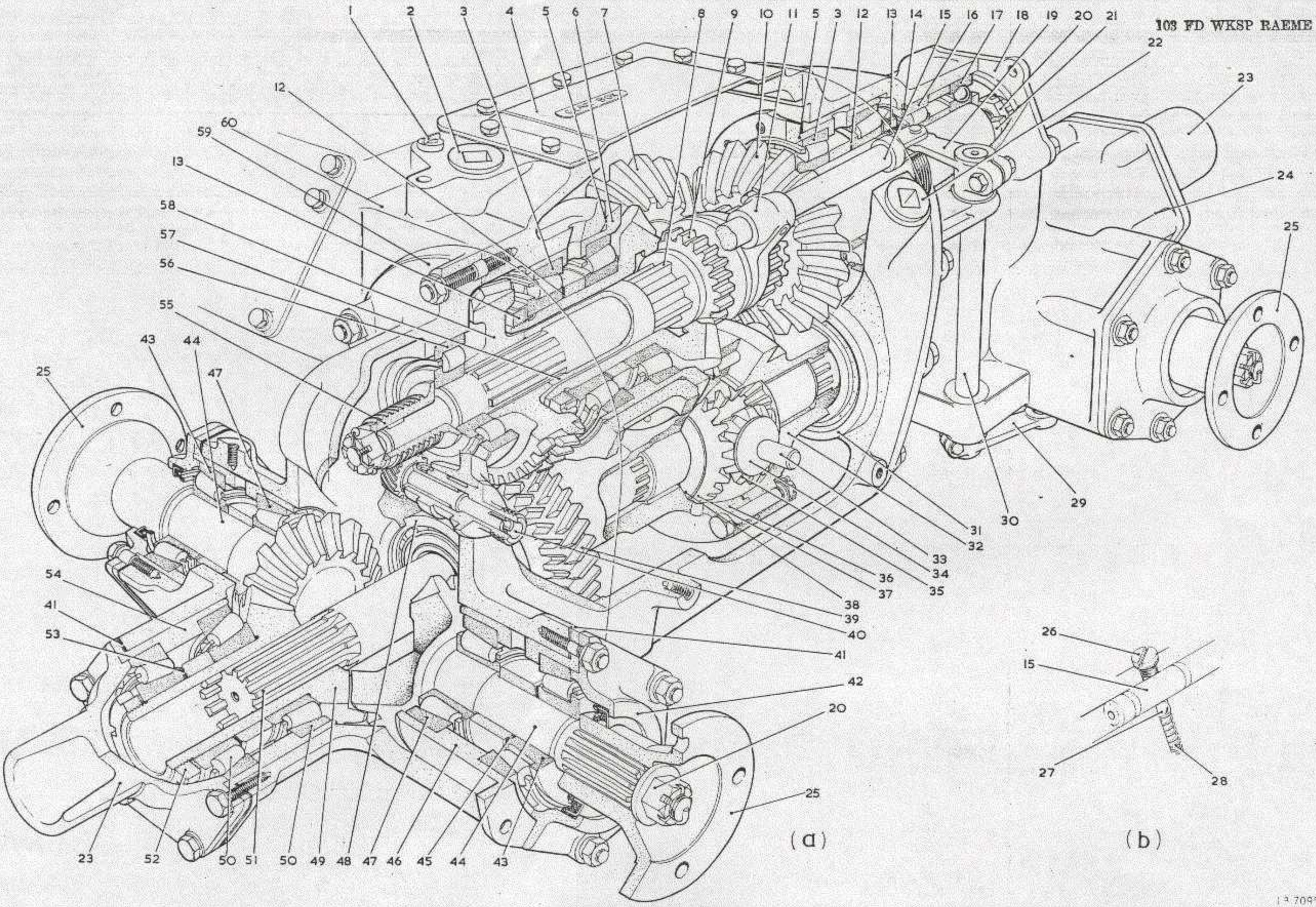
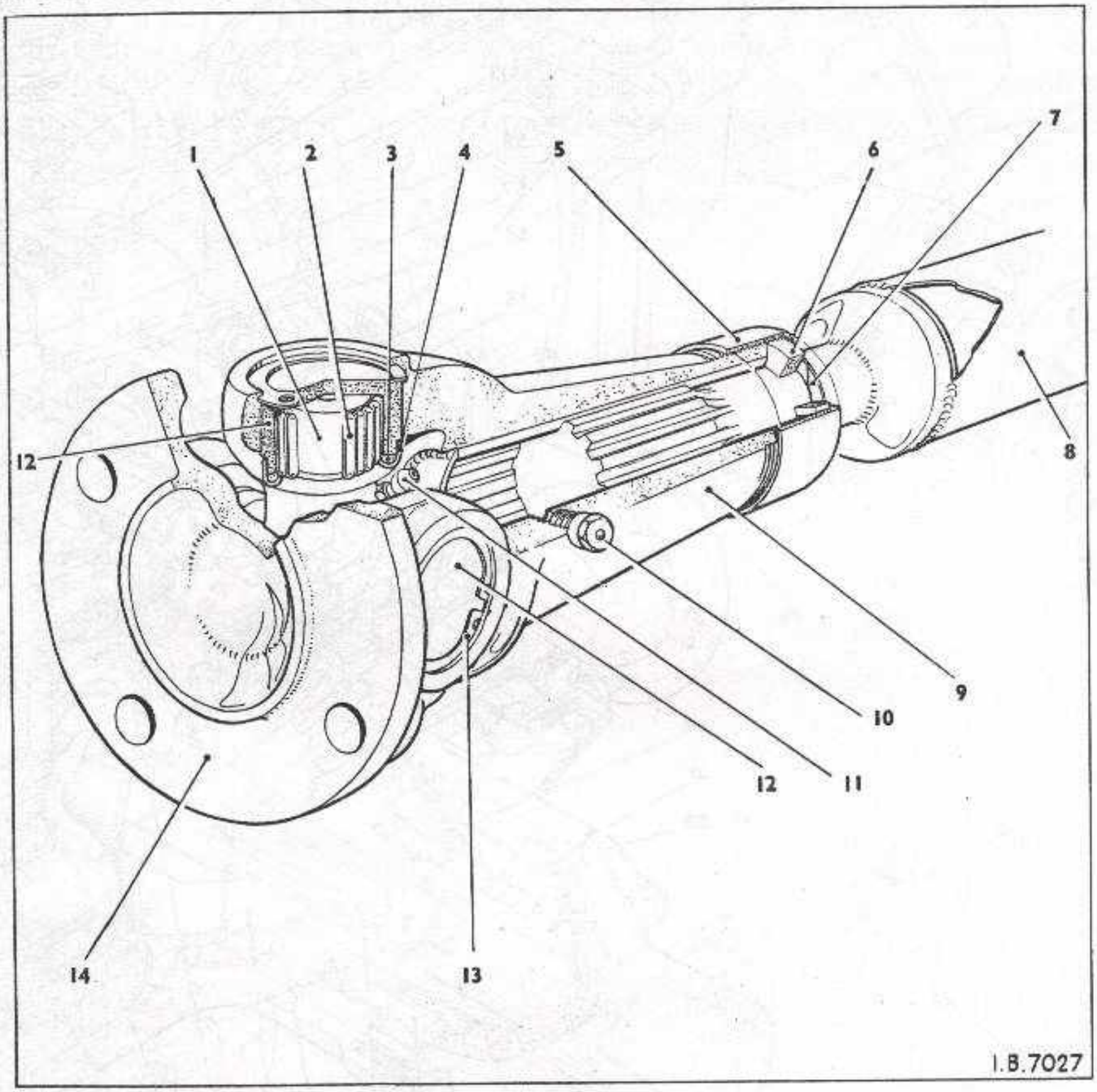


Fig 26 Transfer box

126. The selector fork (11) of the forward/reverse mechanism is bolted to a shaft (15) which slides in bushes fitted to the main casing. Two grooves are cut into the right-hand end of this selector shaft and a spring-loaded ball (Fig 26(b)) engages in one of the grooves when either FORWARD or REVERSE is selected. This ensures positive location of the selector dog and, together with the reverse lead on the dog splines, prevents displacement due to vibration. At the left-hand end of the shaft its fork-end is connected by means of a joint pin to a lever (19). The other end of the lever



1	Journal	8	Tubular shaft
2	Needle rollers	9	Sleeve yoke
3	Cork gasket	10	Hook-on type lubricating nipple
4	Gasket retainer	11	Press-on type lubricating nipple
5	Dust cap	12	Needle bearing race
6	Cork washer	13	Snap ring
7	Steel washer	14	Flange yoke

Fig 27 Propeller shaft sliding spline joint

is attached to the serrated upper end of a shaft (30) which runs vertically through brackets cast on the left-hand output gear casing. At the bottom of this shaft a second lever (29) is fitted to serrations and (as is the top one) bolted at the correct angle; suitable linkage then leads off to the forward and reverse lever mounted in a quadrant to the left of the driver's seat.

Important: *Should the vehicle have to be towed, the transfer box must be placed in neutral. It is not sufficient to place only the gearbox in neutral - see Warning, para 95.*

OPERATION

127. The drive is taken to either directional bevel gear as desired. The double-helical gear splined to the right-hand end of the mainshaft is meshed with a mating gear on the differential assembly in the lower half of the box. This gear causes the small differential pinions to revolve, with the differential casing thereby driving the differential gears and, at the same time, making provision for the vehicle cornering. Halfshafts connect the differential gears with the output pinions which in turn transmit the drive to the four bevel gears and thence to the propeller shafts through tracta joints. The transfer box speed ratio is 1.347 : 1, both FORWARD and REVERSE.

FORWARD AND REVERSE CONTROLS

128. The forward and reverse control consists of a hand lever (Fig 25(10)) a quadrant and appropriate linkage. The quadrant is secured to the hull at the left-hand side of the driver's seat and the linkage leads directly to the transfer box. When the lever is placed in the forward position, "forward" gear is engaged; the central position engages "neutral" and the rear "reverse".

129. The quadrant is constructed from two plates separated by two distance pieces. One plate (11) is secured to all of four studs projecting from the hull while the other fastens to only two of the studs with the distance pieces in between. This latter and narrower plate retains the hand lever, the quadrant assembly being finally secured with nuts and shakeproof washers.

130. The hand lever pivots on a pin integral with the hull plate (11). A spring washer, plain washer and split pin serve to secure the lever to the pin and it is mounted at this fulcrum point by means of an oil-retaining bronze bush. At its lower end, the lever is pin-jointed to the forked end of an adjustable control rod that is attached at its other end to the bottom lever (9) of the transfer box vertical control shaft (see para 126).

PROPELLER SHAFTS

131. The drive from the transfer box is transmitted through two long and two short propeller shafts at front and rear respectively. These shafts are of the conventional tubular type with a needle bearing universal joint at each end, one joint being fixed to the shaft, whilst the other is a sliding or slip spline joint. Except for the difference in length of their tubular shaft portions, the front and rear propeller shafts are identical.

132. The sliding spline joint (Fig 27) which accommodates any alteration in length between the ends of the shaft, and is coupled to the transfer box, comprises a cruciform journal (1) four needle bearings, a flange yoke (14) and a sleeve yoke (9); the fixed joint is of similar construction except that the sleeve yoke is replaced by a

stub yoke, which is integral with the tubular shaft (8). Each bearing race (12) is retained in the yoke by a snap ring (13) and is sealed against loss of lubricant by a cork gasket (3) held in a retainer (4) pressed on to the journal. A dust cap (5) housing a cork washer (6) backed by a steel washer (7) is screwed on the sleeve yoke to protect the splines from the ingress of dirt and water. A "press-on" type lubricating nipple (11) is fitted to the journal of each joint, whilst a "hook-on" type nipple (10) is fitted to the sleeve yoke of the sliding joint. Alignment arrows are stamped on the sleeve yoke and the splined end of the shaft.

BEVEL BOXES AND WHEEL HUBS

133. The propeller shafts transmit the drive to the bevel boxes, one of which is provided for each road wheel. All four bevel boxes are rigidly bolted to the hull of the vehicle, the front bevel boxes being located in the driver's compartment and the rear ones in the engine compartment.

134. A spiral bevel pinion in the bevel box is driven by the propeller shaft and this, in turn, drives a spiral bevel wheel. This bevel wheel imparts the motion to the bevel box tracta fork which is coupled by the inner tracta joint to the inner tracta fork. A coupling sleeve is used to connect the inner tracta fork to the outer tracta fork which in turn drives, through the outer tracta joint (identical to the inner tracta joint), the hub tracta fork. Final drive to the road wheels is through a hub reduction gear driven by this hub tracta fork.

135. It should be noted that the inner tracta joint and fork are part of the bevel box assembly and that the outer tracta fork and joint are part of the hub assembly.

BEVEL BOX ASSEMBLY

136. The four bevel boxes are all similar in principle and are interchangeable in pairs, i.e., the front right and the rear left boxes (Fig 28) are exactly similar while the front left and the rear right are also identical. Before the rear bevel boxes can be removed the engine must be taken out.

137. Each bevel box casing (17) is a one-piece L-shaped casting, housing the bevel pinion and bevel wheel assembly and containing the inner tracta joint within the same casing. A relief valve is incorporated with a large hexagon plug to vent excess air pressure to atmosphere and a filler plug fitted with a joint washer is embodied for topping up the oil; the filler plugs are located in the inner tracta joint housing ends of the bevel box casings at the outer side of the hull. At the bottom of the inner tracta joint housing end of each casing a drain plug (18) is fitted; for convenience of illustration this plug is shown 45° out of position. The hexagon-socket plug (14) is fitted only to late type casings. These casings are of malleable cast-iron and the plug is used for manufacturing purposes; early type casings were of cast steel.

138. The drive from the propeller shaft is taken to a coupling flange (1) which is secured to the integral splined shaft of the bevel pinion (6) with a large washer, slotted nut (2) and split pin. The slotted nut also serves to secure the cones of the two taper roller bearings (8) (separated by a spacer and shims) which support the bevel pinion shaft, the cups of the bearing being contained in a shouldered housing (7). This housing is flanged and between the flange and the casing, shims (4) varying from 0.002 in. to 0.020 in. in thickness, are fitted to ensure correct meshing of the bevel pinion. The pinion bearings should be preloaded 0.000 in. to 0.002 in. A housing (3) for an oil seal (5) fits against the flange of the bearing housing and both housings are bolted to the outer casing with bolts locked by shakeproof washers.

1 Coupling flange
2 Slotted nut, UFN310/A
3 Bevel pinion oil seal housing
4 Bevel pinion bearing housing shims
5 Oil seal
6 Bevel pinion
7 Bevel pinion bearing housing
8 Taper roller bearing, 1.375 in. x 3.00 in. x 0.938 in.
9 Dowel
10 Screw, UFS104/3R
11 Bevel box tracta fork
12 Bevel wheel hub
13 Rivet
14 Plug
15 Bevel wheel
16 Slotted tracta joint
17 Front right and rear left bevel box casing
18 Drain plug (shown 45° out of position)
19 Bearing housing dowel (shown 45° out of position)
20 Bearing housing screw (shown 45° out of position)
21 Inner tracta housing sliding seat
22 Bearing housing shims
23 Tracta housing seat oil seal
24 Locking ring
25 Tracta joint housing shims
26 Spigoted tracta joint
27 Gaiter retaining ring
28 Inner gaiter
29 Ball bearing 1.1/4 in. x 2.3/4 in. x 11/16 in.
30 Coupling sleeve retaining pin
31 Tracta fork coupling sleeve
32 Inner tracta fork
33 Inner tracta fork housing
34 Hose clip
35 Hose clip
36 Oil seal
37 Inner tracta oil seal housing
38 Sealing ring
39 Outer bearing housing
40 Socket-headed screw

(a) Bevel box assembly showing late type bevel wheel and hub with riveted attachment
(b) Part-view showing early type bevel wheel and hub and the attachment by means of screws and nuts

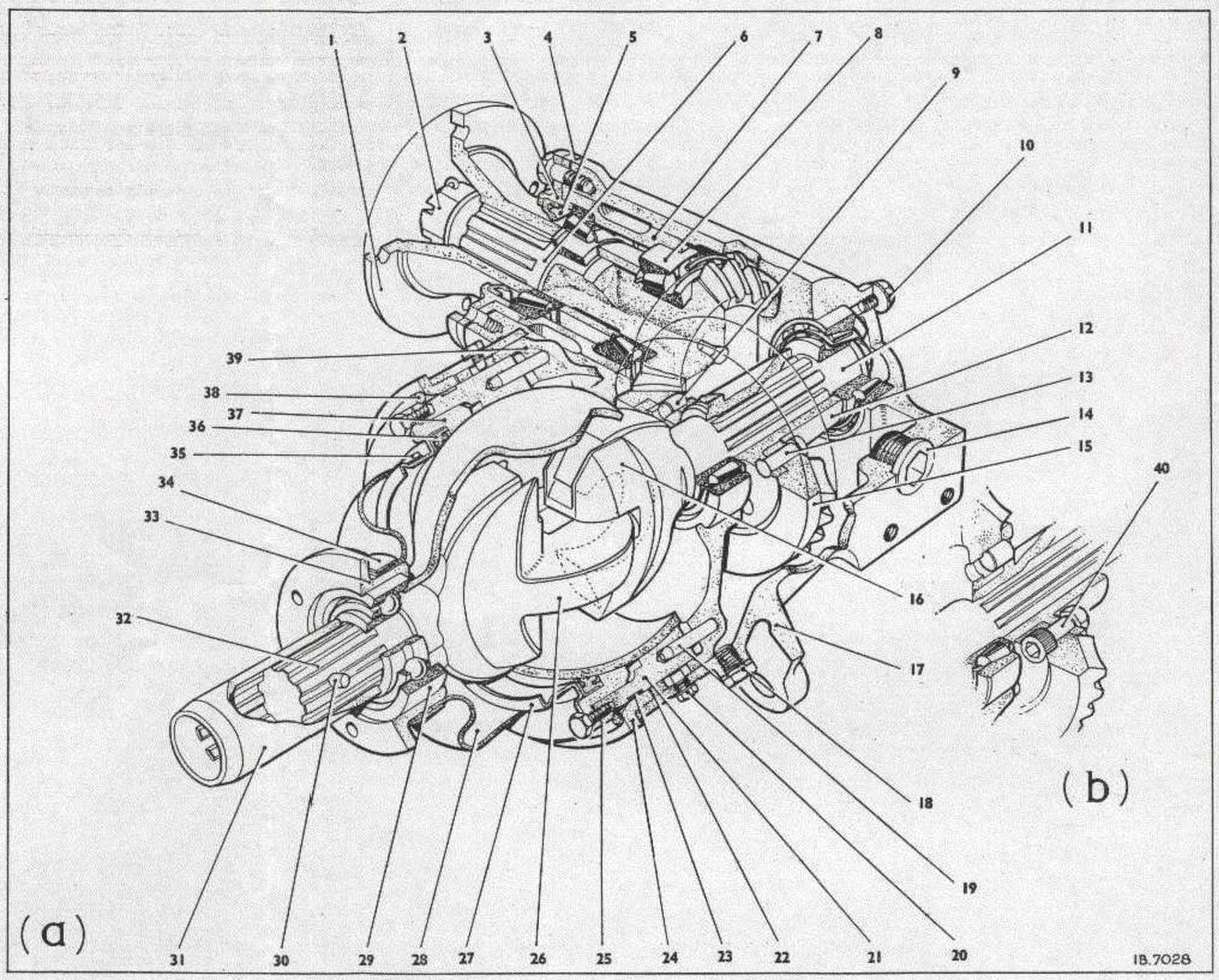


Fig 28 Front R.H. and rear L.H. bevel box assembly

139. A bevel wheel driven by the pinion gives a ratio of 1.923 : 1. The bevel wheel (15) is of the late type, being dowelled and secured by rivets (13) to a flanged and splined hub (12). The early type bevel wheel and the corresponding hub are shown in Fig 28(b); this wheel is also dowelled but is secured to the hub by socket-headed screws (40) and plain nuts, the ends of the screws being peened over. The bevel wheel hub mates with the externally-splined shaft of the bevel box tracta fork (11). It is secured between the cones of two opposed taper roller bearings which are situated one at each end of the hub. A shoulder on the tracta fork shaft bears against the outer end of the cone of the outer bearing and a bolt at the opposite end of the shaft, when tightened, draws down a large washer upon the cone of the inner bearing, thereby holding the assembly securely in position. The bolt is locked with a shakeproof washer. The cup of the inner bearing is housed within the bevel box casing. Two screws (10) permit the roller cup and shims to be tapped out when the bevel box is being dismantled. These shims are used in the adjustment of the bevel wheel. The cup of the outer bearing is held in its own housing (39).

140. The sliding seat (21) of the inner tracta fork housing is free to slide a small amount on the dowels (19) sunk into the outer bearing housing. A seal (23) fits between it and an externally-threaded flanged locking ring (24) which screws into the bevel box casing. The threads of the locking ring are treated with "Wellseal" and a locking plate ensures that the preloading (0.000 in. to 0.002 in.) of the inner and outer taper roller bearings, which is effected by means of shims (22) between the locking ring and the outer bearing housing, is not disturbed. Two dowel-ended screws (20) bolted through from the outside of the bevel box casing prevent rotary movement of the outer bearing housing. Outside the flange of the locking ring an O-section ring (38) sealing the inner tracta housing is fitted.

141. A flanged housing (37) for an oil seal (36) is fitted between the sliding seat and the spherical portion of the inner tracta fork housing (33) shims (25) being fitted between the sliding seat and oil seal housing flanges to obtain proper adjustment. This seal prevents oil escaping from the tracta joint. Adjacent to the flange of the oil seal housing is a gaiter retaining ring (27); the sliding seat, the shims, the oil seal housing and the gaiter retaining ring are secured together in one combined sliding seat and tracta fork housing assembly by screws locked with shakeproof washers. Bostik is applied to contacting faces of the retaining ring and the oil seal housing. The spherical joint must move freely after the housing assembly screws have been tightened.

142. The spherical portion of the inner tracta fork housing is protected by a rubber gaiter (28). Bostik must be applied to the faces between the gaiter and its retaining ring and the gaiter and the inner tracta fork housing, prior to assembly. At both ends, the gaiter is secured with hose clips ((34) and (35) respectively). All gaiter clips have inserts fitted under them.

143. The inner tracta fork housing is free to slide (see para 140) to accommodate variations due to suspension movement. This end movement is taken up in the rotating parts of the tracta joint itself. In addition, at each side of the spherical part of the housing is a drilled hole into which a dowel fits; these dowels prevent rotation of the housing but allow it to rise and fall with suspension movement. V-shaped oil deflectors are welded inside the spherical portion with their apices facing each other. On the periphery of the housing flange is stamped the word TOP to ensure that the housing is fitted with the deflectors uppermost.

144. The tracta forks with their integral shafts are made from steel stampings hardened all over and, after machining, radiused and chamfered on their working faces. A tracta joint is fitted between each pair of forks. Each joint consists of two

separate parts, one spigoted and the other slotted. In each part a groove is cut at right angles to the spigot or slot to receive the fork. The inner side of the claw of the fork clasps round a bearing surface, or journal, within the groove. Individual parts of the joint are free to turn about axes at right angles to the flanks of the forks while the spigot and slot allow relative movement between the two parts of the joint in a plane at right angles to that allowed by the journals. The drive is taken through the flanks of the forks and the sides of the grooves, and the flanks of the spigot and the sides of the slot.

145. The shaft of the inner tracta fork (Fig 28(32)) runs on a single-row rigid type ball bearing (29). On the inner side the inner race of the bearing bears against the stepped-up fork end of the shaft; at the outer end the inner race abuts the splined coupling sleeve (31) which couples together the inner tracta fork shaft and the outer one. The outer race of the ball bearing is held between a flange at the inner tracta fork housing (33) and the projecting lip of the housing (Fig 29(12)) for the outer tracta fork. The flanges of the two tracta fork housings are bolted together by hexagon-headed bolts fitted with shakeproof washers.

146. As already mentioned, a coupling sleeve is used to join the inner tracta fork to the outer tracta fork. A pin (30) secures the sleeve to the inner tracta fork. New pins must always be used when the splined sleeve component is reassembled and they must be rolled over at the ends.

HUB ASSEMBLY

147. The following description and Fig 29 are applicable to the front wheel hub assemblies and, if "hub carrier" be substituted for "hub swivel", are equally applicable to the rear wheel hub assemblies. The sole difference between front and rear wheel hub assemblies is that the hub swivel (7) which is fitted with trunnions for the attachment of the link pins of the suspension assembly, is replaced in each rear wheel hub assembly by a hub carrier; this hub carrier incorporates attachment points for the top and bottom suspension links (see under SUSPENSION AND ROAD WHEELS). Each front and each rear wheel hub assembly incorporates a hub (47) fitted with eight wheel studs (1); the studs at the left-hand side of the vehicle have left-hand threads while those at the opposite side have right-hand threads.

Tracta forks and outer tracta joint

148. The outer tracta joint is enclosed, in a similar manner to the inner tracta joint, in a spherical housing which is part of the outer tracta fork housing (Fig 29(12)). This outer tracta fork housing is bolted to the inner tracta fork housing (Fig 28(33)) the two housings together with their tracta forks forming the axle between the bevel box and the wheel hub. A needle bearing (Fig 29(15)) in the housing (12) supports the outer tracta fork (14). An oil seal (13) in the housing rides on the coupling sleeve (Fig 28(31)).

149. The spherical housing is held in the hub swivel by a seat (Fig 29(18)) and an oil seal housing (8) the seat and housing providing a ball joint for the axle. A machined recess in the oil seal housing accommodates an oil seal, the lip of which bears on the spherical housing and prevents escape of oil. A gaiter (10) is positioned externally over the outer tracta fork housing and is secured at the inner end by a hose clip (11). At the outer end, screws pass through a gaiter cup (19) the gaiter (10) the flange of the oil seal housing (8) and shims (9) and screw into the hub swivel; copper wire is used to lock the hexagon-headed screws.

1 Wheel stud
2 Brake lining
3 Brake drum
4 Brake shoe
5 Brake backplate
6 Late type oil filler plug
7 Front wheel hub swivel or rear wheel hub carrier
8 Outer tracta oil seal housing
9 Tracta joint housing shims
10 Outer gaiter
11 Hose clip
12 Outer tracta fork housing
13 Oil seal
14 Outer tracta fork
15 Outer tracta fork needle bearing
16 Slotted tracta joint
17 Spigoted tracta joint
18 Hub tracta housing seat
19 Gaiter cup
20 Hub tracta fork
21 Circlip
22 Hub bearing distance piece
23 Hub oil seal
24 Hub tracta fork needle bearing
25 Taper roller bearing, 3.1875 in. x 5.375 in. x 1.188 in.
26 Hub swivel and hub carrier dowel
27 Needle rollers, 3 mm x 19.8 mm
28 Socket-headed screws
29 Late type planet gear pin
30 Sun wheel
31 Bolt, UFB105/10R
32 Hub nut lockwasher
33 Hub locknut
34 Ball bearing, 1 in. x 2.1/2 in. x 3/4 in.
35 Hub sun wheel shims
36 Hub sun wheel spacer
37 Bolt, UFB106/12R
38 Circlip
39 Hub bearing housing
40 Hub reduction gear planet cage
41 Hub bearing shims
42 Planet gear cover
43 Planet gear
44 Hub reduction gear cover
45 Hub reduction gear annulus
46 Dowel
47 Hub
48 Wheel nut
49 Early type planet gear pin
(a) Hub assembly, including late type planet gear assembly
(b) Part-view of early type planet gear assembly

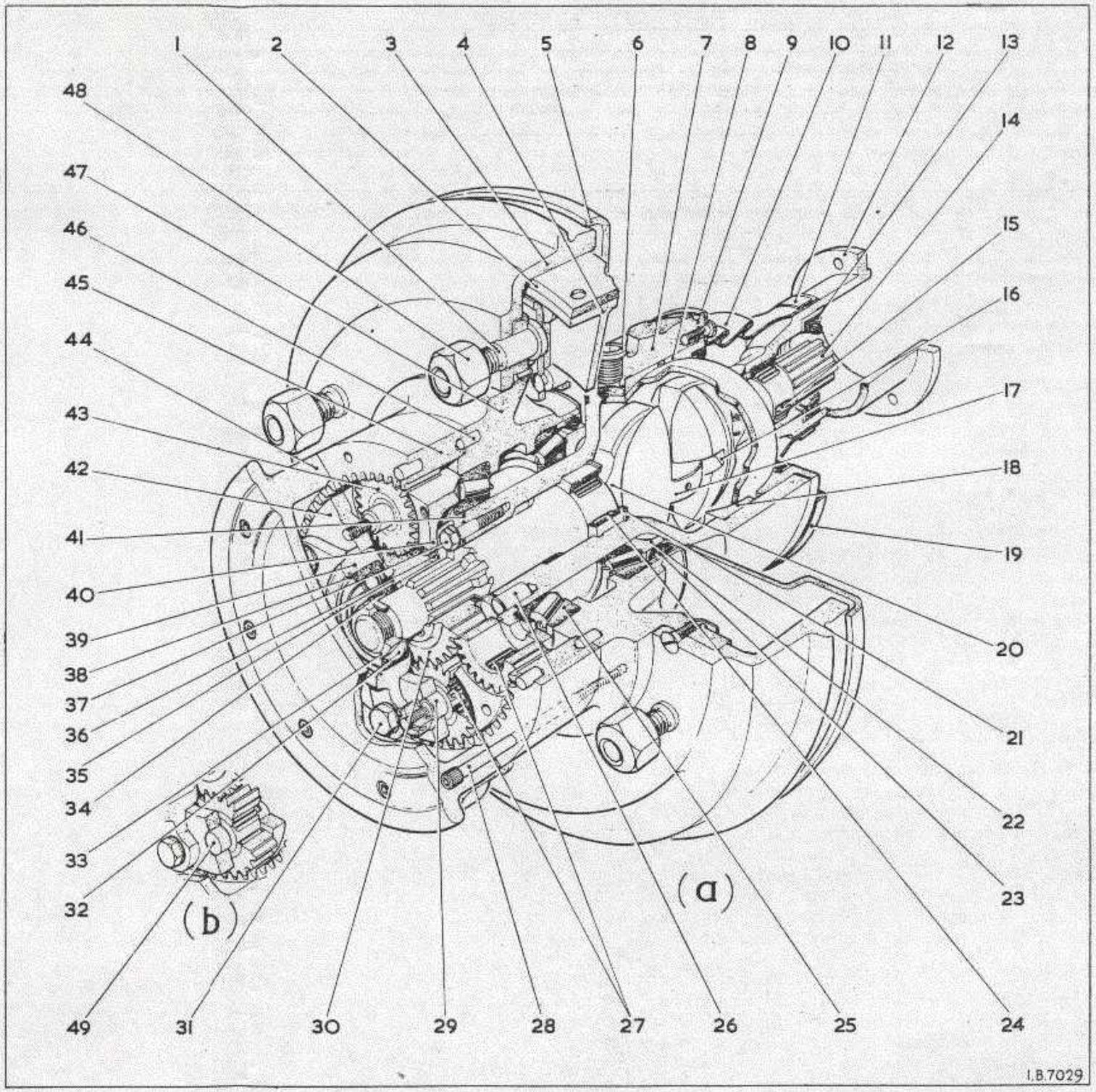


Fig 29 Hub assembly

150. The hub tracta fork is supported at its inner (forked) end in a needle bearing (24) lodged in a recess machined in the hub swivel. This bearing is retained by a circlip (21).

151. The outer end of the hub tracta fork is carried in a single-row rigid type ball bearing (34). The outer race of this ball bearing is secured in a bearing housing (39) which in turn is secured by hexagon-headed bolts (31) locked with shakeproof washers to the planet gear cover (42) and the hub reduction gear planet cage (40). This cage is bolted (37) and dowelled (26) to the hub swivel the hexagon-headed bolts being locked by tabwashers. At the outer end the outer race is held in the housing by a circlip (38). The inner race of the ball bearing is drawn on to the shaft by a nut (33) secured with a lockwasher (32). This nut screws on to the end of the shaft and clamps tight the inner race, shims (35) the sun wheel of the hub reduction gear (30) and a spacer (36) to the shaft. The spacer is pressed against a shoulder formed by a raised portion of the splines upon which the sun wheel is mounted thus ensuring positive location and, when important measurements have been taken and a spacer of correct dimensions inserted, exact adjustment of the shaft.

152. Opposed taper roller bearings (25) pressed on to the hub swivel support the hub. These well-spaced externally-mounted bearings carry the weight of the vehicle and resist lateral forces due to centrifugal action when cornering. The cone of the inner bearing abuts a distance piece (22) while the cone of the outer bearing is located against the hub reduction gear cage (40) of the epicyclic gears. Landing on the distance piece holding the inner race at the inner end are two oil seals (23) with the sealing lips facing each other. The cups of both bearings fit against shoulders formed in the hub. Shims (41) are fitted between the hub swivel and the projecting lip of the hub reduction gear cage. These shims are supplied in three thicknesses to enable the taper roller bearings to be adjusted.

Final drive

153. The final drive to the hub is taken through epicyclic gears which give a large reduction in a small compass. In operation, the sun wheel of this gear train is driven by the hub tracta fork to which it is splined. Meshing with it are six planet gears (Fig 29(43)) free to rotate on pins fixed to the hub reduction gear planet cage and cover; the cage and cover are not free to rotate. Outside the planets is the annulus (45) of the hub reduction gear with teeth on its inner surface enabling it to mesh with the planets. This annulus when driven by the planet gears is made to revolve around the shaft of the sun wheel and consequently causes the hub to turn. The hub reduction gear ratio is 2.400 : 1.

154. The planet gear pins (29) are of the late type. These pins have stepped-down diameters at both ends, while one end, which is longer than the other, is also threaded. The short ends of the pins are fixed in the planet cage (40) by rolling over the protruding portions and grinding them flush. After assembling the planet gears the planet gear cover (42) is secured on the long ends of the pins by slotted nuts, each fitted with a plain washer and locked by a split pin. The planet gears ride on needle rollers (27) fitted between the pin and the gear; at both ends of the needle rollers, thrust washers are fitted. It should be noted that the planet cage and cover, and the bearing housing (39) also, are of the late type introduced with the late type planet pin. The cage is secured to the hub swivel by hexagon-headed bolts, each locked by a tabwasher, as described in para 151.

155. In the early type of planet gear arrangement (see Fig 29(b)) planet gear pins (49) with similar stepped ends are used. One end, slightly shorter than the other, is fixed in the planet cage by rolling, while the other is fixed in the same manner in

the planet gear cover, after the planet gears have been fitted. The early type planet cage is secured to the hub swivel by socket-headed screws, each locked by peening a slug into the serrations on the head. These slugs were originally of copper and later of soft iron.

156. The annulus (45) of the hub reduction gear is located by four dowels (46) on the hub (47) and secured by two, short, socket-headed screws. The reduction gear cover is, in turn, located by a second set of four dowels on the annulus and is secured by eight, long, socket-headed screws (28) which, after passing through the cover and the annulus, screw into the hub.

Relief valve and filler plugs

157. A relief valve is fitted to the outer tracta joint housing to vent to atmosphere air pressures set up by the churning action of the joints. To top up the outer tracta joint housings or road wheel hubs, the filler plug (6) must first be removed along with one of the oil level plugs fitted to the sides of the housing. No provision is made for draining the outer tracta joint housings or road wheel hubs. On later versions of drive the hub filler plugs of male type have been replaced by female type plugs as illustrated.

STEERING

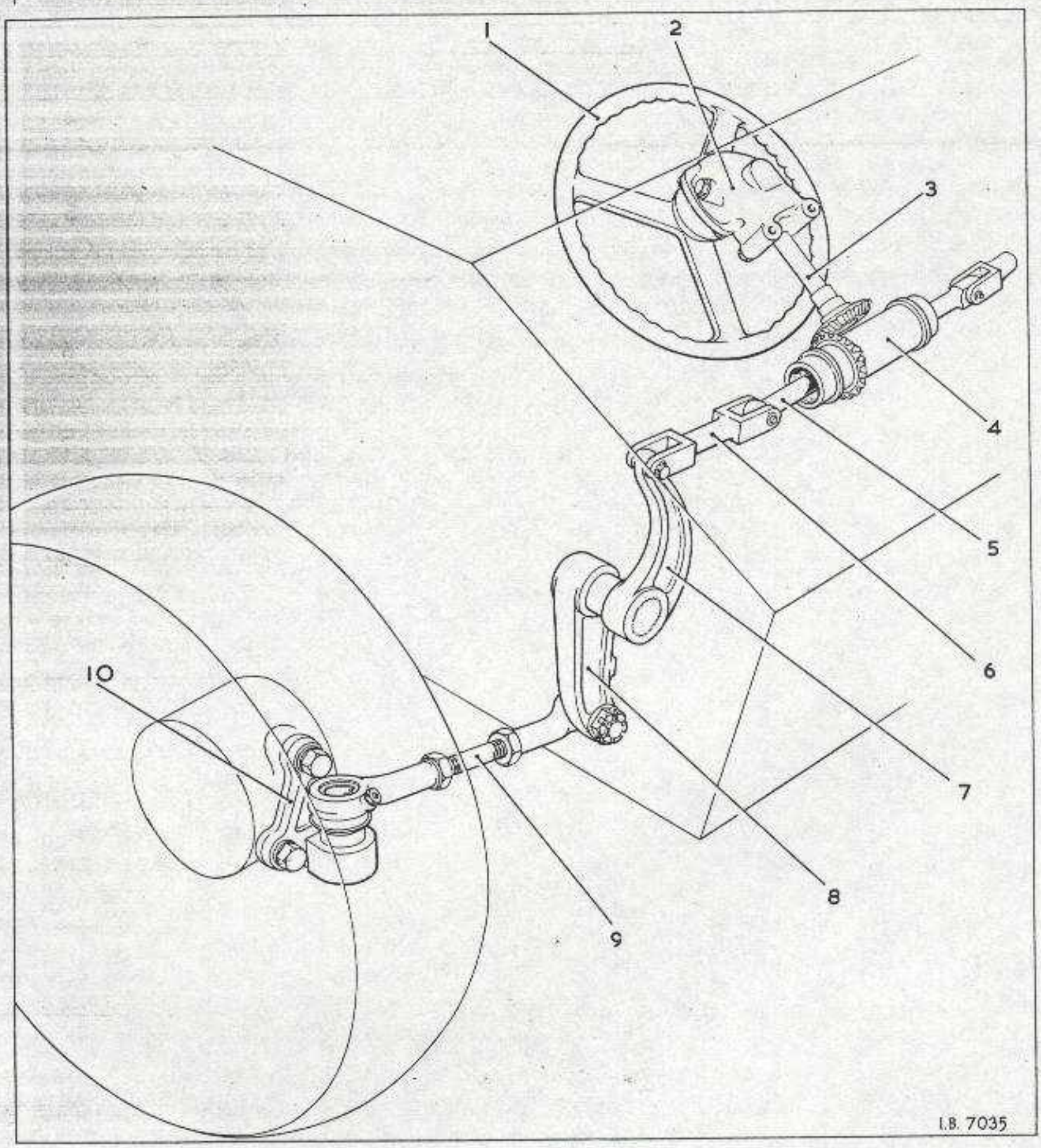
GENERAL DESCRIPTION

158. Steering is effected by means of the front wheels as shown in Fig 30. The steering wheel (1) is fitted to a shaft which is mounted in an upper bevel box (2) attached to the hull front sloping plate. A recirculating ball race (4) which is housed in a lower bevel box is coupled through bevel gears to the upper box by a shaft (3) that is enclosed in a steering column attached to the upper and lower bevel box housings. The recirculating ball race converts the rotary movement of the steering wheel into transverse movement of a shaft (5) the outer ends of which are connected through links (6) to the inner steering levers (7) which are fitted on shafts mounted in casings bolted on opposite sides of the hull. Also fitted on the shafts are outer steering levers (8) which are connected to the adjacent front wheel steering arms (10) by adjustable steering rods (9) incorporating ball socket joints at both ends.

UPPER BEVEL BOX AND STEERING COLUMN

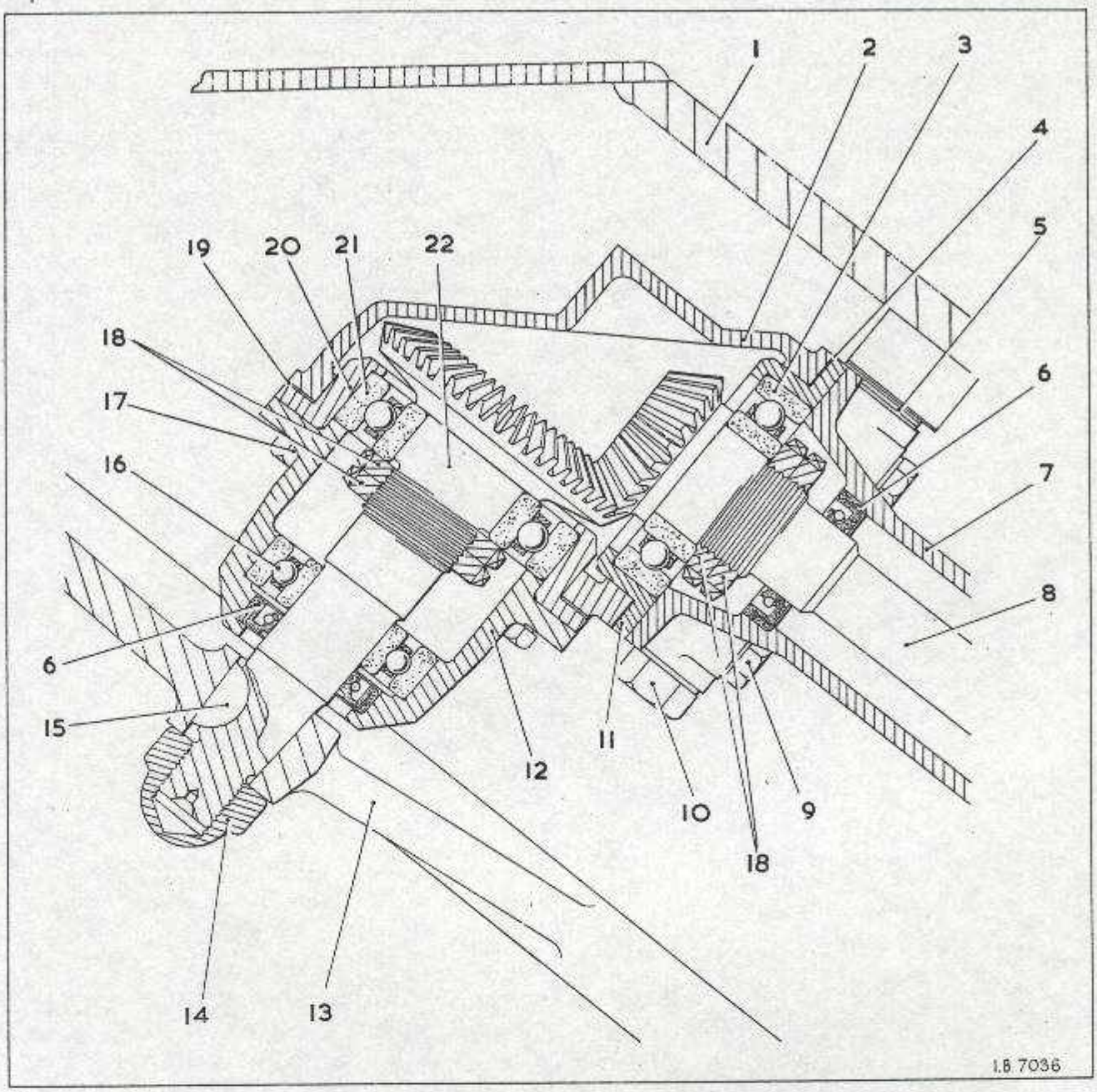
159. A three-spoke steering wheel (Fig 31(13)) is used, the inside rim of which is ridged to afford a positive grip to the hands of the driver. From lock to lock, approximately $3\frac{5}{8}$ turns of the steering wheel are required. The steering wheel (13) is keyed to the tapered portion of the steering wheel shaft (22) which is integral with a bevel gear fitted in the upper bevel box (2). The end of the shaft is threaded for a cap-nut (14) which tightens down onto the hub of the steering wheel.

160. The steering wheel shaft (22) is mounted in two ball bearings (16) and (21) the larger one of which has its inner race fitted on a journal formed on the shaft with a ring nut (18) and similar locknut clamping the race against the bevel wheel shoulder. The outer race fits into a flanged bearing housing (20) which in turn is fitted into a register in the bevel box (2). The outer race of the smaller ball bearing (16) is fitted into the steering wheel shaft housing (12) and the inner race onto a reduced portion of the shaft. A spigot formed on the steering wheel shaft housing fits into the flanged housing (20) and clamps the outer race of the larger ball bearing, and the whole bearing assembly is secured to the bevel box by four setscrews (17) which are locked by shakeproof washers. An oil seal (6) is fitted in the shaft housing adja-



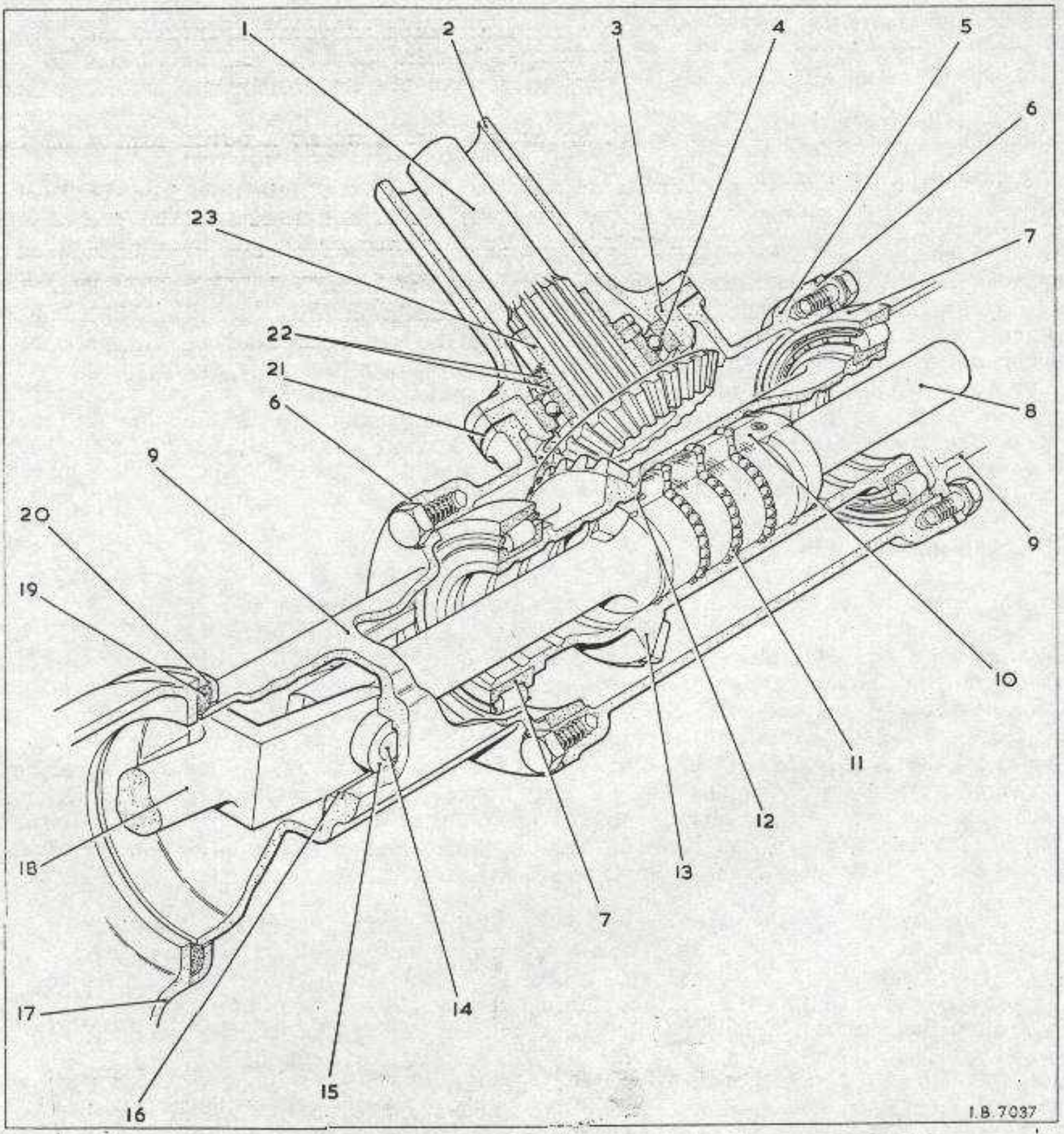
1 Steering wheel
2 Upper bevel box
3 Steering column shaft
4 Recirculating ball race
5 Recirculating ball shaft
6 Steering link
7 Inner steering lever
8 Outer steering lever
9 Steering rod
10 Steering arm

Fig 30 Steering gear assembly



1 Hull
2 Bevel box
3 Ball bearing - 1.1/4 in. x 2.3/4 in. x 11/16 in.
4 Steering column bearing housing shims
5 Securing bolts shims
6 Steering column shaft oil seal
7 Steering column casing
8 Steering column shaft
9 Setscrew
10 Bolt securing bevel box and steering column
11 Steering column upper bearing housing
12 Steering wheel shaft housing
13 Steering wheel
14 Steering wheel cap-nut
15 Steering wheel key
16 Ball bearing - 1 in. x 2.1/4 in. x 5/8 in.
17 Setscrew
18 Ring nuts
19 Steering wheel shaft bearing housing shims
20 Steering wheel shaft bearing housing
21 Ball bearing - 1.3/8 in. x 3 in. x 11/16 in.
22 Steering wheel shaft

Fig 31 Upper steering bevel box and column



1 Steering column shaft
2 Steering column casing
3 Steering column lower bearing housing
4 Ball bearing - 1.3/8 in. x 3 in. x 11/16 in.
5 Recirculating ball housing
6 Extension housing shims
7 Taper roller bearing - 3.1/2 in. x 2 in.
8 Recirculating ball shaft
9 Steering link extension housing
10 Transfer port
11 Anti-friction steel balls
12 Transfer port socket-headed screw
13 Recirculating ball race
14 Steering link joint pin
15 Steering link roller
16 Roller channel
17 Inner steering lever casing
18 Recirculating ball shaft link
19 Rubber oil seal
20 Oil seal housing
21 Steering column bearing housing shims
22 Ring nuts
23 Lower bevel wheel

Fig 32 Lower steering bevel box and links

cent to the small ball race and shims (19) supplied in various thicknesses from .002 in. to .010 in., are fitted between the flanged bearing housing and bevel box to permit the bevel wheel to be adjusted for correct mesh with the bevel pinion.

161. The steering column shaft (8) which has formed on it a bevel pinion on the upper end and splines on the lower end, is mounted in a ball bearing (3). The inner race of the bearing fits onto a journal on the shaft and is clamped against the bevel pinion shoulder by a ring nut (18) and locknut which are identical to those on the steering wheel shaft. The outer race is fitted into a flanged bearing housing (11) which in turn fits into a register in the bevel box. The bearing housing together with the steering column casing (7) which clamps the outer race, is secured to the bevel box by four setscrews (9) locked by shakeproof washers. An oil seal (6) identical to that in the steering wheel shaft housing, is fitted in the upper end of the steering column casing and shims (4) are fitted between the bearing housing and bevel box for adjusting the mesh of the bevel pinion with the bevel wheel. Two bosses formed on the sides of the upper end of the column casing are drilled for bolts (10) which secure the whole assembly to the hull. Shims (5) are provided to obtain the correct alignment of the upper bevel box and steering column with the lower bevel box. An oil filler plug is fitted in the side of the bevel box.

LOWER BEVEL BOX AND LINKS

162. The lower bevel box which houses the lower bevel wheels and recirculating ball device is attached to the lower end of the steering column casing (Fig 32(2)). The inner race of a ball bearing (4) is fitted on the journal of an internally splined bevel wheel (23) which engages the splines on the steering column shaft (1) and the race is secured by a ring nut (22) and identical locknut. The outer race of the bearing is fitted in a flanged bearing housing (3) which in turn is fitted in a register in the recirculating ball housing (5). A spigot formed on the steering column casing fits into the bearing housing and clamps the outer race, and the whole assembly is secured by four setscrews and shakeproof washers. Shims (21) 0.002 in. thick, are fitted between the bearing housing and recirculating ball housing for adjusting the mesh of the bevel wheel with its companion wheel.

163. A recirculating ball outer race (13) which is integral with a bevel gear, is in constant mesh with the lower bevel wheel on the steering column shaft. This race which is bored and has a R.H. helical groove of 0.625 in. pitch machined in the bore is supported at each end in a taper roller bearing (7). The cone of each bearing abuts a shoulder formed on the race whilst the cup is fitted in the recirculating ball housing (5) with the spigot of a steering link extension housing (9) which is secured to the ball housing, forming an abutment. Shims (6) supplied in three thicknesses, are inserted between the flanges of both the housings to permit a bearing preload of 0.000 in. to 0.002 in. to be applied and zero backlash in the gears to be obtained. Each link extension housing is secured to the recirculating ball housing by setscrews fitted with shakeproof washers.

164. A recirculating ball shaft (8) which has an external helical groove similar to that in the outer race machined on the enlarged centre portion, is located in the bore of the outer race with 57 steel balls (11) engaging and occupying approximately three turns of the internal and external grooves. The tolerances are such that rotation of the outer race will cause the shaft to move transversely through the action of the balls tracking in the grooves and imparting a worm and nut action. A slot cut longitudinally in the enlarged portion of the shaft is fitted with a transfer port (10) which is secured by two socket-headed screws (12). The transfer port is provided with three deep grooves which are cut in such a way that the normal continuity of the helical groove on the shaft is broken but the balls are led back, through the transfer

port, to the adjacent part of the groove to be recirculated. The formation and depth of the transfer port grooves are such that the balls are disengaged from the groove in the outer race during the period that they are transferred for recirculation. The plain sides of the transfer port form stops at the ends of the groove on the shaft and prevent the balls from rolling out.

165. An eye-end is formed on each end of the recirculating ball shaft which is connected to the fork-end of a link (18). Bronze bushes are fitted in the fork-end and the connection is made by a stepped pin (14). The reduced ends of the pin are fitted with steel rollers (15) which run in channels (16) machined at each side of the recirculating ball housing. Thus supports and guides are provided for the ends of the shaft. The outer ends of the two link extension housings (9) are each aligned with a steering lever inner casing (17) which is sealed with a rubber seal (19) and seal housing (20) which is secured by setscrews and shakeproof washers to the casing. An oil filler plug is fitted in the recirculating ball housing. Four holes are provided in the recirculating ball housing by which it is attached to the hull by bolts and shakeproof washers. Shims are used to align the lower bevel box with the upper.

STEERING LEVERS

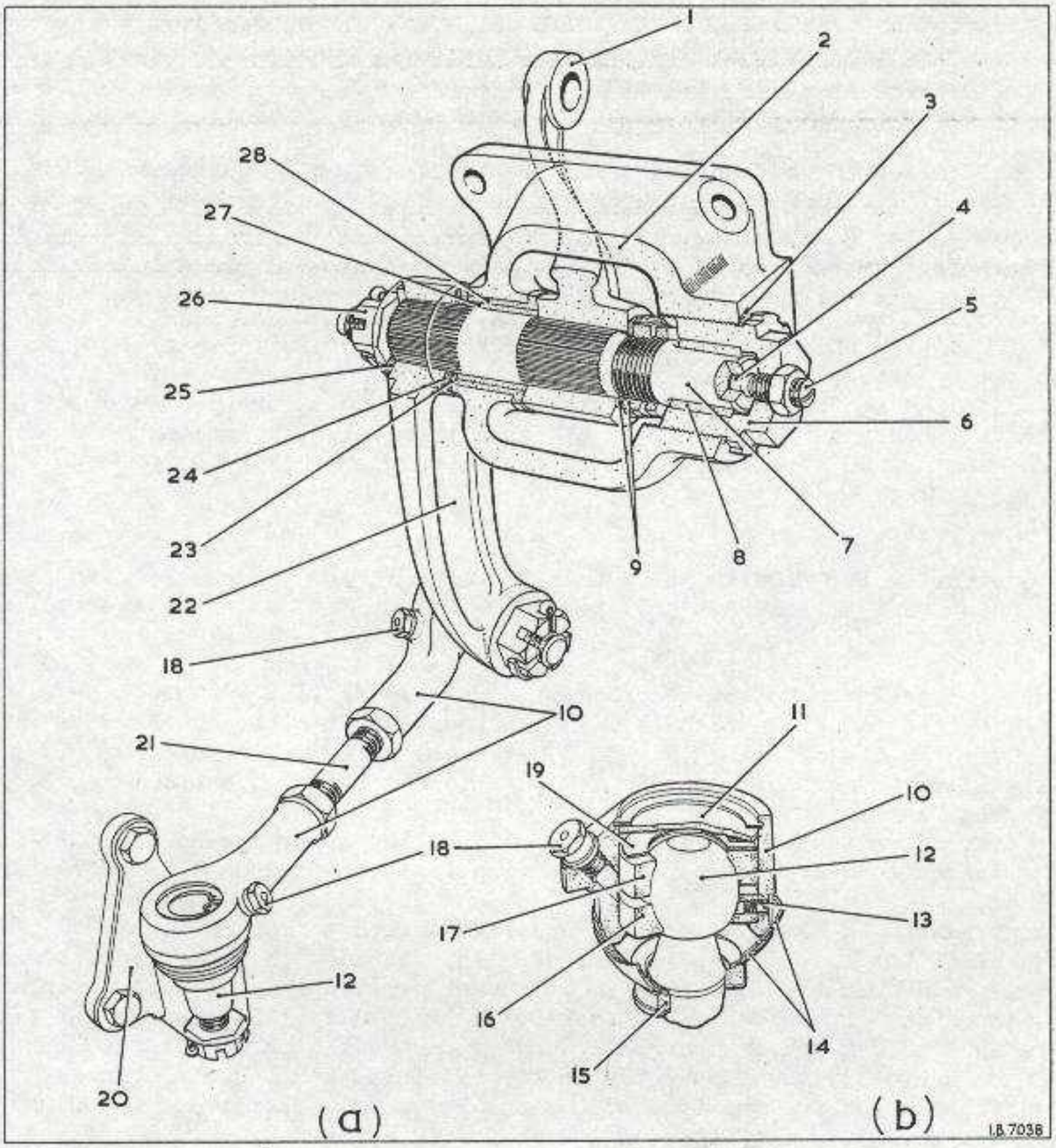
166. The two steering lever units are mounted on each side of the hull. The units are similar except that the casings and levers are "handed" to suit the side to which they are fitted.

167. Each unit comprises a bullet-proof steel outer casing (Fig 33(2)) which is secured on the outside of the side hull plate by four setscrews and shakeproof washers which also secure the inner casing (Fig 32(17)) on the inside. An aperture is cut in the hull plate in which a rubber seal is fitted so that the inner and outer casings together with the link extension housings (9) and recirculating ball housing (5) form one totally enclosed unit. Shims are fitted between the outer casing and hull for obtaining the correct centres between the steering lever shaft and hull centre line.

168. The outer casing is bored at one end and fitted with a flanged bronze bush (Fig 33(28)) whilst the opposite end is threaded and fitted with a screwed bush housing (6) in which a plain bush (8) is pressed. A steering lever shaft (7) on which a steel sleeve (27) is pressed is mounted in the casing with the sleeve located in the flanged bush and a reduced spigot-end on the shaft located in the plain bush in the bush housing. On each side of the sleeve the shaft is tapered and serrated for mounting the steering levers which are provided with similar internal serrated tapered holes. The cranked inner lever (1) is fitted on the shaft and secured by a ring nut and tab-washer (9) which screws on to a thread machined on the shaft. The free end of the lever protrudes into the inner casing and is connected to the fork-end of the recirculating ball shaft link (Fig 32(18). The fork-end is fitted with bronze bushes and the connection is made with a plain pin which is retained by split pins.

169. The end-play of the steering lever shaft is adjusted by an adjusting screw (Fig 33(5)) which screws into the end of the bush housing and contacts a thrust button (4) that fits tightly in the end of the shaft. A locknut locks the adjusting screw after the adjustment has been made.

170. The outer steering lever (22) is fitted on the shaft and is secured by a slotted nut (26) and plain washer (25). A rubber sealing ring (23) with packing rings (24) of the requisite number and thickness to seat the sealing ring are fitted between the casing and lever boss. To facilitate the correct positioning of the levers on the shaft, the ends of the shaft and the levers are marked with a centre punch.



1 Inner steering lever
2 Outer steering lever casing
3 Bush housing lockwasher
4 Thrust button
5 Adjusting screw
6 Bush housing
7 Steering lever shaft
8 Plain bush
9 Ring nut and tab washer
10 Socket
11 Spring retainer
12 Ball pin
13 Spherical cup dowel
14 Spherical covers
15 Rubber retainer
16 Inner ball-pin cup
17 Outer ball-pin cup
18 Lubricating nipple
19 Steering socket spring
20 Steering arm
21 Rod
22 Outer steering lever
23 Shaft sealing ring
24 Shaft packing rings
25 Washer
26 Slotted nut
27 Sleeve
28 Flanged bush
(a) R.H. steering levers and steering rod
(b) Socket and ball-pin assembly

Fig 33 Steering levers and rod

171. Inspection covers are fitted on the front and rear of the inner casings and an oil drain plug is fitted in each base. As the recirculating ball housing, link housings and steering lever casings form one enclosed unit, the drain plug is used to drain all the oil in this unit.

STEERING RODS

172. The two steering rods are identical. Each is connected to an outer steering lever (Fig 33(22)) and steering arm (20) on each side of the vehicle. Each steering arm is fitted to a front hub swivel, being located on dowels and secured by three setscrews and shakeproof washers.

173. Each steering rod is comprised of the rod (21) which has a R.H. thread on one end and a L.H. thread on the opposite end, with locknuts to lock the rod to the sockets (10) after adjustment. The ends of the rod screw into two sockets (10) each of which houses a ball-pin (12). The tapered portion of one ball-pin fits into a mating hole in the steering lever while that of the other is located in a similar hole in the steering arm. The ball-pins are secured by means of slotted nuts and split pins. The ball end of the pin is located between an inner cup (16) and an outer cup (17), the inner cup being held by a screwed-in dowel (13) which is locked by peening metal into the screwdriver slot. A flat coil spring (19) under compression, is located between the outer cup and a retainer (11) which in turn is retained by an internal circlip in the socket. Inner and outer spherical covers (14) are fitted over the open end of the socket to exclude dirt and retain the lubricant. The covers are held against the socket by a rubber retainer (15) and cover when the ball-pin is attached to its appropriate lever or arm.

174. A lubricating nipple (18) is screwed into a small boss on the socket of each ball joint. From the nipple a drilled passage leads to the gap between the spherical cups.

OPERATION

175. Turning the steering wheel causes the bevels to rotate the recirculating ball race (Fig 32(13)) in the lower bevel box and imparts a transverse motion to the recirculating ball shaft (8). The links (18) transfer this movement through the inner and outer steering levers (Fig 33(1) and (22)) to the steering rods and steering arms (20) on the swivel hubs, thereby turning the road wheels in the required direction. The action of the recirculating ball device is described in para 164.

BRAKES

GENERAL DESCRIPTION

176. The construction of the brake assemblies at each of the four wheel stations is similar with the exception of certain components which are "handed" to suit their particular location. The brakes are of the two-leading shoe type and are operated through a conventional hydraulic system by pedal (Fig 34(19)) and through mechanical linkage by the handbrake lever (14). The master cylinder (2) is mounted on the R.H. side of the driver and is connected to the four brake assemblies by solid and flexible tubes, whilst the handbrake lever is connected by control rods and cables.

177. The fluid pressure lines are 5/16 in. O/D Bundylin steel tubing and are held by clips to the frame. From a coupling on the master cylinder a pipe runs along the inner right frame to a 90° connector (4). A flexible hose is lead off from the connector to the rear right-hand backplate. Another pipe from a banjo union fitted to the master cylinder leads to a 180° connector (3) serving to continue the fluid line and to carry pressure via a hose to the right-hand front backplate. A second 180° connector (11) in the same run carries fluid to the left-hand front hose and backplate, the fluid line continuing on along the inner frame to another 90° connector (5) and thence to the hose feeding the left rear backplate.

> **Note:** *Special care must be taken to ensure that the hoses do not twist when the slipnut is being locked to the frame connectors. This is most important on front hoses.*

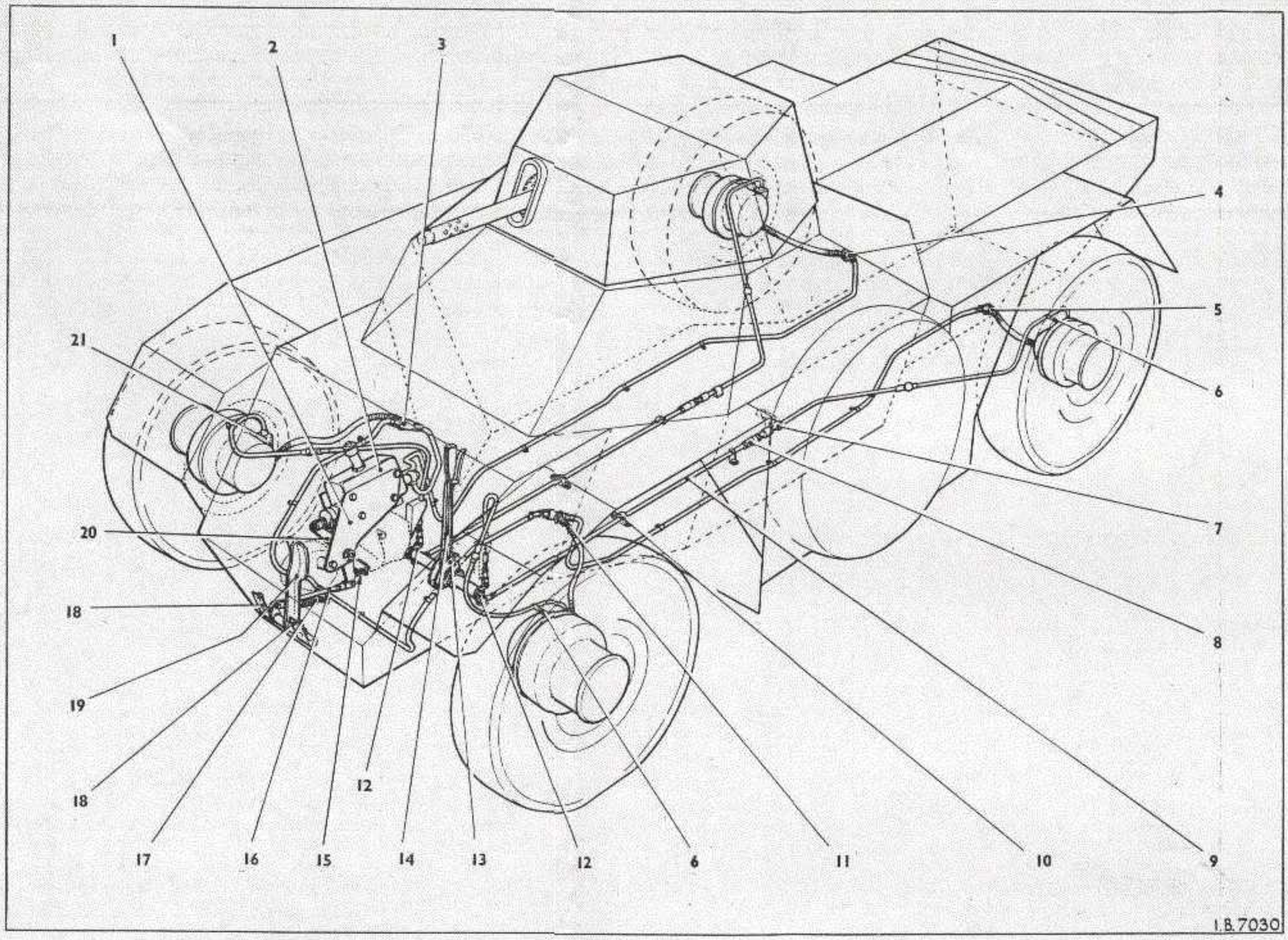
MASTER CYLINDER

178. The master cylinder is mounted between an inner and an outer mounting plate (Fig 35(1)) by four bolts and shakeproof washers. The inner mounting plate is bolted to the hull, the bolts passing through distance pieces.

179. The master cylinder is the integral tank type and consists of a body (6) which is bored to receive a piston (12). A tapered return spring (9) fitted with a valve (8) at its larger end and a spring retainer (20) at its smaller end, loads a main rubber cup (10) on to the head of the piston, a piston washer (11) preventing adhesion of one part to the other. The piston also carries a secondary rubber cup (13) and is deeply recessed to receive a push-rod (17) which is connected to the brake pedal and is held in the off position by a return spring (Fig 34(17)). A piston stop (Fig 35(14)) and a circlip (15) retain the piston in the bore. A rubber boot (16) surrounds the push-rod and is attached to the rod by a clip (18) and to the body by a larger clip (19). A filler extension (3) fitted with a sealing washer is screwed into a coverplate (1) which is secured to the body by cheese-headed screws (4). A gasket (5) is fitted between the coverplate and body. A filler plug (2) fitted with a spring-loaded air inlet valve, screws into the filler pipe.

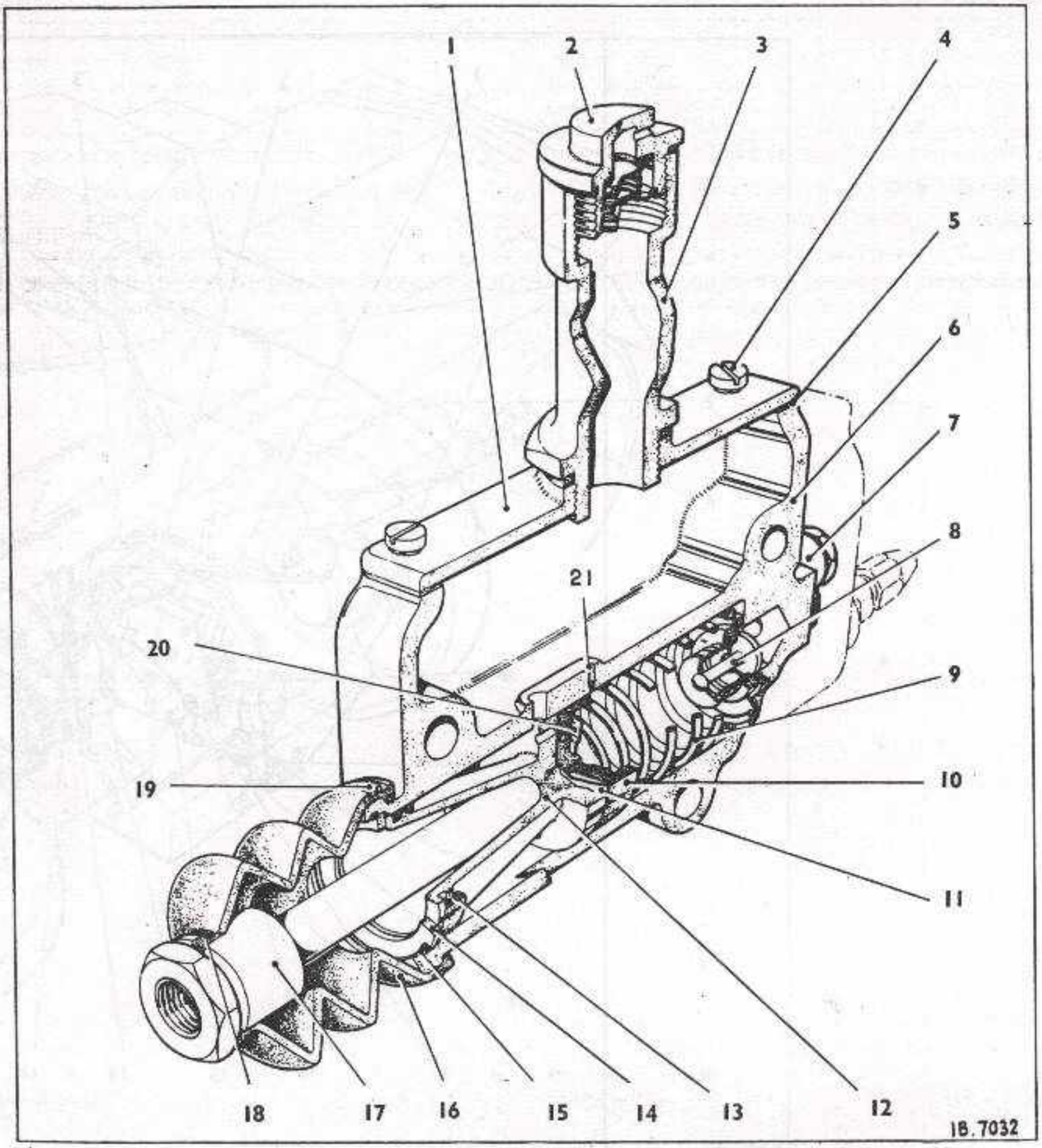
FOOTBRAKE AND LINKAGE

130. The brake pedal (Fig 34(19)) comprises a tubular member with the brake pedal welded to its left-hand end and a lever welded to its right-hand end. The lever is formed with an eye end on which the front fork-end of a control rod (16) is connected by a pin which also provides an anchor for one end of a return spring (17). Flat washers and split pins are used to retain the pins in both fork-ends of the control rod.



1 Master cylinder mounting plate
2 Master cylinder
3 180° connector
4 90° connector
5 90° connector
6 Cable support bracket
7 Abutment bracket
8 Turnbuckle
9 Control rod
10 Guide bracket
11 180° connector
12 Handbrake operating levers
13 Handbrake quadrant and bracket
14 Handbrake lever
15 Footbrake adjustable stop
16 Footbrake control rod
17 Pedal return spring
18 Footbrake pedal brackets
19 Footbrake pedal
20 Master cylinder operating lever
21 Brake expander unit

Fig 34 Brakes arrangement



1	Coverplate	8	Valve	15	Circlip
2	Filler plug	9	Return spring	16	Rubber boot
3	Filler plug extension	10	Main rubber cup	17	Push-rod
4	Cheese-headed screws	11	Piston washer	18	Small boot-clip
5	Gasket	12	Piston	19	Large boot-clip
6	Body	13	Secondary rubber cup	20	Spring retainer
7	Banjo union	14	Piston stop	21	Port

Fig 35 Brake master cylinder

181. The tubular portion of the pedal is fitted with two oilite bushes and is mounted on a shaft between two brackets (18) which are bolted to the hull. At the pedal end, a Mills pin secures the shaft to the bracket.

182. The brake pedal return spring is hooked at its rear end to an anchor plate bolted to the hull floor. The control rod (16) is threaded for adjustment and its rear fork-end is fitted to the bottom end of the master cylinder operating lever (20). This lever is fitted with oilite bushes and it pivots on a shaft mounted on the inner mounting plate (1) and outer plate by means of nuts and shakeproof washers. At its upper end the operating lever is attached to the forked end of the master cylinder push-rod (Fig 35(17)).

183. A hexagon-headed stop (Fig 34(15)) screwed into a fixed bracket on the hull, is contacted by the master cylinder operating lever when the brake pedal is released. The stop is adjusted to give 0.030 in. clearance between the push-rod and the master cylinder piston. Prior to this adjustment being made, the fork-end connecting the operating lever to the master cylinder push-rod is adjusted so that a vertical line taken through the centre of the pivot pin of the lever is 0.2 in. forward of the control rod rear joint pin. After adjusting the stop, and locking it by means of the nut and shakeproof washer at its other end, the control rod is adjusted to give a maximum travel of 8.75 in. at the top of the pedal.

HANDBRAKE AND LINKAGE

184. The steel handbrake lever (14) is welded to a shaft which is mounted at its outer ends in brackets where it is free to pivot in oilite bushes. A third control bracket is situated midway along the shaft and to this bracket are bolted two hand-brake quadrants (13) together with their coverplates. The shaft is supported in the control bracket by four half-bushes pegged by Mills pins which are located two at each side and secured by two bearing caps. Oil grooves are formed in these half bushes for lubrication purposes. The caps are bolted down with socket-headed screws. All three brackets are bolted to the hull floor.

185. The release lever (hand grip) on the handbrake lever pivots on a Mills pin and is connected by a joint pin to two release rods. The bottom ends of the release rods are screwed into pawls. Between each pawl and the rod guide is a light coil spring. Hand pressure on the release lever forces the pawls out of engagement with the serrations of the quadrant; on release of the pressure, the coil springs return the pawls into engagement and lock the handbrake in the selected position.

186. Quadrants should always be assembled with the work "OUTSIDE" showing and have their serrations set at alternate intervals. The angular movement of the handbrake from one end of the quadrant to the other is 57° 30'.

187. A pair of levers (12) set at 90° to each other, is mounted at each end of the handbrake shaft. The eye ends of these levers are connected to the fork-ends of the front brake cables and rear brake rods. Each pair of levers operates the brakes on one side, and, apart from a minor difference in an abutment bracket fitted to the rear run, the linkage at each side is identical.

188. The control rods (9) connecting the handbrake lever shaft levers to the rear turnbuckles (8) at each side are supported in guide brackets (10) and brackets housing rubber grommets. The turnbuckles in turn are connected to the rear brake cables. Adjustment of the front cables is effected by means of the fork-ends directly attached to the swaged-on screwed ends of the cable and adjustment of the rear cables by means of the turnbuckles (8) and fork-ends at the front ends of the rods. The fork-ends

which screw on to the threaded portions of the front cables or the rear rods are secured after adjustment by means of their locknuts. Flats are formed on the cable end portion so that an additional spanner may be used to prevent the cable twisting and becoming kinked when tightening or loosening the locknuts.

189. The brake cables are enclosed in outer casings which are retained by fixed abutments. One abutment bracket for each front brake cable is bolted to each front bevel box, while the outer casing of each rear cable is housed on an abutment (7) located adjacent to the turnbuckle (8). At the left-hand side the rear abutment is attached to the gear change bell-crank bracket and at the right-hand side the rear abutment is welded to the hull. In addition, all the outer casings are held, where they pass through a hole in the hull side plates, in sleeves (Fig 37(25)) protected on the outside by a small rubber boot. Finally, at the termination end, the cable casings are held in the cylinder end cap (22) of the expander unit (see para 195).

190. Each brake cable is supported in a support bracket (Fig 34(6)) at its hub end. This bracket is positioned between two red bands (Fig 37(2)) painted on the cable casing. In the interior of the vehicle the brake linkage systems are protected by the propeller shaft tunnels.

BRAKE ASSEMBLY

191. The brake drums are located on flanges on the hubs and are each held by two countersunk screws and the wheel nuts. A stiffening flange is cast on the outside diameter of the drum. The brake backplates are each held by four setscrews and shakeproof washers, and are mounted on the hub carriers at the rear positions and to the hub swivels at the front.

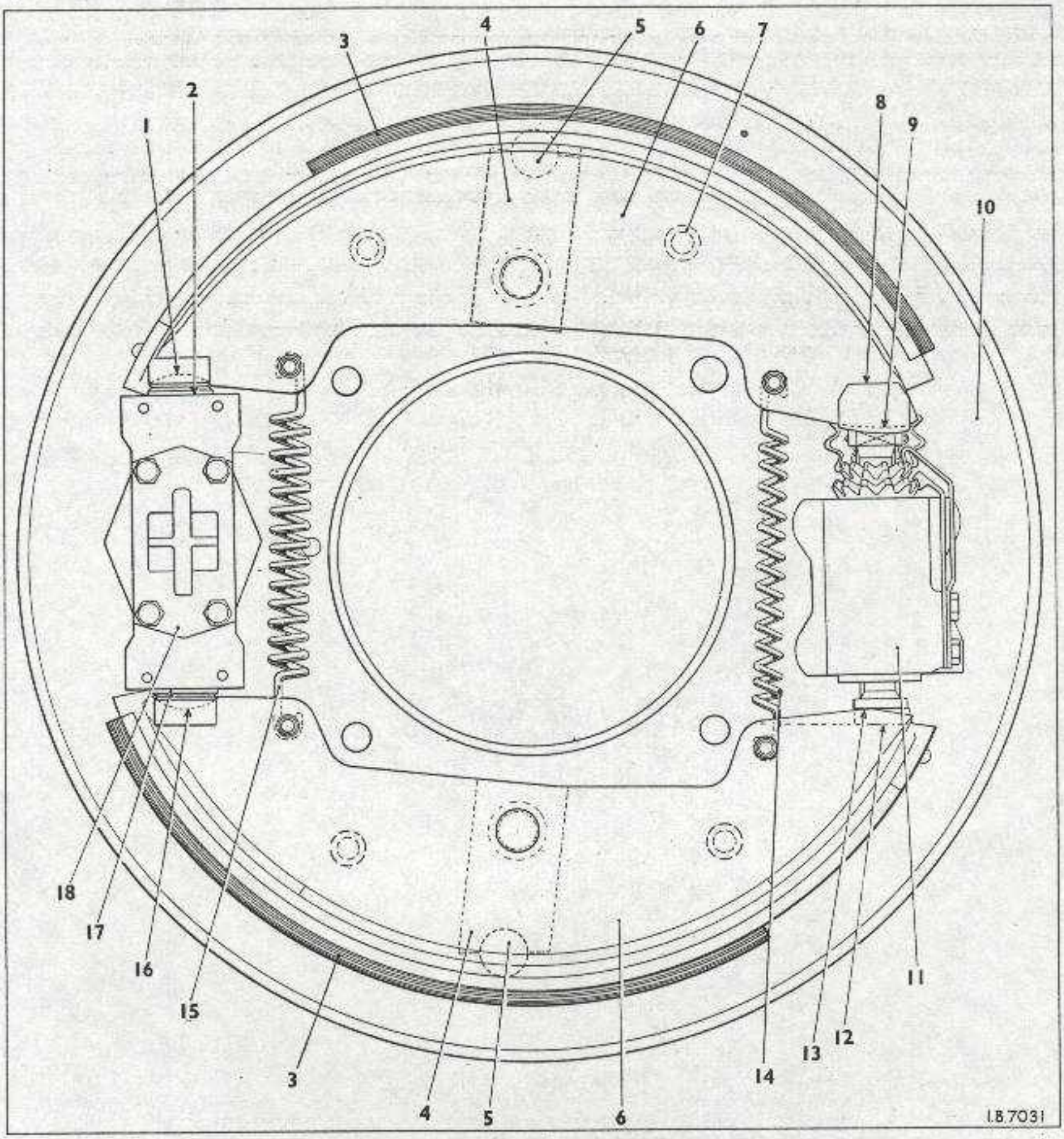
192. The two brake shoes (Fig 36(3)) of each assembly are not anchored directly to the backplate (10), but are each frictionally held in a carrier (6) by two helical springs (7). These springs pass through holes in the brake shoe web and are compressed between the sides of the carrier. Each shoe pivots on a rocker pin (5) which is located in a depression in a link (4) this link being interposed between the sides of the carrier. Abutments for the carriers are provided at points (1) (9) (13) and (16). The carrier and shoe assemblies are retained on the backplate by two pull-off springs (14) and (15) the spring (15) nearer the tappet assembly having the larger diameter. Additional support for the shoes is provided by two steady pins retained by locknuts.

193. An expander unit and a tappet unit (18) are mounted on each backplate, the tappet unit being within the drum and the expander unit being adjacent to the tappet unit on the outside. Diametrically opposite to these units at the front of each backplate is mounted an adjuster unit (11).

194. Red spots are normally painted on the shoe carriers adjacent to the tappet housing and also on the tappet housing. This prevents incorrect assembly of the carrier and thus of the brake shoes.

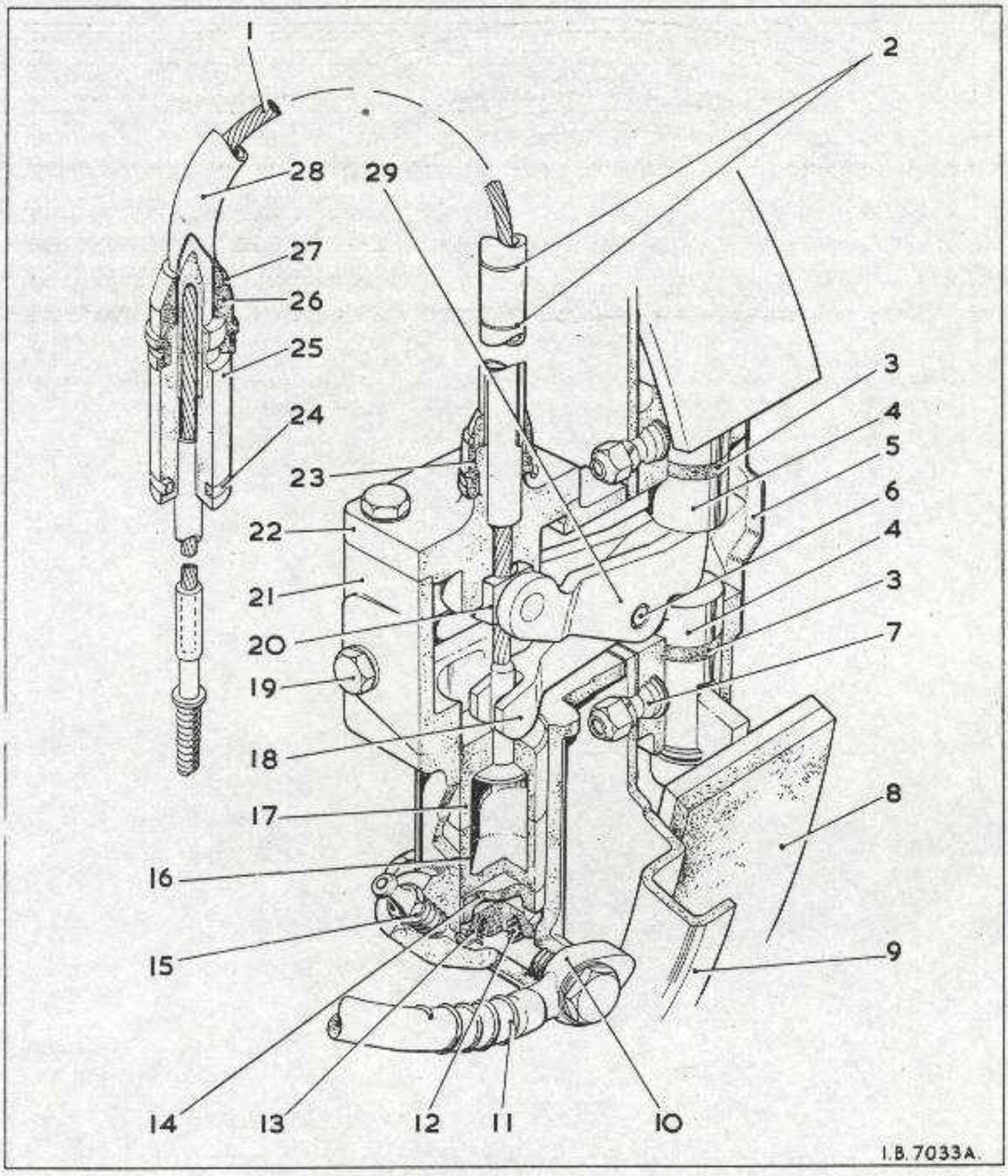
EXPANDER UNIT

195. The expander unit comprises an aluminium alloy body (Fig 37(21)) which is held by four bolts which pass through the backplate and screw into holes in the tappet body. Two dowels are fitted in the expander body to locate it on the backplate and a gasket is fitted to seal it on the backplate. A piston (17) and piston head (16) are fitted in a vertical bore in the expander body. This bore is connected to the fluid line and



1 Shoe carrier abutment - forward direction
2 Brake shoe abutment - forward direction
3 Brake shoe
4 Brake shoe link
5 Brake shoe rocker pin
6 Brake shoe carrier
7 Shoe retaining spring
8 Brake shoe abutment - reverse direction
9 Shoe carrier abutment - reverse direction
10 Backplate
11 Adjuster unit
12 Brake shoe abutment - forward direction
13 Shoe carrier abutment - forward direction
14 Small pull-off spring
15 Large pull-off spring
16 Shoe carrier abutment - reverse direction
17 Brake shoe abutment - reverse direction
18 Tappet unit

Fig 36 L.H. front brake assembly



1	Cable	11	Flexible pipe	20	Trunnion
2	Red bands	12	Filler spring cup	21	Expander body
3	Tappet seal	13	Filler cup	22	Body end cap
4	Tappet	14	Piston cup	23	Inner rubber boot
5	Coverplate	15	Bleeder screw	24	Sleeve sealing ring
6	Hinge pin	16	Hydraulic piston	25	Sleeve
7	Stud	17	Handbrake piston	26	Outer rubber boot
8	Brake shoe	18	Inner lever	27	Clip
9	Backplate	19	Expander nut securing bolt	28	Cable outer casing
10	Banjo union			29	Outer lever

Fig 37 Brake expander and tappet units

has a bleeder hole fitted with a bleeder screw (15). A rubber cup (14) expanded by a filler (13) and spring (12) bears against the piston head. The piston is part of the cable assembly and has a clearance hole to permit free passage of the shank of the swaged-on cable end-portion. A trunnion (20) having a square centre section and cylindrical ends, and drilled to take the cable, is fitted to a slot in the cylinder end cap (22). Pivoted on each end of the trunnion and retained by a circlip is an outer lever (29). A fork-ended inner lever (18) lies between the two prongs of the outer lever and is secured by a hinge pin (6).

196. The cable outer casing is fitted to the cylinder end cap at one end and to an abutment sleeve (25) which is secured to the hull at the other. The outer casing is rubber covered, and a rubber boot (23) is fitted to the casing and end cap at one end and a similar boot (26) is fitted to the casing and sleeve at the opposite end. Both boots are secured by spring clips.

TAPPET UNIT

197. The tappet unit is used, in conjunction with the expander, to operate the brakes. It is held on the backplate by nuts and spring washers on studs (7) cast into the aluminium alloy tappet body, the joint being sealed by a gasket. Two tappets (4) fitted with rubber seals (3) are located in bores in the body. Abutments keys, which lie in slots in the tappets, are each secured to the body by two Mills pins. The opening in the tappet body is closed by a steel coverplate (5) secured by four self-tapping screws and sealed by a gasket. One end of the body is drilled with two inclined holes which are towards the top of the brake assembly when the unit is fitted on the backplate.

ADJUSTER UNIT

198. The adjuster housing (Fig 38(12)) has studs incorporated in the casting by which it is secured on the backplate by nuts locked in pairs by lockplates. The housing is bored to receive an adjuster cap (18) at one end and an adjuster sleeve (14) at the other, the inner end of the sleeve being specially formed to engage with similar slots in the cap. The adjuster cap is counterbored and is fitted with bevelled adjuster nut (19). This adjuster nut is provided with an internal R.H. thread and the adjuster sleeve with a L.H. thread to accommodate two adjuster screws (1) and (15). A two-part clicker spring (20) and (21) is retained on the side of the housing by two screws (17) and engages with the adjuster nut and the adjuster cap respectively to lock the adjustment of the shoes in any required position.

199. On early vehicles may be found adjusters of the type shown in Fig 38(b). These are provided with a series of radial slots so that they can be levered round with a suitable tool, access to the adjuster being by means of a slot in the backplate closed by a captive rubber plug (24).

200. On later vehicles the adjuster described in para 198 was introduced with the adjuster cap and nut in the form of bevel wheels, the nut being smaller in diameter than the cap. These wheels are engaged by a similar pair of wheels (3) and (4) mounted co-axially in the backplate and individually controllable by a hexagon (10) for the smaller (nut) wheel and a square (8) for the larger (cap) wheel. The hexagon head adjusts the leading shoe; the square head adjusts the trailing shoe.

Note: *An Approval has been issued which calls for the provision of a fibre washer behind the R.H. adjuster screw (1) head. This fibre washer, 36048, is similar to the existing washer (16) at the other end of the unit and is fitted as shown at (22) to the adjuster nut (19); the existing adjuster nut, 34589, being replaced by a new adjuster nut, 84058.*

1 R.H. adjuster screw

2 Brake shoe

3 Inner bevel wheel

4 Outer bevel wheel

5 Outer spring

6 Adjusting bolt housing

7 Inner spring

8 Adjusting cap-square

9 Fibre washer

10 Hexagon adjusting nut

11 Washer

12 Adjuster housing

13 Backplate

14 Adjuster sleeve

15 L.H. adjuster screw

16 Fibre washer

17 Clicker spring screws

18 Adjuster cap

19 Adjuster nut

20 Inner clicker spring

21 Outer clicker spring

22 Fibre washer

23 Adjuster nut

24 Rubber plug

(a) Later type adjuster

(b) Early type adjuster

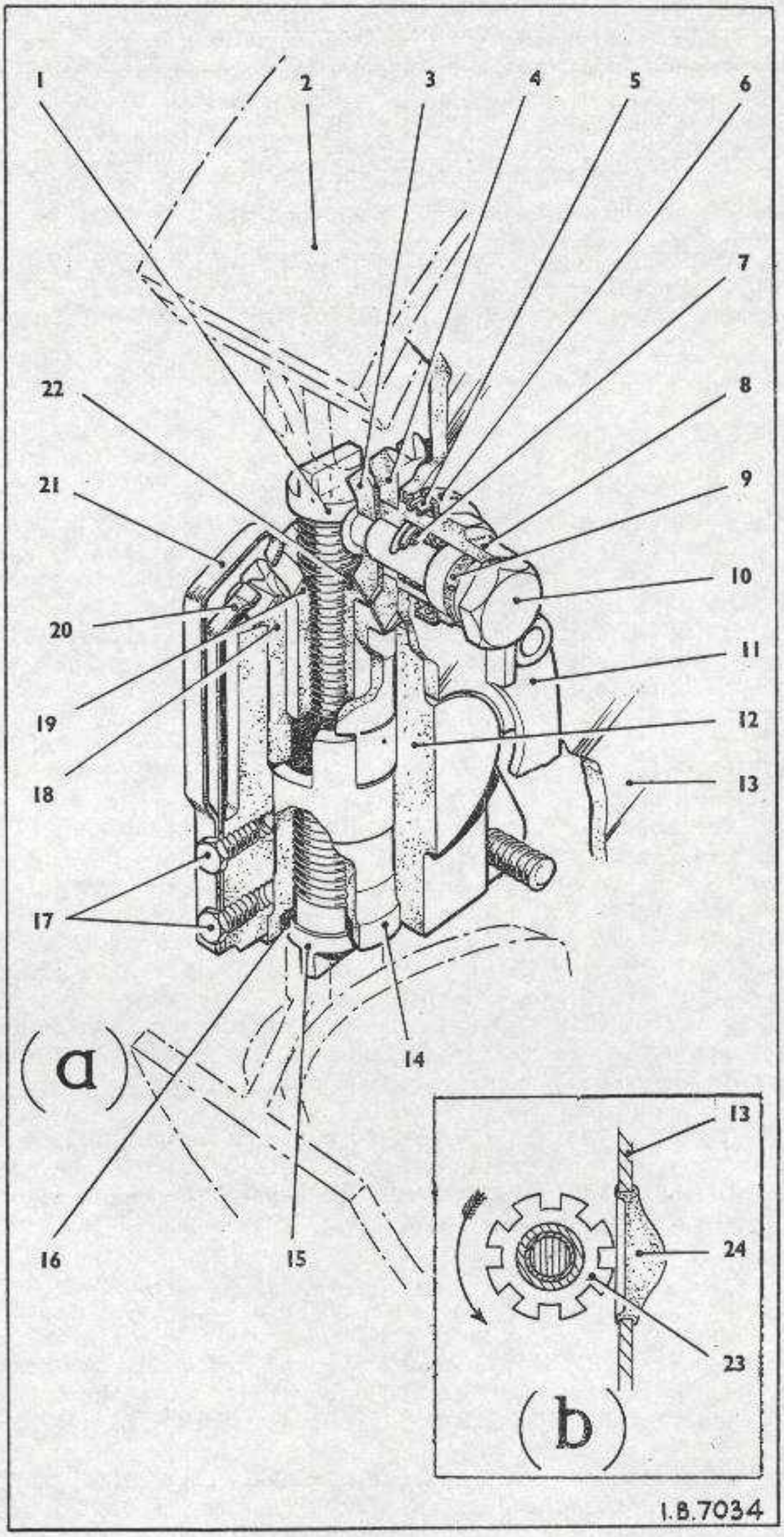


Fig 38 Adjuster unit

OPERATION

201. Depressing the brake pedal causes the push-rod (Fig 35(17)) in the master cylinder to move the piston (12) along the cylinder and the fluid is forced into the pipe lines, past the valve (8) against the reaction of its spring, to the brake expanders. The fluid pressure forces the hydraulic piston head (Fig 37(16)) along the bore, carrying the handbrake piston (17) before it and deflecting the lever (18) which is pivoted to the two outer levers (29) by the pin (6). These levers are pivoted to a cap (22) and therefore a "scissors" action prevails, the heels of the levers forcing the tappets outwards and applying a load to the carriers (Fig 36(6)) at points (1) and (9). The carriers move outwards, reacting against points (13) and (16) on the adjuster screws until the brake shoes contact the brake drum. As the links (4) are allowed a certain amount of angular latitude, the shoes will move in the same sense of rotation as the drum until finding abutments at (2) and (12) with the vehicle moving in the forward direction and at (8) and (17) with the vehicle in reverse. The movement of the shoes is very small and no evidence of it can be felt or heard during operation. As the shoes always find abutments at their trailing ends, two leading shoe characteristics are obtained in both directions.

202. When the pedal is released the brake shoe pull-off springs (14) and (15) cause the fluid to return to the master cylinder (Fig 35) valve (8) moving away from its seating on the body against the pressure of the piston return spring (9). The small port (21) ensures that the system is maintained full of fluid at all times and allows full compensation for expansion and contraction of the fluid due to temperature changes. It also allows any fluid drawn through the small holes in the piston head to return to the reservoir. The valve prevents the return of fluid to the master cylinder during bleeding, thus ensuring that a charge of fresh fluid is delivered at each stroke of the pedal.

203. The handbrake lever operates each of the four brakes in the same way by means of the cable (Fig 37(1)) which moves the cable piston (17) along the bore whilst the hydraulic piston (16) remains stationery.

SUSPENSION AND ROAD WHEELS

SUSPENSION

GENERAL DESCRIPTION

204. Independent suspension, comprising a single coil spring, wishbone type links and a telescopic hydraulic shock absorber, is used at each of the four wheel stations as shown in Fig 39. The top and bottom links (18) and (22) are of unequal length and are fitted with their wide ends pivoting on a bracket (19) attached to the hull. An eye-end on the bottom of the shock absorber cylinder is attached to the top link by means of a pivot pin on which a spring seat (24) also pivots. The piston rod of the shock absorber is attached, through a bump-rubber (39) and grommet (40) to a spring bracket (3) attached to the hull; and the suspension spring (13) which fits over the shock absorber, is compressed between the spring bracket and seat. A lever which forms part of the spring seat is pinned to a control link (23) the opposite end of which is pinned to the link bracket. The outer ends of the links are connected by pivot pins to the rear hub carrier (26) at the rear wheel stations and to the front hub swivel (5) at the front wheel stations. Two rubber bumpers (21) limit the rebound or downward movement of the links and the bump-rubber (39) and lower grommet (40) limit the bump or upward movement. The shock absorbers prevent prolonged bouncing and pitching which the spring may tend to develop.

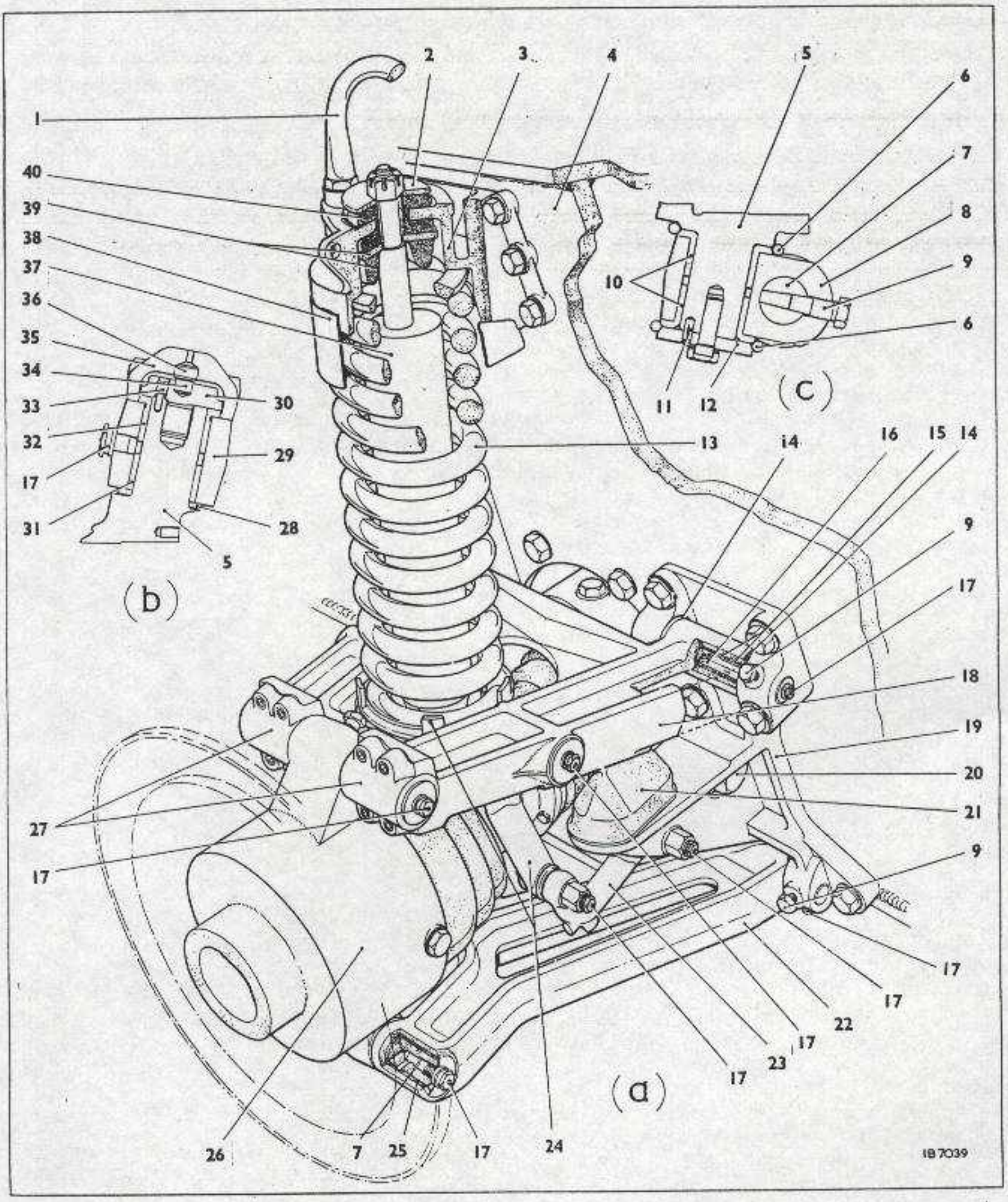


Fig 39 Suspension arrangement

REAR SUSPENSION

205. The two rear suspension units are identical.

Link brackets and links

206. Four identical right-hand and four identical left-hand link brackets are provided for each vehicle. Each pair, comprising one right-hand and one left-hand, is bolted on the hull at each wheel station, one at each side of the inner tracta joint housing. The angle from the vertical of the hull plate is compensated by the different lengths of the suspension links to provide the correct road wheel camber.

207. Each link bracket (Fig 39(19)) is a one-piece steel casting formed at the top and bottom with two lugs bored to take the inner link pins (16). Seven holes are drilled through the bracket for bolts securing it to the hull; shakeproof washers are used to lock the nuts. The bracket has a ribbed platform on which is mounted a suspension bumper (21) and the rib of this platform embodies a boss which is bored to take the pivot pin for the suspension spring control link (23). A large hole is also provided in the rib to give access to an oil filler plug (20) in the inner tracta joint housing.

208. When the link brackets are fitted to the hull, a compound made up of Araldite filler and Hardener No.951 is used to form a perfect mating surface for the brackets. The compound is spread on the hull plate in a soft condition, a sheet of paper is then placed against the compound to prevent the bracket from sticking, then the bracket is fitted and progressively bolted up as tightly as possible. Any excess compound and paper are trimmed off and the remainder is left to harden. When hardened a surface which exactly matches the bracket surface is produced. This method of fitting also applies to the spring brackets (3).

209. The top links (18) which are all interchangeable, are manufactured from steel. Each link is formed by two side members, cross braced by transverse webs, and is triangular in shape with a flat apex. The two inner ends of the side members, at the

Key to Fig 39

1 Lifting eye
2 Washer
3 Spring bracket
4 Hull
5 Front hub swivel
6 Sealing ring
7 Bottom link outer pin
8 Bottom trunnion bush housing
9 Link pin locking screw
10 Front hub bottom swivel flanged bushes
11 Mills pin
12 Retaining plate
13 Suspension spring
14 Sealing ring
15 Inner link pin flanged bushes
16 Inner link pin
17 Lubricating nipple
18 Top link
19 Link bracket
20 Inner tracta joint housing filler plug
21 Rubber bumper
22 Bottom link
23 Spring control link
24 Suspension spring seat with integral lever
25 Outer link pin flanged bush
26 Rear hub carrier
27 Top suspension link caps
28 Felt dirt excluder
29 Top trunnion bush housing
30 Cap screw
31 Front hub swivel top plain bush
32 Front hub swivel top flanged bush
33 Cap screw locking screw
34 Front hub swivel thrust button
35 Front hub swivel top cap
36 Front hub swivel thrust pad
37 Shock absorber
38 Suspension spring guard
39 Bump rubber
40 Grommet

(a) Rear L.H. side suspension viewed from rear
(b) Section through top steering swivel
(c) Section through bottom steering swivel

wide end of the link, are formed into rounded lugs which are bored and are each fitted with two flanged bronze bushes (15). The lugs fit between the upper lugs on the link brackets and pivot on link pins (16) which pass through the lugs and bushes, the pins being retained by tapered ended screws (9). Spacing washers, which are supplied in various thicknesses, are fitted between the bush flanges and bracket lugs and "O" section rubber rings (packings) (14) are fitted in V-grooves formed by chamfers on the bush flanges and spacing washers to retain the lubricant and exclude the entry of dust and foreign matter. Lubricating nipples (17) are fitted in the outer ends of the pivot pins.

210. Midway along the link on each side member bosses are formed to accommodate a pivot pin (Fig 40(8)) and sleeve (7) on which the spring seat (14) and shock absorber (6) pivot. Flanged and a plain bronze bushes (3) and (9) pressed into the bosses form the bearing surfaces for the pin, the flanged bushes being fitted to the inside ends of the bores and afterwards sealed with rubber "O" rings (4). The outside ends of the plain bushes are protected by felt dirt excluders (10) contained within recessed covers (13) which are retained by adaptors (12) in which lubricating nipples (11) are fitted. Two Mills pins (1) locate each of the covers on the ends of the pin. The adaptors are locked by shakeproof washers.

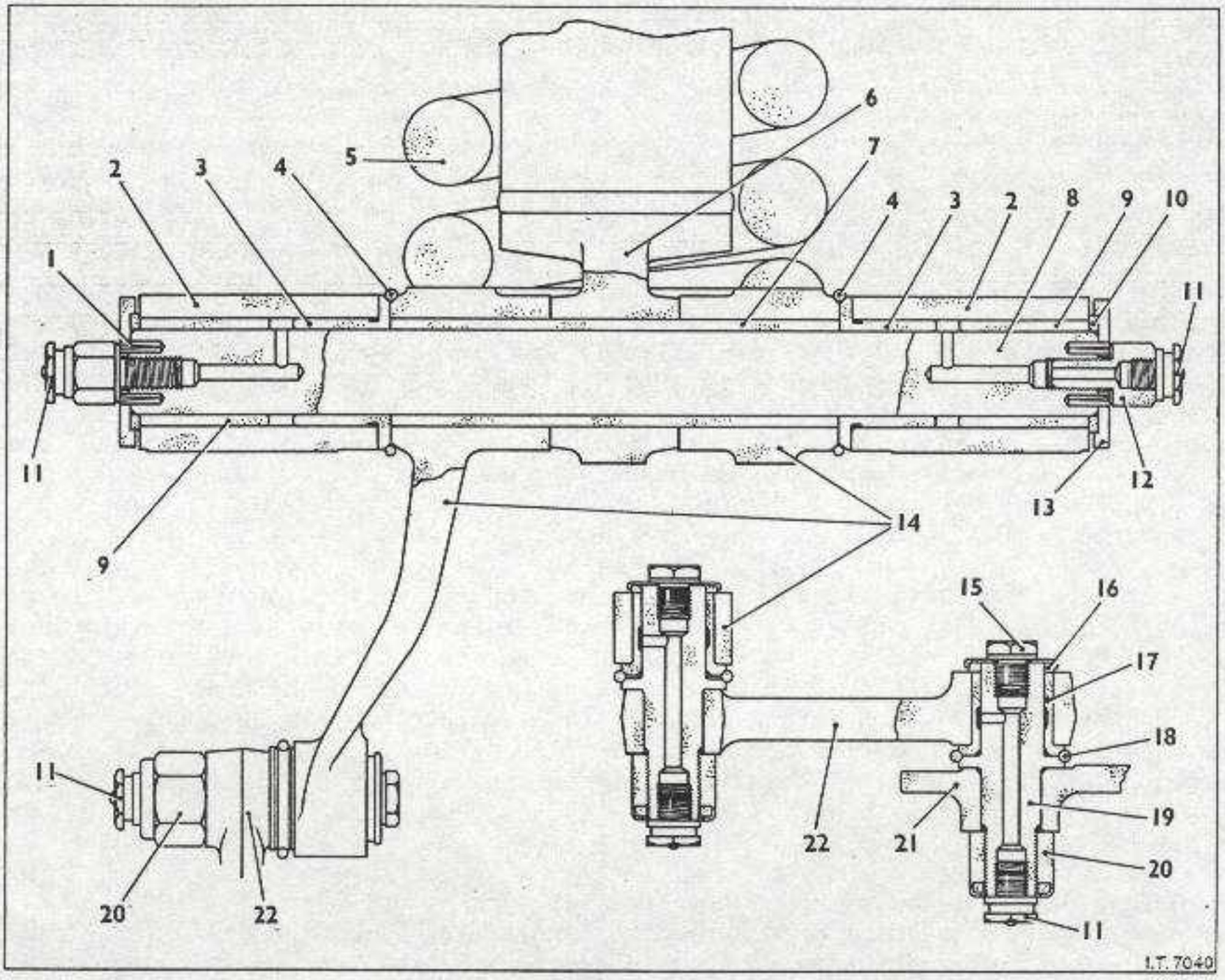
211. The two outer ends of the top link are formed into half-section bush housings and are fitted with caps (Fig 39(27)) each of which is secured by four socket-headed screws. Flanged bushes are fitted in the housings which are located on each side of a bored lug formed on the top of the hub carrier (26). A link pin passes through the bushes and carrier lug and spacing washers are fitted between the bush flanges and lug faces in a similar manner to those fitted on the inner ends; "O" section rubber ring fits in V-grooves formed on the bush flanges and spacing washers. The link pin is retained in the carrier lug by a tapered ended screw and felt dirt excluders contained in recessed covers, identical to those on the spring seat pivot pin, are secured by lubricating nipples on the outer ends of the link pin.

212. The bottom links (22) which are all interchangeable, are generally similar in design to the top links with the following exceptions. Each bottom link is longer than the top link and is narrower at the inner end which is attached to the brackets on the hull. The pivot pin lugs at each end are all the same being formed on the link as described for the inner lugs on the top link and as there is no requirement for a spring seat pivot pin the side members are of uniform section and the cross bracing is differently disposed. The inner ends of the link are attached to the hull bracket through bushes, pivot pins, spacing washers and sealing rings in the same way as the top link, but the lubricating nipples are fitted in the link lugs and not in the ends of the pivot pins.

213. The outer ends of the bottom link are each fitted with a flanged bronze bush which is located on each side of a bored lug formed on the bottom of the hub carrier (26). A link pin passes through the bushes and carrier lug, and spacing washers are fitted between the bush flanges and lug faces. The link pin is retained in the carrier lug by a tapered-ended screw. "O" section rubber sealing rings fit into V-grooves formed by chamfers on the bush flanges and spacing washers and felt dirt excluders contained in recessed covers, identical to those on the spring seat pivot pin, are secured by lubricating nipples on the ends of the link pin. All the pivot and link pins which have lubricating nipples fitted in the ends are drilled so that the lubricant is fed to the bushes.

Springs and spring brackets

214. Each suspension unit is provided with a single coil compression spring (13)



1	Mills pin	9	Plain bush	16	Felt dust excluder
2	Top suspension link	10	Felt dust excluder	17	Flanged bush
3	Flanged bush	11	Lubricating nipple	18	"O" sealing ring
4	"O" sealing ring	12	Adaptor	19	Shouldered pin
5	Suspension spring	13	Recessed cover	20	Self locking nut
6	Shock absorber	14	Suspension spring seat	21	Link bracket
7	Pivot sleeve			22	Control link
8	Pivot pin	15	Screw		

Fig 40 Suspension spring seat and control link

The upper end of the spring is located in a recess in a cast steel spring bracket (3) bolted to the hull plate, whilst the lower end is located in projections on the spring seat (24). At the lower end of a lever which forms part of the spring seat (Fig 40(14)) a flanged bush (17) is fitted for a shouldered pin (19) that is fitted in the end of the spring control link (22) and secured by a self-locking nut (20). An "O" section rubber ring (packing) (18) is fitted into a V-groove formed between the flange of the bush and the shoulder of the pin. At its outer end the bush is fitted with a cover and dust excluder (16) the cover being secured with a screw (15). A lubricating nipple (11) screwed into the pin at the control link end, communicates with passages drilled to the inner surface of the bush in the spring seat lever. The opposite end of the control link is fitted with a bush which fits on a shouldered pin secured in the

rib of the link bracket (21). The bush, and pin are identical to those used in the spring seat lever and the means of retaining, sealing and lubricating the bush and pin is the same.

SHOCK ABSORBERS

215. As shown in Fig 39 each of the four shock absorbers (37) is located centrally inside the suspension spring (13). The piston rod is attached to the spring bracket (3) through a bump-rubber (39) and two rubber grommets (40). The bump-rubber is bonded to a plate which is welded to a sleeve through which the piston rod passes. The grommets fit over the sleeve and are located one on each side of a shoulder formed on the spring bracket, and the whole assembly is secured by a steel washer (2) and slotted nut. The lower eye-end (Fig 40(6)) of the shock absorber cylinder fits on the steel sleeve (7) on which the spring seat (14) also fits. The sleeve is a tight fit both in the eye-end and spring seat, and also on the pivot pin (8) so that rotary movement is taken between the pin and bushes (3) and (9).

Shock absorber - Type 8500

216. A collar (Fig 41(14)) and piston (28) are secured to the lower end of the piston rod (29) by a nut (25). The piston carries six identical valves, four being seated in the upper face, as shown by valve (27) while the two remaining are seated in the lower face. The upper and lower sets of valves are loaded by helical springs (15) and (26) respectively, each acting through a valve plate (16); the upper spring (15) is identical to the gland ring spring (33). The spring loading on the valves is adjusted by fitting shims, as required, between the piston and collar and between the piston and nut. A ball valve (17) is retained in the piston below a bleed drilling by a pin (18).

217. Spigoted in the lower end of the inner or working cylinder (13) and held down on the eye portion of the outer or reservoir cylinder (12) is an end plate (20) having a cast-in seating for a relief valve (21) loaded by a helical spring (23) adjusted by a nut (24). On the upper face of the end plate is seated a plate valve (19) backed by a dished spring and a retaining plate which is secured to the cast-in seating. The plate valve covers eight radial ports in the end plate while the relief valve has an axial drilling leading into a diametrical drilling above the valve face.

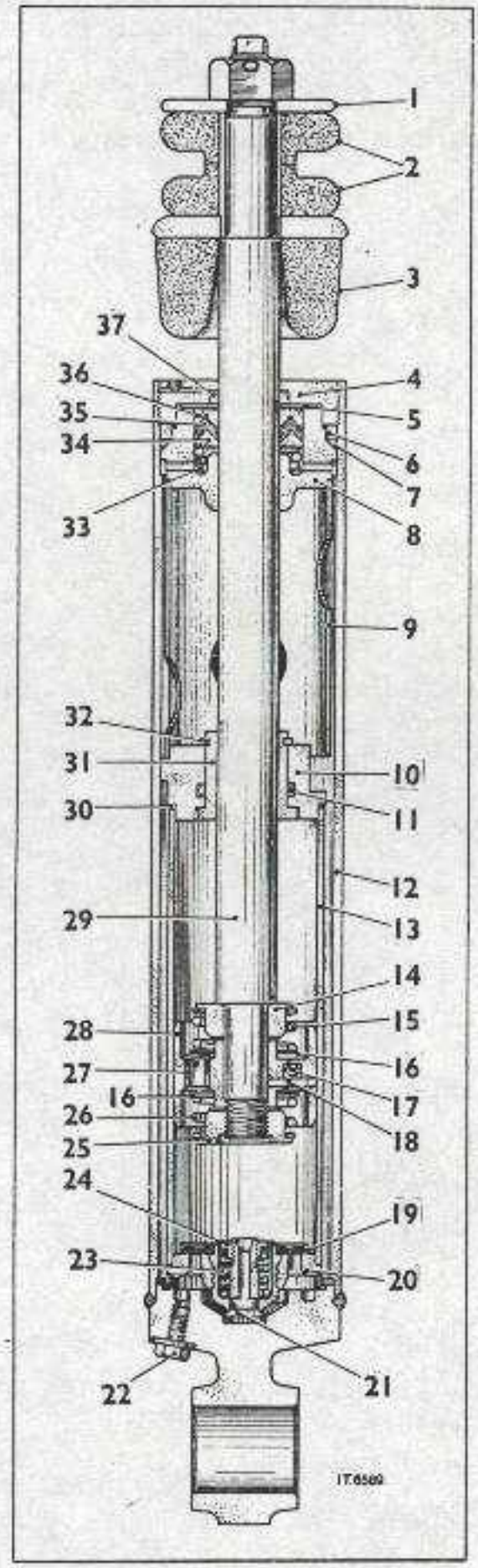
218. A distance bush (10) spigoted into the upper end of the inner cylinder is clamped down on to a copper sealing washer (30). The bush carries a piston rod sleeve (31) secured by a Seeger circlip (32) and is fitted with a seal (11). A gland retaining nut (4) is screwed into the upper end of the outer cylinder to bear down on a gland ring backing washer (5) and so clamps down the piston rod bush (8) the reservoir tube (9) and the distance bush. The nut is locked in position by a socket-headed grubscrew.

219. The piston rod bush houses a chevron seal (35) pressed into the V-shaped groove of a gland ring (36) by a helical spring (33) through a light-alloy header (34) of V-section. Fluid wiped off the rod by the chevron seal and gland ring is returned to the outer cylinder through two drillings in the piston rod bush. A dirt excluding seal (37) is fitted in a recess in the gland retaining nut, which also compresses a seal (7) through a backing ring (6) to prevent leakage of fluid from the outer cylinder.

220. A hexagon-headed screw (22) is fitted to the outer cylinder to facilitate draining when the shock absorber is dismantled on overhaul.

221. The shock absorber includes two rubber grommets (2) carried on the steel portion of a bump rubber (3) secured to the upper end of the piston rod by a large washer (1) nut and split pin.

222. The shock absorber is filled initially with 28.5 cu.in. (467 c.c.) of oil OM-13 and has a compression setting of 700/800 lb at 15 in./sec. (excepting early shock absorbers) and an extension setting of 1050/1150 lb at the same speed. Early shock absorbers (up to and including vehicle No.33BA44) have a compression setting of 550/650 lb at 15 in./sec.



1 Steel washer
2 Rubber grommets
3 Bump rubber
4 Gland retaining nut
5 Backing washer
6 Backing ring
7 Seal
8 Piston rod bush
9 Reservoir tube
10 Distance bush
11 Seal
12 Outer cylinder
13 Inner cylinder
14 Valve spring collar
15 Gland ring spring
16 Valve plate
17 Ball valve
18 Pin
19 Plate valve
20 End plate
21 Relief valve
22 Screw
23 Relief valve spring
24 Relief valve nut
25 Piston rod nut
26 Piston valve spring
27 Piston valve
28 Piston
29 Piston rod
30 Sealing washer
31 Piston rod sleeve
32 Circlip
33 Gland ring spring
34 Header
35 Chevron seal
36 Gland ring
37 Seal

Fig 41 Shock absorber Type 8500

Operation

223. As the top suspension link is shorter than the bottom link and the pivot points are not on the same vertical line, the road wheel will tilt slightly, within the limits of bump and rebound, when the vehicle passes over uneven terrain; but the tyre at the point of contact with the ground will remain approximately at the same distance from the centre line of the vehicle. Consequently tyre scrub is minimized. Also as the spring control (stabilizing) link (Fig 39(23)) is connected to the lever on the spring seat (24) and the link pivots on a fixed point on the link bracket, the seat is kept in the correct angular position relative to the spring throughout the range between bump and rebound. Bump movement is limited by the top of the shock absorber cylinder contacting the bump-rubber (39) and rebound is limited by the top link (18) contacting the two rubber bumpers (21) which are secured to the link brackets.

224. The operation of the shock absorber is as follows. When the road wheel rises, the piston (Fig 41(28)) moves relatively downwards in the inner cylinder (13) and applies pressure to the fluid beneath it. This causes the upper set of piston valves to lift and fluid to flow through the valves to the upper end of the cylinder. At the same time the ball valve (17) is forced upwards to close the lower end of the bleed drilling in the piston. Downward movement of the piston displaces an amount of fluid in excess of that required to fill the upper end of the cylinder, due to the entering piston rod (29). The relief valve (21) moves down, therefore, and the excess fluid flows into the outer cylinder.

225. When the road wheel falls, the piston moves relatively upwards in the inner cylinder and causes fluid to flow from the upper to the lower end. If the piston movement is fast the fluid flows through the lower set of piston valves and a small proportion through the bleed drilling. If the piston movement is slow, the fluid can pass wholly through the bleed drilling. At the same time, the fluid which passed to the outer cylinder on the bump stroke is drawn back through the plate valve to the lower end of the inner cylinder.

FRONT SUSPENSION

226. The two front suspension units are identical and similar to the rear units except for the means of attaching the outer ends of the top and bottom links. Consequently what is written on the rear suspension under para 205 also applies to the front suspension except for the following description of the different method of attaching the links to the front swivel carrier which provides the means of steering.

227. The outer ends of the top link are fitted with bushes, caps (Fig 39(27)) rubber sealing rings, felt dirt excluders and covers as described in para 211, but the bushes are located on two trunnions which form part, and are located on opposite sides, of a top trunnion bush housing (29). The bush housing which is fitted with a flanged bronze bush (32) and plain bush (31) is located on the top swivel pin on the swivel carrier. A cap screw (30) screwed into the top of the swivel pin and locked by a locking screw (33) retains the bush housing on the swivel pin. Fitted in the centre of the cap screw is a thrust button (34) which contacts a thrust pad (36) that is fitted in a top cap (35). This cap is secured to the bush housing by four socket-headed screws. The thrust pads are supplied in different thicknesses ranging from 0.281 in. to 0.296 in. so that the correct end-play of the bush housing can be obtained. A felt dirt excluder (28) and cover are fitted between the bush housing and swivel pin shoulder and a lubricating nipple (17) is provided for lubricating the swivel pin bushes.

228. The outer ends of the bottom link which are fitted with bushes, spacing washers, felt dirt excluders and covers, as described in para 213, are attached to a bottom trunnion bush housing (8) by a pivot pin (7) which is retained in the housing by a tapered-ended screw (9). The bush housing is fitted with two flanged bronze bushes (10) and is located on the bottom swivel pin on the swivel carrier. A retaining plate (12) is secured to the bottom of the swivel pin by a setscrew which is locked by a tabwasher. A Mills pin (11) locks the retaining plate on the swivel pin. Rubber sealing rings (14) are located in V-grooves formed between the bush flanges, retaining plate and swivel shoulder. Lubrication of the pivot pin bushes is effected by lubricating nipples screwed into each end of the pin and lubrication of the swivel pin bushes is effected by a lubricating nipple screwed into the side of the bush housing.

ROAD WHEELS

229. The road wheels are of the twin disc type and are clamped together by a ring of nuts and bolts. The nuts are painted red and should not be moved unless it is necessary to change a tyre. The tyre must be completely deflated before any attempt is made to loosen the nuts.

230. An inner ring of nuts (Fig 29(48)) secures the wheel to the hub (47). The nuts on the right-hand side of the vehicle have right-hand threads while those on the left have left-hand threads.

231. The wheels are fitted with 9.00 in. x 16.00 in. tyres of either "Run Flat" (R.F.) or Giant Low Pressure Cross Country (C.C.) type. A vehicle must always be fitted with a complete set of one type of tyre. It should be noted that the pressures for the two types of tyre are not the same. Correct pressures should be painted on the mudguard above the wheel.

ELECTRICAL EQUIPMENT

GENERAL DESCRIPTION

232. The vehicle is wired on the 24V nominal, negative earth system (Fig 42 and 43), the battery negative lead being connected to an earth stud fitted to a distribution box located at the rear left side of the fighting compartment (Fig 44(25)).

233. The engine is fitted with a fully waterproofed and tropicalized coil ignition system designed to give negative high tension. It is screened and filtered to suppress electrical interference to wireless equipment. For a description of the ignition equipment see EMERs Power S 522 and S 522/2. The ignition circuit is shown in Fig 45.

234. Two 12V 60Ah batteries are located one at each side of the rear of the fighting compartment (Fig 44(9) and (28)). They are connected in series and charged by a 2-speed generator fitted to the inlet side of the engine crankcase (23). The 2-speed feature permits the maximum generator output to be obtained at low engine speed (600 r.p.m.) as well as at high speeds. The generator is an insulated return unit, its negative side being earthed in the generator panel. Alternative marks of generator may be fitted: No.2, Mk 1 - FV175843 or No.2, Mk 2 - FV175866; both are described in EMER Power S 522.

235. The generator is fan ventilated and can be fitted with fording caps and a breather pipe so that it may be run completely sealed. The breather pipe is not fitted in Ferret vehicles because the engine compartment is waterproofed. Consequently, the fording caps which are housed on the generator panel should not be fitted to the generator except for very brief periods.

236. The maximum output of the generator is controlled by two carbon piles housed in a generator panel; one pile controls the maximum voltage at 27.8V-29.2V and the other limits the current to 25A. The generator panel (26) is located immediately forward of the distribution box; it is fitted with felt bushes to provide a resilient mounting. To earth the panel a copper braid is connected to the frame of the box and to an earth stud located between the panel and the distribution box. Alternative marks of generator panel may be fitted. Two fuses in the panel protect the charging and main indicator lamp circuits. The charging circuit is shown at Fig 46.

237. The battery and generator output leads are connected to the distribution box from whence the supply is connected to the various electrical components. Housed in the distribution box is an inter-vehicle starting socket, to facilitate the use of a slave battery should the vehicle batteries become discharged, a pair of inspection lamp sockets and two thermal magnetic circuit breakers. One of the circuit breakers is a 30A unit connected in series with the exterior and interior lamps, inspection lamp sockets, horn, smoke dischargers, windscreen wiper and the wireless set junction box. The second is a 10A unit connected in series with the engine electrical equipment, i.e., the starter solenoid, main indicator lamp, oil pressure warning lamp and switch, coolant thermometer, fuel gauge and instrument panel lamp. The ignition circuit is connected to a battery positive connection and hence is not affected by the circuit breakers except at starting.

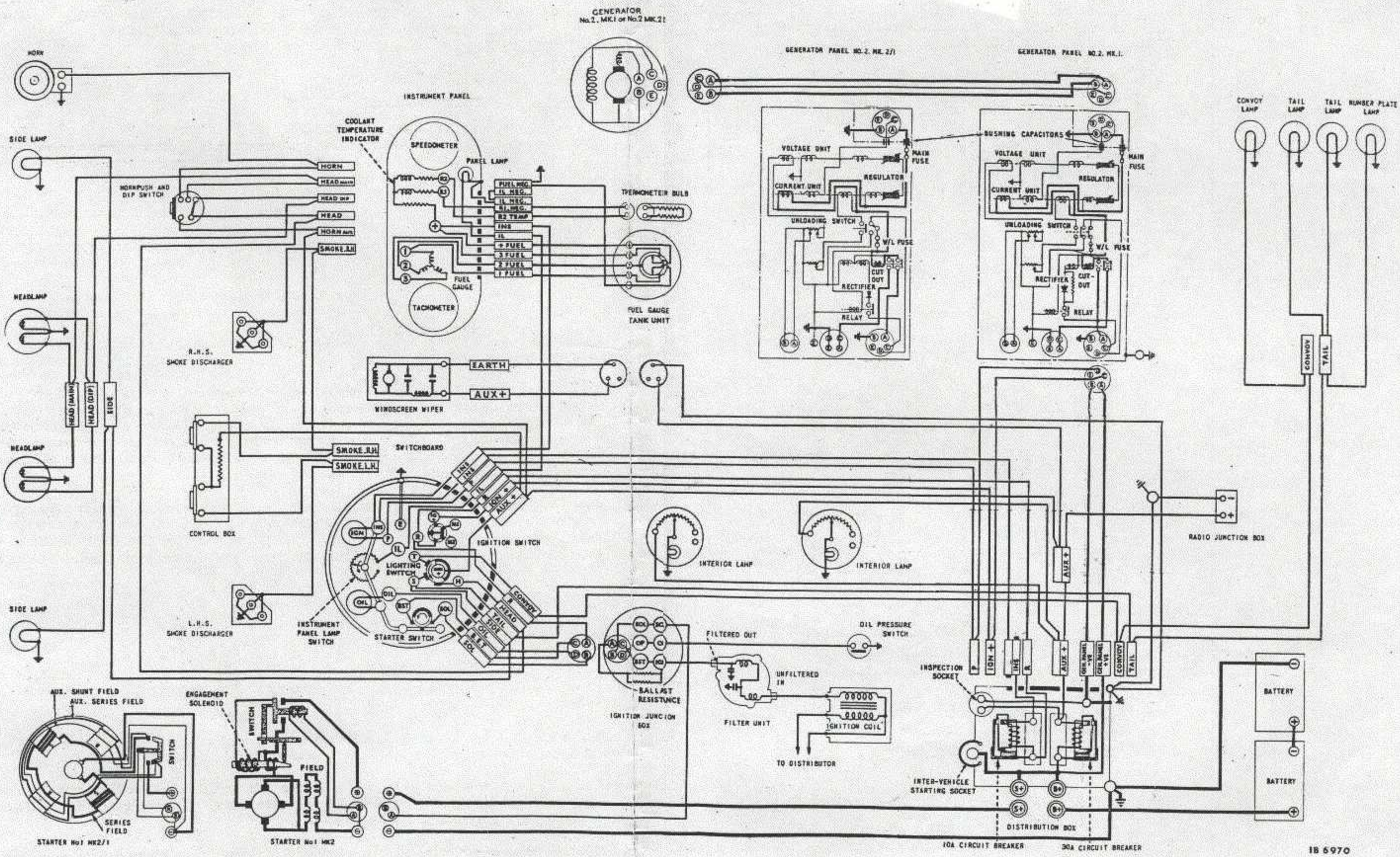


Fig 42 Vehicle wiring diagram

238. The starter motor (12) is of the axial type with a built-in solenoid switch which is operated via a switch located on the driver's switchboard. The switchboard ignition (control) switch must be ON for the starter to operate. It is an insulated return unit fitted to the exhaust side of the engine and its negative lead is connected, together with the battery negative lead, to the distribution box earth stud (Fig 45). Alternative marks of starter may be fitted: No.1, Mk 1; No.1, Mk 2 or No.1, Mk 2/1 (see Data). These are described in EMER Power S 522.

239. Six early vehicles fitted with B60, Mk 3A engines numbered 3837 to 3841 and 3905 incorporated a flywheel housing with a non-standard fixing flange (see note following para 42). The starter fitted to these engines is Simms type 524 SGR41B/3; it is generally similar to the No.1, Mk 1 starter.

240. The switchboard (Fig 44(32)) is located forward and to the left of the driver. It houses the starter switch, the external lighting switch, the ignition switch (para 349), instrument panel lamp switch, main indicator lamp (para 363) and the oil pressure warning lamp (para 362).

241. Located forward and to the right of the driver is the instrument panel (5). It houses a speedometer, engine speed tachometer, fuel gauge and a coolant thermometer.

242. A junction box (27), to which a wireless set may be connected, is fitted just above the generator panel.

243. The external lighting comprises two headlamps (2) and (31) and two side lamps (1) and (30) one of each being mounted on the front of each front wheelguard, two tail lamps (13) and (21) mounted one on the rear of each rear wheelguard, a number plate lamp (19) fitted centrally to the rear vertical plate above the number plate and a convoy lamp (20) located in the centre of the vehicle on the rear sloping plate. These lamps are controlled from the switchboard.

244. The headlamps employ twin filament bulbs and work on the double-dipping system of control in which dipswitch operation changes the filament in use and hence the light beams of both lamps change from the normal to the dipped position and vice versa. The dipswitch (6) is fitted immediately below the instrument panel within easy reach of the driver's right hand.

245. The cables to the number plate lamp and to the convoy lamp are coiled at the back of the lamp and are long enough to permit removal of the rear plate, complete with lamps, for engine servicing.

246. Two interior roof lamps (8) and (11) are fitted to the off and near side upper, centre panels of the fighting compartment. Each incorporates its own switch and dimmer resistance.

247. A horn (4) located on the right-hand wheelguard behind the headlamp is controlled by a switch incorporated in the headlamp dipswitch unit.

248. Smoke dischargers (3) and (29) are fitted to the wheelguards behind the headlamps, the grenades are fired from a switchbox (10) located on the left side of the vehicle just forward of the roof lamp.

249. A windscreen wiper (7) is secured to the frame of the driver's screen. The wiper lead terminates in a 3-pin plug which, when the screen is in use, fits in a socket located to the left-hand side, rear, of the driver above the smoke discharger switchbox.

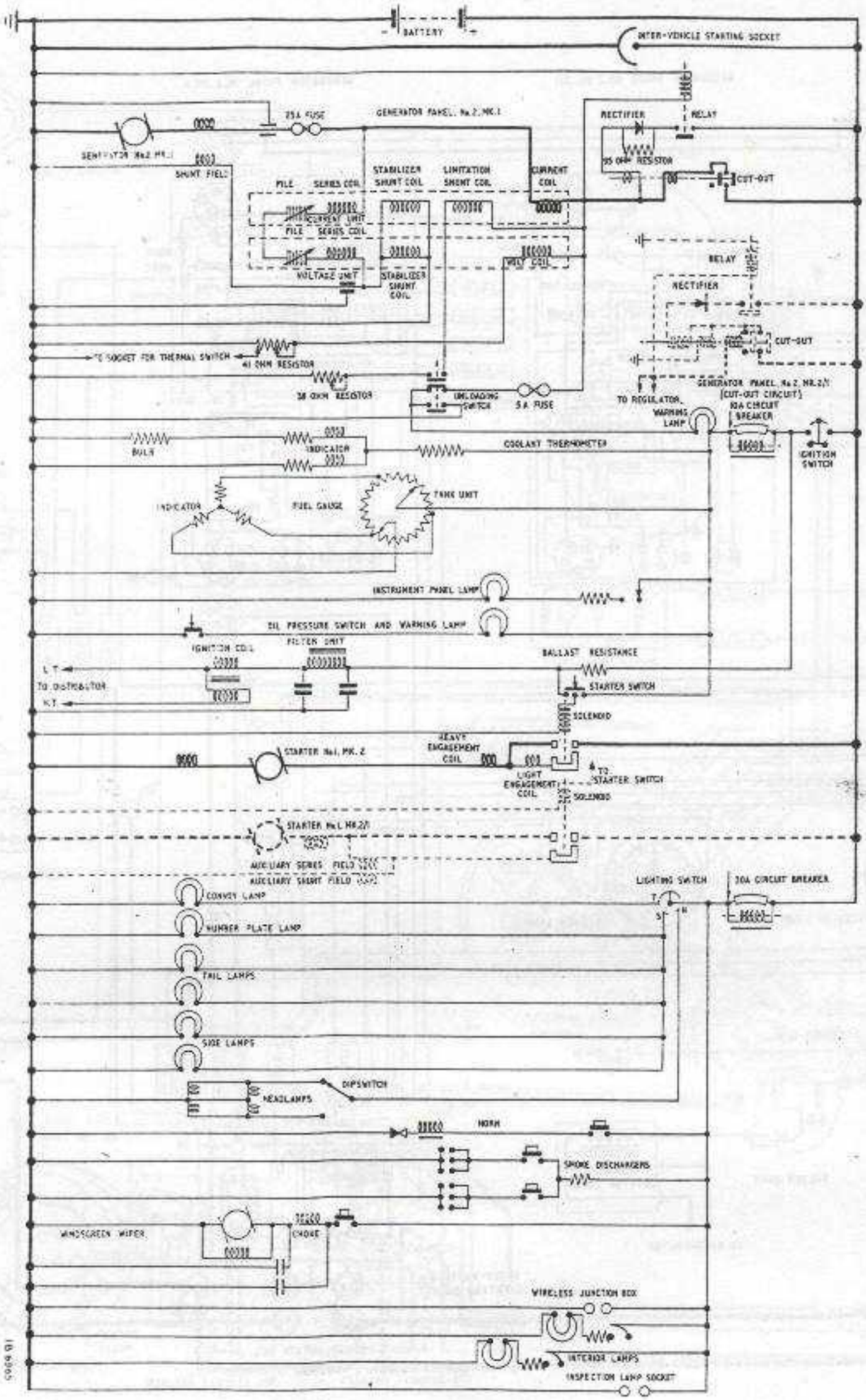
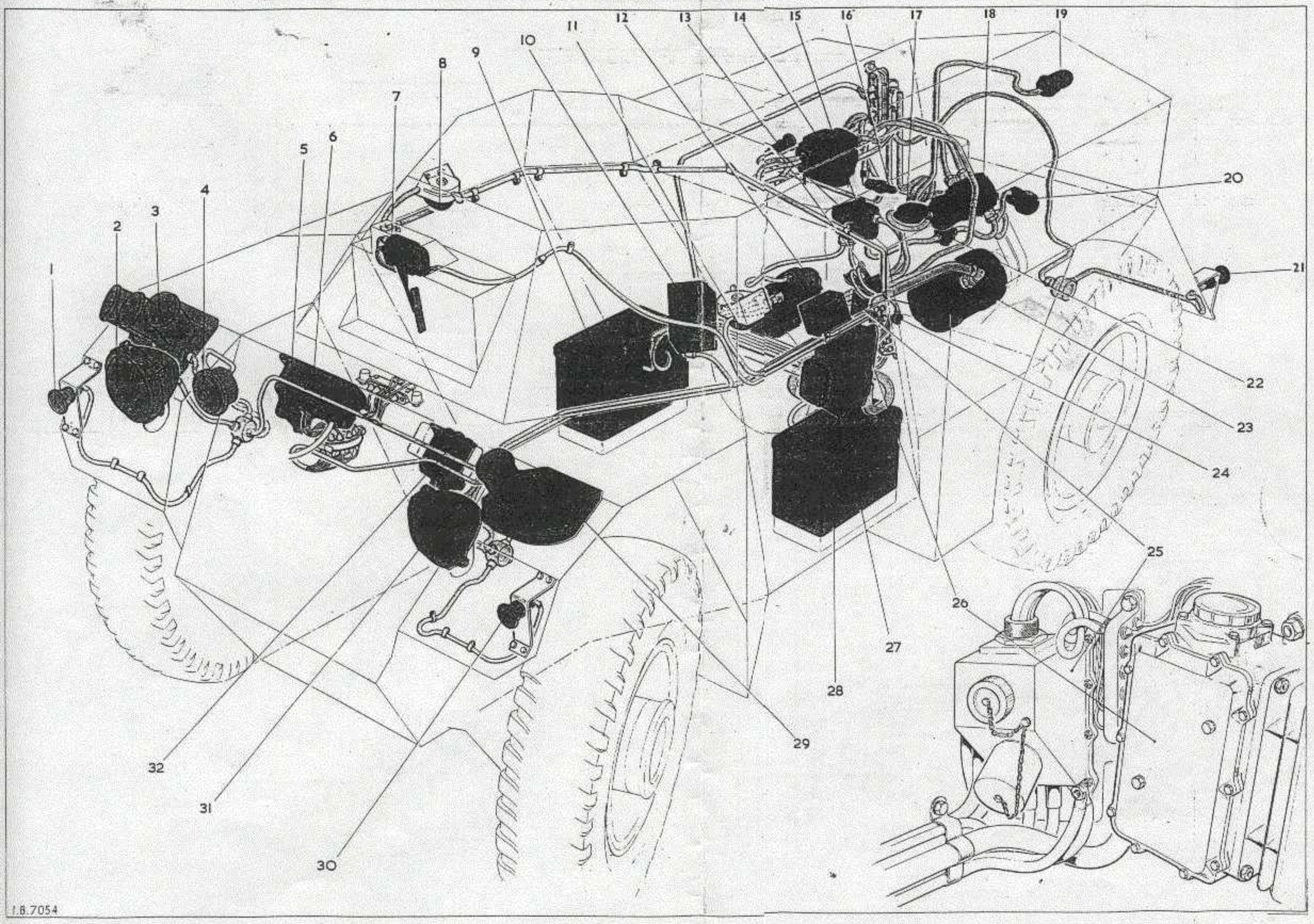


Fig 43 Schematic wiring diagram



1 Side lamp
2 Headlamp
3 Smoke discharger
4 Horn
5 Instrument panel
6 Horn push and dipswitc
7 Windscreen wiper
8 Roof lamp
9 Battery
10 Smoke discharger switchbox
11 Roof lamp
12 Starter
13 Tail lamp
14 Distributor
15 Ignition junction box
16 Thermometer bulb
17 Fuel gauge tank unit
18 Ignition coil
19 Number plate lamp
20 Convoy lamp
21 Tail lamp
22 Ignition filter unit
23 Generator
24 Oil pressure switch
25 Distribution box
26 Generator panel
27 Wireless set junction box
28 Battery
29 Smoke discharger
30 Side lamp
31 Headlamp
32 Switchboard

Fig 44 Installation diagram showing components in red and conduits in green

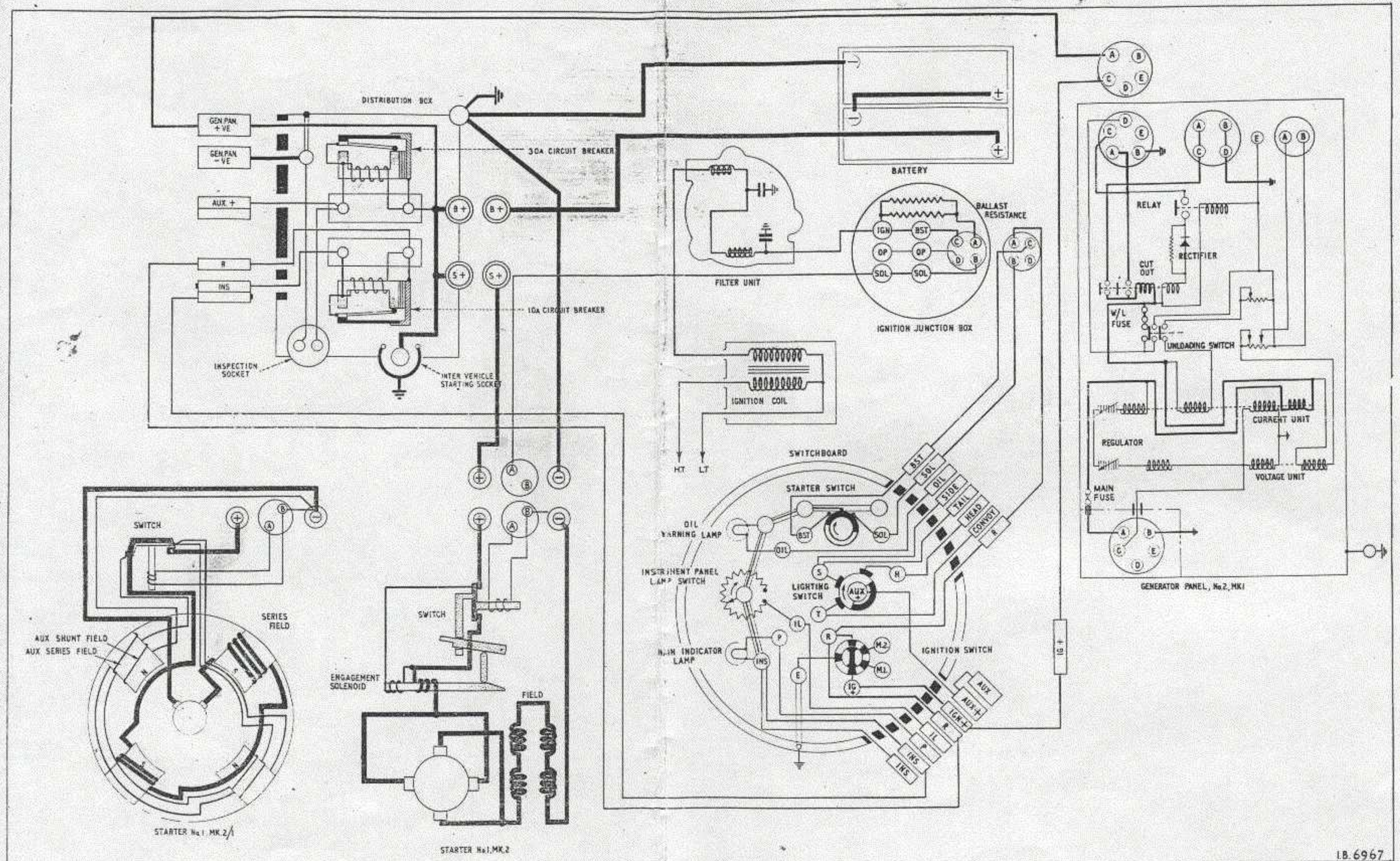


Fig 45 Starter and ignition circuits (red)

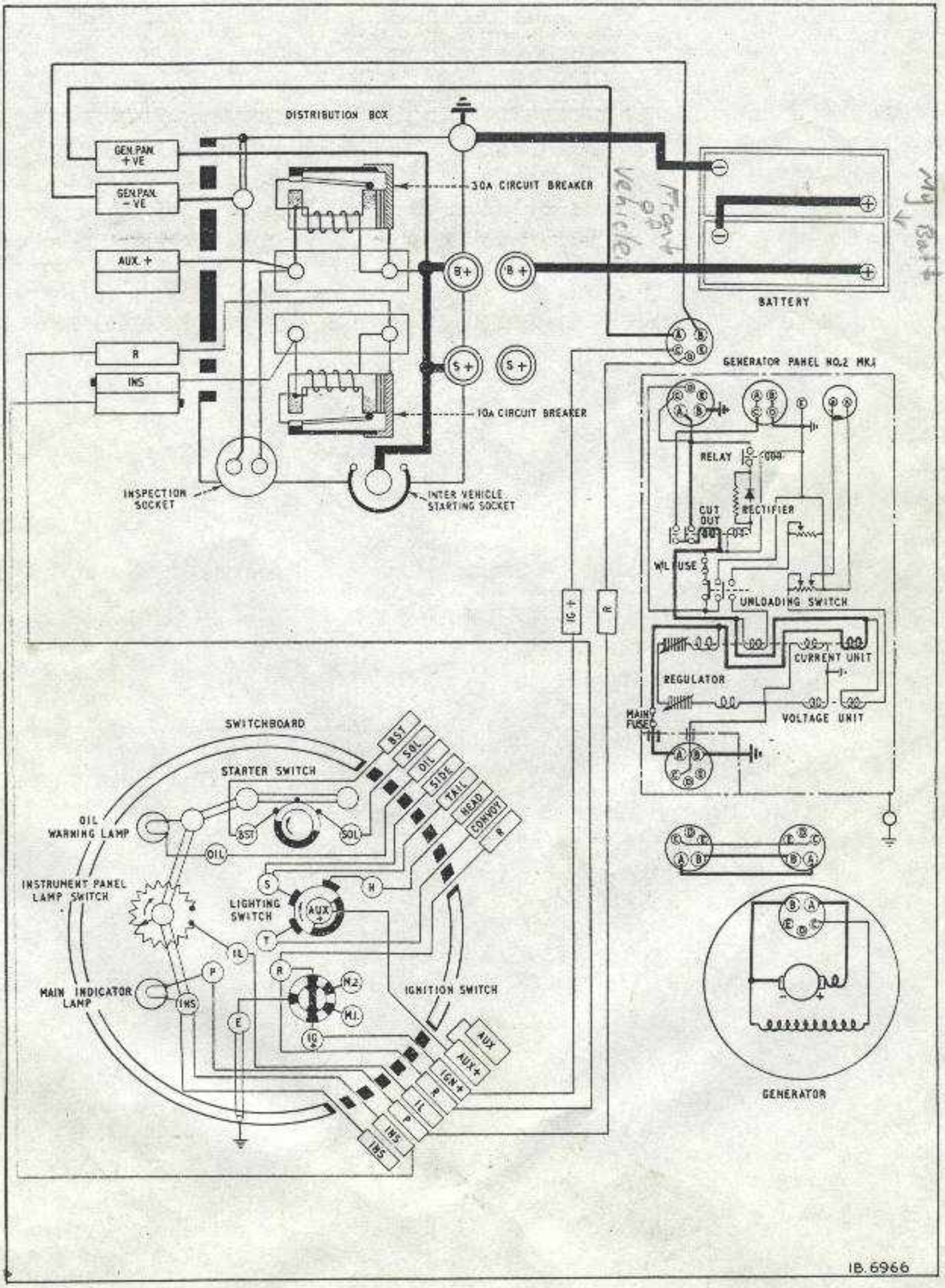
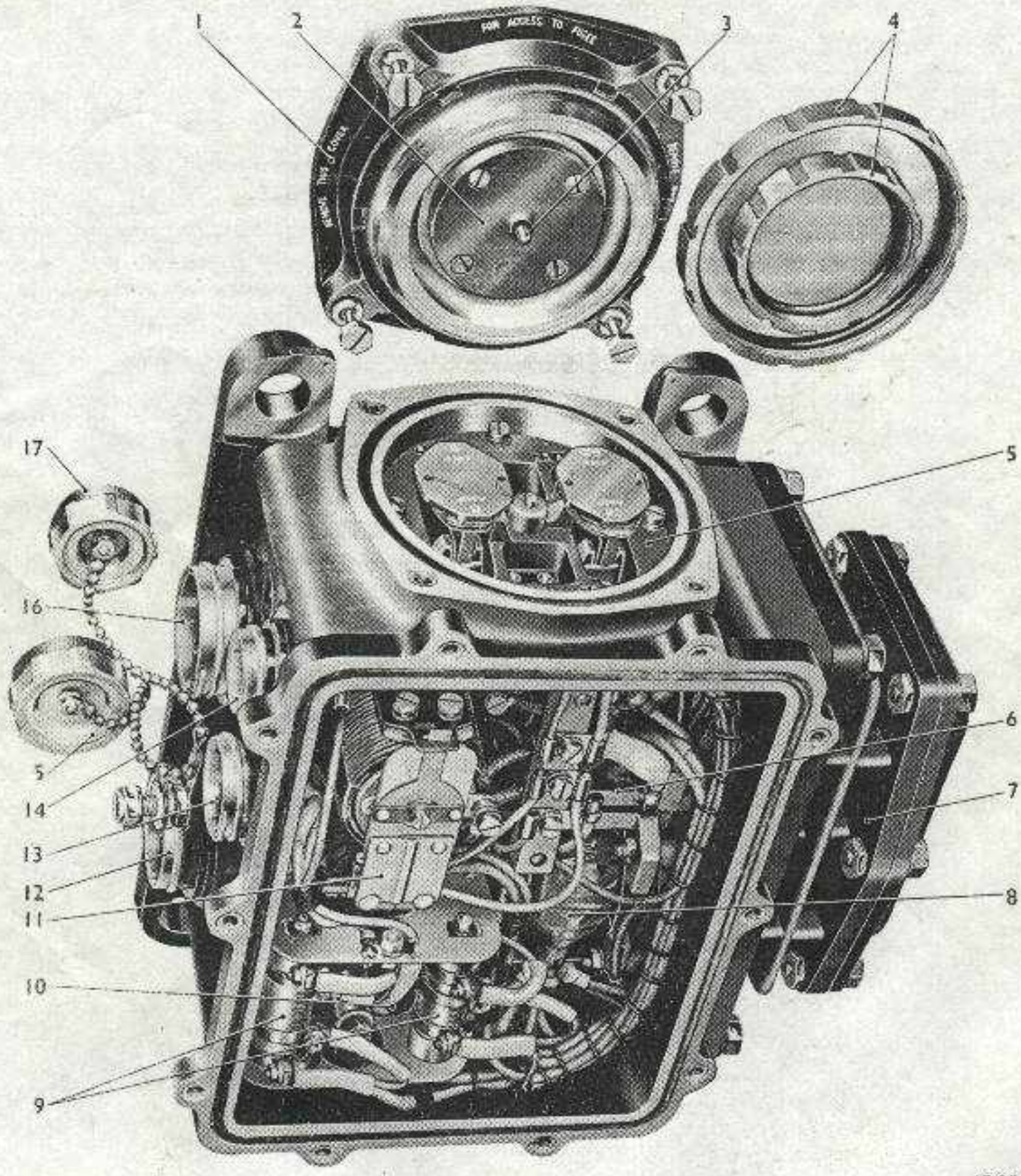


Fig 46 Charging circuit (red) and indicator lamp circuit (green)



1 Fuse cover
2 Switch diaphragm assembly
3 Switch operating plunger
4 Fording caps
5 Switch and fuse base
6 Current unit
7 Regulator assembly
8 Voltage unit
9 Resistors
10 Capacitor
11 Cut-out
12 Generator connection socket
13 Radio battery connection plug
14 Battery thermal switch connection socket
15 Waterproof cap for (13)
16 Vehicle battery and ignition connection plug
17 Waterproof cap for (14)

Fig 47 Generator panel No.2, Mk 1

250. The majority of the equipment is waterproofed, tropicalized and, where necessary, suppressed to prevent interference to wireless equipment.

251. Connections to most units are made by means of plugs and sockets or by nipple connectors; rubber blocks housing nipple connectors are suitably disposed throughout the vehicle thus facilitating the maintenance of the electrical system. Most cables are contained in braided flexible metallic conduits.

252. Copper braid is used to connect the generator panel to a vehicle earth stud, para 236, the distribution box to another earth stud located just forward of the generator panel, and also the engine to earth.

BATTERY No.2, MK I - FV157937

253. Battery No.2, Mk 1 is a 12V 60Ah lead-acid unit and two are connected in series to give a 24V supply. For a description of this type of battery see "EMER POWER J 305, Lead-acid Batteries".

Special features

254. Several special features are incorporated. The batteries are supplied by the manufacturer in a dry-charged condition which makes them available for use two hours after the initial filling. Full instructions for putting them into service are given on the tie-on label supplied with each. The dry-charge will be impaired if the seals have been accidently broken but such a battery will operate satisfactorily if given an initial charge in the normal way.

255. Synthetic micro-porous separators are used. The bottom of each plate has two projections which are handed to fit against two of four sludge plates incorporated in the bottom of the toughened rubber cell case. This helps to reduce damage to the plates should the battery be subjected to mechanical shock. The cells are bonded into an aluminium alloy container.

256. Each battery is fitted with two cable take-off plates. Each battery cable terminal is secured by two bolts with captive washers and nuts. To prevent reversal of connections, the tops of the plates are marked positive and negative respectively and in addition the pitch of the holes in the positive plate is 1.0 in. and that of the negative plate 0.875 in. To prevent crushing by the cable bolts, strengthening bushes are cast in the take-off plates.

257. The design of the terminals is such that the cable ends should be connected to the outside face of the take-off plate with the cable running towards the centre of the battery. The bolt heads with their captive washers are fitted on the inside face of the take-off plate.

Modifications

258. Several modifications of the battery have been approved since its introduction. Originally the 6V and 8V inter-cell connectors were specially shaped and incorporated two No.2 B.A. inserts to provide a mounting for a battery thermal switch when required. The shape of these connectors was subsequently changed and two holes suitable for type Z No.10 self tapping screws superseded the 2 B.A. inserts. A later modification changed the special 8V inter-cell connector to a standard type.

259. Another modification introduced the application of a film of plastic material to all exposed metal surfaces, except the container base and contact area of the take-off plates, to prevent corrosion of the container and to reduce the risk of accidental short circuits. Subsequently, the protective applied to the positive take-off plate was tinted red.

Battery container

260. Each battery is fitted in a partially waterproofed metal container and is secured by two bolts with locknuts entered through holes in the battery handles which screw into pads located at the bottom of the container.

261. The container cover is fitted with a U-section lipped rubber seal which fits tightly on the turned-over rim of the container to ensure a watertight joint. This seal is smeared with silicone sealing compound on assembly. Complete waterproofing is effected by fitting a rubber breather in the container cover; the top of the breather is flanged to seat on the cover and the stem of the breather is grooved. Gasses generated during charging enter the grooves, lift the flange and so escape.

262. Breathers should only be fitted when full waterproofing is a requirement. In cases where breathers have been fitted for normal operations instances have occurred of the cover being blown violently from the battery container owing to failure of the breather to release the gases. Breathers are stowed inside the container on the top of the battery adjacent to the positive terminal.

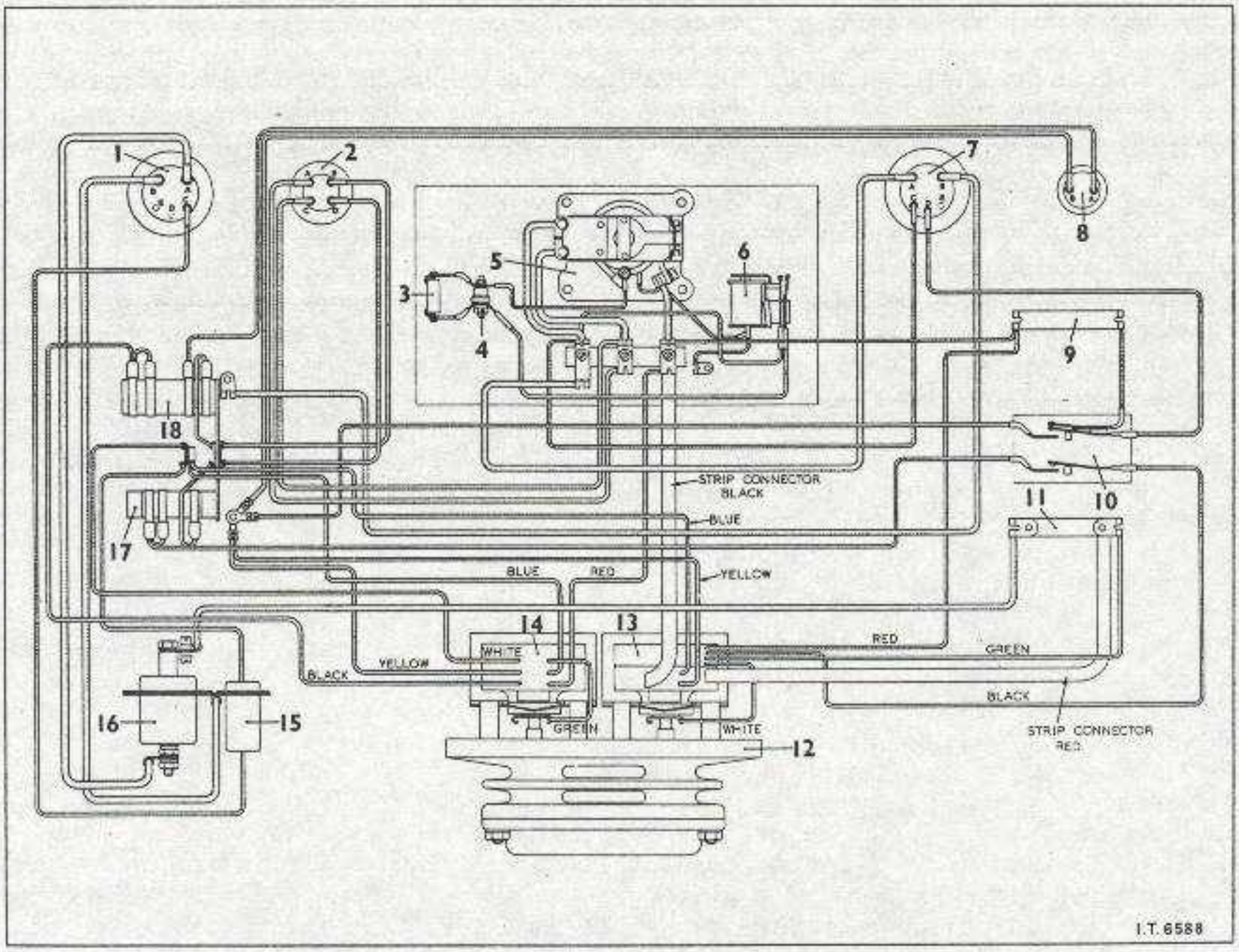
263. Cable entry holes in the container are sealed by tightly fitting rubber bungs. Three other cable bungs are fitted for use when Arctic Battery Heating Kit is fitted; a thin rubber disc moulded in the centre of each of these bungs renders them waterproof. These discs are easily perforated when it is required to fit the additional cables.

GENERATOR PANEL No.2, MK I - FV175848

264. Generator panel No.2, Mk 1 (Fig 47 and 48) controls the output of the Generator No.2, Mk 1 or Mk 2; it is a tropicalized and waterproofed unit, connections to the panel being made by means of breeze type plugs. Housed in the panel is a carbon pile regulator (Fig 47(7)) with resistors (9) a cut-out (11) relay, rectifier, switches, fuses, wireless interference suppression capacitors and fording caps for waterproofing the generator (see para 235).

Regulator

265. The carbon pile regulator comprises two units mounted on a common frame fitted to the side of the panel. One unit is for voltage control (8) and the other for current limitation (6). Each unit embodies a stack of precision made carbon washers (Fig 49(14)) known as a pile, located in a ceramic tube (15) which in turn is enclosed in a finned solid casting (16) for dissipating the heat generated by the pile. The pile is held in a state of compression by a leaf spring assembly (5) carrying a solid armature (6) which is acted upon by an electromagnet. The two piles are connected in series with each other and with the generator field winding.



1 Generator connection socket
2 Radio battery connection plug
3 Shunt resistance for rectifier
4 Rectifier
5 Cut-out
6 Relay
7 Vehicle battery and ignition connection plug
8 Battery thermal switch connection socket
9 Warning lamp fuse
10 Unloading switch
11 Main fuse
12 Carbon pile regulator
13 Current unit
14 Voltage unit
15 0.1 μF capacitor
16 0.25 μF capacitor
17 Current limitation trimmer resistor
18 Voltage ballast resistor

Fig 48 Generator panel No.2, Mk I wiring diagram

Voltage and current carbon piles

266. The voltage unit pile is a composite pile approximately $1\frac{1}{2}$ in. long, consisting of not fewer than 26 carbon washers size 10.9 mm x 5 mm x 0.5 mm interleaved with not fewer than 27 washers size 10.9 mm x 5 mm x 1.0 mm, finished with a washer 1 mm thick at each end. It has a resistance range of 2.5-70.0 ohms and a maximum permissible loading of 70 watts.

267. The current unit pile is approximately 1½ in. long consisting of not fewer than 76 carbon washers size 10.9 mm x 5 mm x 0.5 mm.

268. The electromagnetic windings of each unit are embraced by an iron magnetic circuit (21) embodying an adjustable core (3) which is screwed into the magnet. Two core locking screws (2) are fitted adjacent to the head of the core. The core of the voltage unit is adjusted by the manufacturers to give the best regulation at the nominal regulated voltage (28-29V) and that of the current unit to limit the current to 25A.

269. The leaf springs are clamped between two plates which are machined to maintain the springs at a definite angle in relation to the armature face. They are secured by eight screws. The springs are dowel located to supports (23) fitted to the base of the magnetic circuit. Three spring steel strips 0.006 in. thick and one Telcon spring 0.010 in. thick are fitted each side. The latter is a bimetal element which is embodied with the low expansion side uppermost on the voltage unit, and the high expansion side uppermost on the current unit (see para 281 and 282) to compensate for changes due to temperature. The supports are shaped to eliminate friction and to obtain the correct spring force over the working range of the pile.

270. Fitted to the armature top plate is a brass ferrule assembly (18) which is insulated from the armature and carries a carbon plug (17) to provide electrical connection to the movable end of the pile. The connection to the pile is made to the ferrule assembly.

271. Secured to the casting by two screws is a brass bracket (9) which locates the end of the ceramic tube. An adjustable ferrule (12) with a carbon contact plug (13) screws into the bracket to contact the stationary end of the pile and to apply the required compression. A screw (1) fitted to the bracket locks the ferrule when the required setting is obtained. The bracket is insulated from the casting by mica and bushed screws.

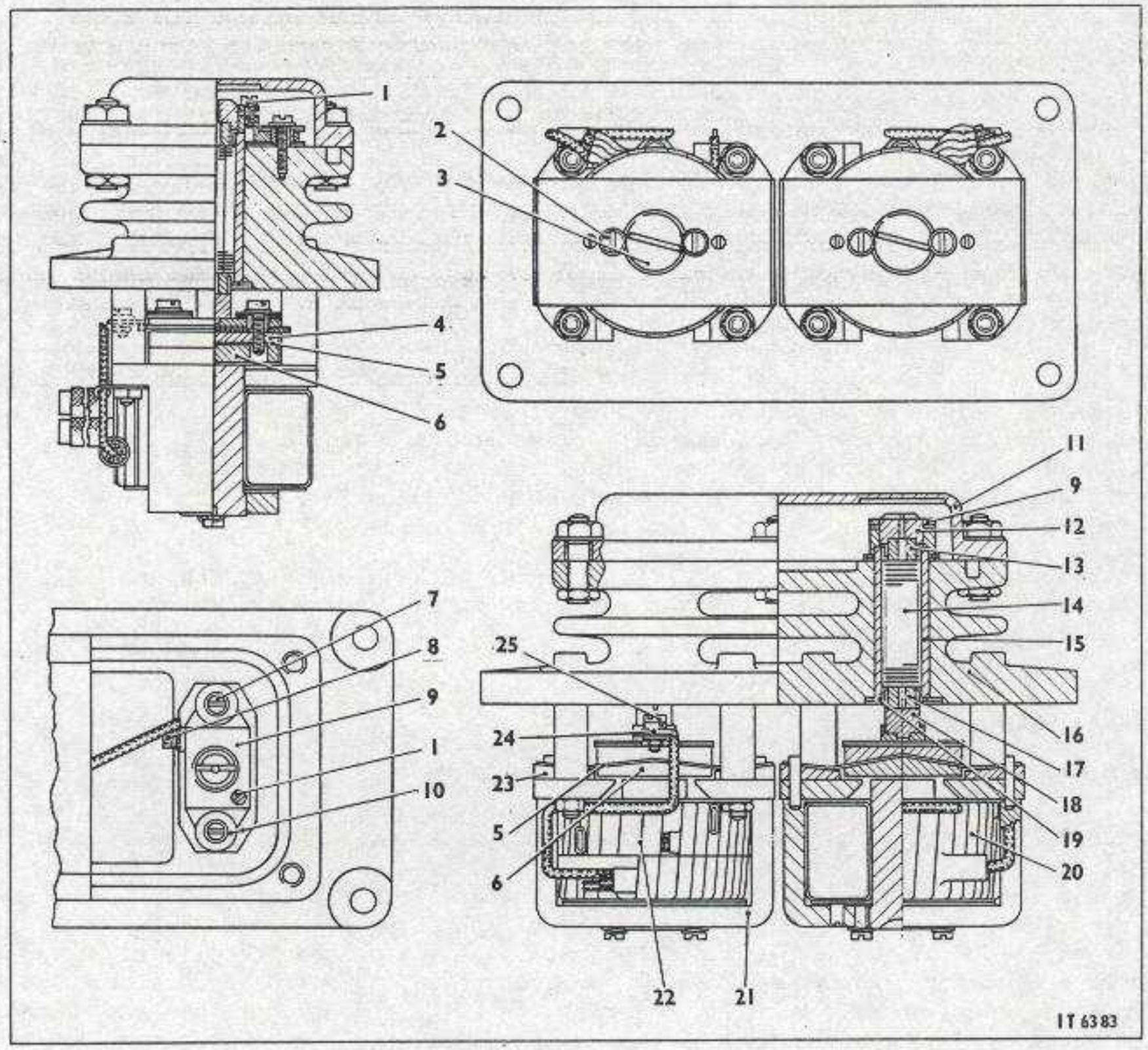
Voltage and current unit solenoids

272. Each solenoid has several different windings. The main coil of the voltage unit is a voltage coil connected in series with a semi-adjustable ballast resistor across the generator terminals (Fig 43) and thus is sensitive to changes in the generator voltage. The coil has a resistance of approximately 14.8 ohms (cold) and the ballast a resistance of 41 ohms. The ballast resistor is fitted in the panel adjacent to the regulator. It is adjusted by the manufacturers of the regulator so that the coil circuit resistance will give the correct current at the regulated voltage i.e., 0.58-0.64A at 28.5V. Another tapping taken from this resistor is connected to a socket provided for a battery thermal switch when required (see para 276).

273. The main coil of the current unit has 30 turns of relatively heavy gauge wire connected in series with the generator and therefore is sensitive to current changes.

Operation

274. When the solenoid is not energized, the armature exerts a pressure on the carbon pile by virtue of the leaf springs and therefore the pile resistance is at a minimum. Energizing the solenoid causes the armature to be attracted to the core. Assisting the magnetic force is the force due to pile reaction, which is maximum when the pressure on the pile is maximum and decreases as the pile pressure is reduced. These two forces act in the opposite direction to the force exerted by the spring and hence the resultant pressure on the pile is the difference between these forces.



1	Bracket locking screw	9	Bracket	18	Armature ferrule
2	Core locking screw	10	Bracket insulation	19	Pile tube location
3	Adjustable core	11	Cover	20	Voltage coil
4	Armature top plate	12	Adjustable ferrule	21	Magnet case
5	Armature spring	13	Terminal plug	22	Current coil
6	Armature	14	Carbon pile stack	23	Spring support
7	Bracket fixing screw	15	Pile tube	24	Pile connector
8	Bracket connecting screw	16	Heat dissipator	25	Armature clamping screw
		17	Terminal plug	25	

Fig 49 Regulator - generator panel No.2, Mk 1

275. As the generator commences to rotate, its voltage builds up and the control current (voltage coil current) of the voltage element approaches its predetermined value, 0.58-0.64A, whereupon the solenoid commences to relieve the pressure on the pile and there is a consequent increase in the resistance of the pile and reduction in the generator field current and terminal voltage. When the generator voltage is such that the predetermined control current is flowing, any further increase in generator speed and consequent terminal voltage and control current results in the regulator armature moving nearer to the core. This movement increases the generator field circuit resistance and reduces the field current and terminal voltage. The control current decreases, the pressure on the pile increases, with a consequent decrease in resistance of the field circuit, and the generator voltage rises to its regulated value. The control level of the voltage unit is 27.8-29.2V.

276. In installations where the battery thermal switch is fitted, when working under tropical conditions, the switch closes at a predetermined temperature to short circuit part of the ballast resistor to earth. Since the regulator control current is constant, the generator voltage falls and so prevents overcharging. Under these circumstances the regulator controls the generator at 25.8-27.2V.

277. The current unit operates in a similar manner but in this case the control current is the generator current and the regulator limits the generator output to 25A nominal, i.e., when the pile is hot, within the limits 24A at 3,300 r.p.m. - 27A at 8,500 r.p.m. generator speed.

Stabilizing windings

278. In addition to the main coil, each solenoid embodies shunt and series stabilizing windings. The shunt stabilizing winding has a resistance of 420 ohms; it is connected across the generator field and is wound so that its magnetic effect assists that of the operating coil. The series winding has 12 turns connected in series with the pile and is wound so that its magnetic effect opposes that of the operating coil. Under steady conditions the two coils provide equal and opposite ampere turns and thus have no effect on the regulator. A fall in generator voltage causes the pile to close but the increase in control current is delayed on account of the field inductance. A transient voltage is therefore built up across the field and so increases the shunt stabilizing ampere turns without a corresponding increase in the series stabilizing ampere turns. This increase in magnetic flux is added to that of the operating coil, giving the same effect as an increase of control current and damping the pile movement until steady conditions prevail. The reverse action occurs with an increase in voltage.

279. The current units fitted to early panels did not embody these stabilizing windings. The introduction of the modification is identified by the erasure of No.1 from the modification record plate and by the addition of /FB to its type number.

Current reducing winding

280. In addition to the main and stabilizing coils, the current unit is fitted with another coil of 600 turns connected in series with a semi-adjustable trimmer resistance of 38 ohms. These two are connected across the generator terminals when a switch is closed by the action of removing the fording caps (para 299). The additional ampere turns result in the generator output becoming limited to 6A. The trimmer resistance is pre-set by the regulator manufacturers to give this current limitation should the generator be running sealed (see para 235).

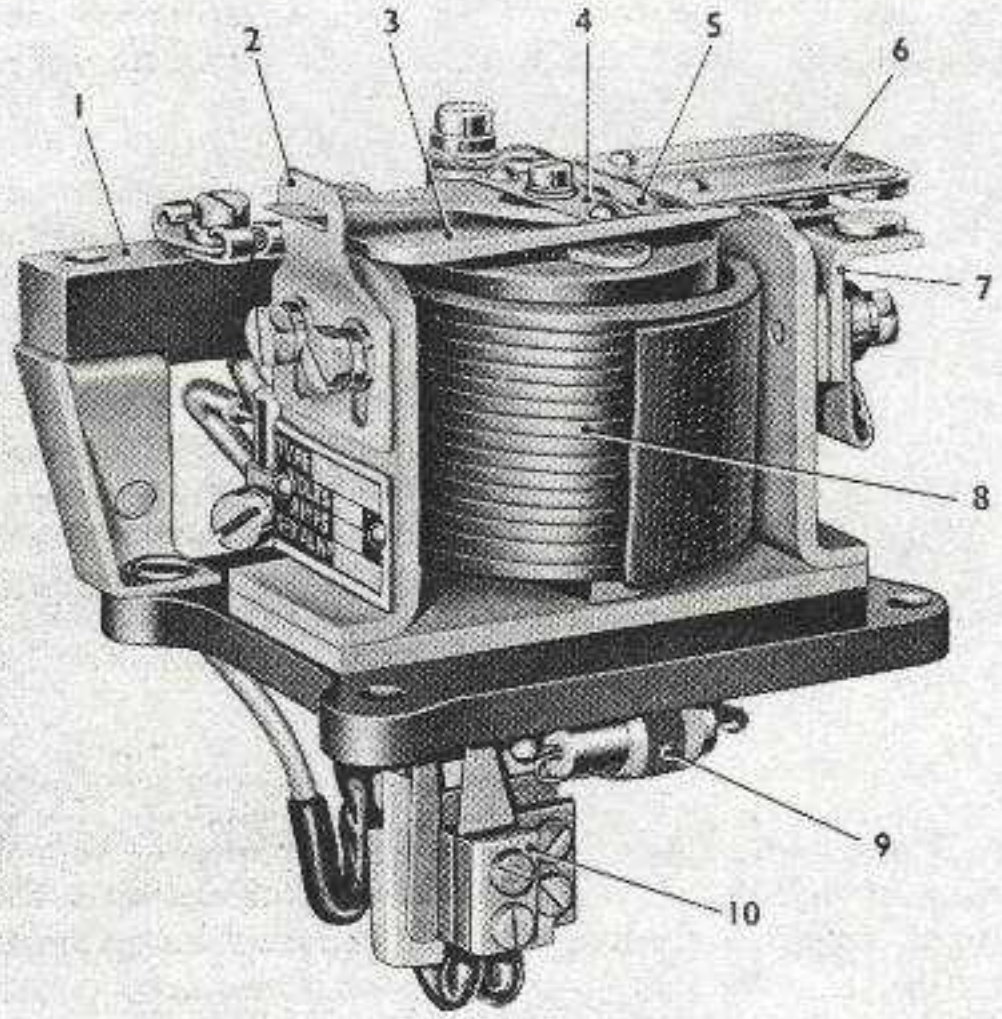
Temperature compensation

281. Temperature compensation of the voltage unit is obtained by a proper selection of the resistance ratio of the coil circuit and by embodying the bi-metal spring (para 269) as the top component in the spring assembly to cater for the resistance change in the operating coil and any expansion characteristics of the regulator. With increase in temperature the bi-metal component of the spring tends to bend away from the armature and support and so reduces the pressure exerted by the complete spring assembly. This in turn compensates for the decrease in magnetic pull resulting from the heating of the copper coil and other parts affected by an increase in temperature. The ballast resistor connected in series with the operating coil has a practically zero temperature coefficient and because of its resistance value compared with that of the coil it swamps out an appreciable amount of the temperature resistance rise of the coil.

282. In the current unit the action of the bi-metal spring is reversed. The bi-metal exerts minimum pressure with the regulator cold and, with heating, the pressure is increased and in this way tends to compensate for any expansion of the cooler and studs.

Cut-out base assembly

283. The cut-out base assembly (Fig 50) comprises a cut-out (8) relay (10) rectifier, resistor (9) and terminal board mounted on an insulated base. Leads from other control board components are taken to "screw-on" terminals on the terminal board so that the assembly may readily be removed from the generator panel.



1 Terminal board
2 Adjustment plate
3 Armature
4 Suspension strip
5 Contact spring
6 Backing plate
7 Contact bracket
8 Cut-out
9 Resistor
10 Relay

I.P.7046

Fig 50 Cut-out base assembly - generator panel No.2, Mk I

Cut-out

284. The cut-out is a magnetically polarized differential type (polarity at the contact end being south) which closes the vehicle battery charging circuit when the generator voltage exceeds the battery voltage by 0.7-1.3V and opens the charging circuit when the reverse current is between 2.4-4.8A. Separate windings are provided for these functions.

285. The magnet is a 35% cobalt steel plate with two vertical arms riveted to it and a square sectioned steel core bolted to it. Wound on the core is the pull-in (differential) voltage coil which has a resistance of 1.60-1.95 ohms at 20°C. Fitted over this coil is a copper strip series coil.

286. The armature assembly is of riveted construction comprising an armature (3) a beryllium copper contact spring (5) with brass backing plates (6) and a beryllium copper suspension strip (4). The suspension strip is disposed approximately centrally along the armature and is secured to the core by a screw and spring washer. Clearance holes for the core are provided in the armature and contact spring so that the armature assembly is free to pivot about the suspension strip.

287. Fitted at one end of the spring are two silver contacts which mate with two similar contacts riveted to a bracket (7) which is bolted to, but insulated from, the adjacent magnet sideplate. The other end of the spring is extended to rest in a slot cut in an adjustment plate (2) which is bolted to the other magnet sideplate. The spring pressure controls the cut-out characteristics and, to permit adjustment of this pressure the two holes for the plate securing screws are elongated.

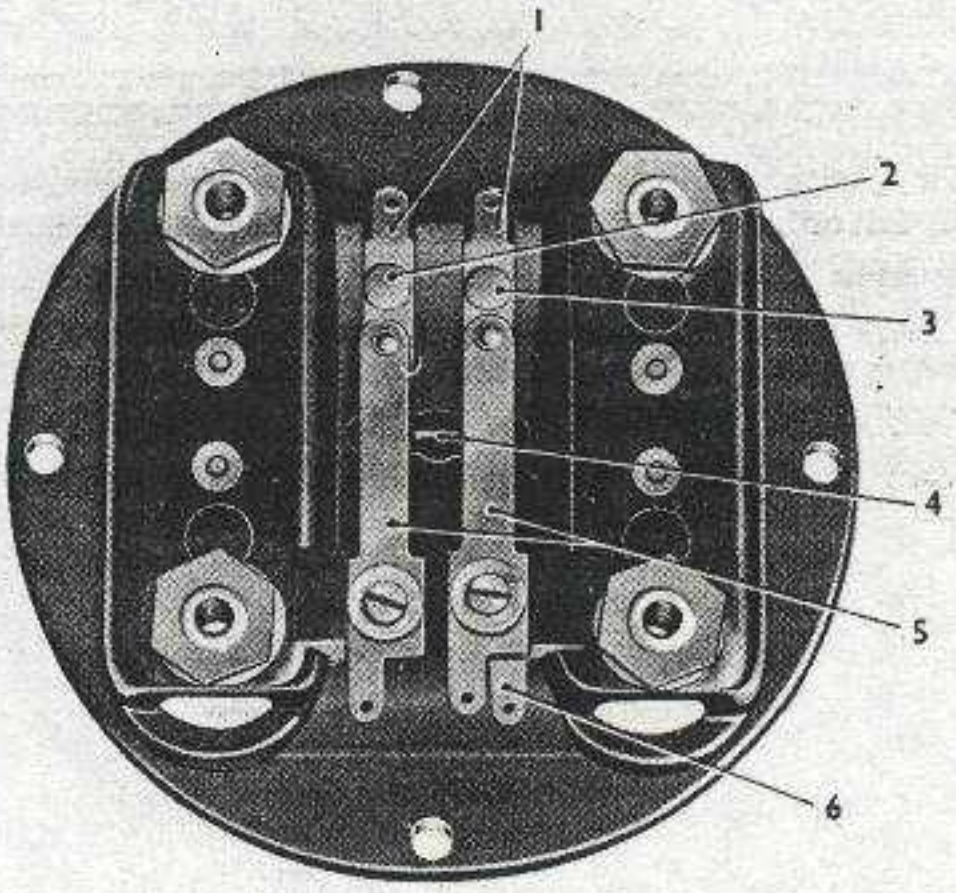
288. A modification of the cut-out has been approved (Table 2) whereby a non-magnetic shim is soldered to the face of the magnet sideplate which is remote from the contacts, and the face of the other is lightly tinned. This reduces the risk of cut-out failure due to vehicle vibration.

289. The pull-in coil is connected across the generator and battery positive terminals and is therefore short-circuited when the cut-out closes. The series coil is connected in series with the cut-out points and with the generator positive lead. It holds in the cut-out when the pull-in coil is short-circuited and throws out the cut-out when reverse current flows.

290. A heavy reverse current or short circuit caused by an incorrect connection may cause the cut-out to become demagnetized; this is indicated by the armature becoming "floppy" and by failure to cut-out. On no account should the cut-out be operated by hand with the battery connected, nor should the battery (or slave lead if the battery has been removed) be disconnected while the generator is running.

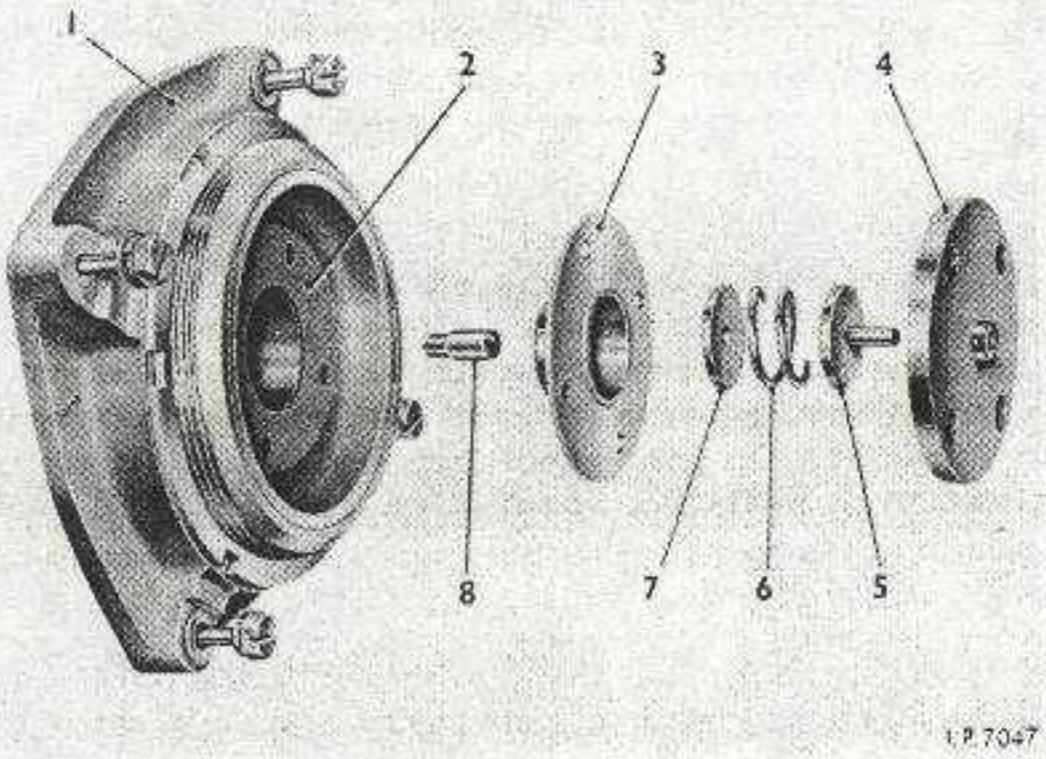
Relay

291. The relay (10) is mounted on the underside of the cut-out base. It is a small single-pole "definite voltage" relay with normally open contacts connected in series with a rectifier and the cut-out pull-in coil. The contact blades are set so that the minimum contact gap is 0.020 in., the minimum contact pressure is 25 grams, and the moving blade exerts a minimum pressure of 10 grams on the armature. The relay coil has a resistance of 400 ohms; it is connected across the generator terminals and operates to close its contacts when the generator voltage reaches 21V (maximum). The relay opens when the generator voltage falls to 8V (minimum).



1 Contact plate
2 1-way switch
3 2-way switch
4 Switch plunger
5 Contact spring
6 Double contact contact spring

Fig 51 Underside of switch and fuse base - generator panel No.2, Mk I



1 Fuse cover
2 Shims and gasket
3 Diaphragm
4 Clamping plate
5 Operating stud
6 Spring
7 Buffer plate
8 Diaphragm plunger

Fig 52 Fuse cover - generator panel No.2, Mk I