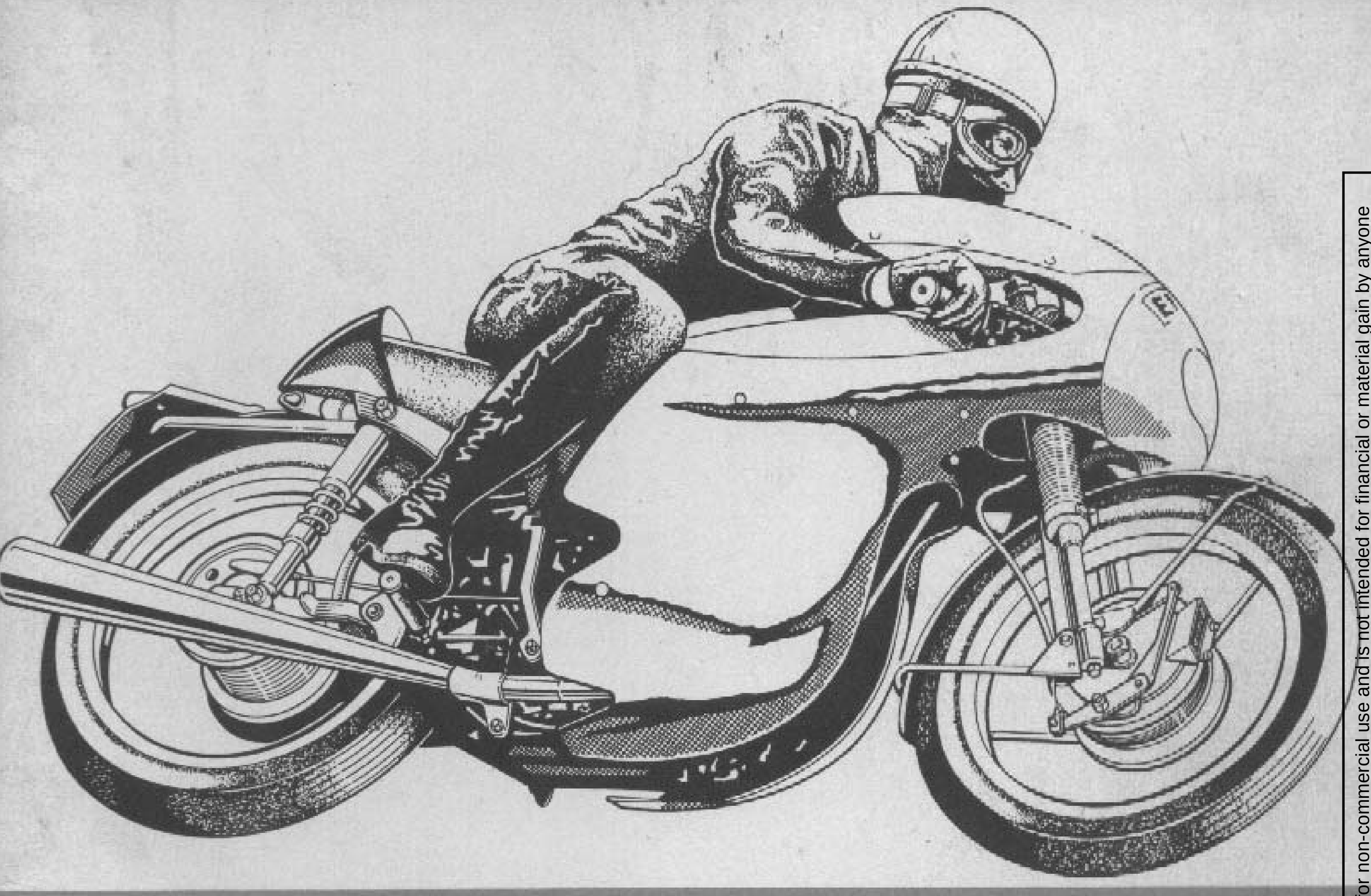
LUCAS SERVICE INFORMATION



MOTOR CYCLE ELECTRICAL EQUIPMENT

SERVICE MANUAL

part 1

JOSEPH LUCAS (SALES & SERVICE) LTD., BIRMINGHAM B18 6AU

LUCAS

motor cycle
electrical equipment

SERVICE MANUAL

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Contents

INTRODUCTION

For many years Lucas have supplied electrical equipment for the majority of British motor cycles. During this time electrical equipment has developed through 6-volt charging systems, coil ignition and A.C. ignition to 12-volt systems with starting motors and capacitor igintion.

This Service Manual describes the operating principles of present day motor cycle equipment, and maintenance necessary at normal service intervals. By following the systematic test procedure time spent on fault diagnosis will be reduced to an absolute minimum.

Older motor cycles can often be modified to the latest specification. Details of the conversion to 12-volt electrical system, capacitor ignition etc. have been included. Wiring diagrams of the circuits are provided.

The scope of this edition of the SB519 has been extended to include ignition, lighting and auxillary equipment, so that the title has been changed to "Motor Cycle Electrical Equipment Service Manual".

WORKING PRINCIPLES

How an E.M.F. is Produced

When a conductor is moved through a magnetic field, an electro-motive force or E.M.F. is induced in it. If the conductor forms a loop or closed circuit, an electric current will register on a sensitive meter connected in the conductor circuit. When the conductor is moved downwards, as shown in the illustration Fig. 1A, the needle swings in a direction corresponding to the direction of current flow. If the conductor is moved upwards, Fig. 1B, the needle will swing in the opposite direction, indicating that the current flow is also in the opposite direction.

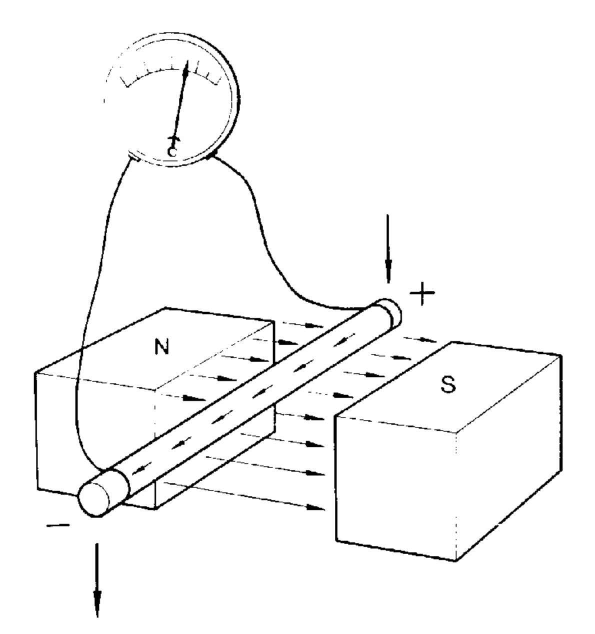


Fig. 1A Generating a current

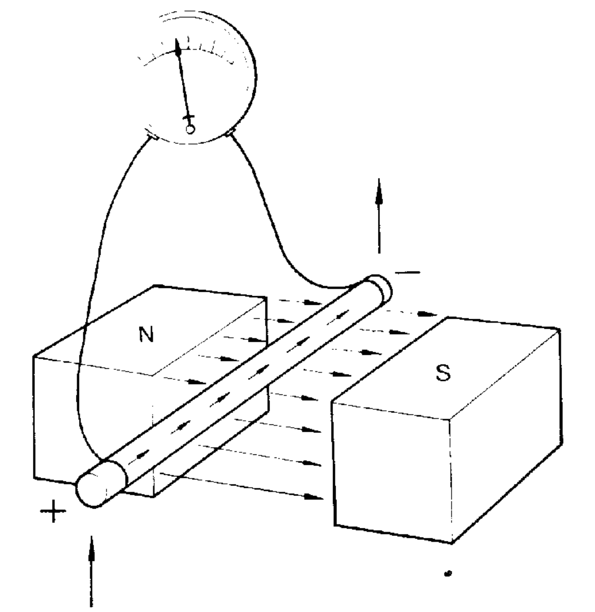


Fig. 1B. Generating a current in the reverse direction

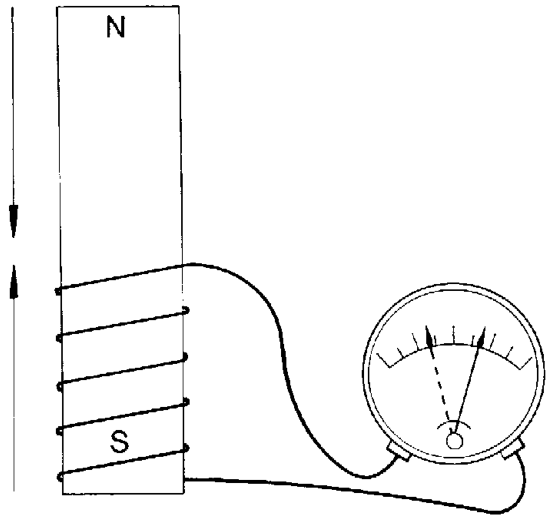


Fig. 2 Moving the magnet inside the conductor

The amount of movement of the needle will depend upon the speed at which the conductor is moved up and down, and the density of the magnetic field. The same effect can be obtained by moving a magnet in and out of a coil of wire, Fig. 2. Induction will again take place and current flows in the wire coil. This time, because the coil consists of several turns of wire, instead of one single conductor, the induction will be increased, thereby giving a greater output. The sensitive meter, if connected across the ends of the coil, will register in exactly the same manner as it did with the single conductor, except a larger deflection will occur.

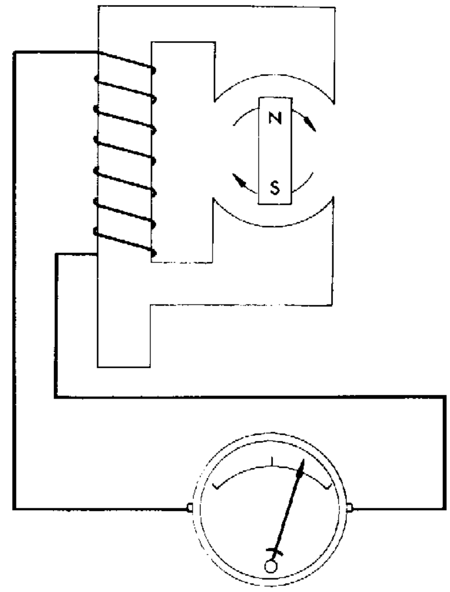


Fig. 3A Simple alternator (0°–180°)

A Simple Alternator

Figures 3A and 3B show an alternator in its simplest form. The coil has now been wound round an iron yoke which concentrates the magnetic field around the coil. In the centre of the yoke a bar magnet is rotated.

The direction of the magnetic field will change every 180° of rotation of the magnet. In 3A illustration the north pole is at the top, but after the magnet has rotated 180°, 3B, the south pole is at the top. The magnetic field has been reversed. The direction of current flow in the coil has also been reversed. Induction has taken place due to movement of the magnet in close proximity to the coil, and alternating current has been produced.

The sine wave shown in Fig. 4 is a simple representation of the current output from an elementary alternator. It shows the current output during one complete revolution of the bar magnet alternator illustrated in Figs. 3A and 3B.

The vertical line represents the current in amperes, which is positive, above the neutral point or horizontal line; and negative below the neutral line. Starting from the left side, this line is divided into 360°, that is, one complete revolution of the bar magnet. From 0° the current gradually builds up to its maximum value at 90°; then gradually decreases until it is zero again at 180°. It now continues in the

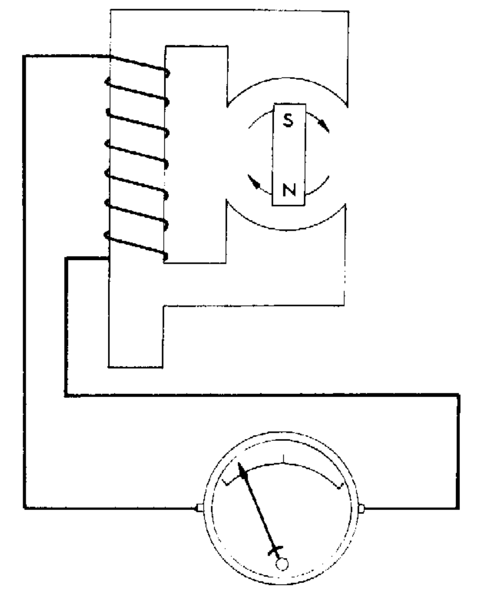


Fig. 3B Simple alternator (180°–360°)

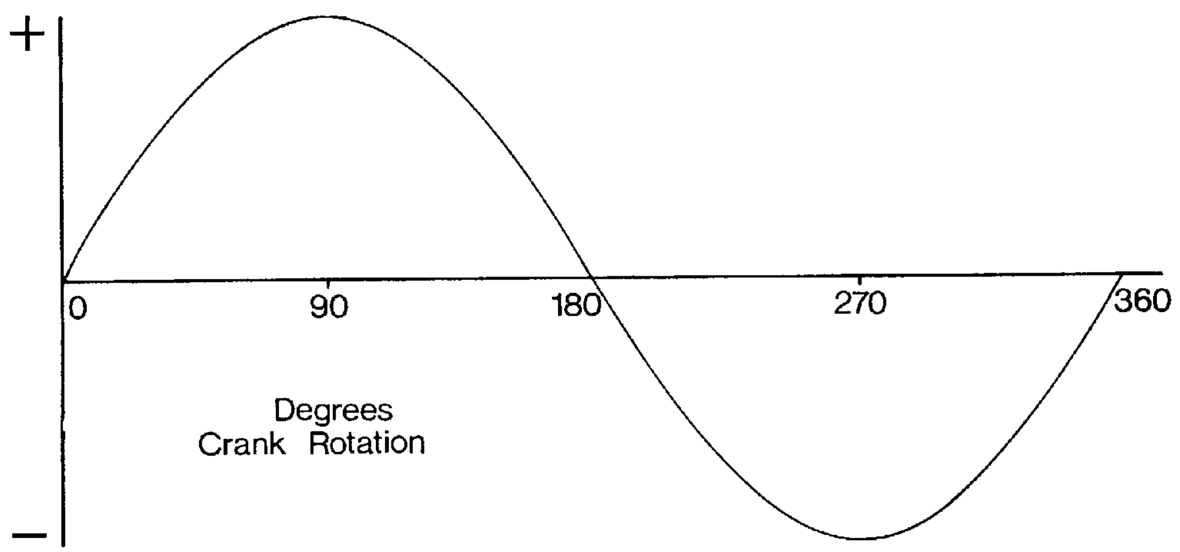


Fig. 4 Alternating current sine wave

negative direction reaching a maximum at 270°, then gradually reduced again, becoming zero at 360°. This cycle is repeated as long as the magnet is rotated.

Exactly the same thing happens with the motor cycle alternator. The current generated in the coils is used for lighting, and ignition purposes, etc. This type of alternator uses a magnetic six-pole rotor to cause the flux reversals, Fig. 5. The coils are stationary, being fixed to the stator assembly.

Rectifier for Battery Charging

Because of the alternating characteristic of the current produced by the alternator it cannot be connected directly to a battery for charging purposes. A battery can only be charged by a D.C. current. If a battery is to be charged by the alternator, then a rectifier must be incorporated in the circuit.

A rectifier is a device for converting an alternating current, Fig. 6A, B and C, into a direct current either by the suppression or inversion of alternate half-waves.

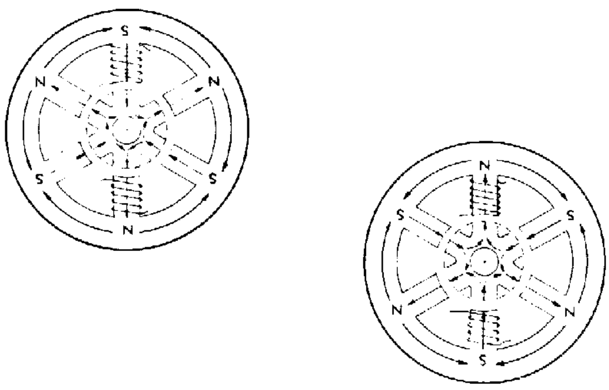


Fig. 5 Lucas alternator arrangement

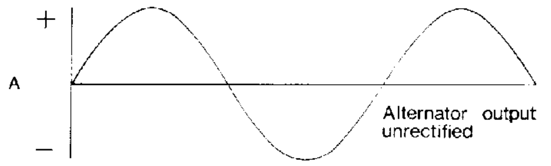


Fig. 6A A.C. current unrectified

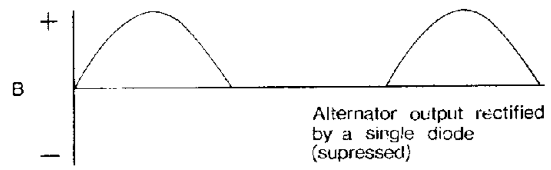


Fig. 6B Half-wave rectification

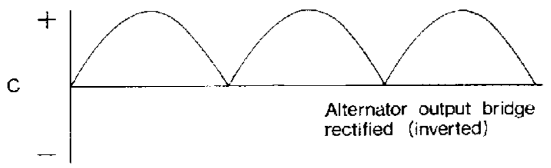


Fig. 6C Full-wave rectification

Silicon diode rectifiers are used with Lucas A.C. equipment. The rectifier consists of 4 diodes, which act as one-way valves. Each consists of two small blocks of pure silicon specially treated by the addition of certain impurities. The blocks are then joined as shown in Fig. 7. Current then flows in the direction of the arrow. The symbol for the diode is shown.

With a diode of this type in the circuit, the generator can be connected so as to charge the

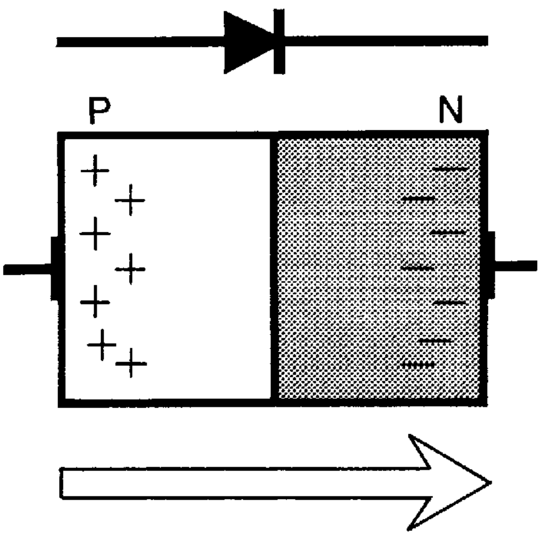


Fig. 7 Construction of a single diode

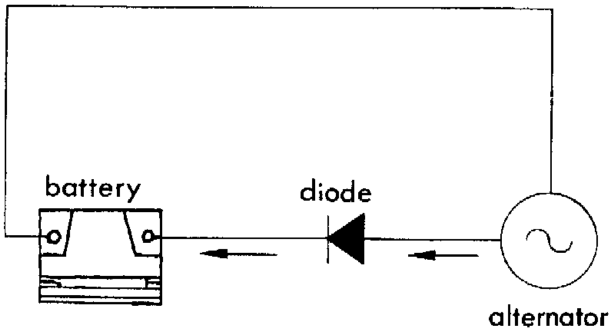


Fig. 8 Half-wave rectification

battery. The alternating output, which in effect would try to flow round the circuit, first in a clockwise direction and then in an anti-clockwise direction, becomes D.C., and current therefore will always flow through the battery in the same direction, Fig. 6B. The negative half-waves, which are shown below the horizontal line, have been suppressed, and only the positive half waves above the line are allowed to pass through the rectifier and round the circuit. This arrangement is known as half-wave rectification, as shown in Fig. 8.

In using this method of battery charging, however, one half-cycle of our generator output is unused. In practice this problem is overcome by the use of a full-wave rectifier.

Full-Wave Rectification

A full-wave rectifier consists of four elements, of the type shown in Fig. 7, connected so as to allow the full output from the alternator to pass through to the battery.

The illustrations in Fig. 9 show the bridge rectifier connected in circuit with an alternator and battery. The left-hand illustration (A) shows the circuit when

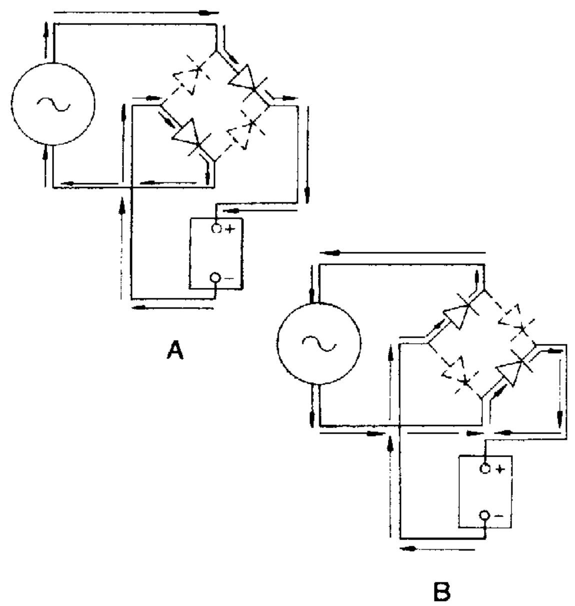


Fig. 9 Full-wave rectification

current is flowing in a clockwise direction; the right-hand illustration (B) an anti-clockwise direction. With this arrangement the full output from the generator is utilised. That is, both the positive half waves and the negative half waves are used to charge the battery, shown by the graph C in Fig. 6, by inversion of the negative half wave.

The silicon diode bridge rectifier incorporates four diodes, each mounted on a small circular plate which acts as a heat-sink.

Controlling the Alternator Output

The simple alternator described previously is, of course, not satisfactory for normal requirements, and in practice the alternator contains several coils, and the bar magnet becomes a multi-pole unit. The ampere output from such an alternator is considerably more than would be obtained from the unit with the single coil and bar magnet. Some form of output control is therefore necessary, otherwise the generator output would remain at a maximum irrespective of load requirements and the battery would become overcharged. The alternator stator carries six coils, one on each pole. These are three pairs of coils, each connected in series. The first pair have a green/black cable connected to them, the other two pairs are

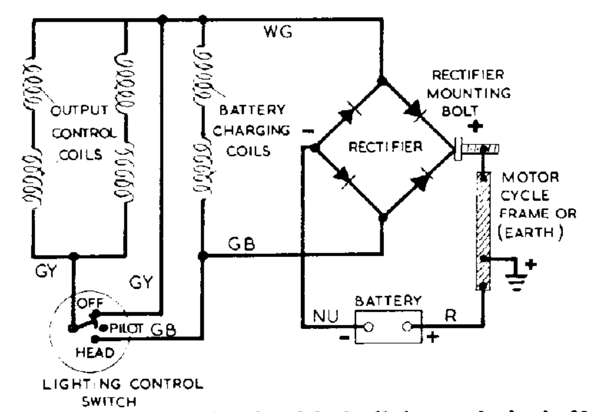


Fig. 10 Charging circuit with the lights switched off

linked together and connected to a green/yellow cable. All the coils have the remaining terminals connected to a common white/green cable.

The single pair of coils connected permanently across the bridge rectifier provide some charging current for the battery, whenever the engine is running.

Connections to the remaining coils vary according to the positions of the lighting and ignition switch, with the ignition key in the IGN position, for coil ignition the basic output control circuits are shown in Figs. 10, 11 and 12.

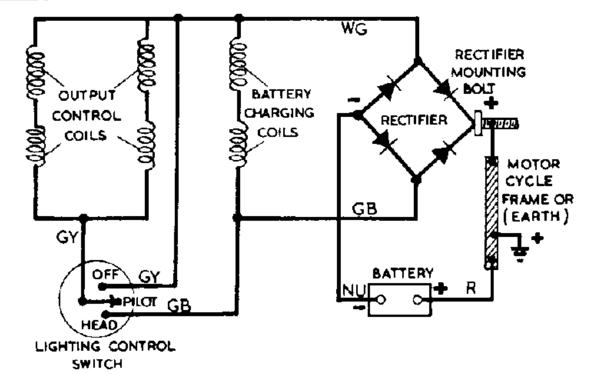


Fig. 11 Charging circuit in the pilot light position

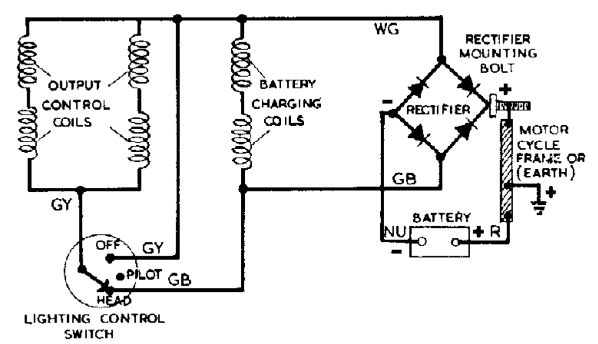


Fig. 12 Charging circuit in the headlight position

With the lighting switch in the OFF position, the output control coils are short-circuited, as shown in Fig. 10, and the alternator output is regulated to its minimum value by the interaction of the coil flux, set up by the heavy current circulating in the short-circuited coils, with the flux of the magnet rotor. Trickle-charging is provided by the permanently connected charging coils.

In the PILOT position, Fig. 11, the control coils are disconnected and the regulating fluxes are consequently reduced. The alternator output therefore increases and compensates for the additional parking light load. On certain applications the short circuit lead is omitted in the OFF position giving the higher output for both OFF and PILOT positions.

In the HEAD position, Fig. 12, the alternator output is further increased by connecting the control coils in parallel with the charging coil. Maximum output is now obtained.

Special Applications

AA and Police machines fitted with two-way radio do not have a short circuit lead in the OFF position. They also incorporate a separate "boost" control switch, which can be used at any time, irrespective of the position of the main lighting switch. When in the "boost" or closed position, maximum output is obtained from the alternator, see Fig. 13. When the switch is open, the output from the alternator depends upon the position of the lighting switch.

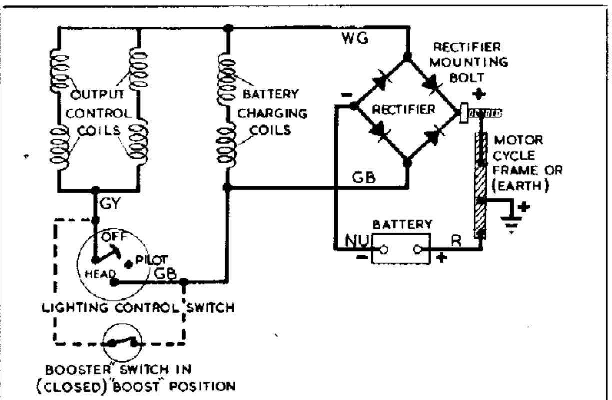


Fig. 13 Charging circuit for motor cycles equipped with a radio

Emergency Starting

Motor cycles fitted with coil ignition and the alternator-rectifier battery charging system are normally provided with a means of starting the engine when the battery is badly discharged. For this purpose, a three-position ignition switch is used, marked IGN, OFF and EMG. On switching to

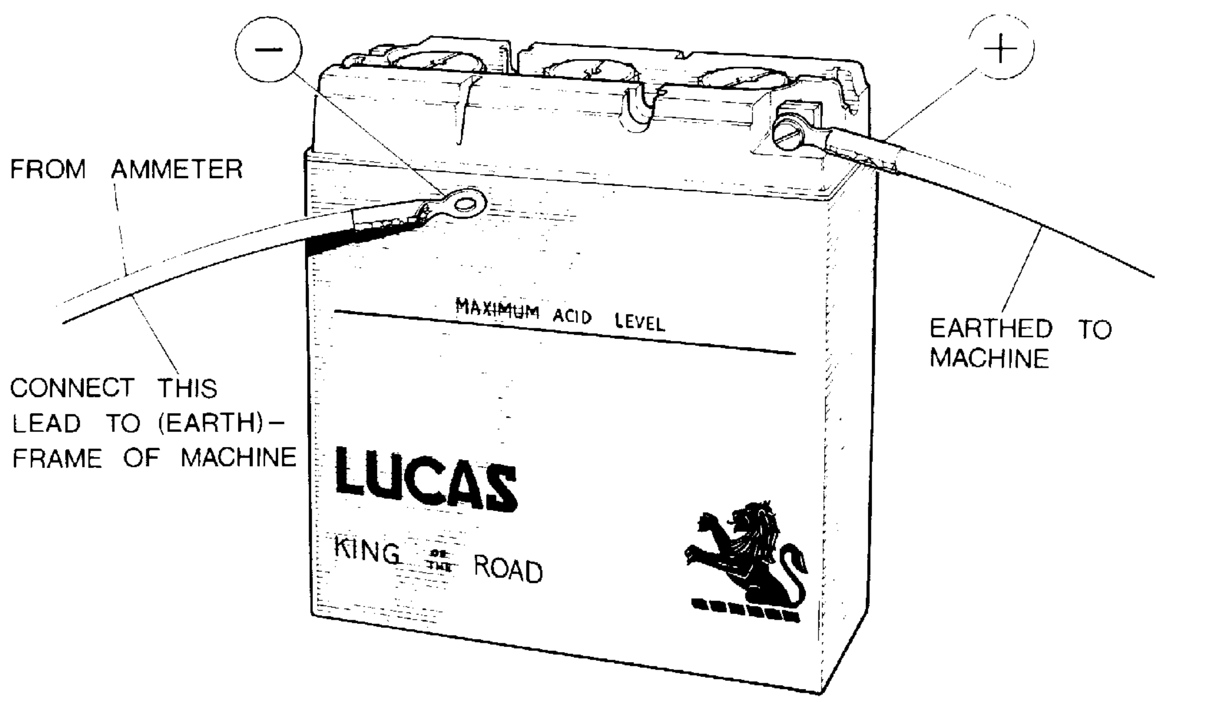


Fig. 14 Running a motor cycle without a battery in the emergency position

EMG and kick-starting the engine, the battery receives a high charging current, and after running for a while, the ignition switch should be turned back to the normal running position IGN. (In the case of single-cylinder machines and twins fitted with two ignition coils, the appropriate time to change back to normal ignition is indicated by a tendency for the engine to misfire. This is because the rising battery voltage is in opposition to the alternator voltage, and consequently the amount of energy available for transfer to the ignition coil is reduced).

The emergency starting feature also enables short journeys to be made (if absolutely essential) without battery or lighting. This is done by connecting the cable normally attached to the battery negative terminal to an earth point on the machine, Fig. 14, and kick-starting the engine with the ignition switch in the EMG position.

Thus a rider can return home even if his battery has failed completely. It must be emphasised, however, that continuous running in these conditions would result in badly burnt contacts in the distributor or contact breaker unit and cannot therefore, be recommended. Also the lighting system must not be switched on.

Single-Cylinder Machines

When current flows through the windings in the direction indicated by the arrows in Fig. 15 and the contacts are closed, the main return circuit to the alternator is through one arm of the rectifier bridge. As the contacts separate the built-up electromagnetic energy of the alternator windings quickly discharges through an alternative circuit provided by the battery and the ignition coil primary winding. This rapid transfer of energy from the alternator to coil causes H.T. to be induced in the ignition coil secondary windings and a spark occurs at the plug.

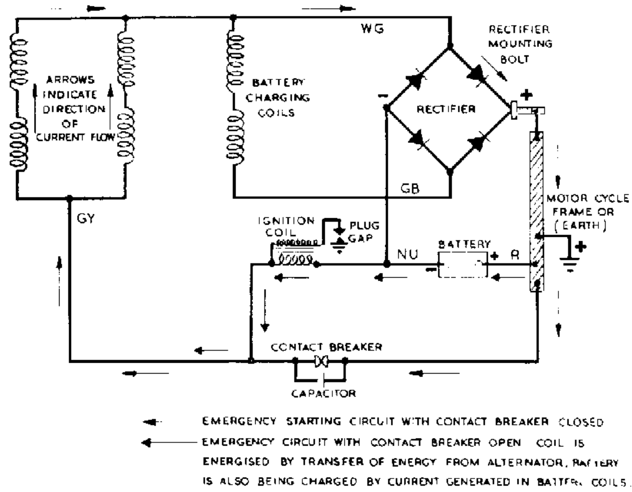


Fig. 15 Emergency start circuit for single cylinder motor cycles

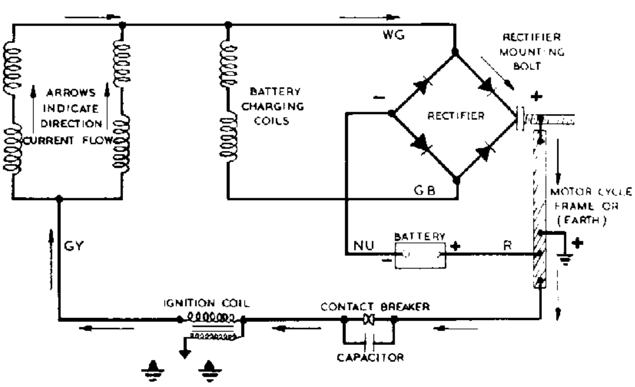


Fig. 16 Emergency start circuit for twin cylinder motor cycles with a distributor

Twin-Cylinder Machines
(single ignition coil and distributor)

Fig. 16 shows that the ignition coil primary winding and the contact breaker are connected in series, and not in parallel as for single cylinder machines. This enables a simpler harness and switching system to be used on twin cylinder machines, but it is unsuitable for use with single cylinder machines due to "idle" sparking before the contacts separate. Twin engines, fitted with a distributor, are unaffected by this premature sparking.

With single cylinder machines connected as shown in Fig. 15 "idle" sparking occurs after the contacts have separated and so does not affect these engines.

The machine should not run continuously with the switch in the emergency start position, because the rising voltage of the battery opposes that of the alternator and gradually the energy available for transfer to the ignition coil is reduced.

The engine will misfire, reminding the rider that he has not returned the ignition key to the IGN position.

Twin-Cylinder Machines (twin ignition coils and twin contact-breakers)

When the ignition switch is in the normal running position IGN, each coil, with its associated pair of contact-breaker contacts, serves one of the cylinders – each functioning as an ordinary battery coil ignition circuit. On switching to EMG, however, one of the ignition coils functions on the energy transfer principle.

The illustration (Fig. 17) shows the circuit used for emergency starting. The No. 1 contact-breaker is arranged to open when the alternating current in the windings reaches a maximum in the direction shown by the large arrows.

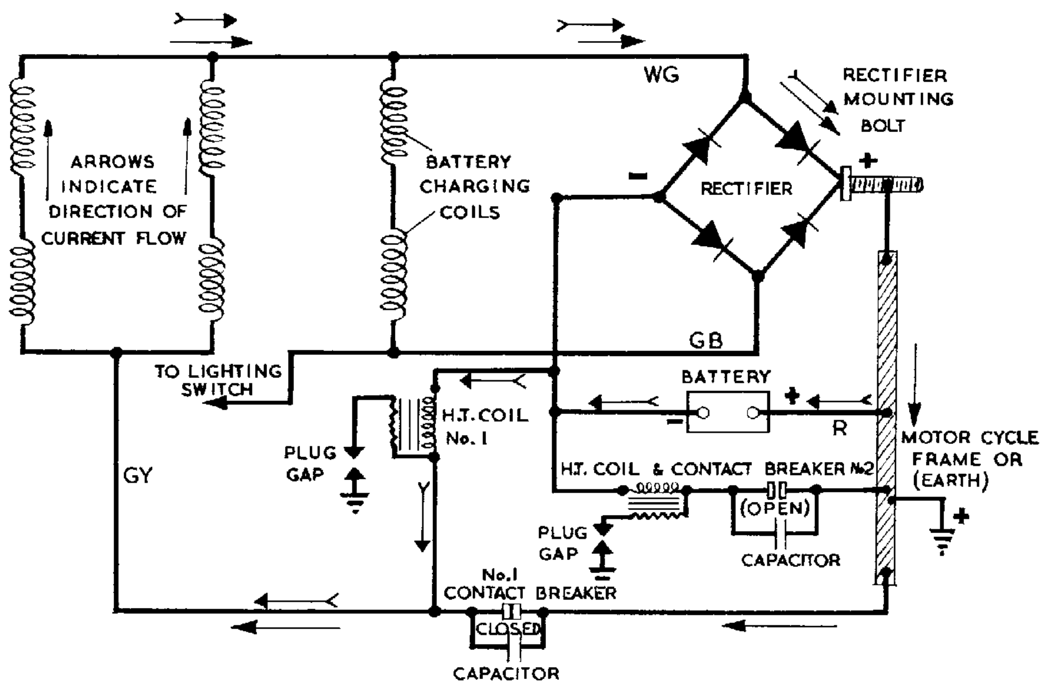
The system functions as follows:–

With the contacts closed, the main return circuit to the alternator is then via one arm (diode) of the rectifier bridge and the closed contacts. In effect the four output control windings have been short-circuited allowing a heavy current to build up and circulate through them.

As soon as the contacts separate, this built-up energy discharges through an alternative circuit provided by the battery and primary winding of the No. 1 or EMG ignition coil. The rapid transfer of current from alternator to the ignition coil primary winding results in H.T. being induced in the secondary winding and an efficient spark at the plug.

The efficiency of the energy transfer ignition is quite high because the alternative path through the battery, when the contacts are opened, is virtually a short-circuit. The "flat" battery has little or no potential difference across it, and consequently very little energy is lost at this point.

However, as the current surges pass through the battery, and there are two charging coils also in circuit, a potential difference is formed across the battery terminals. After several current pulses (assuming the engine has fired and is running on one cylinder), the amount of energy available for the ignition coil is reduced, causing the engine to misfire. This will remind the rider to return the ignition key to the IGN position. The contact points will be badly burnt if the switch is kept in the EMG position for long periods.



—► EMERGENCY STARTING CIRCUIT WITH CONTACT BREAKER NO.I CLOSED

≻—► AS ABOVE BUT CONTACT BREAKER NO.I OPEN & IGNITION COIL NO.I ENERGISED BY ENERGY TRANSFER FROM ALTERNATOR (BATTERY BEING CHARGED & ENERGISING IGNITION COIL NO.2 WHEN CONTACT BREAKER NO.2 CLOSES.)

Fig. 17 Emergency start circuit for twin cylinder motor cycles

Another feature of the system is that the coil No. 2 eventually comes into operation during emergency starting, so that after a few seconds running on one cylinder, number two cylinder cuts-in and the engine functions as a normal twin-cylinder unit. It will not operate on both cylinders after a few more seconds because the rising battery voltage causes misfiring on the one cylinder.

Although the No. 2 coil "SW" terminal is linked to the same feed cable as the "SW" terminal of No. 1 coil, it does not pass any of the energy transferred from the alternator, during the "energy transfer" pulse, at this particular instant the No. 2 contact-breaker points are open, open-circuiting the No. 2 primary circuit. As the alternator current passes through the battery, the voltage rises. Further, while the No. 1 coil is fed by energy pulses from the alternator, the No. 2 coil, when its associated contacts close, will receive current direct from the battery which is gradually becoming charged. This results in the engine firing on both cylinders. It will not run at full power until switched to the IGN position, because the energy now available for the No. 1 coil is being reduced and misfiring will still occur.

Actually, when both coils are functioning, their primary windings are being fed in opposite directions. The No. 1 coil is receiving pulses from the alternator, via the battery, the insulated side of the circuit, through the primary from "SW" to "CB" and back to the alternator. The No. 2 coil is fed by a steady current direct from the battery, via earth, through No. 2 contacts to "CB" through primary to "SW" and back to battery "–ve".

Ignition performance under emergency starting conditions should be equivalent to that of a magneto at kick-start speeds.

NOTE: Where a "boost" control switch is fitted, the switch must be in the off position before attempting an EMG starting. As the switch short circuits the emergency starting system.

The Importance of Correct Timing for Emergency Ignition

Correct ignition timing, both electrically and mechanically, is a very critical factor with the A.C. sets, particularly in relation to emergency starting. As already stated, in the emergency start position the alternator supplies current direct to the ignition circuit. The timing is so arranged that the contacts are opened when the peak of the voltage wave coincides with each firing point of the engine, illustrated graphically in Fig. 18 (A).

If the contacts do not open at the precise instant required, emergency starting performance will be affected. Electrically, the timing position is fixed by the manufacturer, i.e., the alternator rotor is keyed on to the crankshaft in a position consistent with peak voltage, and cannot be altered. It is on the mechanical side that variations in timing can arise. The engine ignition timing must be accurately set to the figures specified for the particular machine. The contact breaker gap must also be set to, and maintained at, the specified figure as any variation in the gap setting will affect the timing position in relation to spark energy. If the timing at the distributor or contact breaker is advanced or retarded excessively either through a timing error, incorrect contact gaps, or weak automatic advance springs, the contacts

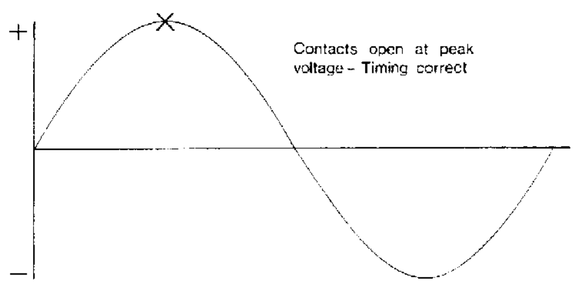


Fig. 18A The effect of correct timing

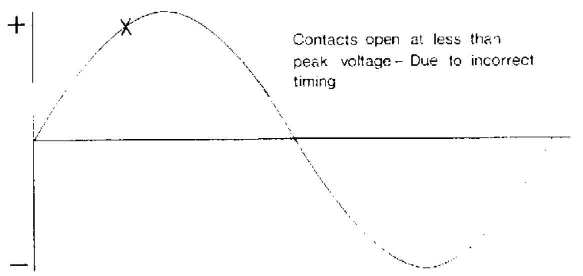


Fig. 18B The effect of incorrect timing

will not open at the peak of the voltage curve, see Fig. 18 (B) and consequently the spark will be weak. REMEMBER, IGNITION TIMING IS CRITICAL.

Poor Starting on Emergency

Faulty or dirty connections in the alternator electrical circuit will obviously have a bad effect on performance. Check the earth connections at the battery and rectifier. Both units are connected to the frame of the machine and a periodic check should be made to see that the connections are tight. Remember that the battery "+ve" terminal is the one earthed to the frame of the machine.

Dirty Contacts or Incorrect Gap Setting

The contact-breaker points should be periodically checked and cleaned, if necessary, and the gap should be maintained at its correct setting, i.e. 0·014"–0·016". This applies to both contact-breaker units.

Dirty Plugs or Incorrect Gap Setting

Plug gaps should be periodically checked and, if necessary, adjusted to the required gap, as specified by the manufacturer. It is also very important that the external insulator is kept clean and dry. Plugs should be replaced, if the electrodes are badly worn.

Faulty Rectifier

A rectifier may be faulty, even though its external appearance suggests it is in good working order. Where any doubt exists, the test procedure should be followed as detailed in Section 4. Do not flash connections to check the circuitry, as the rectifier and alternator could be damaged.

Rectifiers should be kept clean and dry and fitted to allow free passage of air through the plates for ventilation.

Dirty or Corroded Battery Terminals

Battery connections should be kept clean and tight, particularly the earth lead to the frame of the machine. Ensure that the top of the battery is clean and dry.

Sulphated Battery

A sulphated battery is usually the result of lack of maintenance, i.e. failure to maintain the electrolyte at the specified level, and allowing the battery to remain for long periods in a partially charged or discharged condition. A regular check on each cell should be made to see if "topping-up" is required. Distilled water should be added to the electrolyte to bring it up to the correct level.

A.C. Ignition

The alternator designed for A.C. ignition has the ignition generating coils connected in series with each other and with the primary winding of a special ignition coil, model 3ET.

This special ignition coil (Fig. 19) employs a closed iron circuit and has a primary winding whose impedance is closely matched to that of the ignition generating coils of the alternator. As a result of this electrical matching, the ignition performance combines the good top speed characteristics of the magneto with the good low speed performance of the conventional ignition coil.

The A.C. Ignition System functions as follows:

The contacts of a contact-breaker unit or distributor are connected in parallel with the ignition coil primary windings, since one end of the stator winding, one end of the ignition coil primary winding and one side of the contact-breaker is earthed, as shown in Figs. 20 and 21.

When the contact-breaker contacts close, the primary winding of the ignition coil is short-circuited and, at the same time, the stator ignition windings form a closed circuit. As the magnetic rotor turns, voltages are induced in the stator coils resulting in alternating currents while the contacts are closed. When the contacts open, a pulse of electromagnetic energy (developed in the stator while the contacts are closed) is discharged through the ignition coil primary winding. The effect of this energy pulse in the primary winding is to induce a high tension voltage in the ignition coil secondary winding which is then applied either directly or by way of a distributor to the appropriate sparking plug.

Timing Considerations

Since the magnetic rotor of the alternator is keyed (or otherwise located) on the crankshaft, the magnetic pulse in the alternator stator, which produces the energy pulse to feed the ignition coil primary winding, must be timed to occur at the firing point of the engine.

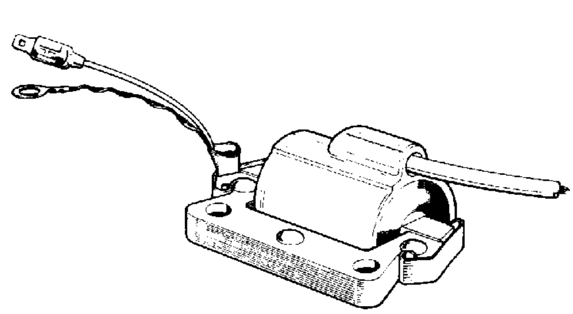


Fig. 19 Model 3 ET. ignition coil

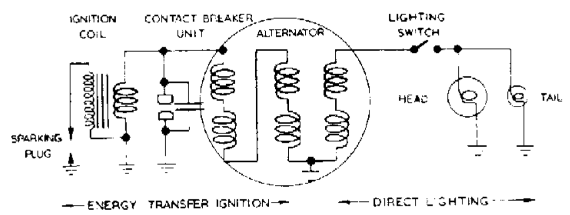


Fig. 20 A.C. ignition circuit for single cylinder motor cycles

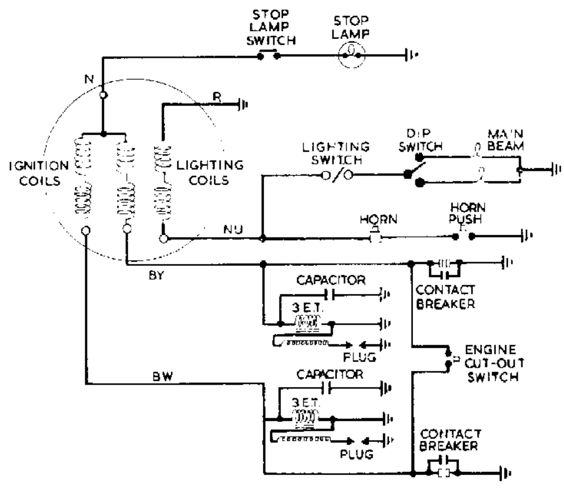


Fig. 21 A.C. ignition circuit for twin contact motor cycles

The magnetic pulse occupies several degrees of crankshaft (and therefore of rotor) rotation. A fairly wide angular tolerance would thus be available for a fixed ignition engine.

However, it is desirable that most four-stroke engines should incorporate an ignition timing control (usually centrifugally operated) giving a range of advanced and retarded sparking. The magnetic relationship of the alternator rotor to its stator must therefore be governed by the fact, that the engine firing point will vary by several degrees between the fully retarded starting condition and the fully advanced running condition.

This is exactly the same problem which obtains with a manually controlled magneto and gives rise to the same characteristics, i.e. the available sparking voltage for a given kick-start speed reduces progressively with the retard angle. A magneto, however, is a self-contained unit and will produce a spark even though seriously mistimed to the engine, because a magneto contact-breaker is always in the correct relationship to the magnetic geometry of the unit. With an alternator, however, the position of the magnetic rotor with respect to the stator, and to the engine piston at the instant of firing, is pre-determined by its position on the engine crankshaft.

The range of retarded magnetic timing that can be used with a particular engine depends in part on that engine's starting performance, since the required plug voltage is influenced by many factors of engine design. The speed at which it can be kicked over in attempting to reach this voltage will depend on piston and bearing friction, kick-starter ratio, etc.

Fig. 22 shows how the available plug voltage varies with different magnetic timing positions and for different speeds of rotation. The reference point is known as the Magnetic Neutral position, where the interpolar gaps of the rotor are situated on the centre-lines of the stator limbs.

It will be seen that although the optimum magnetic position is just past the Magnetic Neutral at 300 rev/min, it changes to several degrees past at 2,000 rev/min, due to distortion of the magnetic flux.

It will also be seen that the sparking performance deteriorates rapidly a few degrees before the Magnetic Neutral position. Hence commercial tolerances on keyways, etc., dictate the inadvisability of approaching too near to this critical point in the advanced or running position of engine timing.

As previously stated, the extent to which the retard timing can be used depends on plug voltage requirements at starting and on kick-starter speed.

For example, if the required plug voltage is 6 kilo-volts, the retarded timing would be restricted to about 20° (engine) if the kick-starting speed was to be limited to 300 rev/min – in practice, a fairly low speed. On the other hand, at the fairly normal kick-starting speed of 500 rev/min, the timing range could be widened considerably with plug voltages up to about 8 kilo-volts.

Accurate ignition timing is an important requirement in the operation of an energy transfer system. The optimum conditions are determined by the engine designers during the development and should always be maintained to ensure the highest performance, both from the engine and from the ignition system designed to work with it.

It will also be appreciated that amateur tuning will not improve the performance of a highly developed engine. Indeed, in certain circumstances, it may be harmful. Indifferent sparking outside the prescribed range will almost certainly indicate tampering and may well serve as a warning to the would-be tuner.

12 Volt Charging System and Capacitor Ignition

The Lucas R.M. series alternator is voltage conscious, but, to avoid overcharging the battery, was used with 6 volt equipment. However, with the introduction of the Zener diode it became possible to control the output for all conditions using 12 volt equipment. Many advantages were gained. Extra output from the alternator, more accurately controlled charge rates and better headlight efficiency.

The Zener diode is constructed from similar materials to the diode used in the rectifier and it will pass current in one direction only. However, when connected in the reverse direction, it will act as an insulator while the voltage is below approximately 14 volts. Above this it will start to conduct current,

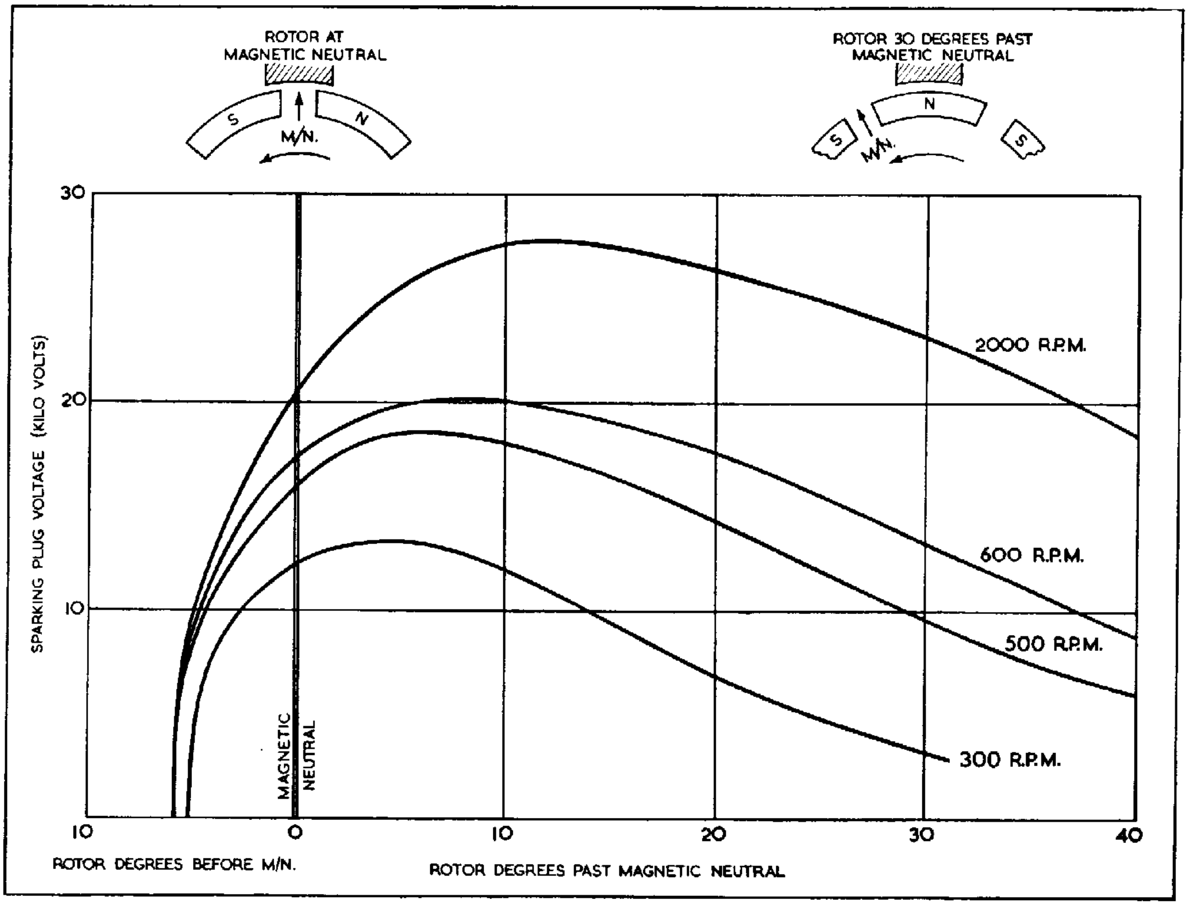


Fig. 22 The effect of magnetic timing on plug voltage at various rev/min

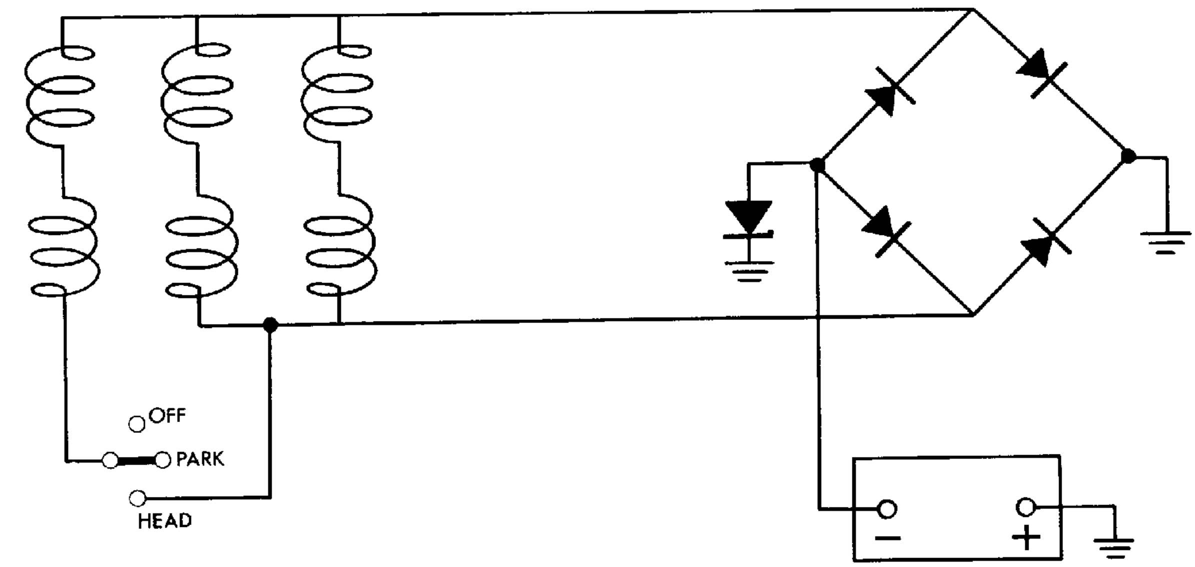


Fig. 23A 12 volt circuit for coil ignition

slowly at first, until at approximately 15 volts it becomes fully conductive. If the Zener diode is connected in parallel with the battery in the charging circuit, as shown in Fig. 23A, it will act as a regulator. When the battery is discharged, its terminal voltage is low and the system voltage is low, and the Zener diode acts as an insulator. All the output from the alternator is then directed through the battery. As the battery is charged, its terminal voltage rises and the system voltage rises accordingly, until approximately 14 volts is reached. At this point the battery requires less charge, so the Zener diode starts to break down and conducts part of the charging current away from the battery. When the battery voltage reaches approximately 15 volts, the Zener diode breaks down completely and conducts all the charging current away. When lighting equipment is switched on, the system voltage falls until it becomes an insulator again, at approximately 14 volts, and the output from the alternator is available to balance the lighting load.

As the Zener diode conducts excess current a large quantity of heat is produced by the diode and in order to keep the temperature within the operating limits, a heatsink is required. The maximum current the diode can carry is limited by the efficiency of the heatsink. In order to remain within this limit the switching arrangements were as shown in Fig. 23 A and B. Later heatsinks have a surface area of at least 72 square inches and are mounted in a good air stream. The full output from the alternator can now be permanently connected across the rectifier. The circuit for this system is shown in Fig. 24 and as the charging system requires no switching arrangement,

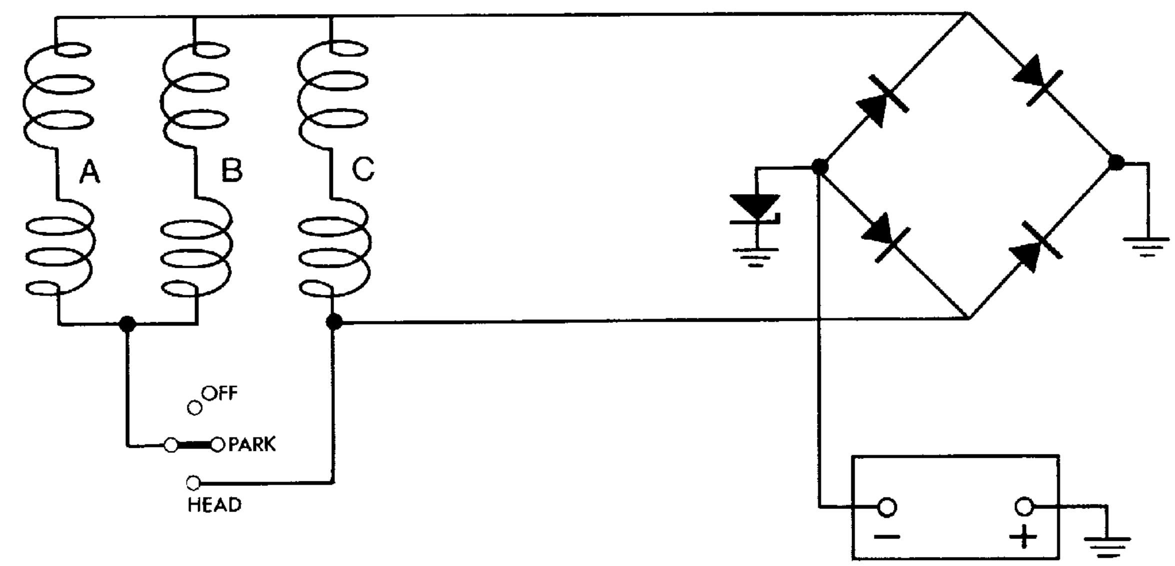


Fig. 23B 12 volt circuit for magneto ignition

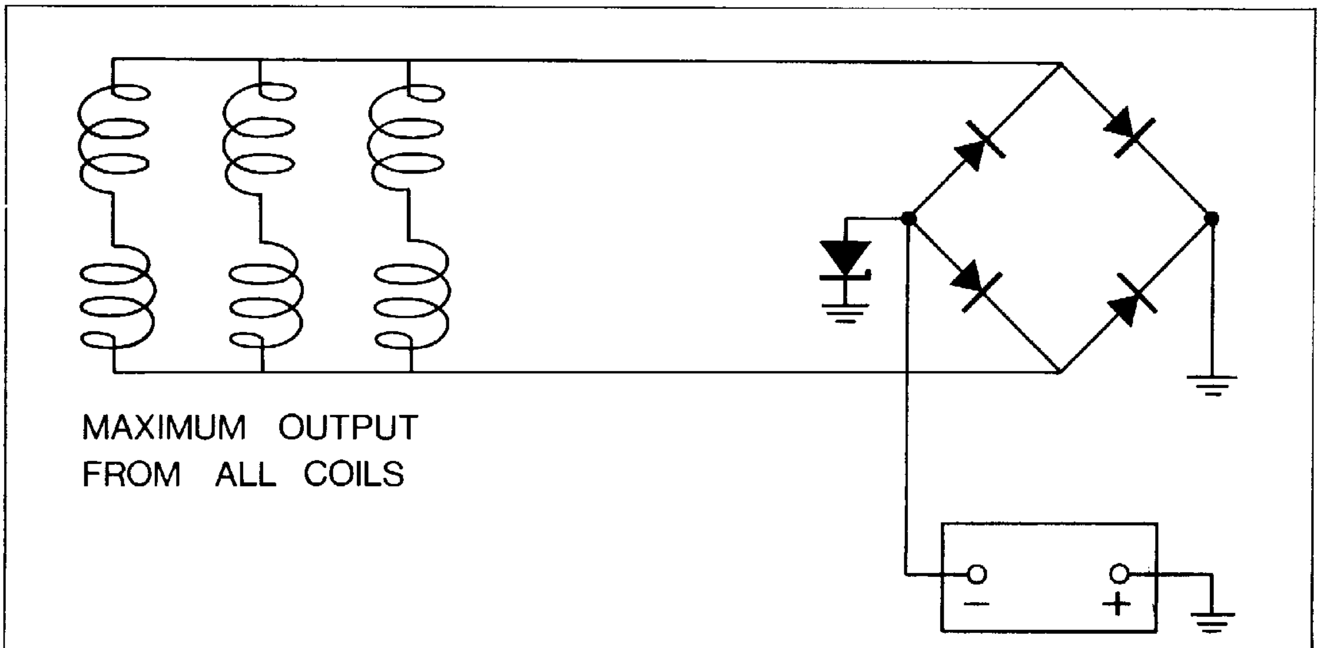


Fig. 24 12 volt circuit connected for continuous maximum output

car type ignition and lighting switches are used.

When the R.M. series alternator is used for 12 volt operation the maximum output is raised from approximately 60 watts on 6 volts to approximately 104 watts. The increased output on kick-over is enough to charge the battery sufficiently to start the machine on third or fourth kick. Consequently, no emergency start is necessary allowing the simple coil ignition circuit to be used.

It may be preferable to remove the battery for sporting events. The Zener diode will then maintain the system voltage at a safe level, but there will be insufficient output from the alternator to start the machine on kick-start. Consequently the 2MC capacitor is connected in parallel with the battery, as in Fig. 25. When the battery is removed, the capacitor stores the impulses from the alternator when the points are open and discharges when the points close to enable other impulses from the alternator to start the machine. The machine will, therefore, operate without the battery, and the full lighting load may be supplied while the engine is running. However, when the engine is not running there will be no lights available for parking etc.

Modern circuitry has now simplified the wiring system considerably and a typical 12 volt charging and ignition circuit is shown on page 45. (Wiring diagram).

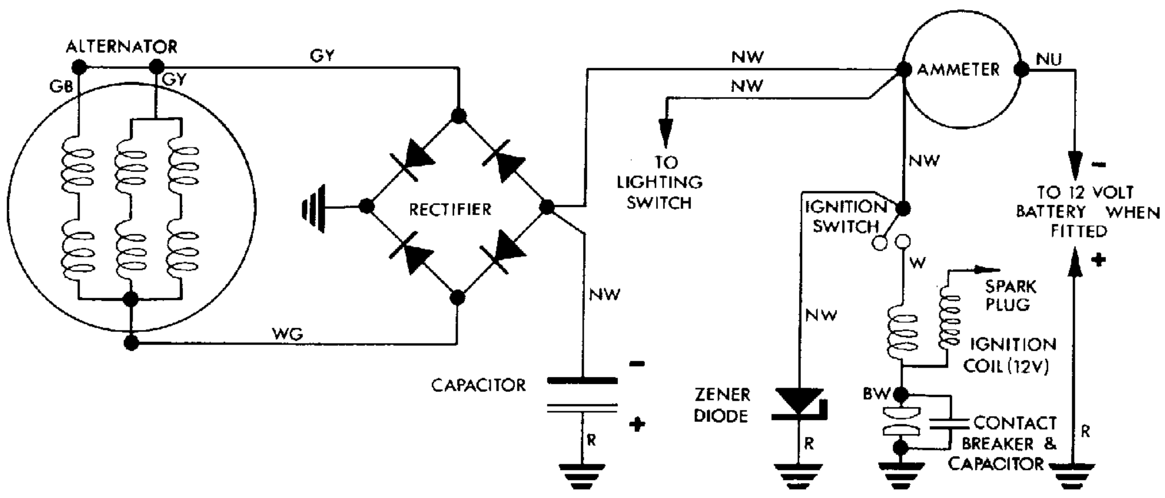


Fig. 25 Basic capacitor ignition circuit

LUCAS EQUIPMENT AND MAINTENANCE

The Battery

Preparation of PUZ5A Batteries for Service

The general instructions for putting dry-charged batteries into service are as follows:

Fill batteries, ensuring that acid and batteries are between 60°F (15·5°C) and 100°F (40°C).

In temperate climates (normally below 80°F – 29°C) the filling acid S.G. must be 1·260.

In tropical climates (normally above 80°F – 29°C) the filling acid S.G. must be 1·210.

Twenty minutes after filling the battery, the S.G. and temperature of the acid is checked and unless there is a fall of more than 10 points in S.G. or a rise of more than 10°F (5·5°C) in temperature, batteries are ready for service. If these limits are exceeded batteries should be charged at the normal recharge rate until S.G. and voltage remain constant for three successive hourly readings and all cells are gassing freely.

Owing to the limited amount of free electrolyte available in PUZ5A the above procedure has been modified, as follows:

With batteries and acid at a temperature of between 60°F (15·5°C) and 100°F (40°C), fill with acid S.G. 1·260 (temperate) or 1·210 (tropical). Read electrolyte temperature a few seconds after filling by inserting a thermometer into each individual cell in turn.

After standing for 20 minutes, individual cell temperatures are again noted.

The open-circuit voltage of the battery is then read using a good grade voltmeter.

If the temperature rise in any one cell or cells is not greater than 10°F (5·5°C) and the open circuit voltages not below 12·4v, the battery is ready for immediate service.

If these limits are exceeded the battery should be charged at 0·8A until the on-charge voltage remains constant over three successive hourly readings and all cells are gassing freely.

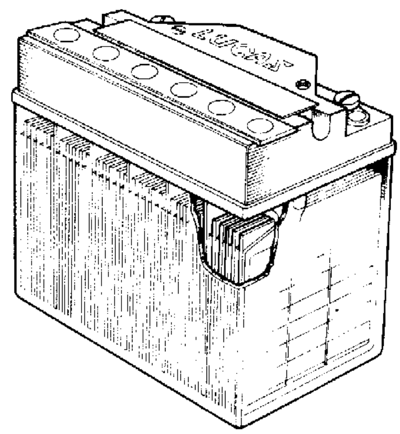


Fig. 26 Battery model PUZ5A

Batteries which are more than 12 months old, before being filled for service should be charged at 0·4A until on-charge voltage remains constant for three successive hourly readings and all cells are gassing freely.

NOTE: Dry-charged batteries are delivered with a blanking plug fitted in the vent overflow pipe. This must be removed before filling.

Topping-up

During charging, water is lost due to gassing. Every week the electrolyte level of each cell should be checked and, if necessary, should be topped up.

USE ONLY DISTILLED WATER, NOT TAP WATER.

Remove the lid and if necessary, unscrew the filler plugs. Add distilled water until the electrolyte reaches the maximum level line on the casing. If there is no maximum level line, ensure that the electrolyte is level with the top of the separator guard.

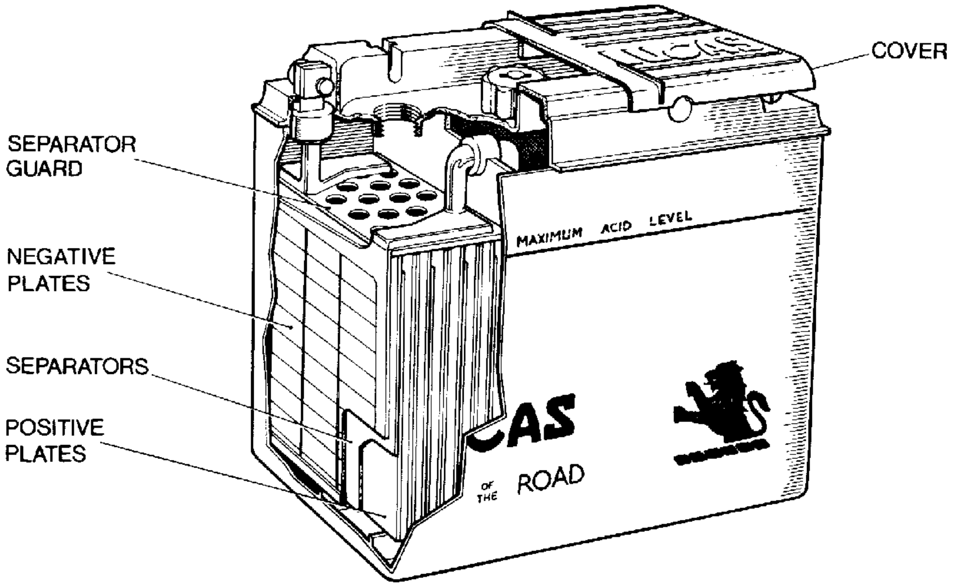


Fig. 27 Battery model MLZ9E

Occasionally, wipe away any dirt or moisture from the top of the battery, ensuring that the terminals are clean and tight. Never leave the battery in a discharged condition.

If the motor cycle is not to be used for a considerable period, the battery should be fully charged and a short refreshing charge given every two weeks, to prevent "sulphation". When a battery is fitted to the machine, ensure that the correct polarity is observed, as reversed battery connections will cause serious damage to other electrical equipment.

COIL IGNITION

6CA Contact Breaker Assembly

The assembly is adjustable for both contact breaker gap and individual timing for each cylinder. Adjustment is made by means of eccentric screws.

Adjustment of the Contact Gap

(i) Turn the engine until the contact breaker gap is at its maximum.

(ii) Slacken the screw (A) which secures the angle plate (fixed contact).

(iii) Turn the eccentric cam screw (B) and adjust the contact point gap between the limits 0·014" to 0·016" (0·35–0·40 mm).

(iv) Tighten the securing screw (A) and recheck the gap setting.

On twin cylinder applications this procedure is repeated for the second contact set.

Engine Timing

(i) Ensure the contact breaker gap is to the recommended setting.

(ii) Lock the cam in the fully advanced position by inserting a $\frac{7}{16}$", (0·4375 ins – 11 mm) internal diameter washer between the existing washer and cam. Retighten the securing bolt with the cam fully advanced against the springs.

(iii) Turn the engine to the fully advanced timing position recommended by the manufacturer.

(iv) Slacken the two screws securing the base plate to the engine.

(v) Select the appropriate contact breaker associated with the cylinder being timed.

(vi) Rotate the base plate till the above contacts are just opening and tighten the screws securing the base plate.

(vii) To obtain fine adjustment, slacken the two screws (C) securing the contact breaker plate and rotate the eccentric cam screw (D), adjusting the position of the contact heel until the points are just opening. (A low wattage bulb of the same voltage as the machine, connected between the contact breaker spring and earth will, when the ignition is switched on, illuminate instantly as the points open. Retighten the two securing screws (C).

On twin cylinder applications, rotate the engine to the second position in accordance with the manufacturer's recommendations, and repeat operations (iii), (v) and (vii).

NOTE: When the timing procedure is completed, remove the $\frac{7}{16}$" (0·4375 ins – 11 mm) washer locking the cam in the fully advanced position (ref. operation (ii)) and retighten the bolt.

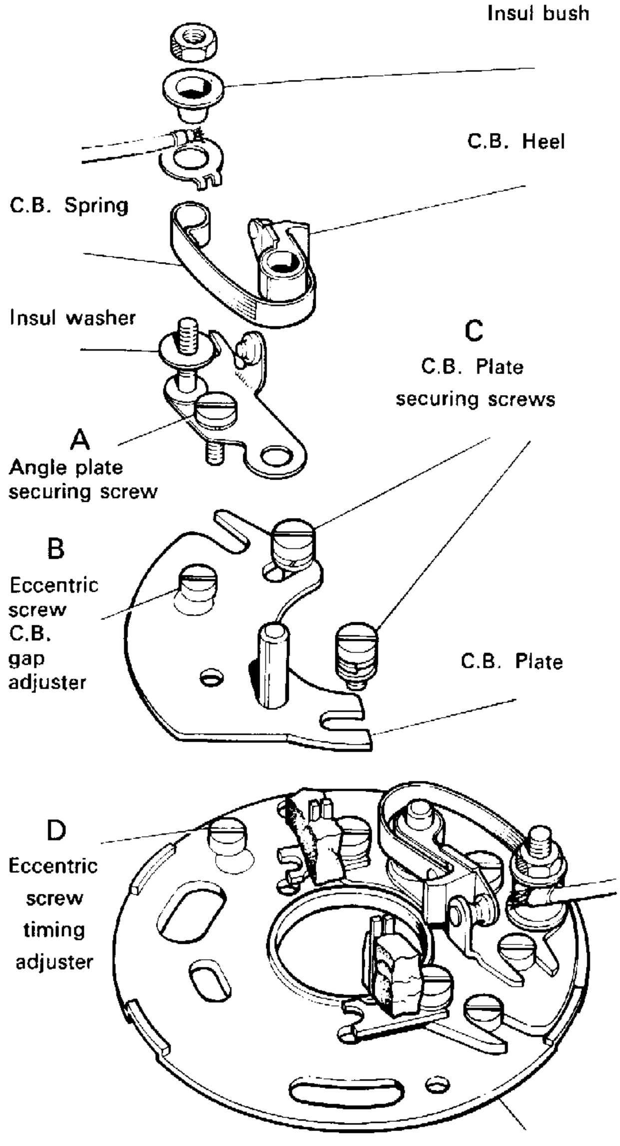


Fig. 28 Contact breaker model 6CA

7CA Contact Breaker Assembly

Adjustment of Contact Gap

Adjust as 6CA on all three sets.

Engine Timing

Adjust as 6CA for the first cylinder then repeat operation (iii), (v) and (vii) for other two cylinders.

Maintenance (6CA and 7CA)

(i) After 500 miles (800 km). Check contact breaker gap and re-adjust if necessary.

(ii) Every 3,000 miles (4,800 km). Add two drops of engine oil to the rear of the cam lubricating wick(s).

(iii) Every 6,000 miles (9,600 km). Release the contact breaker base plate by removing the securing screws. Draw the plate clear of the cam giving access to the auto-advance unit. Lubricate the pivot points B and C (Fig. 30) with one drop of engine oil, wiping away any surplus.

Inspect the condition of the contact surfaces of the contact breakers. If burned or blackened, clean with fine emery cloth or carborundum stone. Replace the plate, check the contact gap and retime the engine.

Warning

Unless otherwise stated in the manufacturer's handbook: Do not apply any form of lubrication to the bearing surface point A. This surface has been lubricated with a special lubricant during manufacture, and no further attention is required.

THE USE OF OTHER LUBRICANTS COULD CAUSE THE MECHANISM TO SEIZE.

2CP Capacitor Pack

The 6CA and 7CA contact breaker units are not fitted with capacitors. The capacitors are mounted separately on their own base plate. A rubber cover is used to prevent damage from water and road dirt. There is no maintenance required beyond the occasional check to ensure that the connections are clean and tight and also the base plate makes good contact to earth.

4CA and 4CC Contact Breaker Assembly

The model 4CA incorporates an auto advance unit, while the model 4CC is designed for fixed ignition motorcycles.

Contact Breaker Gap Adjustment

(i) Turn the engine until the contact breaker is open to its fullest extent.

(ii) Slacken the nut securing the fixed contact plate.

(iii) Adjust the position of the plate until the gap setting is between the limits of 0·014"–0·016" (0·35–0·40 mm) by inserting a screwdriver into the slot provided.

(iv) Tighten the locking nut and recheck the gap setting.

On twin cylinder applications the above process is repeated for the second contact breaker.

Engine Timing

Refer to manufacturer's handbook.

Maintenance

(i) After 500 miles (800 km). Check the contact gap setting and adjust, if necessary.

(ii) Every 6,000 miles (9,600 km). Inspect the contact surfaces and if burned or blackened, clean with fine emery cloth or carborundum stone. Check the gap setting and adjust, if necessary. Turn the engine until the slot in the cam is uppermost and apply one drop of engine oil to the slot. Place one drop of oil on each contact breaker pivot post and smear the surface of the cam very lightly with Mobilgrease No. 2 or equivalent.

NO OIL OR GREASE MUST BE ALLOWED TO GET ON OR NEAR THE CONTACTS.

Ignition Coil

The ignition coil requires no attention, but the exterior should be kept clean. Ensure that all connections are clean and tight. When an ignition coil is replaced, do not overtighten the clamp bolt, as damage to the casing could result in failure of the coil.

The high tension produced by the ignition coil is limited by the spark plug gap. If this gap is excessive or there is an open circuit in the plug lead, the

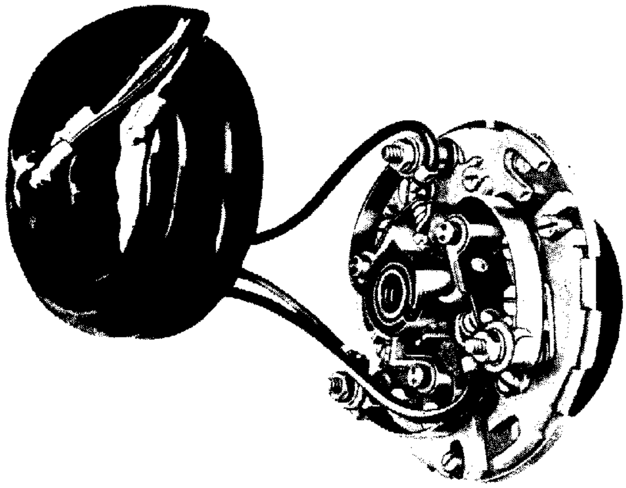


Fig. 29 Contact breaker model 7CA

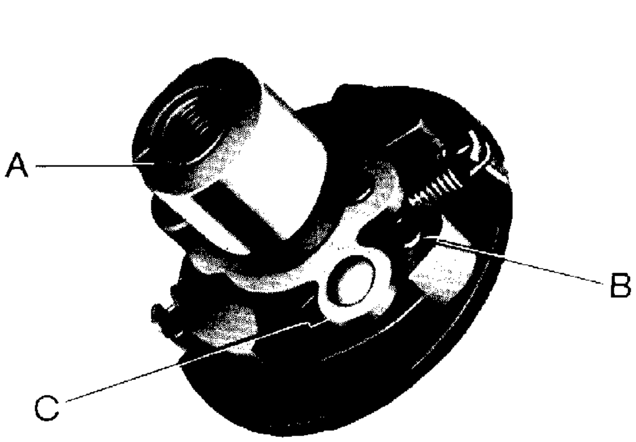


Fig. 30 Auto advance unit used with 6 and 7CA contact breakers

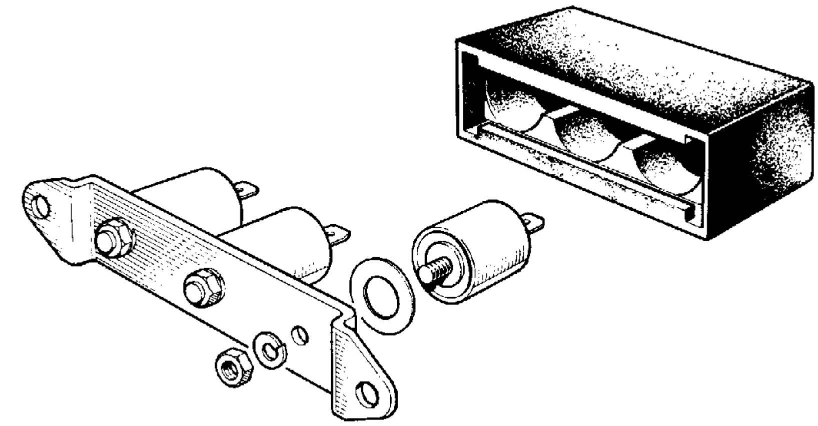


Fig. 31 **Capacitor pack model 2CP**

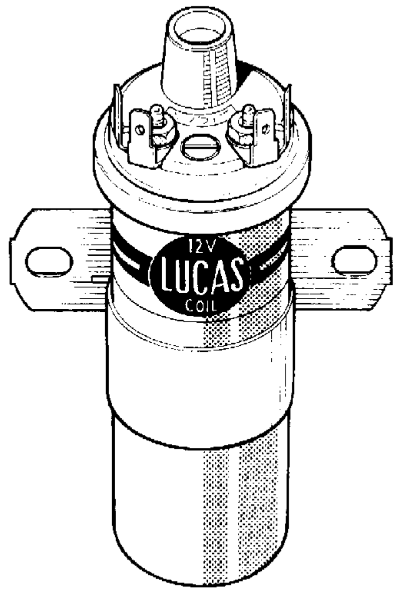


Fig. 33 **Ignition coil model 17M12**

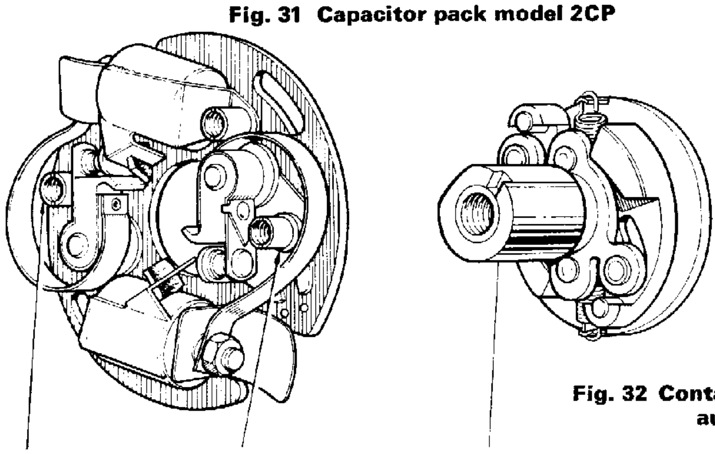


Fig. 32 Contact breaker model 4CA and auto advance unit

voltage could rise to 21,000 volts and normal insulation would break down especially in damp conditions. Ensure the chimney is clean and the H.T. connections are tight.

2MC Capacitor (when fitted)

The 2MC capacitor has been specially designed to withstand engine vibrations. It must be mounted in a spring with the terminals pointing downwards. It is only suitable for use with the 12 volt full output system.

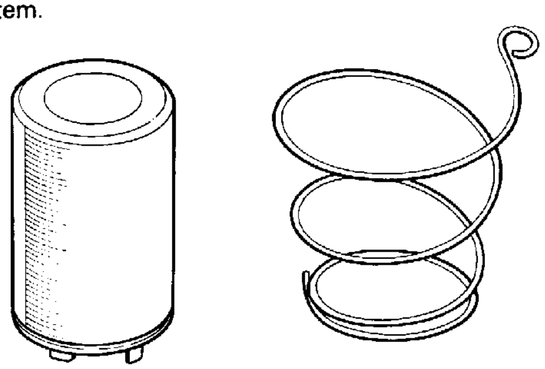


Fig. 34 Capacitor model 2MC and mounting spring

The capacitor requires no maintenance beyond an occasional check to ensure the connections are clean and tight.

NOTE: Ensure correct polarity is observed when connecting up the 2MC capacitor. The single $\frac{3}{16}$" (1·88 ins – 4·8 mm) Lucas blade is positive (+) and should be connected to earth.

When the capacitor is used in conjunction with a battery, occasionally check that the capacitor is operating by disconnecting the battery and starting the machine.

Ignition Warning Light

The ignition warning light only indicates that the ignition is "on". Consequently the light does not extinguish while the engine is running. However, on later machines the ignition and oil pressure warning lights are combined in a single unit. Therefore, the light will extinguish when the engine starts and runs.

If the light from the standard bulb is considered too brilliant and tends to dazzle the rider, the following are recommended for replacement purposes.

Motor cycle voltage	*Recommended Bulb*
6 volt	Part No. 281 (12 volt, 2 watt)
12 volt	Part No. 283 (24 volt, 2 watt)

Fig. 35 Warning light model WL15

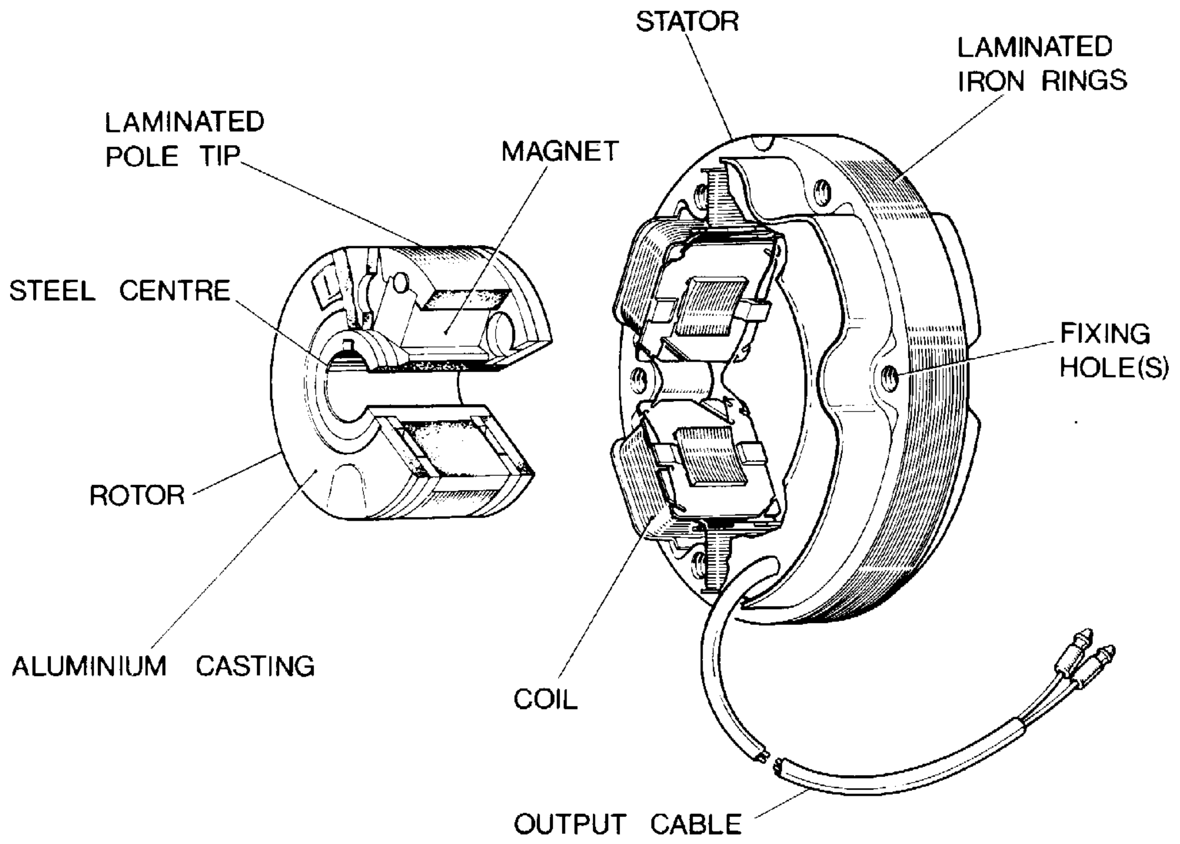


Fig. 36 Encapsulated R.M. series alternator

CHARGING EQUIPMENT

The Alternator

The Stator:

The stator consists of six coils mounted on circular six pole laminations. The assembly is encapsulated to protect the windings from damage by metallic swarf or vibration. There are two types of stators used:

1. The three lead stator, suitable for both six and twelve volt systems
2. The two lead type, which is similar in construction to the three lead version, except that it is internally connected for full output and is only suitable for twelve volt operation.

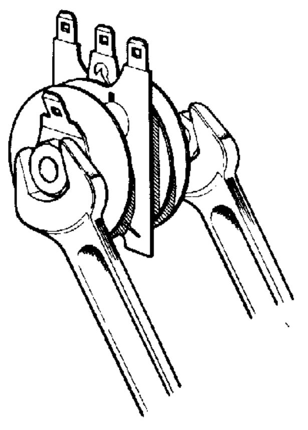


Fig. 37 Silicon diode rectifier

The Rotor:

The rotor has an hexagonal steel centre with a high energy magnet mounted on each face. Each magnet is keyed to a laminated pole tip and the complete assembly is cast in aluminium and machined to give a smooth external finish. The rotor is driven by an extension of the engine crankshaft, and revolves inside the stator. The alternator requires no maintenance beyond checking that the connectors are clean and tight.

The Rectifier

The rectifier consists of four semiconductor diodes connected in a bridge formation, each diode being mounted on its own heatsink. As the diodes get hot during operation, the rectifier must be mounted in a good airflow and kept clean and free from road dirt or corrosion. If the rectifier has to be removed for any purpose, two spanners should be employed, one for the head of the through bolt and the other for the securing nut.

NOTE: The nut clamping the plates together should not be disturbed, otherwise damage to the diode connections may occur.

The rectifier requires no regular maintenance beyond checking the connections are clean and tight, especially the earth connection through the mounting bolt.

Zener Diode

The Zener diode regulates the charge rate to the battery by diverting the excess charging current away from the battery, through the diode. During this process a large quantity of heat is produced. This would destroy the diode if it were not conducted away.

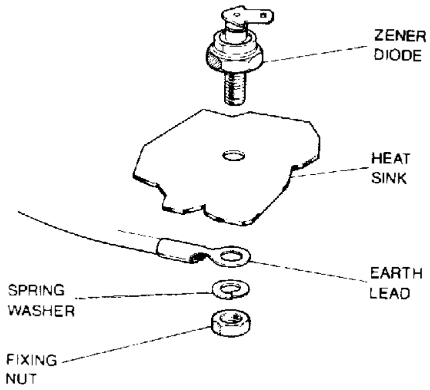


Fig. 38 Zener diode and heatsink

The diode is consequently mounted on a heatsink supplied by the manufacturer of the machine. To ensure efficient operation the diode base must make good metal-to-metal contact with the heatsink as dirt or corrosion under the diode, or a loose diode, would cause overheating and failure.

The Ammeter

The motor cycle ammeter is especially damped to steady the readings and has a scale of 12 – 0 – 12A. It is connected between the rectifier and the battery. The complete unit is factory sealed to prevent the entry of water and consequently requires no maintenance apart from occasionally checking that the connections are clean and tight.

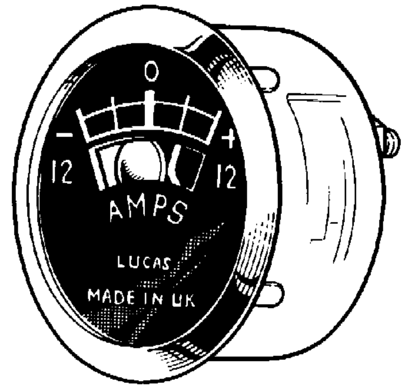


Fig. 39 Ammeter model 2AR

LIGHTING EQUIPMENT

Head and Parking Lights

Lucas motor cycle headlamps incorporate the Lucas light unit which consists of a combined reflector and front lens assembly. A "prefocus" bulb is used with this light unit ensuring that the filament is always correctly positioned in relation to the reflector. Certain headlamps fit into a nacelle type extension of the forks which forms a housing for the headlamp.

Setting the Headlamp

Set the headlamp so that the main or driving beam is projected straight ahead, parallel to the road surface, when the machine carries its normal load.

Many garages possess a Lucas Beamsetter. This is an instrument which enables the beam to be

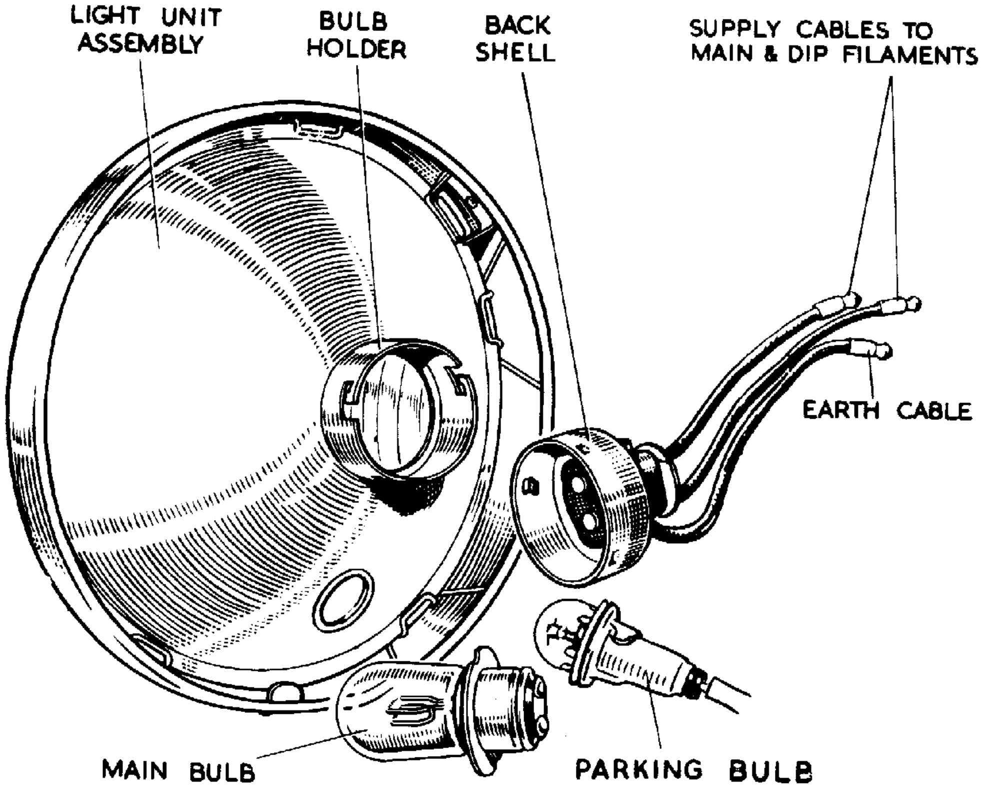


Fig. 40 Typical head and parking light assembly

set accurately. Motor cyclists are strongly advised to make use of this service.

If these facilities are not available, the headlamp may be set by marking off a smooth blank wall as shown in Fig. 41 and shining the lamp on it from a distance of 25 feet.

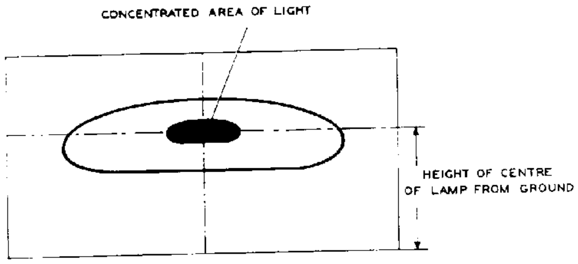


Fig. 41 Headlight adjustment

When setting the headlamp, the motor cycle must be:

(i) Square with the screen.

(ii) Carrying its normal load and standing on level ground.

(iii) At the recommended distance of 25 feet.

On machines where the headlamp is mounted in a nacelle or other special fitting, the instructions laid down by the manufacturer of the motor cycle should be followed.

Bulb Replacement

Slacken the rim retaining screw located at the top or bottom of the lamp body. (On model MCF headlamps the securing screw must be unscrewed completely to release the rim). It will then be possible to detach the rim and light unit complete. To gain access to the headlamp bulb, push the adaptor and twist it in an anti-clockwise direction. The bulb can now be removed from the reflector. Place the correct bulb in the light unit, engage the projections on the inside of the adaptor, press on and secure by turning clockwise. To replace the light in the headlamp, locate the assembly in the lamp body, press the front on and secure in position by tightening the securing screw.

To gain access to the parking light bulb, remove the front rim and light unit assembly and withdraw the parking light bulb holder which is a push fit in the reflector.

Rear Lamps

Motor cycle rear lights incorporate the number plate illumination. They require no regular maintenance but occasionally check that the snap connectors and bulb contacts make a good clean connection.

To replace the bulb, unfasten the screws retaining the lens and carefully remove the lens. The bulb is then removed by pushing inwards and rotating anti-clockwise. When replacing the lens, ensure that the lens body locates correctly with the rubber housing before the retaining screws are tightened. Otherwise, water will enter the lamp causing premature failure. Do not overtighten the retaining screws, or the lens may be cracked.

Flashing Direction Indicators

The flashing indicator set fitted to certain machines consists of four indicator lamps, a flasher unit, together with mounting spring, a warning light and operating switch. Some applications, particularly scooters, use a model 94SA switch incorporating a warning light. If the warning light does not operate, it indicates a fault in the system, for instance, the failure of one of the indicator bulb filaments.

If the system incorporates the later 8FL flasher unit and a signal light fails, the warning light will remain on but will not flash.

Checking a Faulty Operation

If a fault occurs in the system, the following procedure should be adopted:

(i) Check that the bulb filaments are not broken.

(ii) Check that all flasher circuit connections are clean and tight.

(iii) Switch on ignition and check with a voltmeter that the flasher terminal 'B' is at battery voltage.

(iv) Connect together flasher unit terminals 'B' and 'L' and operate the indicator switch. If the flasher lamps on the respective side now light without flashing, the flasher unit is faulty and should be replaced with the same type of unit as was originally fitted.

Replacement Bulbs

When a bulb needs replacement, check that the new bulb is the same wattage as the original. Avoid the use of non-branded bulbs as the filament is often so shaped that correct focusing is impossible; for example, the filament may be to one side of the axis of the bulb resulting in loss of range and efficiency.

LUCAS GENUINE REPLACEMENT BULBS are specially tested to ensure maximum life and efficiency. To assist in identification, Lucas bulbs are marked with a part number. When fitting a replacement, see that it has the same part number as the original bulb.

STARTING MOTOR

Model M3 Starting Motor

The model M3 pre-engaged starting motor is an earth return machine with series connected field coils. A lever operated drive assembly is carried on a straight splined extension of the armature shaft. The starter switch is mounted on the yoke and its contacts close when the drive is almost fully engaged, causing the starter to operate.

Maintenance

Ensure that the battery cable terminal on the starter is clean and tight. If the connection becomes dirty, clean the contacting surfaces and smear with petroleum jelly. No lubrication is necessary until the engine is due for major overhaul. The starting motor should then be examined by the local Lucas agent. Occasionally check the mounting bolts to ensure the starting motor is firmly fixed.

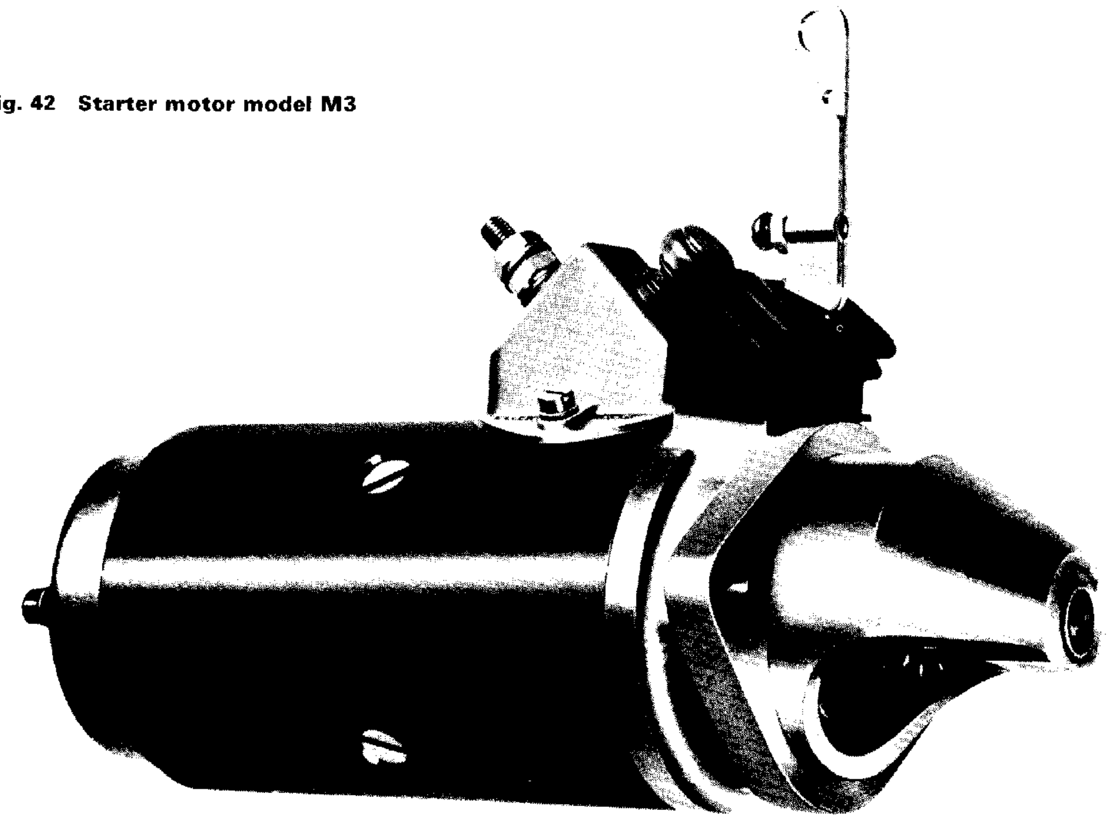
HORNS

Models 6H and 9H Horns

The above horns are pre-set during manufacture and in general no further adjustment is necessary.

If the horn becomes uncertain in its action, giving only a choking sound, or does not vibrate, the horn may not necessarily be faulty. The trouble could be due to a discharged battery, loose connection or

Fig. 42 Starter motor model M3



short-circuit in the wiring to the horn. In particular, ascertain that the horn push bracket is in good electrical contact with the handlebar. The performance of the horn may also be upset by its mounting bracket becoming loose.

Adjustment

The following adjustment will not alter the note of the horn. It will take up any wear on the moving parts, which if not corrected, would result in roughness and loss of performance.

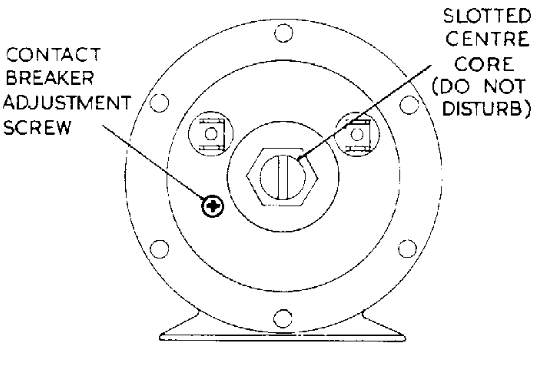


Fig. 43 Horn model 9H

Operate the horn push and slowly turn the adjustment screw anti-clockwise until the horn just fails to sound. Release the horn push and turn the adjustment screw clockwise one notch at a time until the original performance is restored. This usually entails a clockwise motion of one quarter to three-quarters of a turn. The centre locking nut must not be disturbed. If the original performance cannot be obtained do not attempt to dismantle the horn but return it to the local Lucas service centre for examination.

WIRING

Cable Harness

The cable harness requires no maintenance beyond checking that there are no signs of chafing along its length, especially around the steering head where the harness is continually flexing. The harness must not be stretched at any point and the terminals must be clean and tight.

Fused Battery Lead

On 12 volt motor cycles a fuse is fitted in an in-line fuse holder incorporated in one of the battery leads. If this fuse fails, it indicates a fault in the electrical system (such as a short-circuit). The cause of failure should therefore be ascertained before fitting a replacement fuse.

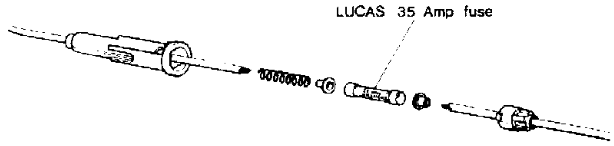


Fig. 44 Fused battery lead

The correct rating of the fuse is 35A. This rating must not be exceeded, neither must the fuse holder be by-passed to overcome fuse failure.

NOTE: When refitting the battery, ensure that the fused lead is not stretched to reach the battery terminal, as this may cause an open circuit at the fuse holder.

H.T. Cables

When the high tension cable shows signs of perishing or cracking it must be renewed with 7 mm p.v.c. or neoprene-covered cable, as detailed below.

Coil Ignition Models:

(i) Pull the defective cable from H.T. terminal.

(ii) Remove the metal terminal from the cable by opening the securing tags. Also, remove p.v.c. cover.

(iii) Fit the p.v.c. cover on the new cable then fit the metal clip.

(iv) Push the new cable firmly into the H.T. terminal moulding and ensure the p.v.c. cover fits tightly.

A.C. Ignition Models:

(i) Pull the defective cable from the H.T. terminal.

(ii) Before inserting the new cable, smear the outer casing with Bostik No. 1 (Clear) adhesive along the length of cable to be inside the coil housing.

(iii) Ensure that the coil H.T. terminal pin is located in the cable conductor and push the cable fully home.

General:

Some coil ignition machines are equipped with self-suppressed high tension cables to reduce radio and television interference. These cables are designed to suit each application individually and therefore, only the correct replacements should be fitted.

SWITCHES

Handlebar Switches Model

Two versions of the handlebar switch are used for right- and left-hand fitting. Each switch has different functions, although they outwardly appear similar. Both switches have one lever, two push buttons, and they are sometimes cast to form the pivot for the clutch and brake levers.

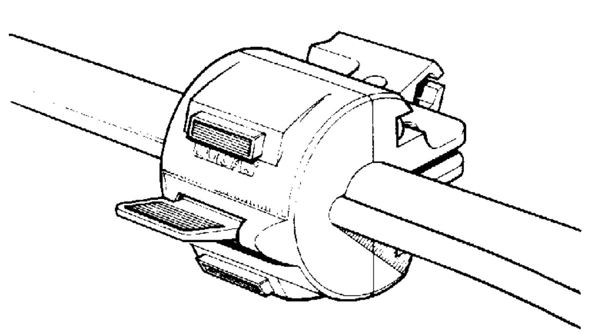


Fig. 45 Handlebar switch model 169SA

The left-hand switch controls headlight dipping on the lever, headlamp flash on the upper push button, and horn on the lower push button. The right-hand switch controls the direction indicators on the lever, the starter solenoid on the upper push button, and the ignition cut-out (or kill) on the lower push button.

Both switches are pre-wired and may have either female Lucar connectors or bullet snap connectors. The circuitry for these switches is shown in the typical wiring diagram for machines fitted with the electrical component box in Fig. 84.

Headlight Switch Model 57SA

This switch is used on the majority of 12 volt motor cycles. It is a toggle type switch, having three positions, "Off", "Parking" and "Headlight". The toggle lever action enables a rider to operate the switch easily with a gloved hand. The circuitry used with this switch is shown in the basic lighting circuit diagram Fig. 79.

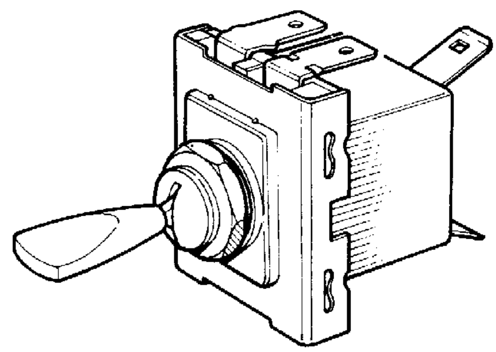


Fig. 46 Light switch model 57SA

Model 118SA Stop Lamp Switch

If the 118SA stop lamp is misaligned when the brake is adjusted, the excessive pressure from the operating mechanism will probably damage the fixing base of the switch. The following procedure should therefore be adopted after brake adjustment.

(i) Slacken the two bolts securing the switch.

(ii) With the brake in the fully off position (brake lever against front stop), insert a $\frac{1}{32}$" (0·793 mm) spacer between the contacting brake mechanism and the switch plunger. Adjust the switch position so that the plunger is fully depressed (see Fig. 47).

(iii) Lock fixing bolts in this position.

(iv) Remove spacer and check the switch is operating correctly.

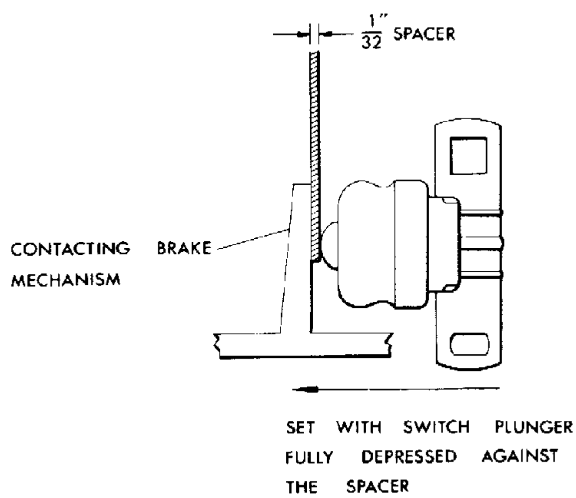


Fig. 47 Stop lamp switch model 118SA

Ignition/Lighting Switch

The model 149SA switch acts as the master switch for both the ignition and the lights. It is key operated and has four positions:

Position 1 Lights only: The key may be removed in this position enabling the machine to be parked safely at night.

Position 2 Off position: Again the key may be removed leaving everything isolated.

Position 3 Ignition only: The key cannot be removed. This position is used during normal daytime riding.

Position 4 Ignition and lights: Again, the key may not be removed. This position is used for all riding after dark.

THE ELECTRICAL COMPONENTS BOX

Certain motor cycles now incorporate the majority of the electrical components in a die-cast aluminium box. As the components are now close together the circuitry differs slightly from previous arrangements. The test procedure has been modified accordingly.

The following components are installed in the box.

1. The ignition capacitor.
2. The 8FL flasher unit.
3. The 2MC capacitor.
4. The ignition/lighting switch.
5. The Zener diode.
6. The rectifier.
7. A 9-pin plug and socket.
8. The ignition coil.
9. 2 reflex reflectors.

These parts are arranged as shown in Fig. 49.

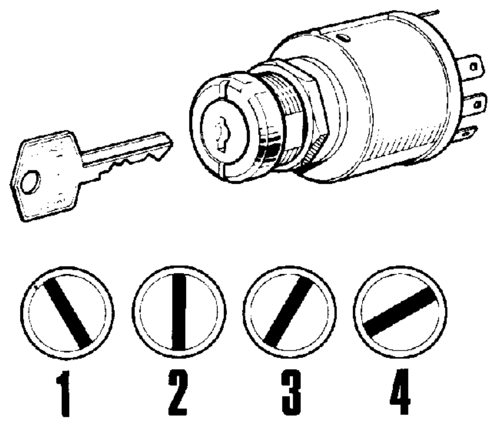


Fig. 48 Ignition/Light switch model 149SA

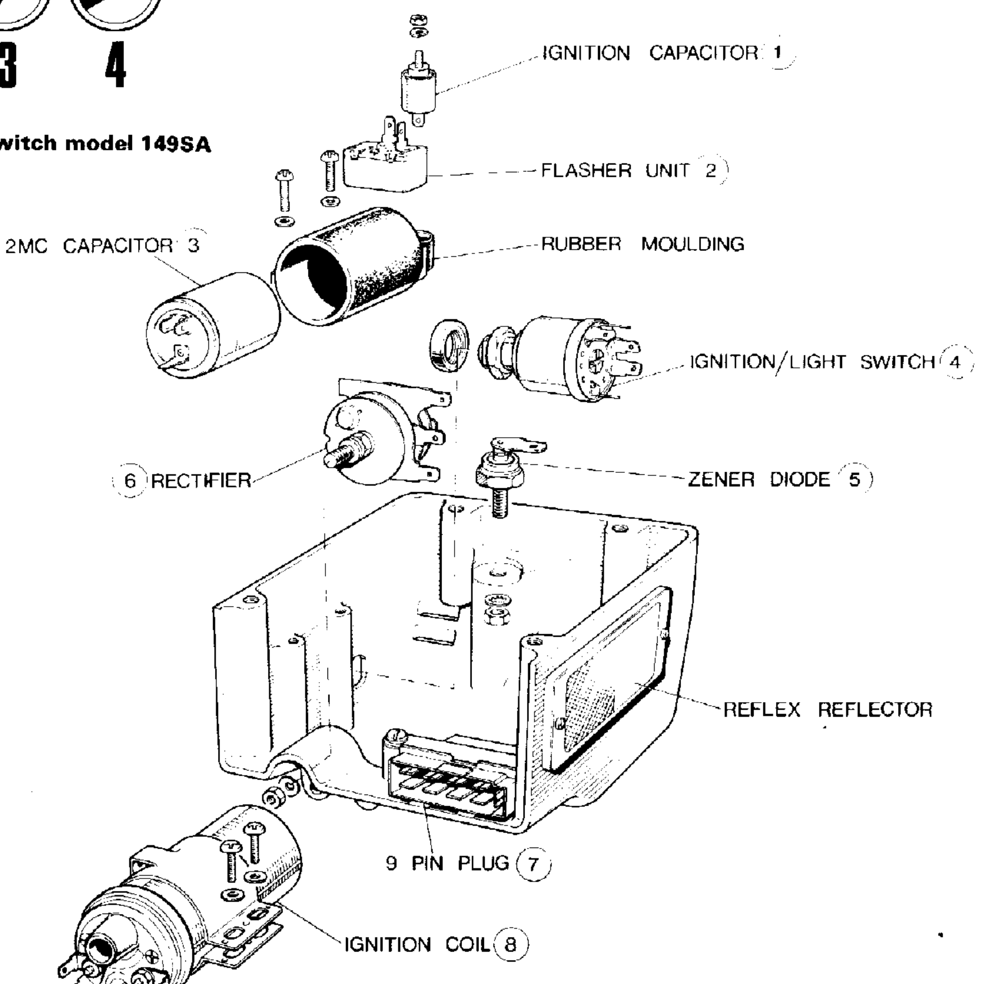


Fig. 49 Electrical component box

Converting 6 Volt Alternator Equipped Motor Cycles to 12 Volt

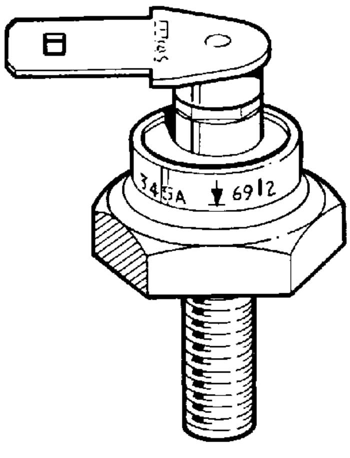


Fig. 50 Zener diode

Function of Zener Diode as a Charging Current Regulator

Fig. 51A shows how the diode is connected in the alternator circuit. It is in parallel with (or shunted across) the battery, and operates as follows:

When the battery is in a low state of charge, its terminal voltage will be low (and the same voltage is across the diode). The maximum charging current then flows into the battery from the alternator. At first current is not-passed by the diode, the latter being non-conductive due to the low battery terminal voltage. However, as the battery voltage rises, the system voltage also rises until, at approximately 14 volts, the Zener diode becomes partially conductive, and an alternative path is provided for a small part of the charging current. Small increases in battery voltage result in large increases in Zener conductivity until, at approximately 15 volts, about 5 amperes of the alternator output is by-passing the battery. The battery will receive only a portion of the alternator output while the system voltage is relatively high.

As the system voltage falls, due to the use of headlamp or other lighting equipment, the Zener diode current decreases and the balance is diverted and consumed by the component in use. If the electrical loading is sufficient to cause the system voltage to fall below approximately 14 volts, the Zener diode will become non-conductive and the full generated output will be used to meet the demands of the system.

To prevent overloading the Zener diode some form of switching is required. When the lighting switch is in the positions "Off" and "P", four coils of the stator are permanently connected across the rectifier for coil ignition circuits, and two coils for magneto circuits, Fig. 51B. In the "Head" position full alternator output is obtained by connecting all six coils across the rectifier.

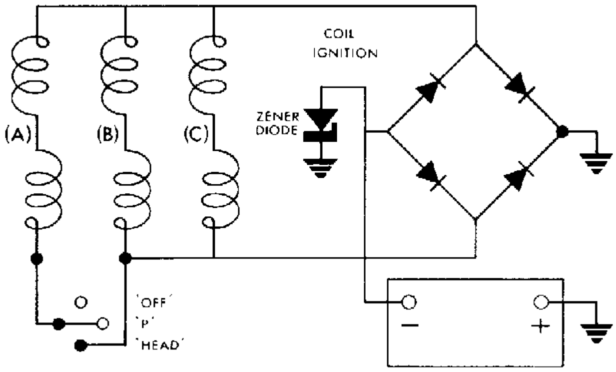


Fig. 51A Charging circuit showing Zener diode connection

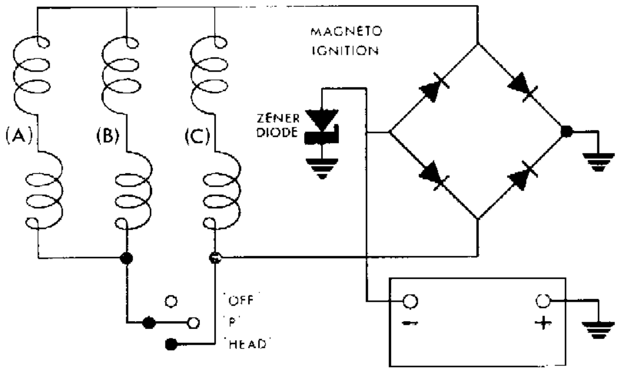


Fig. 51B Charging circuit for magneto equipped motor cycles

New Equipment Required

When converting a Lucas motor cycle alternator circuit from 6-volt to 12-volt the electrical units which must be considered are: battery, Zener diode and its associated heat sink, in-line fuse, rectifier, ignition coil, distributor (or contact breaker unit), horn, lighting equipment, and any extra electrical accessories that may be fitted. The original stator and rotor except energy transfer units, are retained in every application providing they are in good working condition. Each of these units is considered below.

Battery

Use the new 12-volt motor cycle battery type PUZ5A which is resistant to vibration and petrol. The special design features are a chamber venting system, with a one-piece manifold for easy topping up, and a transparent container allowing easy checks on acid levels.

Another method of obtaining a 12-volt supply is to connect another 6-volt battery in series with the existing battery. Providing the two batteries are of the same type and capacity, and the old one is in a charged and healthy condition, this arrangement will function satisfactorily. The battery capacity should be at least six or seven ampere-hours. Two batteries model MKZ9E, connected in series would give a 12-volt capacity of 8AH at the 10-hour rate. Two of these batteries occupy approximately the same space as one PUZ7E battery.

Two MLZ9E batteries having a capacity of 12 ampere-hours at the 10-hour rate, or one 12-volt

PUZ5A battery with a capacity of 8 ampere-hours at the 10-hour rate, could be used, depending on space available.

For sidecar use, one of the smaller car batteries such as model BHN5A/7/8 could be installed in the sidecar.

Battery Model	*Voltage per Unit*	*Ampere-Hour Capacity (10-Hour Rate)*
MKZ9E	6	8
MLZ9E	6	13
PUZ5A	12	10
BHN5/7A-8.85	12	22

Zener Diode and Heat Sink

A stud-mounted Zener diode, Part Number 49345, will be required. The diode must be mounted on a heat sink to prevent its working temperatures from rising above the designed operating range. The heat sink must be made of copper or aluminium sheet approximately $\frac{3}{8}$" (3·2 mm) thick, have a minimum area of 25 square inches, and be as square as space limitations permit. In practice, it is found that an area of 6" (152 mm) x $4\frac{1}{4}$" (108 mm), (as shown in Fig. 52), can most readily be accommodated. The diode must be mounted as near to the centre of the heat sink as possible. Care must be taken to see that the metal of the heat sink is clean, free from enamel and flat around the diode fixing hole to ensure maximum heat conduction from the diode.

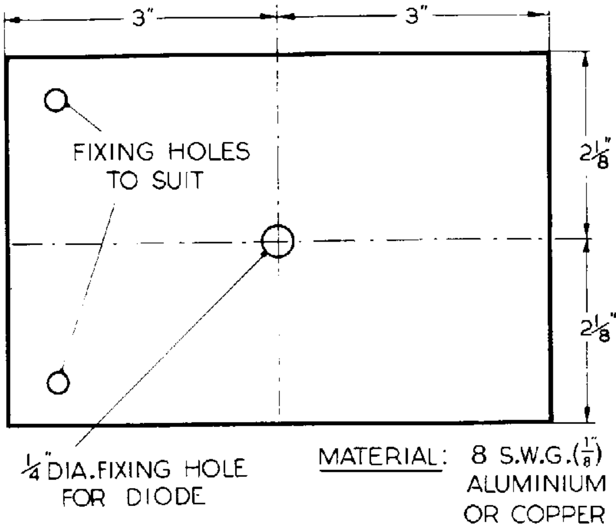


Fig. 52 Suitable heat sink dimensions

Fused Earth Lead

Available under Part Number 54938986 and connected between the positive terminal of battery and earth as shown in Fig. 53. Replacement 35A fuses are available (Part Number 188218).

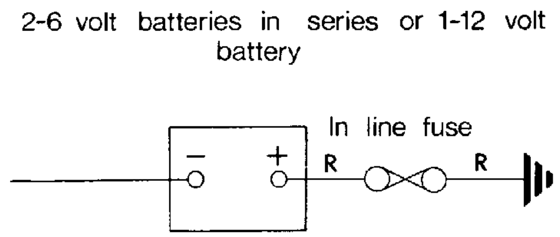


Fig. 53 In-line fuse position

Rectifier

Several types of rectifier have been used on alternator equipped machines but only the latest design, Part Number 49072, is suitable for the conversion. This is a silicon diode bridge unit, which functions in either 6 or 12-volt circuits. IF THE EXISTING RECTIFIER IS A SQUARE SELENIUM UNIT, OR ONE OF THE EARLIER TYPES, IT SHOULD BE REPLACED BY PART NUMBER 49072.

Ignition Coil(s)

The existing ignition coils will be 6-volt units. These must be replaced by the equivalent 12-volt unit.

Replace model MA6 with 17M12, Part Number 45223.

Distributor and Contact Breaker

The capacitor fitted in the model 18D1 and 18D2 distributor is unsuitable for 12-volt operation. It must therefore be removed and a new capacitor, Part Number 54441582, fitted externally.

All other original capacitors are suitable.

Horn

Several 12-volt horns are available, including the more powerful high frequency model 6H, and the car type horn, model 9H, which can be used either singly, or as a matched pair (high and low note). A relay will be required if horns are fitted. This limits the current passing across the horn button contacts.

Horn model 6H:	Part No. 70183
Horn model 9H, Low Note:	Part No. 54068087
Horn model 9H, High Note:	Part No. 54068086
Relay model 6RA:	Part No. 33188 (for use with twin horns).

Headlamp

On machines fitted with 7-inch dip left light units (Marked "RIGHT-HAND DRIVE"), replace the bulb with Lucas No. 414, 12-volt 50/40 watt.

On machines fitted with dip right headlamps (Marked "LEFT-HAND DRIVE"), replace the bulb with Lucas No. 415, 12-volt 50/40 watt.

On machines fitted with 7-inch vertical dip light units (Marked "MOTOR CYCLE"), replace the bulb with Lucas No. 446 12-volt 50/40 watt.

The total driving lamp(s) loading should be between 50 and 75 watts.

On machines fitted with $5\frac{3}{4}$-inch vertical dip lights (Marked "MOTOR CYCLE LIGHTWEIGHT"), replace the bulb with Lucas No. 446, 12-volt 50/40 watt.

Replace parking light bulb with No. 989 12-volt 6 watt.

12-volt speedometer bulbs are obtainable from Smiths Motor Accessories Ltd.

Stop-Tail Lamp

If the bulb holder is designed to accept non-reversible bulbs, use No. 380, 12-volt 6/21 watt (with off-set pins). If the bulb holder accepts reversible bulbs, fit bulb No. 381, 12-volt 6/21 watt. (Ensure the bulb is inserted the correct way round).

Sidecar Lamp

For the Lucas sidecar lamp model 569, use bulb No. 989, 12-volt 6 watt.

Electrical Accessories

The manufacturer of any electrical accessories fitted to your machine should be consulted about their suitability for 12-volt operation before connecting them to the converted circuit.

In the case of lamps, it will be necessary to fit a suitable 12-volt bulb.

Installing the New Equipment

With the exception of the battery and the Zener diode, the new equipment will replace existing units and fitting should present no difficulty.

Battery

The most difficult problem will probably be how to accommodate an extra battery on the motor cycle. Unfortunately, as each machine requires a different approach, it is not possible to make comprehensive recommendations. However, the following suggestions may be helpful:

If machines are equipped with the black "Milam" cased PUZ7E battery, two MKZ9E batteries (these occupy approximately the same space as the PUZ7E) can usually be accommodated. Where a plastic cased MLZ9E battery is in use, an additional MLZ9E battery may be fitted alongside the original or in some adjacent position.

NOTE: The earlier versions of some machines now equipped with MLZ9E batteries were originally fitted with PUZ7E batteries. In these instances, the original PUZ7E battery carrier may be obtained through your motor cycle dealer.

The batteries could also be mounted in the boot of a sidecar or in a suitably modified pannier.

Ensure that batteries are fixed firmly, as insecure mounting will cause failure due to vibration. If the two batteries are mounted side by side, a thin sheet of rubber should be placed between them (see Fig. 54) to prevent chafing.

Zener Diode

The diode and its heat sink must be mounted so that a good air stream passes over both sides of the plate to ensure efficient cooling. At the same time its location must be such that the diode will remain reasonably dry and clean.

On many machines these requirements will be met by mounting the heat sink underneath the front of the petrol tank, on the tank mounting bracket. Efficient operation of the diode depends upon the existence of a good earth connection. A separate cable link between the heat sink and the frame of the machine is, therefore, recommended.

CAUTION: The body of the Zener diode is made of copper to ensure maximum heat conductivity. This means that the fixing stud has a relatively low tensile strength, and must be subjected to a tightening torque within the limits of 24–28 lb.f.-ins. (2·72–3·16 Nm).

Connecting-Up

The new units must now be connected into the circuit. (All additional cable used in the conversion should be 28/·012" or equivalent, unless otherwise stated).

Battery

The two batteries should be connected in series by means of a short link wire which must join the +ve terminal of one battery to the —ve terminal of the other, as shown in Fig. 54.

The remaining +ve terminal should be connected to the Red fused earth wire, and the —ve terminal to the Brown/Blue wire to the ammeter or lighting switch.

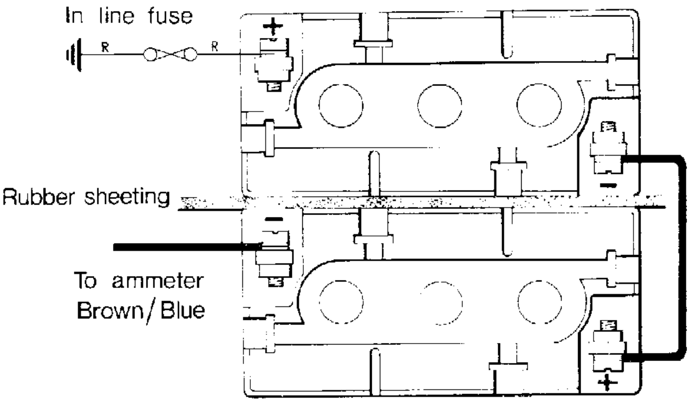


Fig. 54 Two 6 volt batteries connected for 12 volt operation

Zener Diode

The connection from the Lucar terminal of the diode should be made to a point along the Brown/White, Brown/Purple, Purple or Brown/Blue cable from the rectifier centre terminal.

NOTE: The method of fitting Lucar connectors to cables is shown stage-by-stage in Fig. 63.

Rectifier (When applicable)

The terminals of the silicon bridge rectifier have the same arrangement as the earlier selenium types, the connections should therefore be as shown in Fig. 55.

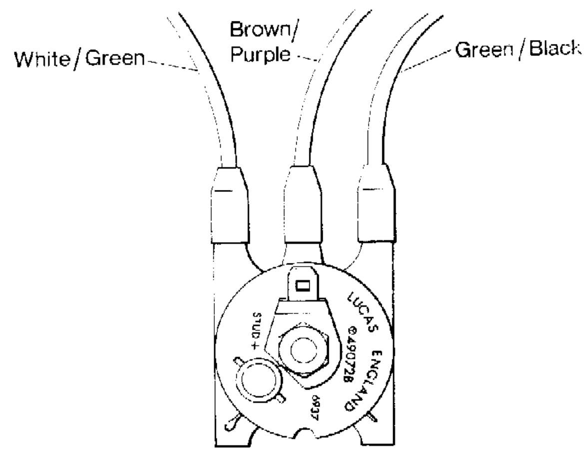


Fig. 55 Rectifier connections

If the original circuit includes a White/Green (Green/White or Light Green) cable connecting a rectifier terminal to the lighting switch, this must be disconnected at the switch and taped up.

When fitting the rectifier to the machine remember the earth connection should be made to the Lucar on the bolt head.

Ignition Coil

The terminal arrangement of the replacement coil is identical to the original coil. The White cable should be connected to the "SW" or "—ve" terminal, and the Black/White cable to the "CB" or "+ve" terminal.

Capacitor (When applicable)

Connect the capacitor either to the L.T. terminal of the contact breaker unit (or distributor), or to the ignition coil terminal "CB" (or "+"). The body of the capacitor must be in good electrical contact with earth.

Horn

Connect in the same manner as the original, or as directed in the fitting instructions supplied with the new horn(s).

Replacing 8H Horn with 6H Type

Generally the 8H horn can be replaced with the larger 6H type, but where the 6H will not fit into the same position, an additional mounting bracket may be required. These should be obtained from the motor cycle manufacturer concerned or their agents.

To extend the horn leads, the two Lucar terminals should be removed from the leads and replaced with single snap connectors and nipples (Part Nos. 900288 and 900269) using 14" ·010" cable for the extension, refitting or replacing the Lucar terminals and sleeves (Part Nos. 54942078 and 54190042), for connecting to the horn.

Alternator

With coil ignition machines four of the six alternator coils should be permanently connected across the rectifier and the remaining two coils brought into circuit when the headlamp is switched on. As shown in Fig. 56 two of the three alternator-to-wiring-harness connections (Green/Yellow and Green/Black) are transposed at the snap connectors.

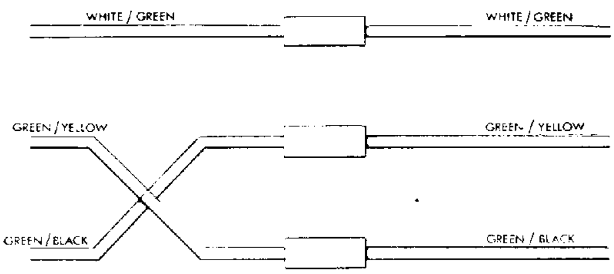


Fig. 56 Alternator connections for coil ignition motor cycles

NOTE: In two-colour cables, the first named is the main colour and the second the tracer. The colours at present used have been chosen for their permanency (they do not discolour with age and normal service). For reference, the four transistional colour coding schemes used with 3-lead motor cycle alternators are given below:

1	2
Light Green	Light Green
Mid Green	Green-with-Yellow
Dark Green	Dark Green
3	**4**
Green-with-White	White-with-Green
Green-with-Yellow	Green-with-Yellow
Green-with-Black	Green-with-Black

With magneto equipped machines there is no ignition coil load so the output from four alternator coils would be too high for the diode to control. Thus only two of the alternator coils are permanently connected across the rectifier, and the remaining four coils are brought into circuit by the lighting switch. This is done by connecting the alternator output cables colour to colour, as shown in Fig. 57.

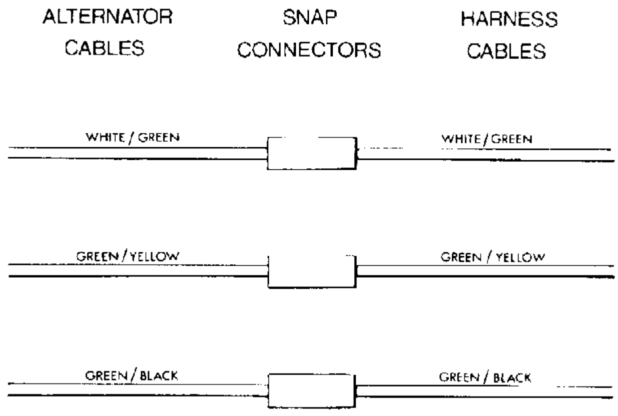


Fig. 57 Alternator connections for magneto ignition motor cycles

CONVERSION TO CAPACITOR IGNITION

Object of the System

The object of this system is to enable a motor cycle to be run, with or without a battery, enabling the rider to use the machine for competition work, and then re-fit the battery for normal road use.

Starting and lighting are equally effective with or without the battery, but additional accessories or parking lights cannot be used if the battery has been disconnected.

How the System Works

The capacitor stores the energy pulses from the alternator and supplies the ignition coil with sufficient energy to ensure adequate plug sparking for starting and running at all speeds throughout the engine operating range.

New Equipment Required

In the case of motor cycles already fitted with Lucas 12-volt systems, it is only necessary to purchase the 2MC capacitor complete with mounting spring.

Earlier machines wired to give partial generator output in "Off" and "Pilot" positions will not have heat sinks of sufficient size. These must, therefore, be replaced. Minimum dimensions of the heat sink are given below.

Energy transfer equipped machines, however, will further require a battery charging alternator stator, wiring harness, lighting and ignition switches, and contact breaker unit.

CAUTION: The minimum size for the Zener diode heat sink, when used with the 2MC capacitor system is 6 in. x 6 in. x $\frac{1}{8}$ in., aluminium or copper plate (or an alternative shape of equivalent total surface area, i.e. 72 square ins.). The Zener diode should be centrally mounted, flat on its base, **which must make direct metal-to-metal** contact with the plate. The assembly should be mounted on the machine so that it is in an unobstructed air stream, avoiding as far as possible, dirt or water thrown up by the road wheels.

Mounting the Capacitor

Two types of springs are available for mounting the capacitor, one for fixing underneath a vertically positioned bolt, the other for a horizontal fixing point. Whickever spring is used the capacitor **must** be positioned with its terminals pointing downwards, as in Fig. 58.

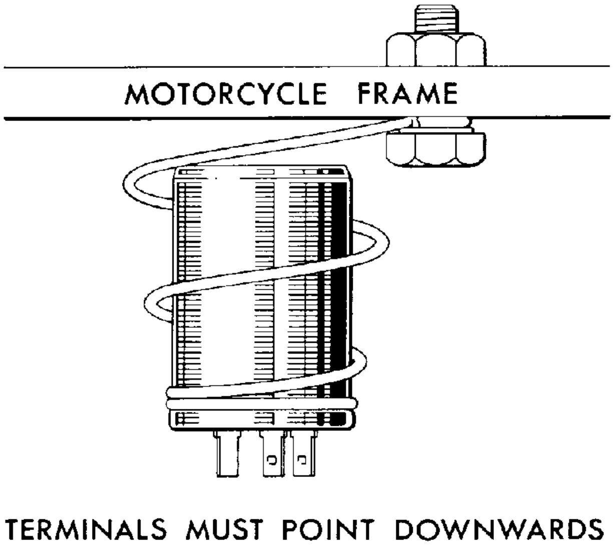


Fig. 58 Capacitor mounting

To fit the spring to the capacitor, insert the capacitor into the widest coil end and push it down until the small coil at the other end locates in the groove on the capacitor body.

Wiring Connections

CAUTION: The 2MC is an electrolytic **polarised** unit which may be irreparably damaged if incorrectly connected.

It will be seen that there are two sizes of Lucar connector on the unit. The small $\frac{3}{16}$ inch Lucar is the **positive** (earth) terminal, the rivet of which is marked with a spot of **red** paint. The double $\frac{1}{4}$ inch Lucar forms the **negative** terminal.

The capacitor negative terminal **and** Zener diode must be connected to the rectifier centre (D.C.) terminal or to a convenient point on the Brown/White lead. (This would be the Brown/Purple, Brown/Blue or Purple lead on some models). **They must not be connected to the ignition coil.**

Modifying Alternator Cable Connections

The alternator should be reconnected to give full output in all lighting switch positions. This can be done by joining the alternator external leads Green/Black and Green/Yellow using a double snap-connector, Part No. 850641.

Running with Battery Disconnected

Before running the machine with the battery disconnected THE BATTERY NEGATIVE LEAD MUST BE INSULATED to prevent it from shorting to earth (touching frame of machine).

Do not run the machine with the Zener diode disconnected as excessive voltage will damage the 2MC capacitor.

Periodic Check for Faulty Capacitor

A faulty capacitor may not be apparent when used while the battery is connected in circuit. Periodically check that the unit is serviceable by disconnecting the battery and starting the machine in the normal manner.

CLIPPER DIODE

A common fault experienced with machines equipped with Direct Lighting is the blowing of bulbs. This may be due to faulty dipper switches, causing momentary voltage surges, bad connections or intermittent earths. Whichever is the cause, the Clipper diode effectively protects bulbs against excessive voltage, but of course will not prevent failure caused by vibration, filament fractures or faulty bulb manufacture. The Clipper diode is available under Part No. 83137.

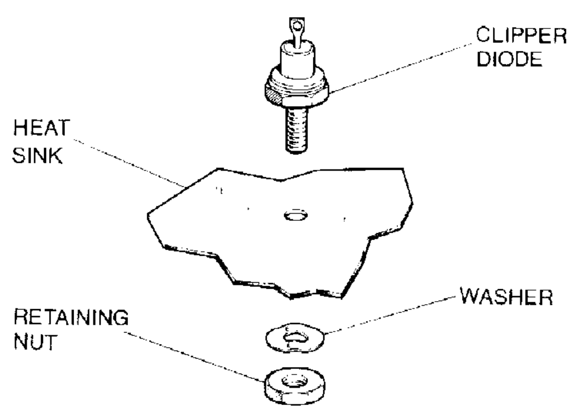


Fig. 59 Clipper diode mounting

Installation

The diode is wired into the circuit so that when the lights are switched on, the generator also supplies the diode. This can be achieved by connecting either into the tail-lamp feed or the wire supplying the dipper switch. If no dipper switch is used, the connection could be made directly to the headlamp bulb feed. (Fig. 60).

Either an aluminium or copper plate not less than 16 gauge in thickness and measuring 2 in. x 3 in. (50 x 76 mm) is required. Mount the diode on the plate by drilling a $\frac{3}{16}$ (0·1875) in. (4·77 mm) hole approximately in the centre of the plate, ensuring that all burrs are removed from round the edges of the hole so that the base of the diode bears flat on the plate.

Mount the plate on the machine in a convenient position so that air circulates around the diode and plate when the motor cycle is in motion. Do not position the unit too close to the ground or wheels since salt-contaminated mud and water may corrode the diode body. Ensure that the diode is properly earthed to the machine.

Operation

While the generator is below the safe maximum value for the bulbs, the diode does not absorb any of the output, so there is no loss of light. This is of prime importance when travelling at low speeds.

When the voltage has increased to the safe maximum value, the diode begins to absorb part of the output, and prevents further increase in voltage. Thus, the bulb load can be adjusted to give the best possible light output at all speeds without having to overload the generator, to keep down the voltage.

Limitations

The diode is normally recommended for use with generators whose rated output does not exceed 21 watts. If the diode is for use on higher output machines, the size of the mounting plate (heat sink) should be increased as follows:

Output	*Heat Sink*
25 watts 30 watts	3 in. x 3 in. 3 in. x 4 in.

The diode should not be used on generators having an output greater than 30 watts. Maximum working temperature, measured at the side of the diode, must not exceed 115°C.

WARNING: As the mounting stud is made of copper, care must be taken not to overtighten when bolting to the mounting plate.

TWIN HORNS

High speed motor cycles require a more effective warning system. The Lucas twin horns meet this requirement and as they are used intermittently they have no adverse effect on the electrical system. Twin horns are available for 6 or 12 volt operation. Model 9H horns together with the required relay are available from the local Lucas Agent or Service Centre and must be connected as shown in Fig. 61.

ANTI-THEFT SWITCH FOR COIL IGNITION MOTOR CYCLES

One of the most usual methods of thief-proofing a machine has been the use of a concealed switch which isolates the lighting and ignition circuits. By using model 45SA switch, Part No. 31923, not only are the ignition/lighting circuits isolated as before but, in addition, the horn is sounded when there is any attempt to start the motor cycle.

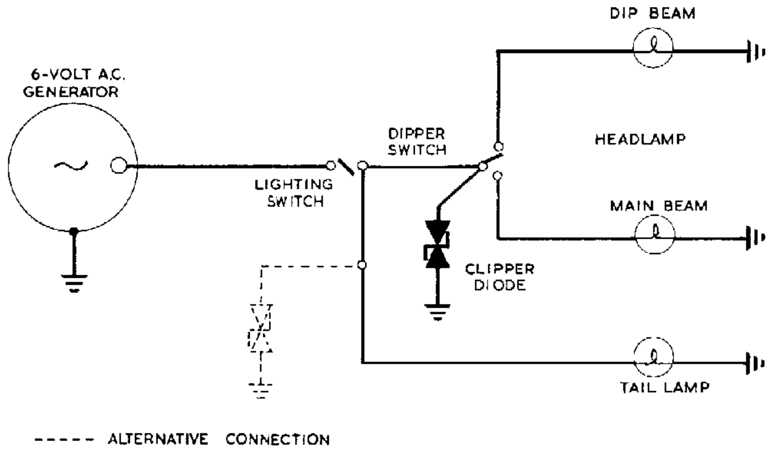


Fig. 60 Clipper diode connections

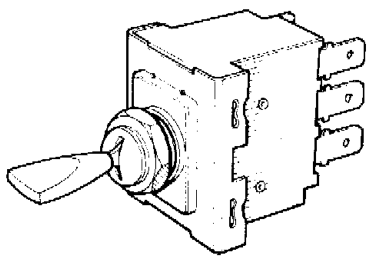


Fig. 62 Anti-theft switch

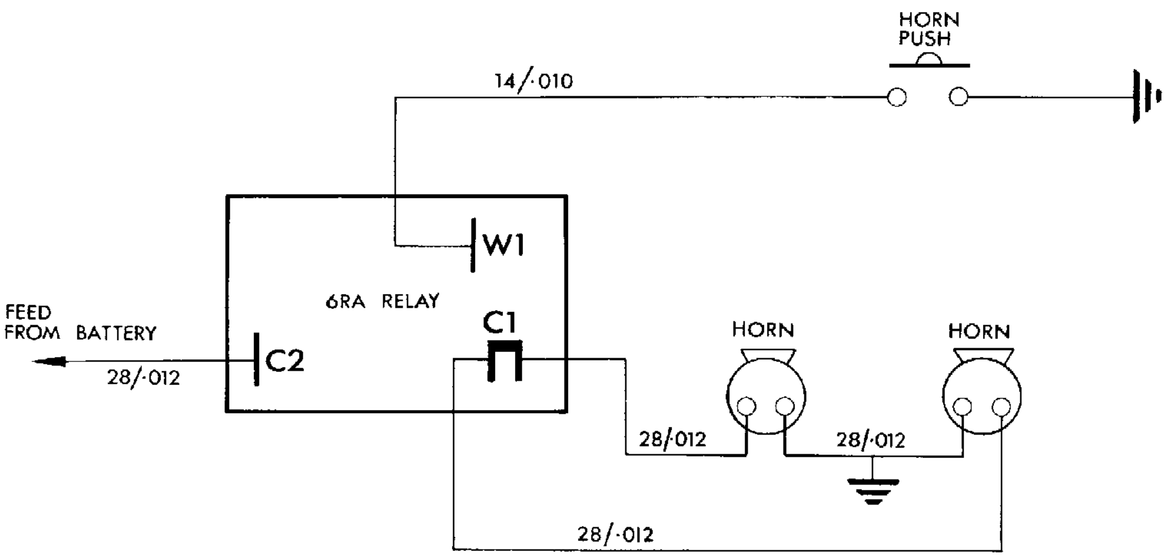


Fig. 61 Twin horn circuit

To fit the 45SA switch the connection between the positive (+) terminal of the battery and earth must be disconnected. The positive (+) terminal is connected to the No. 2 terminal of the 45SA switch, using 28/·012 cable. The No. 1 terminal is then connected to earth using the same type of cable. Disconnect the horn feed cable from the horn, and tape up. (If two cables are connected to the horn feed cable, these must be connected together before taping).

Make up another length of 14/·010 cable to connect the feed terminal of the horn to the No. 5 terminal of the 45SA switch. (It may be necessary to extend this cable). A double snap connector is fitted in the horn-to-horn push cable and an additional cable inserted from here to the No. 3 terminal of the 45SA switch. The feed from the ignition switch to the SW terminal on the coil is disconnected at the coil and reconnected to the No. 5 terminal of the 45SA switch along with the feed cable to the horn. Finally, No. 4 terminal is connected to the SW terminal of the coil. (Fig. 85 page 51).

With the switch in the normal position, the electrical system behaves normally. However, when the switch is in the "on" position, any attempt to start or short-circuit the ignition switch will cause the horn to operate.

FITTING A LUCAR CONNECTOR

It is essential that the Lucar connector is fitted in accordance with the following instructions to ensure the efficient operation of the associated equipment.

STAGE 1
Thread the insulating cover over the cable

STAGE 2
Strip the insulation neatly from the conductor

STAGE 3
Feed conductors through the aperture and grip the cable firmly in the tags

STAGE 4
Splay conductors back towards the cable and spread flat

STAGE 5
Solder securely and neatly to the connector. Do not allow solder to run through the aperture

STAGE 6
Allow the joint to cool. Slide the cover over the connector

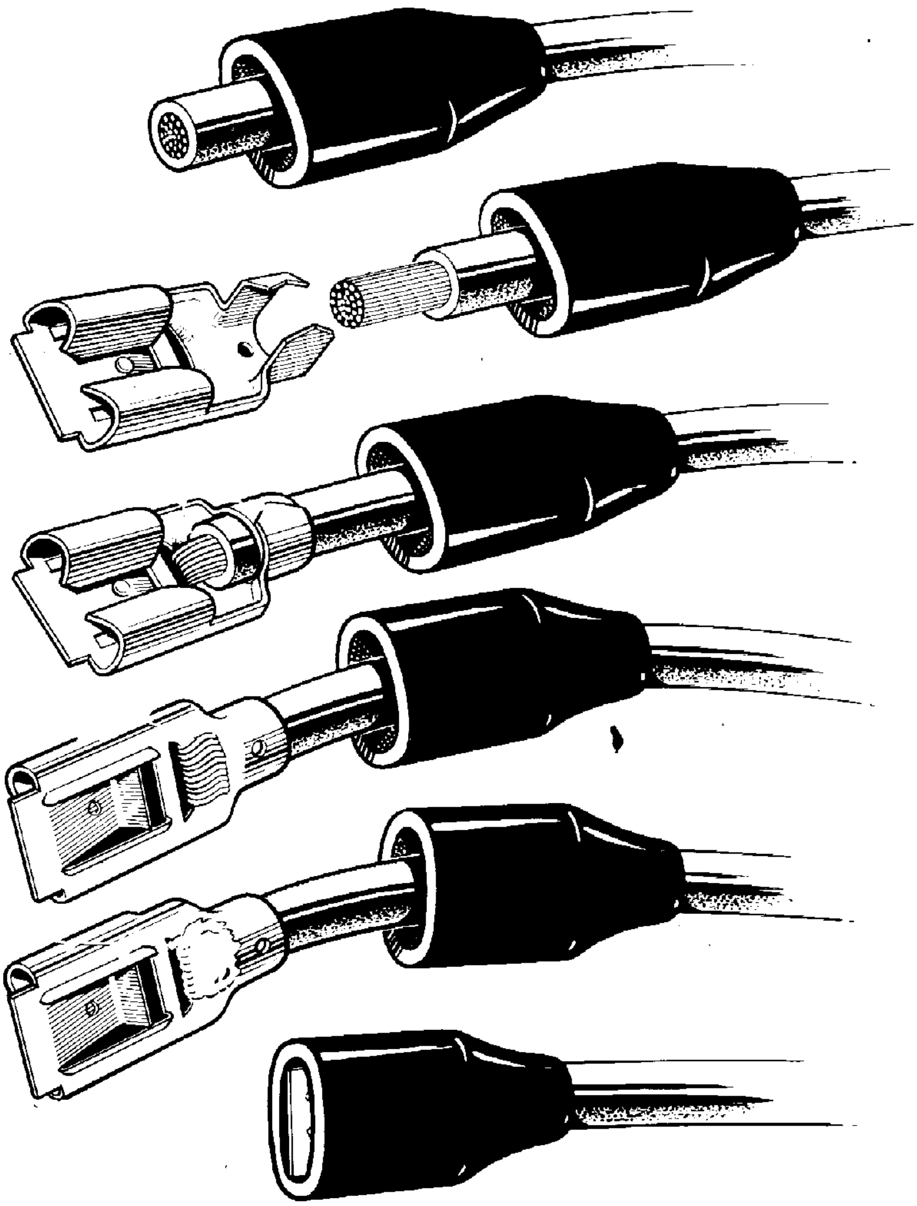


Fig. 63 Fitting instructions for Lucar connectors

TEST PROCEDURE

In order to carry out systematic checking of the electrical circuitry the following test equipment is required.

(i) A.C. moving coil voltmeter scale 0–15 V
(ii) D.C. moving coil voltmeter scale 0–18 V
(iii) D.C. moving coil ammeter scale 5·0–25 A
(iv) Load resistor of 1 ohm capable of carrying 15 A
(v) Load resistor of 0·5 ohm capable of carrying 24 A
(vi) Length of cable having a small crocodile type clip at each end.

The "Wilkson" test box (Fig. 64) contains all the above units in a metal case which is compact and easy to use.

In addition a suitable hydrometer, scale 1·000–1·300 will be required.

NOTE: Certain motor cycles are now fitted with an electrical component box and special instructions are marked with (*). Otherwise normal instructions apply.

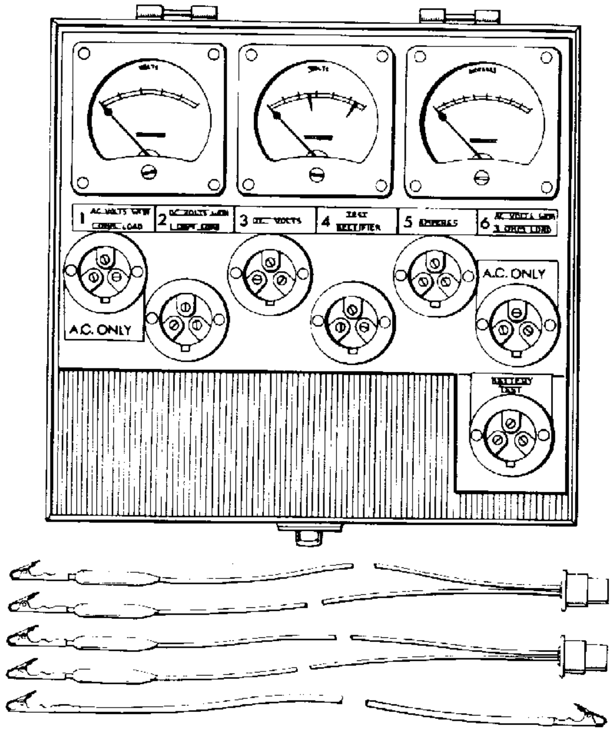


Fig. 64 Wilkson test box

Test I. Battery

Where possible a hydrometer test should be taken and the table below indicates the readings obtained with given battery conditions. The figures quoted are accurate at 15°C (60°F) and the results must be corrected to this figure. This is done by adding 0·007 to the reading for every 10°C (18°F) above 15°C (60°F), and subtracting for every 10°C (18°F) below. A variation of 0·040 between the readings obtained from each cell indicates a faulty battery, which should be checked by a Lucas battery agent.

(b) **High Rate Discharge**

As a battery ages its capacity is reduced. This may be due to the formation of heavy sulphate or the shedding of the active material from the plates. The high discharge test should be carried out after the battery has been recharged to at least 70% Connect.

	Specific Gravity (corrected to 15°C (60°F))	
	Climates normally Below 25°C (77°F)	*Climates normally Above 25°C (77°F)*
Fully charged	1·270 – 1·290	1·210 – 1·230
70% charged	1·230 – 1·250	1·170 – 1·190
Discharged	1·110 – 1·130	1·050 – 1·070

the D.C. voltmeter and one ohm load across the battery, as shown in Fig. 65, and keep in position for 15 seconds. The table below gives the minimum voltage for a healthy battery. Directly after 15 seconds the reading should remain steady, as a falling or low voltage indicates that the battery is faulty and must be taken to the local Lucas battery agent for examination.

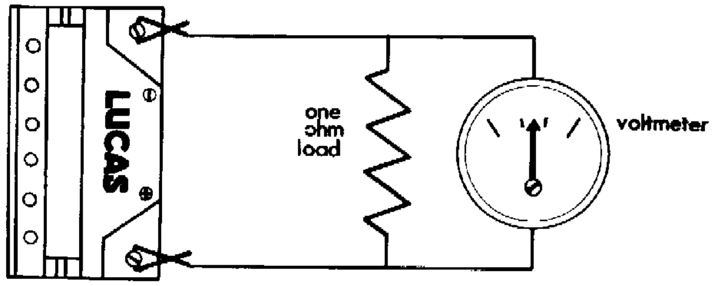


Fig. 65 High rate discharge test

Battery Voltage	*Voltmeter Reading*
12	9·4
6	4·8

Test II. Charging Circuit

(a) **D.C. Input to the Battery**

Disconnect the battery negative terminal and connect the ammeter between the battery post and the cable terminal (Fig. 66). If a Zener diode is fitted, it must be disconnected and the lead insulated to obtain full output from the alternator.

***Special Instructions for the Electrical Components Box**

The Zener diode is disconnected by removing the straight Lucar connector with a Brown/Blue cable from the 2MC capacitor.

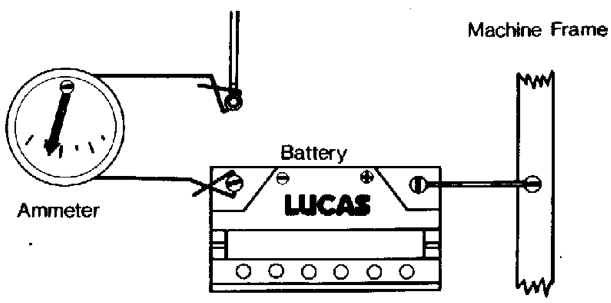


Fig. 66 Maximum charge rate test

Start the engine and increase speed to approximately 3,000 rev/min and note the ammeter readings. The following readings are obtained when the battery and charging system are in good condition.

Lighting switch position	*Minimum Current Reading*	
	Three-lead stator	*Two-lead stator*
Off	2·5 amp	4·5 amp
Headlamp Main beam	1·0 amp	1·0 amp

The readings may be higher provided there are no signs of over charging. If the readings are lower, a possible fault is indicated.

(b) Connections

On 6-volt and early 12-volt machines the cable connections to and from the lighting switch must be clean and tight. Check the alternator, rectifier, and battery terminals before proceeding with (c).

(c) Alternator Output

Disconnect the alternator output leads at the snap connectors and connect an A.C. voltmeter with a 1 ohm load resistor in parallel (Fig. 67). If the results are as shown in the following table the alternator is in good condition.

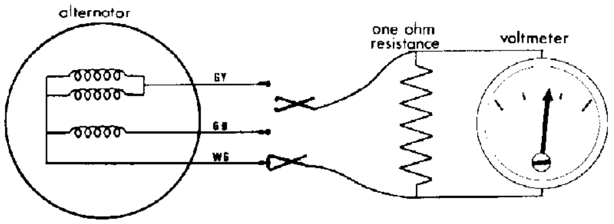


Fig. 67 Alternator output test

Voltmeter and Resistor between		*Minimum Voltage Readings*		
		Three-lead stators		*Two-lead stators*
		RM20	*Others*	*RM21*
White/Green	Green/Black with Green/Yellow	10	8·5	—
White/Green	Green/Yellow	—	—	9
Any one lead and stator (earth)		No reading		

Faults	
Voltmeter Reading	*Diagnosis*
All readings low	Demagnetised rotor. Return to Lucas agent for remagnetising
Low reading on one connection	Faulty coil
Zero reading	Open-circuit

NOTE: There should be no reading between any output lead and earth. A reading would indicate a breakdown of the insulation, and the stator should be replaced.

Test III. The Rectifier

Reconnect the alternator leads to the main harness. Disconnect the cable from the centre terminal of the rectifier and connect the D.C. voltmeter with the 1 ohm load as shown in Fig. 68. Start the engine and increase speed to approximately 3,000 rev/min. Turn the light switch to the headlamp position and take a reading from the voltmeter. This should read not less than 7·5 volts, which indicates the rectifier is operating satisfactorily. A lower reading indicates that the rectifier is faulty. This can be confirmed by checking each diode individually.

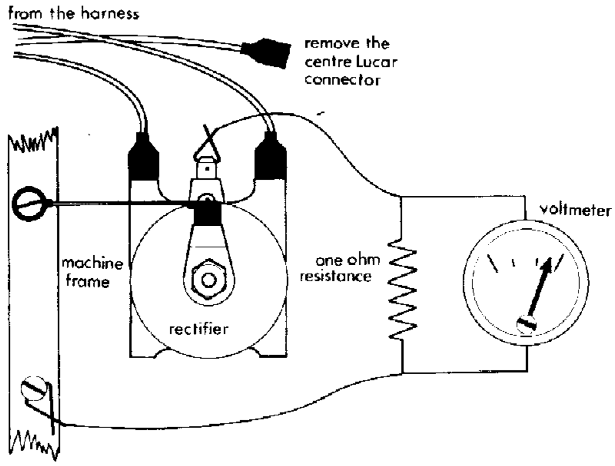


Fig. 68 Rectifier test in position

To check individual diodes a battery and a headlamp bulb are used. Remove the rectifier from the machine and connect the bulb and battery as shown in Fig. 69A. Then reverse the connections. If the bulb lights in one direction only the diode is satisfactory. If the bulb lights in both directions the diode is short-circuit. If the bulb will not light in either direction the diode is open-circuit. The test should then be repeated in the other three positions (Fig. 69B).

If any diode is faulty, the rectifier must be replaced.

NOTE: The silicon diode rectifier is interchangeable with the selenium type and should be tested in the same manner.

*Special Instructions for the Electrical Components Box

As the connections are not easily reached, the following method must be used:

(i) Disconnect the Zener diode as in Test II and reconnect the alternator cables into the main harness.

(ii) Disconnect the snap connector junction for the Brown/Blue cable at the box.

(iii) Connect a D.C. voltmeter (with the 1 ohm load in parallel) with the Red lead to earth and the Black lead to the Brown/Blue cable from the box.

(iv) Locate the White/Yellow cable in the other snap connector junction from the box, and using a jumper lead connect the cable from the box to the negative (—) terminal of the battery.

(v) Start the motor cycle and run at approximately 3,000 rev/min. A reading of 7·5 volts should be obtained, otherwise proceed with the rectifier bench test.

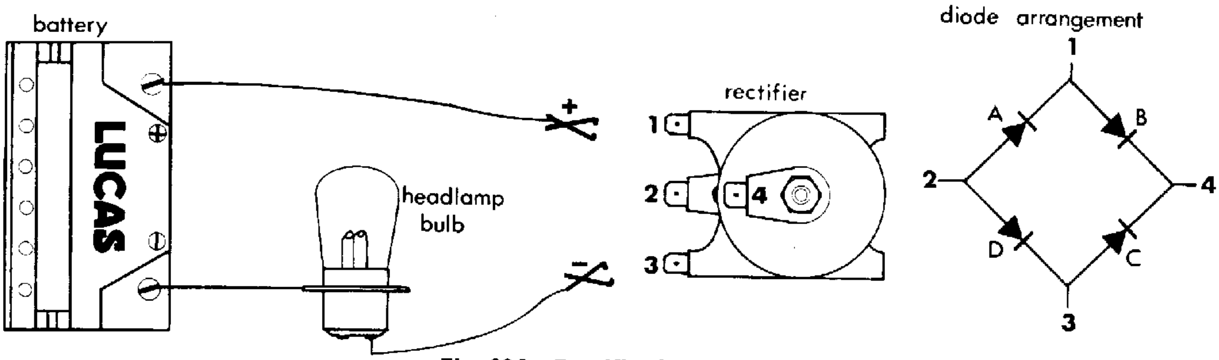


Fig. 69A Rectifier bench test

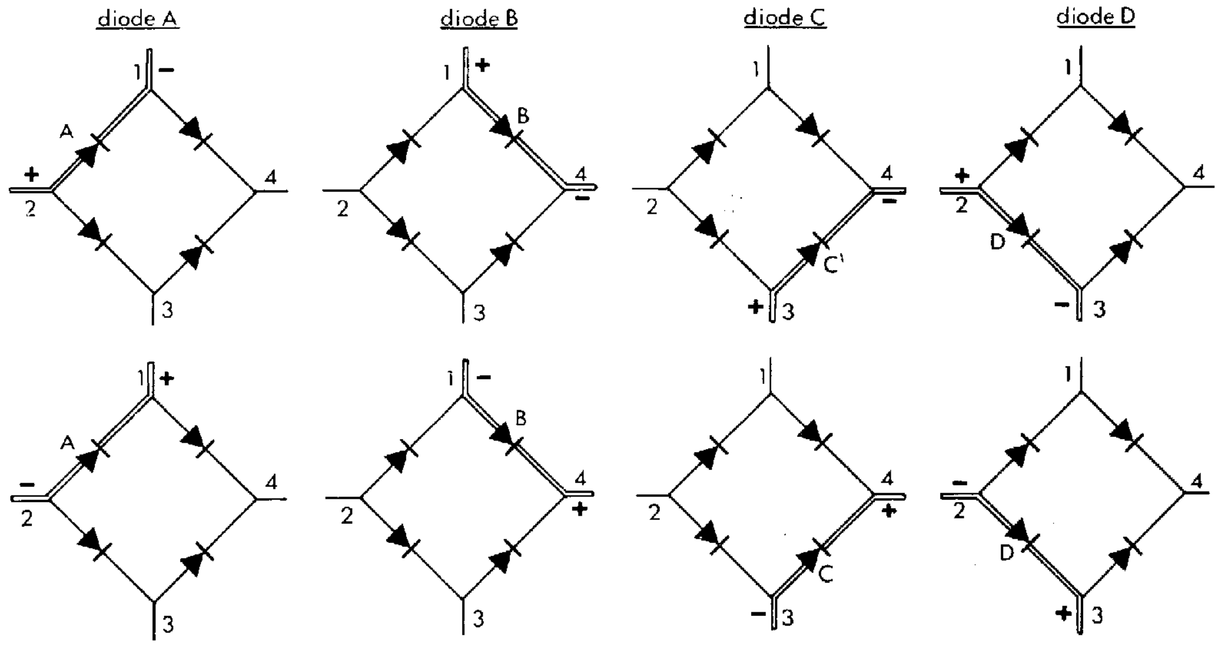


Fig. 69B Rectifier bench test (individual diode circuits)

Test IV. The Zener Diode

Replace the rectifier and connect correctly. Ensure the battery is fully charged before starting the motor cycle. Pull the cable off the Zener diode and connect the D.C. ammeter Red (+) lead to the Zener diode terminal and the Black (—) lead to the cable disconnected from the Zener diode. Connect the D.C. voltmeter without the 1 ohm load, with the Red lead to earth and the Black lead to the Zener Lucar blade, as shown in Fig. 70. Check that the electrical load except the ignition is switched off, increase speed to approximately 3,000 rev/min and note the readings. As the system voltage rises to approximately 12·75 volts, there should be no reading on the ammeter.

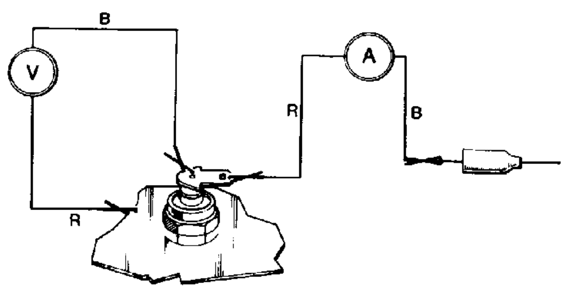


Fig. 70 Zener diode test

Above approximately 12·75 volts a reading should start on the ammeter. When the ammeter rises to 2 amps, the voltmeter should read between 13·5 and 15·5 volts. If the readings do not come within this specification the diode must be replaced.

NOTE: When refitting a Zener diode, the contact between the diode and the heat sink must be clean and free from corrosion. Also the retaining nut must not be tightened beyond 24–28 lbs.f.ins. (2·72–3·16 Nm).

*Special Instructions for the Electrical Components Box

Disconnect the Zener diode as in Test II, connect a D.C. voltmeter Black lead to the straight Lucar with the Brown/Blue cable (at 2MC capacitor) and the Red lead to earth. Connect a D.C. ammeter Black lead to the straight Lucar with the Brown/Blue cable and the Red lead to the right-angle Lucar with a Brown/Blue cable. Otherwise the test follows the normal procedure.

Test V. Ignition

Connect the D.C. voltmeter, without the 1 ohm load, with the Black lead to the 'CB' or '+' terminal of the coil and the Red lead to earth (Fig. 71). Turn the engine until the contacts open. When the ignition is switched on, the voltmeter should read battery volts. No reading indicates either an open-circuit ignition switch, cable, coil primary winding or a short-circuit across the contacts. This can be confirmed by disconnecting the coil/contact breaker lead at the coil. If battery voltage is then indicated the fault is due to either the contacts or the wiring from the coil to the contacts. Failure of this sort is very often caused by incorrect assembly of the contact breaker insulating washers.

Turn the engine until the contacts close. The voltmeter should then read zero. Any reading indicates the contacts are burnt or dirty and should be cleaned or stoned flat.

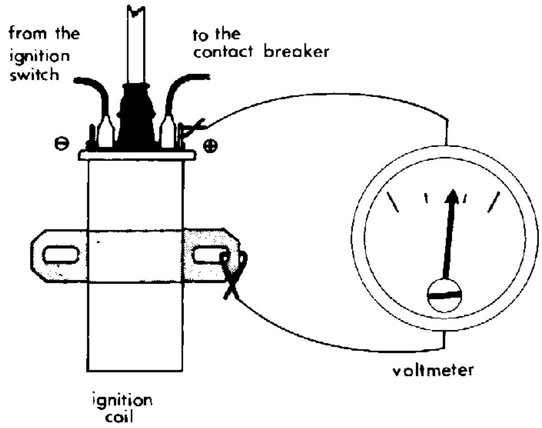


Fig. 71 Coil and contact breaker circuit test

Connect the voltmeter with the Red lead to earth and the Black lead to the 'SW' or '—' terminal of the coil (Fig. 72). Ensure the contacts are closed and switch on the 'ign' switch. Observe the voltmeter reading. Then quickly transfer the Black lead to the battery '—' terminal and again observe the reading. The difference between the two readings should not exceed 0·5 volts. Readings in excess of this indicate a high resistance in the ignition feed circuit, i.e. faulty ignition switch, cut-out button or wiring.

Test VI. 2MC Capacitor

The operation of the 2MC capacitor should be checked at normal service intervals. Disconnect and insulate the battery negative terminal. Start the engine and switch on the full lighting complement. A faulty capacitor will result in difficult starting. Remove the capacitor from the machine and connect to a 12-volt battery.

IMPORTANT: Correct polarity must be observed. Ensure the small single Lucar blade is connected to the positive (+) terminal and the larger double blade to the negative (—) terminal. After 5 seconds disconnect the battery and allow the capacitor to stand for 5 minutes. Connect the voltmeter across the terminals. An initial reading of not less than 9 volts should be obtained. (Some voltmeters may show an instantaneous overswing. This should be ignored). If an initial reading of less than 9 volts is obtained, the capacitor is leaking and should be replaced.

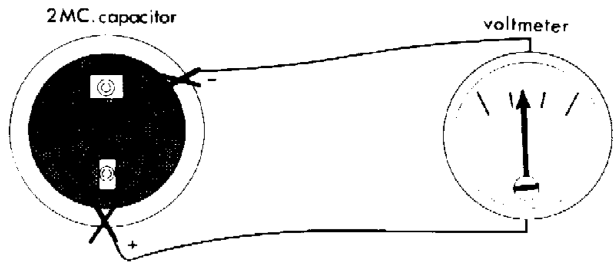


Fig. 73 Capacitor bench test

Test VII. Emergency Start Circuit (6-Volt Applications)

Ignition timing must be accurately set to the manufacturer's recommendations after checking the contact gap and alternator output.

Ensure all leads are connected correctly. Connect the D.C. voltmeter, without the 1 ohm load, with the Red lead to earth and the Black lead to the contact breaker coil terminal. Turn the engine until the points open. Then switch on the ignition switch and check the voltmeter readings. The following readings should be obtained.

Transfer the voltmeter Black lead to the Green/Yellow harness lead at the alternator connector when the ignition switch is on the emergency position, the voltmeter should register battery volts.

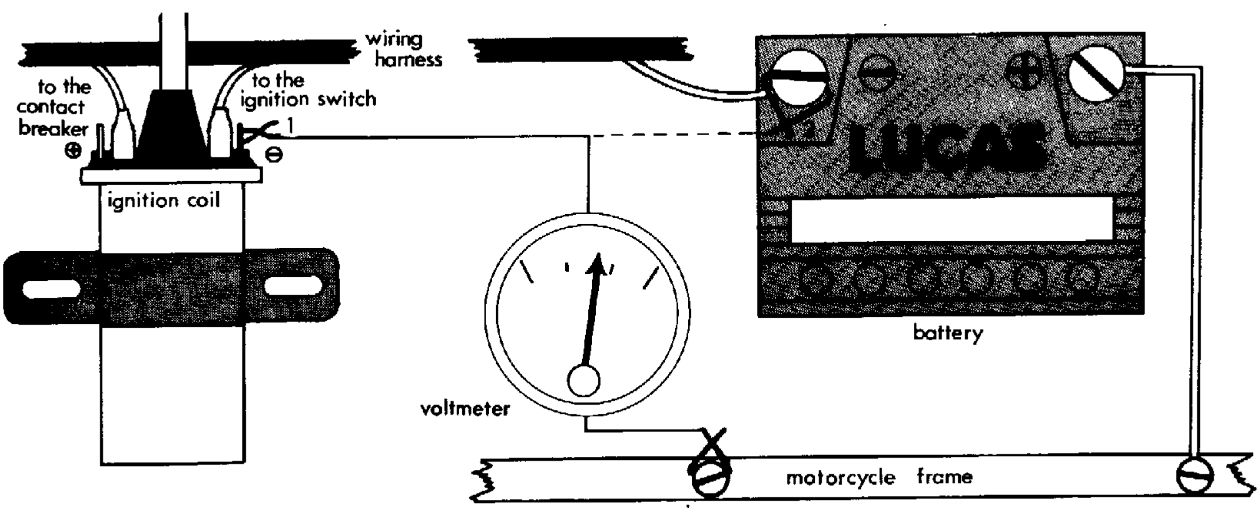


Fig. 72 Ignition feed circuit check

Test VIII. Energy Transfer (A.C.) Ignition – Direct Lighting

NOTE: Tests which necessitate running the engine, can only be performed if the ignition system is operating correctly, i.e. ignition timing, contacts and plug gap settings etc., are in accordance with the manufacturer's recommendations.

If the alternator timing and plugs etc., are satisfactory and the E.T. ignition coil is suspect, but a replacement is not immediately available, the following procedure will enable further tests to be carried out.

To enable the motor cycle to be started a substitute ignition system is used. This comprises of a 6-volt battery and a standard type motor cycle ignition coil. Connect as follows:

(1) Positive battery lead to frame of machine (earth).
(2) Negative battery lead to substitute ignition coil ('SW' or '—').
(3) Connect ignition coil ('CB' or '+') to contact-breaker on machine, removing the existing lead from contact-breaker.

(A) **Alternator**

(i) Disconnect all alternator cables from main harness – Red, Brown/Blue, Black, White (and Brown when fitted).
(ii) Run engine at fast idling speed.
(iii) Connect A.C. voltmeter (with 1 ohm resistor in parallel) across coils as follows:

Connect Voltmeter between	*Voltmeter Reading (minimum)*
Red and Brown/Blue	5·0 volts
Black/Yellow and Black/White	1·5 volts
Red and Brown (when fitted)	3·5 volts
Any lead and stator (earth)	No reading

CONCLUSIONS:

If all readings are low it indicates that the rotor is demagnetised.

A low reading across any coil (when the remainder are satisfactory) indicates a short-circuited coil.

A zero reading indicates open-circuited coil(s).

A reading between any lead and stator indicates earthed coil(s).

(B) **The E.T. Ignition Coil**

There is no method of checking the output of the coil in situ. When a coil is suspect, it should first be checked by substitution, and then bench-tested.

Test Equipment Required

A four-cylinder car-type contact-breaker (distributor) is required, having closed periods of not less than 42° and an operating range of up to 750 rev/min. Also, a 12-volt battery, a three-point rotary spark gap and a 1 ohm resistor (approximately 15 watt).

Test Procedure

(a) Connect the 12-volt battery, contact-breaker and 1·0 ohm resistor in series with the primary winding of the ignition coil. Connect the negative side of the battery to the earthed end of the primary winding, as shown in Fig. 74.
(b) Connect the spark gap electrode which is farthest from the ionising electrode, to the negative side of the circuit, by means of a jumper lead.
(c) Connect the H.T. lead from the ignition coil to the three-point spark gap, at the main electrode nearest to the ionising electrode.
(d) Run the contact-breaker at 750 rev/min. Regular sparking should occur between the main electrodes when set to 8 mm (approximately 14kV). Do not continue this test for more than 30 seconds because there will be considerable arcing at the contact-breaker points due to slow running and the low resistance of the primary winding.

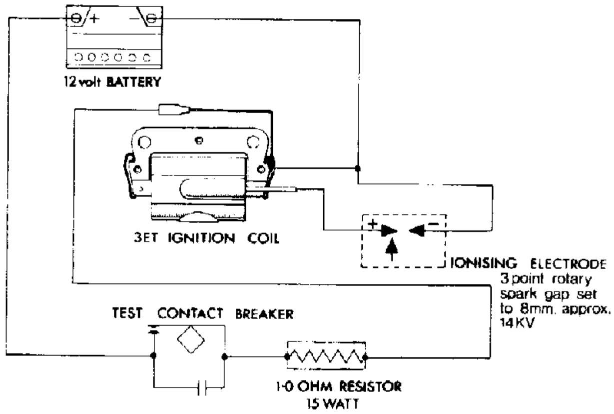


Fig. 74 Model 3 E.T. ignition coil bench test

Test Conclusions

If there is intermittent sparking or no sparking, replace the coil.

Ignition Coil Bench Test

A standard model 23D6 distributor (or a model 25D6 distributor fitted with a model 23D contact breaker plate assembly) is used to make and break the primary circuit of the coil under test. A contact set with a spring tension of 28–32 oz., Part Number 544 135 68, must be fitted in place of the standard unit. The closed period (dwell angle) is modified to 38°–40° by adjusting the contact gap. The capacitor should be 0·18–0·25 microfarads.

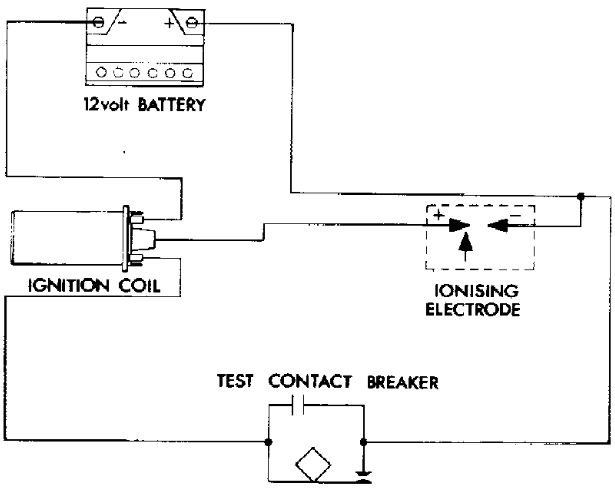


Fig. 75 Ignition coil bench test circuit

The three-point test gap should be connected so that the auxiliary electrode is adjacent to the H.T. electrode. The auxiliary electrode causes the gap to break down at a lower voltage with more consistent sparking. It is therefore essential that the coil test circuit is wired correctly and that the correct battery terminal is earthed.

Coil Position

While under test the coil should be mounted at an angle of 45° with the 'CB' (+) terminal uppermost. The coil case must be earthed during the test.

Saddle Screw Torque

All coils except MA6, MA12, 17M6 and 17M12	10–14 lbf.in. (1·13–1·58 Nm)
MA6 and MA12	5–7 lbf.in. (0·56–0·79 Nm)
17M6 and 17M12	8–12 lbf.in. (0·90–1·36 Nm)

Insulation Resistance

Between either L.T. terminal and the coil case, the insulation resistance should be at least 20 megohms at 500V.

Low Speed Test (Stationary Gap)

For this test a three-point gap is adjusted to the appropriate setting. Run the distributor at 100 rev/min.

It is not possible to specify a gap at which no missing at low speeds will occur, since contact breaker conditions are not sufficiently consistent at these speeds. The test specification calls for not more than 5% missing. This may be regarded as not more than 30 misses in one minute.

This test should be carried out with the coil cold, at 20°C (68°F).

High Speed Test

(a) **Setting Rotary Gap** (Fig. 2)

Set the gap between the H.T. electrode and the earth electrode of the rotary gap to approximately 4·75 mm.

Start the rotary gap.

Connect an LA12 ignition coil to a 6-volt supply of the correct polarity, and the test contact breaker (Fig. 75).

Set a peak voltmeter to negative position then connect it between the H.T. terminal and the earth terminal of the battery.

Increase the speed of the contact breaker unit until the rotary gap is just sparking irregularly.

Reset earth electrode if necessary until voltage is 8kV and the rotary gap is just sparking irregularly.

THIS SETTING IS MOST IMPORTANT.

(b) **Test**

Remove the peak voltmeter from the circuit.

Replace the calibration coil with the coil to be tested.

Ensure the supply voltage, earth polarity and contact breaker speed are as quoted in the table below.

If irregular sparking occurs on the rotary gap the coil is faulty.

TEST CIRCUIT

The standard test circuit, Fig. 75, is suitable for all coils marked '+' and '—' and positive earth coils marked 'CB' and 'SW'. The following results should be obtained:

Model	*Primary Resistance (ohms) 20°C*	*Low Speed Test Gap (mm)*	*(ins)*	*High Speed Test (rev/min)*	*Supply Voltage (min)*	*(max)*
LA6	1·0 – 1·1	11	0·44	2750	6·0	6·5
LA12	3·0 – 3·4	10	0·40	3000	12·0	12·5
*MA3	0·6 – 0·7	7·5	0·30	2500	6·0	6·5
MA6	1·8 – 2·1	8	0·32	2250	6·0	6·5
MA12	3·0 – 3·4	9	0·35	3000	12·0	12·5
17M6	1·7 – 1·9	8	0·32	2250	6·0	6·5
17M12	3·3 – 3·8	9	0·35	3000	12·0	12·5

* The MA3 coil is tested with a 0·5 ohm ballast resistor in series.

LOCATION AND REMEDY OF FAULTS

Although every precaution is taken to ensure trouble-free running, electrical faults may sometimes arise and the following test procedure is recommended.

When checking the continuity of circuits, a flash-lamp battery and bulb should be used. Do not "flash" the end of a live cable to earth, as this may cause heavy currents which damage the equipment. If a vehicle battery is to be used, a low wattage bulb of similar voltage must be connected in series with the circuit to be checked. Never check the continuity of alternator stator windings when the rotor is in position. The rotor should be removed to avoid demagnetisation and reduced output.

If, after carrying out the following checks, the owner cannot trace the cause of trouble, he is advised to contact the local Lucas agent or service centre.

Battery Charging Systems

Engine will not start on IGN position:

(i) Turn the switch to EMG position if provided. If the engine now starts, the battery is probably discharged.
If there is no EMG position, check the condition of the battery and recharge, if necessary.

(ii) Remove the H.T. cable from the sparking plug and hold the cable end about ⅛" from a metal part of the engine while the latter is turned over. If sparks occur regularly, the ignition system is functioning correctly. Check for engine defects after examining the sparking plug.

(iii) If sparks do not occur in test (ii), check for a fault in the low tension circuit. Check the wiring from battery to fuse, switch, coil and contact breaker. If the circuit is continuous, examine the contact breaker and if necessary clean and adjust the contacts. Also, check the engine timing.

Engine will not start on EMG position:

Carry out previous tests (ii) and (iii), check that the alternator rotor is the correct way round on the engine shaft (the name "Lucas" should face away from the engine).

Engine misfires:

(i) Examine the contact breaker. If necessary, clean the contacts and adjust the gap.

(ii) Remove the sparking plug (or each plug in turn), rest it on the cylinder head and observe if a spark occurs at the plug points when the engine is turned. Irregular sparking may be due to dirty plugs (which may be cleaned and adjusted) or to defective high tension cables. If the insulation of any cable shows signs of deterioration or cracking it should be renewed.

(iii) If sparking is regular at each plug when tested as described in (ii), the trouble is probably due to engine defects, and the carburetter, petrol supply, etc., must be examined.

(iv) If misfiring occurs after the engine has been running for some time, check that the ignition switch is in the normal IGN position. If run continuously in the EMG position, the rising voltage of the battery may eventually cause misfiring to occur.

A.C. Ignition

Important:

1. Keep the contact breaker clean and ensure the maximum opening is set at 0·014"–0·016".
2. Keep the sparking plug electrodes clean and correctly set.
3. Keep to the manufacturer's timing instructions.

Engine will not start or misfires:

(i) Remove the H.T. cable from the sparking plug and hold the cable end about ⅛" (3 mm) from the cylinder block. Sparks should jump this gap regularly when the engine is turned at kick-start speed.

(ii) If sparks are obtained, check the sparking plug, reset and clean, or renew as necessary.

(iii) If no sparks are obtained, inspect the H.T. cable and renew, as necessary. Check contact breaker gap setting.

(iv) If the sparking plug, H.T. cable and contact breaker gap setting are satisfactory, check for engine defects, faulty fuel supply, etc.

Charging Equipment

Battery in low state of charge:

(i) This will be indicated by poor or no lights when the engine is stationary, and varying light intensity when the engine is running.

(ii) Check the condition of the battery, and recharge if necessary.

(iii) Check the wiring from the battery to switch, rectifier, and alternator. Ensure all connections are clean and tight.

Excessive circuit voltage:

(i) This will be indicated by burnt out or blackened bulbs and possibly burned ignition contacts.

(ii) Examine the wiring for loose or broken connections.

(iii) Check the earth connections to the battery, rectifier and Zener diode.

(iv) Examine the battery, checking the electrolyte level and removing any corrosion.

Lighting Equipment

Failure of lights:

(i) If one bulb fails to light, replace with a new bulb.

(ii) If all lamps fail to light, check the fuse (if fitted) and check the battery condition, recharging if necessary.

(iii) Examine the circuitry and replace broken or loose connections.

Lights fade when switched on:

Check the battery condition, and recharge if necessary.

Brilliance varies with engine speed:

Check the battery condition, and recharge if necessary.

Lights flicker:

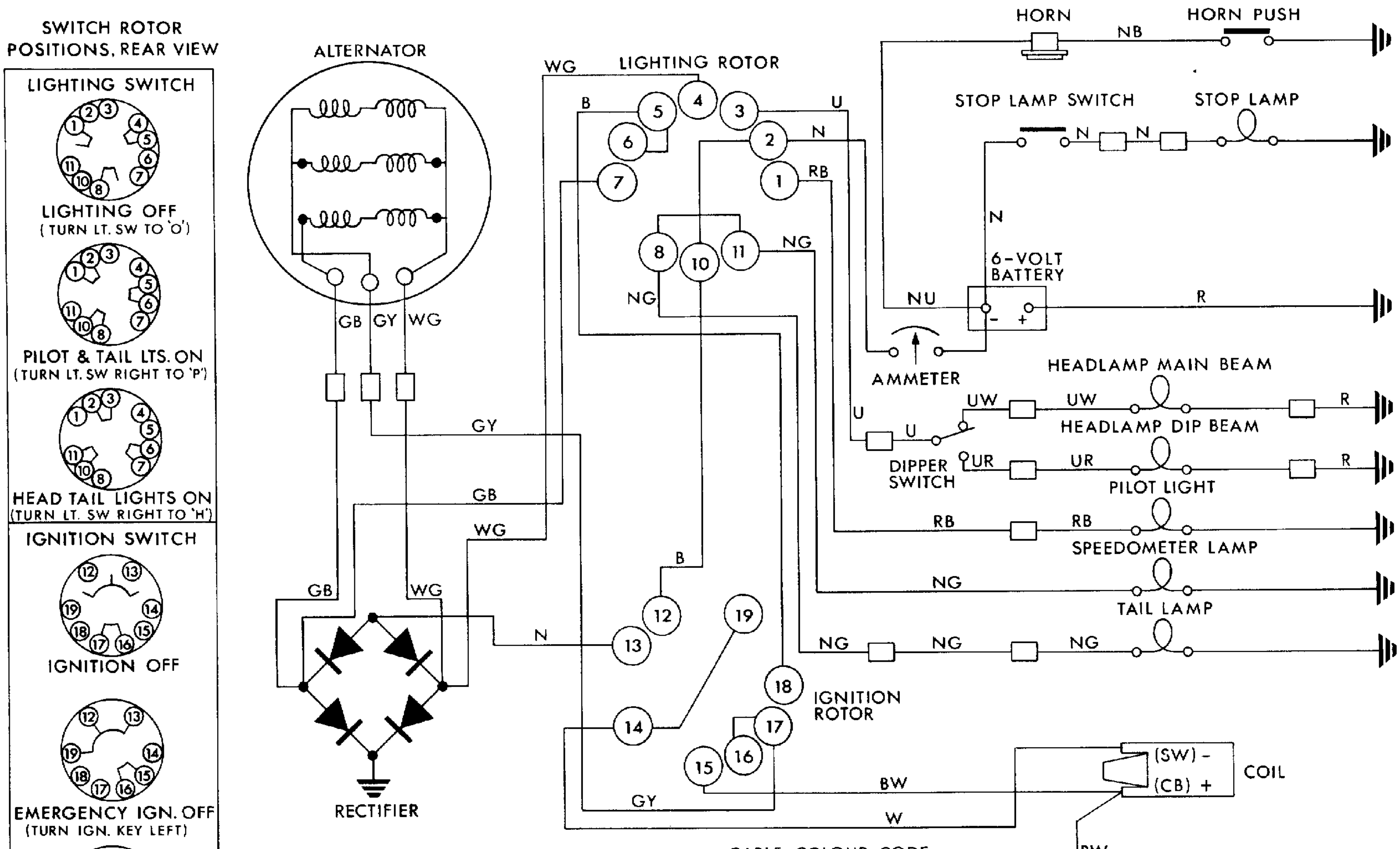
Examine the wiring for loose connections or damaged cable insulation. Check the battery condition.

Headlamp illumination insufficient:

(i) If the bulb is discoloured or filaments have sagged as a result of long service, replace with a new bulb of the same type.

(ii) Check the setting of the lamp and the condition of the reflector.

WIRING DIAGRAMS

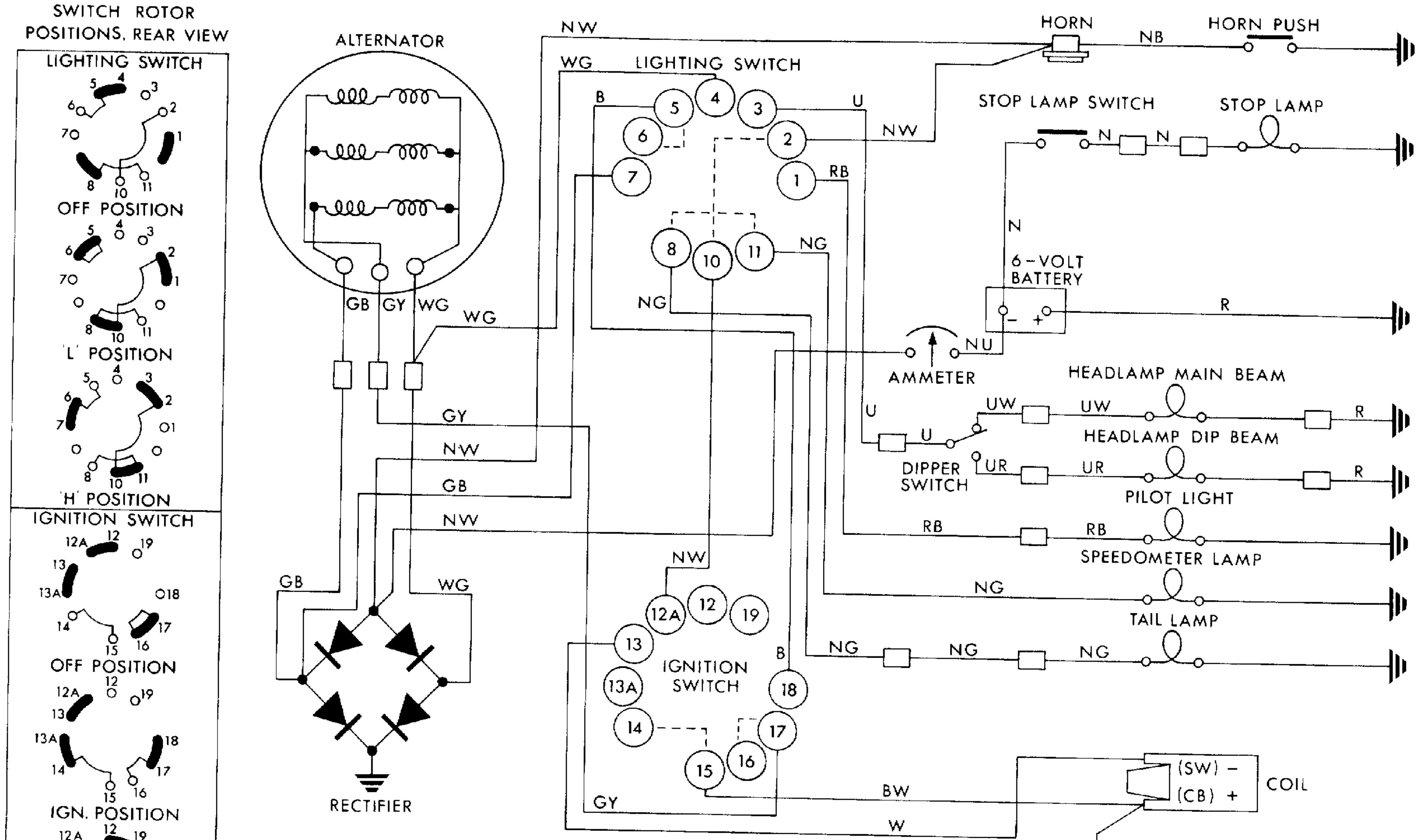


CABLE COLOUR CODE

B	BLACK	P	PURPLE	Y	YELLOW
U	BLUE	G	GREEN	D	DARK
N	BROWN	S	SLATE	L	LIGHT
R	RED	W	WHITE	M	MEDIUM

When a cable has two colour code letters, the first denotes the main colour and the second denotes the tracer colour.

Fig. 76 Typical 6 volt system using PRS8 switch in a single cylinder machine

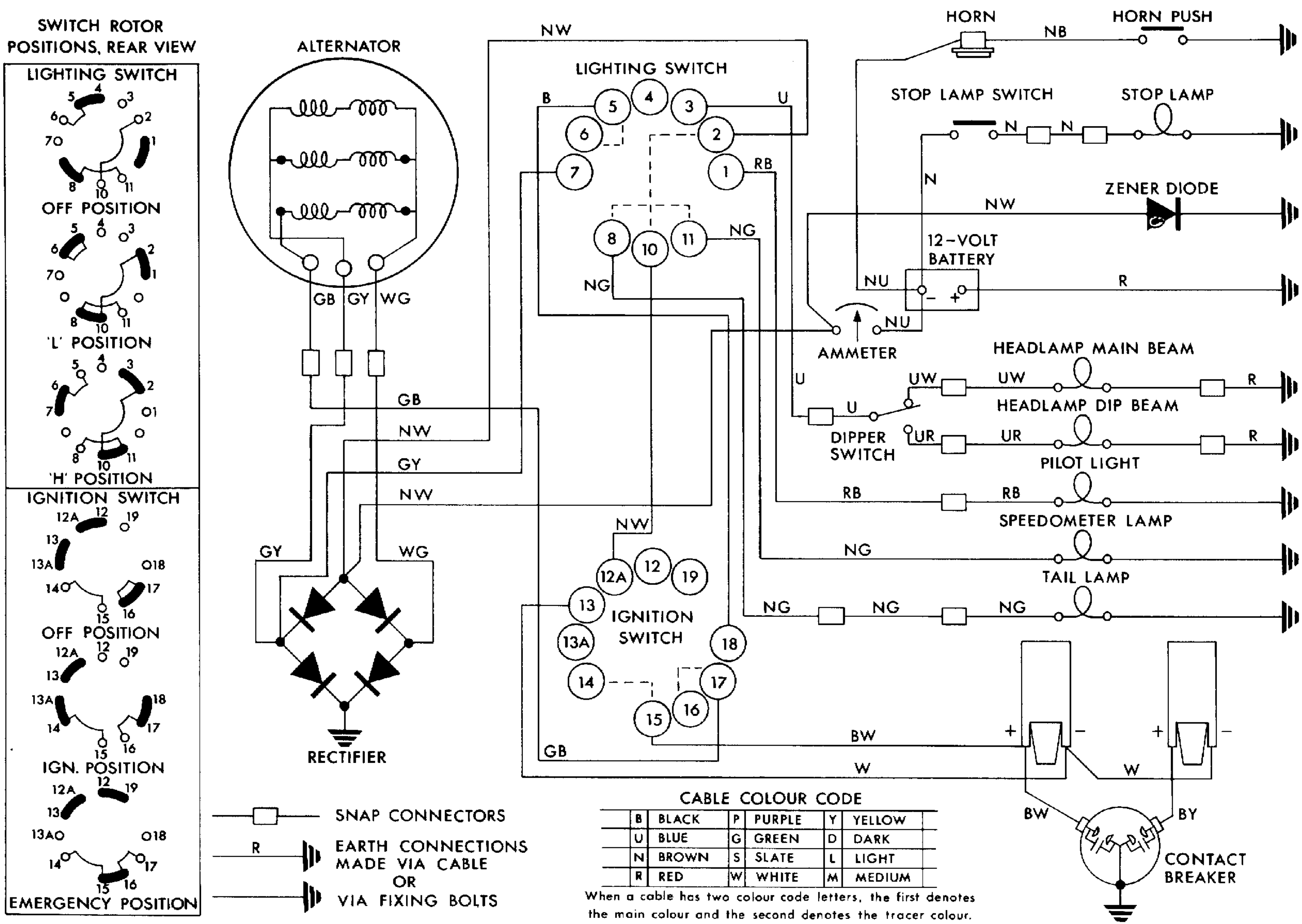


CABLE COLOUR CODE

B	BLACK	P	PURPLE	Y	YELLOW
U	BLUE	G	GREEN	D	DARK
N	BROWN	S	SLATE	L	LIGHT
R	RED	W	WHITE	M	MEDIUM

When a cable has two colour code letters, the first denotes the main colour and the second denotes the tracer colour.

Fig. 77 Typical 6 volt system with 88SA ignition and light switches

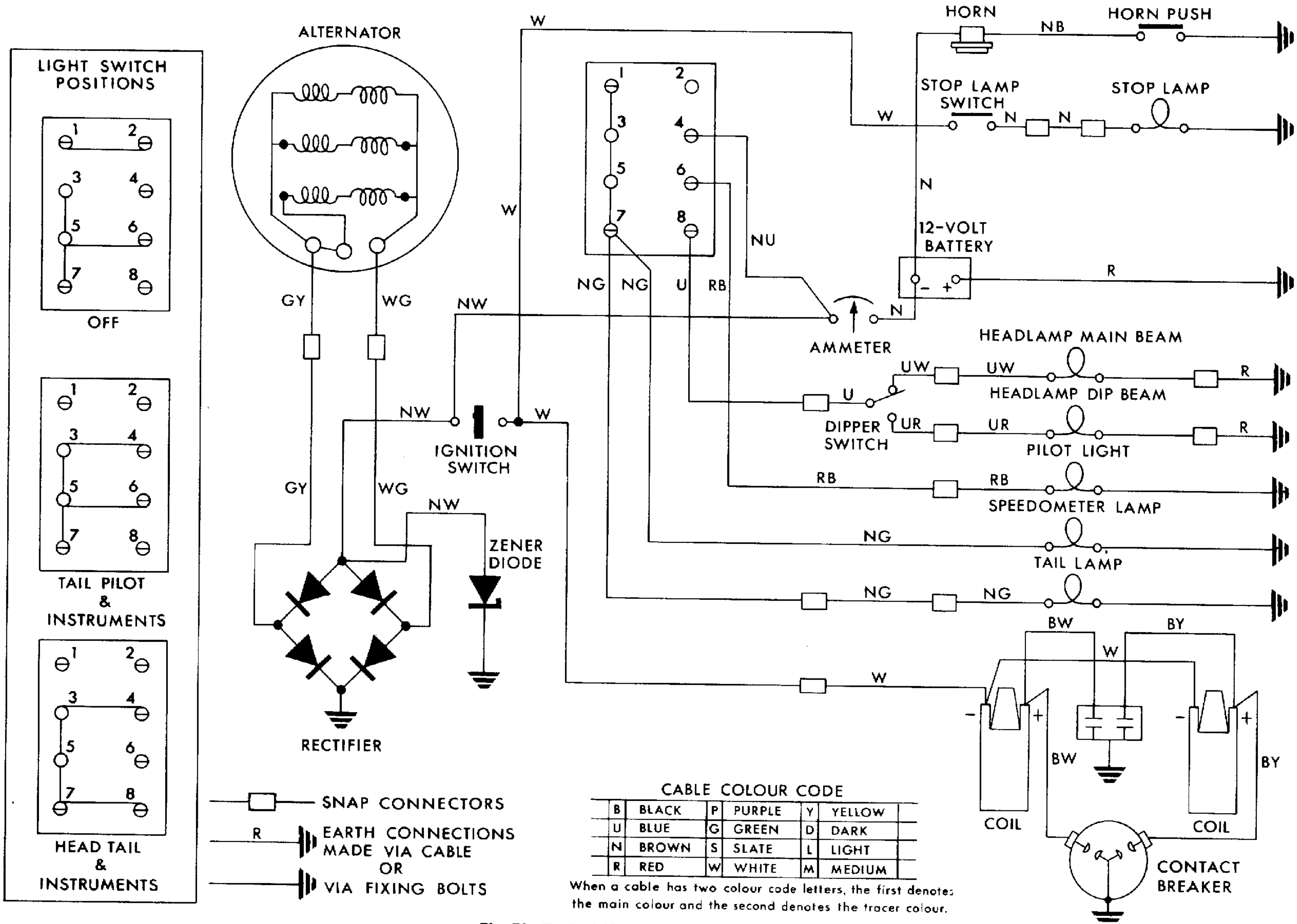


CABLE COLOUR CODE

B	BLACK	P	PURPLE	Y	YELLOW
U	BLUE	G	GREEN	D	DARK
N	BROWN	S	SLATE	L	LIGHT
R	RED	W	WHITE	M	MEDIUM

When a cable has two colour code letters, the first denotes the main colour and the second denotes the tracer colour.

Fig. 78 Typical 12 volt 2 charge rate

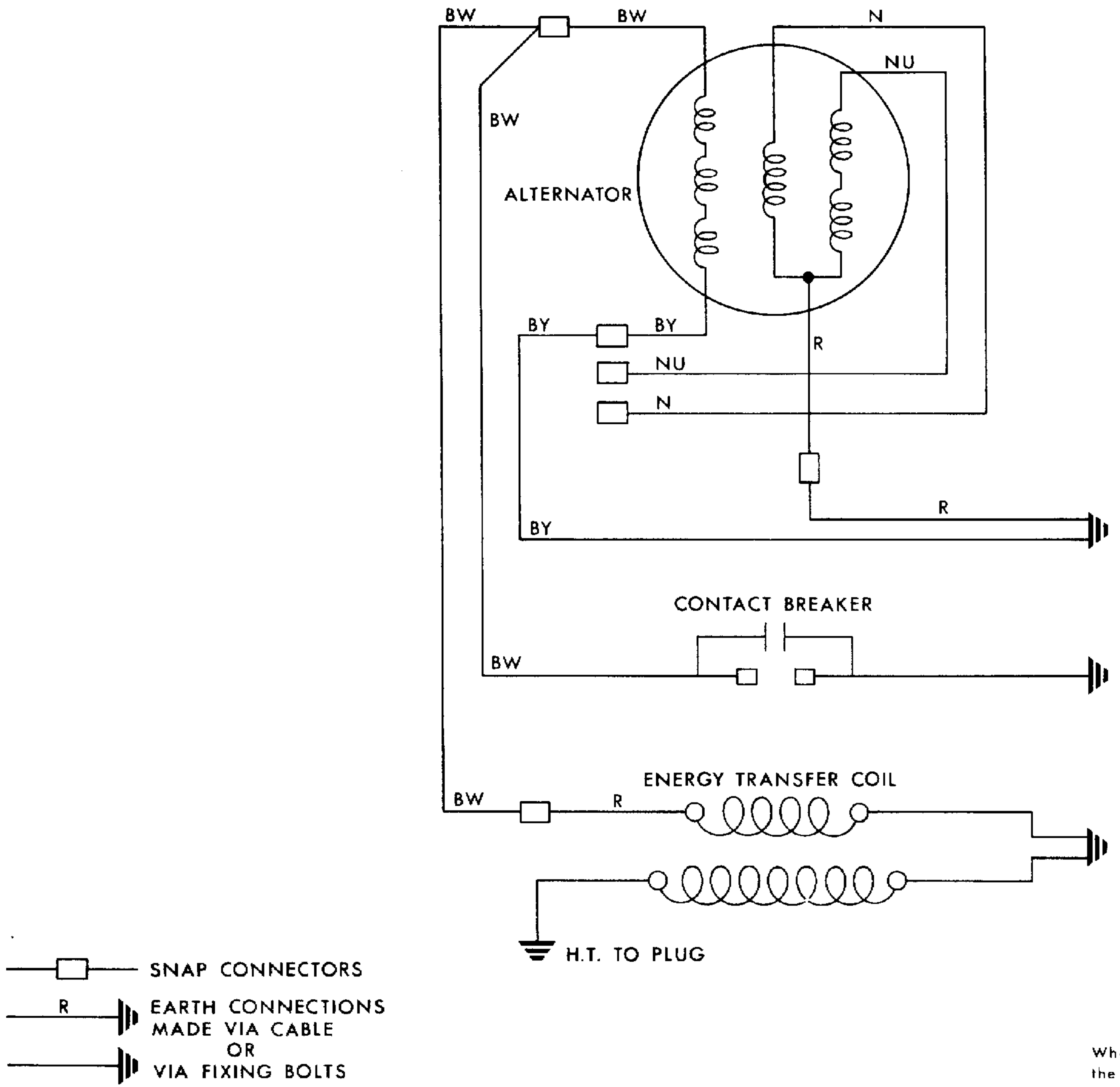


CABLE COLOUR CODE

B	BLACK	P	PURPLE	Y	YELLOW
U	BLUE	G	GREEN	D	DARK
N	BROWN	S	SLATE	L	LIGHT
R	RED	W	WHITE	M	MEDIUM

When a cable has two colour code letters, the first denotes the main colour and the second denotes the tracer colour.

Fig. 79 Typical 12 volt system (full output)

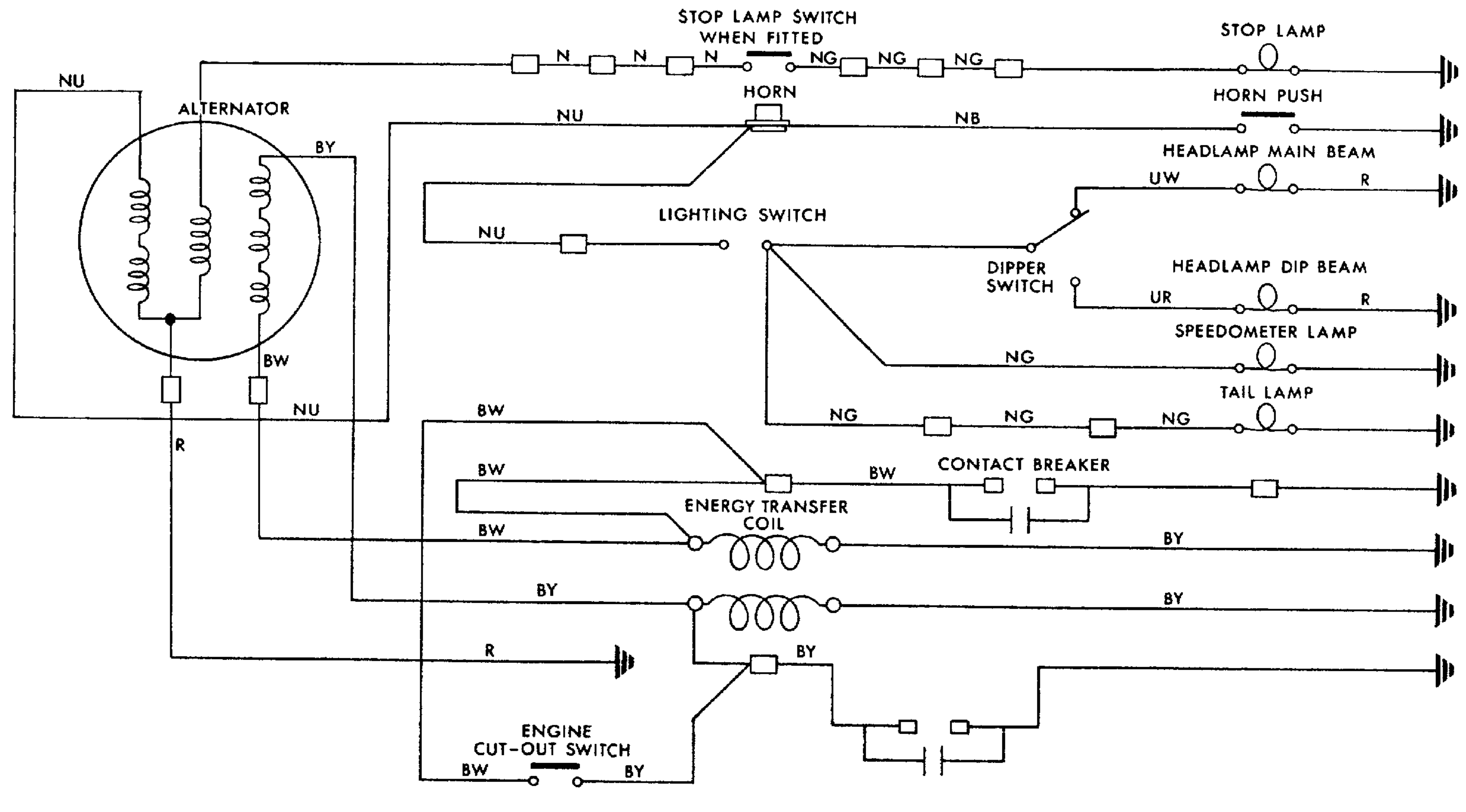


CABLE COLOUR CODE

B	BLACK	P	PURPLE	Y	YELLOW
U	BLUE	G	GREEN	D	DARK
N	BROWN	S	SLATE	L	LIGHT
R	RED	W	WHITE	M	MEDIUM

When a cable has two colour code letters, the first denotes the main colour and the second denotes the tracer colour.

Fig. 80 Typical energy transfer for single cylinder machines (without lights)

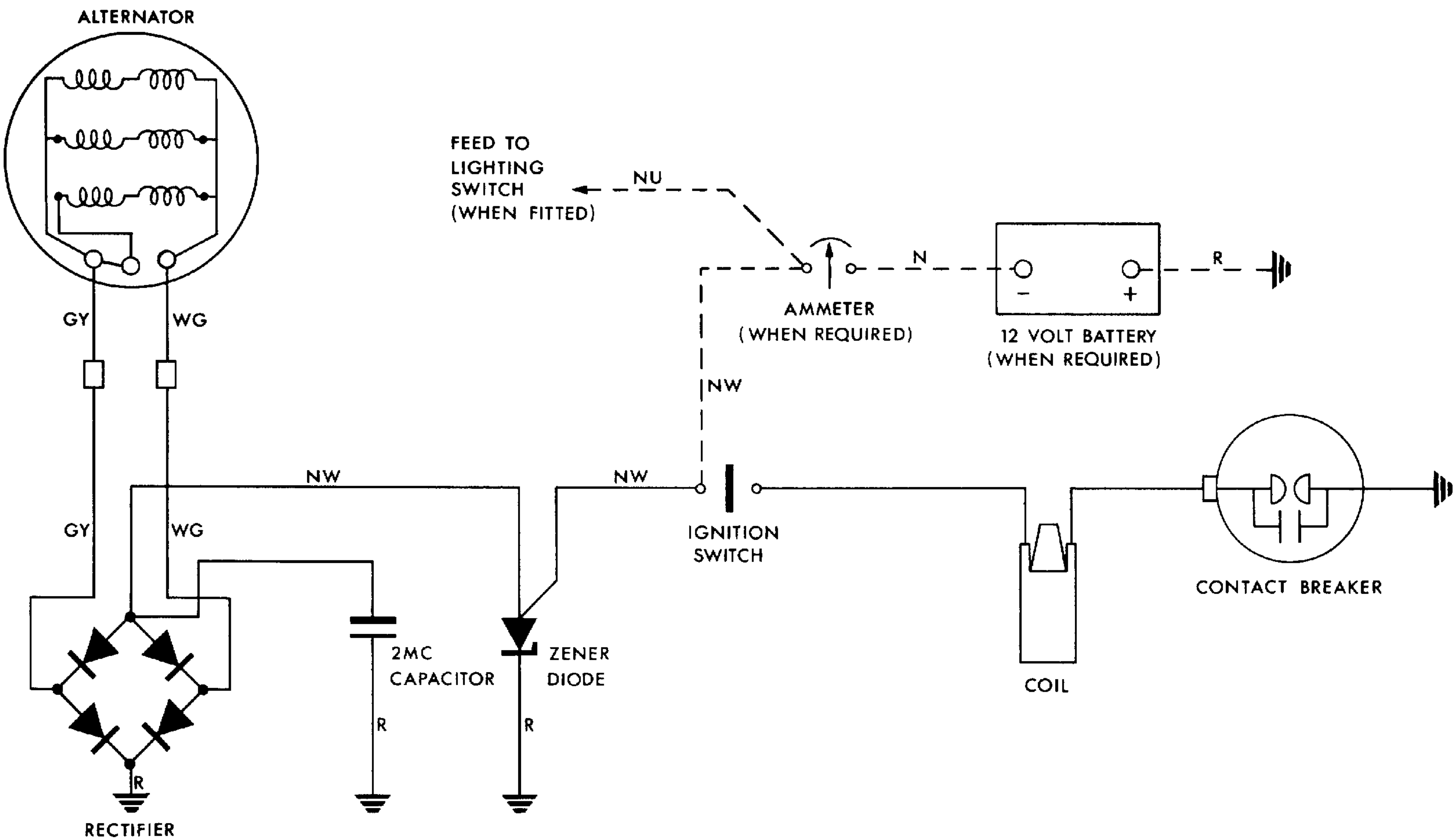


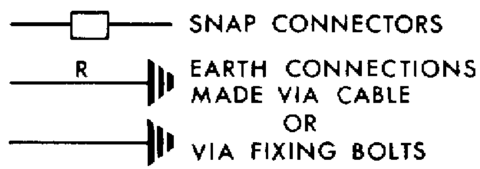
CABLE COLOUR CODE

B	BLACK	P	PURPLE	Y	YELLOW
U	BLUE	G	GREEN	D	DARK
N	BROWN	S	SLATE	L	LIGHT
R	RED	W	WHITE	M	MEDIUM

When a cable has two colour code letters, the first denotes the main colour and the second denotes the tracer colour.

Fig. 81 Typical energy transfer system for twin cylinder machines (with lighting)



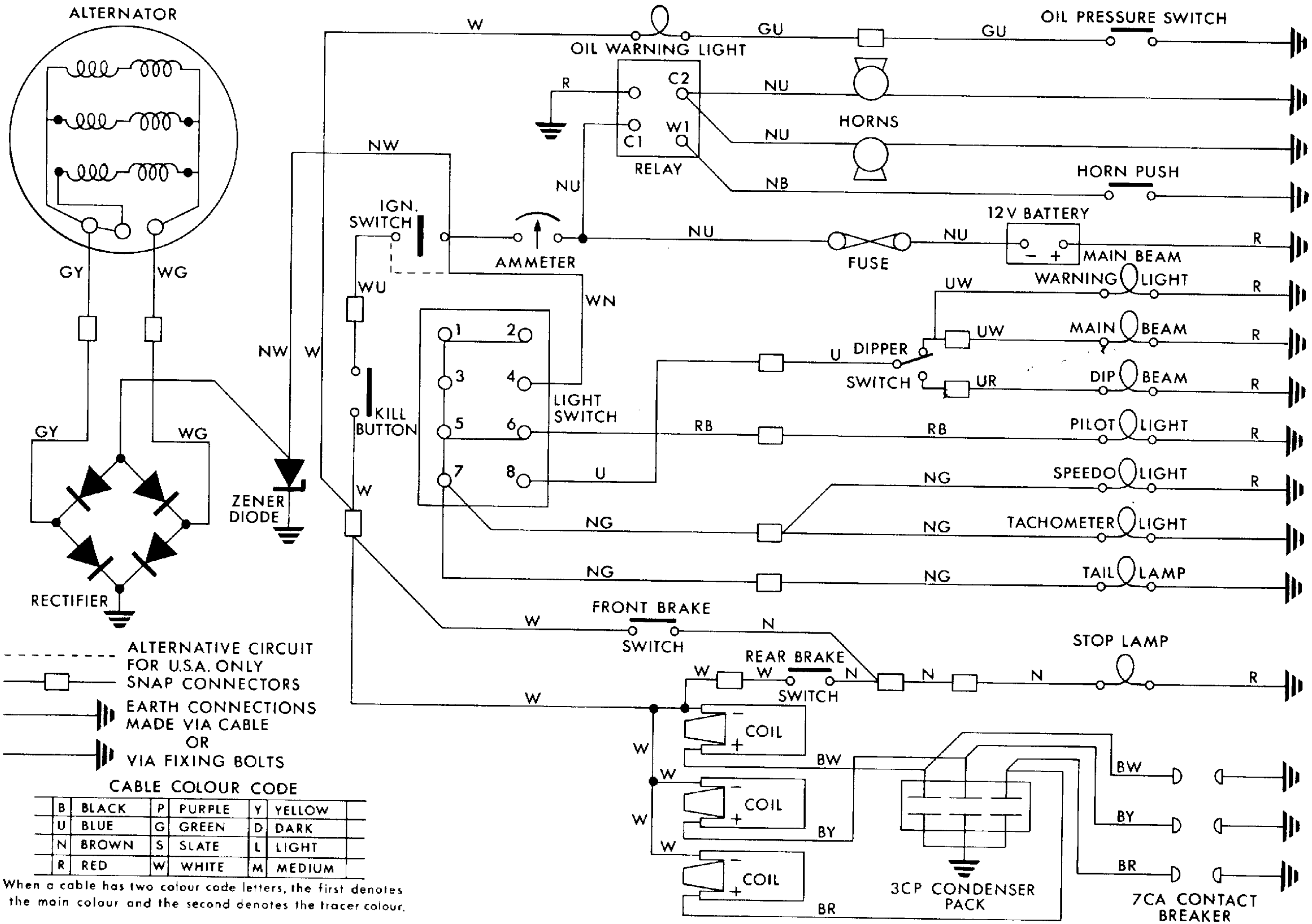


CABLE COLOUR CODE

B	BLACK	P	PURPLE	Y	YELLOW
U	BLUE	G	GREEN	D	DARK
N	BROWN	S	SLATE	L	LIGHT
R	RED	W	WHITE	M	MEDIUM

When a cable has two colour code letters, the first denotes the main colour and the second denotes the tracer colour.

Fig. 82 Basic capacitor ignition system

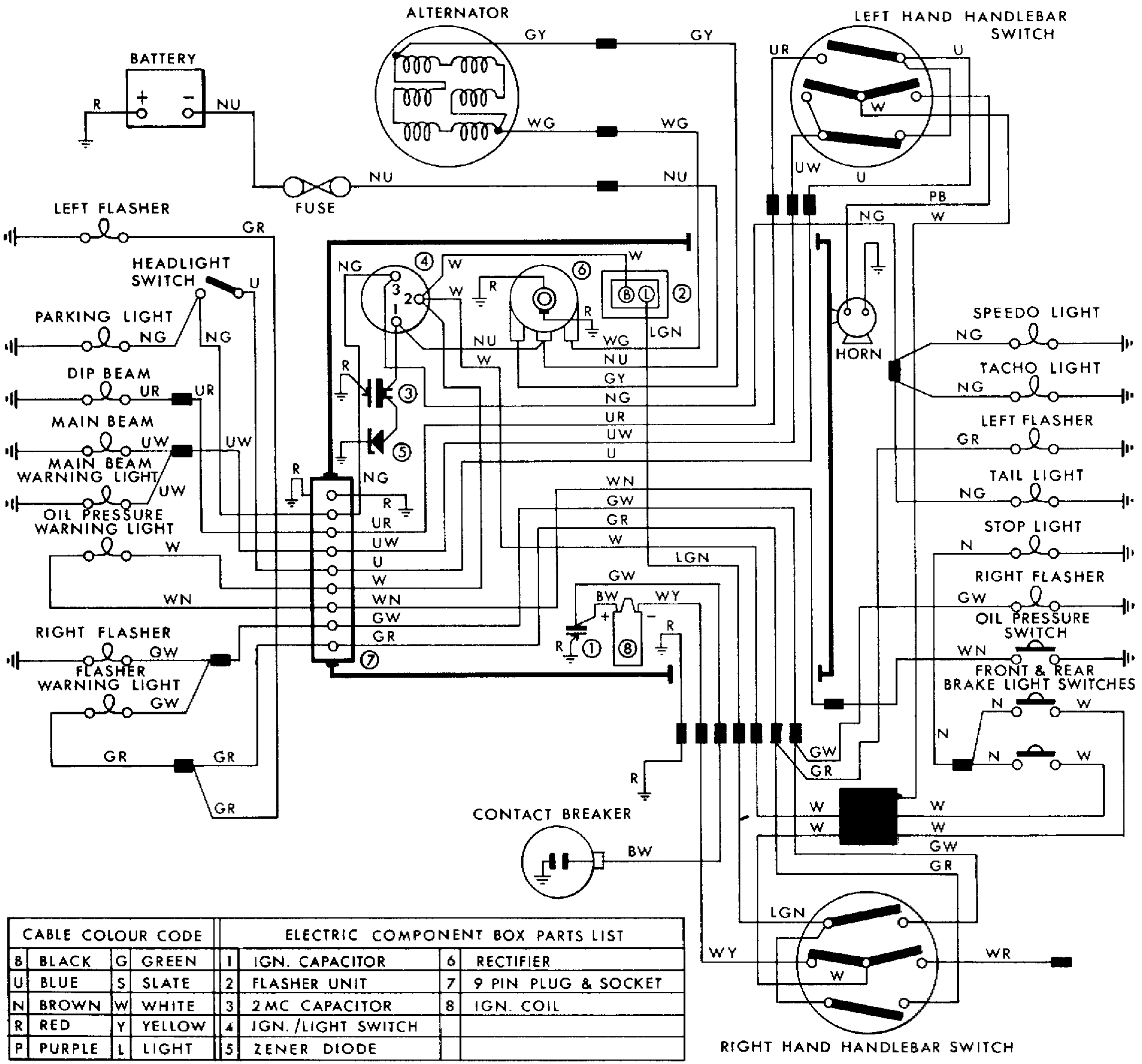


CABLE COLOUR CODE

B	BLACK	P	PURPLE	Y	YELLOW
U	BLUE	G	GREEN	D	DARK
N	BROWN	S	SLATE	L	LIGHT
R	RED	W	WHITE	M	MEDIUM

When a cable has two colour code letters, the first denotes the main colour and the second denotes the tracer colour.

Fig. 83 Typical 12 volt system for three cylinder machines



CABLE COLOUR CODE			
B	BLACK	G	GREEN
U	BLUE	S	SLATE
N	BROWN	W	WHITE
R	RED	Y	YELLOW
P	PURPLE	L	LIGHT

ELECTRIC COMPONENT BOX PARTS LIST			
1	IGN. CAPACITOR	6	RECTIFIER
2	FLASHER UNIT	7	9 PIN PLUG & SOCKET
3	2MC CAPACITOR	8	IGN. COIL
4	IGN./LIGHT SWITCH		
5	ZENER DIODE		

IGNITION/LIGHTING SWITCH

INTERNAL CONNECTIONS

LIGHTS ONLY
1-3

OFF
2-3

IGNITION ONLY
1-2

IGNITION & LIGHTS
1-2-3

LEFT HAND HANDLEBAR SWITCH

CABLE COLOUR CONNECTIONS

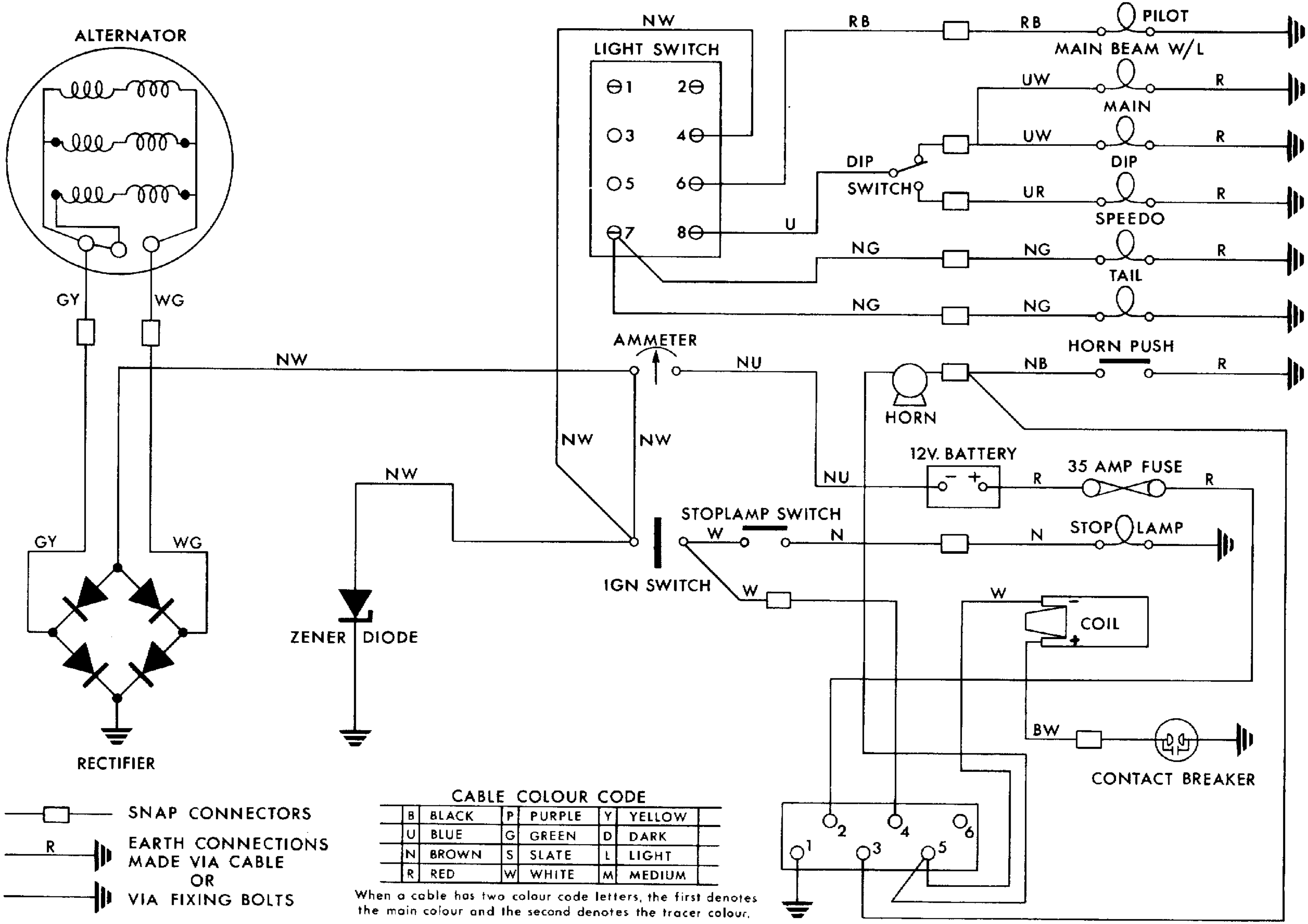
ACTION		CABLES
	HORN	
PUSH		W-PB
	HEADLAMP FLASH	
PUSH		W-UW
	DIP SWITCH	
LEVER	DIP	U-UR
	MAIN	U-UW

RIGHT HAND HANDLEBAR SWITCH

CABLE COLOUR CONNECTIONS

ACTION		CABLES
	INDICATORS	
LEVER	LEFT	LGN-GR
	OFF	
	RIGHT	LGN-GW
	STARTER (NOT USED)	
PUSH		W-WR
	KILL BUTTON	
PUSH	DISCONNECTS W&WY	

Fig. 84 Typical circuit for machines fitted with the electrical component box



CABLE COLOUR CODE

B	BLACK	P	PURPLE	Y	YELLOW
U	BLUE	G	GREEN	D	DARK
N	BROWN	S	SLATE	L	LIGHT
R	RED	W	WHITE	M	MEDIUM

When a cable has two colour code letters, the first denotes the main colour and the second denotes the tracer colour.

Fig. 85 Anti-theft switch installed in a typical system