RESTRICTED

The information given in this document is not to be communicated, either directly or indirectly, to the Press or to any person not authorised to receive it.

# SERVICE INSTRUCTION BOOK

FOR

# CAR, SCOUT, HUMBER, II

CHILWELL CATALOGUE NO. 64/28

This publication has been produced to the instructions of

THE CHIEF INSPECTOR OF FIGHTING VEHICLES

to whom all communications should be addressed

FIRST EDITION
OCTOBER, 1944

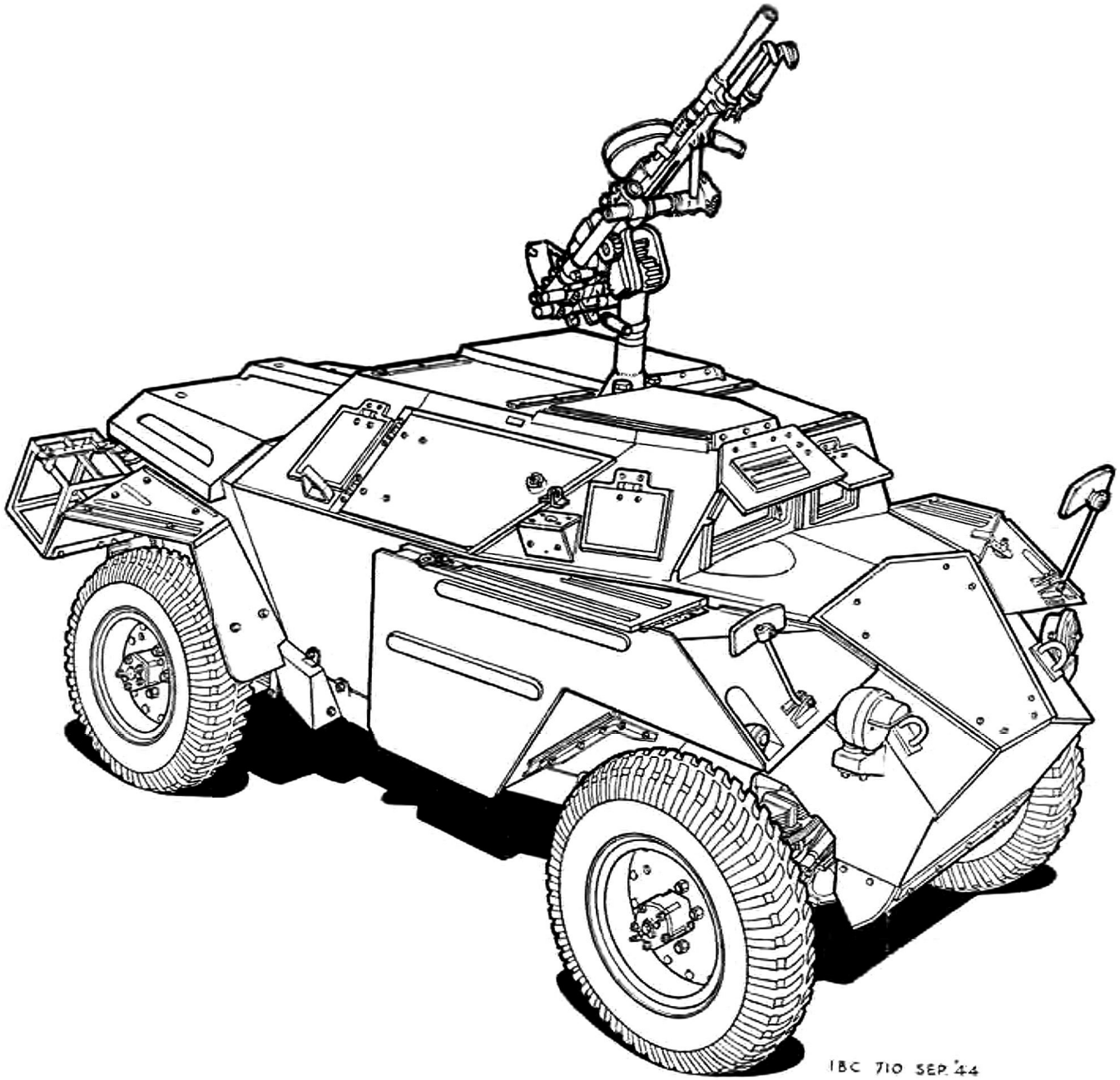



Fig. 1.—CAR, SCOUT, HUMBER II—RIGHT SIDE VIEW.

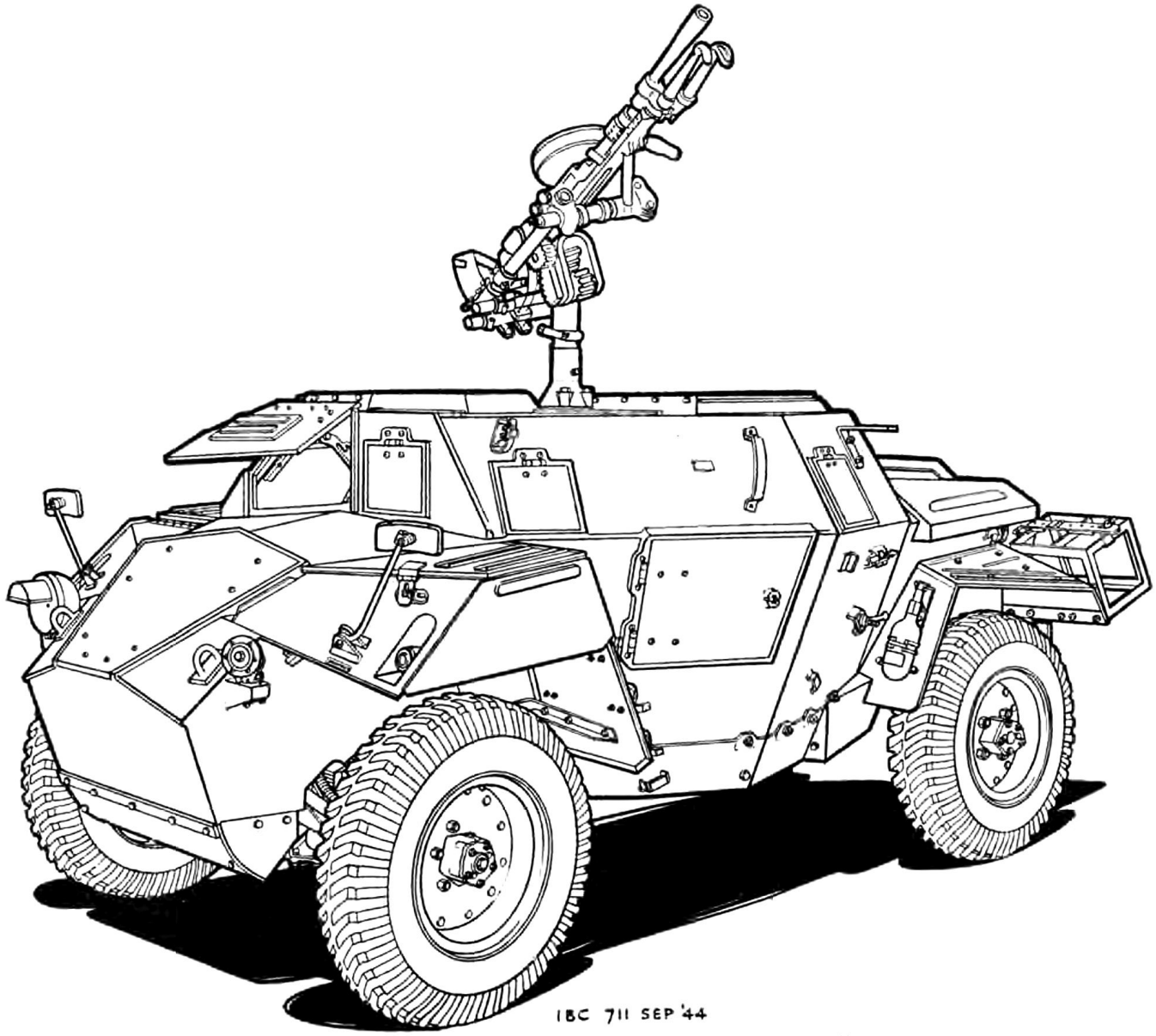



Fig. 2.—CAR, SCOUT, HUMBER II, LEFT SIDE VIEW.

# FOREWORD

The Car, Scout, Humber II is a light, fast, armoured vehicle, for use as a communicating link between units.

It is equipped with a No. 19, Mark III wireless set.

The engine is installed at the rear end of the vehicle. This improves the observation facilities for the crew.

The armament consists of a Bren gun carried on a pillar mounting on the roof of the vehicle, and a Thompson sub-machine gun stowed. Access to the Bren gun is by a sliding panel in the roof. The gunners seat can be raised to the firing position by a quick acting adjustment. The Bren gun can be fired and traversed when necessary, by remote control from within the vehicle.

For driving over rough country, steep hills, and difficult places, four wheel drive and reduced gear ratios are provided. **When driving on normal surfaces, the standard gear ratios and rear axle drive must only be used.**

Run-flat tyres are fitted, enabling the vehicle to be run up to a distance of 50 miles after the tyres have been damaged.

The vehicle is provided with equipment to enable the batteries to be efficiently charged while the vehicle is stationary, as required when on outpost duty and the wireless set is being used for extended periods.

The information in this book combined with efficient maintenance work carefully carried out, will enable the vehicle to be maintained in first class fighting condition.

This book consists of two principal sections divided into chapters, each dealing with a main unit or a group of units. These chapters are further sub-divided into parts. Where necessary for clarity or easy reference parts may be further sub-divided into sub-sections.

The two principal sections are as follows :—

SECTION A. Operation, maintenance and adjustments.

SECTION B. Detailed description of the moving parts of the vehicle.

It is essential that this Service Instruction Book be read in conjunction with the instructions laid down in the appropriate Military Training Pamphlet for the vehicle and the relevant Crew Maintenance Insert in A.B.413.

Information regarding lubricants and periods of maintenance will be found in the Crew Maintenance Insert of the appropriate Army Book 413 and the information included therein will be taken as the ruling guide should it differ from that included on the lubrication chart in the pocket of this book.

No modifications are described in this book and only the latest information is included, unless two or more types of any part are to remain in the service, in which case particulars of each are included.

**For Frost Precautions see page 11.**
**For Fire Precautions see page 12.**

WIRELESS EQUIPMENT (Maintenance and operation of the No. 19 W.T. set fitted in this vehicle is covered in the separate instruction book demandable from The Commandant, Central Ordnance Depot, Donnington).

SECTION

# A

# OPERATION, MAINTENANCE AND ADJUSTMENTS

# CONTENTS

## SECTION A

# LIST OF ILLUSTRATIONS

# GENERAL INSTRUCTIONS

## MECHANICAL POINTS REQUIRING PARTICULAR ATTENTION ON RECEIPT OF A VEHICLE

A vehicle must be examined thoroughly as indicated below, immediately it is received.

1. Examine the engine, gearbox, transfer box, front and rear axles for any oil leakage. Report any leakage.
2. Have the vehicle on level ground and check the oil levels and top up as necessary with correct lubricant (*see* lubrication chart). Engine, gearbox, transfer box, front axle, rear axle, brake fluid reservoir. Report any unusually low level noted.
3. Check the level of water in the radiator, top up as necessary (leave 1¼ inches air space between the water level and the filler neck for expansion) use soft water when possible. Examine for water leaks and report if found.
4. Examine the fuel system for any leakage, check and ensure that all screwed joints are tight.
5. Check tyre pressures. Correct these as found necessary. Check all wheel nuts for tightness.
6. Operate all electrical equipment to ensure satisfactory performance. Examine battery electrolyte, top up as required. *See* page 37.
7. Start the engine, note the dynamo charging rate on normal and high speed drive. Report any unsatisfactory condition of the engine.
8. Test the vehicle to ensure that all equipment is operating satisfactorily, particularly the suspension, clutch, brakes, and steering. Operate the vehicle in all gears for two and four wheel drive.
9. Check that all tools and equipment are complete. Report shortages at once.

## DRIVING CONTROLS

### Access to Vehicle

When all hatches and doors are shut, entry can be effected only by unlocking either the right- or left-hand door by means of a detachable " T " key, two of which are supplied with each vehicle.

When hatches are open, access is obtained through them immediately over the driver's and gunner's seat. The upper escape hatch on the right side of the vehicle has external hasps, while the lower escape hatch on the left side has internal hasps. Padlocks are provided to lock these as required.

### Driving Seat Adjustment

The driver must adjust the seat to ensure that all the hand and foot controls are within easy reach.

The seat adjusting catch is on the right-hand side. Press the lever down, slide seat to required position, release lever and slide seat slightly backwards and forwards until it is correctly located in the securing slot. The seat cushion is adjustable for height :—Position the rear cross rail as required. It should also be noted that the seat backrest can be raised and hinged to the rear to facilitate entry.

### Controls

The location of the instruments and driver's controls is shown in Figs. 3, 4 and 5, the illustrations being lettered for ease of reference to the following explanatory paragraphs :—

Fig.

5 (A) **Ignition Switch.** Turn anti-clockwise for " ON." Switch " OFF " when car is stationary.

5 (B) **Ignition Warning Light.** Glows red when ignition is switched on, remains alight while engine is idling, and goes out when engine is either accelerated or switched off. Report if this does not occur.

3 (C) **Starter Carburetter Control.** (Also referred to as " Choke Control.") Varies the strength of the mixture for starting purposes. (*See* " Starting Procedure," page 8.)

3 (D) **Hand Throttle Control.** Enables engine to be run faster than idling speed and to assist " warming up " without use of accelerator pedal.. Should not be used to control car speed when driving.

5 (E) **Starter Switch.** Operates a solenoid switch on starter motor. To operate—press button. (*See* " Starting Procedure," page 8.)
**Note :** An emergency push switch is fitted on front end of starter motor (press rubber cap).

5 (F) **Oil Pressure Gauge.** On starting engine from cold it will record 50-60 lb. per square inch. Normal oil pressure for warm engine is 30-40 lb. per square inch. Report immediately if the gauge either fails to register, does not record a steady reading or shows continuous low pressure.

5 (G) **Temperature Gauge.** Indicates working temperature of engine. Normal recording when engine hot, 160°–190° F. Report if engine is overheating.

5 (H) **Ammeter.** Records amount of current passing into the battery. Reading will vary according to condition of battery. Report if no charge is recorded when lamps are not being used.

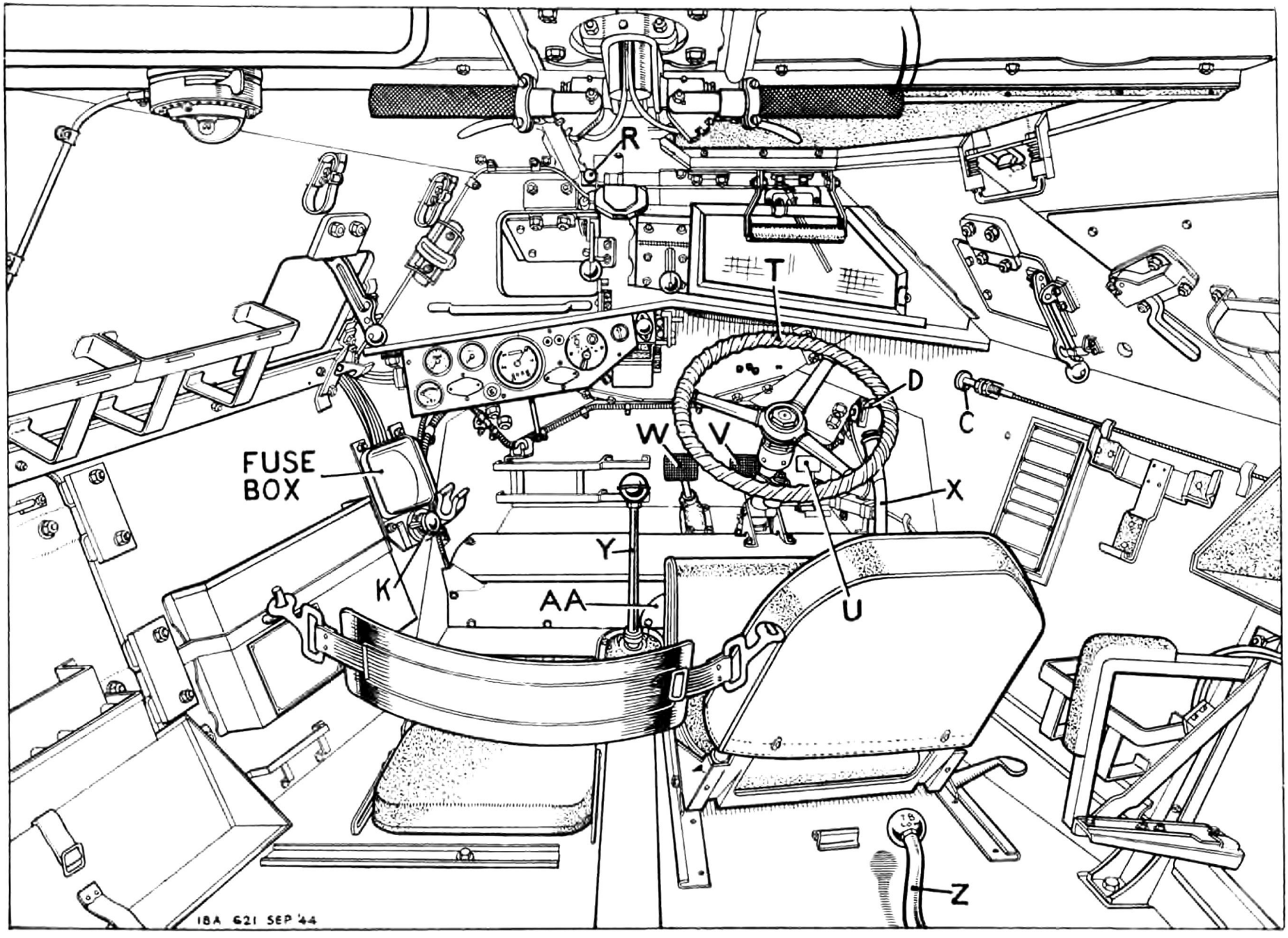



Fig. 3.—HULL, INTERIOR VIEW (FRONT).

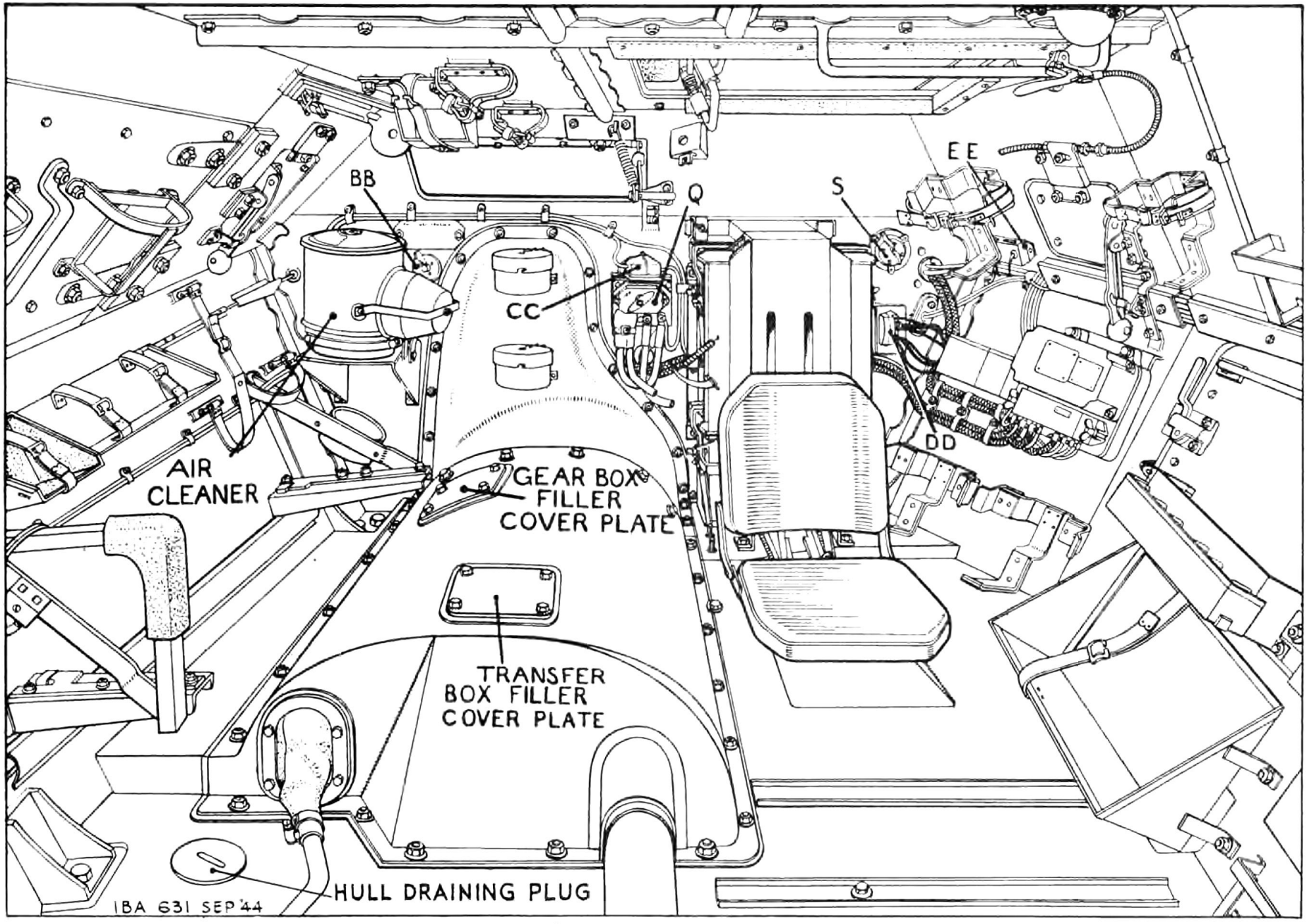



Fig. 4.—HULL, INTERIOR VIEW (REAR).

Fig.

5 (J) **Lighting Switch.** Has four positions, reading from right to left:—

OFF.
T. Tail lamp.
S. & T. Side and tail lamps.
ALL. Head, side and tail lamps.

3 (K) **Convoy Light Switch.** Controls tail and convoy lamps so that both cannot operate at the same time. Must be used in conjunction with lighting switch (J). When " OFF," lamps operate as indicated in (J). When " ON," the convoy lamp takes the place of the tail lamp in all three operative positions of the lighting switch.

5 (L) **Panel Light Switch.** Controls lamps concealed in the instrument panel. The switch is operated by a semi-rotary movement. " OFF " is the centre position, " DAY " lighting is obtained by turning the switch clockwise, and " NIGHT " lighting is obtained by turning the switch anti-clockwise.

5 (M) **Compass Light Switch.** Identical with panel light switch.

5 (N) **Inspection Lamp Sockets.** An inspection lamp with sufficient flexible cable to enable its use anywhere on the vehicle is included in the tool kit. Plug into the sockets when required.

5 (O) **Horn Switch.** Normal push type.

5 (P) **Speedometer.** Records mileage covered, total and trip, the latter in tenths of a mile, and the speed of vehicle in miles per hour. Trip mileage control lever is rotated to re-set to zero.

4 (Q) **Battery Master Switch.** Isolates battery from wiring circuit. Switch off when vehicle is parked. Useful in an emergency. Turn right for " ON," left for " OFF."

3 (R) **Windscreen Wiper Switch.** Pull out for " ON " and push in for " OFF."

4 (S) **Petrol Tap.** Turn to right for " MAIN," left for " RESERVE," and upright for " OFF." Main supply 17½ gallons—reserve supply 2 gallons. Total tank capacity 19½ gallons.

3 (T) **Steering Wheel.** This is not adjustable.

3 (U) **Accelerator Pedal.** Should be used with discretion, using the range of throttle opening to suit engine requirements, i.e. partial throttle will often assist acceleration more than full throttle. Always operate smoothly, not in jerky movements.

3 (V) **Brake Pedal.** Avoid violent and harsh braking. Use lower gear ratios when descending steep hills.

3 (W) **Clutch Pedal.** Operate decisively, using full range of travel. *Do not use pedal as a foot rest.*

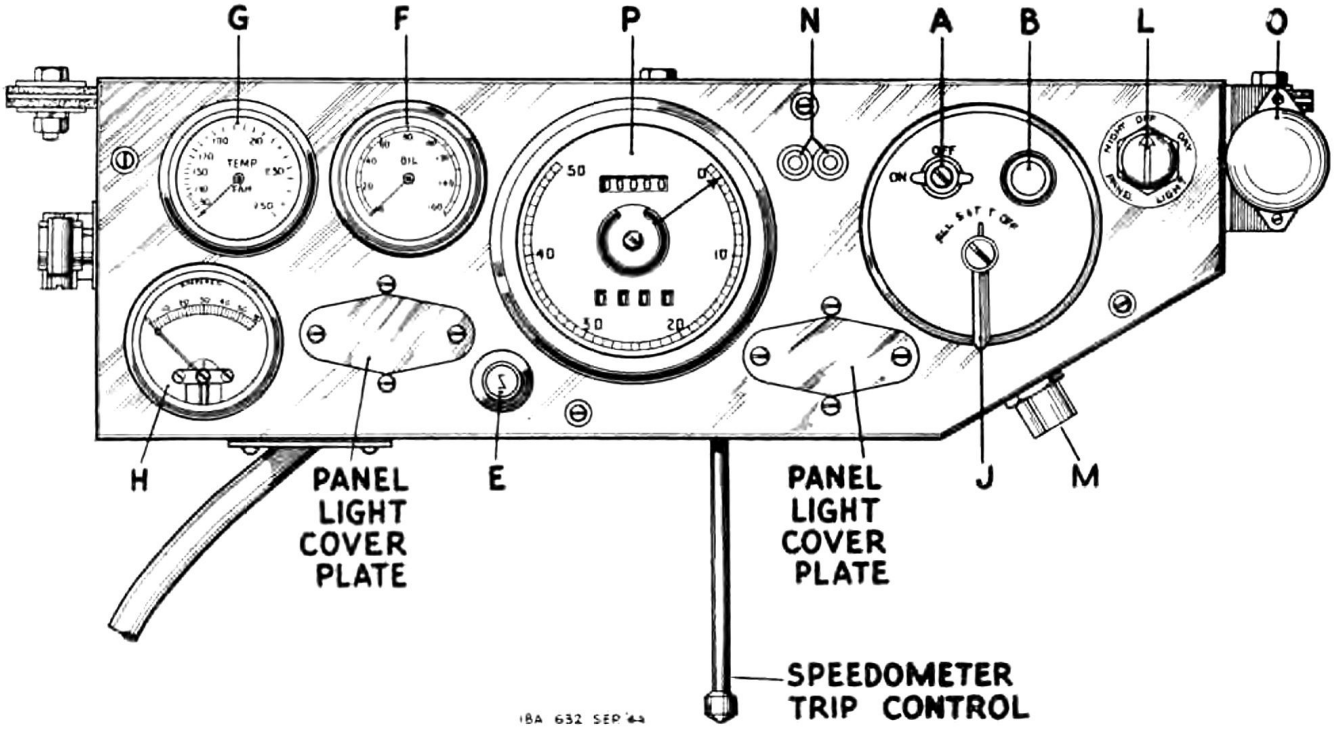



Fig. 5.—INSTRUMENT PANEL

## DRIVING CONTROLS—*continued*

Fig.

3 (X) **Hand Brake.** Use only for parking purposes. To release, press knob at top of hand grip, pull lever slightly rearwards and then, still pressing the release knob, push the lever forwards.

3 (Y) **Change Speed Lever.** The position of the gears is shown on the knob of the gear lever. Gear changing from 1st to 2nd, 2nd to 3rd and 3rd to top is assisted by synchromesh engagement of the gears, and it is only necessary to make a slight pause in the neutral position. Allow the engine speed to decrease when changing up, and to increase when changing down. It is only necessary to double declutch when changing down from 2nd to first gear, *see* driving instructions, page 10.

3 (Z) **Transfer Box Lever.** Controls the transfer box, which provides :—

(*a*) Rear-wheel drive operation at normal gear ratio, or

(*b*) Four-wheel drive, operating through a lower gear ratio. Push down for rear-wheel drive, pull up for four-wheel drive. (*See* " Driving Instructions," page 10.)

**Note :** All main gearbox ratios can be used both for four- and two-wheel drive.

## STARTING INSTRUCTIONS

Before starting up the engine the following points must receive attention.

Examine and, if necessary, rectify :—

1. Water level in radiator. (*See* page 21.)
2. Engine oil level.
3. Petrol level in tank.
4. Tyre pressures. (*See* page 30.)

Set petrol tap to " MAIN " position.
Turn battery master switch " ON."
Check that gear lever is in " neutral " position. It should be possible to rock the lever sideways.
Set hand throttle to fully closed position.
See that hand brake lever is ON.
If vehicle has been standing for more than four or five days, operate petrol pump priming lever in order to make sure that carburetter float chamber is full. (*See* page 16.)

### Normal Weather Conditions—Engine Cold

Switch on ignition, noting that warning light glows.
Pull carburetter starting device (choke) control knob out to first stop.
Do **not** touch the accelerator pedal.
Press starter switch button.
As soon as the engine starts, release the starter switch and open the hand throttle by moving the lever through approximately one-third of its travel.
After approximately thirty seconds' running, push the starter carburetter control back to the closed position.

### Extreme Cold Conditions—Engine Cold

Insert the starting handle and turn the engine over by hand to free the engine.
Switch on ignition.
Pull carburetter starting device (choke) control knob out to first stop, turn it half left and pull again to further stop.
Do **not** touch the accelerator pedal.
Press starter switch button.
As soon as engine starts, release starter button and push the starter carburetter control back to the mid-way position, *i.e.* first stop.
Open the hand throttle by moving the lever through approximately one-third of its travel.
After approximately sixty seconds' running, push the starter carburetter control back to the fully-closed position.

### All Weather Conditions—Engine Hot

Starter carburetter control should be fully closed, i.e. in the normal running position.
After switching on ignition, slightly depress accelerator pedal and press starter button.
Release starter button as soon as engine fires.

**Note :** If the engine does not start after using the starter motor continuously for eight seconds, release the starter button, wait a few seconds, then press the starter button for a further eight seconds. Should the engine fail to start after three or four attempts, check over the items as instructed below.

The control knob for the starter carburetter has three definite positions. Fully in. First stop out. Second stop out. It must not be used in any intermediate position.

## STARTING FAULTS, AND TREATMENT

When the engine fails to start this may be due to faulty petrol supply, air leak in the induction system, or a fault in the ignition circuit.

Faults due to sticking valves, loss of compression, incorrect valve or ignition timing cannot be dealt with by the crew and must be reported.

The following remarks deal only with the usual simple faults that may be dealt with by the crew, and will assist the crew to make a clear report concerning the failure of the engine to start.

**Weak Battery**

Should the starter motor fail to turn the engine easily, try starting the engine by means of the starting handle. Do not exhaust the battery by use of the starter motor.

If the engine is cold operate the starter carburetter control as described on page 8. Turn the engine steadily about six complete revolutions until gas is drawn into the cylinders. Switch the ignition on. Pull the starting handle upwards smartly. Continue the quick pull up of the starting handle several times if the engine fails to start at once. Take care not to over choke the engine.

**Test of Petrol Supply to Carburetter**

Turn the petrol tap to the reserve position. Remove the bolt securing the petrol pipe union to the carburetter. Blow all dirt away from the filter positioned round this bolt. The engine must not be hot while the following operation is carried out or fire may result. If possible place a cleaning cloth under the petrol pipe union where it is disconnected. Operate the hand priming lever on the petrol pump (if the camshaft is preventing this lever from operating the pump, turn the engine one revolution) and if petrol is being pumped correctly, it will issue in a good spurt from the disconnected banjo union at each movement of the priming lever. Wipe away all surplus petrol immediately. Refit the filter and sealing washers and tighten the banjo union bolt. Should the pump fail to deliver petrol to the carburetter, check level of petrol in the tank and if this is correct report failure of petrol supply.

If the petrol supply is found correct proceed as follows.

**Test for High Tension Current at Plugs**

Remove the H.T. cable from any plug, place it so that the terminal is $\frac{1}{8}$ inch from any metal part of the engine. Switch the ignition on. Turn the engine by means of the starting handle. A regular spark should occur at each alternate revolution of the engine. Increase the spark jump by moving the terminal until it is $\frac{1}{4}$ inch from the engine casting to prove the supply of a suitable H.T. current from the distributor.

Failure of sparking to occur at the H.T. cable terminal may also be due to the inner surface of the distributor or the rotor, becoming covered with a conducting film or dampness. These surfaces must be clean and dry.

If correct, proceed as follows.

**Test Spark Plug Gaps and Cleanliness**

Plugs having the internal insulation covered with oil or carbon are not likely to cause complete failure of the engine to start, but it may be advisable to remove all plugs to ensure that these are clean and the insulation sound. Clean the plugs, check the spark gaps and reset them if necessary to .018 inch–.020 inch.

If correct, proceed as follows.

**Test for the Opening and Closing of Contact Points**

When no spark occurs at the terminal of the spark plug cable, it is necessary to test the low tension circuit for fault.

Remove the two screws securing the distributor cover (not the two locked screws, *see* Fig. 14) and lift this off, placing it if possible with the centre brush near some earth point on the engine to prevent a flash over occurring. Remove the inspection lamp from its bracket in the fighting compartment and plug it into the sockets on the switchboard to ensure that the bulb lights satisfactorily. Switch the ignition on. Place the inspection lamp terminals so that one makes contact with the low tension terminal of the distributor, while the other terminal makes contact with the condenser body. Turn the starting handle to rotate the engine. If the inspection lamp lights and goes out completely in regular sequence, it is proof that the contact points are opening and interrupting the low tension current correctly.

Should the lamp remain alight the whole time or almost the whole time that the engine is being turned it indicates incorrect contact gap or dirty contact point faces. *See* page 22.

If the lamp does not light proceed as follows.

**Test for Low Tension Current at Distributor**

Remove the low tension wire from the distributor terminal. With the ignition switched on, make a momentary contact between a clean part of the metal body of the distributor and the low tension cable. A good snappy spark should occur. Refit low tension terminal and distributor cover. Report break in the low tension circuit if no spark occurs.

**Test Induction System for Leakage**

Check that all bolts and nuts securing the carburetter to induction manifold and the manifold to the cylinder block are tight. Observe if the packings between these faces are in position correctly and appear in sound condition. Oil placed on the edge of these packings will be drawn in at the point of any air leak as the engine is rotated quickly.

In the preceding pages, brief descriptions have been given of the driver's controls and instruments, together with detailed instructions for starting up the engine, and the driver should be fully conversant with these features before attempting to operate the vehicle.

At this stage it is essential for the driver to understand quite clearly the conditions governing the use of **rear-wheel only** and **four-wheel drive.**

**FOUR WHEEL DRIVE MUST NOT BE USED ON MAIN ROADS or other similar surfaces providing good adhesion to the tyres. Use of four-wheel drive under these conditions will cause damage to the transmission.**

Four-wheel drive is necessary only on loose surfaces, rutted tracks, and similar conditions liable to be encountered in cross-country driving. In deep snow or on ice it will also be beneficial.

### Driving Away

Assuming that the engine has been started up :—

Check that oil pressure is recorded on the gauge, and that the ammeter is recording " charge."

See that hand throttle is closed.

Fully depress clutch pedal.

Engage suitable transfer box gear—press lever down to fullest extent for two-wheel drive ; pull upwards to fullest extent for four-wheel drive.

Engage the desired gear in main gearbox by pushing gear lever in the direction indicated by the markings on the knob. (1st for up gradient, 2nd for level, 3rd for down hill, or reverse if necessary.)

Release the hand brake lever.

Gradually release the clutch pedal and, at the same time, gently depress the accelerator pedal, when the vehicle will commence to move. This operation should be practised until it is carried out in such a way that the drive is taken up smoothly, as violent, jerky starts are detrimental to the transmission.

### Gear Changing—Up

A higher gear ratio should be engaged as soon as the vehicle is moving forward easily and the engine shows no signs of labouring.

When changing from 1st to 2nd, 2nd to 3rd or 3rd to top it is unnecessary to double declutch as these gears incorporate synchromesh, enabling easy gear engagement, but, although double declutching can be used on all gears if preferred, the following sequence of operations should be observed :—

Release the accelerator pedal.
Depress the clutch pedal.
Move the gear lever into " neutral."
Pause.
Move the gear lever into the required gear.
Gradually release the clutch pedal and at the same time accelerate gently and smoothly.

### Gear Changing—Down

As soon as the engine shows signs of being overloaded, *i.e.* when climbing steep hills, etc., a lower gear should be selected. An experienced driver will study the ground over which he is travelling and change down before the engine commences to labour and the road speed drops too low.

When changing down from top to 3rd, or 3rd to 2nd, double declutching is unnecessary and the procedure is as follows :—

Depress the clutch pedal.
Move the gear lever into neutral.
Pause.
Move the gear lever into the gear required.
Release the clutch pedal.

No mention has been made of the accelerator pedal as it is only necessary to ease the pedal pressure and not remove the foot from it. This, when the clutch pedal is depressed, will enable the engine speed to increase so as to synchronise with the speed of the gearbox, and a smooth engagement will result, bearing in mind that owing to the weight of the vehicle, the necessary increase in engine revolutions is very small in the lower gears.

Changing from 2nd to 1st necessitates double declutching, the procedure, which differs slightly from that of changing up, being as follows :—

Release the accelerator pedal.
Depress the clutch pedal.
Move the gear lever into neutral.
Release the clutch pedal.
Momentarily depress and release the accelerator.
Depress the clutch pedal.
Move the gear lever into 1st gear.
Gradually release the clutch pedal.

The extent of acceleration required during the operation varies according to the speed of the vehicle before the change is made, but, generally speaking, it should be sufficient to increase the engine speed by approximately 50 per cent.

The above movements must be practised to obtain perfect timing, and each operation with foot or hand clearly defined, with a distinct pause when the gear lever is in neutral.

Practise until a smooth, noiseless change can be obtained instinctively.

### Gear Changing—Reverse

Reverse gear should **never** be engaged when the car is moving forwards. The car must always be at a standstill.

Before engaging the gear the driver is well advised (providing that circumstances permit) to open the rear observation hatch, as this will considerably facilitate any reversing movement.

When moving the gear lever in " neutral," additional pressure is required to overcome the resistance of the reverse stop spring. This is fitted as a safety measure to prevent accidental engagement of reverse gear when the vehicle is travelling forwards and a gear change is being made.

The use of reverse gear for prolonged distances should be avoided wherever possible, and, generally speaking, it should be a rule never to exceed 200 yards.

**Four-Wheel Drive.** (Use of the Transfer Box Lever.)

As has been mentioned previously, four-wheel drive must only be used on soft or cross-country surfaces.

The car speed should be reduced to 10 m.p.h. or less, in 1st gear. Double declutching is necessary, the engine speed being increased when changing into four-wheel drive and decreased for two-wheel drive engagement.

Push lever down for two-wheel drive.

Pull lever up FULLY for four-wheel drive.

**When Travelling :—**

Do not use hand throttle to control car speed.

Do not use the clutch pedal as a foot rest.

Do not hold the clutch pedal out to coast.

Engage low gear when descending steep hills or negotiating very rough country.

**Stopping**

Release the accelerator pedal and apply pressure to the brake pedal gently but firmly.

When the speed of the car is reduced to walking pace, depress the clutch pedal and move the gear lever into neutral. When the car is stationary, apply the hand brake and switch off ignition.

Avoid harsh braking wherever possible.

**Leaving the Vehicle**

Before leaving the vehicle, switch off the main battery switch.

Ensure that the hand brake lever is " on," and the gear lever in neutral.

Close all hatches; **don't leave the vehicle without taking a door key.**

When parking on a steep gradient, chock or wedge one of the wheels, additionally to putting on the hand brake.

## FROST PRECAUTIONS

It is MOST IMPORTANT that precautions be taken to prevent freezing of the liquid contained in the engine cooling system during cold weather.

The efficiency of this system depends upon the circulation of coolant, as the heat must be conducted from the engine to the radiator. It is, therefore, disastrous if the coolant, which should be circulating, is frozen.

Furthermore, water expands as it freezes, and in consequence will crack the radiator, cylinder block or pipes. Then when the ice is melted, the system will leak badly and need a major overhaul to put it right again. To prevent such trouble, one of the following methods can be adopted.

(1) Use an anti-freeze solution.

(2) Drain the cooling system completely.

(3) Run the engine periodically.

### 1. Use of Anti-freeze

The coolant is made into an anti-freeze solution by adding ethylene-glycol to the water. The proportion of ethylene-glycol to water is 1 : 2 for temperatures down to 4° Fahrenheit.

Ethylene-glycol has a much greater searching action than water and for this reason it is most important to keep all joints in good condition.

To fill up with anti-freeze solution, first drain the cooling system as described in Chapter 1 A, Page 21.

See that all joints are properly tight.

Prepare the solution in separate containers, using proportions of one part of Ethylene-glycol to two parts of water and mix thoroughly. Close the radiator drain tap and pour the prepared coolant into the radiator header tank until the bottom is just covered. Start the engine and run it (without racing) until the coolant is warm. Then top up to the correct level, so avoiding waste by overflow due to expansion. NEVER TOP UP COLD.

After the system has been filled with anti-freeze coolant, the strength of the coolant solution must be maintained by topping up, when necessary, with anti-freeze solution. The system must not be topped up with water only, as this reduces the degree of protection afforded.

When the cooling system has been filled with anti-freeze coolant, a RED CIRCLE must be painted round the header tank filler cap. This mark will be painted out if the cooling system is drained and not refilled with anti-freeze.

**When using anti-freeze coolant do not drain the cooling system in cold weather.**

Should it become necessary to drain the cooling system for repairs, the anti-freeze solution must be collected in suitable containers for subsequent refilling of the system.

### 2. Draining the Cooling System

When anti-freeze is not available, DRAIN THE COOLING SYSTEM COMPLETELY WHEN PARKING.

If there is no water supply near, collect and keep the water drained off for re-use.

When all water has been drained off, run the engine for one minute and stop it.

**Leave a notice on the vehicle that the cooling system is empty.**

Should this be overlooked and the engine started up, seizure will quickly occur. If, however, the mistake is discovered before seizing, stop the engine and LET IT COOL DOWN BEFORE POURING IN THE COOLANT.

When filling up after the cooling system has been drained, bring the water to the engine. Close the drain tap, free the engine by hand, then start the engine. Fill the cooling system IMMEDIATELY with water, keeping the flow as continuous as possible.

Warm up the engine by running it fairly fast, BUT DO NOT RACE IT.

### 3. Running the Engine Periodically

If it is impossible to secure anti-freeze, and the vehicle must be ready for immediate use, freezing of the coolant can be prevented by periodical running of the engine. To do this, run the engine at a fast speed for periods of five minutes at intervals dependant upon the severity of the cold. DO NOT RACE THE ENGINE.

This also applies to vehicles which are halted temporarily.

**Under conditions of severe cold, be sure to change the lubricants as indicated on the lubrication chart.**

## FIRE PRECAUTIONS

One Pyrene (Carbon-Tetrachloride) extinguisher is mounted on the sloping roof plate, on the right side behind the driver.

One Methylbromide extinguisher is mounted on the left-hand rear mudguard. Later vehicles will have this mounted behind the tool locker on the right-hand front mudguard.

Precautions against fire are of the utmost importance, and the crew must minimise the danger of fire by regular attention to the general cleanliness of the vehicle and particularly to leakages of oil or fuel.

Both extinguishers are suitable for use on fires caused by electrical equipment.

### Fire Prevention

1. Petrol will be turned off before any adjustments are made to the petrol system.
2. The ignition and the battery master switch will be switched off before any adjustment is made to the electrical equipment, wiring circuits, wireless, or to the petrol system.
3. The draining of petrol tanks will be supervised by an N.C.O., who will be responsible that adequate fire precautions are taken, including turning off the petrol before the container being filled is full, and the immediate covering of any spilled petrol with sand or earth. Containers used for draining will be removed from the vicinity of the vehicle as soon as they are filled.
4. The use of petrol for cleaning engine or other parts, or for washing down, is forbidden.

### Pyrene

This extinguisher held to the sloping roof plate by a spring clip, is operated by a double pumping action, after turning the handle to the left to free it from the locked position.

Its use is chiefly for small internal fires. Any quantity of liquid may be pumped onto the fire until the extinguisher is exhausted. The gas produced when the liquid contacts the fire is two-and-a-half times heavier than air and the personnel dealing with an outbreak of fire should be outside the vehicle, and in such a position that any wind will carry the fumes away from them. Every effort should be made to avoid inhaling the fumes by keeping well above the fire or ground level.

Immediately an extinguisher has been used it must be refilled or exchanged for a full one, and when the fire is extinguished and danger of a further outbreak removed, the vehicle must be thoroughly cleaned until all trace of Carbon-Tetrachloride has been removed.

### Methylbromide

This extinguisher is held outside the vehicle in a clip secured by a quick release toggle clamp. It is necessary for personnel to make themselves thoroughly used to its location and the method of removing it from the bracket.

This extinguisher is operated by striking the brass knob on the ground, or on the vehicle and directing the jet of spray now coming from the nozzle of the extinguisher onto the fire. IT IS MOST IMPORTANT THAT THE NOZZLE MUST POINT AWAY FROM ANY PERSON as the gas given off is highly dangerous.

Personnel must keep well above the fire or ground level as this gas is three-and-a-half times as heavy as air, and they should be in the position where any wind will carry the fumes away from them. Never use the extinguisher in a confined space.

This extinguisher when once operated gives off a jet at high pressure approximately 15 feet long for about one minute, and this continues until the extinguisher is exhausted.

The Methylbromide extinguisher is very effective in putting out fires supported by oil or petrol, it excludes the oxygen necessary to support combustion, by forming a gas blanket which sinks down onto the fire.

This extinguisher cannot be refilled except by special equipment and a replacement must be obtained immediately.

### Note the following points

1. Make yourself familiar with the position of both fire extinguishers, and how to remove and operate them.
2. The operation of the Pyrene extinguisher can be stopped when required.
3. The operation of the Methylbromide extinguisher CANNOT BE STOPPED until it is exhausted.
4. Never operate a fire extinguisher while you are inside the vehicle.
5. Always be in the position where fumes are blown away from personnel.
6. Avoid breathing any fumes and keep as high as necessary to avoid the low concentration of gas from the extinguisher.
7. Report any fire immediately it has been dealt with.
8. Immediately after any fire secure a replacement extinguisher, or refill the pyrene type where this is possible.
9. Use the Methylbromide extinguisher at once on any petrol or oil fire which may assume serious dimensions.

# VEHICLE DATA

| | |
|---|---|
| Weight of vehicle (laden and 2 men) .. | 7,803 lbs. |
| Crew .. .. .. .. .. .. | Two men |
| Armament : | |
| Bren .. .. .. .. .. | Mounted on roof |
| Thompson sub machine .. .. | Stowed |
| Ammunition : | |
| Bren .303 .. .. .. .. | 990 rounds |
| Thompson .. .. .. .. | 200 rounds |
| Smoke bombs, hand grenade type .. | 9 rounds |
| Wireless set .. .. .. .. .. | No. 19, Mark III |
| Overall length .. .. .. .. .. | 12 ft. 7 in. |
| Overall width .. .. .. .. .. | 6 ft. 2½ in. |
| Overall height .. .. .. .. .. | 6 ft. 11¼ in. |
| Wheel base .. .. .. .. .. | 7 ft. 6¾ in. |
| Wheel track .. .. .. .. .. | 5 ft. 1 in. |
| Ground clearance (laden) .. .. .. | 9½ in. |
| Fording depth .. .. .. .. | 3 ft. |
| Engine (Humber) .. .. .. .. | 6 cylinder, petrol, S.V. |
| Bore .. .. .. .. .. .. | 85 mm. 3.35 in. |
| Stroke .. .. .. .. .. .. | 120 mm. 4.72 in. |
| Governed R.P.M. .. .. .. | 3,100 r.p.m. |
| B.H.P. .. .. .. .. .. | 87 b.h.p. at 3,300 r.p.m. |
| Fuel capacity .. .. .. .. .. | 19½ galls. (including 2 galls. reserve) |
| Fuel consumption (road) .. .. .. | 11 m.p.g. |
| Maximum speed (road) .. .. .. | 57–61 m.p.h. |
| Gear box .. .. .. .. .. .. | 4 forward speeds and one reverse. Synchromesh engagement for 2nd, 3rd and 4th. |
| Transfer box .. .. .. .. .. | 1.477 reduction for F.W.D. only |
| Clutch .. .. .. .. .. .. | Single dry plate |
| Steering .. .. .. .. .. .. | Worm and nut |
| Suspension (front) .. .. .. .. | Independent front wheel suspension, by normal single transverse spring. |
| Suspension (rear) | Normal semi-elliptic springs. |
| Shock absorbers .. .. .. .. | One double acting hydraulic type fitted to each wheel suspension point. |

# *CHAPTER IA*
# THE POWER UNIT
## *Part I*
## THE ENGINE

The engine is a six cylinder side valve type.

The cylinder block and detachable cylinder head are cast iron, and the head is secured by 22 nuts, the joint being sealed by a copper asbestos gasket.

Small lugs cast on the side of the head are to assist in breaking this joint when necessary.

It is possible to fit new gaskets to the exhaust and induction manifolds without removing the manifolds from the exhaust pipe, by unscrewing the nuts securing the manifolds to the cylinder block and carefully pulling the manifolds away from the block. The induction manifold drain tap B (Fig. 9) remains open in all normal conditions.

Two plates covering the valve chest at the right side of the engine can be removed to facilitate valve adjustments. This adjustment to the valves is further assisted if the exhaust and induction manifolds are also removed complete. (First see note on two-speed dynamo control unit, page 45.)

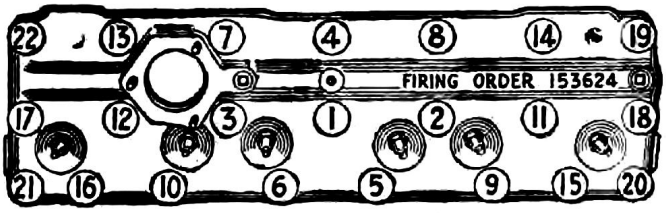



Fig. 7.—CYLINDER HEAD NUTS.
Order for tightening.

The engine is supported at the rear end by rubber blocks from the rear cross member of the chassis, while the gear box forming the engine front support is also mounted on rubber blocks.

It is essential that the engine is kept clean so that any leakage of oil or fuel is quickly apparent, and also to facilitate maintaining all screwed connections of the engine and its accessories tight.

Care must be taken not to damage the small metal tubes from the thermostat in the cylinder head and the oil pressure gauge on the right side of the engine. It is impossible to repair these when damaged.

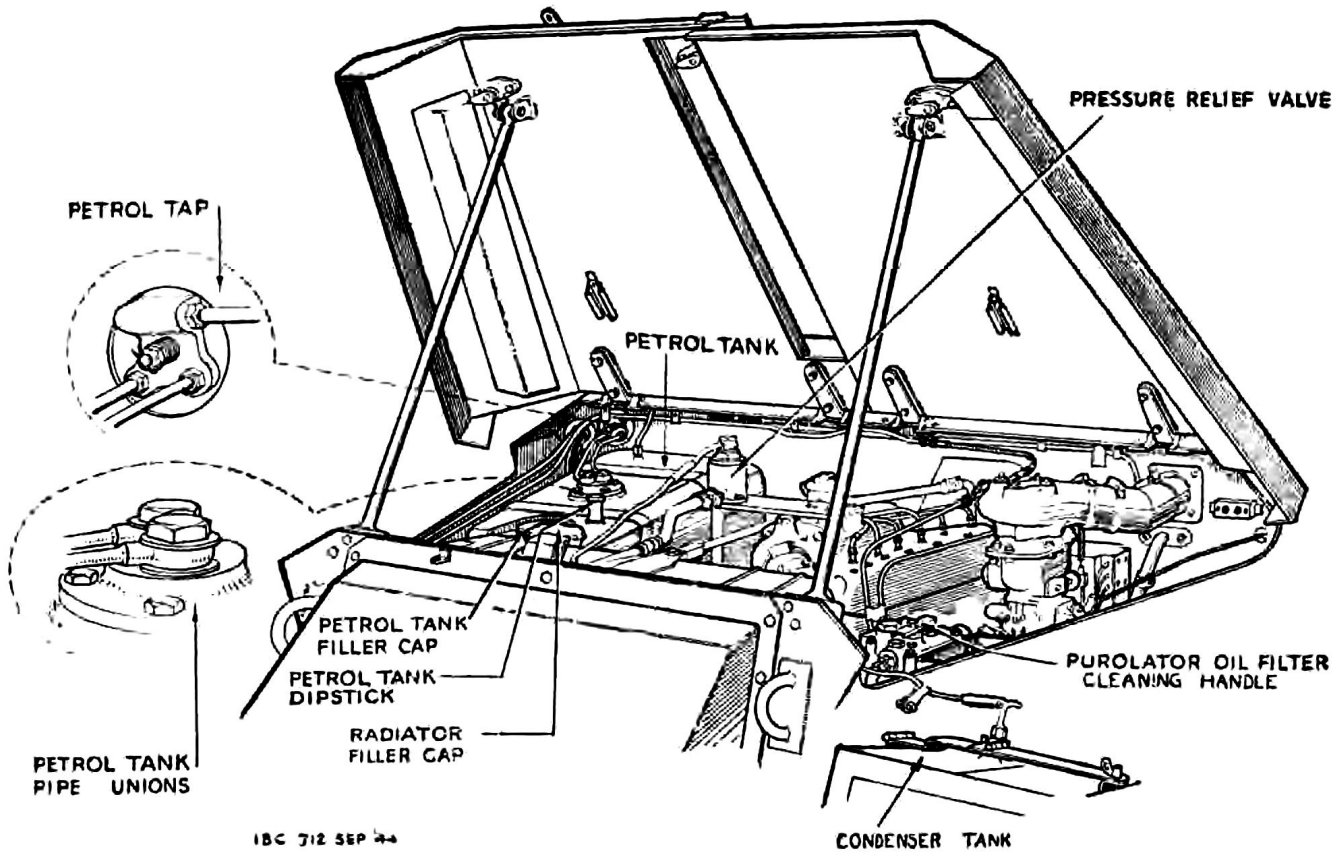



Fig. 6.—ENGINE COMPARTMENT ACCESS.

**Maintenance.** (In accordance with the crew maintenance insert to A.B. 413.)

A thorough examination must be made regularly to ensure that all bolts or nuts are secure, and that every part is in a sound condition. Rectify, or report any such defect as may be necessary. Cylinder head nuts should be checked for tightness in the order shown in Fig. 7.

To gain access to the engine lift the two top engine cover plates, secure these firmly by locating the support rods in the holes provided. (Fig. 6.)

An engine that is maintained in a clean condition requires less maintenance time, it is more easily inspected and improved operation is assured.

### The Exhaust System

Check all bolts or nuts securing the exhaust manifold to the cylinder block and exhaust pipe. Inspect the packings at these points, and report if they require attention.

Inspect the exhaust pipe to ensure that it is sound and making a good connection with the silencer.

Check the fixing of the silencer, its flexible connections must be firmly locked at all four points to the rear cross member of the chassis. (A. Fig. 24.)

Rectify, or report any defect. Observe if there is any leakage of exhaust gas when the engine is running.

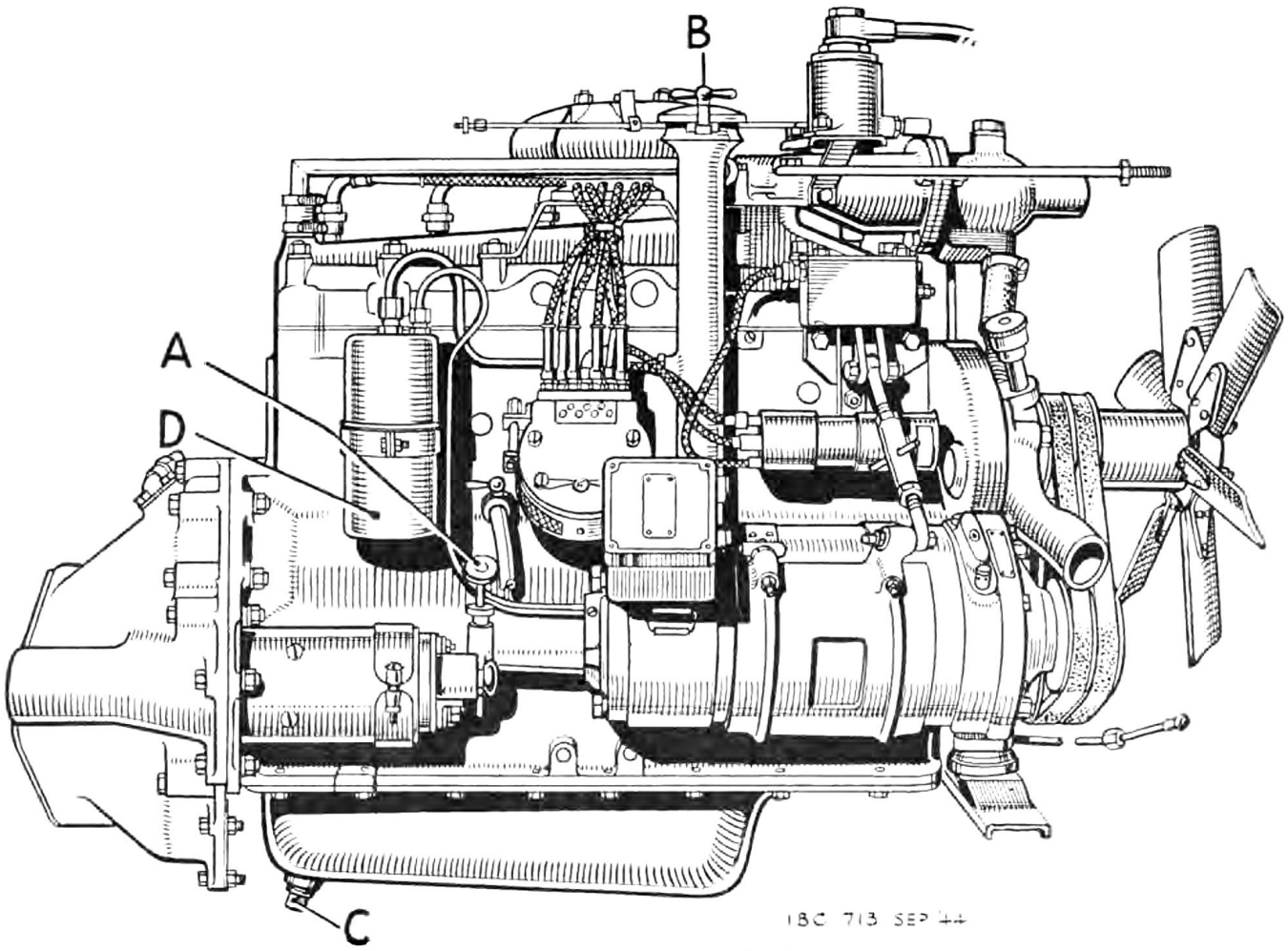



Fig. 5.—ENGINE, LEFT SIDE VIEW.

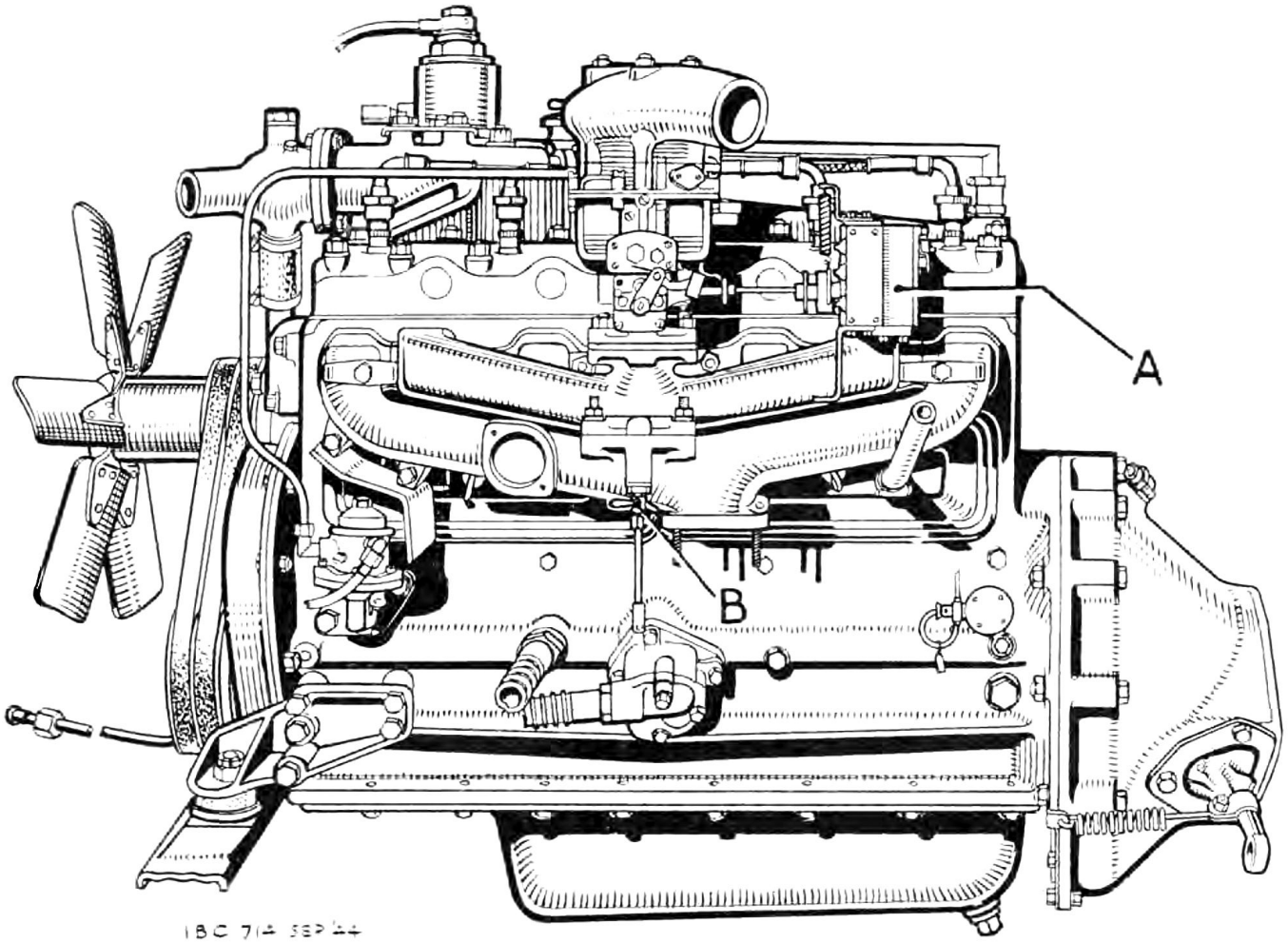



Fig. 9.—ENGINE, RIGHT SIDE VIEW.

## *Part II*

## THE CARBURETTER

Maintenance consists only in ensuring that all connections are tight, that there is no leakage of petrol, and regular cleaning of dirt, etc. from the filter and inside the float chamber. The jets should be cleared of any stoppage when this is necessary, they should not be interfered with otherwise.

**Before making any adjustment to the carburetter, read the notes relating to the two-speed control Box.** Page 41.

Regularly check that the two nuts securing the carburetter to the induction manifold are tight and that the packing is in good condition.

The six screws retaining the top cover must be tight.

All petrol pipe connections must be kept tight and free from leaks.

### The Petrol Filter

Clean this filter regularly as follows:—

1. Unscrew the banjo union bolt (a fibre washer is fitted at both joint faces).
2. Withdraw the bolt and filter from the union, and remove the filter from the bolt.
3. Clean the filter gauze thoroughly with petrol or compressed air.
4. Examine the fibre washers and renew any that are faulty. Replace the washers and filter in correct position to the banjo union, then tighten the bolt securely.
5. Operate the hand primer lever on the petrol pump, until the carburetter is full. Check for leakage.

### The Float Chamber

The twin float chamber requires regular cleaning, and this may be done as follows :—

1. Hold a large cleaning rag adjacent to the main jet so that it will absorb all petrol flowing from this point.
2. Remove the main jet. (Fig. 10.)
3. Flush the float chamber out with petrol by operating the priming lever of the petrol pump.
4. Replace the main jet and its fibre washer securely.
5. Fill the carburetter with petrol—using priming lever on the pump—and check for petrol leakage.

### Jets

In the event of any jets becoming choked, remove and clean them as follows :—

1. Unscrew the main jet, starter petrol jet, and the pilot jet.
2. Remove the air cleaner attachment from the top of the carburetter—four nuts and two hose clips—and then unscrew the air correction jet.

   **Note :** Under no circumstances should wire or other probe be used for cleaning any jets.
3. Thoroughly clean all jets by blowing compressed air through the hole in each jet.
4. Replace all jets securely. Ensure that all fibre washers are sound and replaced correctly. Replace air cleaner connections.

Do not interfere with the carburetter unduly. Unskilled attention may cause trouble.

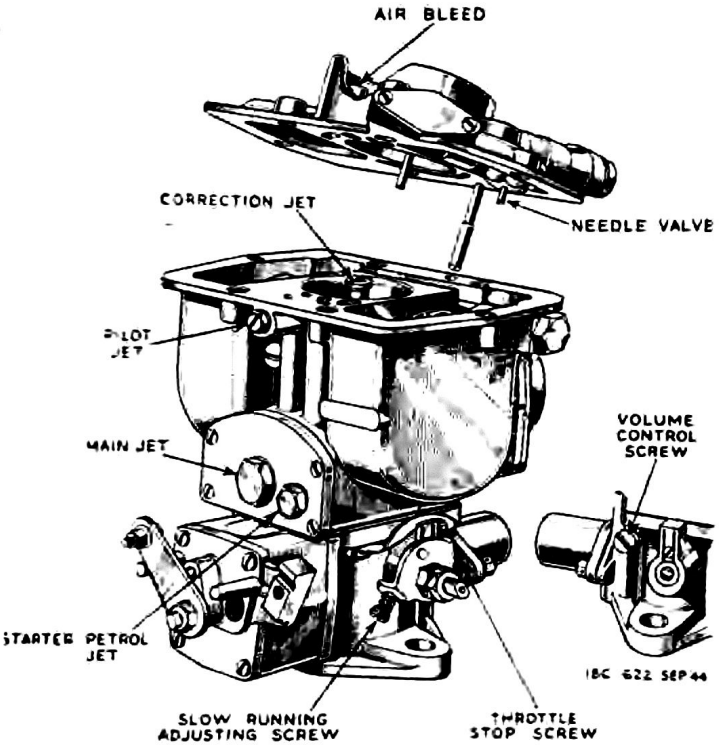



Fig. 10.—CARBURETTER.

## *Part III*

## THE AIR CLEANER

**(See Figs. 4 and 11)**

The air cleaner is mounted on the right-hand side of the fighting compartment and is connected to the carburetter intake by means of a flexible tube clipped in position.

Thus, all air entering the carburetter is filtered and cleaned.

This air filter is of the oil bath type and requires cleaning regularly under normal conditions. *See* A.B. 413 crew maintenance insert.

If the vehicle is being used under exceptionally severe conditions or over very dusty ground, the filter will require attention at more frequent intervals, dependent on actual usage.

### To Clean the Air Cleaner. (Fig. 11)

Proceed as follows :—

1. Remove the top cover after slackening the retaining nut (A) with the fingers.
2. Turn the filter element wing nut (B) and unscrew anti-clockwise to its fullest extent.
3. Move the retaining bridge (C) round until it can be disengaged from the slots in the filter body flange.
4. The element (D) can now be lifted out.
5. Wash the element thoroughly in petrol or paraffin.
6. Lift out the oil container (E), pour away the oil and clean out the sediment. **Do not use fluffy rags.**

### To Reassemble

1. Replace the oil container (E) and refill with engine oil (for correct grade see Lubrication Chart), up to the oil level marking. (**Do not overfill.**)
2. Replace the filter element (D). (Make sure that the wing nut (B) is unscrewed fully anti-clockwise) and engage the retaining bridge (C) with the slots.
3. Move the bridge round until it is at right angles to the slots, then turn the wing nut (B) clockwise until it is finger-tight only.
4. Replace top cover (A) and tighten the nut fully finger-tight only.

**IMPORTANT: Make sure that all cork gaskets are in good condition and are face fits.**

The centrifugal cleaner attached to the side of the main filter automatically discards dust and does not require cleaning. The only point to watch is to see that the dust discharge slots do not become choked by large pieces of foreign matter, such as dead leaves, etc.

### Crankcase Ventilation

Filtered crankcase ventilation is provided by a pipe led from the valve compartment cover to the air cleaner.

1. Examine rubber tube for damage, perishing or leaks.
2. Tighten the clips as necessary.
3. Tighten bolts holding metal tube to the bulkhead if necessary.
4. Examine welded joints for fractures, and report if found damaged.

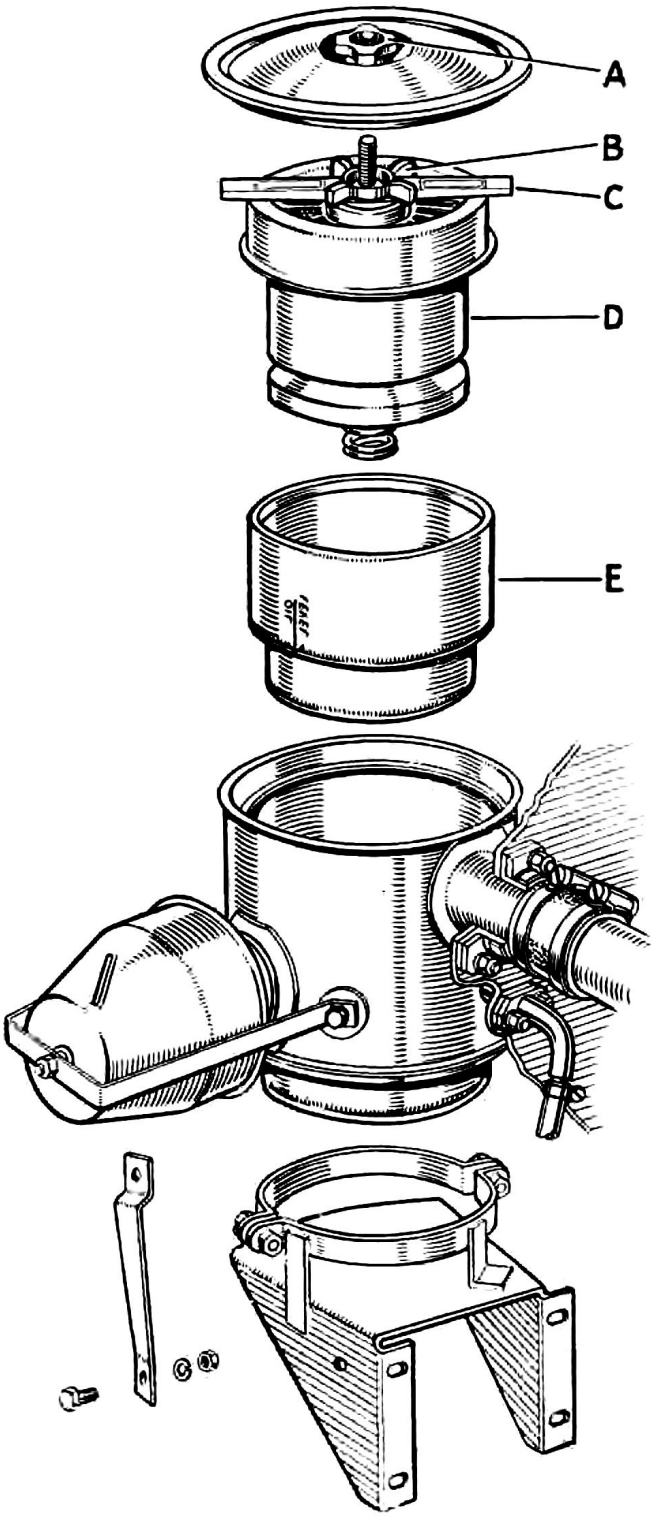



Fig. 11.—AIR CLEANER.

## *Part IV*

## THE FUEL SYSTEM

General maintenance is confined to inspection of the petrol tank, its holding down arrangements, and all petrol pipes and screwed joints.

The tank is held in position by two steel straps, each held securely by a bolt. The bottom end of each strap is hooked over a rib under each tank support bracket. The soft packings between the tank and supporting brackets and straps must be retained in position to prevent abrasion. Screwed joints which continue to leak when tightened normally, must be reported as faulty. Undue tightening will not be satisfactory.

### The Petrol Tap. (Fig. 12)

This is a 3-way tap mounted on the rear bulkhead in the driving compartment. There are three positions for the lever, "MAIN," "OFF" and "RESERVE."

**Maintenance.** (In accordance with Crew Maintenance Insert to A.B. 413).

1. Check that petrol is not leaking at points B.C.D. and E.
2. Check that the screwed joints A.B. and E. are tight.

Tighten screwed joints as necessary to maintain firm and leak-proof connections.

### The Petrol Tank Filter

A filter is incorporated in the tank filler neck, and all petrol must pass through this filter when filling the tank.

It is detachable for cleaning purposes; do this by using a screwdriver in the head of the screw secured in the centre of the filter base.

Clean it by washing in petrol or by the use of compressed air. Do not scrape it. It must be securely screwed in position when replaced.

### The Petrol Tank

Frequently examine the tank for signs of leakage, particularly at the welded ends. This should be done after returning from any severe cross country run.

Petrol may be drained from the tank when necessary by removing the plug from the tank bottom. Check for leakage when this plug is replaced and the tank is full.

### The Petrol Pump

Examine the pump for leakage of petrol as follows. The engine should be stopped and the hand priming lever on the pump operated until it becomes free, thus indicating that the carburetter float chamber and pump are filled.

**Note:** When the engine is stopped in a certain position the priming lever will not operate the pump, due to the rocker arm (D) (Fig. 43) resting on the high point of the cam (H) as illustrated.

In this case it will be necessary to turn the engine one complete revolution before the priming lever will operate the pump.

Inspect for petrol leakage at:—

1. The joint washer between the set bolt and top dome.
2. The joint between the pump body and top dome.
3. The drain plug.
4. The joint between top and bottom halves of the pump body.

Petrol leakage at 1 and 2 cannot be cured by unduly tightening the set bolt. It is essential to have undamaged joint faces and a sound gasket or washer at these points to ensure a good joint.

A leakage at 3 may be cured by tightening, or by fitting a new joint washer.

A leakage at 4, when all the screws connecting the top and bottom halves are tight, will require a replacement pump.

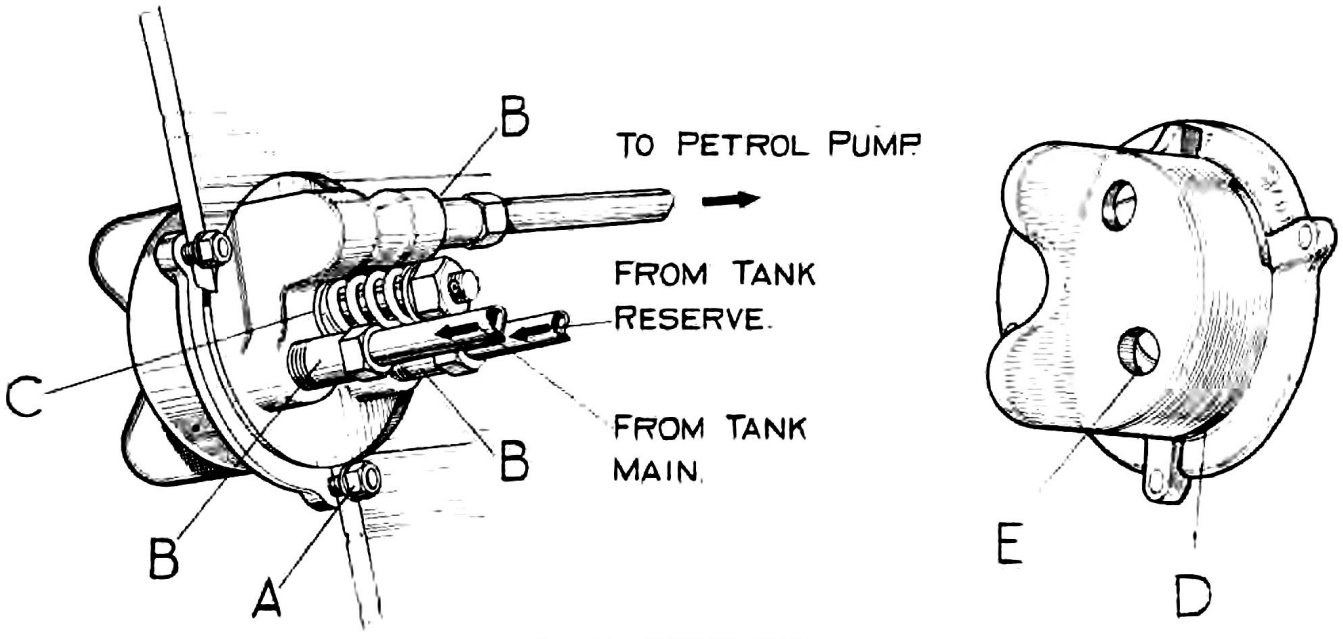



Fig. 12.—PETROL TAP.

### Petrol Pump Filter

To clean the pump filter gauze, proceed as follows :

1. Unscrew the set bolt securing the top dome.
2. Remove set bolt, washer, top dome and filter gauze. Take care not to damage the sealing gasket, fibre washer, or joint faces.
3. Clean the filter gauze with petrol or compressed air.
4. Remove the drain plug and fibre washer, and clean any sediment from the petrol chamber. Take great care not to allow any dirt to fall on the pump valves. (*See* Fig. 43.)
5. Replace the drain plug and gasket securely.
6. Carefully refit the filter gauze in its correct position. Observe that the joint faces of the top dome are flat and clean and the gasket is sound. Fit it in position, and replace the set bolt and fibre washer, then tighten this bolt, but not unduly.
7. Operate the priming lever until the carburetter is full, then inspect for any leakage.

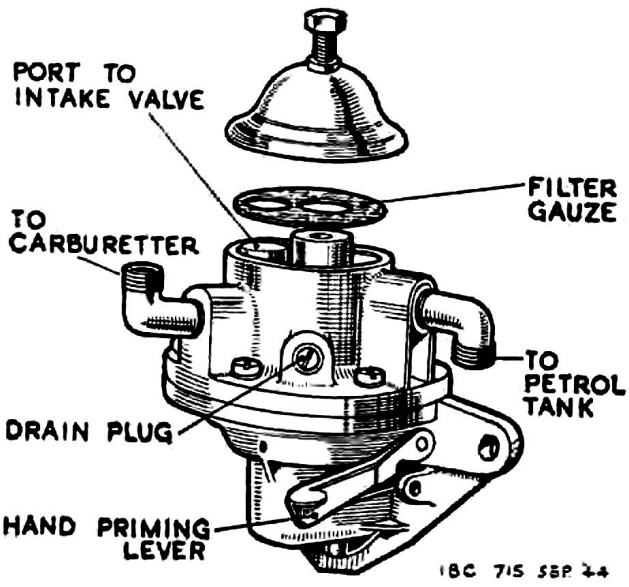



Fig. 13.—PETROL PUMP.

## *Part V*

## THE LUBRICATING SYSTEM

**Maintenance.** (In accordance with Crew Maintenance Insert to A.B. 413.)

### Lubrication

The engine is provided with a dipstick, **screwed** into the crankcase on the left-hand side.

**Engine oil must be examined frequently.**

To check the oil level, proceed as follows :—

1. Drive the vehicle on to level ground ; otherwise a false dipstick reading will result.
2. Unscrew and remove the dipstick (A) (Fig. 8), and wipe off the oil with a clean rag. Note the " High " and " Low " marks.
3. Replace the dipstick and screw it home.
4. Remove it again and examine the oil level.
   If the level is below the top graduation mark, fresh oil must be added (for correct grade see Lubrication Chart).
   The filler neck (B) (Fig. 8) has a hinged filler cap.

### To Drain the Sump

The engine oil must be changed as instructed on lubrication chart, or more frequently as conditions warrant. Drain the sump when the engine has been running and the oil is warm. This allows the oil to flow freely and to carry with it sediment and sludge.

1. Place a large tin or similar receptacle beneath the engine.
2. Unscrew the drain plug (C) (Fig. 8) on the base of the sump at the rear.
3. Allow the oil to drain away.
4. Replace the drain plug, and make sure it is tight.
5. Refill with fresh engine oil (12½ pints) as Lubrication Chart.
6. Check the oil level with vehicle on level ground. This must be up to the top line of the dipstick.
7. Start the engine and check the oil pressure shown on the gauge, which with the engine warm should read 30–40 lb. per sq. in.

### The Oil Filters

The smaller of the two oil filters (D) (Fig. 8), mounted on the left side of the crankcase, is a sealed unit. It cannot be dismantled for cleaning and, therefore, under normal running conditions, a new filter complete must be fitted as instructed on lubrication chart. When the vehicle is being driven over rough ground for long periods it is advisable to change the filter every time the engine is filled with fresh oil.

This filter is attached to the crankcase, on the left-hand side of the engine.

To remove and replace :—

1. Disconnect the oil pipes at the filter.
2. Slack off the clip securing the filter to the crankcase by unscrewing the bolt.
3. Fit a new unit in place of the old one, and tighten the original clip in position.
4. Connect the oil pipes.
5. Start the engine, and check the oil pipe unions for leaks ; also examine the oil pressure.

   **No further attention is required to this filter.**

A second oil filter (Purolator type) is mounted on a bracket bolted to the hull side plate on the right side of the engine compartment, and it is connected to the engine by two flexible pipes.

**Maintenance.** (In accordance with Crew Maintenance Insert to A.B. 413.)

The filter element may be cleaned by giving one complete turn of the handle at the top of the filter.

### To Dismantle the Filter

Remove the four bolts securing the body to the filter head and withdraw the body. Slacken the nut securing the scraper spindle in the head and swing the scraper clear of the filter element. Remove the split pin and washers securing the filter element to the centre spindle and withdraw the element.

Thoroughly wash the filter element in cleaning fluid such as paraffin or petrol and wipe off with a soft cloth. DO NOT USE A WIRE BRUSH OR SCRAPER. Clean all sediment from the interior of the body.

### To Rebuild the Filter

Examine the gasket making the joint between the filter head and body and renew it if necessary. Replace the filter element on the centre spindle and secure it by the washers and split pin. Swing the scraper to the filter element and tighten the nut lightly to secure the spindle in the head. Adjust the position of the blade to give a light rub when the element is turned, and then finally tighten the securing nut. Replace the filter body and secure it to the head by the four bolts and nuts. Tighten the nuts evenly and ensure that the joint is oil tight.

### To Prime the Filter

Unscrew the vent plugs in the inlet and outlet bosses sufficiently to uncover the cross drilled vent in the shank and remove the prime plug. (In some early units it is necessary to remove the vent plugs.) Fill through the priming orifice until oil overflows at the vent plugs, then replace the prime plug and tighten down the vent plugs to ensure that good oil tight joints are made.

## *Part VI*
## THE COOLING SYSTEM

The engine is liquid cooled and the system holds 30 pints of liquid. The coolant circulates by thermo-syphon action assisted by a vane type water pump. Metal and rubber pipes connect the various parts of the system.

**Pressure relief and thermostatic valves require no maintenance or lubrication:**

### Lubrication

Lubricate the water pump impeller shaft by screwing down the lubricator one complete turn. (*See* Fig. 8.)

Observe the instructions on the lubrication chart and in A.B. 413 Crew Maintenance Insert.

### Maintenance

1. Examine the level of coolant in the radiator and if necessary, top up as follows.
   Raise the engine compartment top plate and secure it in position. Remove the radiator filler cap. (*See* Fig. 6.) Add the correct coolant water or anti-freeze solution), until the level is 1¼ inches below the filler neck (this is to allow for expansion when the water is warm). Replace the filler cap securely.
2. Inspect the radiator mounting bolts, tighten as necessary and lock them securely. These are accessible from underneath, immediately behind the silencer. (B.) (Fig. 24.)
3. Inspect all rubber hose for signs of cracking or signs of deterioration and report if renewal appears necessary.
4. Inspect all possible points for leakage of coolant from the system and report any such leakage.
5. Check the fan bearings for wear by grasping two opposite blades of the fan, and test for rocking or end movement. Check the fan for loose rivets or bent blades and that the four nuts securing the spinner to the fan centre are tight. There should be 5/16 inch clearance at all points between the fan and cowl.
6. Check the tension of each fan belt, when this is correct it is possible to deflect the belt ¾ inch from its normal straight line position, mid-way between the two pulleys, by light hand pressure. If necessary adjust this tension as described in Chapter V A. Page 42.
7. Check the correct working of the water pump as follows. Warm the engine by running it for a short period, and then stop it. Drain coolant from the radiator until the bottom of the header tank is just clear of the level of coolant. Start the engine and note the volume of coolant being circulated by the pump. Refill the header tank to the correct level.

### To Flush the Radiator

When necessary this may be done as follows. Remove the radiator filler cap and drain the system (save anti-freeze solution for re use). If the drain tap (D.) (Fig. 24) is choked it may be freed by pushing a piece of stiff wire through the tap. Place a hose pipe in the radiator filler neck and adjust the inflow of water to equal the maximum flow from the tap, and continue until the water runs clear.

If the system is to be refilled with anti-freeze solution, remove the hose and allow all water to drain away. Close the drain tap and refill the system with anti-freeze solution to the correct level.

## THE IGNITION SYSTEM

The distributor situated mid-way along the left side of the engine is the only portion of the ignition system requiring regular maintenance, except the sparking plugs.

### Lubrication

1. Slacken off the two screws securing the distributor cover, as indicated in Fig. 14 and remove the cover.
2. Carefully remove the rotor from the cam.
3. Allow a few drops of thin oil to penetrate the space between the cam and its fixing screw in the centre of the distributor shaft. Add a few drops of thin oil to the cam lubricating pad.
4. Replace the rotor, take great care that it is correctly fitted to the cam and pushed fully into place.
5. Refit the distributor cover and secure the two fixing screws.

**Maintenance:** (In accordance with Crew Maintenance Insert to A.B. 413.)

1. Remove the distributor cover as described above.
2. Examine the inside of the distributor moulding, this must be quite clean and dry, any film of moisture or other conducting matter must be removed by polishing with a soft cloth.
3. Examine each pair of contact points, the face of each contact should be flat and smooth, and the gap between them at maximum cam lift must be between .010 and .012 inch. It is most important that this dimension is maintained and that each pair of contacts have the same maximum gap opening.

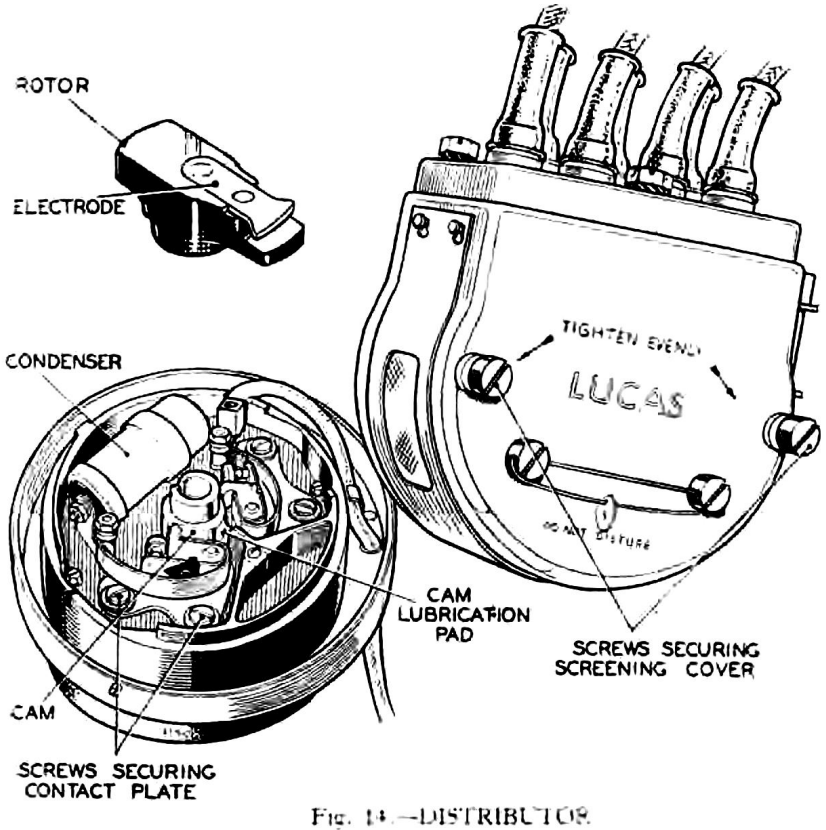



Fig. 14.—DISTRIBUTOR.

4. To adjust the contact gap. Turn the engine by hand until one pair of contacts are at maximum opening.
5. Slacken the two screws holding the fixed contact plate one turn each.
6. Move the fixed contact plate until the gap between contact faces is within the limits .010 and .012 inch.
7. Both screws must be tightened gradually and simultaneously, to avoid disturbing the setting. When the screws are tight check that the gap opening is still within the limits given above.
8. Turn the engine until the second pair of contact points are at maximum opening and repeat the operations 5, 6 and 7 above.
9. When it is not possible to fit new contact points and the surface of the old points are burnt, it may be possible to make these serviceable by polishing the faces with fine carborundum cloth until they are flat and polished. Finally clean all carborundum dust from the contact face.
10. Before replacing the rotor ensure that it is clean and dry, and that the electrode is not reduced in length due to the sparking between it and the distributor cover electrodes. The spring loaded brush in the distributor centre must be free in its locating hole in order that it may make good contact with the rotor electrode.

### Sparking Plugs

When the mechanical condition of the engine is good and the carburation is correct, the sparking plugs will not require frequent attention, but they may be removed for inspection at regular intervals.

When the electrodes are burnt, or the insulators are cracked, **fit new sparking plugs.**

Remove the carbon deposit from the plug body, electrodes and insulators, if the plugs are sooty or dirty.

**Re-gap the plug points to .018 in.–.020 in.**

Badly fouled sparking plugs should be cleaned wherever possible on a sand-blast type of plug cleaner.

If there is any doubt, fit new plugs and have the originals cleaned later for further use.

If they are clean, and the points are set at the correct gaps, **replace them. They do not need attention.**

When replacing the sparking plugs in the engine, be sure the high tension leads are well home in the spring connectors and that the fixing units are screwed down. Make sure that the sparking plug washers (copper and asbestos) are in position.

Do not use undue force on these operations, or difficulty will be experienced should it be necessary to remove the connector from the sparking plug, or plugs from the cylinder head.

### The Filter Unit and Coil

No attention is necessary beyond ensuring that the brackets are bolted firmly in position and that the high and low tension leads are secure.

# *CHAPTER IIA*

# THE TRANSMISSION

## *Part I*

## THE CLUTCH

The clutch is controlled by a foot pedal pivoting on a shaft and connected through a ball joint to a relay lever. Both pedal and relay lever are mounted on needle roller bearings. A flexible metal cable connects the relay lever and the clutch withdrawal lever.

### Lubrication

Clean all lubricating points free from dirt, etc. before applying fresh lubricant.

1. The clutch pedal fulcrum pin is lubricated from point A.
2. The clutch, relay lever pin is lubricated from point C.
3. The ball-joint between the pedal and relay lever is lubricated by force feed oil can.
4. The cable clevis pin on the relay lever is lubricated by force feed oil can. The above points are shown on Fig. 15.
5. The clutch cable is lubricated from the point shown on Fig. 15. Also see lubrication chart. **The clutch unit must not be lubricated.**

**Maintenance.** (In accordance with Crew Maintenance Insert to A.B. 413.)

Check the "Free Movement" of the clutch pedal, and if necessary adjust it as follows.

When the clutch pedal is depressed, the correct amount of "Free Movement" before resistance of the clutch springs is felt, is from ¾ inch to 1 inch.

1. From underneath the car locate the spherical nut securing the cable to the clutch withdrawal lever. (Fig. 16.)
2. Using two spanners, hold the spherical nut and slacken the lock nut.
3. To reduce "Free Movement," screw the spherical nut up, and to increase this, the spherical nut must be slackened off further.
4. Check the adjustment and if correct lock this securely. Make a final check of the adjustment, and if necessary make a further adjustment.
5. Inspect pedal and relay levers for wear of bearings and report if excessive.
6. Check the cable for fraying and each clevis and pin for wear. Also the two springs adjacent to the clutch withdrawal lever.
7. Ensure that the clutch housing drain hole is clear

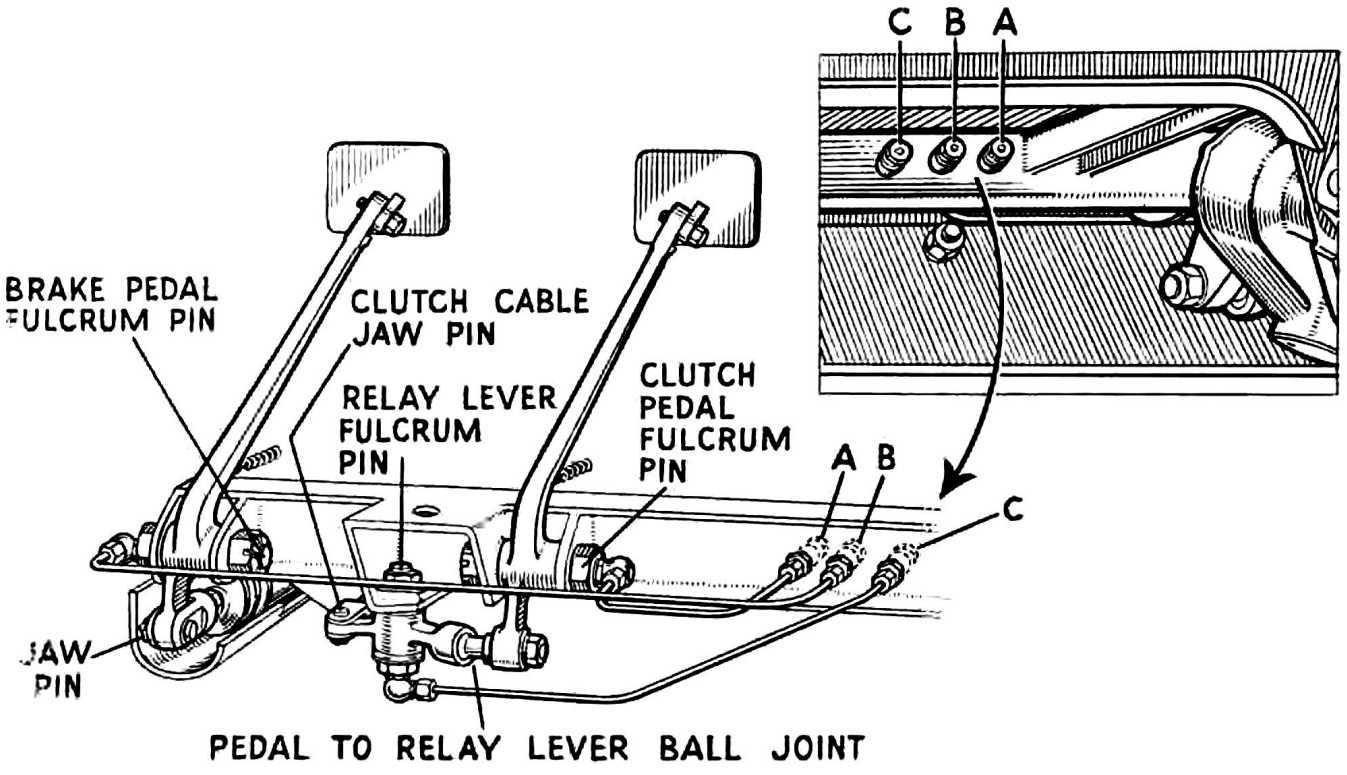



Fig. 15.—CLUTCH AND BRAKE PEDAL LUBRICATION

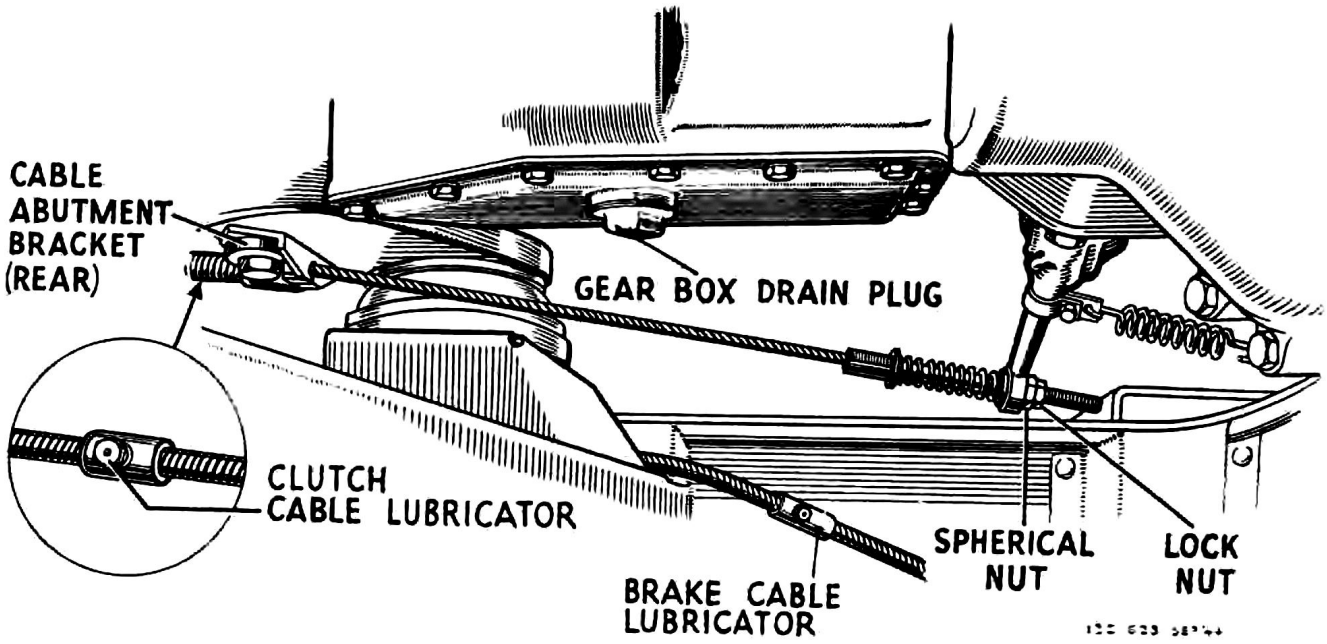



Fig. 16.—CLUTCH PEDAL ADJUSTMENT.

## *Part II*
## THE GEARBOX
**(Figs. 16-17)**

### Lubrication

1. Remove the cover plate held to the rounded floor plate by four set bolts. (*See* Fig. 4.)
2. Unscrew and remove the dip stick, carefully check the level of lubricant and if necessary top up to the high mark on the dip stick with lubricant, as directed by the lubrication chart.
3. Replace the dip stick carefully, and clean off any surplus lubricant from outside the gearbox. Check for any leakage. Report if any excess quantity of lubricant is required to top up to the correct level.
4. Replace the cover plate and gasket to the floor plate.
5. The three points A, B and C (Fig. 17) may be lubricated by a force feed oil can when the gaiter at the bottom of the gear lever is removed. When this gaiter is replaced, ensure a watertight joint by carefully tightening the four nuts securing the clamp plate.

Drain and refill the gearbox as instructed on the lubrication chart and the Crew Maintenance Insert to A.B. 413.

This should be done immediately after a run, when the lubricant is warm and will flow freely from the box.

### To Drain and Refill the Gearbox

1. Remove the cover plate held to the rounded floor plate by four set bolts. (*See* Fig. 4.)
2. Unscrew and remove the dip stick.
3. Unscrew the drain plug (Fig. 16) and allow the lubricant to drain into a container placed underneath.

   When necessary (every third draining period) the gearbox base plate, held by 15 set bolts may be removed, but great care must be taken to prevent damage to this and the gearbox joint faces. Before replacing the base plate remove the old gasket and ensure that both joint faces are clean and flat. Fit a new gasket, and tighten all the set bolts evenly, then inspect that the joint is sound.
4. Replace the drain plug securely.
5. Fill the gearbox with correct lubricant to the high level mark on the dip stick (5 pints), and replace the dip stick.
6. Clean surplus lubricant from outside the box and inspect for any leakage.
7. Replace the cover plate and gasket to the rounded floor plate.

**Maintenance.** (In accordance with Crew Maintenance Insert to A.B. 413.)

1. Frequently inspect the gearbox for oil leakage.
2. Examine and tighten if necessary the bolts and nuts on the top cover plate, side cover plate, and bottom cover plate of the gearbox.
3. Examine the front connection of the gearbox lever for tightness where it is secured to the cross member of the chassis.
4. Ensure that both dirt excluding gaiters on the gear lever are sound and tight.

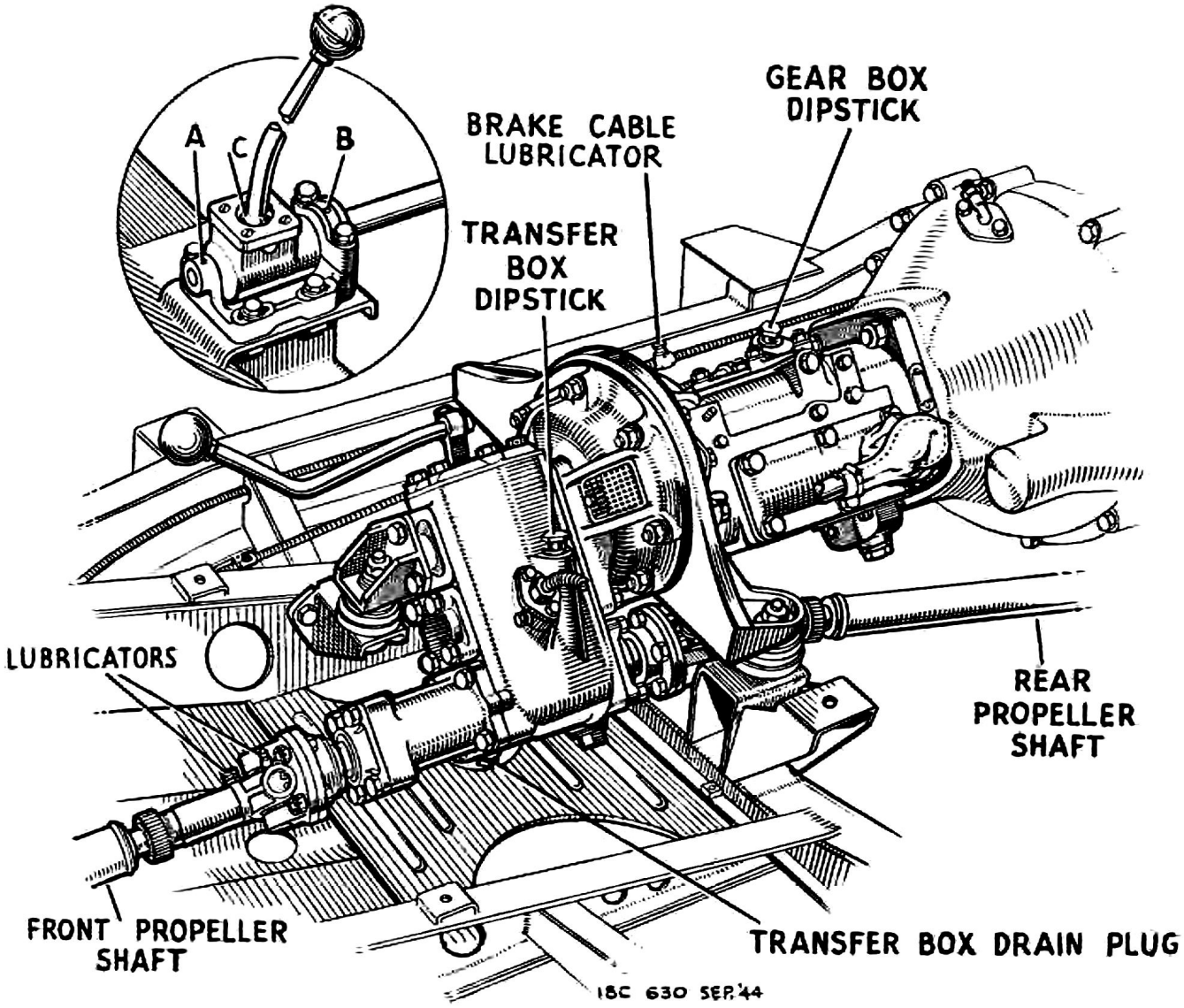



Fig. 17.—GEARBOX AND TRANSFER BOX.

## *Part III*

## THE "METALASTIK" COUPLING

The "Metalastik" coupling is a resilient coupling between the gearbox and transfer box. It is contained in a split aluminium housing which connects the gearbox and transfer box. This aluminium housing, together with the support bracket interposed between the two halves of the housing, forms the forward support point for the power unit.

**Lubrication—None** required.

**Maintenance**

1. Inspect frequently and, if necessary, tighten the eight bolts securing the halves of the aluminium housing and the engine support plate.
2. Clean off mud, etc., from wire mesh cover plates.
3. Inspect for leakage of oil into the housing from the gearbox or transfer box, and report any leakage.
4. Inspect and, if necessary, tighten the bolts securing engine support bracket to chassis frame, and report if the rubber blocks show signs of deterioration.

## *Part IV*

## THE TRANSFER BOX

**(See Fig. 17)**

The transfer box provides power take-off points for the front and rear propeller shafts and is also a two-speed auxiliary gearbox.

The transfer box gear selector lever has three positions, as follows.—

1. When the lever is in the low position, the higher gear ratio is in use, and the drive is transmitted to the rear wheels only.
2. With the lever in the intermediate position, the transfer box is in "neutral."
3. With the lever in the fully raised position, the lower gear ratio in the transfer box is engaged, and the drive is transmitted to both front and rear wheels.

**Lubrication**

Access is gained to the transfer box combined dipstick and filler plug by removing the cover plate (Fig. 4) on the gearbox cowl.

Top up with oil regularly to the top mark on the dipstick.

Drain and refill with lubricant as instructed on lubrication chart and A.B. 413 Crew maintenance Insert.

1. Remove the four screws and cover plate over transfer box. (Fig. 4.)
2. Remove the dipstick. (Fig. 17.)
3. Remove drain plug from bottom of transfer box, and drain for fifteen minutes.
4. Refit drain plug, and refill with two pints of the correct grade of oil.
5. Refit cover plate and gasket securely to floor plate, and check for oil leaks.

**Maintenance**

1. Examine the transfer box frequently for any signs of oil leaks and tighten all nuts holding the covers in position, if necessary.
2. Examine the oil seals where the drive shafts emerge from the transfer box, and report any leaks at these points.
3. Examine the transfer box front support bracket bolt for tightness, and the rubber mounting pad for any sign of deterioration.

## *Part V*

## THE FRONT TRANSMISSION

This comprises the front propeller shaft, bevel gear and differential unit, telescopic transverse drive shafts, and the inner and outer Tracta joints.

### Lubrication

It is most essential that the 16 lubricating points are regularly and correctly lubricated. Clean each lubricating point free from dirt, etc. before applying fresh lubricant.

| | | | |
|---|---|---|---|
| Front propeller shaft .. .. | 3 | lubricators | |
| Inner Tracta joint housing .. (*See* note below) | 2 | ,, | A |
| Outer Tracta joint housing . (*See* note below) | 2 | ,, | B |
| Tracta shaft telescopic joints .. | 2 | ,, | C |
| Swivel pins .. .. .. | 4 | ,, | F |
| Hubs (*See* note below) .. .. | 2 | ,, | |

Bevel gear and differential (*See* note below). One filler plug.

The lubricating points are indicated on Figs. 18–19.

Drain and refill the bevel gear as instructed on the lubricating chart and by the Crew Maintenance Insert to A.B. 413.

**Note :** Level plugs are screwed into the Tracta joint housing immediately below the lubricators. It is intended that this screwed plug be removed when the joint is being lubricated, so as to prevent over filling the bearing with lubricant, and consequent damage to the oil seals. However, the lubricant specified is not sufficiently fluid for them to be made use of as indicators of the amount of lubricant required. Therefore, great care must be taken not to overfill these joints, and in general it will be found that approximately 4 ozs., or about half the gun capacity will suffice, although this will depend upon the quantity which has escaped past the oil seals.

**Note :** The hubs must not be over filled with lubricant. To guard against this when filling them, jack up each wheel in turn and remove the grease escape plug. (Fig. 18.) Rotate the wheel until this opening is uppermost, and fill the hub by means of the lubricating gun until lubricant appears at the escape hole. Replace the plug securely.

**Note :** Access to the bevel drive housing filler plug is gained by removing the floor plate (AA). (Fig. 3.) Remove the level plug and the filler plug. Before removing the level plug be sure that it is the correct plug and NOT the adjusting screw for the bronze thrust pad.

**Maintenance:** (In accordance with Crew Maintenance Insert to A.B. 413.)

Regularly check that all nuts and bolts on the front transmission are tight and securely locked.

Jack up the front wheels and test for excessive play in the wheel bearings, and the swivel pin bearings.

Report if leakage of lubricant is found at any point.

## *Part VI*

## THE REAR AXLE

### Lubrication

Regularly lubricate as instructed in the Crew maintenance insert A.B.413 and the lubricating chart. Remove all dirt, etc., from the lubricators before applying lubricant.

| | | |
|---|---|---|
| Propeller shaft | | 3 Lubricators. |
| Hubs | *See* notes under front transmission | 2 ,, |
| Bevel gear and differential | | 1 Filler plug. |

Drain and refill bevel gear as instructed by the A.B.413 Crew maintenance Insert and lubrication chart.

### Maintenance

Regularly check that all bolts and nuts are tight and securely locked. Check frequently for any leakage of oil, and rectify or report as necessary.

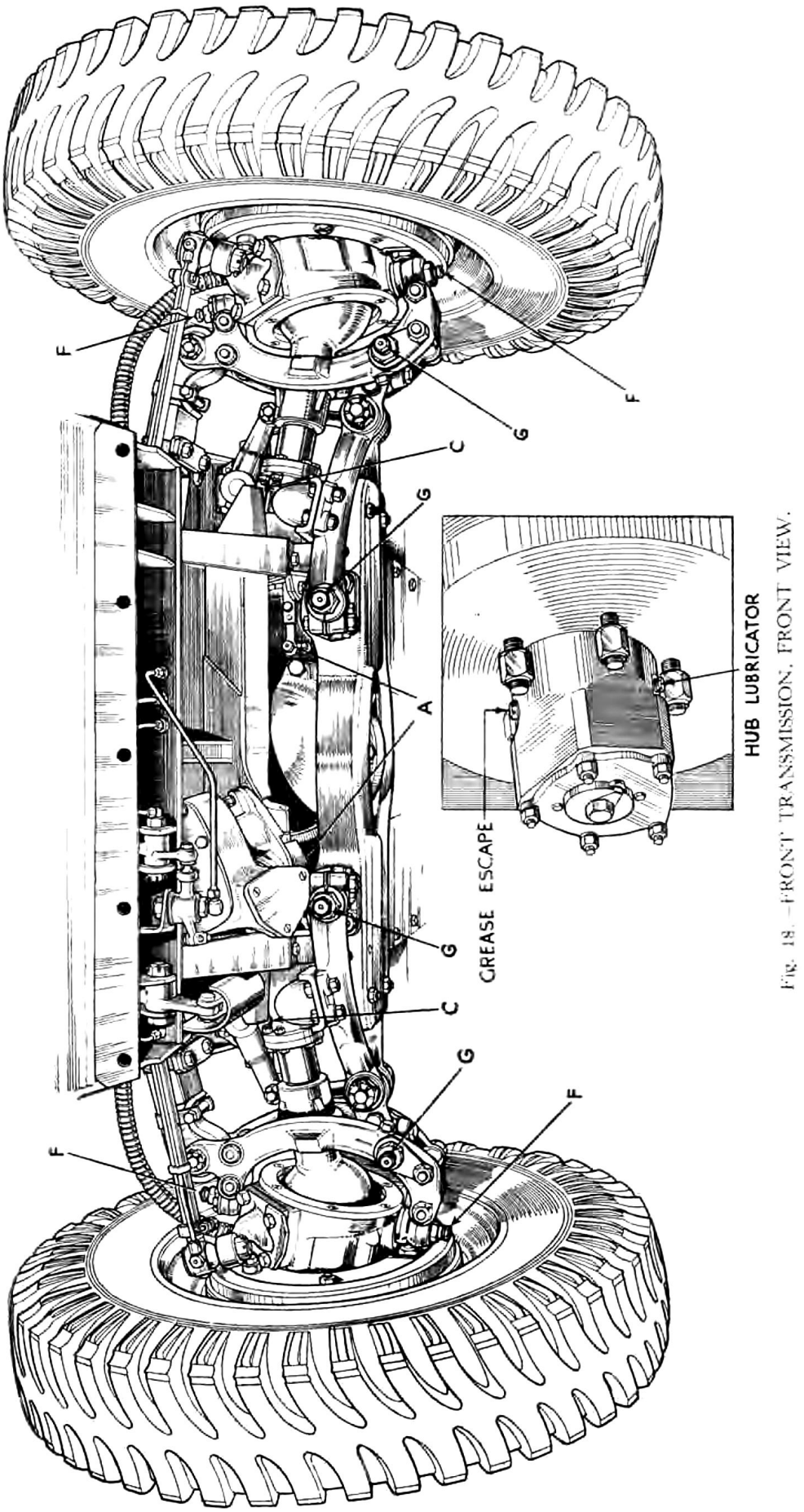



FIG. 18.—FRONT TRANSMISSION, FRONT VIEW.

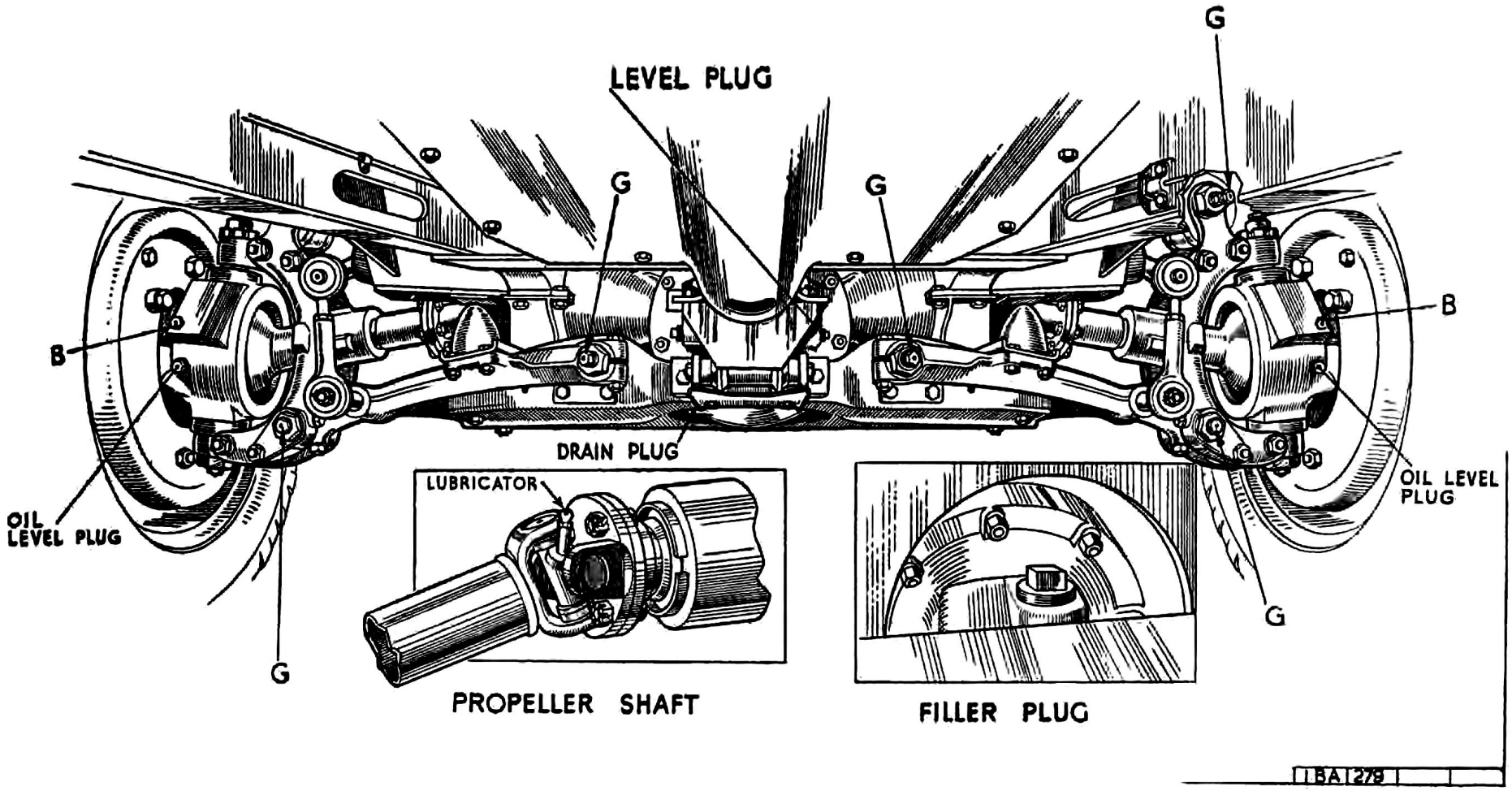



Fig. 19.—FRONT TRANSMISSION, REAR VIEW.

## *Part VII*

## WHEELS AND TYRES

**(Fig. 20)**

Maintenance of correct tyre pressure is essential. Unequal pressure, as between opposite wheels at front and rear, must be avoided under all circumstances, for this condition would adversely affect steering and vehicle control generally.

Check pressures frequently with the appropriate gauge, for with the "run flat" tyres which are fitted to this vehicle it is impossible to tell even the approximate pressure by visual inspection. Moreover, the driver cannot tell by the pull of the steering to what degree a tyre is inflated or deflated. All that the driver can decide is that steering is upset by unequal pressures.

Although one or more of the tyres may have been pierced and thus deflated by bullets, shrapnel, etc., the " runflat " properties ensure that they can carry their full load for a maximum distance of about fifty miles, and the speed of the vehicle must be reduced accordingly. **But,** at the earliest possible moment afterwards, the affected wheel or wheels, together with R.F. tyre equipment, must be removed and returned to workshop for examination and any necessary replacements.

**In the most exceptional circumstances,** when traversing particularly difficult terrain, such as very soft sand, the tyres may be deliberately deflated. Such an emergency deflation is effected by depressing the valve centre and **not** by removing the valve core. The tyres will then give a satisfactory cross-country performance. As soon as possible after an emergency deflation, an R.F. tyre must be re-inflated to its correct pressure.

**An R.F. tyre which has been shot up, or run for twenty consecutive miles deliberately deflated, or run an aggregate of seventy-five miles deliberately deflated, must be returned to workshop for inspection. Keep accurate records of the mileage run deflated.**

Any R.F. tyre on which the tread has worn practically smooth in the centre must be removed from service because not only is its cross-country performance lessened, but also its ability to support its load when deflated has been appreciably reduced.

To equalise the rate of wear, change over the tyres from opposite wheels, and from front to rear and vice versa, at regular intervals, according to conditions of service.

Regularly jack up the vehicle and remove all stone and gravel that have become embedded in the rubber. Report for immediate attention any large cracks or cuts.

Whether or not they are inflated, these tyres must never be overloaded.

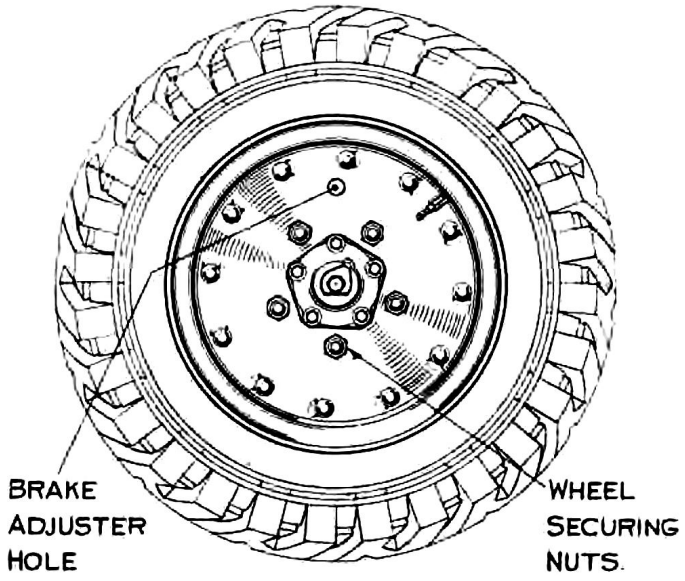



Fig. 20.—WHEEL AND TYRE ASSEMBLY.

Overloading will cause overheating which, in a short space of time, may cause the total collapse of the tyre. This is particularly important to remember in hot climates.

The considerable weight of the tyre assembly places heavy stresses on the wheel securing studs and nuts. Check these frequently for tightness and for signs of damaged threads. Be sure always that the valve centres and cores are tight and secure.

**When fitting rear road wheels, the hole in wheel should line up with brake drum cover plate, to enable brake shoes to be adjusted without removing the wheel. (Fig. 20.)**

**Note :** To avoid damage to the transmission due to incorrect or unequal tyre pressures, when it is being operated by personnel not advised of these correct pressures, the following may be taken as a guide to ensure safe operation.

Vehicle unladen (*i.e.* driver and no stowage). Front 20 lbs., rear 30 lbs.

Vehicle laden. Front 24 lbs., and rear 34 lbs.

Operation on four wheel drive at incorrect tyre pressures is detrimental to the transmission, and may result in serious damage to it.

# *CHAPTER IIIA*

# SUSPENSION

## *Part I*

## ROAD SPRINGS

### Front Spring

A transverse leaf spring is employed for the suspension of the front road wheels. This spring is secured at the centre, to the chassis frame and connected at its extremities by suitable linkage to the top of the steering stub axle assembly. The bottom of the stub axle assembly is located by a "wishbone" shaped link assembly pivoting at both ends on screwed steel bushes. The road wheels are therefore independently sprung, and can rise or fall according to road undulations without directly influencing each other.

### Lubrication

Before commencing, relieve the loading on the spring by jacking vehicle on chassis frame.

Clean off all road dust or grit from the lubricators before applying fresh lubricant. Use lubricant quoted on Lubrication Chart, and continue operating the gun until lubricant exudes from both ends of the bushes.

Spring eye bolts (two points) and bottom link bushes (eight points). (G) (Figs. 18 and 19.)

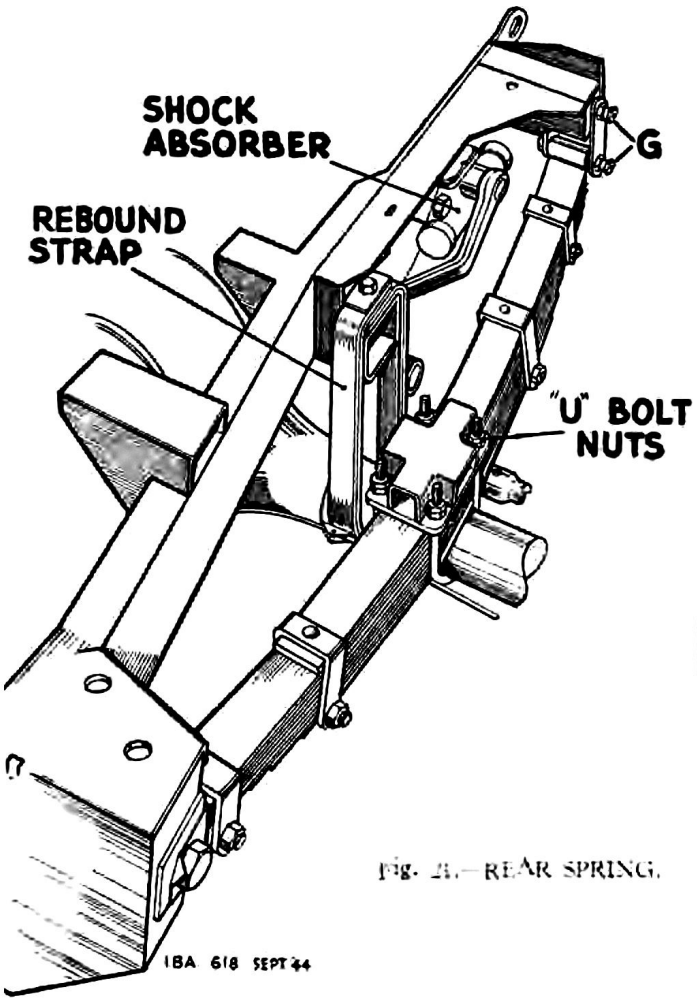



Fig. 21.—REAR SPRING.

### Maintenance

Frequently clean the road spring with paraffin and a stiff brush and spray or paint the spring sides with engine oil.

Inspect (in accordance with Crew Maintenance insert to A.B. 413) regularly, and, if necessary, tighten all securing bolts and nuts:

(*a*) Road spring to frame clamps.
(*b*) Spring leaf clamps.
(*c*) Spring eye bolts.
(*d*) Bottom link cross member to chassis bolts.
(*e*) Bottom link cross shaft bracket bolts.
(*f*) Bottom link to side plate bolts.
(*g*) Rubber bump and rebound pad nuts.

Also inspect and, if necessary, report the following:

(*a*) Broken spring leaves and clips.
(*b*) Deterioration of rubber pads.
(*c*) Damaged bottom link cross member.
(*d*) Damage to bottom links (wishbone).
(*e*) Damage to side plates connecting spring eye and bottom link.

The spring eye and bottom link bushes should be lubricated frequently and will require no further attention. The design relies upon a certain amount of "play," but if after prolonged usage this is suspected of being excessive, the matter should be reported for workshop attention.

### Rear Springs

These are normal semi-elliptic type springs. The front end of each spring is secured to the chassis by silent bloc bushes which MUST NOT BE LUBRICATED. The rear end of each spring is connected to the chassis by shackle linkage.

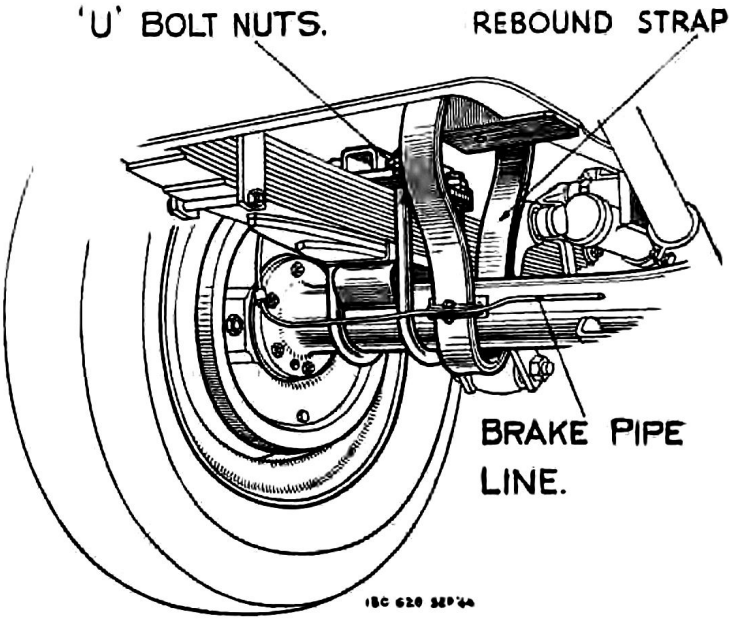



Fig. 22.—REAR AXLE, SHOWING REBOUND STRAP.

**Lubrication**

Regularly lubricate the two shackle bolts of each spring, points (G) Fig. 21.

Clean off all road dust or grit from the lubricators before applying fresh lubricant. Use lubricant quoted in Lubrication Chart, and continue operating gun until lubricant exudes from both ends of the bushes.

**Maintenance**

Frequently clean the road springs with paraffin and a stiff brush, and spray or paint the spring sides with engine oil.

1. "U" bolts securing springs to axle casing—these should be "dead" tight. (Fig. 22.)
2. Spring leaf clamping bolts.
3. Spring eye and shackle bolts.
4. Rebound strap securing bolts. (Fig. 21.)
5. Bump rubber securing nuts.

Also inspect and, if necessary, report :—

6. Broken spring leaves or clamps.
7. Deterioration of rebound straps.
8. Deterioration of bump rubber blocks.

## *Part II*

## THE SHOCK ABSORBERS

The vehicle is fitted with four shock absorbers. One is connected to each bottom link of the front suspension, while at the rear, one is connected to each end of the axle case. (H Fig. 24.)

It is essential that all fixing bolts and nuts are maintained tight, any failure to do this will result in rapid wear and serious damage. Inspect all connections frequently, tighten and lock them securely immediately any slackness is apparent.

**Faulty shock absorbers cannot be repaired except at the workshop,** replacement units must be fitted when necessary.

To test a shock absorber, disconnect it from the axle, move the arm as fully as possible backwards and forwards. If the arm can be moved easily without much effort, it is faulty.

To top up a shock absorber with fluid, it is necessary to remove it completely from the vehicle.

Thoroughly wash the shock absorber body with paraffin and dry it off with a clean cloth. It is essential that every particle of grit be removed, particularly from around the filler plug.

Secure the shock absorber in a vice and unscrew the filler plug ; it is important that this filler hole is at the highest point during filling operations.

Fill the shock absorber with fluid (*see* lubrication chart) and at the same time as fluid is being poured in, the arm of the unit must be moved backwards and forwards to its full extent to expel any air which may be in the unit.

When full replace the plug and sealing washer firmly, taking great care not to allow any dirt to enter the unit.

**Lubrication**

The ball joint in the linkage connecting the front shock absorber to the axle must be regularly lubricated until lubricant may be seen escaping from the joint faces.

# *CHAPTER IVA*

# STEERING AND BRAKES

## *Part I*

## STEERING

The steering unit is secured to the front cross member by three nuts locked by split pins. It is not adjustable for rake or height, and support for the outer steering column is provided by a bracket bolted to the hull floor plate.

Two ball-jointed track rods connect the drop arm to the stub axles.

**Lubrication**

Always clean away any dirt from the lubricators or filler plugs before lubricating any point.

1. Steering box. (Fig. 23).
   The filler plug is accessible from inside the vehicle, oil should be filled through this hole until level with the bottom threads of the filler hole.
2. Steering track rod joints (two lubricators). Fig. 23.
   The inner and outer ball joints are connected by copper pipes. Operate the grease gun until grease exudes from each bearing.
3. Swivel pin bearings (four lubricators). (F, Fig. 18).

**Maintenance.** (In accordance with Crew Maintenance Insert to A.B. 413)

Regular inspection must be made to ascertain if the following have been damaged, or if workshop adjustment is necessary.

1. Steering track rod and arms.

2. Steering column end float.
   Grasp the steering wheel with both hands and exert push and pull pressure. There should be no perceptible movement.
3. Lubricator pipe lines.
4. Play in the swivel pin bearings.
   Raise the front end of vehicle until both wheels are free.
   Grasp the road wheel at top and bottom and attempt to rock it sideways. There should be little or no perceptible play in these bearings. Do not confuse this with play in the hub bearings.
5. Steering lock.
   With the two front wheels jacked up clear of the ground, turn the steering wheel to full lock in both directions. The stops bolted to the stub axles should make contact with the lug on each side plate.
6. Front Wheel Alignment.
   This can only be satisfactorily checked by the workshops. drivers must inspect the tyres for irregular wear, and when apparent, this must be reported for workshop examination.

Inspect, tighten and lock up as necessary :—

1. Nut securing the steering wheel to column.
2. Bolts and nuts holding the steering column support bracket.
3. The three nuts securing steering unit to the chassis.
4. Nut securing the drop arm to steering unit.
5. Nuts securing the track rods.
6. Bolts securing the steering arms to the stub axles.

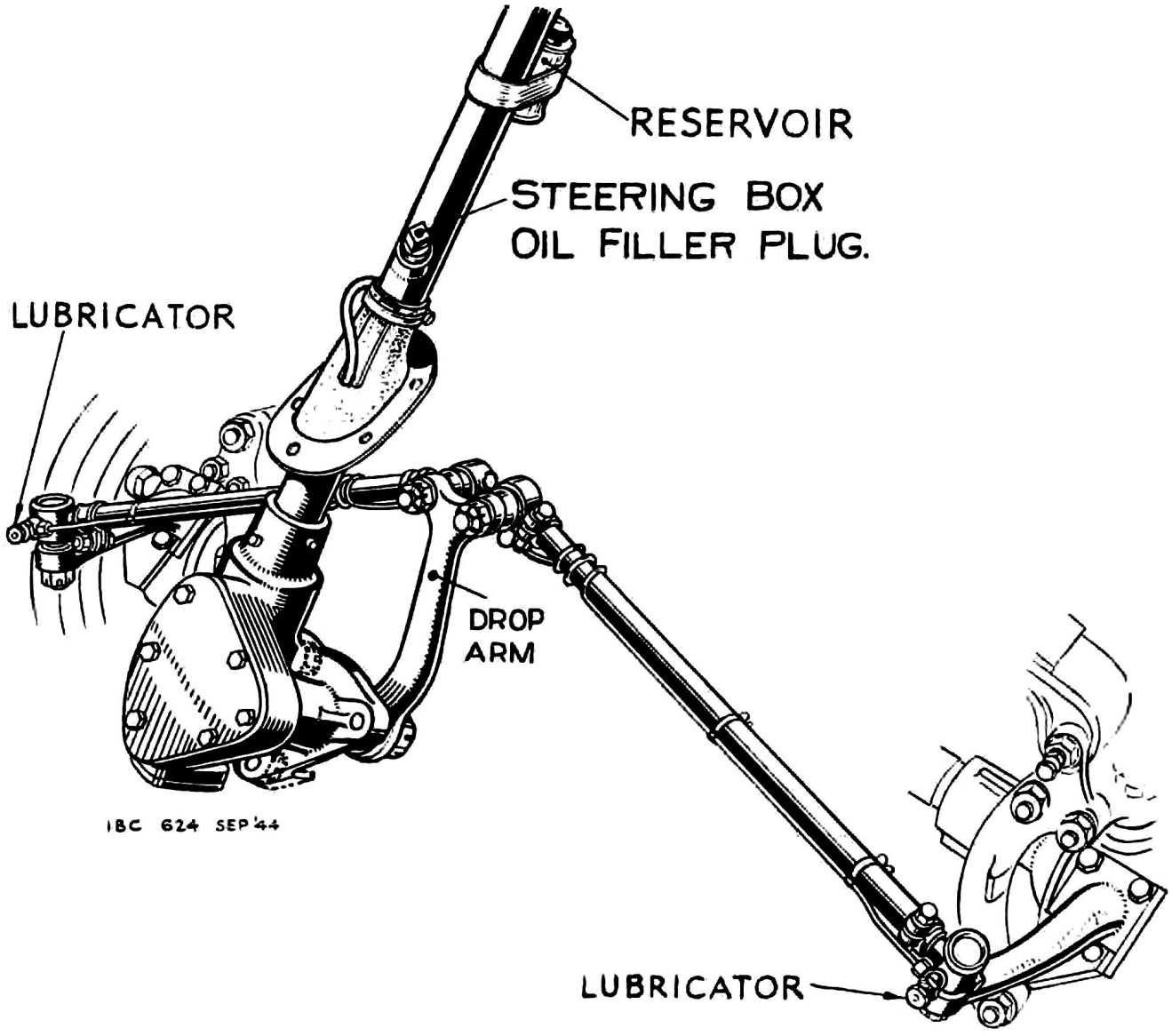



Fig. 23.—STEERING LAYOUT.

## *Part II*

## THE BRAKES

The foot brake operates on all four wheels by pressure of the fluid contained in the pipes connecting each brake cylinder to the master cylinder, which in turn is connected to the foot brake pedal.

The hand brake operates the shoes of the rear wheels only, by means of a cable and rod mechanism.

### Lubrication

Clean all dirt from the lubricators before applying fresh lubricant.

1. Brake pedal fulcrum pin, lubricator B, Fig. 15.
2. Hand brake cable, *see* Fig. 25.
3. Clevis pin connecting the brake pedal to the master cylinder, use force feed oil can, *see* Fig. 15.
4. Hand brake lever bearing, ratchet and pawl, use force feed oil can, *see* Fig. 25.
5. Brake rod clevis pins and bearings (five points) on the rear axle case, use force feed oil can. (G. Fig. 24.)

**Maintenance.** (In accordance with Crew Maintenance Insert A.B. 413.)

Regularly check the operation of the brakes immediately the vehicle is taken on the road, and report at once if this is not satisfactory.

Inspect and top up if necessary the fluid level in the brake fluid reservoir on the steering column. (Fig. 23.) Use fluid as specified by the lubrication chart. The reservoir must be maintained half full of fluid.

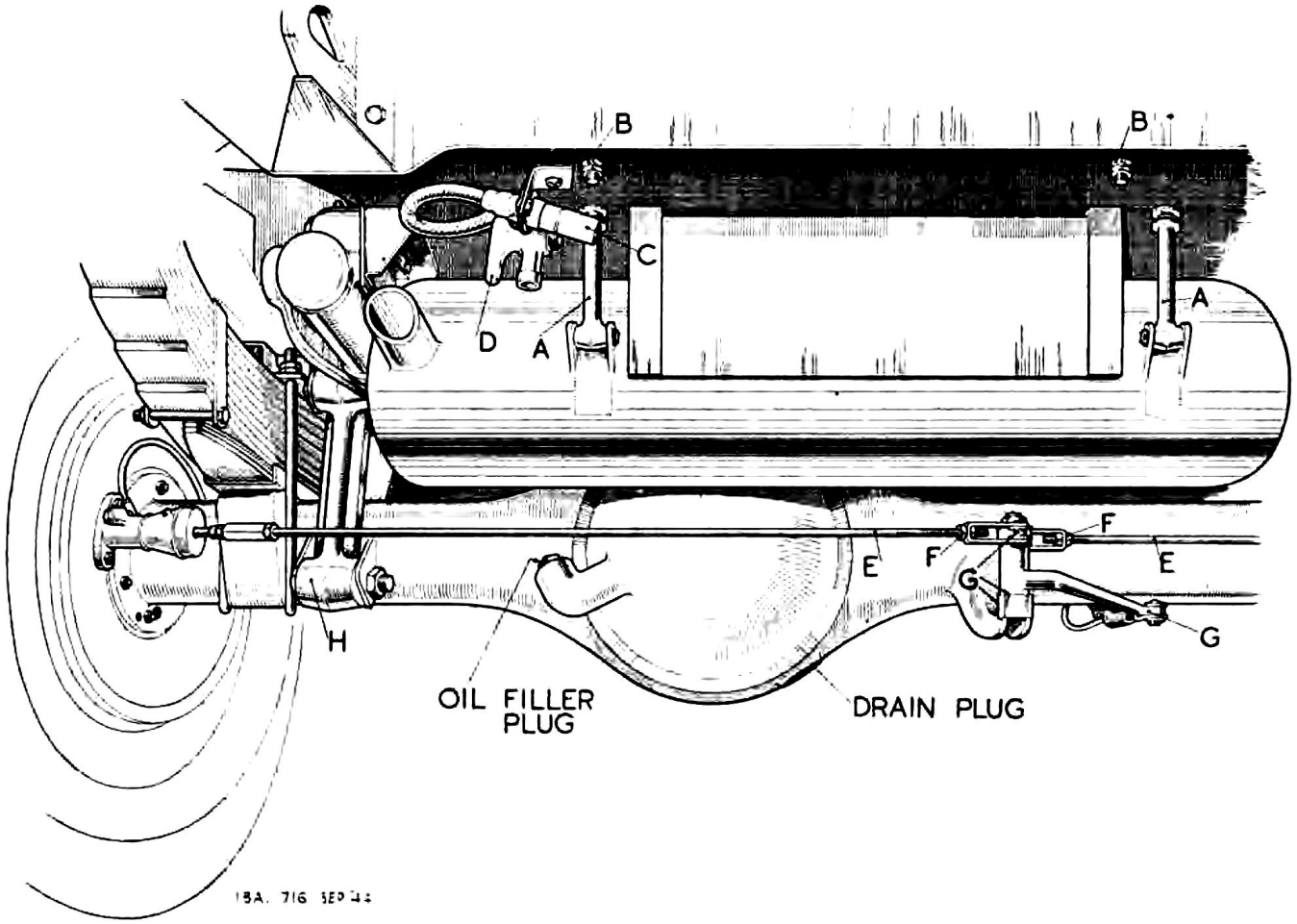



Fig. 24.—REAR BRAKE TRANSVERSE RODS

**Great care must be taken that no dirt or grit enters the reservoir.**

Inspect, tighten and lock up as necessary :

1. The bolts securing master cylinder and guard plate (four bolts total).
2. Nuts and bolts securing the pipe lines to the vehicle.
3. Pipe line joints and unions.
4. Hand brake connections.

**Do not alter the length of the hand brake rods or cable**

**Note :** The two nuts securing each brake cylinder to the rear brake plate MUST NOT BE FULLY TIGHTENED. They are correct when slackened back half a turn from the fully tightened position.

Check the brake system for leakage of fluid whilst the brake is applied, and report any such leakage at once.

Check the foot brake pedal free clearance. The correct clearance is $\frac{3}{8}$ inch "free movement" at the pedal tip before contact is made with the master cylinder piston. This clearance is more easily checked by hand pressure on the foot pedal, and any change found in this dimension must be reported.

## Brake Adjustment

As the brake linings wear, the foot pedal travel will gradually increase. When a point is reached where the pedal is within 1 in. of the front hull plate before solid resistance is obtained, the brake shoes must be adjusted

Each shoe is adjusted independently.

To adjust the brakes, proceed as follows :—

### Front Brakes (Fig. 26)

1. Jack up the front of the vehicle until the wheel is free to revolve.
2. Turn the hexagon bolt head on the outside of the brake back plate (a partial turn should be sufficient) until the brake shoe prevents the wheel being turned.
3. Slack off the adjuster the slightest possible amount to free the wheel without sign of drag. The adjuster is self locking. Repeat on the second hexagon adjuster.

### Rear Brakes (Fig. 27)

Each pair of shoes is adjusted by means of a serrated wheel inside the drum.

1. Jack up the vehicle so that the wheels are free to rotate.

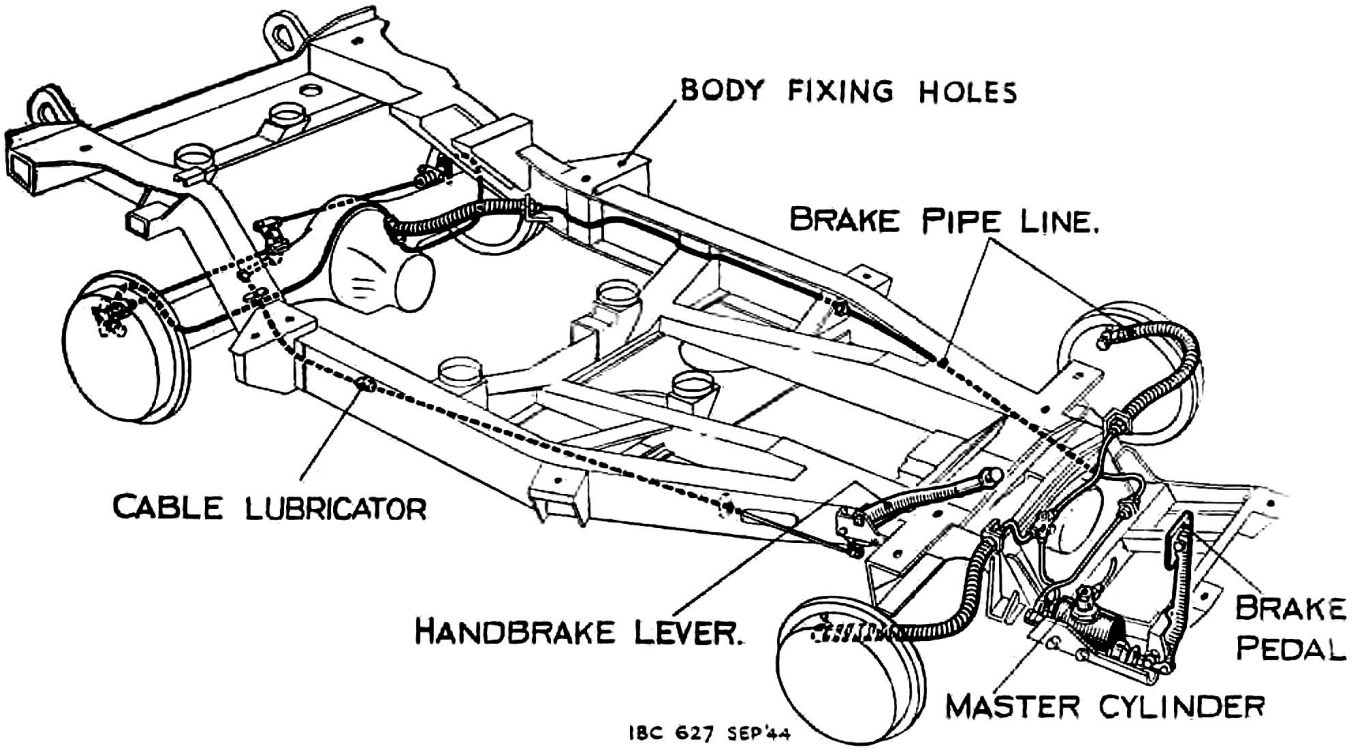



Fig. 25.—BRAKE LAYOUT

2. Insert a screwdriver in the hole provided in the road wheel and push aside a small cover plate on the brake drum. This reveals a hole in the drum. (Fig. 20.)

3. With the blade of the screwdriver projecting through the hole, rotate the wheel, bringing the screwdriver to the rear of the car, when contact will be made with the serrated adjuster.

4. Adjustment is made by turning the serrated wheel towards the front of the vehicle for the right side brake, or to the rear of the vehicle for the left side brake.

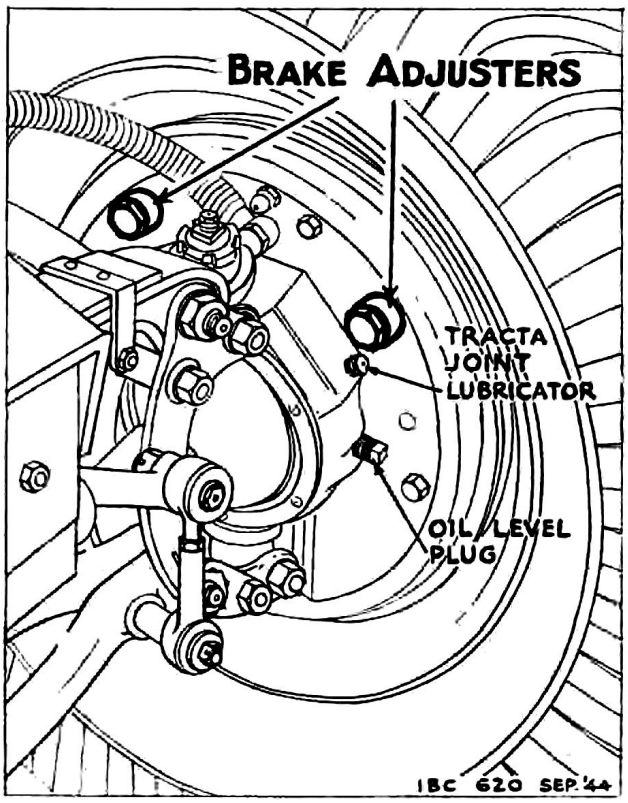



Fig. 26.—BRAKE ADJUSTMENT (FRONT).

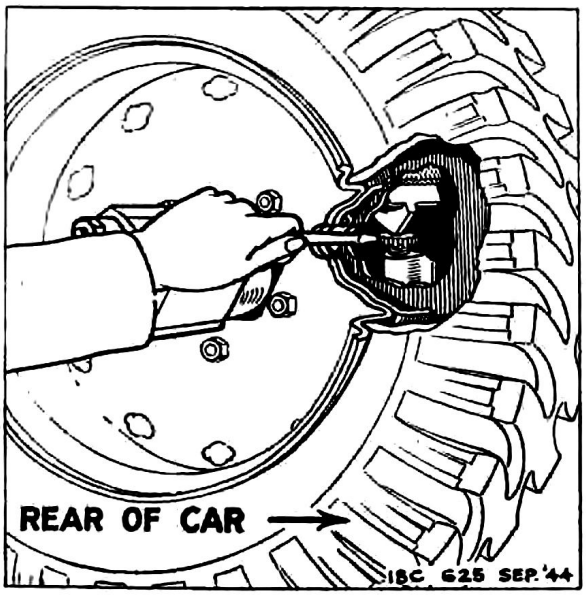



Fig. 27.—BRAKE ADJUSTMENT (REAR).

5. Turn the serrated wheel until the pressure of the brake shoes prevents the wheel from being revolved, then release the adjuster sufficiently to allow the wheel to rotate without drag.

6. The adjuster is self locking. Repeat the procedure with the other rear wheel.

7. Replace small cover plate on brake drum.

**Note:** When replacing a wheel, the hole mentioned above should coincide with the hole in the brake drum.

### Hand Brake

No separate adjustment is required for the shoes once the foot brakes have been set. The length of the cable or the rod linkage must **never** be adjusted.

# *CHAPTER VA*

# THE ELECTRICAL SYSTEM

In addition to the electrical details described on page 7, there are the further following items of equipment.

**Batteries**

Secured in two cradles on the bulkhead behind the gunner's seat.

**Two-speed Dynamo**

On the left side of the engine at the rear.

**Starter**

On the engine clutch housing at the left side, and below the engine mud shield.

**Control Board**

On the left side wall of the fighting compartment near the gunners seat.

**Two-speed Control Box**

Mounted on the engine manifold and connected to the carburetter.

**Fuse Box**

On the left wall of the fighting compartment below the instrument panel.

**Battery Cut-off Switch**

On the bulkhead near the batteries.

**Windscreen Wiper**

Mounted between the two front visors.

## *Part 1*

## LIGHTING

### Procedure for Replacing Bulbs, etc.

### Headlamp, Type L–WD–HIR (Fig. 28)

### Removing Lamp Front and Reflector

To remove the lamp front, slacken the securing screw at the bottom of the rim and swing it downwards out of the slot. Remove the front from the bottom of the lamp first. When replacing, locate the top of the rim first, then press on at the bottom, and secure by means of the screw. The bulb can be removed from its holder, when the front is taken off, by pressing inwards and turning in an anti-clockwise direction.

The reflector is secured to the lamp body by means of a rubber bead and can be withdrawn when the bead is removed. When replacing, the projection on the reflector rim must be fitted into the location at the top of the lamp body, and the reflector must be secured by refitting the rubber bead, the thicker lip of which must be located over the reflector rim and the lamp body.

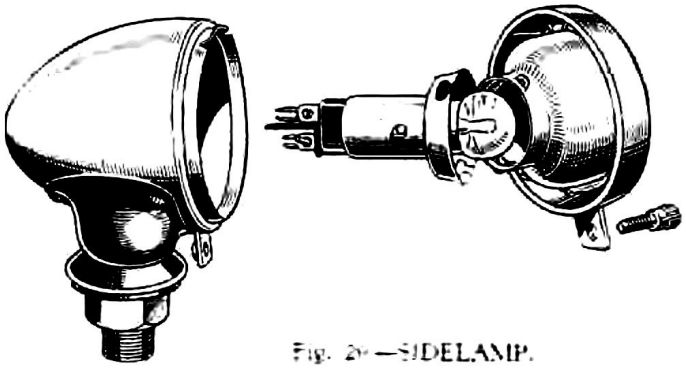


Fig. 29.—SIDELAMP.

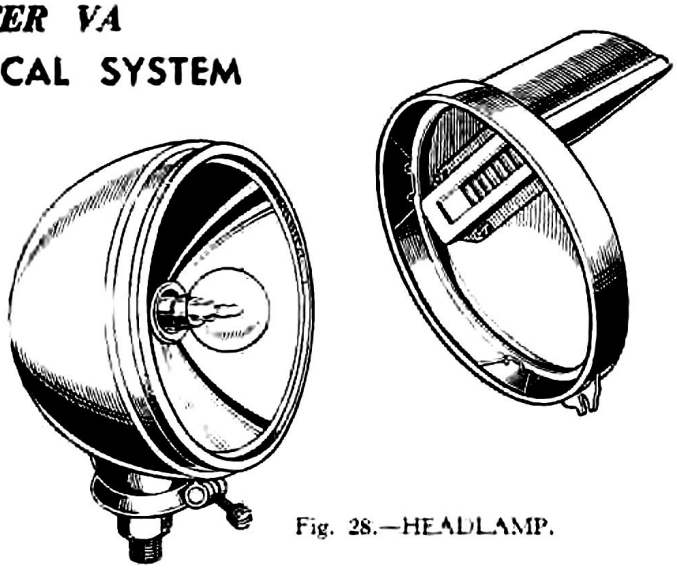


Fig. 28.—HEADLAMP.

### Setting and Focussing

The lamp must be set to ensure that the beam is projected below the horizontal. The lamp can be moved on its adjustable mounting when the fixing nut at the bottom of the lamp mounting is slackened. Tighten the nut after making the adjustment.

To obtain the best driving light, the bulb should be correctly focussed in the reflector. To adjust the position of the bulb, remove the front and reflector and slacken the screw on the clamping clip at the back of the reflector. Slide the bulb holder backwards or forwards until the smallest circular patch of light is obtained, and finally tighten the screw.

### Cleaning

Remove any dirt from the glass lens by wiping with a damp cloth. Care must be taken when handling the reflector to prevent it from becoming finger-marked. It can, however, be cleaned by polishing with a fine chamois leather. Metal polishes *must not* be used.

### Sidelamps, Type L–WD–SIR (Fig. 29)

To remove the lamp front and reflector, withdraw the locking screw at the bottom of the lamp and pull the front and reflector away from the lamp body. When replacing, locate the top first, then press on at the bottom and secure by tightening the fixing screw. The bulb holder can be removed by unclipping it from the back of the reflector. If it is a tight fit, it can be removed by carefully levering it off with a screwdriver. Remove the bulb by pressing in and turning in an anti-clockwise direction.

### Tail Lamps, Type L–WD–TIA

To remove the cover carrying the red glass, twist and pull the cover off its spring clips. When replacing, position the locations in the cover on the spring and push home. Remove the bulb by pressing in and turning in an anti-clockwise direction.

### Convoy Lamp, Type L–WD–AF1A

To remove the cover, twist and pull it off its spring clips. When replacing, position the locations in the cover on the spring and push home. Remove the bulb by pressing in and turning in an anti-clockwise direction.

### Replacement of Bulbs

When it becomes necessary to replace a bulb, one of the same size and type as that used originally must be fitted.

Bulbs fitted are as follows :—

Headlamp : 12-volt, 36 watt S.B.C. double-contact.

Side, tail, roof and convoy lamps : 14-volt, 7 watt S.B.C. double-contact.

### Electric Horn, Type HF1235

The horn is adjusted by the manufacturers to give its best performance and will give a long period of service without any attention. If a horn becomes uncertain in its action, making only a choking sound, or does not vibrate, it does not follow that it has broken down. First ascertain that the trouble is not due to some outside source, *e.g.* a discharged battery, or a loose connection or a short circuit in the wiring of the horn. It is also possible for the performance of the horn to be upset by the fixing bolt working loose. This can be ascertained by removing the horn from its mounting, holding it firmly in the hand and operating the push. If the horn is proved faulty, fit a replacement.

### Screen Wiper, Type CW1

The wiper is of the self-starting type, and is controlled by a switch mounted adjacent to it.

The wiper motor is provided with sufficient lubricant during manufacture and requires no further attention.

### Roof Lamp, Type TL3-R

The lamp is controlled by a switch lever fitted in the lamp base. The first movement of the lever switches on the bulb through a resistance ; further movement reduces the resistance in series with the bulb and so increases the brightness of the bulb. Set the lever to give the light best suited for the conditions of use.

To remove the bulb, press it in and turn it in an anti-clockwise direction to detach it from its bayonet fixing and then withdraw it.

### Wiring and Fuses

The wiring has positive and negative feeds to all equipment except engine ignition, which is fed by cable from the positive side only.

The negative feed is through the body of the engine.

The wiring is protected by five fuses in the fusebox in the fighting compartment (Fig. 3).

When it is necessary to replace a fuse, first check the cause of this and make the necessary corrections, or the new fuse will also blow.

Regularly check that the connections in this box are tight.

Blown fuses may be the result of loose connections in the equipment supplied by the fuse, or by vibration and movement of the vehicle, damaging the insulation, where the cable is secured by metal clips to the hull. Damage also may occur at the bottom ends of the flexible metal tubes or near the point of entry into the various items of equipment and where the cable leaves the hull.

The battery cut-off switch is near the battery (Q) (Fig. 4), and when switched off completely disconnects all the circuits from the battery.

### To Replace a Fuse

1. Swing the wire clip holding fuse cover to one side, and remove the cover.
2. Remove the holder carrying the blown fuse.
3. Remove all pieces of old fuse wire, and fit a new fuse from the wire wound on the fuse holder.
4. Make sure all the surfaces are clean and free from burning, and press fuse and holder well into its position ; make sure the connection is firm and tight.
5. Replace cover, making sure the retaining pad is holding the fuses in position.

   Bring the wire clip into position in the centre of the cover to retain it.

Remove only one fuse at a time, and replace before removing any other.

Always replace a fuse in its original position, and use only the wire supplied as spare on the holder of each fuse.

**Never use any other size or material.**

Headlamp circuit protected by Fuse A :
Size 34 S.W.G.

Sidelamp circuit protected by Fuse B :
Size 34 S.W.G.

Tail lamp circuit protected by Fuse C :
Size 34 S.W.G.

Wireless circuit protected by Fuse D :
Size 27 S.W.G.

Convoy lamp and screen wiper circuit protected by Fuse E :
Size 34 S.W.G.

The wire is tinned copper of standard wire gauge.

### Instrument Panel (Fig. 5)

This is held to the front top plate by three bolts and nuts.

Felt packings are placed between the top plate and the fixing brackets, to reduce noise and vibration.

The front of this panel is held in position by four screws.

Regularly check that these fixing screws are secure, and check that the cables and cable clip are secure and undamaged where they enter at the side

When it is necessary to replace a bulb in this panel, remove the small plate in front of the bulb ; it is only necessary to completely remove one screw. Press the bulb, turn it anti-clockwise and pull it out. Replace with new bulb and in reverse order.

To replace the ignition warning light bulb, unscrew the knurled rim holding the red glass, and pull it out complete with bulb. Withdraw bulb from the securing spring, replace new 16-volt 3-watt screw type bulb, with the three-point spring holding the glass portion of the bulb to the red glass. Replace in switchboard and screw tightly in position.

**The Battery, L-WD-3**

To top up the battery remove the lid and cell vent plugs from each battery and fill with distilled water to ½ inch above the tops of the separators.

If distilled water is not available, one of the following may be used :—

(*a*) Any drinking water that is not discoloured.

(*b*) Rain water.

(*c*) Condensed water from boiler plants which does not contain suspended matter.

(*d*) As a last resort river water may be used, but it must be strained before use.

Examine battery connections, which must be clean, tight and free from corrosion.

Connections must be kept smeared with mineral jelly.

If the battery appears weak, and will not turn the engine over, or the terminals are corroded, REPORT THE MATTER AT ONCE.

**Note :** Never allow a naked flame or a lighted cigarette near the battery vent plugs when it is being charged or immediately after charging.

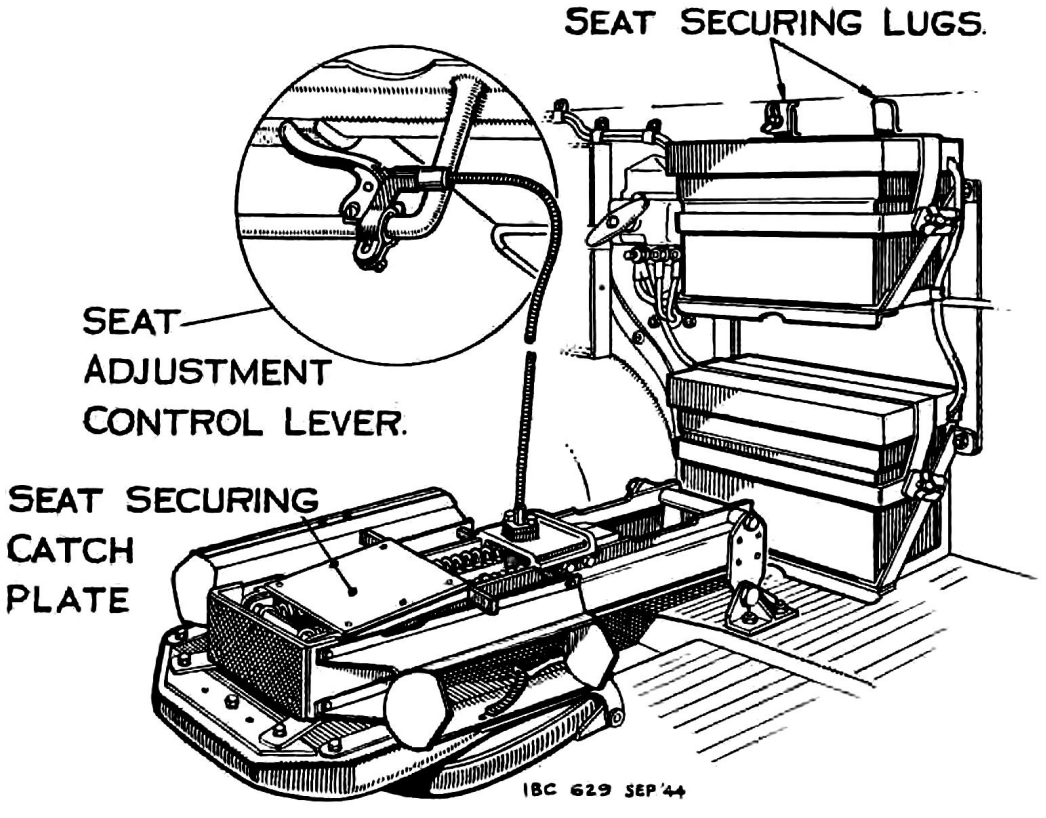



Fig. 30.—ACCESS TO BATTERIES.

## *Part II*

## STARTING

The starter is operated by a solenoid switch mounted on the commutator end bracket of the starter and which is controlled by a press button switch fitted in the instrument board.

In the event of an emergency or when making engine adjustments the solenoid switch can be operated directly by pressing the plunger under the rubber end cap of the switch. Operate the switch firmly to prevent burning of the switch contacts—press smartly and release smartly.

Observe the following points when starting the engine :—

1. See that the controls are properly set and that the ignition and petrol are switched on.
2. Operate the switch firmly and release it as soon as the engine fires.
3. Do not operate the starter when the engine is running. If the engine will not fire at once, allow it to come to rest before pressing the switch again.
4. Do not run the battery down by keeping the starter on when the engine will not start.

### The Starter M-45-G

This is secured to the clutch housing on the left side of the vehicle.

**Check the following details regularly.**

1. That the three securing bolts are tight.
2. That the three cables to starter motor are secure and that the rubber covers are undamaged and in position.
3. That the two cables to the solenoid are undamaged where they pass through any metal clips.

**Maintenance.** (In accordance with Crew Maintenance Insert to A.B. 413.)

1. Slacken the screw securing the inspection cover over the brush gear, and move this along the body of the motor.
2. Check that all brushes are free in their guides, a light pull at the flexible connection of each brush will indicate if this is free, and the pressure spring will return the brush to its position on the commutator.
3. Check each brush spring for pressure and see that it is undamaged.
4. Make sure the gear is in neutral and the ignition switched off; depress rubber cap of solenoid switch and operate starter by this. Observe any signs of sparking at brushes, and that the commutator runs true.
5. Refit the inspection cover and make sure it is in position correctly, so as to exclude all dirt and moisture.
6. Report any signs of sparking at the brushes, weak brush springs, or worn brushes.

Dirt or grease must be cleaned off the commutator with a cotton cloth.

Do not lubricate any part of the starter.

The only trouble likely to be experienced is if the flywheel gear becomes worn and the starter pinion fails to make a correct engagement, resulting in jamming of these two gears.

The following are instructions for freeing jammed starter gears :—

1. **Make sure ignition is switched off.** Remove the cover held by two screws over the shaft end, apply a spanner to square end of starter shaft now exposed and turn it in a clockwise direction by means of the spanner. When it is free, replace the cover and its two screws.
2. When the gears are badly jammed, it may be necessary to slacken off the three bolts securing the starter motor to the clutch housing before the first item mentioned above can be used to free the gears. Finally, make sure that the three fixing bolts are quite secure.

Report if this jamming occurs more than two or three times.

## *Part III*

## THE TWO-SPEED DYNAMO AND CONTROLS

**Description**

This dynamo is on the left side of the engine and is driven by twin belts. The pivoted cradle in which it is held provides the necessary belt adjustment.

The dynamo incorporates an electrically controlled gearbox which enables it to be driven either at engine speed for normal running purposes, or at an increased speed (3.17 : 1) for battery charging when the vehicle is stationary.

In this latter condition the engine is running at a speed slightly in excess of that at which it normally idles, thus conserving fuel and eliminating unnecessary engine noise ; a point of major importance under certain operational conditions.

The gearbox is controlled by the switch lever situated on the engine compartment bulkhead adjacent to the carburetter air cleaner. This lever is coupled mechanically to a control box mounted on the induction manifold. The control box contains the switch gear and also incorporates a carburetter throttle control. When high speed drive is engaged, this carburetter control increases the engine speed a predetermined amount, to give the necessary power for the increased dynamo load. The dynamo will now be rotated at its most economical speed to supply maximum output at minimum r.p.m. On the other hand, when high speed drive is in use and the accelerator pedal is depressed, thus further increasing the engine speed, the carburetter control automatically returns the dynamo from high speed to normal drive.

From the foregoing, it will be apparent that the operational efficiency of the two-speed drive mechanism is entirely dependent on the correct adjustment of the carburetter control. Correct adjustment is therefore absolutely vital, and it must be clearly understood that only fully qualified personnel should be permitted to undertake this work and then only when they are really conversant with the undertaking. Normally, no adjustment is necessary, but the removal of any of the control linkage, the carburetter or manifold, or even the disturbance of any of these items are sufficient to upset the adjustment and if such an event occurs the high speed drive must on NO ACCOUNT BE USED until the personnel and equipment are available for re-checking.

**Operation.**

**To operate Dynamo on High speed Drive**

DO NOT ATTEMPT TO ENGAGE THE HIGH SPEED DRIVE WHEN THE VEHICLE IS MOVING. It must only be engaged with the vehicle stationary and at normal engine idling speed.

1. Switch on the ignition, start the engine, warm it up and then allow it to run at normal idling speed.
2. Move the switch lever (BB. Fig. 4) clockwise and hold it in this position for 10 seconds. This should allow the high speed gear to become fully engaged.
3. Release the switch lever and ensure that it returns fully to its stop. Note that the ammeter is indicating approximately 10 amps. charge when the battery is almost fully charged

(This will vary according to the degree to which the battery is discharged.) In an extreme case this may be as high as 55 amperes. Belt slip must not occur, as this will result in a reduced charging rate, increased belt and pulley wear, and hot pulleys. (*See* belt adjustment, page 42.)

At the end of the charging period, normal dynamo drive must be re-engaged by increasing the engine speed through the accelerator pedal or hand throttle control.

**Maintenance.** (In accordance with Crew Maintenance Insert to A.B. 413.)

**Check the following details**

1. That all bolts or nuts holding the dynamo in position are secure.
2. That the twin belts are in sound condition and adjusted correctly. The belts have correct tension when it is possible to depress the belt $\frac{3}{4}$ inch from its normal straight line by a light hand pressure applied midway between the pulleys. (*See* belt adjustment, page 42.)
3. Check oil level in dynamo gearbox. (*See* lubrication, page 42.)

**Check the following details carefully as instructed**

1. That the screws securing the bonding glands at the three cable entries are secure.
2. Remove terminal box lid and check that the terminal connections are tight. Refit lid to terminal box.
3. Slacken the screw securing the brush gear inspection cover and remove this cover.
4. Examine all brushes. Each must be free in its guide. A light pull on the flexible connection of each brush will indicate if it is free, and the pressure spring will return the brush to its position on the commutator.

   If any brush is not free, remove it from its guide, clean the inside of this guide with a cloth and wipe off any grease and dirt which may be on the side of the brush.

   ALWAYS, when replacing a brush, be sure it is replaced in the guide in exactly the position it occupied originally. The flexible brush connection must be free, and clear of any obstruction.
5. If the spring pressure is weak (13-14 oz. is correct), move the free end of the spring into a further notch on the brush arm until it is correct.
6. Check that the commutator is clean, dry, and has a smooth surface running perfectly true. Clean off any dirt or grease from the commutator, and report any roughness or burning of the surface, or if it has been worn out of true.
7. Replace the inspection cover and secure it in position correctly, so as to exclude dirt and moisture.

   Report wear on brushes, when any brush is reduced to ½ inch long. Report oil or grease escaping from the bearing on to the brush gear or commutator.
8. Drain and refill dynamo gearbox. (*See* lubrication, below.)
9. Check the dynamo speed with a tachometer held firmly in the shaft centre at commutator end.

   The dynamo should be running in high speed drive, with vehicle stationary, and the speed should be in the limits 1,900–2,150 r.p.m. when charging at approximately 10 amps. If the dynamo speed is outside these limits, adjust the control box operating shaft as described on page 44. (The dynamo speed may drop to 1,600 r.p.m. if charging rate is near the maximum of 55 amps.)

**LUBRICATION.** (*See* Fig. 31.) (As directed by the Crew Maintenance Insert to A.B. 413 and Lubrication Chart.)

First remove all dirt, etc., from the plugs for draining, filling or checking the oil level.

Dirt or other matter, except the correct lubricant, may cause serious damage.

Remove the lower of plugs (27) Fig. 31.

Remove plug (26) and top up with oil until it overflows from the lower plug hole from which plug (27) has been removed.

Replace the two plugs when topped up and oil has ceased to overflow from plug hole (27).

Take care that sealing washers are replaced on plugs and that these are oil tight. Carefully check for any oil leaks. Renew any sealing washers as necessary.

(At regular intervals as directed by Crew maintenance insert to A.B. 413.)

Drain the oil from dynamo gearbox by removing plug (28) Fig. 31.

Refit plug (28) and remove plugs (26) and (27). Refill with oil as detailed above, then refit plugs.

Remove plug (29) from dynamo shaft end, and thoroughly saturate the wick with oil.

Replace the plug.

Take care that sealing washers are replaced on plugs, and that all these are oil tight. Carefully check for any oil leaks. Renew any sealing washers as necessary.

**Adjustments**

Belt Adjustment. (*See* Fig. 31)

1. Slacken the two nuts locking the turnbuckle.
2. Rotate the turnbuckle until the belt tension is such that hand pressure on the belt midway between fan and dynamo pulley, will allow it to be deflected ¾ inch from its normal position.
3. When the adjustment is correct, lock the turnbuckle by the two nuts.

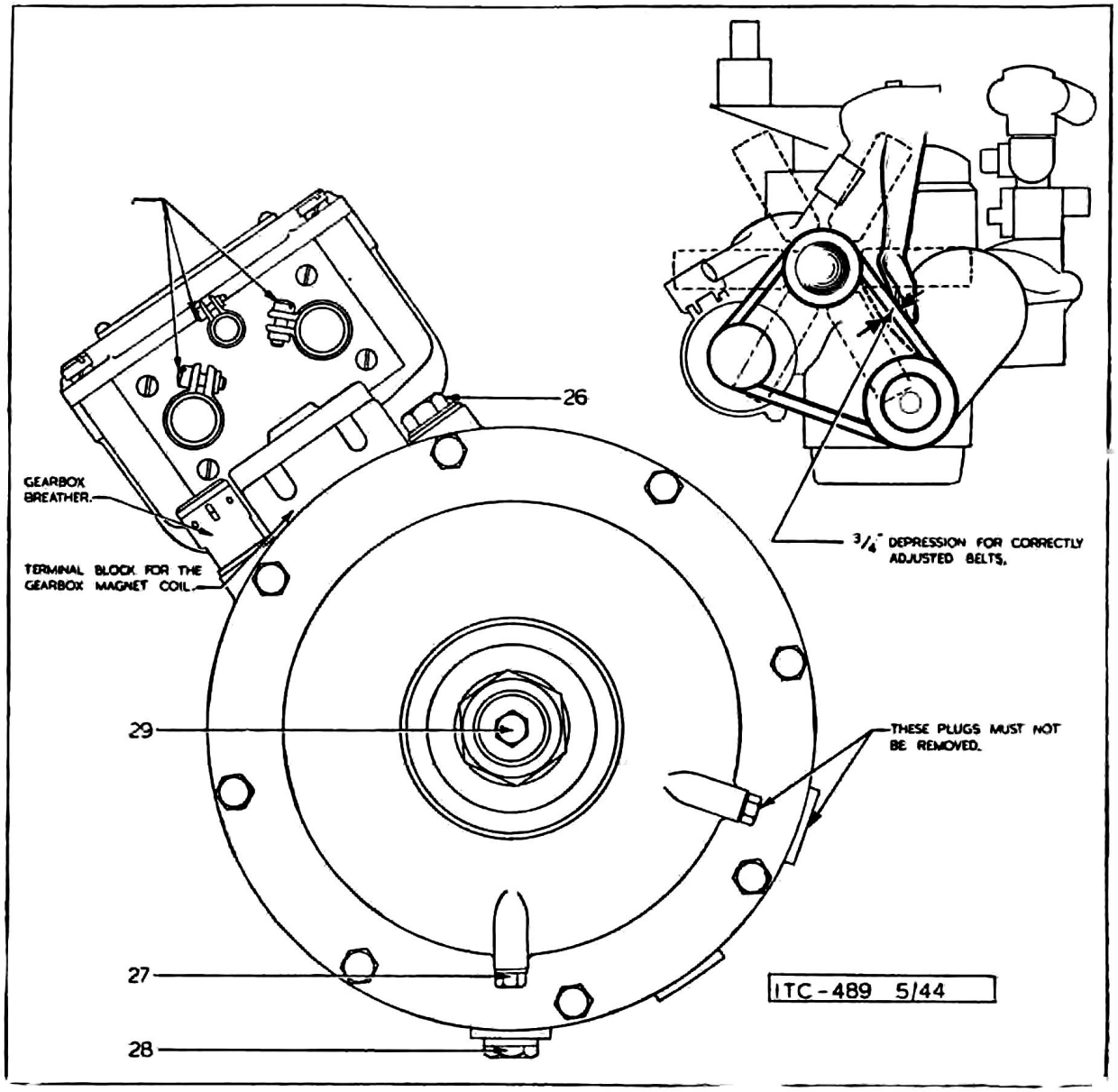



Fig. 31.—DYNAMO GEARBOX LUBRICATION POINTS AND BELT ADJUSTMENT.

**Fitting New Belts**

Always fit new belts in pairs.

1. Slacken the turnbuckle locknuts, and rotate the turnbuckle until the belts are quite slack.
2. Disconnect the turnbuckle by removing the top bolt securing it to the bracket.
3. Wedge the dynamo until it is as near as possible to the cylinder block.
4. Remove the old belts.
5. Fit a new belt to the first line of pulleys (use only hands or a piece of thin rope for this operation).
6. Transfer this belt gradually to the second line of pulleys (do not use tools such as tyre levers or screwdrivers).
7. Fit the second belt to first line of pulleys.
8. Refit the fixing bolt and secure turnbuckle to the bracket.
9. Adjust belt tension to $\frac{3}{4}$ inch deflection as described above, and tighten the turnbuckle locknuts.
10. Run engine to check satisfactory operation of the new belts.

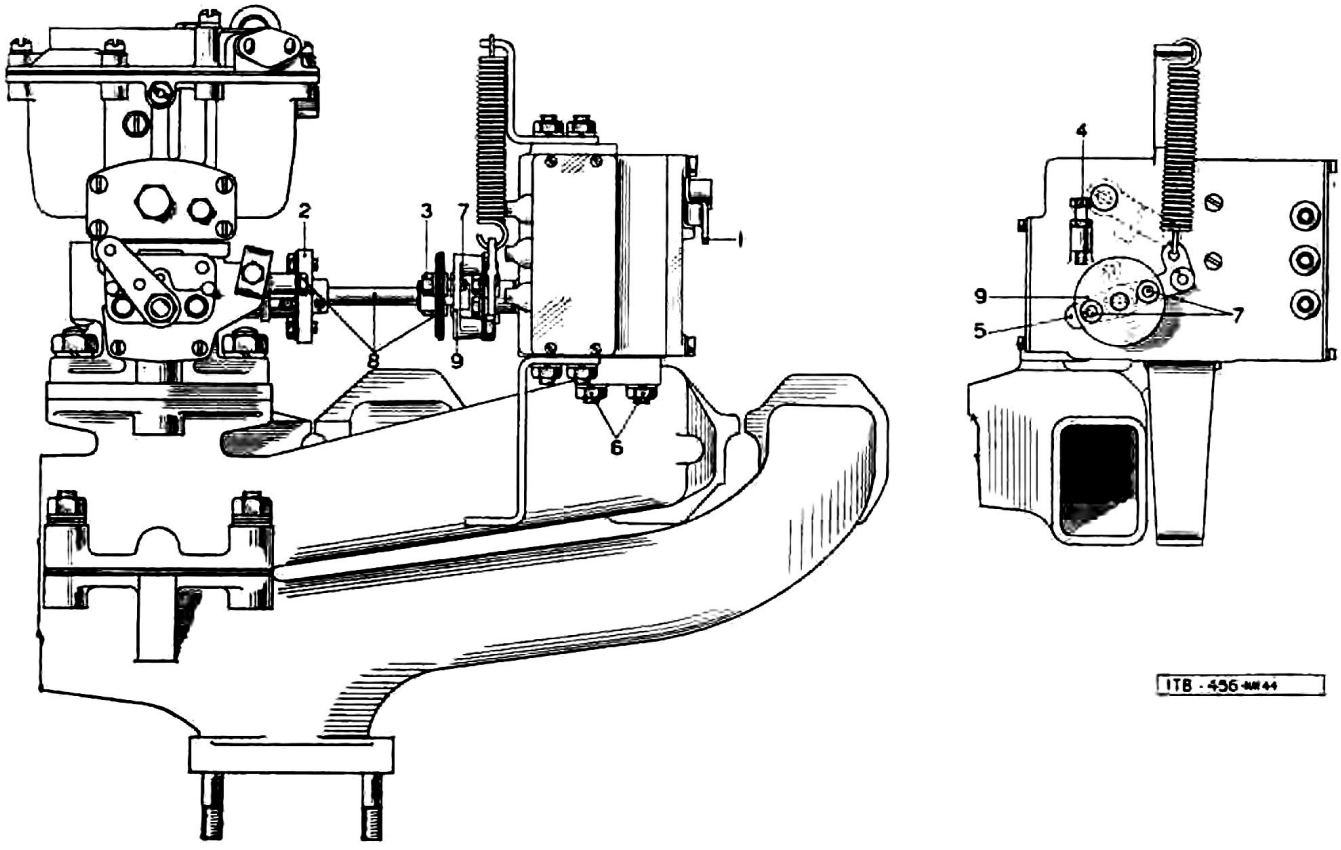



Fig. 32.—CONTROL BOX AND OPERATING SHAFT.

**The Operating Shaft.** (*See* Fig. 32)

DO NOT REMOVE CARBURETTER OR INTERFERE WITH THE OPERATING SHAFT BEFORE READING THE FOLLOWING INSTRUCTIONS:—

The adjustment of the operating shaft is critical and if not correct may cause serious damage.

This adjustment can only be made successfully if a tachometer is available to check the dynamo speed.

DO NOT disturb any screwed connections of the operating shaft if a tachometer is not available for re-checking the adjustment when removing either carburetter or control box. It must be disconnected by withdrawing the shaft and driving pins from the coupling as described on page 45. (Removal of carburetter in emergency.)

The operating shaft must not be slackened or removed from the carburetter. If a replacement carburetter is fitted, or whenever any carburetter adjustments have been made, other than the regular maintenance of cleaning filter, float chamber, jets or attention to petrol leakage, the operating shaft must be adjusted immediately a tachometer is available and if it is suspected that the adjustment of the operating shaft is faulty and causing excessive dynamo speed, high speed drive must not be employed. To safeguard against its use disconnect the switch lever from the control box at the ball joint. It is then necessary to pull the control box lever (1) fully down into its lowest position to complete the dynamo charging circuit for normal operation. Report the operating shaft for re-adjustment at earliest opportunity.

**To adjust the Operating Shaft.** (*See* Fig. 32)

Tools necessary are:—Screwdriver, $\frac{1}{8}$ inch Whit. spanner, $\frac{1}{4}$ inch Whit. spanner and tachometer.

Dynamo speed range when operating on high speed drive is 1,900 to 2,150 r.p.m. Approximate charging rate, dependant on condition of battery, 10 amps.

1. Start up engine and run it until warmed up.
2. Hold the coupling (2) by means of the $\frac{1}{4}$ inch spanner and keep light contact between the throttle and throttle adjusting screw until adjustment is complete.
3. Slacken the two nuts (3) with the $\frac{1}{8}$ inch spanner.
4. Turn the switch lever (inside fighting compartment) clockwise to engage high speed drive.
5. Turn throttle adjusting screw until dynamo speed is 1,900 to 2,150 r.p.m. as indicated by tachometer held in shaft centre at commutator end. Make sure this reading is correct and that no slip is occurring.
6. Maintain the light contact between throttle and adjusting screw and tighten the two nuts (3). It is important that these are tightened gradually and simultaneously, to prevent a faulty setting.

7. Release the ¾ inch spanner from coupling, check that the dynamo speed is within the limits.
8. Open the throttle to engage normal drive.
9. Unscrew the throttle adjusting screw until the engine runs at the normal idling speed of 400 r.p.m.
10. Operate the lever to engage high speed drive.
11. Check dynamo speed to ensure that it is within the limits 1,900 to 2,150 r.p.m. Observe ammeter to ensure that the dynamo is charging approximately 10 amps.
12. Open throttle to engage normal drive if speed and charging rate are correct, or readjust the operating shaft if the dynamo speed is out of the limits.

    Repeat 10, 11 and 12 three times to ensure that the setting remains constant.
13. Stop engine, open throttle to engage normal drive.

    Use ¾ inch spanner on coupling (2) and turn the throttle until it is wide open against the stop screw. Adjust screw (4) until it makes contact with lever (5). Then screw it down a further half turn and secure it by the locknut.

**Note :** The cable for operating the throttle must not be pulling on the operating lever of the control box, nor must the clevis and clevis pin be binding on this lever, otherwise the control box mechanism will not engage correctly, or it may fail to engage.

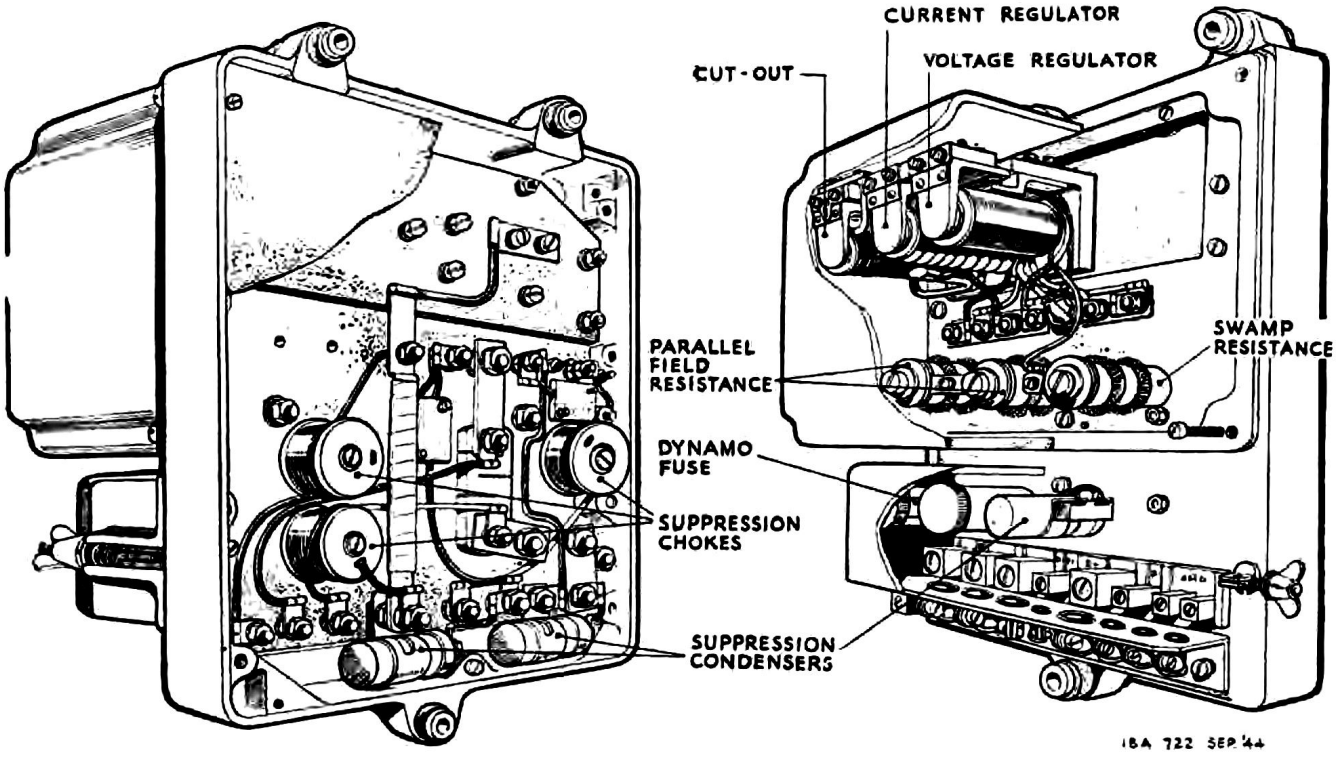



Fig. 33.—CONTROL BOARD.

### Removal of Carburetter in Emergency

To remove and replace carburetter without re-adjusting the operating shaft when a tachometer is not available, remove all necessary connections from the carburetter, except those to the operating shaft.

Slacken the three nuts (6) Fig. 32 securing the control box to manifold.

Lift the carburetter and control box until the carburetter and operating shaft can be detached from the control box coupling by withdrawing the two driving pins (7) from coupling (9). Take care not to strain or damage the operating shaft and couplings (8). If any doubt exists that the adjustment of the operating shaft has been disturbed on replacement of the carburetter, disconnect the switch lever from the control box at the ball joint to prevent operation of the dynamo on high speed drive. Pull the lever (1) fully down to allow the dynamo to operate on normal drive. Report that operating shaft requires re-adjustment at earliest opportunity.

### Emergency check of Dynamo Speed

In emergency only, the following method may be used as a check on the dynamo speed, but it must not be considered as really reliable, and the adjustment of the operating shaft described on page 44 must be carried out at the earliest possible opportunity.

Remove the H.T. cable from a plug and hold this to engine body so that a spark occurs regularly at this point.

With the engine running and the dynamo in high speed drive, very carefully count the sparks for a quarter of a minute. This will require some practice before an accurate count can be made. Count only in units of 10, and indicate each 10 by holding successive fingers on the hull. Remember your early counts will be wrong, but careful practice will ensure reasonable accuracy. The limits are 72 to 82 sparks for a quarter of a minute, with 10 amps charging rate. Finally, report the operating shaft to be checked by tachometer at early opportunity.

**To Renew a Blown Dynamo Fuse**

1. Turn the battery cut-off switch to "off."
2. Remove the terminal cover from the control board.
3. Pull the spring loaded knobs holding the fuse in position, and turn each knob until held clear of the fuse.
4. Remove all pieces of the old fuse and ensure that each contact face is clean so as to make a good contact with the new fuse.
5. Next try to find the cause of the fuse blowing; this may be due to a loose connection in the charging circuit, or a faulty cable.
6. Take a spare fuse from the spring clip in the terminal cover and carefully fit it in position on the fuse pillars.
7. Turn both spring loaded knobs and allow them to hold the fuse firmly in position.
8. Replace the terminal cover.

**Note :** Should a dynamo fuse blow repeatedly, the circuit must be checked by workshop personnel.

# *CHAPTER VI A*

# THE HULL

The hull is mainly formed by sections of armour plate welded together, and is held to the chassis by 14 bolts. (*See* Fig. 25.) At the front a detachable plate held by eight screws and nuts, provides access to the inner forward end of the vehicle. Below this, another plate held by nine bolts and nuts gives protection to the front axle. Valances are held at each side of the hull at the bottom by nuts and the louvre plate at the rear of the vehicle is held by 11 bolts. Six lookout points are provided and these may be held at the open or closed position by self-locking handles. The driver's windscreen is protected when necessary by a visor which may be secured in the open, half open or closed position by the operating handle. An electric windscreen wiper is fitted and the switch is attached to the body of the windscreen wiper motor.

Two sliding doors on the roof allow easy access to the vehicle. These are operated from inside and spring catches retain them in the fully open or closed positions. Two side doors are normally held closed by spring catches, and they may be opened from outside by a key provided. Hasps are fitted to these doors and hull plate so that they may be locked as required. A locker for tools, etc. is incorporated with each front mudguard. These have dust tight joints at the lids and provision for locking them. The mudguards are held to the hull by bolts and nuts.

An interior light is provided on the hull roof adjacent to the gunners seat. Adjustable seats are provided for the driver and gunner, and an emergency seat (Fig. 3) beside the driver accommodates a third member when necessary. The gunner's seat is raised by spring action, controlled by a trigger mounted on the roof grab handle forward of the sliding top door. (*See* Fig. 30.) With this seat in the raised position, the gunner's head and shoulders are above the roof level, giving him unrestricted observation, and placing him in a position to reload the Bren gun. When the catch (Fig. 30) holding the gunners seat to the engine bulkhead is lifted, the seat swings forward and lies on the floor to give access to the two batteries.

**Lubrication**

First wipe all grit and dirt from the places to be lubricated and then apply fresh lubricant to the following : —

1. The two side doors. Hinges, operating handles, door edges.
2. Lookout doors and drivers visor. Hinges, operating handles and door edges.
3. Engine compartment top covers. Hinges, locking catches and the hinges of the support rods
4. Sliding doors on roof. All slides and spring catches.
5. Gunner's and driver's seats. All slides and spring catches.
6. Swing plate on the rear covering starting handle aperture.
7. Hinges on tool lockers and the straps retaining spare P.O.W. containers.

**Maintenance.** (In accordance with Crew Maintenance Insert to A.B. 413.)

1. Inspect the nuts and bolts securing the hull to chassis. (Fig. 25.) Front axle shield. Side valances. Rear louvre plate. Front armour plate.
2. All bolts and nuts on lookout and other doors.
3. Spring catches on doors and seats.
4. Inspect the security of all internal and external fittings to the hull.
5. Inspect the hull for signs of cracks or other damage. Report any fault that cannot be dealt with by the crew.

Water may be drained from the hull when necessary by removing the three plugs in the floor. One of these is shown in Fig. 4 and they may be removed by a half turn to release the spring catch.

# *CHAPTER VIIA*

# THE GUN MOUNTING

## MOUNTING, A.A., P.L.M., BREN M.G., Mk. I

The P.L.M. mounting supports a single Bren, drum fed machine gun, the mark and serial number of the mounting being given on an inscription plate attached to the main pillar of the mounting. The mounting has a universal movement controlled by a handle bar unit, a turning movement of which traverses the gun, whilst a swinging movement elevates or depresses the gun. Firing is effected by a duplex trigger mechanism embodied in the handle bar unit.

A spare drum of ammunition is carried on a bracket which forms part of the mounting.

The main pillar of the mounting is secured to the fighting compartment top plate and a travelling lock serves to hold the mounting locked, with the gun horizontal, when the gun is out of use. The travelling lock is released by pressure on a spring catch.

**The travelling lock must be in use when the gun is not in use.**

A foresight and a rear sight are fitted to the mounting at the left.

### Adjustments

*Firing Gear*

Adjustments to the firing cables are effected at the rear of the mounting by means of the adjusting nut to each cable at the point where the cables are connected to the actuating levers of the pivot bar. The two cables should be adjusted so that the trigger actuating rod connected to the firing lever at the left-hand end of the pivot bar just contacts the trigger of the Bren machine gun. The gun should fire upon pressure on either trigger of the handle bar unit.

*Handle Bar Unit*

The position of the handles may be adjusted to suit the gunner by sliding each handle along the fork pin sufficiently to disengage the spring loaded stud from the quadrant and moving the handles to new positions as provided by slots in the quadrants.

It is essential that the handle-bars of the P.L.M. mounting when not in use, should be set horizontally and at right angles to the fighting compartment guns to prevent interference with the latter. When the machine gun is required for use, or the gunner is at the alert, the handle-bars should be turned towards the gunner and adjusted to a position of better leverage.

### The Machine Gun Anchorage

The position of the clamps on the cross tube and cross bar of the mounting, and the position of the anchorage lugs in the clamps may be adjusted, after slackening the clamping bolts, to align the eyes of the anchorage lugs with the co-operating members on the M.G. The adjustment should be such that the gun assumes a horizontal position or thereabouts when the parking gear is engaged.

### Removing and Replacing the guns

Removal of the bolts from the front and rear anchorage lugs at the point where they are connected to the gun will release the gun from the mounting complete with cocking rod. Replace the bolts after the gun has been removed. When replacing the gun both bolts should be tight.

Do not interfere with the setting of the two anchorage lugs unless necessary. (*See* M.G. anchorage.)

Check firing gear adjustment after replacement of guns. (*See* Firing Gear Adjustment.)

**Maintenance and Lubrication.** (In accordance with Crew Maintenance Insert to A.B. 413.)

The whole of the mounting must be kept clean and free from dust and accumulated grease, especially the gear mechanism. All bearing surfaces must be frequently oiled. At the following points where Tecalemit lubricators are fitted oil is to be introduced at intervals as necessary.

| | |
|---|---|
| Handle-bar Unit . . . . | Two points |
| Main Pillar . . . . | One point |
| Bearing Bracket . . . . | Three points |

Graphited grease should be applied lightly to the gears mounted on the bearing bracket and to the teeth of the actuating pillar of the handle-bar unit.

Oil for cleaning and lubrication must be used as directed by the lubrication chart and the Crew Maintenance Insert to A.B. 413. For temperatures above and below normal, use lubricants specified by Force Headquarters.

Paraffin is used for removing old lubricant.

SECTION

# B

# DETAILED DESCRIPTION OF THE MOVING PARTS OF THE VEHICLE

# CONTENTS

## SECTION B

# LIST OF ILLUSTRATIONS

## SECTION B

# *CHAPTER IB*

# THE POWER UNIT

## *Part I*

## THE ENGINE

The engine is mounted in the rear of the chassis. It is a six cylinder side-valve unit with a bore of 85-mm. and a stroke of 120-mm. giving a cubic capacity of 4,085-cc. The horse-power developed is approximately 87 at 3,300 r.p.m.

### Cylinders

The crankcase and cylinders are an integral casting, the crankcase is ribbed to provide housings for the crankshaft main bearings and also to prevent distortion.

A feature of the cylinder block is the spacing of the bores. These instead of being equidistant, are located in pairs, the two bores of a pair being close together, with a larger space between each pair. This arrangement has the advantage of reducing the overall length of the cylinder block, while still permitting unrestricted flow of cooling water from the block to the cylinder head.

### Crankshaft

The crankshaft has counterweights and is balanced statically and dynamically. A balance weight is bolted to the crankshaft web between crank pins Nos. 1 and 2, Nos. 3 and 4, Nos. 5 and 6. This eliminates crankshaft whip and assists even distribution of the load on the main bearings over their entire surface.

The four main bearings are detachable steel-backed white metal shell type, constructed in halves and held in position on the journals by bearing housings and caps. Small tags on the edge of the bearings fit into recesses machined on the joint between the bearing cap and housing to prevent rotation. End thrust is taken on steel-backed white metal washers fitted on each side of the rear main bearing, the lower half of each washer being dowelled to the bearing cap.

At the clutch end of the crankshaft, a flange provides connection for the flywheel, and a ball bearing in this end of the crankshaft is for the purpose of supporting the end of the primary shaft of the gearbox. Oil is prevented from escaping past the main bearing at this end by grooves cut on a raised portion of the shaft adjacent to the bearing. (*See* Fig. 34.) At the other end a long key provides the drive for the timing sprocket and dynamo driving pulley, and these are held in position by the starting handle dog screwed into the end of the crankshaft.

### Connecting Rods

These rods have an " H " section and the big ends are split to enable assembly to the crankshaft. The bearing caps are secured to the connecting rods by special bolts and nuts, although an alternative design incorporating integral studs instead of loose bolts is also used.

The big end bearings are of white metal, run directly into the rod and cap, the whole being accurately reamed to form a bearing surface.

An oil way is drilled up the centre of each rod from the big end to the small end brush, to provide lubrication for the gudgeon pin. A small hole is also drilled in the boss of each big end to create a fine oil spray for the cylinder walls. The small end bush is bronze and is pressed into the rod, and this has an internal groove for lubrication of the gudgeon pin.

The connecting rods are offset in relation to the big end, one type fitting cylinders 1, 3 and 5 while the others are offset for cylinders 2, 4 and 6.

### Pistons

The pistons are made of a light alloy, and are provided with four rings. The two top rings are plain compression rings while the one immediately above the gudgeon pin is an oil scraper type. A plain compression ring is fitted to the bottom of the piston skirt. Expansion of the piston is allowed by a " T " slot cut in the skirt on the non-thrust side.

The gudgeon pins are fully floating and are positioned by circlips at each end.

### Cylinder Head

This is detachable and is secured to the block by 22 studs and nuts, and a copper asbestos gasket of the usual type forms a compression joint at this point. The lower face of the head is designed to form the combustion space for the cylinders. Passages in the cylinder head casting allow free flow of the coolant from the block to the outlet pipe on top of the cylinder head and so back to the radiator.

Internal stiffening ribs in the head assist in preventing distortion.

### Camshaft

The camshaft is located in the right-hand side of the crankcase in four steel-backed white metal shell type bearings that are lubricated direct from the main bearing oil ways.

It is driven by a roller chain from the crankshaft sprocket.

A helical gear mid-way along the camshaft engages with another gear on the oil pump spindle and so drives the oil pump and also the ignition distributor connected by a dog coupling, to the oil pump spindle.

An eccentric is formed on the camshaft to operate the mechanical petrol pump.

### Timing Chain Tensioner

The timing chain is tensioned by a wide, curved, flat spring carried on a shoe hinged at one end, and a toggle link pivoted at one end engages a spring loaded

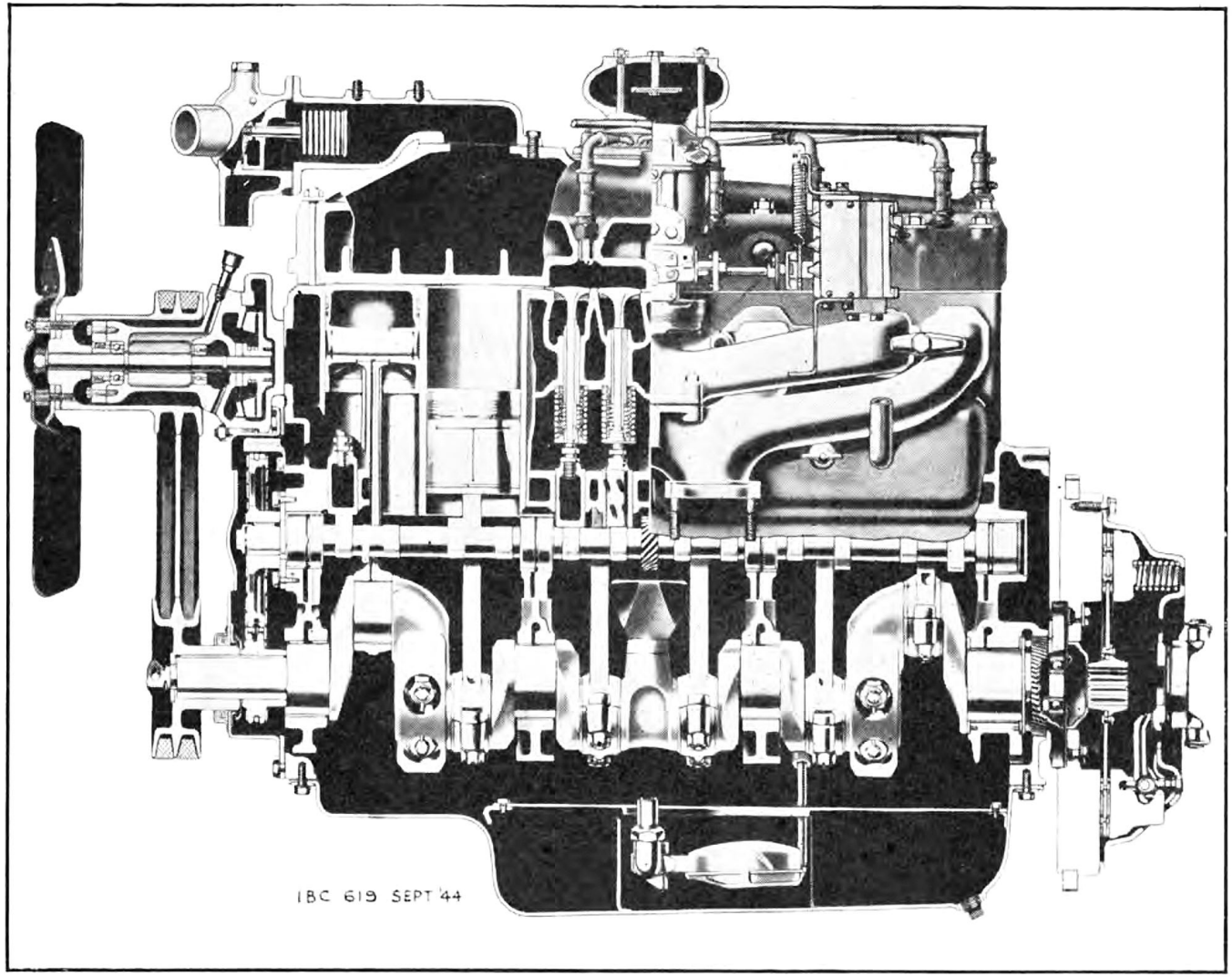



Fig. 34.—ENGINE—LONGITUDINAL SECTION.

piston located in the shoe to provide the necessary pressure. This cylinder and piston is damped to prevent rapid oscillation, by being maintained full of lubricating oil.

### Tappets

The tappets are hollow steel cylinders located in guides formed in the metal of the valve chest. Slots in the tappet wall ensure adequate lubrication. The tappet rides on the cam in the usual manner, and correct clearance between the tappet and valve is obtained by a screw adjustment in the top of the tappet which is locked by a nut.

Rotation of the camshaft therefore opens each valve a predetermined amount at the correct instant to allow gas to enter and leave the cylinders. The valves are returned to the closed position by springs.

### Valves

The valves are arranged in position immediately above the camshaft and tappet assemblies, and operate in guides pressed into the cylinder casting.

Each valve is closed by two springs, one within the other and these springs are positioned between the top of the valve chest and a collar fitted round the valve stem. The collar is held to the valve stem by split conical cotters.

### Induction and Exhaust Manifolds

Both manifolds are secured on the valve chest side of the cylinder block.

The induction manifold has three branches, each mating with ports in the cylinder block and supplying two cylinders.

The carburetter is mounted on a flange immediately above the point where the three branches meet, and this point is separated from direct communication with the exhaust manifold only by a copper plate, so that a hot spot is provided upon which all the incoming petrol-air mixture impinges before passing to the branch pipes. This ensures complete vaporisation of the particles of petrol before the mixture enters the cylinders.

### Water Pump and Fan

The centrifugal vane type water pump is located at the timing cover end of the cylinder block. The spindle, which carries the impeller vane, is mounted on two ball bearings in a cast iron housing and projects through it to carry the fan driving pulley, which is driven by twin "Vee" belts from the crankshaft pulley.

Between the rear face of the impeller vane and the pump spindle housing is a carbon washer, driven by a peg so that it rotates with the spindle and is held in contact with the face of the housing by a coil spring, while between the spring and the carbon washer is a rubber sealing washer. This combined rubber and carbon sealing gland is not adjustable. In the event of slight leakage of coolant past the gland, a drain hole is provided in the base of the annular space separating the two bearings from the impeller end of the housing.

The cooling fan, which is bolted to the water pump pulley, operates in the reverse manner from normal, and expels air from the engine compartment through the radiator, instead of drawing air through the radiators into the engine compartment.

## *Part II*

## CARBURETTER

Twin float chambers are used in this downdraught carburetter to ensure constant supply to the engine regardless of gradient. The carburetter comprises a main unit for normal running and a special device for instant starting under all weather conditions.

There is an adjustable control for slow running or idling.

To limit the speed of the engine, irrespective of the accelerator pedal position, a throttle governor is sealed in the carburetter.

In addition, the system includes an economy device which supplements the main source of fuel mixture for acceleration and high speeds, while permitting the use of a weaker mixture for normal running.

The two float chambers are interconnected by means of an enclosed cavity formed by the side cover plate in which the main and starter jets are secured. The main jet assembly, which is supplied with petrol from the cavity, is therefore located mid-way between the two float chambers. (Fig. 35.)

The two floats are connected by means of levers attached to a spindle. One of these levers operates the single fuel intake (needle) valve. This design ensures that the petrol level in the main jet assembly remains constant under all operating conditions.

### The Starter Carburetter

Integral with the main unit, the "starter" device functions independently. It has two phases of operation—one for starting from cold under normal conditions, and the other to suit conditions of severe frost.

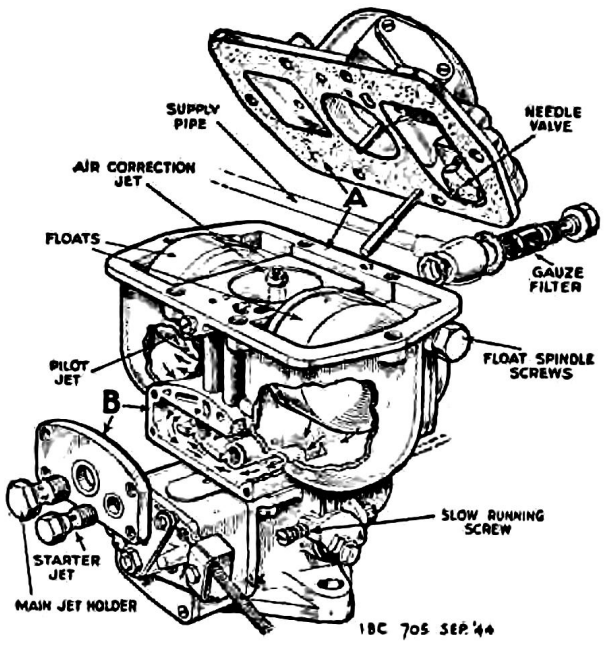



Fig. 35.—CARBURETTER FLOAT CHAMBERS.

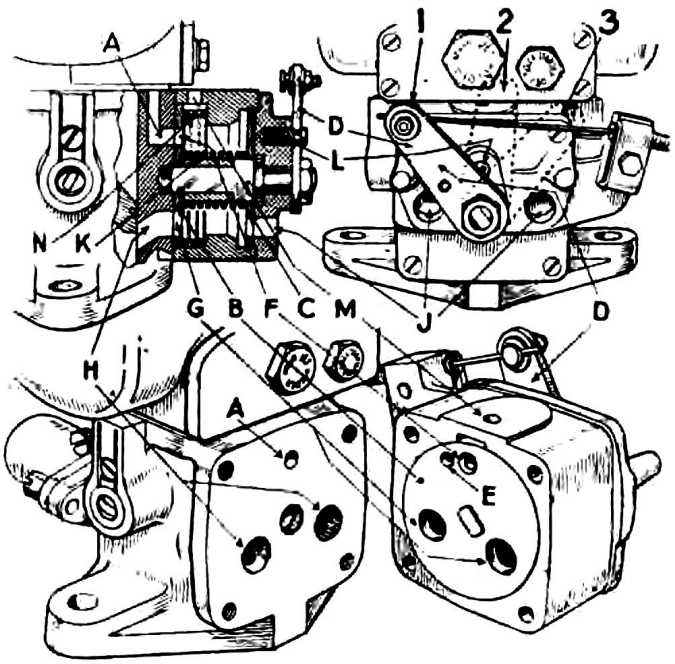



Fig. 36.—STARTER CARBURETTER.

Fig. 35 shows how petrol reaches the starter jet from the inter-connecting cavity between the two float chambers. Then the petrol passes through suitably drilled passages in the carburetter body, finally reaching the point (A) in Fig. 36.

Two discs (B) and (C) are mounted on an operating spindle, the rotation of which is controlled by the lever (D). The disc (B), which is held in spring loaded contact with the carburetter face by the spring (N), is drilled with four holes (E) and (F) to permit entry of fuel to the mixing chamber, and (G) to allow the mixture to pass into the induction pipe by way of the two channels (H). The other disc (C) is also in spring-loaded contact with the opposite wall of the mixing chamber, the air supply to which is obtained through two holes (J) in this wall. When the lever is operated, these holes register with two similar holes in the disc (C). This disc is also capable of considerable lateral movement along the spindle, the movement being controlled by the spring (K).

### Starting Up

When starting up the engine from cold in NORMAL weather the starter carburetter knob is pulled out to its first stop. This, in turn, pulls the lever (D) (Fig. 36) half-way through its arc of travel (2), where it is held by the spring-loaded ball (L). In this position the small hole (E) in the disc (B) registers with the fuel way (A), the holes (G) with the channels (H), and the holes in the disc (C) with the air jets (J).

thereby supplying a mixture of approximately 5 to 1 air petrol ratio.

In conditions of SEVERE FROST the knob is pulled out to the first stop, turned half left and pulled out again; this takes the lever (D) to the full limit of its travel (3). The large hole (F) in the disc (B) registers with the fuel way (A), the holes (G) remain in line with the channels (H), while the air jets (J) are blanked off by the disc (C), thus closing off all air from the source. There is, however, a permanent air bleed which takes the form of a small hole (M) in the top of the mixing chamber.

Immediately the engine fires, the suction in the mixing chamber, between the two discs, pulls the outer disc (C) off its seating, thus permitting the entry of air and weakening the mixture.

This weakening process is progressive; as engine speed rises, so the suction in the mixing chamber increases and, in turn, the disc is pulled farther off its seating against the pressure of the spring (K).

The initial mixture strength is approximately 1 to 1 air petrol. It is important, therefore, that the starter carburetter control is pushed back to the normal position as soon as possible.

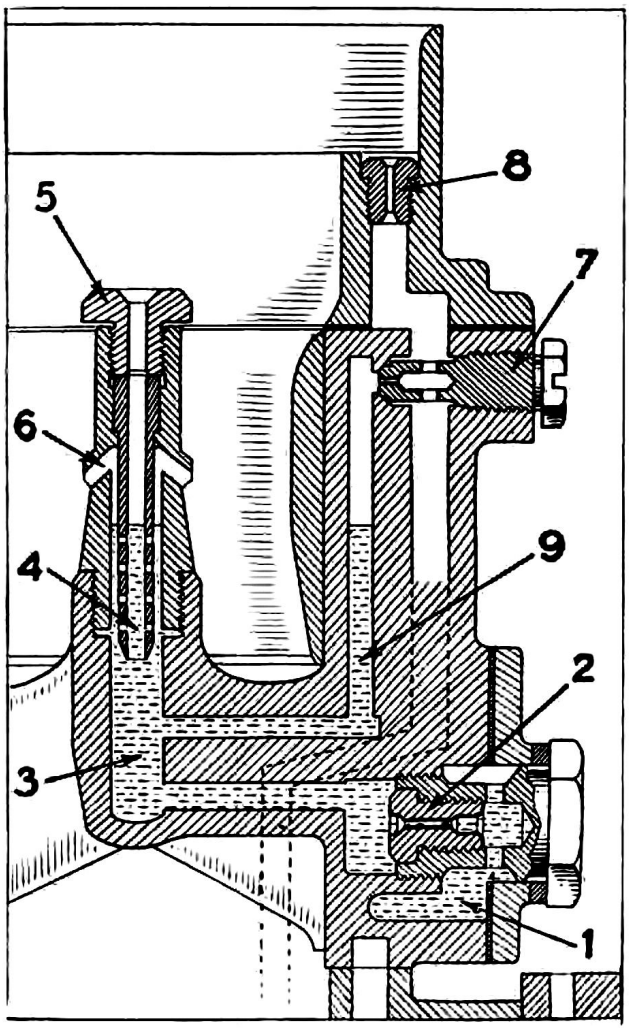



Fig. 37.—FUEL SUPPLY TO MAIN AND IDLING JETS.

During the use of the starter carburetter, the main throttle is kept shut, but if it is necessary to warm up the engine while the vehicle is stationary, slow opening of the throttle will relieve the suction on the air control disc (C) and prevent the engine stalling through over-richness. Alternatively, if it is required to drive away immediately, the starter carburetter control may be pushed to the normal, and alter the closed position while so doing.

### The Main Fuel Supply

Concerning the main fuel supply, petrol passes from the float chamber inter-connecting cavity (1) (Fig. 37), through the main jet (2) into the emulsion tube well (3). Thence it passes up the drilled emulsion tube (4), where it meets air entering via the correction jet (5). The resulting mixture passes through the six holes in the emulsion tube into the space between the tube and the wall of the petrol well. Opening of the throttle causes a high velocity air current through the choke tube, which draws the mixture upwards and into the air stream through the six radial holes (6), two of which are shown on Fig. 37.

Located immediately above the main jet holder (Fig. 35), the idling or pilot jet is easily removable without any dismantling of the carburetter. This jet (7) (Fig. 37) is supplied from the emulsion tube well by a small drilled channel (9). Above the pilot jet is the pilot air bleed (8), which provides a permanent source of air supply for the emulsion which, so formed, passes vertically downwards through the

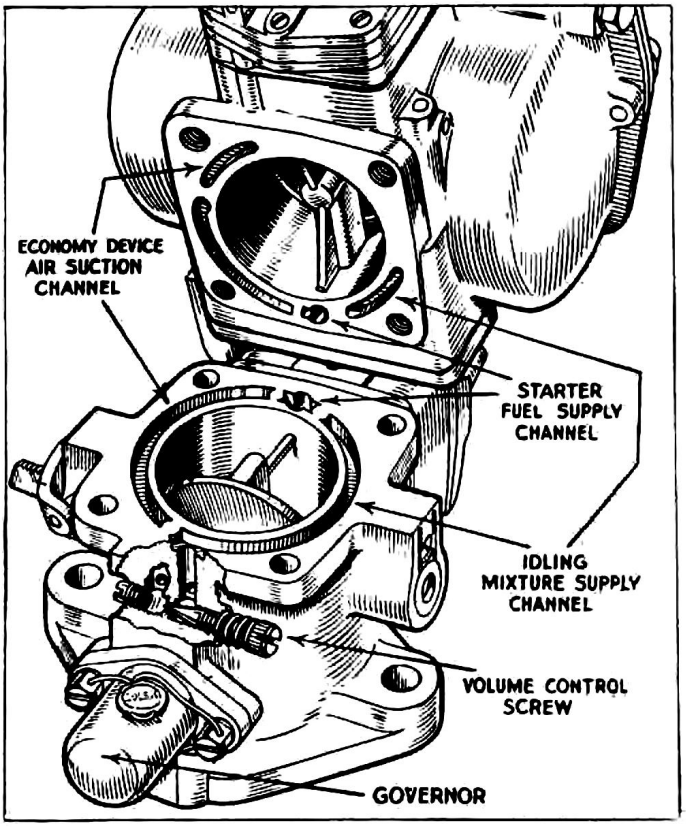



Fig. 38.—CARBURETTER, TOP AND BOTTOM HALVES.

channels shown in Fig. 38 to the induction pipe. Its passage is regulated by the volume control screw.

**The idling or pilot jet** (7, Fig. 37) provides the restricted fuel mixture for "ticking over." A slow-running screw is mounted on the abutment plate of the throttle lever (Fig. 35). This limits the closing of the throttle and thereby determines the engine's idling speed. Screwing in this part increases engine speed, and screwing out has the opposite effect.

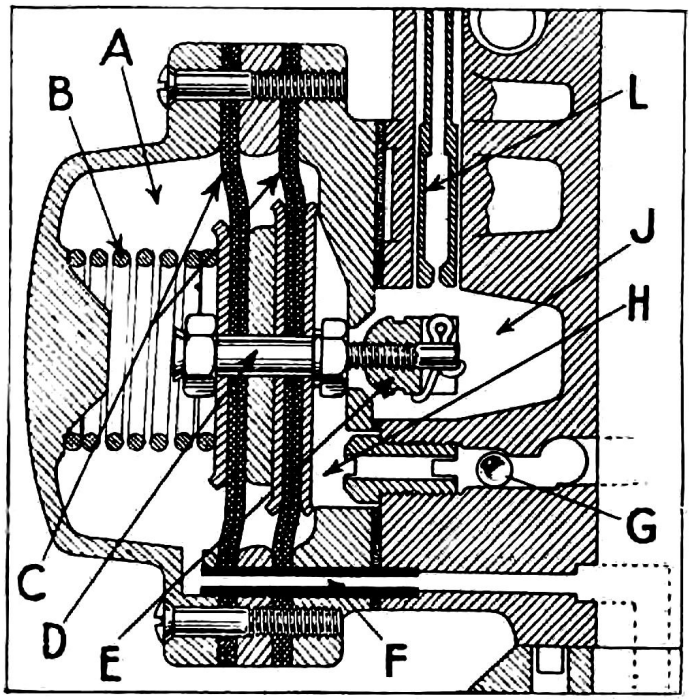



Fig. 39.—SECTION THROUGH CARBURETTER ECONOMY DEVICE.

**The volume control screw** (Fig. 38) varies the richness of the idling mixture. Turning it in an anti-clockwise direction enriches the mixture up to the limit of the pilot jet output; clockwise rotation will weaken the mixture.

### Economy Device

Entirely automatic in action, the "economy device" has no external connections. It is set permanently to suit the engine's requirements and must not be adjusted. The functions of this device are indicated by Figs. 39 and 40.

The assembly comprises a chamber (A) occupied by a spring (B), compressed between the outer wall and a set of diaphragms (C), through the centre of, and fixed to which, passes a shaft (D) terminating in the valve (E). In the base of the chamber (A), a channel (F) leads to the engine side of the throttle, which is under depression when the throttle is closed and the engine is turned over. In these circumstances a vacuum is created in the chamber (A), thus drawing the diaphragms against the pressure of the spring and closing the valve (E). At the same time, petrol pressure against the ball valve (G) is released, and fuel, flowing from the float chamber, fills the chamber (H). Opening of the throttle releases the vacuum in the chamber (A), and spring pressure pushes the diaphragms in the reverse direction. Consequently the following action takes place.

First, petrol pressure forces the ball valve (G) on to its seating, thus preventing the return of petrol to the float chamber. Secondly, the valve (E) is opened and petrol is forced from the chamber (H) into the space (J). This latter action displaces petrol already present in the space (J); the petrol is forced along a drilled passage and then vertically up the capacity tube (L), through the injection tube (M), (Fig. 40), finally emerging into the choke.

It will be realised, therefore, that an additional supply of petrol is available for acceleration from a source entirely independent of the main jet. A further function of this unit is the provision of additional fuel for high speeds.

At full throttle openings the injection tube (M) is subject to depression because of the high velocity air stream in the choke tube. Therefore, an additional supply of petrol is induced from the base of the capacity tube (L). This source of supply is readily replenished from the float chamber, since both the valve (E) and the ball valve (G) are open. Such an arrangement, however, does not cause excessive fuel consumption, as this is counteracted by the capacity tube (L) being calibrated. At normal touring speeds,

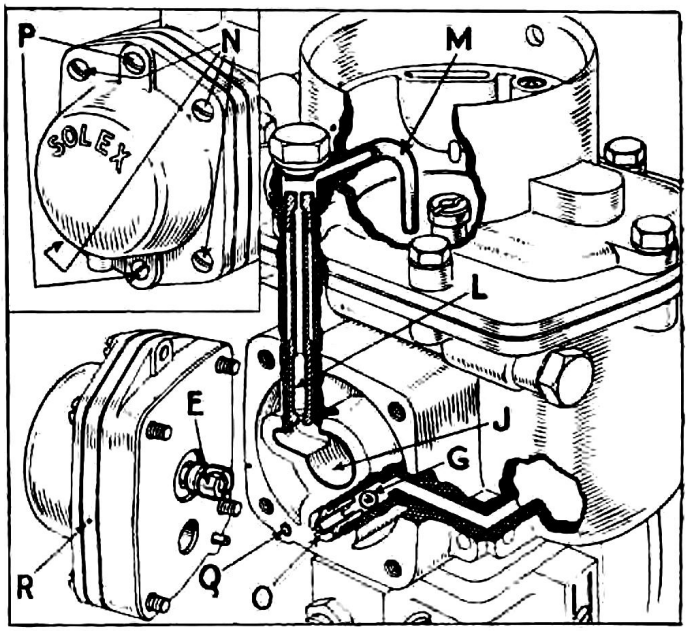



Fig. 40.—CARBURETTER ECONOMY DEVICE.

with the throttle in its mid-way position, the valve (E) is seated, so that no petrol is released from the chamber (H, Fig. 39), and the deep depression on the end of the injection tube (M, Fig. 40) is sufficient to raise the petrol from the capacity tube (L).

With this economy device installed, the main jet is reduced in strength to the point where maximum economy plus maximum efficiency at normal touring speeds are assured. If these units were not incor-

porated, the size of the main jet would have to be considerably increased to meet the fuel requirements for high speed and acceleration.

**The Throttle Governor (Fig. 41)**

This is an entirely separate unit, set and sealed for a definite speed. From the illustration it will be seen that the throttle is mounted eccentrically on the spindle.

The "tail," or upper portion (A), is longer than the "head" or lower portions (B). Thus, because of the velocity of the ingoing air stream, air pressure on the inclined face of the "tail" tends to close the throttle. But this closing effort is resisted by the coil spring (C) anchored to the head of the throttle and, since the pressure of air charge on the throttle increases as engine speed rises, the throttle will begin to close only when engine revolutions and air pressure both read a value greater than the tension of the spring.

These values have been carefully calibrated and the necessary setting accurately obtained. So that the throttle shall be suitably sensitive to the opposing forces of air pressure and spring tension, it floats on a hardened ground spindle on needle roller bearings. The spindle, in turn, operates in substantial bronze bearings with full provision for taking end thrust. It is coupled to the accelerator, but the throttle is free to rotate on it independently. This free movement is limited by a single drive of dog formation (D), between the spindle and the throttle.

The result is that the throttle is always positively closed by the dog when the accelerator pedal is released. But on the pedal being depressed, the throttle is opened by the spring, the opening being limited by the extent the dog drive has receded from it. Sufficient lost movement is provided so that when the driver's foot is kept right down on the pedal, the governor will operate freely, and so control the speed of the engine.

SEE ALSO CHAPTERS V A AND V B FOR TWO-SPEED DYNAMO CONTROL CONNECTION TO CARBURETTER.

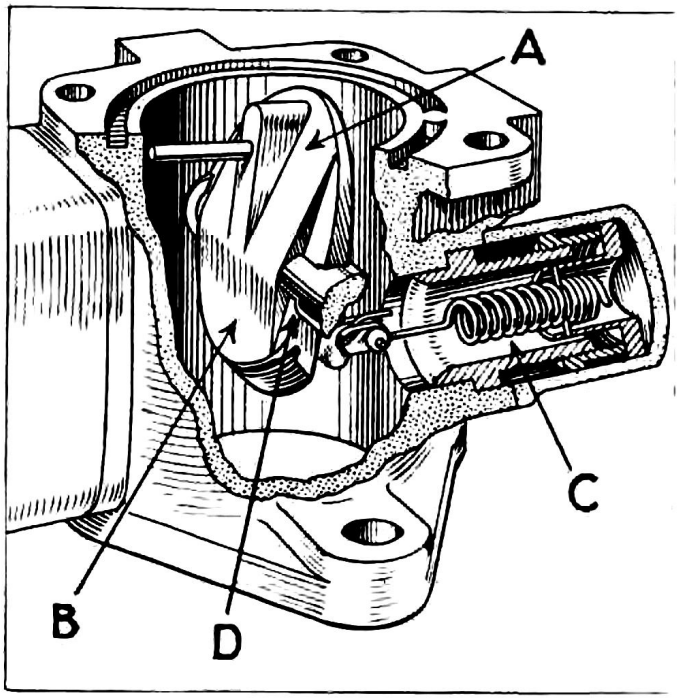



Fig. 41.—THROTTLE GOVERNOR

## *Part III*
## THE AIR CLEANER

Air is essential to the internal combustion engine, and it will be appreciated that the normal atmosphere contains particles of dirt, grit, etc., this being particularly evident in hot dusty conditions such as are encountered in the desert. The effect of these impurities if allowed to enter the engine would be to form an abrasive compound, and cause rapid wear of these parts, and it is therefore necessary that all air should be thoroughly filtered before passing to the engine.

The air cleaner fitted to the Scout car is a large capacity oil bath type embodying two stages of cleaning, and is mounted inside the fighting compartment, the connections between it and the carburetter being a combination of rubber and steel pipes.

When the engine is started, air is drawn into the cleaner through fan-like louvres in a small metal container, which is secured to the side of the main air cleaner body. Additional slots in this container cater for the ejection of all large particles of grit, etc., while the fan-like louvres prevent the ingress of dead leaves and similar matter. This represents the first or preliminary stage of the filtering. The main air cleaner consists of four major components :

1. An outer casing or body.
2. A metal oil container or oil bath.
3. A filter element.
4. A cover plate.

1. The outer casing or body is a deep metal container embodying an inlet pipe at its base and an outlet pipe at the top. On the inside wall are two platforms or lips, the lower of which is a complete ring and the upper being complete except for two diametrically opposed cut-outs.
2. The oil bath container is of such a size that it fits inside the main body, leaving a space approximately $\frac{1}{4}$ in. wide on either side, while its depth is such that its top lip is approximately $\frac{1}{2}$ in. below the surface of the lower platform or lip of the main body.
3. The filter element consists of a cylindrical metal container packed with steel wire to form a dense matted filter gauze. The lower part of the cylinder is smaller in diameter than the oil bath, so that when fitted inside it there is approximately $\frac{1}{4}$ in clearance between the two. The upper half of the element is larger in diameter, and seals on the lower lip of the main body. A

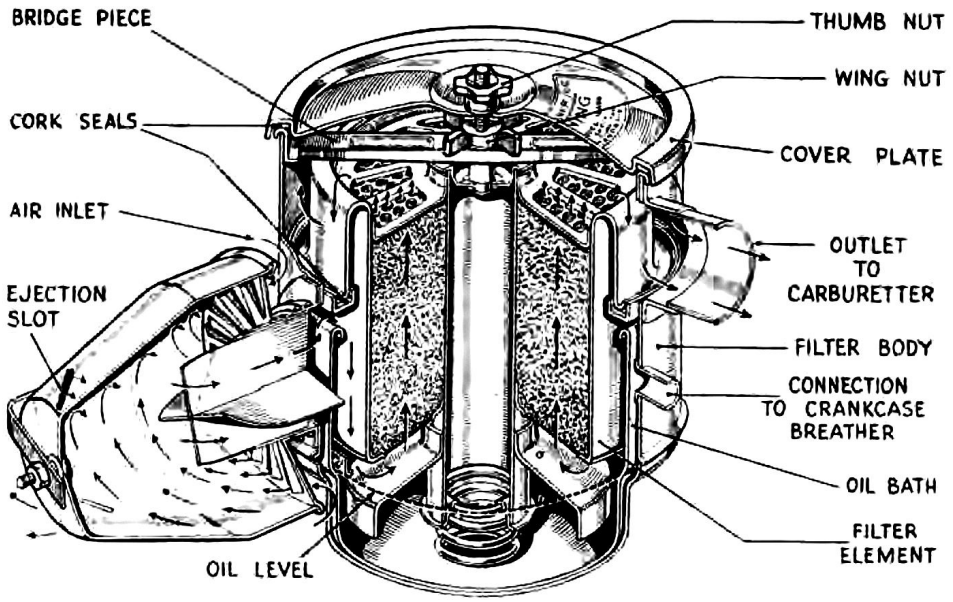



Fig. 42.—AIR CLEANER.

bridge piece on top of the element enables it to be held in position under the upper lip on the main body, a stud and wing nut being provided to ensure adequate sealing and security.

4. The cover plate. This is merely a circular disc sealing the top of the main body from the atmosphere. It is provided with a cork gasket fitted in a depression on its outer rim and a thumb screw which locates on the stud projecting from the centre of the filter element.

### Operation

Having entered at the base of the main body, the air passes upwards in a space between the outer wall of the oil bath and the inner wall of the body until its progress is prevented by the flange formed in the filter element. The air changes direction and passes downwards in the space formed between the inner wall of the oil bath and the outer wall of the filter element. On reaching the bottom of the oil bath the air again changes direction and, passing over the surface of the oil, travels up through the filter element, where it is drawn away to the carburetter via the connecting pipe line and hoses. It will be appreciated that the flange formed in the filter element with its cork gaskets forms a positive seal between the upper and lower halves of the main body, and virtually divides this component into two compartments. The constant changes of direction of the air through the filter element, together with its passage over the oil in the oil bath, ensures it has been filtered of all impurities.

An additional function of the air cleaner is to prevent impurities entering the engine through the crankcase breather, for which purpose a smaller air outlet is provided in the main body and connected by suitable hoses to the valve chest cover plate.

## *Part IV*
## THE FUEL SYSTEM

Fuel is drawn from the petrol tank through either of two pipes connecting the top of the tank to the fuel tap. One pipe connected to the "MAIN" opening of the tap is connected at its other end to the shorter of the two pipes in the tank so that when the bottom of the pipe is clear of petrol, a reserve quantity of two gallons is left. The other pipe connecting the "RESERVE" opening of the petrol tap is joined at its other end to the long pipe in the tank enabling the reserve fuel to be drawn.

The mechanical pump mounted on the side of the engine draws petrol from the tank through either of the two previously described pipes and passes it to the carburetter through pipes connecting tap to pump and then the carburetter at a pressure of $2\frac{1}{2}$ to $3\frac{1}{2}$ lbs per sq. inch.

There are various filters to prevent dirt, etc. passing to the carburetter jets. One is situated in the tank filler opening, another is in the body of the fuel pump, and a third is in the banjo union connection between the petrol pipe and the carburetter.

### The Petrol Tap

The petrol tap mounted on the bulkhead, is operated from the fighting compartment. It has three positions, "OFF," "MAIN" and "RESERVE" and is operated by a semi-rotary movement. This tap is the cork disc type.

### The Petrol Tank

This is a welded steel container situated on the left side of the engine compartment, and secured by two steel straps. Felt pads placed between the tank and its fixing straps and brackets prevent abrasion and it holds 17½ gallons plus 2 gallons reserve.

The tank filter is held in position in the filler opening by a screw in the base of the filter, and it may be removed for cleaning by unscrewing this screw. A drain plug is screwed into the bottom of the tank and a dipstick calibrated in gallons is screwed in the top of the tank.

A vent is provided for the tank, to allow air to enter as petrol is withdrawn and this takes the form of a pipe from the tank top to a high point outside the vehicle and then bent downwards to prevent the entry of dirt or water.

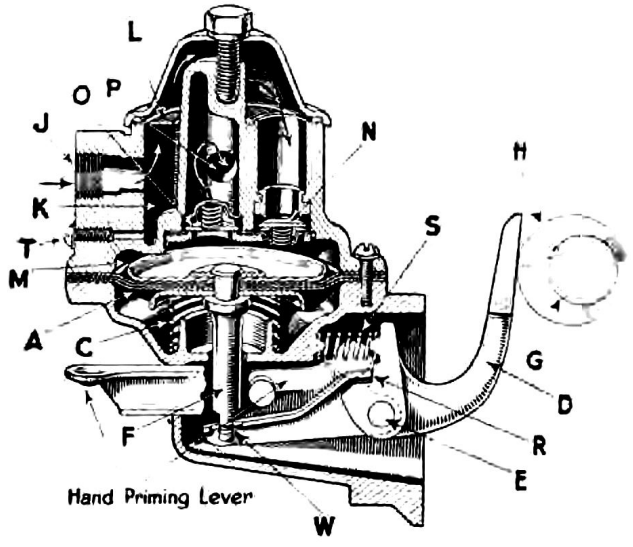



Fig. 43.—THE PETROL PUMP.

### The Petrol Pump. (Fig. 43)

This is mounted on the camshaft side of the engine and is driven from the camshaft (G) when it rotates and causes the eccentric (H) to lift the rocker arm (D) pivoted at (E) and connected to the pull rod (F). This movement pulls the rod (F) together with the diaphragm (A) downwards, against the pressure of spring (C). In this way a vacuum is created in the pump chamber (M) and the suction valve (N) is pulled off its seating. Fuel from the pipe line entering at (J) passes to the sediment chamber (K) through the filter gauze (L) and into the pump chamber (M). As the camshaft rotates further, the rocker arm (D) is released, and the pull rod and diaphragm, through pressure of the return spring (C), return to their original positions. This forces fuel from the chamber (M) through the pressure valve (O) and into the carburetter pipe line via the hole (P). The rocker arm (D) comprises two pieces, the outer operating the inner one by making contact at (R). The rocker arm being two separate pieces pivoted at (E) allows one half to be operated by the eccentric (H) without operating the other half when the pump is full of fuel. When the pump chamber (M) is full and under pressure the diaphragm (A) and pull rod (F) are pressed downwards against the pressure of spring (C) and at the same time hold the inner member of the rocker arm away from point (R). This position will be maintained until the carburetter intake valve opens and relieves the petrol pressure.

The spring (S) is incorporated simply to maintain constant contact between the rocker arm and the eccentric to prevent noisy operation.

## *Part V*

## THE LUBRICATING SYSTEM

The lubrication of the engine is based on the WET sump principle; that is to say, the oil reservoir is formed by the crankcase sump and no separate oil tank is used.

Lubricant is pressure fed throughout the engine by means of a gear driven oil pump, mounted on the crankcase on the carburetter side of the engine.

The oil pump is driven in tandem with the distributor by means of a spiral gear secured to its shaft, which mates with the helical gear on the camshaft.

The intake side of the oil pump is connected to the oil sump by a pipe line on the end of which is pivoted a floating oil intake unit and filter which lies on the surface of the oil, so that, as any foreign matter in the oil settles at the bottom of the sump, clean oil only is drawn from the surface. (Fig. 44.)

From the pump the oil passes through external, flexible pipe lines to an oil filter unit known as the "Purolator." This unit consists of a wire wound filter element enclosed in a two-piece casing. The inlet and outlet orifices are situated in the head of the casing and are clearly marked by arrows showing the direction of flow. A non-adjustable relief valve is also incorporated in the head as a safeguard, in the event of excessive pressure being developed as the result of a dirty filter element. The position of the "Purolator" filter on the chassis, and the length of the pipe lines, combine to make this unit serve as an oil cooler.

On leaving the "Purolator" the lubricant passes into the main oil gallery which runs the length of the crankcase. From the main oil gallery oil is forced

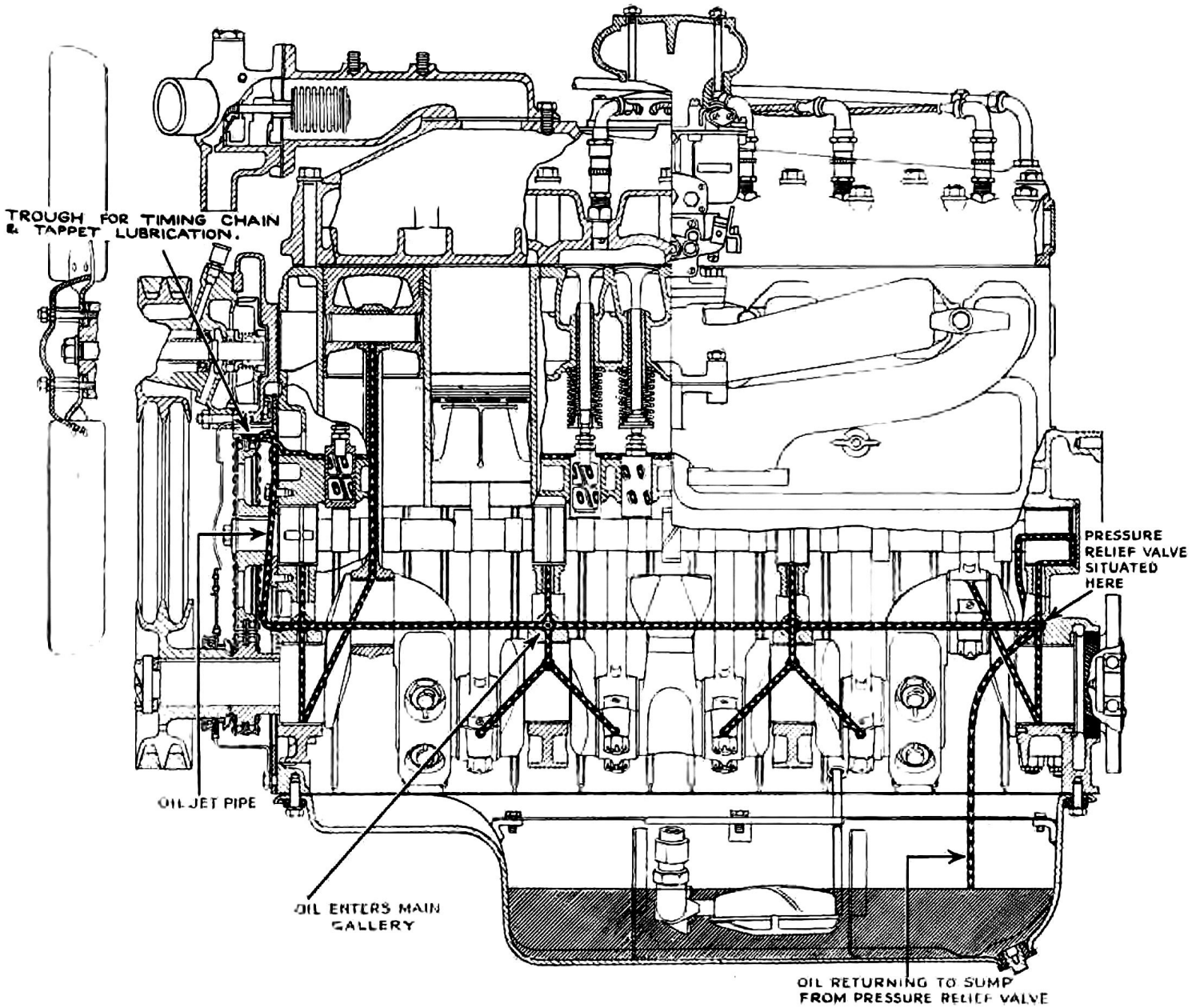



Fig. 11.—ENGINE LUBRICATION SYSTEM—LONGITUDINAL SECTION

along oil ways in the cylinder block to the four main bearings, and enters under pressure into passages drilled in the crankshaft, to lubricate the big end bearings. A drilled oil way in the central web of each connecting rod provides lubricant for the gudgeon pins, and a small hole in the big end boss permits a limited amount of oil to be projected on to the cylinder walls. (Fig. 45.)

Oil passages from the main gallery also serve the camshaft bearings.

The timing gears are lubricated from No. 1 main bearing feed, a jet of oil being directed by a short pipe line to a special trough and thence to the timing chain. Surplus oil from the trough is fed through a hole in the cylinder block to a channel along the base of the tappet chamber.

An oil relief valve is incorporated in the main oil gallery and is set to open when oil pressure builds up in excess of 40–50 lb. per sq. in.

The oil way to No. 2 main bearing extends right through the cylinder block and terminates in a tapped hole in the left-hand side of the cylinder block. From this a copper pipe leads to an externally mounted A.C. oil filter, and a further pipe leads from the filter to the oil filler pipe. It will be appreciated, therefore, that **all** the circulating oil is filtered by the " Purolator " unit, and a proportion of it is again filtered by the A.C. unit. (Fig. 45.)

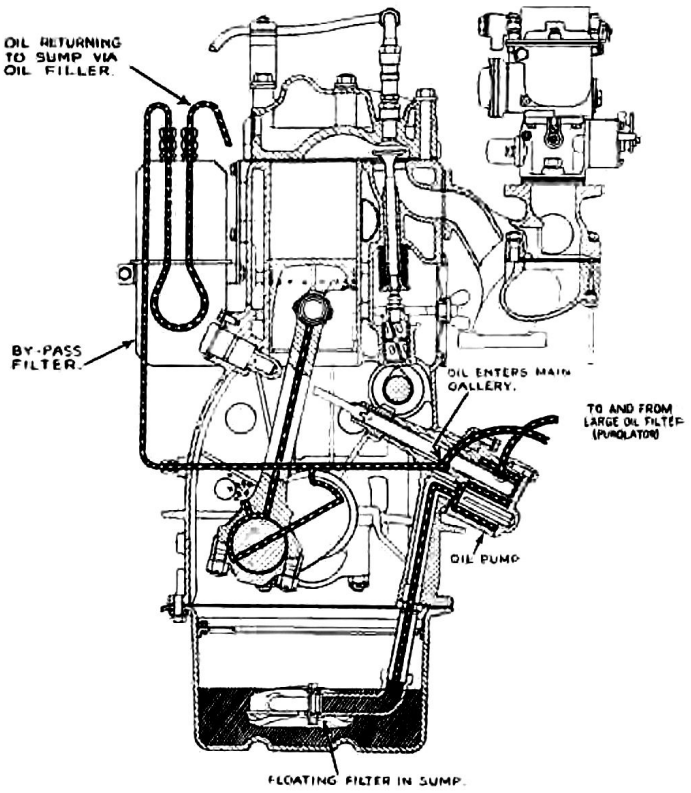



Fig. 45.—ENGINE LUBRICATION SYSTEM—TRANSVERSE SECTION

## *Part VI*

## THE COOLING SYSTEM

The engine is liquid cooled and the system contains 39 pints of liquid, circulated by a vane type pump.

The water passages of the cylinder block and head are connected to the radiator and pump by rubber hose in the normal manner, and incorporated in these connections are two automatic valves. (1) Thermostatic valve. (2) Pressure relief valve. The thermostatic valve prevents circulation of the liquid through the radiator when the liquid is cold, and so causes it to assume normal temperature quickly. When normal temperature is reached the liquid is allowed to flow through the radiator in the normal manner. The pressure relief valve permits a pressure in the cooling system up to a maximum of 5 lbs. per sq. inch. This increases the boiling point to 228° F.

### Operation of the Cooling System

The water pump forces the coolant into a long oval section pipe housed inside the engine cylinder block. This pipe has holes drilled in it at suitable intervals through which the coolant escapes to impinge on the surface of the metal surrounding the exhaust valve seats. Thus the hottest part of the engine receives the maximum supply of coolant before the heat of the latter has increased by contact with the other parts of the cooling ways.

Passing out of the above-mentioned pipe, the coolant disperses round the cooling ways arranged round the cylinder bores, etc., during which process it becomes increasingly hot, and therefore rises in the engine until it arrives at the highest point of the cylinder head, from when it passes via a further radiator hose to the top of the radiator.

Upon entering the radiator at the top it flows down the radiator, due to the action of the pump drawing liquid from the bottom. The cooling process is materially assisted by the air passing through the radiator from the fan. The coolant then once more enters the engine via the bottom of the radiator, and through the hose and pump as cool liquid.

### The Thermostatic Valve

This is situated in the casting bolted to the cylinder head and through which the liquid passes from the head to the radiator. See Fig. 44. This is a mushroom type valve and controlled by a bellows attached to the valve stem. The bellows contain a special fluid with an alcohol base sensitive to temperature. Thus when the temperature is high the bellows expand and open the valve. Conversely, as the liquid becomes cold the bellows cause the valve to close.

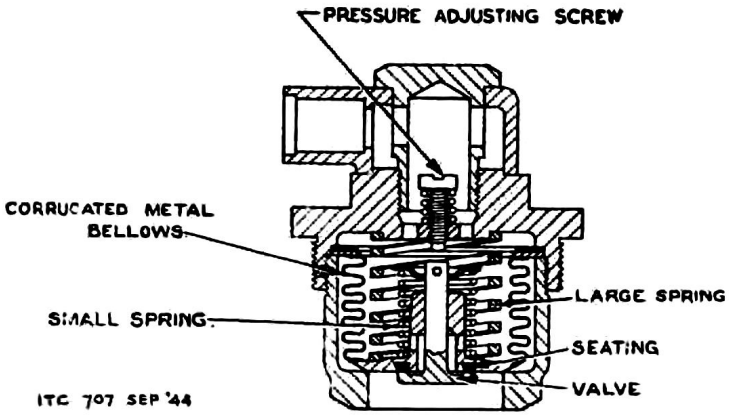



Fig. 46. - PRESSURE RELIEF VALVE.

When the engine is started up from cold this closed valve prevents coolant from circulating through the radiator, but a small bore by-pass pipe allows a reduced quantity to flow to the water pump. As the coolant becomes hot quickly due to the action of this valve the bellows expand and allow the coolant to circulate through the radiator normally.

### The Pressure Relief Valve

This is mounted on a bracket bolted to the cylinder head and is connected by a small pipe to the condenser tank, and another pipe connects it to the radiator header tank.

The construction of this valve is shown in Fig. 46. As pressure rises in the radiator the valve and seat are pressed upwards, compressing the bellows; when these are pressed upwards a certain distance the valve stem makes contact with the adjustable stop above it and further movement of the seat and bellows due to increased pressure separates the valve and seat allowing steam or hot coolant to pass to the condenser tank. The adjusting screw at the top regulates the pressure at which the valve opens.

As the engine becomes cool the valve, which is spring loaded at 3 lbs. per sq. inch, opens and allows the condensed coolant to be drawn from the condenser tank into the cooling system again. In addition to raising the boiling point in the cooling system, this device also assists in maintaining it full of coolant.

### The Fan

This is a normal 6-blade fan, driven by twin belts, and fitting closely in a cowl directing the air blast through the radiator. The fan drives air from the engine compartment through the radiator and out of the vehicle through the rear louvres.

## *Part VII*
## THE IGNITION SYSTEM

The ignition system is coil and distrbutor, and operating current is supplied from the batteries. The distributor is driven from the oil pump shaft, the connection being an off-set tongue on the end of the distributor shaft engaging a corresponding slot in the end of the oil pump shaft. Current to the ignition system is controlled by a semi-rotary switch on the switchboard.

### The Coil

This is enclosed in a sealed metal container, and the high and low tension cables make spring connection with the terminals inside the coil. Each cable is retained in position by a metal sleeve screwed into the top of the container. The coil consists of a laminated iron core on which are wound the low and high tension windings. These two windings are connected in series, and although connected at one end to the metal container for earthing purposes, are separated from the core and container by installation.

The opening of the contact breaker points, caused by rotation of the cam, stops the flow of low tension current through the coil. This sudden stoppage of magnetising current (assisted by the condenser connected across the contact points) produces an induced voltage of about 7,000 volts in the secondary winding of the coil. This voltage is fed via the distributor and high tension cables to the appropriate sparking plug.

### The Distributor

Two duties are performed by the distributor. (1) It causes the high tension current from the coil to be directed to each sparking plug in correct sequence. An insulated rotor arm fixed on the cam and rotating with it, connects the central brush of the distributor to each of the six electrodes of the distributor head in turn. (2) By means of a cam and contact breaker, it interrupts the supply of low tension current to the coil, so causing an induced high tension voltage at the correct instant to produce a spark across the sparking plug points.

The timing of the spark is advanced automatically as the engine speed increases. This is brought about by two weights that advance the position of the cam on its shaft as they move outwards due to centrifugal force. The weights are restrained by two springs which cause them and the cam to return to the retard position at low engine speeds.

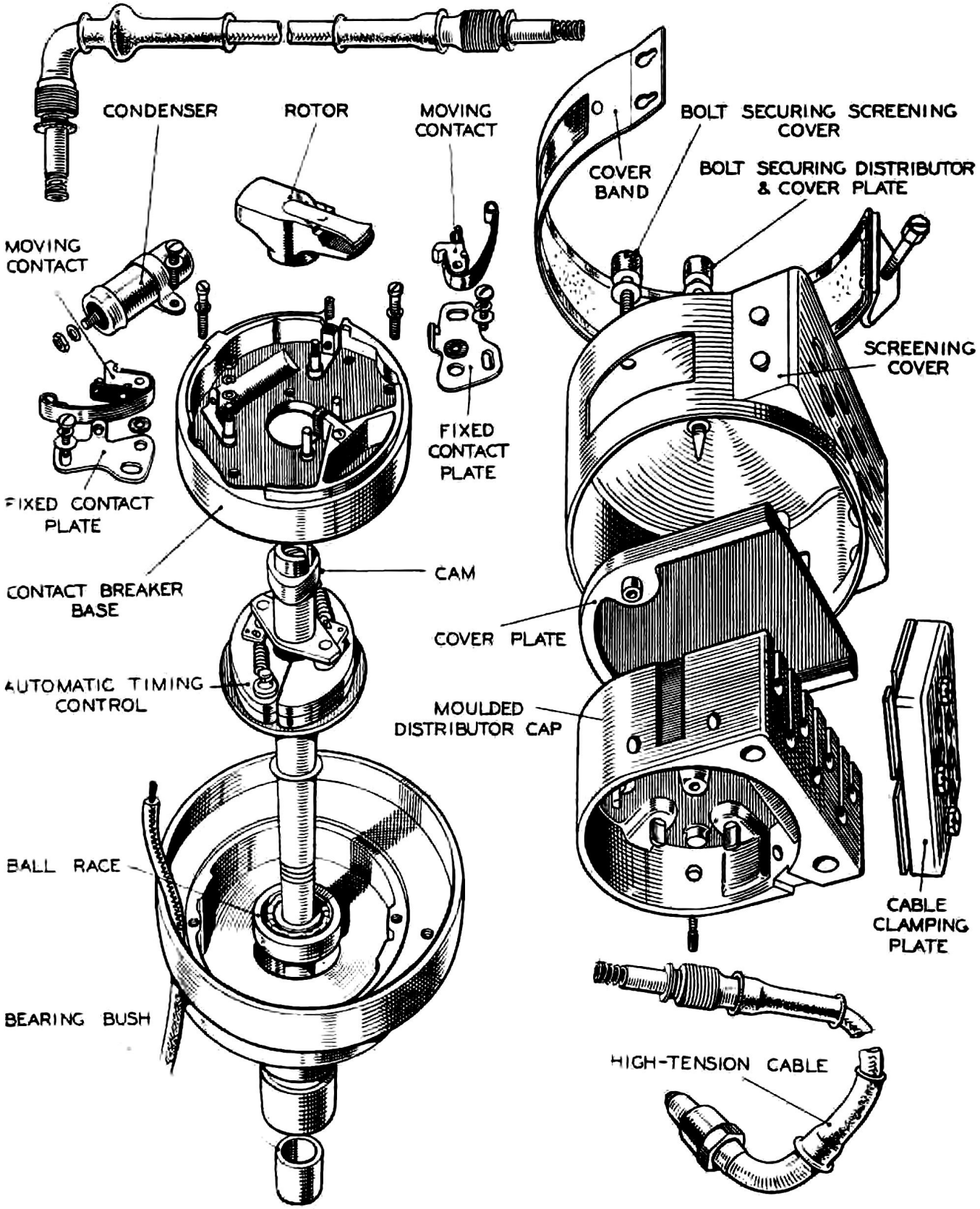



Fig. 47.—THE DISTRIBUTOR.

### The Condenser

This is fixed to the contact breaker base plate, the metal clip round the body and its firing screw forming one terminal connection between the condenser and fixed contact point. The insulated terminal of the condenser is secured to the insulated contact point by a screwed stud and nut through the connection plate. The condenser reduces sparking at the contact points when these are separated by rotation of the cam, the effect of this is considerably increased length of service from the contact points, and also a much increased voltage induced in the secondary winding of the ignition coil.

### Screening

The ignition system is completely screened as follows, to prevent interference with wireless reception. The coil, distributor and plugs are completely enclosed in metal screens connected to earth. The cables have an external covering of metal braid, this being securely connected in each instance to the earthed screening of the component to which the cable is connected. A filter unit comprising choke coils and condensers are housed in a metal box secured to the cylinder head, this unit prevents feed back of high frequency oscillations from the contact breaker to the wiring system.

# *CHAPTER IIB*

# THE TRANSMISSION

## *Part 1*

## THE CLUTCH (Fig. 48)

The clutch is fitted between the engine and the gearbox, and it provides the means for connecting or disconnecting the two units at will. Its purpose is to enable the engine power to be positively but at the same time gradually and smoothly transmitted to the gearbox, thus avoiding shock loads on the transmission. In this capacity it contributes largely to the driver's control of the vehicle.

At the outset it should be understood that the engine and gearbox are not directly coupled together, although the end of the gearbox primary shaft protruding from the end of the gearbox is supported in a ball race housed in the centre of the flywheel, so that one can rotate while the other is stationary.

The object of the clutch, therefore, is to provide the means for transmitting engine power to the gearbox on one hand and to permit the drive to be broken on the other, but at the same time providing smooth progression between the two extremes.

Briefly this is achieved as follows: A disc, faced with friction linings on both sides, is free to slide on, but is splined to the primary shaft. This disc or driven plate is compressed between the flywheel and a circular plate known as the pressure plate, the latter being controlled by a series of coil compression springs, which in turn are located by a cover plate, bolted to the flywheel.

Thus pressure of the springs forces the pressure plate, and in turn the driven plate, into firm contact with the flywheel and, since this plate is splined to the primary shaft, the connection between engine and gearbox is then positive. This is the normal position of the clutch. When the clutch pedal is depressed it operates the withdrawal mechanism which pulls the pressure plate against the pressure of the coil springs, away from the driven plate. This relieves the pressure contact between the flywheel and the driven plate friction liners, thus freeing the drive between the engine and gearbox.

Bearing in mind the foregoing description of the basic working principles of the clutch, it is now possible to consider the design in greater detail.

### The Driven Plate

This incorporates a central hub, having a disc flange on its periphery, drilled through the centre and splined to mate with the splines of the primary shaft. In the flange are eight slots of special shape. On one face of the flange a large diameter disc of spring steel is fitted, and on the other side is a smaller diameter disc or backing plate. These also incorporate slots similar to those in the flange of the hub.

Coil compression springs, located by spring steel wire and small riveted clips, are fitted in these slots, thus providing a positive but flexible connection between the outer disc and the inner hub.

The driven plate disc, which comprises a number of separate segments riveted to the centre, is faced on either side with friction linings. The method of securing the linings provides a "cushion" effect. Each lining is riveted independently to a separate set of segments, and by this means each lining presents a flat face to operate on the machined face of the flywheel and pressure plate and at the same time each will "give," and thus absorb shock loads. It will be seen, therefore, that the driven plate embodies two special features designed to relieve shock loading of the transmission units—firstly the method of securing the linings to the driven plate disc, coupled with the special formation of the disc, and secondly the method of connecting the driven disc to the hub, through the coil compression springs.

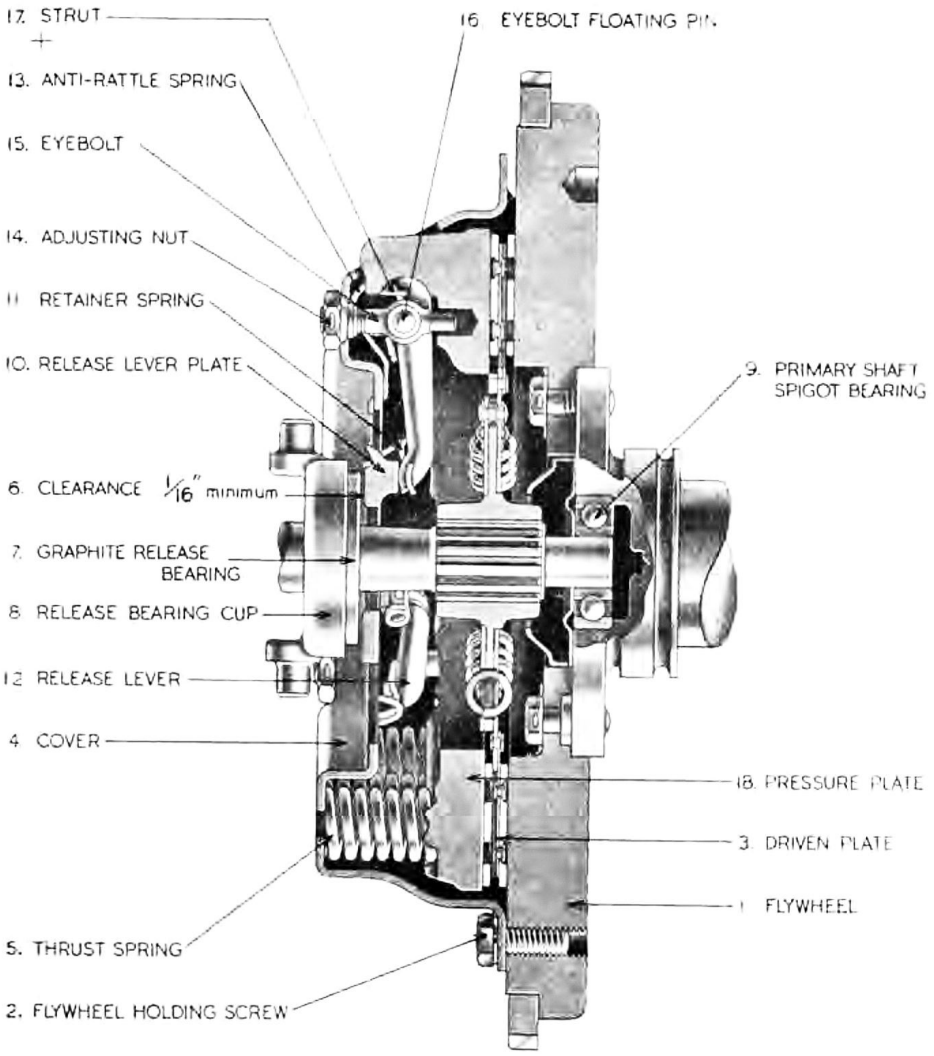



Fig. 48.—CLUTCH ASSEMBLY.

### The Pressure and Cover Plates

The pressure plate is a large metal hoop, one face of which is machined to form a friction surface for the driven plate. The other face has four lugs which engage in holes in the clutch cover and prevent independent rotation. The release levers are secured to these lugs.

The clutch cover is a metal pressing with a flanged outer rim which is bolted to the flywheel. Between the cover and the pressure plate are twelve compression springs, housed in recessed formations in the cover and located by circular lugs in the pressure plate.

The design of the withdraw mechanism, coupled with the lugs on the pressure plate, prevents independent rotation of the cover and pressure plates, but, whilst the cover plate is secured directly to the flywheel, the pressure plate is capable of fore and aft movement within the limits imposed, on the one hand by the compression spring and on the other by the driven plate and flywheel.

### Withdrawal Mechanism. (See Fig. 48)

A graphite release bearing (7) is mounted in a cup (8) which is connected to the clutch pedal by linkage described in a later paragraph. A release plate (10) is attached to the inner ends of four release levers (12) by means of retainer springs (11). The position of the release plate is such that there is a clearance of 1/16 inch. between the machined surface of its outer face and the release bearing.

Each release lever (12) is pivoted on a floating pin (16), which remains stationary in the lever and rolls across a short flat portion of the enlarged hole in the eye bolts (15). The outer ends of the eyebolts extend through holes in the clutch cover and are fitted with adjusting nuts (14), thus each lever is located and locked in correct position. The outer ends of the release levers engage the pressure plate lugs, by means of struts (17), which provide knife edge contact, so eliminating friction at this point.

In operation the release bearing is moved into contact with the release plate, and it will be seen that

further movement causes the release levers to pivot in the eyebolt, their outer ends, through the medium of the struts, forcing the pressure plate away from the driven plate. Thus the pressure contact between the flywheel and the driven plate is relieved, and the latter is free to revolve independently of the flywheel, thereby isolating the engine from the gearbox.

### Clutch Operational Control

The release bearing and cup assembly described previously is operated by a withdraw lever which is roughly " Y " shaped and pivots about its centre on a pin mounted in a bracket secured inside the clutch housing. The two open ends of the withdraw lever engage with two circular lugs on the release bearing cup and are held in position by special retainer springs.

The single arm of the withdraw lever projects through a hole in the clutch housing, and is connected to a flexible steel cable, housed in a metallic sheath. This cable runs forward to the front end of the chassis frame, where it is secured to one end of a relay lever which pivots about its centre on needle roller bearings. The other end of the relay lever embodies a spherical recess in which is engaged the ball end of a pin secured to the lower end of the clutch pedal. The clutch pedal is mounted on needle roller bearings in a bracket attached to the chassis, in an identical manner to the foot brake pedal.

Movement at the clutch pedal pad is therefore transmitted to the relay lever, the cable, the withdraw lever and, finally, the release bearing and cup assembly which, as previously described, operates the release levers and the pressure plate.

## *Part II*

## THE GEARBOX

The gearbox when assembled on the vehicle forms part of the front support of the engine, being attached to the engine clutch housing by four studs. The front end of the gearbox is secured to one half of the housing of the Metalastic coupling by six bolts, and this forms the gearbox bearing covers at this end.

The gearbox support bracket held between the halves of the Metalastic coupling housing is supported from a cross member of the chassis on rubber pads. The gearbox is mounted in the chassis at an angle and the gear operating lever is inclined towards the left side of the vehicle at about 45°.

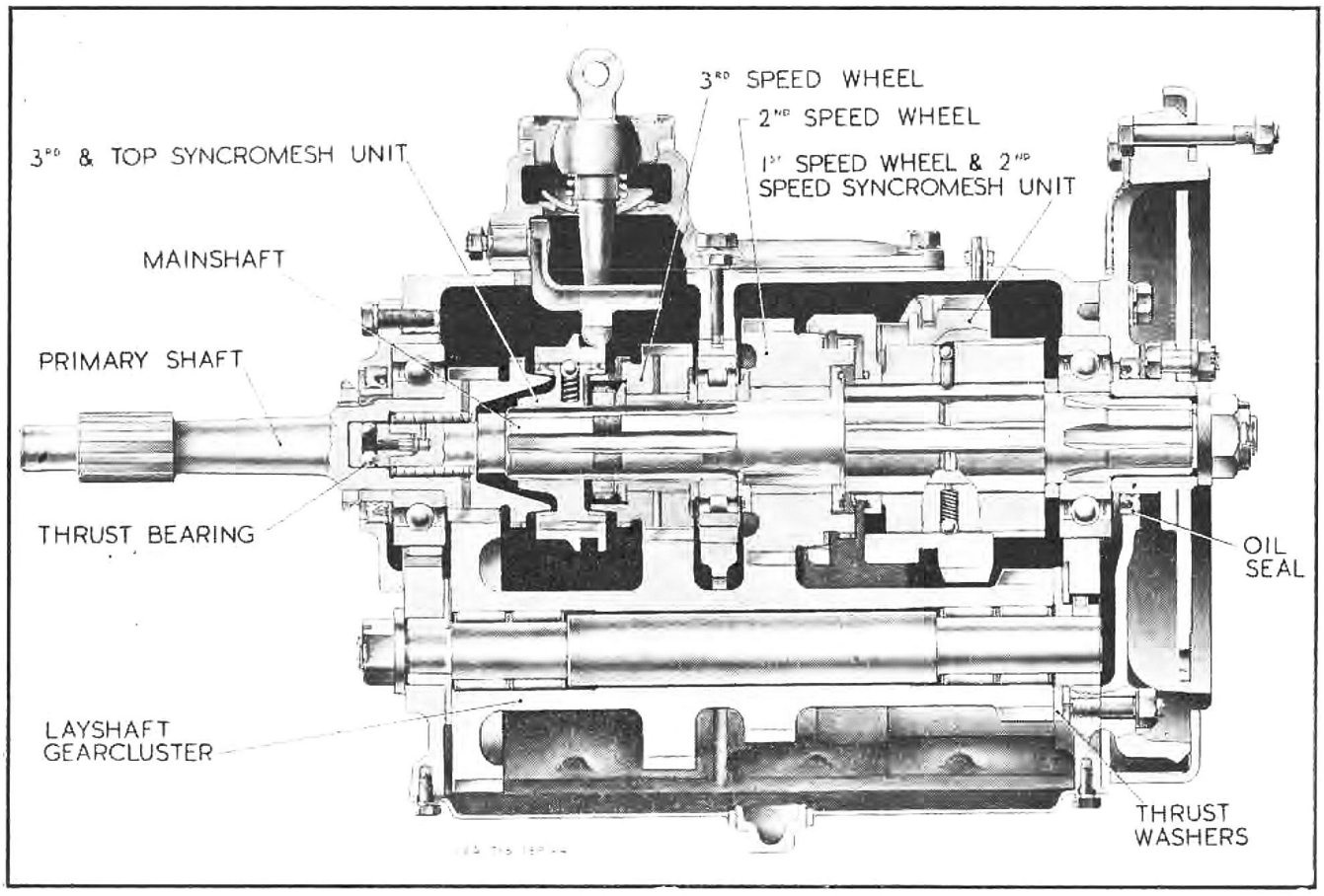



Fig. 49.—GEARBOX, LONGITUDINAL SECTION.

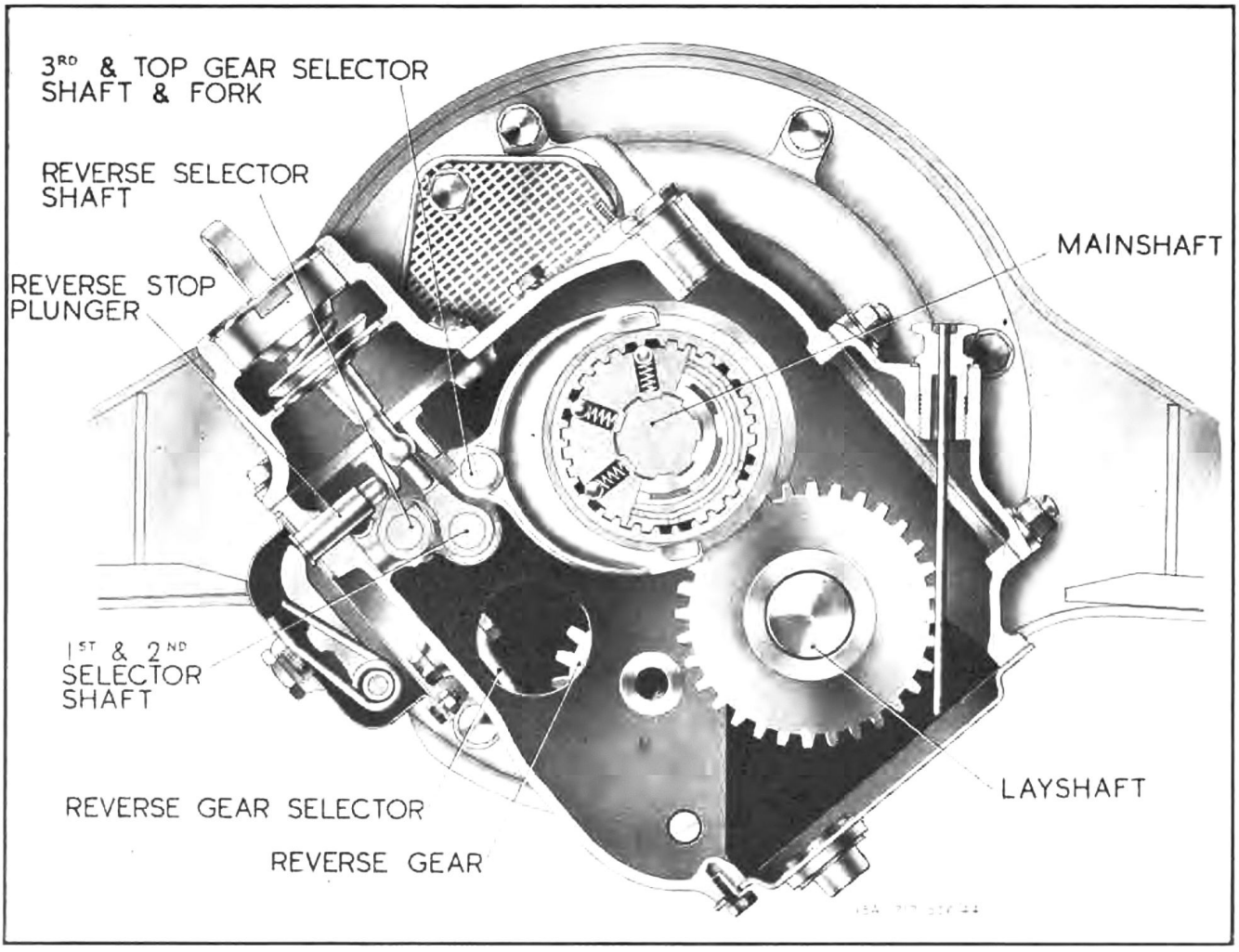



Fig. 50.—GEARBOX, TRANSVERSE SECTION.

The gearbox is an iron casting having a stiffening web mid-way across the box for locating the gear fork rods, reverse pinion shaft, and mainshaft centre bearing.

The gears provide four forward speeds and reverse. Top and third speeds have normal synchromesh engagement of the constant mesh helical gear dogs. Second speed gear has " inertia lock balked " synchromesh engagement, this is also a constant mesh helical gear. First and reverse gears are obtained by sliding the straight tooth gears directly into mesh.

THE RATIO OF THE VARIOUS GEARS IS :—

| | |
|---|---|
| TOP GEAR .. .. | 1 : 1 |
| THIRD GEAR .. .. | 1.544 : 1 |
| SECOND GEAR .. .. | 2.508 : 1 |
| FIRST GEAR .. .. .. | 3.900 : 1 |
| REVERSE GEAR .. .. | 3.900 : 1 |

### The Primary Shaft

This is a short shaft, having at one end a helical gear which meshes with a gear on the layshaft. These two gears are in operation when first, second, third and reverse speeds are engaged.

A recess in the primary shaft gear forms the outer race of the flexible roller bearing at the end of the mainshaft. The opposite end of the primary shaft when the gearbox is in position on the vehicle, locates in the ball bearing fitted in the end of the crankshaft. The splines formed on the shaft adjacent to this bearing location, engage the clutch driven plate and transmit power from the clutch to the gear box. (*See* Fig. 48.) The primary shaft is located by a ball bearing housed in the gearbox wall, and an oil seal is provided at this point to prevent the escape of lubricant into the clutch housing.

Passages are provided in the primary shaft gear between the bottom of the teeth and helical grooves cut in the surface of the roller race. This ensures lubricant penetrating to this bearing, and passages in the end of the mainshaft enable the lubricant to pass to the thrust bearing at the end of the mainshaft.

### The Mainshaft

Three bearings support this shaft in the gearbox. At one end a flexible roller bearing locates it in the primary shaft gear. Mainshaft thrust is taken at this point by four steel balls rolling between a ball race pressed in the end of the mainshaft and a ball race

held in the primary shaft recess. A roller bearing supports the mainshaft between second and third speed gear wheels. This roller bearing is located in the stiffening rib placed mid-way across the gearbox, and it is secured in this position by a set screw engaging a slot machined in the outer diameter of the bearing housing. The output end of the mainshaft is supported by a ball bearing housed in the gearbox wall, and lubricant is prevented from escaping into the Metalastic coupling housing by an oil seal at this point.

Power output from the gearbox is by means of a steel disc secured by splines and slotted nut to this end of the mainshaft. This steel disc forms part of the Metalastic coupling.

On either side of the centre roller bearing, and located endwise on a bronze bush is a constant mesh helical gear. Both these gears have passages from the spaces between the gear teeth to the bush for lubrication purposes.

The synchromesh mechanism placed between the mainshaft helical gears controls top and third speed operation. At the output end of the mainshaft, a straight tooth gear can be moved along splines to make direct engagement with the layshaft gear for operation on first speed. Coupled to this straight tooth sliding gear is the synchromesh mechanism for engaging second speed.

### The Layshaft

This comprises a cluster of four gears solid with the tubular shaft, the bore of which is ground at each end to form the outer race of the roller bearings on which it rotates. Two solid type roller bearings are fitted at each end of the layshaft. The shaft round which the gears rotate is located endwise by a shoulder and slotted nut where it passes through the gearbox wall. At the other end a key secures the shaft to the gearbox wall to prevent rotation. At the output end of the gearbox, thrust on the layshaft is provided for by a fixed bronze washer and a hardened steel washer, one being fixed to the gearbox wall while the other can rotate.

### Reverse Gear Pinion

This is a straight tooth pinion free to rotate on the reverse shaft. The groove in which the operating fork locates is mid-way along the length of the teeth.

To operate the reverse gear, the pinion is moved along its shaft and makes direct engagement with the teeth of the first speed wheels. Reverse rotation of the output shaft results, due to connecting the two first speed gear wheels through the medium of the reverse wheel. During forward running the reverse pinion is stationary.

### Selector Mechanism

This is the normal type, having spring loaded steel balls to locate the gear operating forks and rods in their various positions.

The reverse gear selector fork slides along a shaft located between the gearbox wall and the centre stiffening rib. It is controlled by a lever pivoted on a bolt in the side of the gearbox which transmits the movement of the gear lever from the top of the box. A spring loaded plunger operating through the gearbox side is a safety device, this increases the resistance to engagement of reverse gear and therefore reduces the possibility of accidental engagement.

A small lever pivoted on the gearbox lid and straddling the gear operating lever prevents the accidental engagement of two gears at the same time. The gear operating lever on the gearbox, swivels in a spring loaded socket and it is connected to the driver's gear lever by means of a steel tube. At the point of connection to the gearbox, this joint is enclosed in a leather gaiter secured to the tube and gearbox top by hose clips. This is for dirt and water excluding purposes. The front end of this tube connects to the driver's gear lever where it is secured to a cross member of the chassis by the bracket in which the gear lever swivels.

The oil capacity of the gearbox is five pints.

### The Synchromesh Operation

The arrangement for selecting third and top gears may be seen in Fig. 49. The two constant mesh gear wheels on the mainshaft used for third and top gear operation are provided with external straight teeth or dogs, these are bevelled at the front edges to facilitate engagement with an internally splined sleeve. On one side face of these gears an external cone is provided. Both gears are fixed endwise, the left-hand gear is integral with the primary shaft, and the right-hand gear is free to rotate on the mainshaft.

Mid-way between these gears and splined to the mainshaft is a hub, capable of being moved as required along the splines. This hub is provided with six radial holes each housing a spring loaded ball. The periphery of this hub is splined, and a bronze internal cone is provided at each side. An internally splined steel sleeve located on this hub can be moved as required along the hub splines to connect with the dogs on either third or top gears. Mid-way along the bore of this sleeve a semi-circular groove locates the sleeve to the hub in the neutral position when the spring loaded balls engage this groove. The spring loaded balls also provide the pressure required to engage the cones as the sleeve is moved along the hub and is forced past the spring location when either gear is being engaged. An external groove on this sleeve accommodates the gear change fork.

Synchromesh engagement of third and top gears operates as follows. Movement of the gear lever slides the splined sleeve and hub along the mainshaft towards either third or top gear, until the internal bronze cone of the hub engages with the external cone of the selected gear. Continued pressure on the gear lever causes the two cones to grip and after a short interval to rotate in synchronism. When this condition has been reached, additional pressure on the hand lever depresses the spring loaded balls and

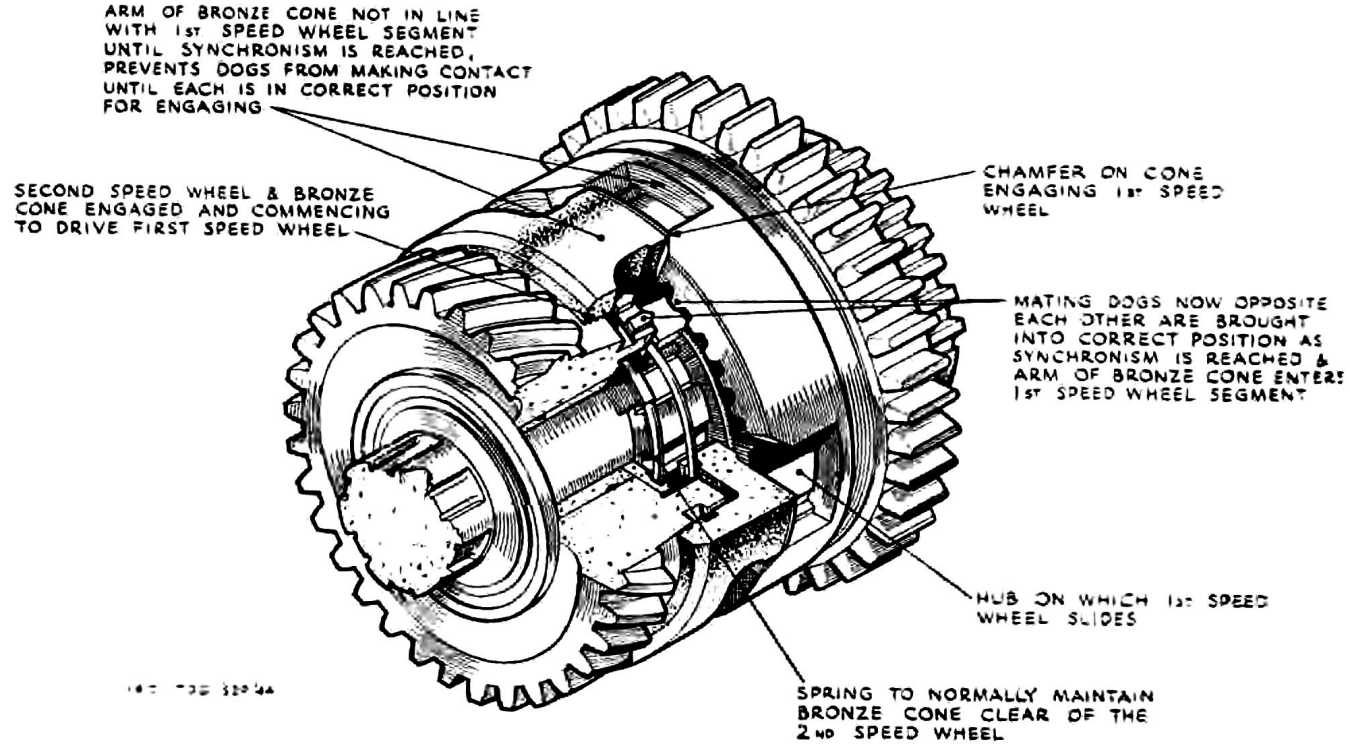



Fig. 51.—SYNCHROMESH ASSEMBLY FOR SECOND SPEED.

allows the sleeve to move into full engagement with the dogs on the gear wheel.

It will be apparent that a slight pause is necessary in the movement of the gear lever to allow the cones to synchronise before moving into full engagement. A hurried movement of the gear lever may result in crashing the engaging dogs before the cones have fully synchronised.

Synchromesh engagement of second gear is different from the foregoing and the explanation below should be read with reference to Fig. 51.

The second speed helical gear is located endwise on the mainshaft and rotates on a bronze bush. It has straight teeth or dogs with bevelled engaging edges and an external cone at one side as in the case of the third and top gear wheels. A bronze cone to mate with the second speed gear wheel cone is carried separately on the mainshaft, and it is supported by a four arm spider splined to the mainshaft. These splines are a loose fit to allow the cone a certain radial movement relative to the mainshaft. The two cone faces are normally held apart by a spring on the mainshaft.

A hub splined internally and externally, and capable of being moved along the mainshaft, is provided with four radial holes housing spring loaded balls, while another hole houses a steel ball and plunger. The four steel balls locate as before in a semi-circular groove mid-way along the bore of the splined sleeve. The function of the spring loaded balls is to locate the sleeve and hub while in neutral and also to provide the spring pressure required to engage the cones for second speed engagement.

When engaging first gear, the ball and plunger are pressed down into the groove in the mainshaft, thus locking the hub to the mainshaft, also it ensures that during the operation of disengaging first gear the hub cannot slide into contact with the bronze cone and so cause unnecessary wear of these faces.

In this case the splined sleeve is integral with the first speed gear wheel. At the opposite end to the gear, the sleeve is formed into four segments to allow it to pass between the arms of the bronze cone and so make engagement between the internal splines of the sleeve and the dogs on the gear wheel. The edges of these segments are chamfered.

Synchromesh engagement of second gear operates as follows. Movement of the gear lever slides the first speed gear wheel towards the second speed gear and as the first speed gear wheel is held on a hub by means of the pressure of the spring loaded steel balls this hub also moves along the mainshaft until it has pushed the bronze and steel cones into contact and caused them to begin to rotate in synchronism. The lost radial movement of the cone due to the loosely fitting splines causes the arms of the cone to rest on the chamfered edges of the sleeve segments and so prevent the segments passing the arms of the cone to enter into engagement with the gear wheel dogs. Continued pressure will only cause greater load to be applied to the bronze cone, thus increasing its driving effect, and only when the two cones are rotating in synchronism is it possible to move the splined sleeve further along the mainshaft, due to the reduced pressure of the cone arms on the chamfered edges of the sleeve segments. The movement of the gear lever may now be completed, until the sleeve segments are fully engaged with the dogs of the second speed gear wheel.

It will be seen that it is impossible to crash the engaging dogs into early engagement with this type of synchromesh mechanism.

## *Part III*

## THE TRANSFER GEARBOX

**(Figs. 52 and 53)**

The transfer box is a unit mounted in front of the gearbox and directly connected to its output shaft by means of a flexible coupling of "Metalastik" design. This coupling consists of steel pressings of special form bonded together by rubber inserts; thus, when placed between the output shaft of the gearbox and the input shaft of the transfer box it makes a positive but resilient drive between the two units.

The purpose of the transfer box is to transmit the drive either to the rear axle only or to both the front and rear axles, whichever is required under any given circumstance. In this connection it should be recorded that the drive to both axles, or four-wheel drive, is required **only** when the vehicle is traversing rough terrain, really severe hills, etc., and on NO account must it be used on normal roads, or similar surfaces, giving good adhesion to tyres.

When normal drive—that is to say, rear wheel drive only—is engaged, there is no change in gear ratio between the gearbox output shaft and the rear axle, but when four-wheel drive is engaged, a reduction in ratio of 1.477 to 1 is effected.

The transfer box consists of a cast-iron casing which houses three parallel shaft assemblies.

The top shaft is the input shaft, and this carries a constant mesh double helical gear which is free to rotate on it, and a sliding gear which is mounted on splines and can only rotate in unison with the shaft.

The intermediate shaft carries two gears—a double-helical constant mesh gear and a straight spur gear, both of which are splined to the shaft, so that all three revolve as a unit. Additionally, this shaft carries a small helical gear which provides the drive for the speedometer.

The bottom shaft assembly is in two parts :—

1. The rear shaft carries a double helical gear, so positioned that it is in permanent engagement with its counterpart on the intermediate shaft. On the rear end is a coupling flange, which is connected to the rear propeller shaft, and on the forward end a small spur gear is machined.
2. The forward shaft is housed in a small extension of the main casing, and its forward end carries a coupling flange for connecting the drive to the front propeller shaft. The rear end of this shaft fits into a recess in the forward end of the rear shaft and is mounted on needle roller bearings. The two shafts can therefore revolve independently, but a dog gear with internal teeth is splined to the forward shaft and can slide along this shaft to engage with the spur gear on the end of the rear shaft, thus locking the two together.

### Operation

The sliding gear on the top shaft can be moved forward to engage internal teeth cut in one face of the double-helical gear, thus locking the latter to the input shaft. Since this double-helical gear is in permenent mesh with the intermediate constant mesh wheel, which in turn meshes with the gear on the bottom rear shaft, the drive is transmitted to the rear output coupling.

The ratio is uncharged, *i.e.* the output shaft (bottom shaft) rotates at the same speed as the input shaft (top shaft).

When the sliding gear is moved rearwards it frees the double-helical constant mesh gear and engages with the straight spur gear on the intermediate shaft which, since both gears on this shaft are mounted on splines, transmits the drive to the bottom shaft. Due to the relative sizes of the gears on the top and intermediate shafts, however, a reduction in ratio of 1·477 to 1 is effected. At the same time as this low gear is engaged, the selector mechanism moves the sliding dog on the forward output shaft into mesh with the spur gear on the rear shaft, thus locking the two together and transmitting the drive to the front transmission unit, in addition to the rear axle.

### The Selector Mechanism

Gear selection is made by means of a gear lever mounted on a shaft on the side of the casing. The inner end of the shaft is fitted with a double lever, the top end of which engages a fork which operates the sliding gear. The lower end of this lever is coupled to a second lever pivoted on the side of the casing. The lower arm of this second lever engages with the selector fork mounted on the front drive selector rod. Since the front drive dog striking fork is also mounted on this rod, it will be appreciated that movement of the transfer gear lever is transmitted simultaneously to both the top shaft sliding gear and the bottom shaft sliding dog.

The front drive striking fork is free to slide on the selector rod and is fitted in such a manner that it is positively moved by the rod when the drive to the front transmission is disengaged. When the front transmission is being engaged, however, the fork is moved by means of a compression spring held between it and a collar on the end of the rod. The reason for this latter arrangement is that there will be occasions when the spur gear and the sliding dog on the bottom shaft will not engage, because the teeth are butting. If, in such instances, the striking fork was rigidly secured to the rod it would then be impossible to engage either front or rear wheel drive

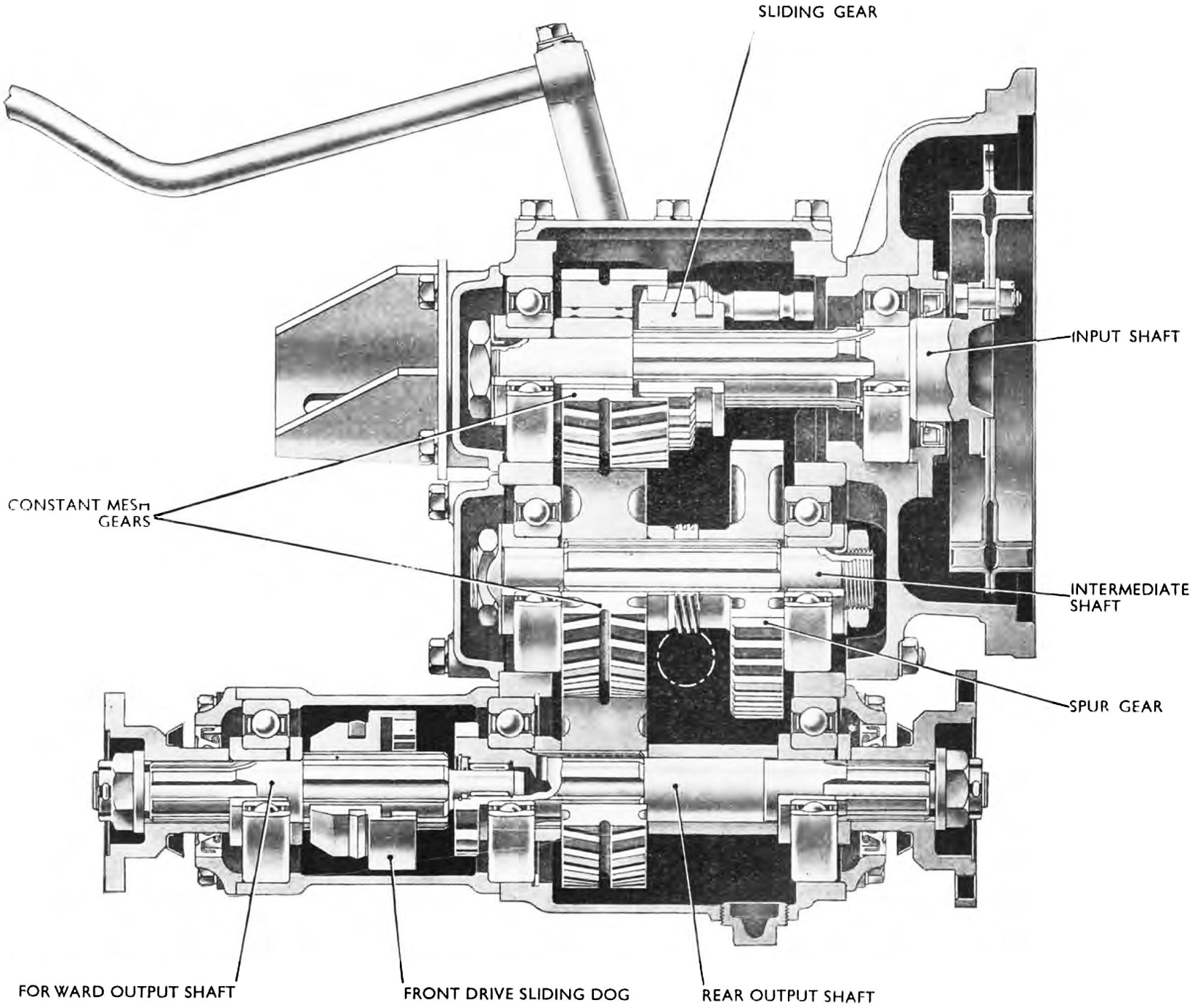



Fig. 52.—TRANSFER BOX—LONGITUDINAL SECTION

(in the lower ratio). The fact that the rod is free to slide in the fork, however, enables the drive to the rear axle to be engaged only, and while this is taking place the spring will be compressed. As soon as the rear shaft commences to rotate, the teeth on the dog gear and shaft will move out of alignment and the spring will force the striking fork to move the dog gear into engagement. The drive will then be transmitted simultaneously to the front and rear propeller shafts. It will be appreciated that the period of time taken by this sequence of operations is negligible, and no matter whether the vehicle is stationary or in motion when the gear change is made, the rear output shaft is rotated through only a fraction of revolution before full engagement is possible.

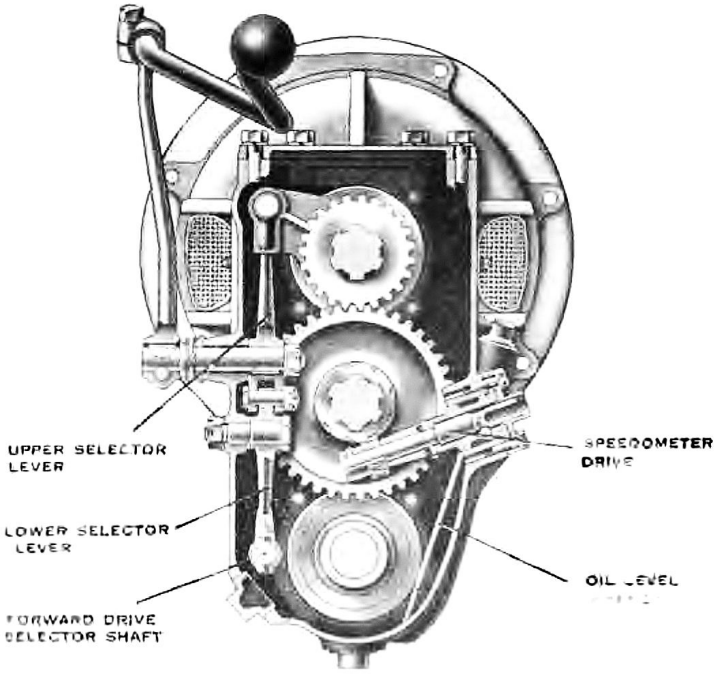



Fig. 53.—TRANSFER BOX, TRANSVERSE SECTION.

## *Part IV*
## THE PROPELLER SHAFTS AND UNIVERSAL JOINTS

Two propeller shafts connect the transfer box to the front and rear axles. These are the normal type of tubular construction, having universal joints at each end, and also incorporating a splined telescopic joint, which is necessary to accommodate the variation of distance between axle and transfer box as the road springs operate between compression and rebound.

The spider forming the universal joint bearing has four arms. The two opposite arms of this spider and a set of needle roller bearings fit into bearings ground in lugs on the coupling flange, while the two remaining arms fit into bearings ground in the lugs of the centre portion of the propeller shaft.

The needle rollers are held in position by metal covers and snap rings, which retain the lubricant in the bearings and also exclude any dirt, etc.

When the splined telescopic joint is assembled, it is most important that the arrow on each part should be in line. This is to ensure that both bearings attached to the centre portion lie in one plane. The bearings attached to both the coupling flanges will then also lie in one plane which is at 90° to the centre bearings.

Each propeller shaft has three lubricators.

## *Part V*
## THE DRIVING AXLES

### Rear Axle

The rear axle in addition to locating the rear wheels and forming a point of connection to the chassis, through the springs, also provides the driving mechanism between the propeller shaft and the road wheels.

The axle casing fitted transversely across the vehicle forms the main portion, and the stub axles are bolted to each end of this. These stub axles locate the taper roller bearings and hubs on which the wheels rotate. The hubs are each connected to an axle shaft, and these connect by splines to the bevel wheels of the differential, housed in the centre of the axle case.

### The Axle Case

This is a banjo type casing, Fig. 54, and brackets forming the spring anchorage are welded to the outside near each end. A flange at each end of the axle locates and supports a brake backplate and stub axle. The front centre portion of the case forms the location point for the crown wheel and bevel housing.

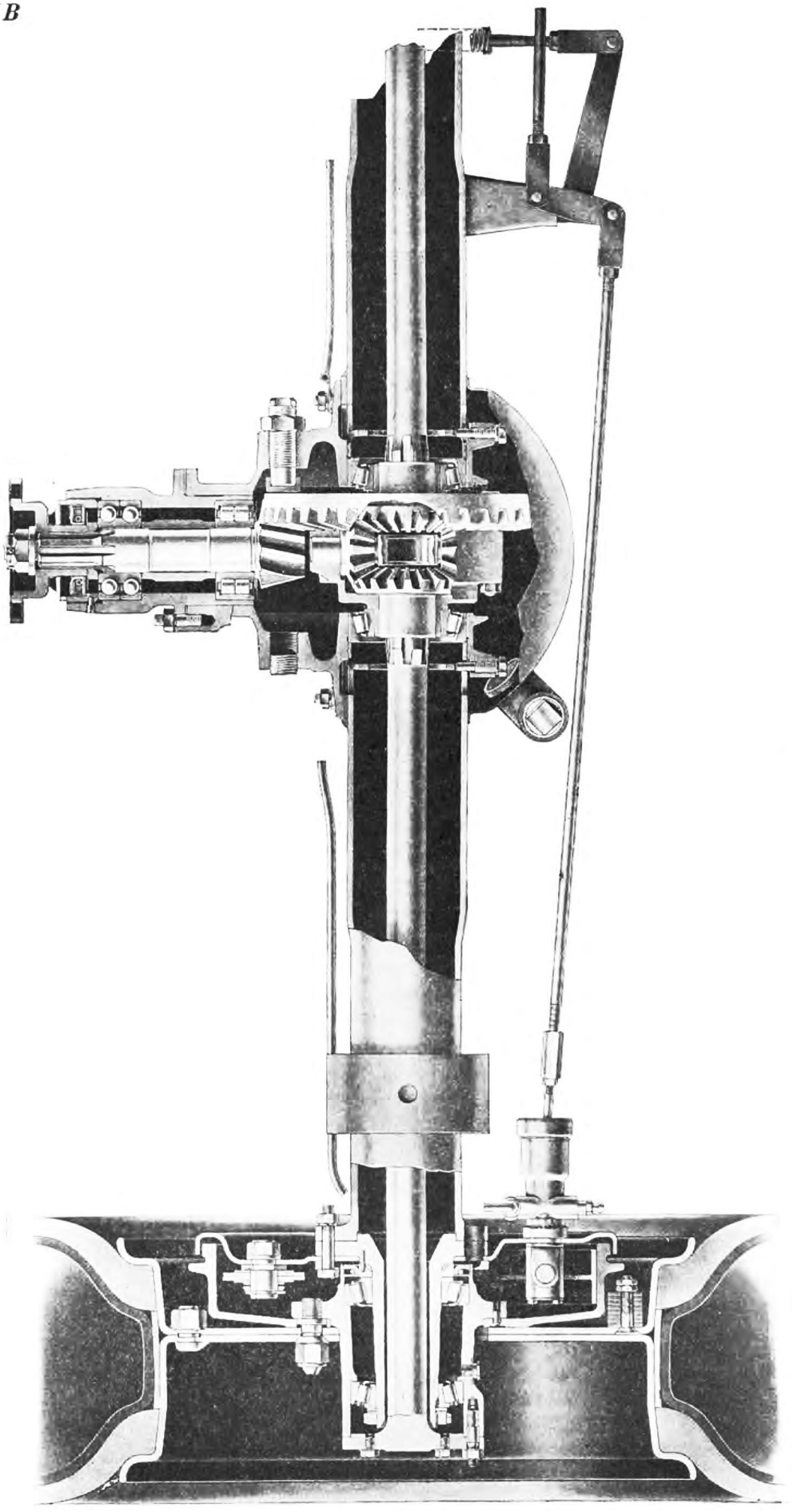


Fig. 51.—REAR AXLE.

### The Crown Wheel and Bevel Housing

This assembly consists of a casting, which, when it is bolted in position in the centre of the axle case, supports the crown wheel and differential bevel wheels in line with the axle shafts. The driving pinion and sleeve is secured to this housing by nuts and studs, Fig. 54. It is in line with and connects to the propeller shaft coupling.

The crown wheel locates on the outside of one half of the differential casing and is secured to it by the bolts which clamp the two halves of the case together. Inside this differential case, are two bevel gear wheels having splined bores to mate with the axle shafts. A boss on each bevel gear surrounding the splined bore forms a bearing locating each gear in the side of the case. When the differential case is assembled, a four-arm spider carrying a bevel pinion on each arm is located between and engages with the two larger bevel wheels, *see* Fig. 54. With the exception of thrust washers, this comprises the whole of the differential gear.

The crown wheel and differential gear are supported in the bevel housing by two taper roller bearings pressed on to the differential case and located in a split housing of the main casting. A screw adjustment controls the degree of engagement between the crown wheel and pinion, while a bronze thrust pad placed behind the crown wheel is adjustable to prevent undue flexing of the crown wheel under the stress of suddenly applied peak loads.

The bevel pinion and sleeve assembly is secured to the bevel housing by studs and nuts. Shims placed between the connecting faces of these two assemblies (together with the screw adjustment to the crown wheel bearings) control the degree of engagement between the teeth of the crown wheel and pinion. The radial load of the pinion is taken by a roller bearing, while a special thrust bearing at the other end of the sleeve takes the thrust of the bevel pinion.

### The Wheel Hubs and Stub Axles

A stub axle and brake back plate is secured to each end of the axle case by bolts and nuts, *see* Fig. 54. Two taper roller bearings mounted on each stub axle carry the wheel hubs. These bearings are adjustable, and the adjustment is locked by a hexagon nut and tab washer. The brake drum is positioned on the hub flange and located by the studs securing the road wheel. Three countersunk screws secure the brake drum to the flange to retain it in position when it is necessary to remove the road wheel. Each road wheel is secured to the hub by five hexagon nuts. These have right-hand threads at the right side of the vehicle and left-hand threads at the left side. Each hub is connected to the bevel gear wheel of the differential by an axle shaft splined on its inner end to engage the splined bore of the differential bevel wheel. A flange formed on the outer end of the shaft is drilled to locate over the five studs screwed into the end face of each hub, and is retained in position by nuts. This forms the drive from the differential to the hub and road wheel. Oil seals and felt washers are placed at the essential points to prevent entry of dirt into the lubricating system and to stop the leakage of lubricant from the axle. *See* Fig. 54.

### Operation

It will be seen that the weight of the vehicle is not carried by the axle shaft but by wheel, hub bearings, hub, axle case and spring. Power is delivered from the engine via the clutch, gearbox, transfer box, propeller shaft and the rear axle pinion to the crown wheel and through the differential, along the axle shaft to the hub and road wheel.

The differential allows the two rear road wheels to rotate at different speeds as necessary when turning, particularly in a small radius turn. This is accomplished through the four bevel pinions placed between the two main bevel wheels of the differential. The four bevel pinions must turn at the same rate as the crown wheel, but as the inner road wheel when on a small radius turn will not rotate so quickly as the outer road wheel during this turn, the four bevel wheels on the differential spider allow this difference in the speed of the road wheels by turning on the spider. This can easily be proved in a practical way when both rear wheels are raised clear of the ground, by placing the gear lever in any gear to prevent the propeller shaft turning, then free the hand brake. When either rear wheel is turned, the opposite rear wheel will rotate the reverse way at a similar rate of speed.

### The Front Axle

This comprises a bevel pinion and sleeve attached to the bevel housing, a centre axle case, two inner Tracta joints, two outer Tracta joints, stub axles, the swivel pins and their connecting plates.

### Driving Pinion and Sleeve and Bevel Housing

These are almost identical with those of the rear axle, the chief difference being in the angle of the teeth of the crown wheel and pinion which is opposite to those of the rear axle.

### Centre Axle Case

This is a short case suspended from the chassis cross member by two bolts passing through silent-bloc bushes located in the casing. It houses the crown wheel and differential in the same manner as the rear axle. The ends of the case form half of the spherical housing for accommodating the inner Tracta joints. The driving bevel sleeve when in position is held by a bracket bolted to the bottom link cross member underneath the axle casing.

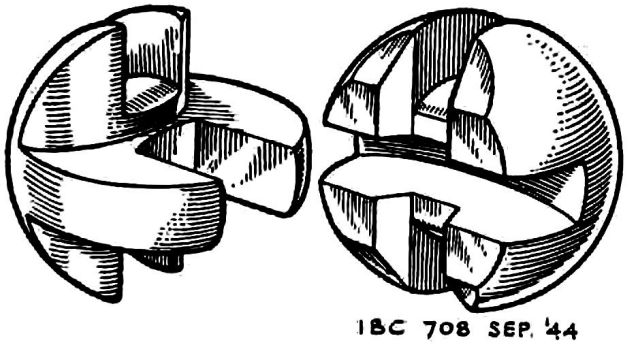



Fig. 55.—TRACTA JOINT CENTRE PIECES.

### Inner Tracta Joints

Each Tracta joint comprises a spherical housing in two halves with a spring loaded oil seal to prevent loss of lubricant. Two forked shafts and two slotted spherical joints (*see* Fig. 55). housed inside the spherical housing complete the joint.

Each end of the centre casing of the front axle forms one-half of the Tracta joint spherical housing. The other half is retained in position in this by a screwed gland and oil seal. *See* Fig. 57. This illustration shows how the two Tracta shafts connect to the centre pieces of the joint and transmit power from the differential bevel wheel to the outer Tracta joint shaft. Spring loaded oil seals prevent the lubricant escaping from the joint. The principal on which the tracta joint operates is: the two centre pieces each have slots or tongues at 90°. These centre pieces connect together and also to both forked shafts by means of the tongues or forks engaging the slots. By this means they are able to transmit power at the angle to which they may be deflected.

### Outer Tracta Joints

It will be seen by reference to Fig. 57 that one Tracta joint shaft connects to the inner Tracta joint shaft by a splined sleeve capable of a sliding movement along the inner shaft. This is to accommodate the changing centre distances between the two Tracta joints as the axle moves up and down due to irregular road surfaces. The two centre pieces of the joint are housed in a two-piece spherical housing, one-half being integral with the stub axle and supported by the taper roller bearings attached to the upper and lower swivel pins.

### Stub Axles and Hubs

Two taper roller bearings mounted on each stub axle support the hub, these are adjustable and are locked when adjusted, by nut and tab washer. A flange splined internally fits on the Tracta shaft where it protrudes through the stub axle, and at the same time it engages with the five studs secured in the end face of the hub, being locked in position by five nuts. A set bolt and large washer screwed into the end of the Tracta shaft secures this shaft to the flange. The brake back plate is held in position on the stub axle by bolts, and the wheel is held to the hub flange by five nuts in the normal manner.

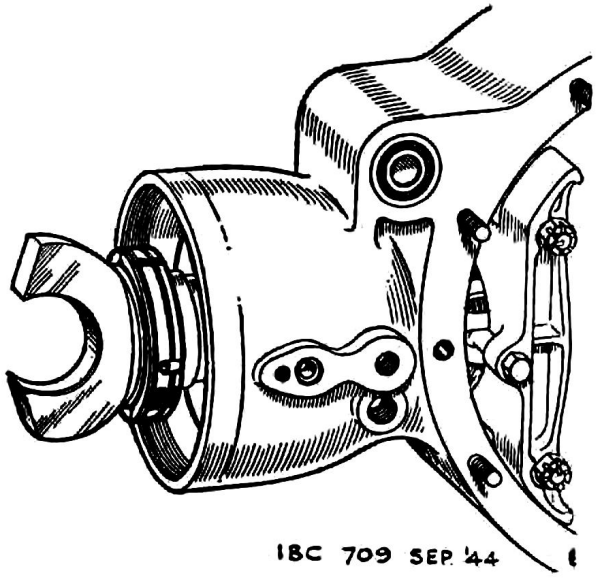



Fig. 56.—INNER TRACTA SHAFT, PARTLY WITHDRAWN.

## *Part VI*

## WHEELS AND TYRES

To facilitate tyre fitting, each wheel is manufactured in halves and held together by 12 bolts and nuts near the outer edge. The wheels are held to the hubs by nuts on the 5 studs of the hub flange. Each wheel carries 6 studs on its inner face to accommodate balance weights, and it is MOST ESSENTIAL that each wheel is correctly balanced before being fitted to a vehicle.

The tyres are Run-flat and are constructed so that in the event of a tyre being pierced by bullets, shrapnel, etc., and thus deflated, it will carry its full load for a maximum distance of approximately fifty miles, which should normally be sufficient to bring the vehicle to safety. In very exceptional circumstances, tyres may be deliberately deflated by depressing the valve centre. The tyres will then give a completely satisfactory performance even while traversing very difficult country.

"Run-flat" properties are provided by the exceptionally stout outer cover, by the small diameter inner tube, and by the resilient rubber bead spacer.

# *CHAPTER IIIB*

# SUSPENSION

## *Part I*

## FRONT AND REAR ASSEMBLIES

### The Front Suspension (Fig. 57)

The front suspension permits either wheel to be deflected by road conditions without influencing the other wheel, also it permits the front wheels to transmit power drive when required without affecting steering conditions. A leaf spring fitted transversely across the front of the vehicle is anchored to the chassis cross member at the centre of the spring by "U" bolts. A bottom link cross-member bolted firmly to the chassis frame underneath the front axle has two links pivoted on this near the centre of the vehicle. These links connect to the bottom of each stub axle, while the top of each stub axle is secured to a spring eye. This linkage controls the stub axle position to maintain it correct at all deflections of the spring.

The fact that road wheels may be driven by a universally-jointed shaft, and the presence of the outer "Tracta" universal joints prevent the use of the conventional type of long swivel pin. These take the form of two small swivel pins each fitted with a taper roller bearing, housed one at the top and the other at the bottom of the stub axle. The swivel pins with their bearings are carried in suitably machined carriers clamped between the side plates mentioned above.

Conical-shaped rubber blocks are employed as bump and rebound stops.

### The Rear Suspension

Two semi-elliptic leaf springs are used at the rear of the vehicle, the front eyes being fitted with silent-bloc bushes and bolted directly to brackets on the chassis frame. Each silent bloc bush consists of a rubber sleeve bonded between two tubes. The outer tube, constituting the external diameter of the bush, is clamped into the spring eye, and the inner tube forming the bore of the bush is gripped securely in the bracket mentioned above, by the bolt passing through the centre. The tightening of the bolt on assembly is carried out with the spring deflected to its laden position, so that subsequent spring action with the vehicle in motion conveys an equal twisting effect in either direction upon the rubber formed in the bush.

The rear spring eyes are bushed to form a pivot connection with a shackle, this being arranged by the provision (top and bottom) of a shackle pin on which is fitted a distance tube free to move in the spring eye and bushes, the tubes, however, being slightly longer than the bushes.

Also mounted on the shackle pin are two thrust washers which fit inside the shackle, butting against the ends of the distance tube. It will be seen that the spring eye with its bush is free to move on its distance tube, due to the tube being longer than

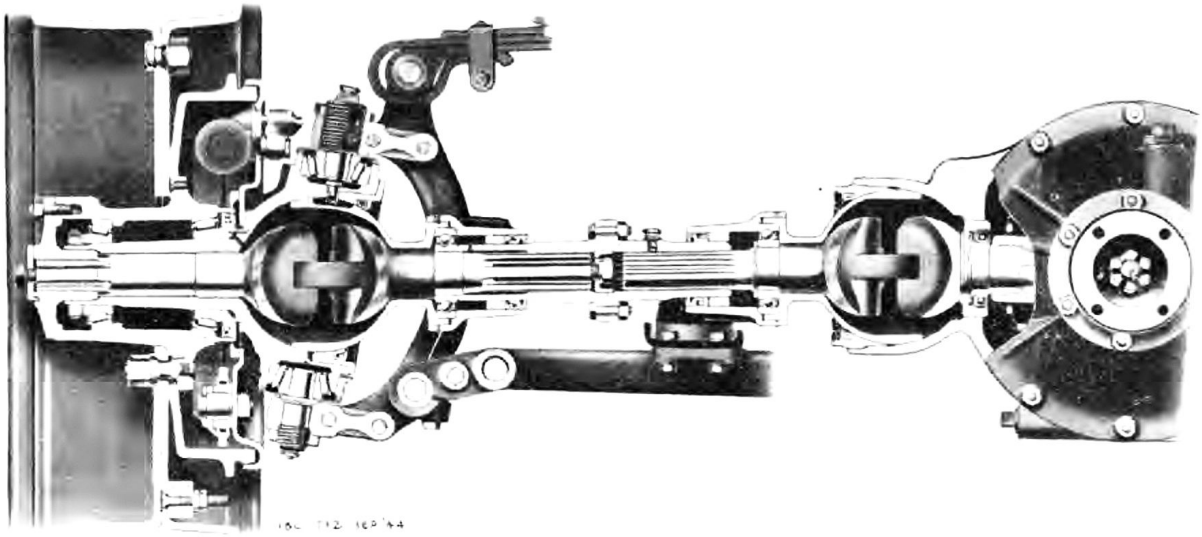


Fig. 57.—FRONT TRANSMISSION AND SUSPENSION.

the bush, end float is provided; this should not exceed .010 in.

The shackle pins are drilled and provided with a lubricator, and both bushes are grooved for lubrication purposes.

Clamping the spring leaves together are four clips and a dowel bolt provides correct location. The springs are secured to the top of the axle casing by two large "U" bolts and clamp plates.

It should be noted upon assembly that the centre dowel bolt is nearer the rear spring eye than the front.

Towards each end of the axle casing a rebound strap bolted to a rectangular extension of the chassis frame passes round the axle casing; this provides a check to the axle movement should the wheels leave the ground, and to prevent any possibility of the spring exceeding its free chamber.

Rubber buffers are bolted to the chassis frame to damp out shocks should the axle hit the frame under exceptional conditions.

## *Part II*

## SHOCK ABSORBERS

**(Fig. 58)**

**Type:** Front axle .. P6–15 double-acting.
Rear axle .. P7–1 ,,

The shock absorbers fitted to both front and rear axles are double acting; equal resistance is offered to the compression and to the recoil of the road springs.

The shock absorbers are arranged to provide the required damping for the vehicle to which they are fitted, and no adjustment is provided.

The P7 type shock absorbers fitted to the rear of the chassis are larger than the P6 type fitted to the front, but both types function in exactly the same manner, the only difference being in the cylinder capacity; the P6 is 1¾ in. diameter, and the P7 1¼ in. diameter.

### Constructional Features

The shock absorber is fitted with two separate pistons, flexibly connected by " D " shaped springs. The pistons are actuated through hardened pads by a rocker, fitted tightly on serrations formed on a shaft, to which the lever arm is also fitted. The arm is connected to the axle by a connecting link through bearings.

At the outer end of each piston is a circular valve plate, on the inner seating of which is a pressure valve arranged to operate at a predetermined maximum resistance.

On the inner seating of the valve plate there is a recuperating non-return valve, which permits the fluid to flow freely from the recuperating chamber to the pressure or working chamber.

To control the resistance at speeds lower than that which is required to open the pressure valve, a small orifice, fitted with a metering pin of predetermined size, is provided. A filter is fitted behind the valve plates.

### Operation

The axle movement is transmitted to the rocker shaft by a connecting link and lever. Mounted between the rocker shaft bearings on tightly fitting serrations, the rocker converts the rotary motion of the shaft to the reciprocating motion of the pistons through hardened surfaces. The pistons are coaxial but separate, a spring flexibly joining the two pistons. Any wear on the hardened surfaces is thus taken up automatically without passing the damping load through the spring. At the outer end of the piston, a circular valve plate carries on the inner spring seating the pressure valve operating at a predetermined maximum resistance, an orifice of the required area being provided in the valve seat to give the correct resistance. No adjustment is therefore

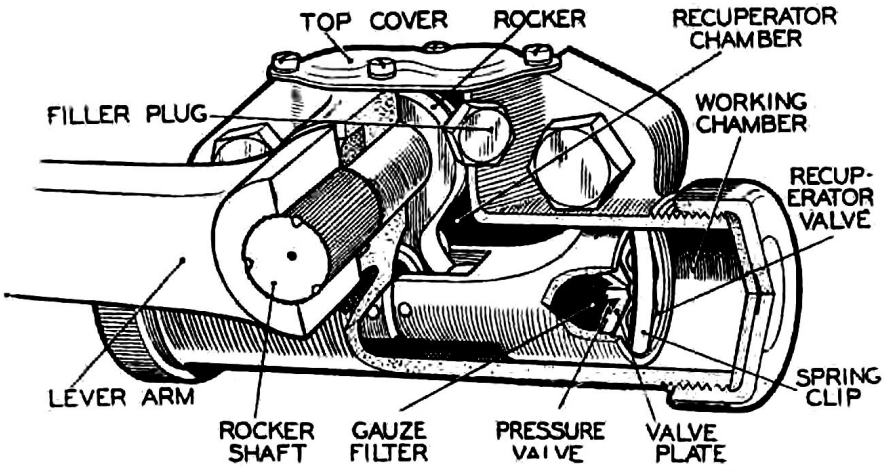



Fig. 58. INTERNAL ARRANGEMENT OF SHOCK ABSORBER.

required. On the outer seating of the valve plate, a recuperating valve is fitted.

**Operation**

Movement of the axle causes rotation of the rocker shaft and lateral movement of the piston, *e.g.* to the left. The valves in the left hand piston both remain closed, offering fluid resistance to the piston and consequently to the axle. The valve in the right-hand piston is opened by the flow of fluid, thus filling this chamber ready for the next stroke. Should the axle movement be excessive in speed, the high pressure generated will open the valve in the left-hand piston, preventing excessive resistance which would cause damage and hard riding. Movement to the right follows through the same cycle.

# *CHAPTER IVB*
# STEERING AND BRAKES
## *Part I*
## THE STEERING (Fig. 59)

The steering unit is the worm and nut type. The steering box housing the worm and nut and supporting the rocker shaft, is held to the front frame extension of the chassis by three studs and nuts. The angle of the steering column and the position of the steering wheel is not adjustable.

A tube permanently attached to the steering box is supported from the floor of the vehicle by a bracket, and inside this outer steering column at the top end there is a ball race for the purpose of locating the inner steering column. The inner steering column has a fine thread at the top end (*see* Fig. 59) and is located in the outer steering column by a ball race which is adjustable so as to provide easy turning while preventing any longitudinal movement of the inner shaft. This thrust race comprises a set of uncaged steel balls held between the outer race and two inner races. One of the inner races butts against a shoulder of the inner column, while the other inner race is adjustable by being screwed on to the inner column. When adjusted correctly this is locked by a hexagon nut on the inner steering column.

A multi start quick pitch worm—or screw— is formed on the lower end of the inner steering column, and it is fitted into a long bronze nut which moves along the worm when the inner column is being turned. The rocker shaft located in the steering box at right angles to the steering column is mounted on a ball bearing and bronze bush, and as will be seen in Fig. 59 it is linked to the bronze nut by a ball and socket.

Therefore, as the inner steering column is rotated by the steering wheel, the bronze nut moves up and down the column taking with it the ball and rocker shaft connected to it, and so causing rotation of the rocker shaft. The steering drop arm is coupled to this rocker shaft at its outer end, and is held positively to the shaft by tapered splines and a large nut. The drop arm is connected to two steering track rods by ball joints, and each of these connect to the steering arms bolted to the stub axles.

A plug screwed into the outer steering column provides the lubrication point for the worm and nut and also the rocker shaft. The four ball joints of the track rods are lubricated from a lubricator fitted to the outer ball joint on each rod, the inner ball joints are connected to the outer joints by copper tube for lubricating purposes. The ball joints are the spring loaded self-adjusting type.

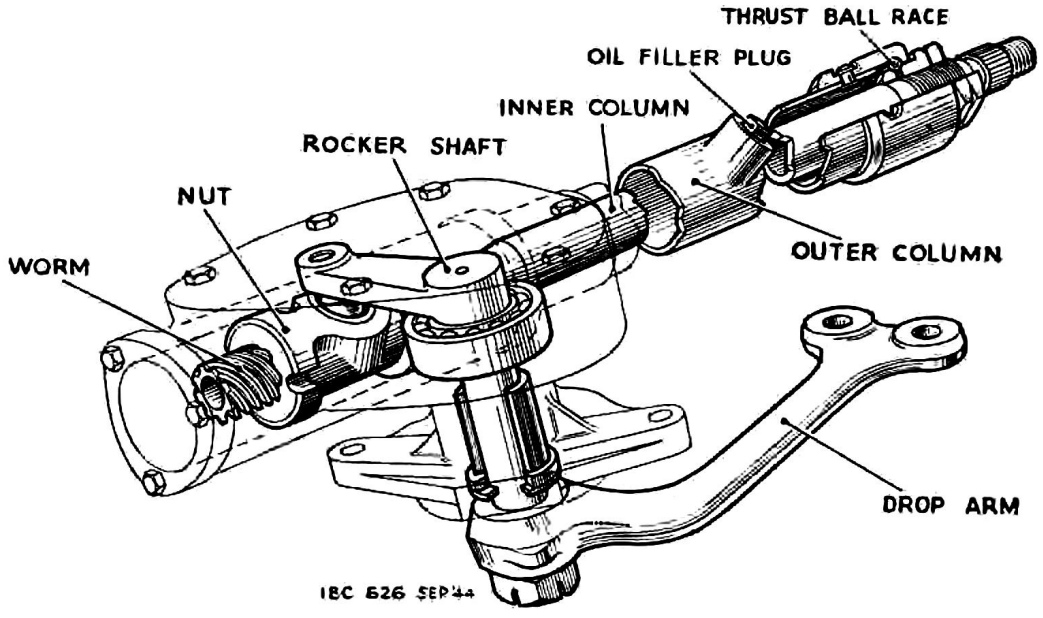



Fig. 59.—STEERING UNIT.

## *Part II*

## THE BRAKES

The foot brake is a hydraulic system operating on all four wheels. The system consists of an auxiliary supply tank or reservoir mounted on the steering column, an integral supply tank and master cylinder in which fluid pressure is generated, wheel cylinders which transmit fluid pressure to the brake shoes and a pipe line consisting of tubing, flexible hose and unions connecting the master cylinder to the wheel cylinders.

Operation of the foot brake pedal causes the piston of the master cylinder to move and create a pressure in the system which causes the pistons of each wheel cylinder to move outwards and so expand the brake shoes.

When all the brake shoes are in contact with the drums, solid resistance is obtained at the pedal. Further effort on the pedal generates high pressure in the master cylinder and through the system, thereby increasing the force applied to the brake shoes.

The pressure generated in the master cylinder is transmitted with equal force to each wheel cylinder, thus ensuring perfect equalisation and efficiency in direct proportion to the effort applied at the pedal.

When the pedal is released, the brake shoe return springs force the wheel cylinder pistons, and therefore the fluid, back to the original positions in the system.

The hand brake operates on the rear wheels only, and is applied mechanically. Operation of the hand brake does not affect the hydraulic mechanism, and vice versa.

### The Foot Brake Pedal

The foot brake pedal pivots on needle roller bearings and it connects at the lower end, directly with the push rod which operates the master cylinder piston. The needle roller bearings are lubricated from a point on the chassis cross member. (*See* Fig. 15.)

### The Master Cylinder (Fig. 60)

The master cylinder situated immediately below the brake pedal (*see* Fig. 15) is protected by a guard plate.

The master cup is held to the piston by the spring retainer and piston return spring, while the other end of this spring retains the check valve in position at the end of the master cylinder. A by-pass port connecting the supply tank and master cylinder allows the system to compensate for any expansion or contraction of the fluid due to changes in the temperature. It also serves to release excess fluid drawn into the pressure chamber from the annular space formed by the piston skirt after application of the brakes, and excess fluid from the pipe lines.

On the release of the brake pedal, a vacuum is created in the pressure chamber by the rapid return of the piston, which causes the master cup to collapse and fluid to be drawn via small holes in the piston head. As the system comes to rest, due to the action of the brake shoe return springs, this excess fluid passes freely to the supply tank via the by-pass port.

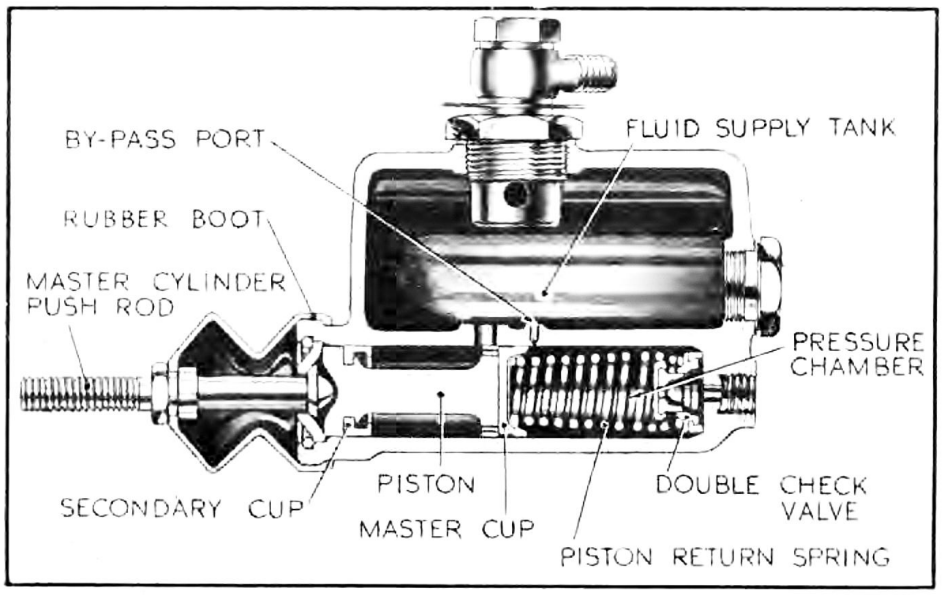



Fig. 60.—BRAKE MASTER CYLINDER.

At the output end of the pressure chamber is a double check valve which consists of a perforated metal body to which is attached a rubber valve seat, and inside the body a small rubber cap which seals the perforations.

The action of the valve under normal braking conditions is as follows : On depressing the brake pedal the piston forces fluid through the perforations in the valve body, causing the internal cup to collapse and create a free passage. On releasing the pedal, the action of the brake shoe return springs causes the fluid delivered to the wheel cylinders to be returned to its original position in the system. In so doing the returning fluid lifts the complete valve assembly to allow free passage, until the pressure it exerts is overcome by the piston return springs, when the valve closes.

At the open end of the cylinder a rubber boot prevents the ingress of dirt, whilst a secondary cup is fitted to the piston to prevent leakage of fluid into the boot.

### The Front Wheel Cylinder (Fig. 61)

The front wheel cylinder is held to the brake back plate between the free ends of the two brake shoes. A bleeder valve and flexible hose is screwed into the cylinder from the outside of the back plate.

Inside the wheel cylinder are two pistons, each fitted with a rubber cup and separated by a spring. At each end of the cylinder a rubber boot locates in a groove on the outer diameter, and in a groove on the end of the piston. This is to prevent the ingress of dirt.

The end of a brake shoe bears against each piston and when the brake pedal is depressed, fluid is forced via the master cylinder and pipe lines to the space between the two pistons of the wheel cylinder, forcing the pistons apart, thus pushing the brake shoes outwards into contact with the brake drum.

When the brake pedal is released, the brake shoe return spring returns the pistons to their original positions.

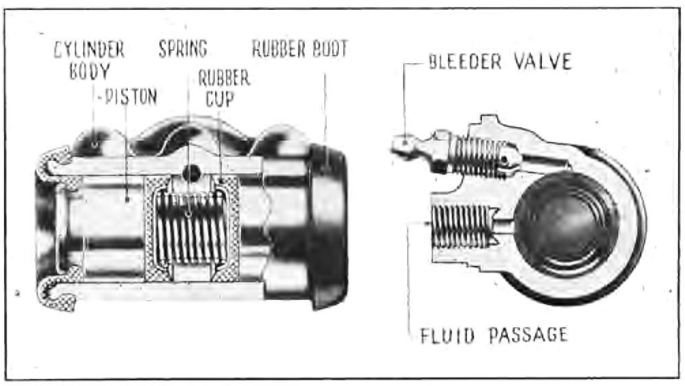



Fig. 61.—BRAKE OPERATING CYLINDER—FRONT.

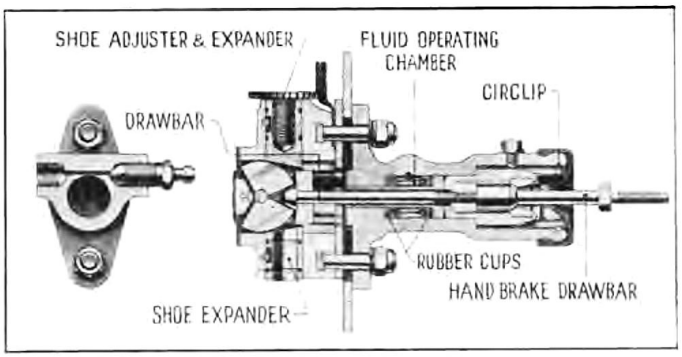



Fig. 62.—BRAKE OPERATING CYLINDER—REAR.

### The Rear Brake Transverse Cylinder (Fig. 62)

The rear brake transverse cylinder bolted on the outside of each rear brake back plate houses the rubber cups, piston, and draw bar assembly. The cylinder must not be bolted tight to the back plate, see later note, but must have sufficient freedom to be self-adjusting in relation to the position of the brake shoes.

The action of the gear is as follows. On depressing the brake pedal, fluid under pressure enters the cylinder between the opposed rubber cups and forces the piston along the bore, carrying with it the draw link. This in turn pulls the bisector draw bar, thus forcing the roller segments between the tappets and driving them outwards to expand the brake shoes. The draw bar to which the mechanical linkage is coupled remains unaffected. On releasing the brake pedal the brake shoe pull off spring causes the shoes to drive the tappets inward and retract the draw bar, piston, etc.

On applying the hand brake lever the linkage coupled to the draw bar operates the bisector through the draw link and draw bar without disturbing the piston.

**Note :** The cylinder and bisector must be free to slide across the brake back plate when adjusting. The approximate amount of freedom required will be obtained by tightening the fixing bolt until the double spring washer is fully compressed and then slackening the nut off half a turn.

### The Hand Brake

The hand brake lever is of the orthodox type, having the usual type of ratchet and pawl parking control.

To the bottom of the lever a cable is attached through the medium of a pivoted jaw, and the cable passes to the rear of the vehicle, where it is connected to a rocking lever which pivots upon a bracket secured to the rear axle casing.

Brake operating rods connect each rear brake draw link to the rocking lever.

This system operates independently of the hydraulic mechanism, although actuating the same rear brake shoes. At the point where the inner brake cable enters the outer conduit a felt block is provided, to prevent the entry of dirt or water.

### The Pipe Line

The pipe line consists of special tubing and flexible hoses, connected by adapters and clipped to the chassis to prevent vibration.

### The Brake Shoes

Each brake drum contains two semi-circular metal shoes, to which are riveted fabric linings. These shoes are secured to the brake back plate at one end by being fitted over an anchor pin and held by a circlip and metal washers, and at the other (actuating) end by butting against the hydraulic pistons and held in this position by a strong coil spring.

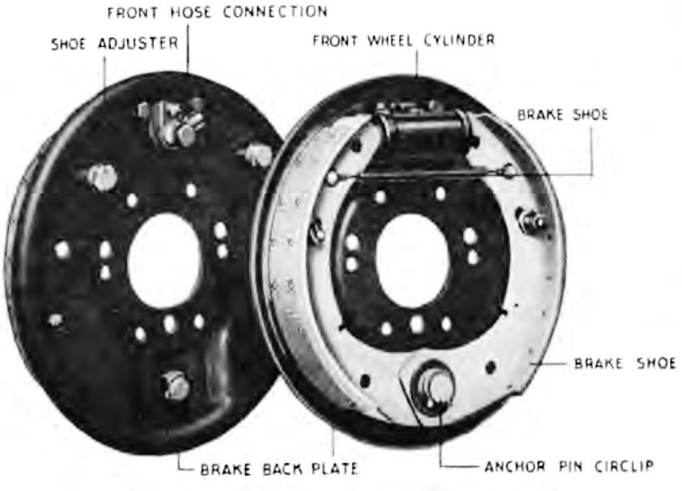


Fig. 63.—FRONT BRAKE ASSEMBLY.

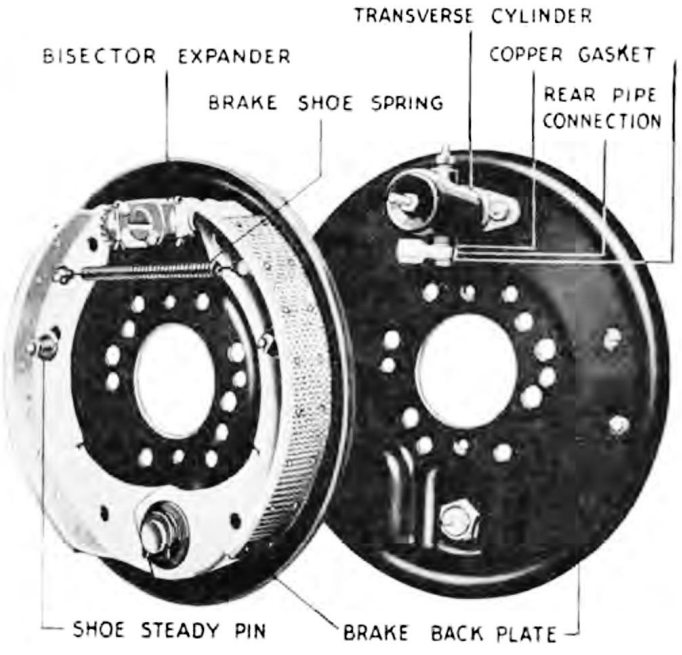


Fig. 64.—REAR BRAKE ASSEMBLY.

# *CHAPTER VB*

# ELECTRICAL EQUIPMENT

## *Part I*

## WIRING AND FUSES

The wiring is held in position by metal clips, secured by nuts and washers on studs welded to the hull at intervals of 6 in. to 8 in.

Where it is necessary to provide screening to prevent interference with wireless reception, the cables are covered by a metal braid which is earthed by connection to the hull.

Cables which are in a position likely to be damaged by bad weather conditions, or by accidental rough treatment, are protected by enclosing them in flexible metallic tubing, or in a trough of sheet steel bolted to the hull, forming conduits.

A few of the cables are held by the metal clips only, and are not provided with any metallic protection. These are the feeds to wireless set, interior light, screen wiper, starter solenoid.

All cables going forward from the instrument panel to the horn, head and side lamps are in flexible metal tube. The tail and convoy lamp cables are enclosed similarly where they pass through the engine compartment and outside the vehicle. Between the instrument panel and control board the cables are protected by enclosure in a sheet metal trough, having a lid held in place by nuts on studs welded to the hull.

The main cables between battery, cut-off switch and starter are not protected by an mechanical cover. The length of cable is short and the position is one where accidental damage is unlikely to occur; the insulation is tough rubber. The main battery negative is earthed by being connected to the starter motor flange, after passing through the battery cut-off switch. All circuits are disconnected when this switch is off.

All cables passing through the bulkhead to engine compartment are protected at this point by a treated felt bush, held in position by a metal flange bolted to the bulkhead.

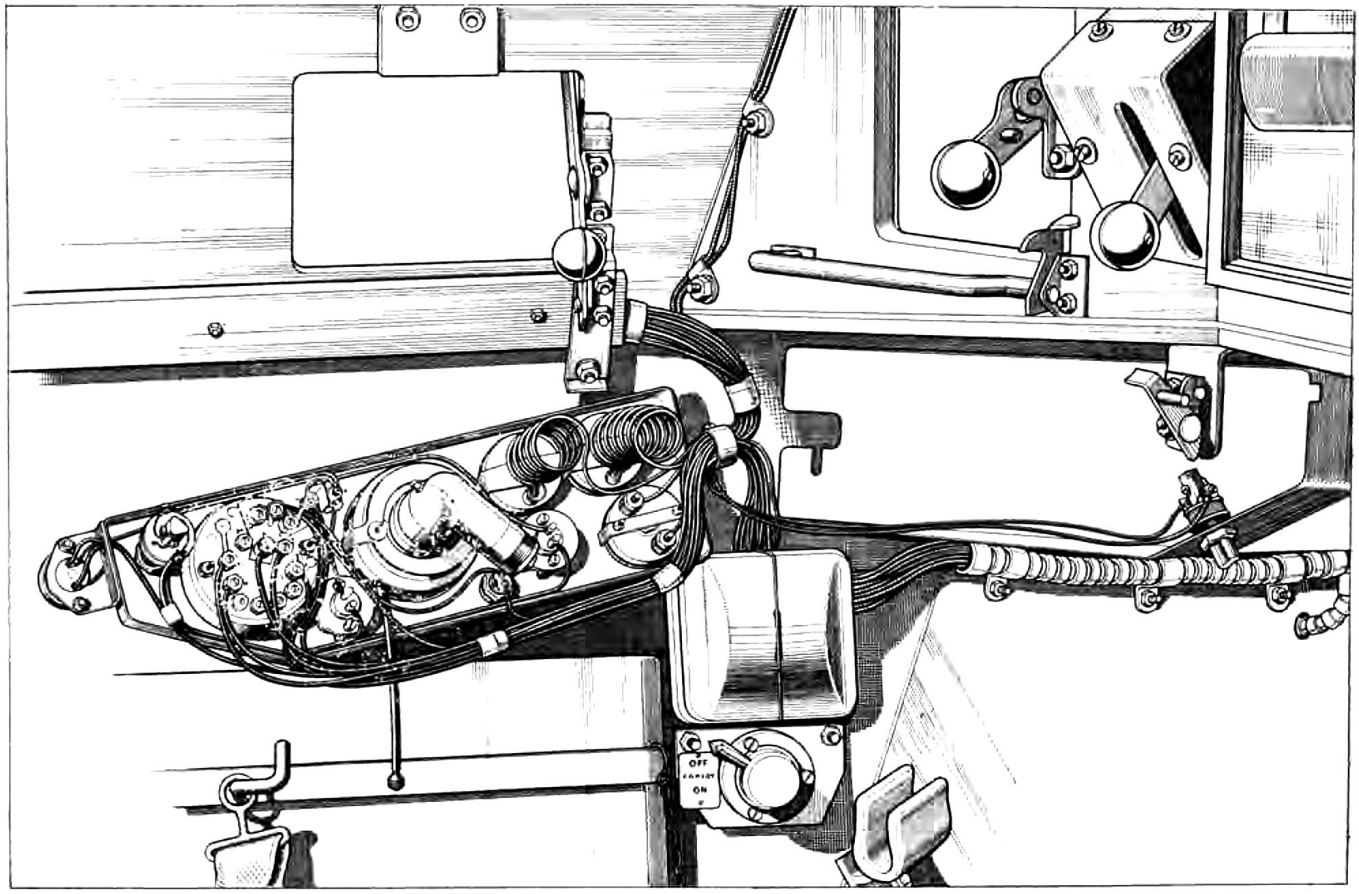


Fig. 65.—INSTRUMENT PANEL—REAR VIEW.

The feed to engine ignition is by one positive cable only, the return negative being through the engine body and main starter cable. All other equipment is supplied by twin cables. The negative side of the wiring is earthed at starter motor body and battery terminal.

There are six fuses protecting the equipment of this vehicle, five are in the fuse box on the left wall of the fighting compartment (details are given on page 38), and their object is to prevent serious damage to the wiring, or the possibility of fire should a short develop. As soon as the wiring circuit is overloaded, the fuse will blow and break the electrical circuit. The dynamo fuse is a special one in the control board, and protects it in a similar manner to that described above.

### Instrument Panel (Fig. 65)

The front panel on which the instruments are mounted is held in position by four screws. When these are removed, the panel can be pulled out for inspection and adjustment. It is illuminated from the rear by two bulbs.

Mounted on it is the water temperature thermometer, oil pressure gauge, speedometer, switch board, ammeter, starter push button, compass light switch, panel light switch, horn push button, inspection plug sockets.

A rotary switch on the switch board has positions for illuminating tail lamps only, tail and side lamps or head, tail and side lamps. The ignition switch is on the same switchboard. These are very simple and robust switches, and if kept clean and dry, and with a little vaseline on the contacts, they should give no trouble.

The ignition warning light becomes illuminated when the ignition is switched on, and remains so until the dynamo begins to charge the battery, or until the ignition is switched off.

### Battery Cut-off Switch

This is mounted on a bracket and held by three screws ; it is on the bulkhead near the battery. When this switch is turned off, all circuits are disconnected.

**Note :** If this switch is turned off while the engine is running sufficiently fast to charge the batteries, the engine will continue to run on ignition current supplied by the dynamo, if the wiring is free from faults ; therefore do not switch off the main switch while the engine is running.

## THE BATTERY

### Function of the Battery

The battery is a device for storing energy and supplying current for starting the engine, lighting lamps, etc. The energy so used is automatically replaced by the dynamo when driven above a speed of 820 r.p.m. by the engine.

### Description of a Cell

The battery comprises several individual cells each approximately 2 volts. Each cell contains a group of positive plates and interleaved between each pair is a plate connected to the negative group.

Separators of specially treated wood insulate each plate from the next and the cell is filled with electrolyte consisting of pure sulphuric acid diluted with distilled water, to a level ½ inch above the plates. The various cells of a battery are connected together to give 6 volts per battery.

### What Happens to an Idle Battery

An idle battery gradually loses its charge by internal action, to the extent of about 1 per cent. of its capacity per day (less than this on a brand new battery, more on a very old one). Hence, a fully-charged battery, if it is allowed to stand idle for a month, will be only about 70 per cent. charged at the end of that time.

To counteract this loss of charge, an idle battery should be given a freshening charge at the normal rate at least once every month.

### What Happens to the Electrolyte

In service, none of the sulphuric acid in the electrolyte is lost (unless, of course, there is accidental spilling). Water, however, is gradually lost by evaporation and "gassing."

It follows, therefore, that only water must be added to maintain the level of the electrolyte. Acid must never be added, except to compensate for spilling. If possible, the water which is added should be pure (distilled).

In hot climates topping-up will be required more frequently, because of the increased amount of evaporation.

### Operation at Very Low Temperatures

The effect of low temperature on discharge is to reduce the capacity and voltage at all rates. Batteries bearing a "—21° F." marking, however, are designed to give an adequate performance for engine starting down to a temperature of —20° F. (or in emergency down to —30° F.), provided they are maintained in a well-charged condition.

The effect of recharging at low temperatures is to raise the battery voltage above normal, and also to increase the amount of charging needed to restore the cells to a fully-charged state.

Low temperatures tend to make the containers and sealing compound more brittle, and special care is therefore necessary in handling.

Should freezing of the electrolyte occur, the battery plates will rapidly be ruined. The higher the specific gravity, the lower is the temperature at which freezing takes place; hence it is important to keep the battery as fully charged as possible. On continuous discharge at currents greater than the 10-hour rate, the output obtainable, at a given temperature, will not be sufficient to reduce the specific gravity to a figure at which it would freeze at that particular temperature. If the discharge rate is very low or intermittent, however, or if the battery temperature is allowed to fall considerably after the discharge has been completed, this may result in freezing.

If the battery is topped-up whilst at a low temperature, there is a risk that the added water may freeze if it is not immediately mixed up with the electrolyte. For this reason topping-up should only be done whilst the cells are on charge and gassing, particularly if the level has fallen below the tops of the plates. Furthermore, not more than one dessertspoonful of water should be added at one time.

The specific gravity of the electrolyte varies with temperature, because the acid contracts when cooled and expands when heated. The true specific gravity is assumed to be the figure shown at 60° F. In order to calculate the true specific gravity from readings at other temperatures, it is necessary to **subtract** one point (.001) from the observed hydrometer reading for every 2½° F. by which the temperature is below 60° F. For temperatures above 60° F. a similar amount should be **added** to the observed reading.

### Operation at High Temperatures

Although the standard W.D. battery with "—21° F." marking will function at temperatures up to 140° F., it is advisable to avoid temperatures above 110° F. as far as possible, as they tend to reduce the life of the battery. The capacity obtainable at high temperatures is, however, somewhat greater than normal.

Evaporation of water from the electrolyte is increased at high temperatures, and topping-up is therefore required more frequently.

## *Part II*

## THE STARTER

This is secured to the engine side of the clutch housing by three bolts. The drive mechanism is enclosed in the clutch housing, and the main starting switch, which is operated by a solenoid, is mounted on the end of the starter motor.

The motor is a four-pole machine having series parallel connected windings. The field coil windings are rectangular wire of large capacity, and connected permanently to two of the four brushes. These field coils are insulated by cotton tape impregnated by

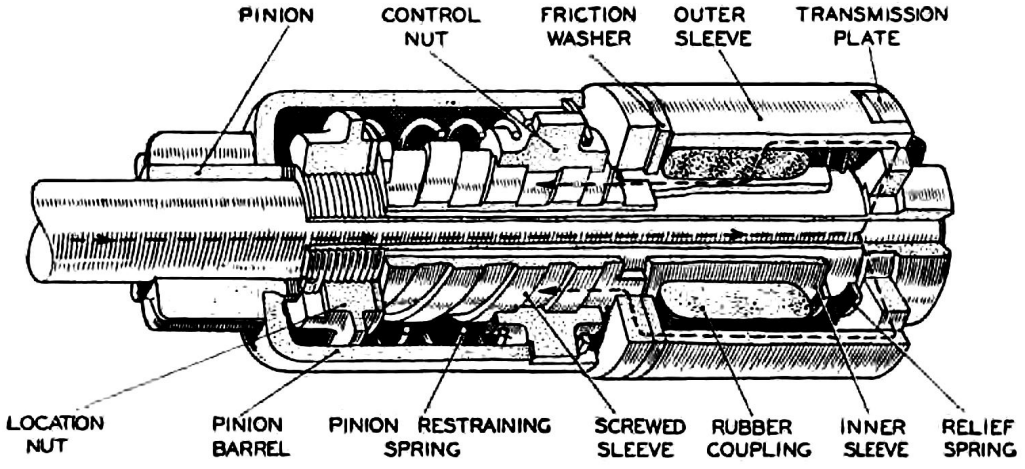



Fig. 66. THE STARTER DRIVE.

insulating varnish and held in position in the body of the machine by the pole pieces. Each of these is secured by a countersunk-head screw, through the outer shell of the body.

The coils of the armature winding are held in position to prevent movement due to centrifugal force and driving torque, by an insulated steel band on the windings, and the shape of the slots in which these coils are enclosed. The coils are connected to the commutator by being soldered into slots in the segments.

The commutator is a segmented copper cylinder in which each segment is insulated, and also insulated from the armature shaft. The outer diameter on which the brushes make contact, for the purpose of supplying current to the armature winding, must be smooth and perfectly round. It should be clean, dry, and have a polished appearance.

The armature bearings are porous bronze bushes of the self-lubricating type, and can be easily renewed when worn. The drive mechanism is mounted on the extension of the armature shaft and is secured to it by a key and set pin.

The starter drive mechanism (Fig. 66) operates in the following manner. The assembly is built on a sleeve, splined at one end and secured to the shaft by a key. A transmission plate in the form of a washer registers with the splines of the main sleeve coupling, which has a rubber coupling between the inner and outer steel sleeves. The inner sleeve registers with a quick-thread sleeve carrying a control nut. This has four projections connecting it to the barrel of the starter pinion. A light spring on the screwed sleeve assists in keeping the starter pinion in a disengaged position.

When the switch is pressed and power applied to the starter, the armature revolves, turning the splined sleeve, rubber coupling, and screwed sleeve.

The starter pinion barrel and control nut are not positively connected, so do not rotate so quickly, due to inertia. It therefore follows that the control nut moves along the quick thread sleeve, and in doing so carries the barrel and pinion with it until the pinion engages with the teeth of the flywheel starter gear. When the pinion assembly is at the end of its travel the pinion teeth rotate the flywheel and engine.

When the engine fires, the flywheel gear will turn the starter pinion assembly at a higher speed than the starter, and so will cause it to screw out of engagement, by the action of the control nut returning down the screwed sleeve.

The solenoid starter switch, mounted on the end of the starter, has two connections, a large cable which supplies the starting current to the main switch contacts, and a small cable which, when the starter button on the instrument panel is depressed, passes current to a coil wound round a soft iron core, which induces a magnetic field. This causes the main contacts to close and so operate the starter motor.

The main negative cable is secured to the flange of the starter motor by one of the securing bolts.

*Chapter VB*

## TWO-SPEED DYNAMO TYPE DW7X-10X

### Detailed Description

**Dynamo.** (*See* Fig. 67)

This is a 12-volt machine fitted with eight brushes in four brush holders. Rotation is clockwise looking on the driving end. It has four poles, and is fitted with plain-wound field coils shunt connected in the normal manner.

Two condensers are fitted in the terminal box connected to the main positive and negative terminals. The second and body connections to the condensers are connected together and earthed to the side of the terminal box.

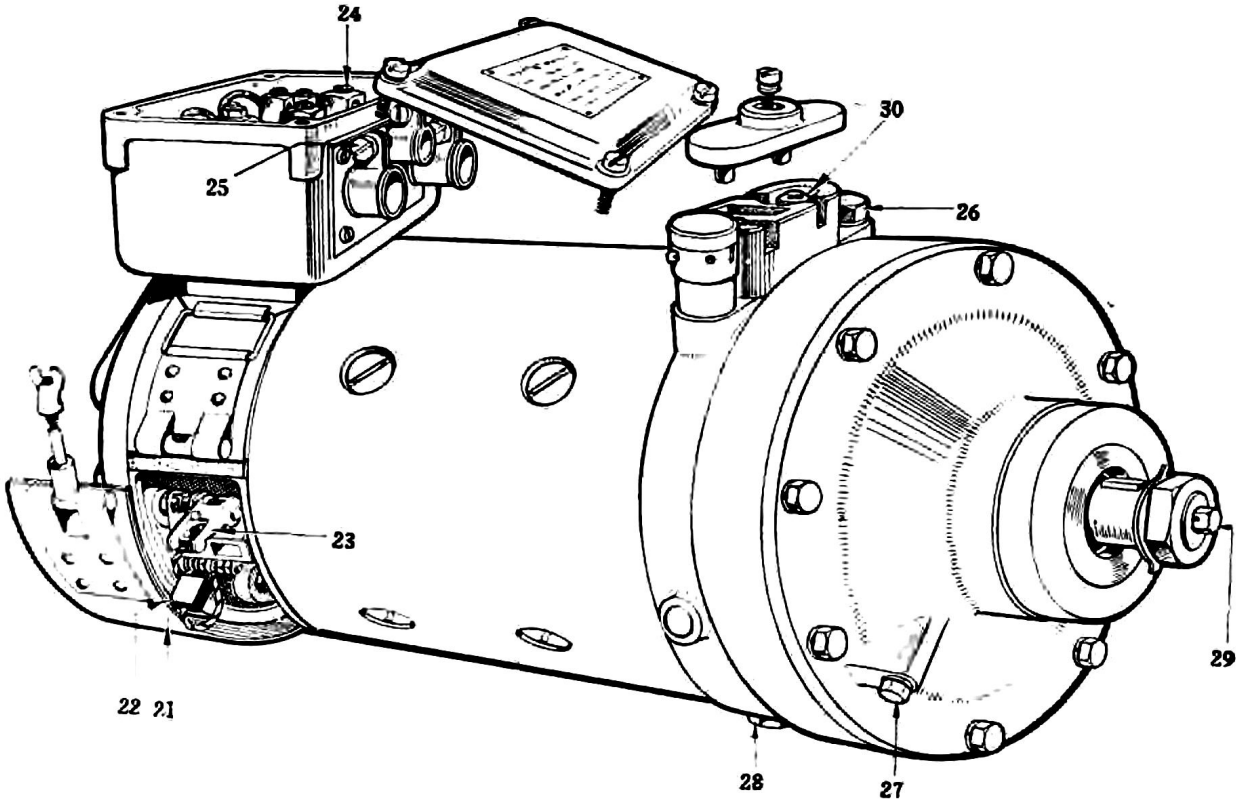



Fig. 67.—THE DYNAMO, TYPE DW7X-10X.

**Rating**

Cutting-in speed 820 r.p.m.

Lamp load 42 amps.

Maximum load 55 amps.

Maximum load speed 1,250 r.p.m.

Weight 80 lbs.

Outside diameter 7 inches.

Ball bearings are fitted at both ends of the armature. These bearings are packed with grease and do not require any attention between overhaul periods.

The following equipment is associated with the two-speed dynamo.

**High Speed Gearbox**

This is integral with the dynamo and is housed in the casting forming the drive end.

**Control Box. Series I**

This unit is mounted on the induction manifold in line with the carburettor. (A. Fig. 9.)

**Operating Shaft**

This is a small shaft fitted at each end with a flexible coupling. One of these couplings has slots to provide a means of making adjustment to control the engine speed for the high speed drive. This shaft connects the control box to the carburettor throttle shaft.

**Relay. Series I**

This is mounted on the bulkhead behind the commander. (DD. Fig 4.) When high speed drive is being engaged, it disconnects the dynamo field coil to reduce the dynamo load as it is speeded up. At the same time it short-circuits the resistance which normally limits the current in the gearbox magnet coil.

**Resistance. R.U. 10, Type 42**

This is mounted on the left wall of the vehicle near the commander's seat. (EE. Fig. 4.)

**Fuse**

This is mounted on top of the battery cut-off switch. (CC. Fig. 4.)

**Switch Operating Lever**

This is mounted on the bulkhead near the air cleaner. (BB. Fig. 4.)

**Control Board. Type 155-2B**

Mounted on the hull wall near the gunner.

The dynamo is a normal shunt connected machine and the output is regulated by the control board connected to the field coil circuit of the dynamo. This control results in a heavily discharged battery being recharged at a high rate which is gradually reduced as the battery becomes charged. When the battery is charged the current input from the dynamo is very small and not easily discernible on the ammeter.

The dynamo incorporates a gearbox which enables it to be driven at engine speed for normal use or at an increased ratio (3.17 : 1) for use when the vehicle is stationary and it is required to charge the battery.

The gearbox is of epicyclic design and the change-over from normal to high speed drive is effected by means of an electro-magnet controlled by the driver. *See* Fig. 68.

The driving shaft (A) on which the pulley (B) is mounted is coupled through splines to a carrier member (C) on which is fitted three planet gears (D). These engage firstly with a sun wheel (E) which is keyed on to the dynamo armature shaft and secondly with an annulus (F) which is connected mechanically through tooth-shaped splines to the gearbox armature (G). Facing the gearbox armature and separated from it by a small clearance is the fixed magnet ring (H) arranged to be energised by current passing through the coil (J) fitted in the magnet ring, when the high speed drive is required. The energising of the magnet causes the gearbox armature to move along its splines until it contacts with the magnet ring when it becomes locked in a stationary position. To obtain the best engagement of the armature with the magnet ring, the face of the magnet ring has an austenitic iron insert (K) and the armature is fitted with a Ferodo ring (L) which projects by a definite small amount from the face of the armature. A free wheel (M) is provided between the planet wheel carrier and the annulus which locks these components together when the normal direct drive is engaged.

The operation of the gearbox is as follows :—

**Normal Direct Drive**

The pulley (B) drives the shaft (A) which rotates the planet wheel carrier (C). The initial movement of the carrier causes the rollers of the free wheel (M) to ride up the inclined surface of the profile plate (N) attached to the annulus (F) and so locks the planet wheel carrier to the annulus. The annulus (F), planet wheel carrier (C) and the sun wheel (E) which is keyed to the dynamo armature shaft now rotate as a locked assembly and the armature is driven at normal pulley speed.

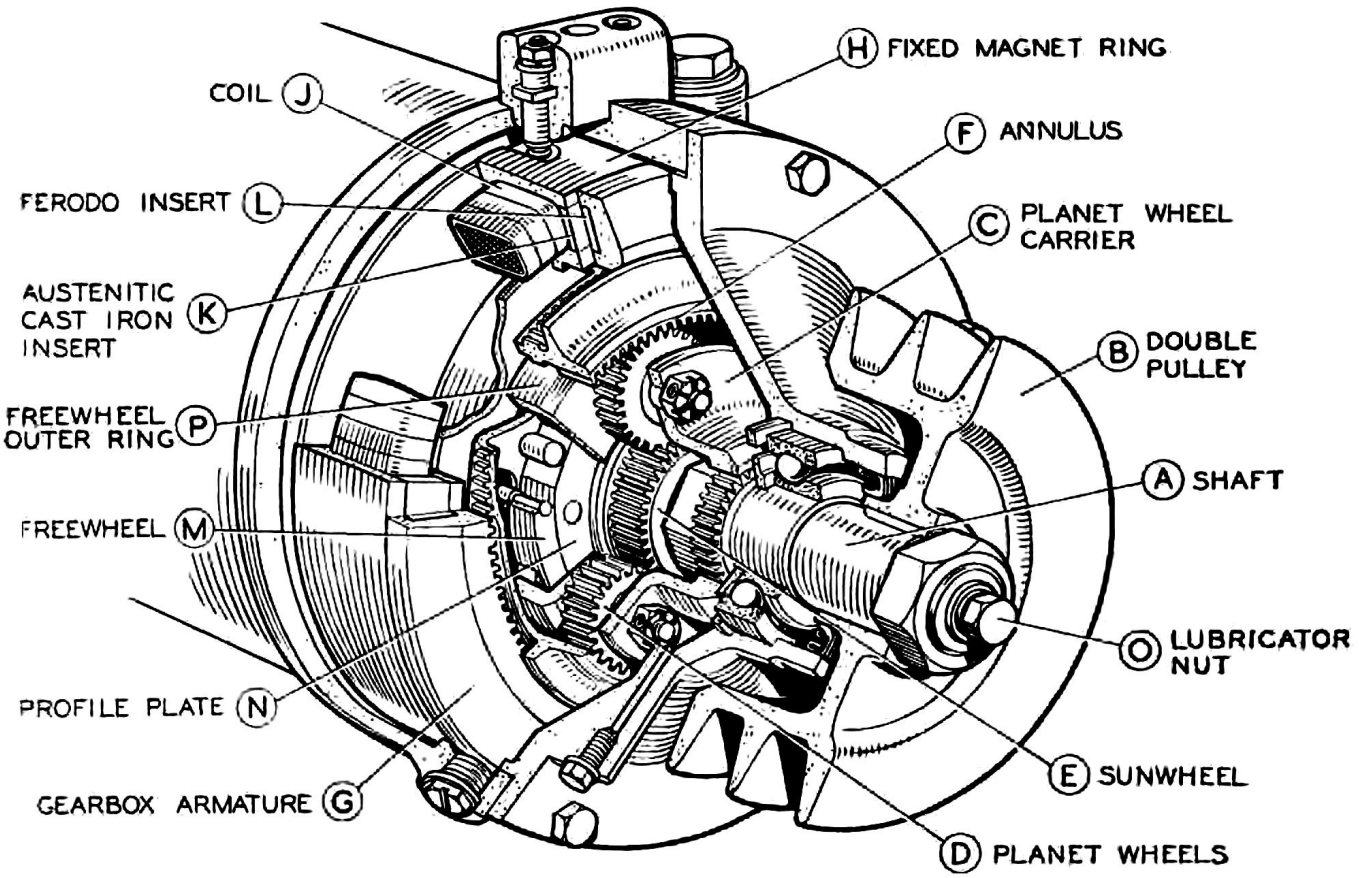



Fig. 68.—SECTION OF DYNAMO GEARBOX.

**High Speed Drive**

The operation of the dynamo gearbox control causes the electro-magnet to be energised and gearbox armature ring (G) becomes locked to the magnet ring (H). Rotation of the pulley (B) drives the planet wheel carrier (C) and planet gears (D) rotate round the inside of the annulus (F) and drive the sun wheel (E) at a speed greater than the pulley speed by a predetermined ratio. From the sun wheel the drive is taken direct to the dynamo armature shaft on which it is keyed.

**Method of Control**

The electro-magnet is energised from the battery by a switch in the control box mounted on the engine. At the same time a relay short-circuits the current limiting resistance in this circuit. The control box is operated by a switch lever fitted to the shaft which projects through the engine compartment bulkhead.

The control box houses two switches arranged to be operated through the spindle actuated by the lever connected by ball joints to the switch lever on the bulkhead, and it also incorporates a lever arm fitted on a second spindle which is coupled to the carburetter. This carburettor control is arranged so that movement of the main spindle during the engagement of the high speed drive also causes the speed of the engine to increase from that at which it normally idles, to a speed sufficiently high to ensure that the engine will not stall, due to the additional load of the dynamo when it is charging the battery. In addition, the control box provides an over-riding control which automatically breaks the circuit of the electro-magnet when the accelerator pedal is depressed to increase the engine speed. This causes the normal direct drive to come into operation and so prevents the dynamo from being driven at an excessively high speed.

During the operation of engaging the high speed drive the dynamo load is momentarily interrupted in order to ensure rapid engagement, while after the engagement a resistance is connected in series with the electro-magnet in order to avoid overheating the magnet winding and to reduce the current taken from the battery.

The wiring diagram of the control system is shown in Fig. 69. It comprises the switch lever (1), control box (2), relay (3), series resistance (4) and electro-magnet (5). The arrangement of the control box is shown in Fig. 70. The operation of the system is as follows : Movement of the switch lever to engage the high speed

drive causes the rotation of the spindle (A) (Fig. 70), in the control box and the cam (B) fitted on the spindle closes the contacts of the switch (C). This completes the circuit from the operating winding of the relay to the switch (D). Further movement of the spindle (A) engages the drive to the cam (E) controlled by a spring and to an arm (F). Rotation of the cam (E) causes a second arm (G) fitted on a shaft (H) attached to the carburettor to move until the end of the arm engages with a tooth (J) in the cam (E). This results in the engine speed being increased sufficiently to ensure satisfactory operation. At the same time, the lever arm (F) moves and at the end of its travel closes the contacts of the switch (D). The winding of the relay is now energised, and the relay armature pulls down to the pole face; this open-circuits the two contacts connected to terminals (F) and (F1) (Fig. 69), which disconnects the dynamo field, while at the same time the contacts connected to terminals (5) and (6) are joined and the resistance connected in series with the winding of the electro-magnet is short-circuited in order to apply full battery voltage to the electro-magnet winding which is connected to earth via the switch (D) (Fig. 70), and so the high speed drive is engaged.

At the end of approximately 10 seconds, which is necessary to obtain full engagement of the high speed drive, the control lever is released. Spindle (A) is returned to its normal position and the movement of cam (B) causes the contacts of switch (C) to open and disconnects the winding of the relay. The relay armature moves away from the pole face and the contacts connected to terminals (F) and (F1) are joined to complete the circuit of the dynamo field, following which the dynamo will commence to charge the battery. At the same time the contacts connected to terminals (5) and (6) are separated and the resistance is connected in series with the winding of the electro-magnet in order to avoid overheating the winding and to economise in the current taken from the battery. The engagement of the end of the arm (G) with the tooth (J) on the cam (E) prevents the movement of the arm controlling the switch (D), so that the circuits of the electro-magnet remain completed through the contacts of this switch.

When the throttle is opened, the movement of the arm (G) releases the cam (E) which is returned to its original position by a spring and the contacts of the switch (D) separate to disconnect the winding of the electro-magnet and so restore the direct drive to the dynamo.

### Control Board

This is bolted to a bracket, welded on the left side of the fighting compartment. It comprises a base board on which are mounted voltage and current regulators, resistances and the cut-out switch, enclosed by a sealed metal cover which **must not be removed; these units can only be adjusted by a highly skilled electrician having the necessary special equipment.**

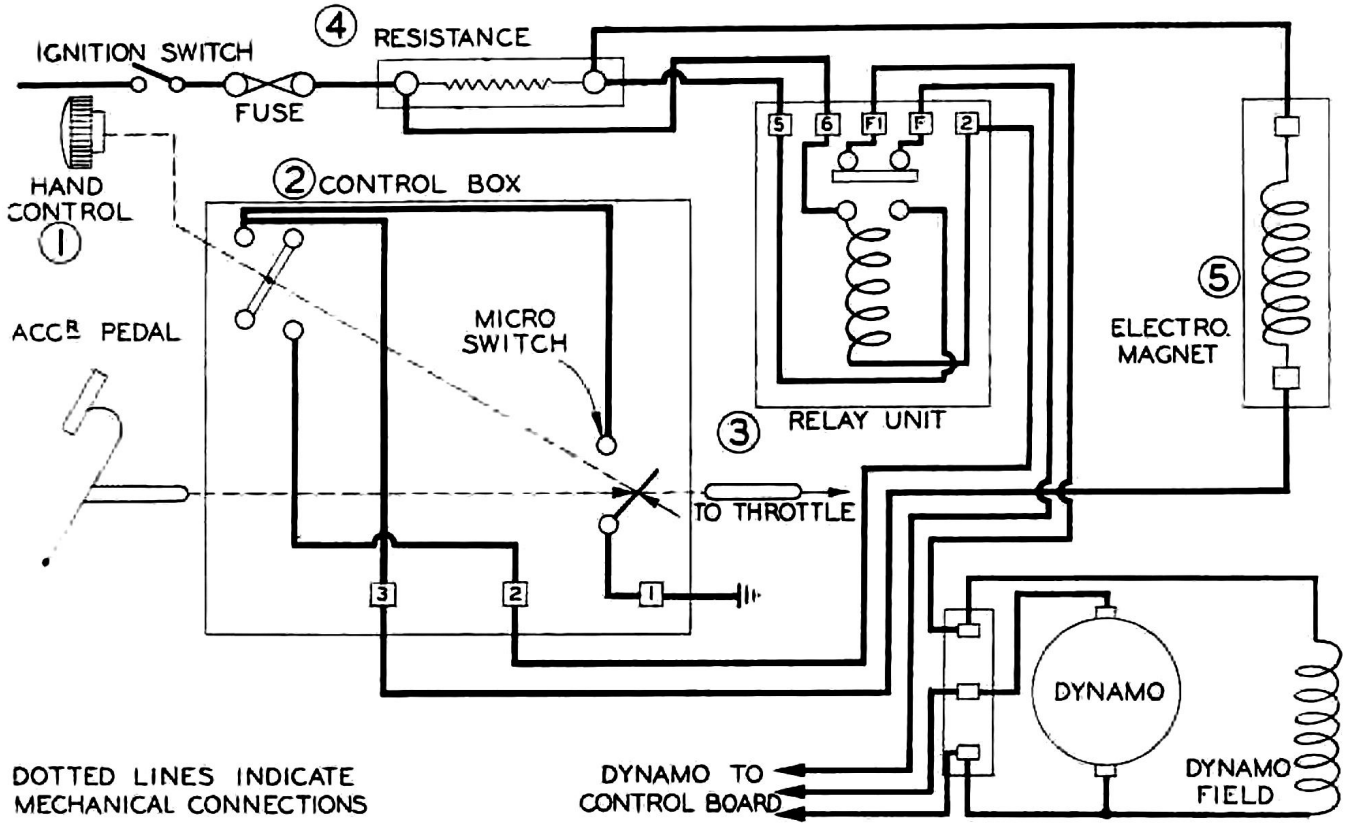



Fig. 69.—WIRING DIAGRAM FOR TWO-SPEED DYNAMO.

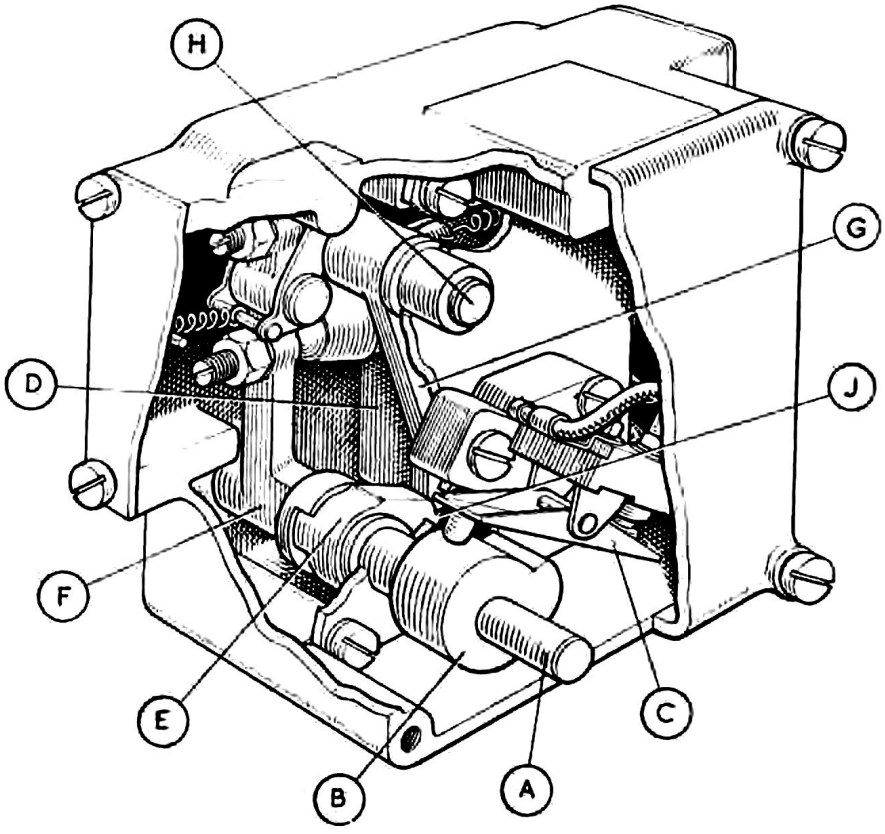



Fig. 70.—SECTION OF THE CONTROL BOX.

At the bottom of the board is a terminal and fuse box, provided with a cover held in position by two hinged screws and wing nuts. Eight cables enter this terminal box and at each entry point the external metal braid of the cables is bonded to earth by the cable clamp through which it passes. The fuse is a special strip type, fusing at 120 amperes and so protecting the dynamo and its wiring.

Choke coils and condensers are installed for suppressing high frequency currents, which cause wireless interference ; these are fitted at the rear of the base board.

The control board regulates the dynamo voltage to a maximum of 15.3, and the current output to a maximum of 55 amperes. The cut-out switch automatically connects the dynamo and battery circuits at any time the dynamo speed is sufficient to generate a voltage which will charge the battery. It immediately disconnects these two circuits when the dynamo is not generating.

### Voltage Regulator

The voltage regulator is in the form of a solenoid. The armature of this solenoid is pivoted in such a way as to be capable of very rapid vibration, and attached to it is one of a pair of contact points, the other point being fixed but adjustable. The armature position is controlled by an adjustable spring, and these points are normally closed.

When the dynamo voltage tends to rise above 15.3 the regulator solenoid is magnetised sufficiently to overcome the pressure of the spring which holds the armature away. This attraction breaks the circuit which was closed by the contact points, and so inserts a resistance into the field coil circuit, thus reducing the dynamo voltage.

This vibration of the armature, and the consequent opening and closing of its contact points, is continuous and extremely rapid, and takes place for the whole period that the voltage requires regulating. The windings are so balanced and arranged that very little sparking takes place at these contact points. The opening of these contact points causes the current of the dynamo field coils to pass through a resistance which was being short-circuited by them, and this reduces the voltage being generated by the dynamo.

### Current Regulator

The current regulator is of similar construction to the voltage regulator and operates in exactly the same manner, controlling the current by this rapid switching " in " and " out " of a resistance in the dynamo field coil circuit.

The two regulating solenoids are adjustable. The armature spring pressure is controlled by a screw which is secured by a lock nut. The contact points are also controlled by screws locked in position by hexagon nuts.

The solenoid operated cut-out switch is quite automatic. There are two windings : one is a shunt winding receiving the full dynamo voltage ; the other is a series winding of few turns, and carries the main current. Voltage from the dynamo causes the shunt coil to attract the cut-out switch armature, so closing the contact points which connect dynamo and battery. There are two pairs of contacts for this switch, main and auxiliary. The auxiliary contacts are adjusted to open last and close first, so that no sparking takes place on the main contacts.

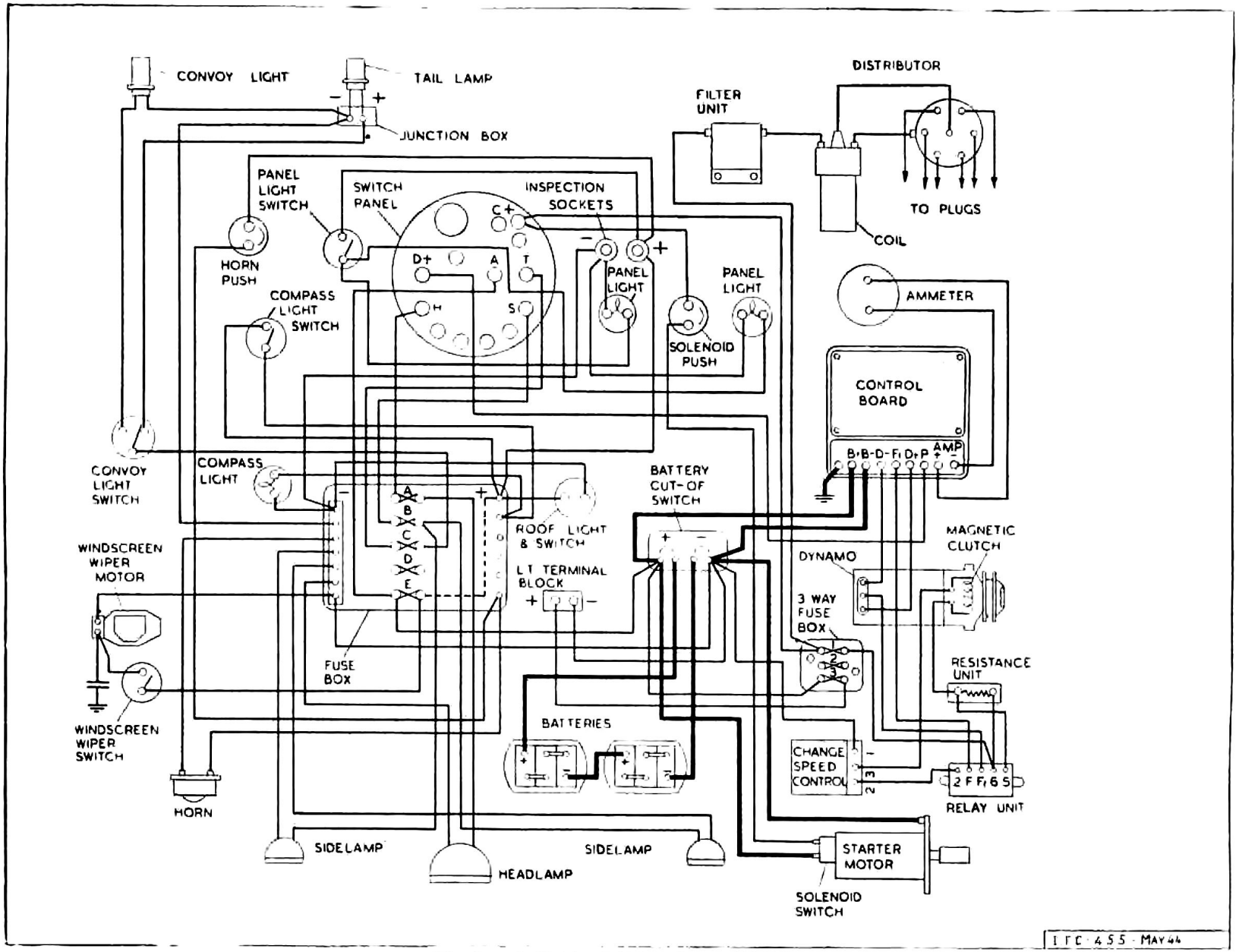



Fig. 71.—WIRING DIAGRAM (VEHICLE).

## *CHAPTER VIB*

# THE HULL

This is a structure formed of various sections of armour plate welded together, and it is secured to the chassis by 14 bolts and nuts at the points shown in Fig. 25.

Three valances fitted at each side at the bottom are secured to the hull by nuts. A shield at the front protects the front transmission from damage, and this is secured to the hull by nine bolts and nuts. The front sloping armour plate is held in position by eight screws and nuts. The rear plate of the hull is held in position by 11 bolts, and the louvres forming this back plate protect the radiator from damage while allowing air to pass from the engine through the radiator to the exterior of the vehicle. A swing plate covers the hole through which the starting handle is inserted when it is required. Two studs and hand nuts are fitted to this rear plate to hold the sand channels.

The lower escape door on the left may be locked by the two hasps welded to the inside, while the upper escape door on the right side may be locked by hasps welded to the outside. Both these are normally secured by self-locking spring catches. The drivers windscreen is quickly replaceable, being secured in position by two swing catches. It is protected when necessary by closing the visor. The visor may be locked in open, half open or the closed position by the operation handle. There are in addition six look-out points; one each on the Front and Rear face and two on each side face, these are at a height convenient to both driver and gunner. They are operated by a lever at the side of each look-out position, and may be locked when closed, by a catch secured to the hull plate.

Entry is normally made through the sliding doors on the roof. Both these are locked when closed by spring catches, and may only be opened from inside. Rain channels are provided to prevent the entry of water.

All mudguards are secured to the body by angle brackets, bolts and nuts. A tool locker is incorporated with each front mudguard, and the top lid has a dirt excluding packing at the point of contact with the sides. Each may be locked by a padlock.

A detachable plate is fitted to the hull floor over the front axle and this is held by 11 nuts and eight set bolts, the joint is made water tight by a felt packing and sealing compound. The apertures through which the foot brake, clutch pedal, hand brake, and gear lever, pass, are sealed by gaiters held to the floor plate by clamping plates each held by four nuts.

A curved floor plate covering the gearbox and transfer gearbox is secured to the hull floor by 16 nuts and six studs, while a plate attached to the bulkhead and hull floor by 14 nuts and four studs, allows access to the clutch and engine at overhaul periods.

Attached to the rear, behind the mudguards are brackets supporting four 2-gallon cans for Petrol, Oil and Water. One can is used as the condenser tank for the cooling system. These brackets may be locked by padlock. The engine compartment top plates are hinged, and may be locked when closed by hasps and padlock. Four ventilating slots are provided in the engine compartment top covers to form a shielded air intake for engine cooling, while the hot air is driven out through the louvers forming the back plate.

Two towing hooks are provided at the front and the rear.

## *CHAPTER VIIB*

# THE GUN MOUNTING

### MOUNTING, A.A., P.L.M., BREN M.G., Mk. I

(*See* **Figs. 72 and 73**)

The P.L.M. mounting, Mk. I carries a single Bren gun which has a universal movement within a traversing range of 360°.

The main components of the mounting comprise a main pillar assembly, a bearing bracket assembly, actuating cradle and trigger gear assembly, handle bar unit assembly, and a travelling lock assembly.

The main pillar (1) is bolted to the fighting compartment top plate by bolts and houses the pillar sleeve (3) of the handle bar unit. The upper part of the pillar sleeve extends through the main pillar and fits within a seating in the bearing bracket (4) clamped in place by a bearing bracket clamp (5) in such a manner that the bearing bracket can rotate freely when the handle bar unit is moved to impart a traversing movement to the actuating cradle. A thrust washer (6) is interposed between the main pillar and the bearing bracket. A Tecalemit lubricator (7) enables lubricant to be introduced.

The bearing bracket carries the gear mechanism by means of which movements of elevation and depression are conveyed to the actuating cradle from the handle bar unit. The gear mechanism consists of an actuating gear (8) pinned to a shaft mounted in bearings in the bracket, one end of the shaft having screwed thereto a driver segment (9) which meshes with an idler gear (10) rotatable on a spindle secured to the bracket by a lock nut. The idler gear trans-

mits motion to a driven segment (11) secured to a spindle (12) rotatably supported in the bearing bracket and constituting a trunnion. The driven segment has bolted thereto the clamp (13), for holding the main tube of the actuating cradle on which the Bren gun is mounted.

The actuating cradle and trigger gear assembly is constructed primarily of tubular members, the main tube (14), the front cross tube (15), the rear cross bar (16) and the carrier bar (17) the latter supporting the pivot bar which forms part of the trigger gear. The front cross tube and rear cross bar and the carrier bar are clamped to the main tube by means of cross tube clamps (18) (19) and (20) respectively, the rear cross bar and front cross tube is fitted at their extremities each with a clamp (21). The front cross tube clamps a front anchorage lug (22) to which is bolted the front mounting lug of the Bren gun. The rear cross bar clamp is similarly provided with a rear anchorage lug (23) to which is bolted the rear mounting lug of the Bren gun. A cross bar clamp (24) mounted on the rear cross bar supports a spare drum (Bren) bracket (25) at the right-hand side of the gun. The front sight (26) is secured to the front cross tube and the rear sight (27) to the rear cross bar at the left of the cradle.

The carrier bar (17) has pinned thereto a centrally arranged thrust plate bearing (28) and at each end the pivot clips (29), the pivot bar pivoting in the bearings and having secured thereon the actuating levers (30) and the firing levers (31). The ends of the firing cables (32) are secured to the actuating levers and the cable adjustment nuts bear on the thrust plate. The firing lever at the left of the pivot bar is pivotally connected to the trigger actuating rod (33) the free end of which is bent to engage the trigger of the Bren gun. The helical twist spring under tension (34) serves to return the parts after operation of the trigger mechanism of the handle bar unit. A cocking rod (35) is connected to the cocking lever of the gun by the clip (36) and extends to the rear of the cradle where it presents an upturned end as a grip.

The hand bar unit forms the controlling medium for the mounting, the handles (37) embodying the triggers (38) to which the firing cables are attached. The handles are each pivoted to the quadrant (39) which forms part of the sleeve (40) pinned to the spindle (41) rotatable in the bracket (42) brazed to the lower end of the pillar sleeve (3). The spindle (41) has pinned thereon the actuating segment (43) meshing with the toothed actuating pillar (44) the upper part of which drives the actuating segment (8) of the bearing bracket. The actuating pillar is grooved lengthwise to form paths for the two firing cables. The handles each house a spring loaded stud engageable with one or other of a series of notches (45) in the quadrant thus enabling the position of the handles to be adjusted, by sliding the handle over the fork pin (46), to disengage the stud for re-engagement in another notch.

When the guns are not in use it is essential, in order to avoid interference with wireless reception that the cradle is locked with the M.G. gun in a horizontal position or thereabouts. This locking is effected by a travelling lock pivoted to the main pillar and comprising a ferrule (47) rotatably supported on a bolt (48) by means of which it is mounted between lugs (49) forming part of the main pillar. The ferrule is integral with the support (50) engaged with the pillar tube (51) and held thereto by a pillar tube clamp. The free end of the pillar tube is fitted with a spring loaded catch (52) engageable with the front cross tube, between a pair of aligning collars (53), to hold the cradle in the horizontal position. When the travelling lock is not in use it is swung down to rest on the turret top plate.

### Operation

A rotary movement of the handle bar unit will transmit movement to the sleeve and thence to the bearing bracket, to traverse the guns, a swinging movement of the handle bar unit will raise or lower the actuating pillar and through the gear mechanism of the bearing bracket will move the driven segment to elevate or depress the gun.

Pressure on either trigger of the handle bar unit will, through the intermediary of the firing cable, firing lever and trigger actuating rod, fire the gun.

Remember to release travelling lock when the gun is brought into use and **lock travelling lock to cradle when the gun is out of use.**

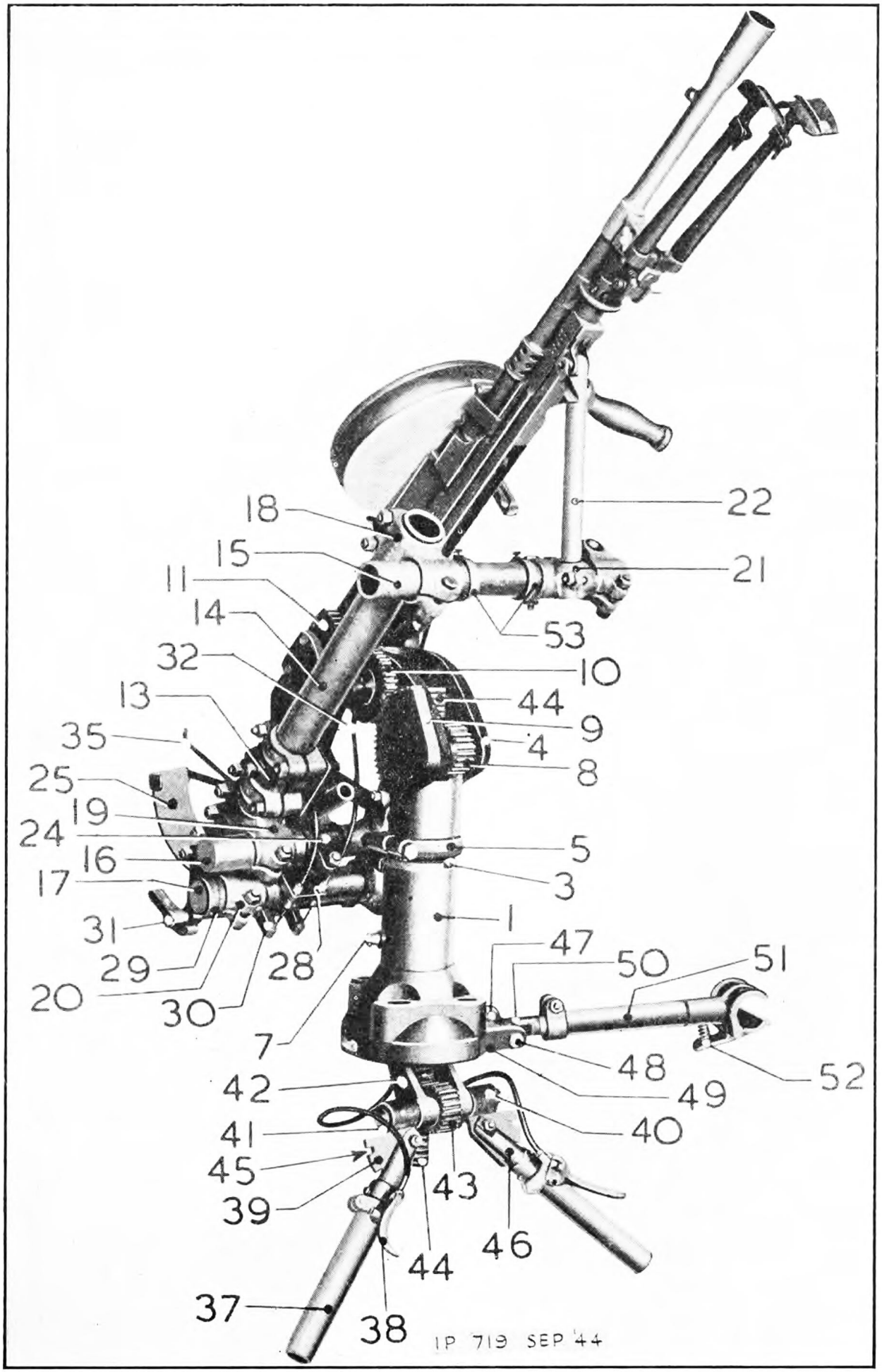



Fig. 72.—FRONT VIEW OF P.L.M. MOUNTING.

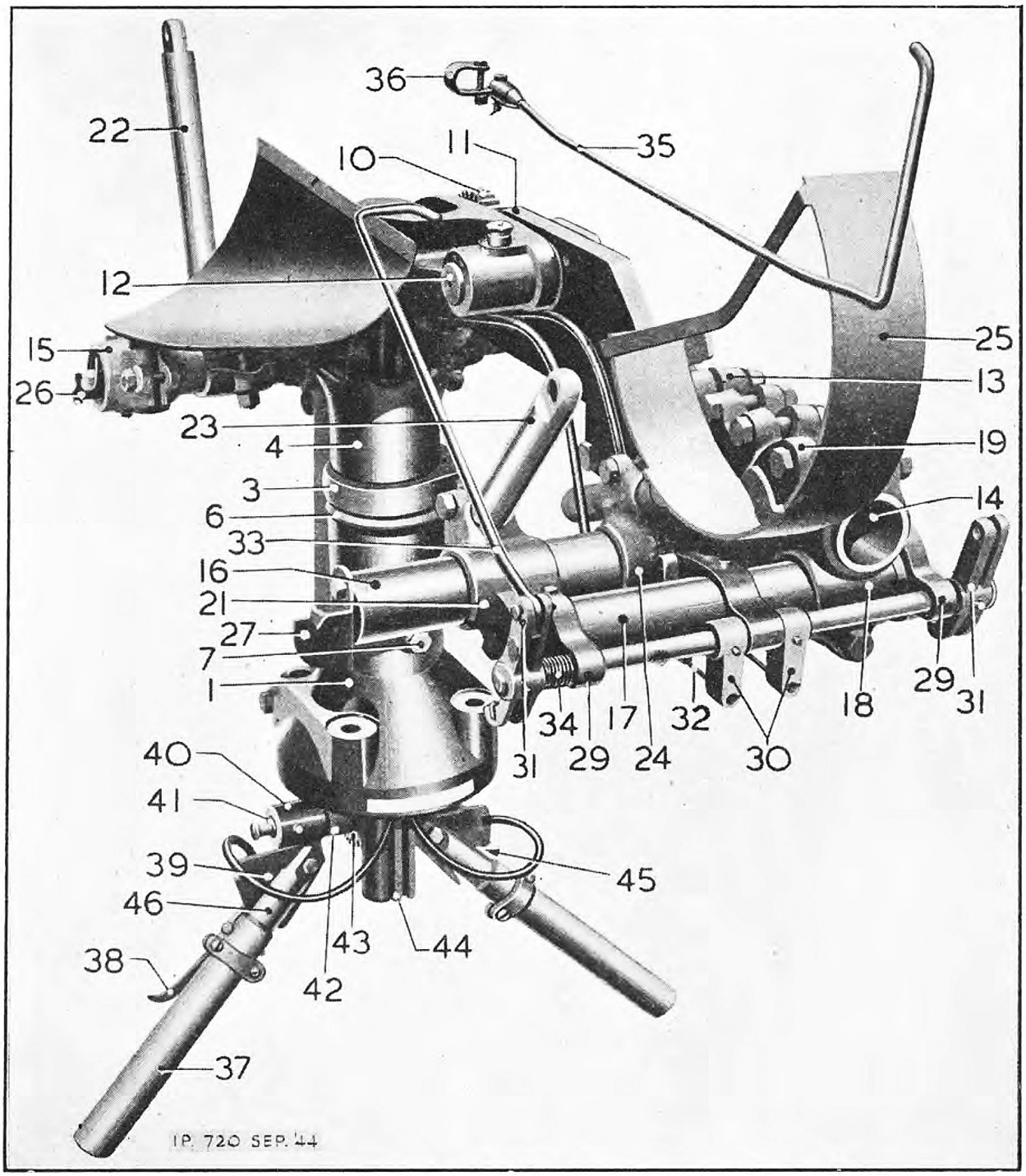
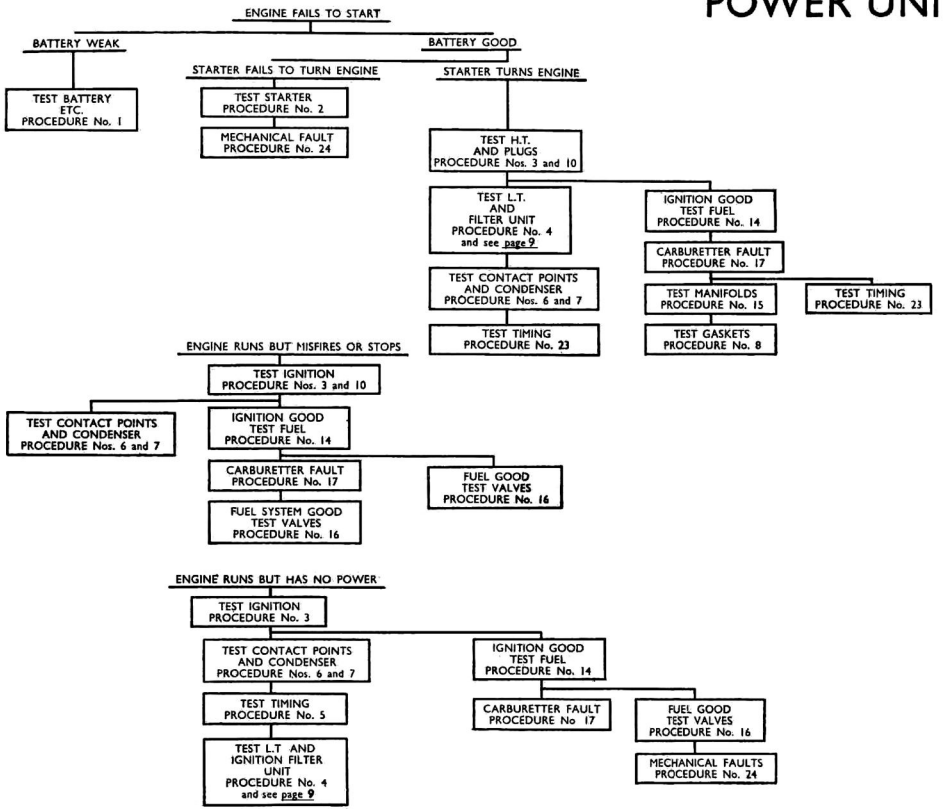



Fig. 73.—REAR VIEW OF P.L.M. MOUNTING.

# POWER UNIT FAULT—FINDING CHART.




## STARTER DOES NOT TURN THE ENGINE

**1. Battery at fault**

Check the cleanliness and tightness of all battery and starter connections. Press the emergency knob on the end of the switch on the starter motor. Switch on a light and press the starter switch; if the light decreases considerably in intensity, the battery is almost discharged or faulty.

**Remedy.** Fit a replacement battery or start the engine by hand or towing.

**2. Starter at fault**

Remove the starter, ensure that the starter gear is free on the screwed shaft extension. Examine the teeth of the flywheel for damage by the engagement of the starter gear. Examine the starter motor bearings for excessive wear. Examine the brushes for sticking, dirty condition or faulty spring pressure.

**Remedy.** Start the engine by hand or towing. A replacement starter will have to be fitted.

## ENGINE TURNS BUT WILL NOT START

**3. Ignition coil at fault**

Remove the distributor cover and place it so that the centre brush is ¼ inch away from any earth point of the engine. Switch the ignition on and turn the engine by hand. If the coil is in good condition three good sparks should regularly jump across this ¼ inch gap for each engine revolution. See also information on page 9.

**Remedy.** Fit a replacement coil.

**4. Ignition filter unit at fault**

Disconnect the filter unit, and connect the coil temporarily direct to the cable from the ignition switch. This unit is not likely to give trouble.

**Remedy.** Fit a replacement unit.

**5. Ignition timing faulty**

Remove the valve cover plate and turn the engine by hand until the No. six exhaust valve is just closing and the inlet valve just opening. Remove the distributor cover and examine the position of the rotor. This should be pointing to the position occupied normally by the segment connected to the No. 1 cylinder plug. The contact points should be just opening. Faulty timing due to a stretched and slipped timing chain or a sheared driving pin in the distributor gear requires workshop attention.

**6. Contact points at fault**

Check and adjust the points in accordance with the information on page 22. If still faulty workshop attention is necessary.

**7. Condenser at fault**

This is usually denoted by badly burnt contact points. It may be possible to drive the vehicle a short distance when the contact points have been cleaned and adjusted, and the sparking plug points closed to .01 inch.

**Remedy.** Fit a new condenser.

**8. Gaskets at fault**

A cylinder head gasket blown between two cylinders can usually be checked by turning the engine by hand and noting if the compression of two adjacent cylinders is faulty. This will require workshop attention.

For faulty carburetter and manifold gaskets see No. 15 on this page.

**9. Valves at fault**

See No. 16 on this page.

## ENGINE WILL RUN BUT MISFIRES OR STOPS

**10. Sparking plugs at fault**

Remove all plugs and clean all carbon or oil from inside the plug body. Set the spark gap to .018–.020 inch on each plug by bending the outer electrode. Plugs having cracked or damaged insulation must be renewed

**11. Contact points at fault**

Check and adjust the points in accordance with the information on page 22. If still faulty workshop attention is necessary.

**12. Condenser at fault**

See No. 7 on this page.

**13. Ignition coil at fault**

See No. 3 on this page.

**14. Fuel supply at fault**

Check supply of fuel to carburetter in accordance with the information on pages 9 and 19.

**15. Carburetter and manifold gaskets faulty**

Check all possible points between the carburetter and cylinder block for air leak as described on page 9.

**16. Valves at fault**

Remove the valve cover plates and carefully check the clearance between the tappets and valve stems. This should be .012 inch for the inlet valves and .018 inch for the exhaust valves. This adjustment is controlled by the screw in the top of the tappet and the lock nut on this screw.

Sticking valves will result in loss of compression and can only be dealt with by the workshops.

**17. Carburetter at fault**

Remove the top cover from the carburetter and remove all dirt or water from the carburetter bowl. Replace top cover securely. Remove pilot jet, starter jet and main jet and blow these clear of any obstruction. DO NOT USE A WIRE OR OTHER PROBE FOR THIS. Replace all sealing washers on the jets and refit the jets.

## ENGINE WILL RUN BUT HAS NO POWER

**18. Ignition coil fault**

See No. 3 on this page.

**Remedy.** Fit replacement coil.

**19. Ignition timing at fault**

See No. 5 on this page. Faulty timing will require workshop attention.

**20. Contact points or condenser at fault**

See Nos. 6 and 7 on this page.

**21. Fuel supply and carburetter at fault**

See Nos. 14 and 17 on this page.

**22. Valves at fault**

See No. 16 on this page.

**23. Valve timing at fault**

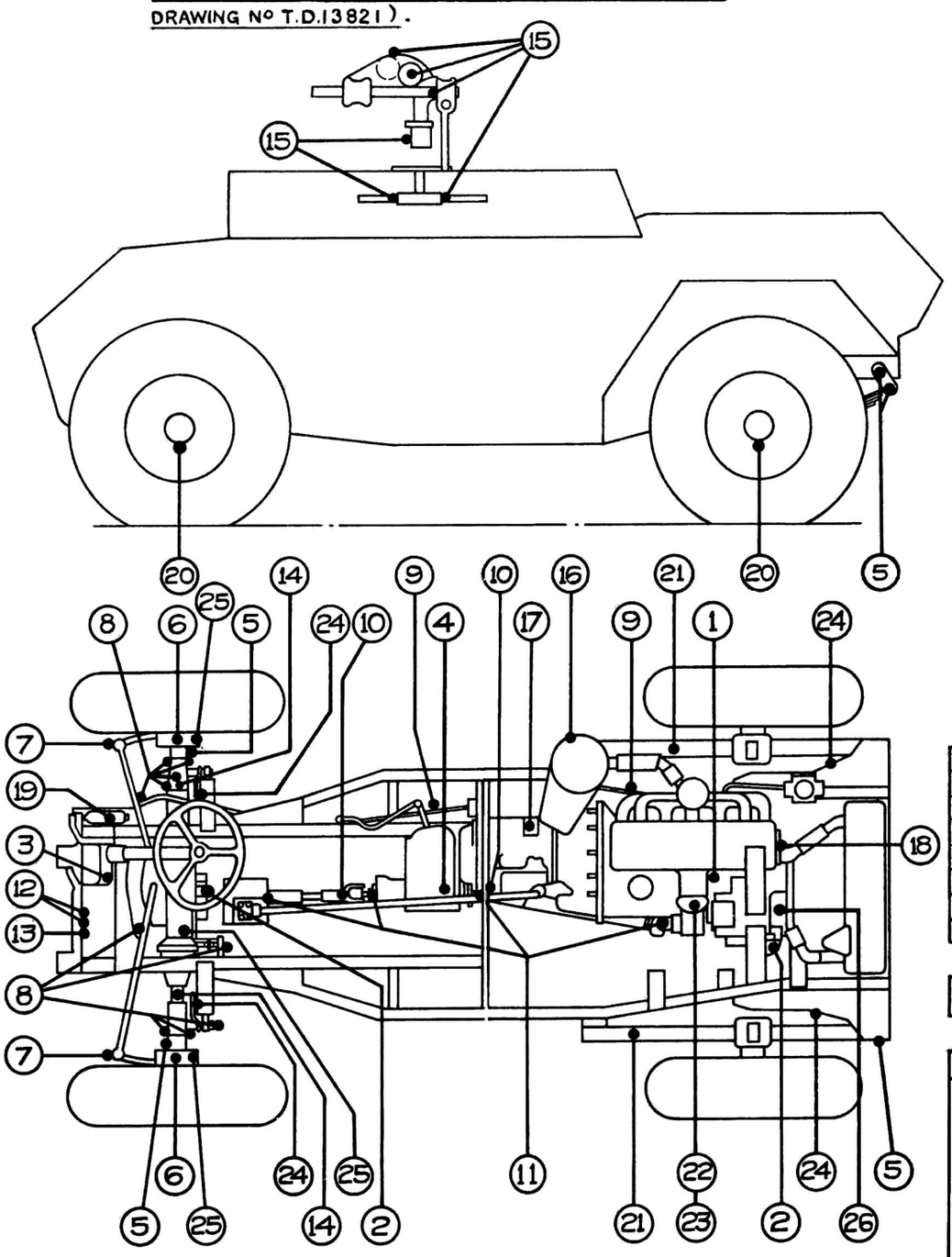
Turn the engine by hand until the distributor rotor is pointing to No. 6 sparking plug lead. At this point of the engine revolution, the No. 1 exhaust valve should be just closing while the No. 1 inlet valve will be just opening. This may be seen by removing the valve chest cover. If the timing is not as described report the vehicle for workshop attention.

**24. Seized pistons or bearings at fault**

Turn the engine by hand, and if there is serious mechanical stiffness (don't confuse with compression) report the vehicle for workshop attention. This fault is always accompanied by unusual noise from the engine.

# CAR SCOUT, HUMBER I & II.

(THIS CHART CANCELS PREVIOUS ISSUES BEARING DRAWING Nº T.D.13821).




# LUBRICATION CHART

| Locn Nº | COMPONENT | REMARKS | NORMAL 20°-90°F | PREVIOUS W.D. LUBRICANT 20°-90°F | ARCTIC BELOW 0°F | SEVERE WINTER 0°-20°F | TROPICAL ABOVE 90°F |
|---|---|---|---|---|---|---|---|
| **DAILY** | | | | | | | |
| 1 | ENGINE | TOP UP. CHANGE OIL AT FIRST 500 ML. THEN 2,500 ML. | 30 HD. | M. 160 | 10 HD. PLUS 15% KEROSENE | 10 HD. | 50 HD. |
| 16 | AIR CLEANER | DUSTY CONDITIONS. CLEAN & REFILL | 30 HD. | M. 160 | 10 HD. PLUS 15% KEROSENE | 10 HD. | 50 HD. |
| **WEEKLY** | | | | | | | |
| 2 | AXLES FRONT & REAR | TOP UP. CHANGE OIL AT FIRST 500 ML. THEN 2,500 ML. | HYPOID 90 | C.600 | HYPOID 80 PLUS 10% KEROSENE | HYPOID 80 | HYPOID 90 |
| 3 | STEERING BOX | TOP UP | HYPOID 90 | C.600 | HYPOID 80 PLUS 10% KEROSENE | HYPOID 80 | HYPOID 90 |
| 4 | TRANSFER BOX | TOP UP. CHANGE OIL AT FIRST 500 ML. THEN 2,500 ML. | C.600 | C.600 | HYPOID 80 PLUS 10% KEROSENE | HYPOID 80 | C.600 |
| 5 | SPRING SHACKLE PINS | 6 LUBRICATORS | HYPOID 90 | C.600 | HYPOID 80 PLUS 10% KEROSENE | HYPOID 80 | HYPOID 90 |
| 6 | SWIVEL PIN BEARINGS | 4 LUBRICATORS | HYPOID 90 | C.600 | HYPOID 80 PLUS 10% KEROSENE | HYPOID 80 | HYPOID 90 |
| 7 | STEERING ROD JOINTS | 2 LUBRICATORS | HYPOID 90 | C.600 | HYPOID 80 PLUS 10% KEROSENE | HYPOID 80 | HYPOID 90 |
| 8 | BOTTOM LINK BUSHES & FRONT SHOCK ABSORBER LINK | 10 LUBRICATORS | HYPOID 90 | C.600 | HYPOID 80 PLUS 10% KEROSENE | HYPOID 80 | HYPOID 90 |
| 9 | CLUTCH & HANDBRAKE CABLE | 2 LUBRICATORS | HYPOID 90 | C.600 | HYPOID 80 PLUS 10% KEROSENE | HYPOID 80 | HYPOID 90 |
| 10 | PROPELLOR SHAFT SPLINE | 2 LUBRICATORS | HYPOID 90 | C.600 | HYPOID 80 PLUS 10% KEROSENE | HYPOID 80 | HYPOID 90 |
| 11 | PROPELLOR SHAFT BEARINGS | 4 LUBRICATORS | HYPOID 90 | C.600 | HYPOID 80 PLUS 10% KEROSENE | HYPOID 80 | HYPOID 90 |
| 12 | CLUTCH & BRAKE PEDAL BEARINGS | 2 LUBRICATORS | HYPOID 90 | C.600 | HYPOID 80 PLUS 10% KEROSENE | HYPOID 80 | HYPOID 90 |
| 13 | CLUTCH RELAY LEVER BRG: | 1 LUBRICATOR | HYPOID 90 | C.600 | HYPOID 80 PLUS 10% KEROSENE | HYPOID 80 | HYPOID 90 |
| 14 | TRACTA FORK SPLINES | 2 LUBRICATORS | HYPOID 90 | C.600 | HYPOID 80 PLUS 10% KEROSENE | HYPOID 80 | HYPOID 90 |
| 15 | GUN MOUNTING | 6 LUBRICATORS | HYPOID 90 | C.600 | HYPOID 80 PLUS 10% KEROSENE | HYPOID 80 | HYPOID 90 |
| 16 | AIR CLEANER | NORMAL CONDITIONS. CLEAN & REFILL | 30 HD. | M.160 | 10 HD. PLUS 15% KEROSENE | 10 HD. | 50 HD. |
| 17 | GEARBOX | TOP UP. CHANGE OIL AT FIRST 500 ML. THEN 2,500 ML. | 50 HD. | M. 220 | 10 HD. PLUS 15% KEROSENE | 10 HD. | 50 HD. |
| | HANDBRAKE LEVER | OIL CAN | 30 HD. | M.160 | 10 HD. PLUS 15% KEROSENE | 10 HD. | 50 HD. |
| | CHANGE SPEED CONTROL | OIL CAN | 30 HD | M. 160 | 10HD. PLUS 15% KEROSENE | 10 HD. | 50 HD. |
| | ACCELERATOR CABLE (OIL RESERVOIR CARB: END) | OIL CAN | 30 HD. | M. 160 | 10 HD. PLUS 15% KEROSENE | 10 HD | 50 HD. |
| | BRAKE FULCRUM & CLEVIS PINS | OIL CAN | 30 HD. | M. 160 | 10 HD PLUS 15% KEROSENE | 10 HD. | 50 HD. |
| 18 | WATER PUMP | ONE TURN OF GREASER | GREASE Nº 1 | GREASE G.S. | GREASE Nº 0 | GREASE Nº 0 | GREASE Nº 2 |
| 19 | BRAKE MASTER CYLINDER | TOP UP REMOTE RESERVOIR FITTED ON STEERING COLUMN. | FLUID BRAKE HYD. Nº 3 | FLUID BRAKE HYD. Nº 3 | FLUID BRAKE HYD. Nº X | FLUID BRAKE HYD. Nº 3 | |
| 26 | TWO SPEED GEAR ON DYNAMO (WHEN FITTED) | TOP UP (REMOVE LEVEL PLUG FOR THIS OPERATION & AFTERWARDS REPLACE) | 10 HD. | M.120 X | 10 HD. PLUS 15% KEROSENE | 10 HD. | 10 HD. or M.80 |
| **MONTHLY** | | | | | | | |
| 20 | WHEEL HUBS | 4 LUBRICATORS | GREASE Nº 1 | GREASE G.S. | GREASE Nº 0 | GREASE Nº 0 | GREASE Nº 2 |
| 21 | ROAD SPRINGS | CLEAN & PAINT WITH OIL | 30 HD. | M. 160 | 10 HD. PLUS 15% KEROSENE | 10 HD. | 50 HD. |
| 22 | DISTRIBUTOR SHAFT & CAM. BRGS. | OIL CAN - 1 OR 2 DROPS | 30 HD. | M. 160 | 10 HD PLUS 15% KEROSENE | 10 HD. | 50 HD. |
| 23 | DISTRIBUTOR. CAM & CONTACT BREAKER PIVOT | SMEAR LIGHTLY | GREASE Nº 1 | GREASE G.S. | GREASE Nº 0 | GREASE Nº 0 | GREASE Nº 2 |
| 24 | SHOCK ABSORBERS | TOP UP - 4 UNITS | FLUID BRAKE HYD. Nº 3 | FLUID BRAKE HYD. Nº 3 | FLUID BRAKE HYD. Nº X | FLUID BRAKE HYD. Nº 3 | |
| 25 | TRACTA JOINT HOUSING | 4 LUBRICATORS | GREASE Nº 1 | GREASE G.S. | GREASE Nº 0 | GREASE Nº 0 | GREASE Nº 2 |
| **COMPONENT OVERHAUL** | | | | | | | |
| | WINDSCREEN WIPER | PACK ON ASSEMBLY | GREASE Nº 1 | GREASE G.S. | GREASE Nº 0 | GREASE Nº 0 | GREASE Nº 2 |

## GENERAL

ENGINE OIL FILTER (BY-PASS) CHANGE FILTER EVERY 3,000 MILES.

PRESSURE OIL FILTER - FULL FLOW

(1) NON-SCRAPER TYPE
EVERY 500 MILES
DROP BASE, REMOVE ELEMENT & WASH THOROUGHLY IN CLEAN PETROL. REPLACE ELEMENT, REFILL BASE WITH CORRECT GRADE OF OIL & REPLACE BEFORE STARTING ENGINE.

(2) HANDLE SCRAPER TYPE
DAILY - 1 TURN OF HANDLE.
WEEKLY - DRAIN (WHILE HOT) & BEFORE STARTING ENGINE REFILL WITH CORRECT GRADE OF OIL THROUGH PLUG HOLE ON INLET SIDE.
EVERY 3,000 MILES. DROP BASE & WASH OUT. REFILL BASE WITH CORRECT GRADE OF OIL & REPLACE BEFORE STARTING ENGINE.

AUG. 1944.

T.D13821/1