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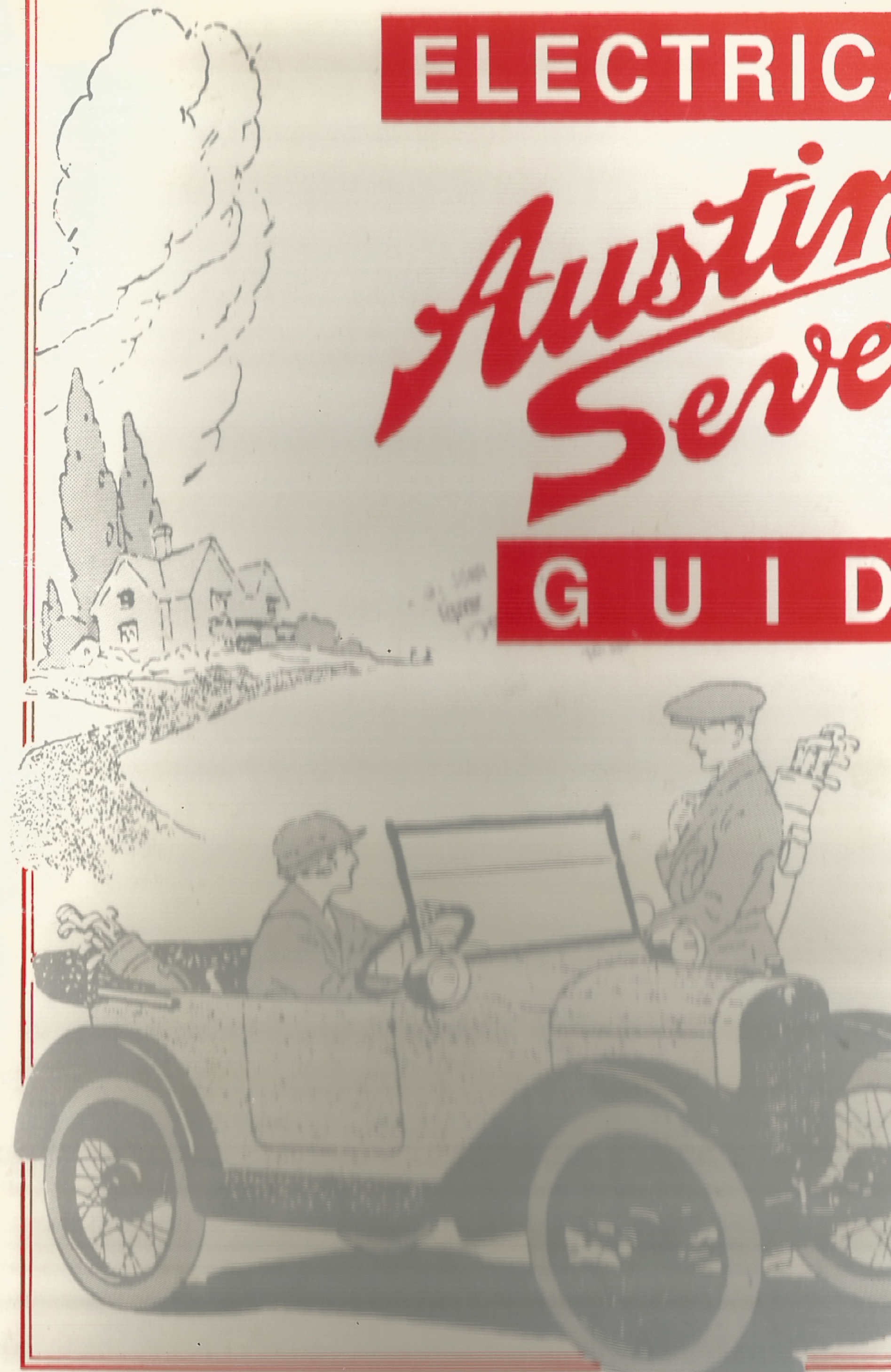


A CLOSER LOOK AT DYNAMOS, CUT-OUTS AND SWITCH PANELS.

By D. G. (Harry) Hales

1. INTRODUCTION

The basic principles of generating an electric current will not be dealt with in this article as they can easily be found in many textbooks.

(a) The Cut-Out

The function of the Cut-Out is to prevent the battery discharging into the Dynamo when the Dynamo is producing less voltage than the battery.

The Cut-Out is a normally open relay with two windings. The first winding has many turns of fine wire and is arranged to close the relay contacts when the Dynamo generates one or two volts above the battery voltage. The second winding has a few turns of thick wire and is usually visible wound around the outside of the first winding. This second winding carries the charging current as is in series with the contacts. It is wound in a direction to assist the voltage operated coil when the dynamo is charging and to cancel the effect of the voltage winding when reverse current starts to flow due to low generation voltage.

(b) Earthing the Cut-Out

It is essential to earth the Cut-Out. The C.A.V. and Lucas CF1 type Cut Outs have their earths connected to the casing and thence to the chassis via the holding down bolts. However, with a well restored car in which the metal is covered with plenty of paint this doesn't always happen, so a separate lead may be necessary. The Lucas CF3, CFR and CFR2 all have provision for an earth lead.

(c) The Warning Light

From about 1928 the electrical system contained a warning light. This was originally incorporated in the switch panel, but with the appearance of the long

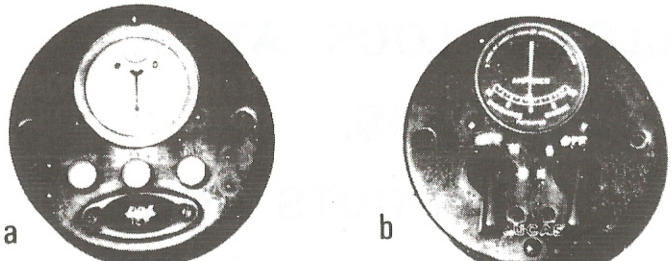


Fig. 1. Switch panels. (a) C.A.V. (b) Lucas type ... SM3.

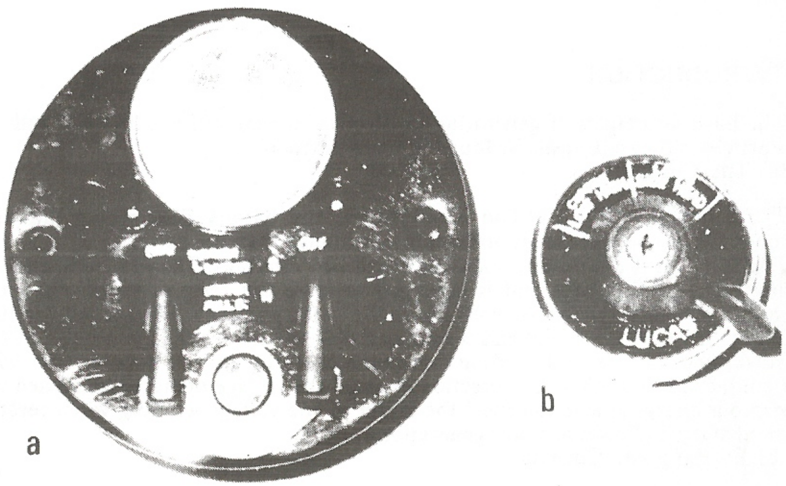


Fig. 2. Switch panels. (a) Lucas type SM5, (b) Lucas type SA1.

wheel - based cars it became part of the dashboard fitment. It is connected (via several terminal posts) from the Dynamo side of the Cut-Out to the live end of ignition coil. When the engine is running and the Cut-Out is closed and the ignition on the lamp is short circuited and it cannot light. With the engine stopped and the ignition on, the lamp lights via the Dynamo to earth. Similarly with the ignition off and the Dynamo producing some voltage (even if not enough to charge) the lamp finds a return path via the ignition coil providing the ignition contact breaker is closed. This is why the ignition lamp gives a flash of light as the engine dies down when switched off from high revs.

(d) Charging circuits

The changes which occurred throughout the years to the charging circuits are shown in Figs 9 to 14.

2. DYNAMO TYPES AND ASSOCIATED SWITCH PANELS

(a) **1922 - 1928** DF and DFL Types.

These are the earliest form of Dynamo fitted and cover all magneto engined cars. The DF type has enclosed brush gear (see Fig 3(b)) but in the DFL type (see Fig 3(a)) the brush gear is exposed. The maximum charge obtainable is 5 amps and there is no provision for half charge.

The DF Dynamowas usually fitted with a C.A.V. switch panel and C.A.V. Type E Cut-Out (see Figs 1(a) and 4(a) and (b)). The field circuit fuse is incorporated in the switch panel; the Cut-Out having no fuse in it at all. A single strand of 5 amp fuse wire wound once around the card should be used when the fuse requires renewing.

The later type of Switch Panel, type SM3 (see Fig 1(b)) is usually used in conjunction with Cut-Out type CF1. In this case the fuse is in the Dynamo output side D of the Cut-Out. It does not effectively protect the field coils, but of course, does prevent the Dynamo giving excess current. The fuses are shaped as shown in Fig 5

Originally the Cut-Out had quite a few of these permanently connected to one of the terminals; as one blew another could be pulled down and inserted. A piece of fuse wire rated at about 10-15 amps will do just as well.

Both types of Cut-Out and Switch Panel are interchangeable between the two types of Dynamo, but the Cut-Outs must be properly earthed.

There is no ignition warning light fitted to either of the switch panels.

Both Dynamos have ball bearings at either end of the armature. The front bearings in each type should be lubricated very sparingly by oiling the nipple that locates them in their housing. The DF type also has an oiler for the rear bearing, but the DFL relies on being packed with new grease when it is serviced.

If trouble is experienced with the connections remember that the field lead (SH) is connected to the outer ring (2 B.A. terminal) which in turn is connected to one of the two leads going into the body of the dynamo. This is shown clearly in fig 6. The D lead goes to the 2BA terminal nut on the fixed brass brush holder. This is the only lead going to this particular brush.

The third brush is adjusted by loosening the clamp screw and rotating the brush and ring together until an output of 5 amps is achieved, then re-tightening the screw. Bear in mind that the DYN switch on the C.A.V. switch panel (see Fig 1(a)) must be pulled out for the Dynamo to operate and on the later type SM3 panel the left hand switch must be switched to the D position (see Fig 1(b)).

(b) **1928 - 1931** C.A.V. / Lucas Type DEL.

With the change to coil ignition in late 1928 a different Dynamo was required. This was the introduction of what became the standard arrangement of driving the distributor from the end of the armature shaft. The Dynamo had a short armature with a short body (Fig 7(a)) and a long end cap holding the brushes and distributor (Fig 7(c)).

It then changed to a longer body (Fig 7(b)) and short aluminium end cap (see Fig 7(d)), but retained the same armature. The final variation consisted of a longer armature, the same body, but this time with a steel end cap (Fig 7(e)).

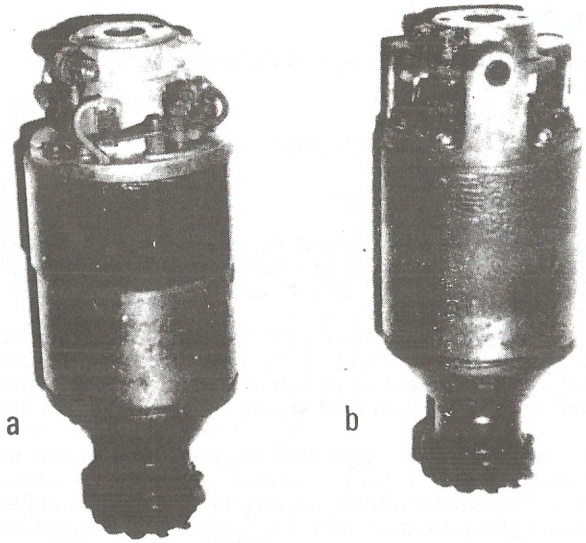
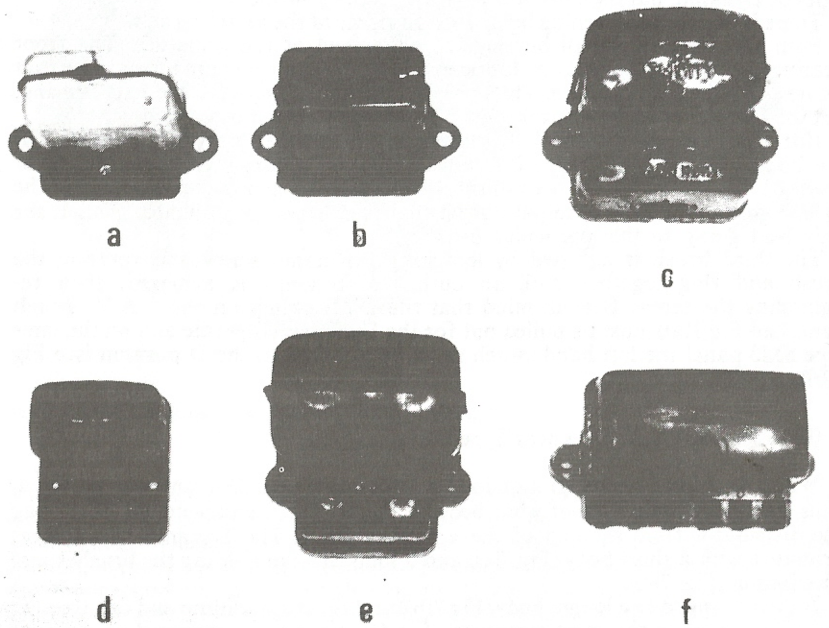


Fig. 3. C.A.V. dynamos for magneto engines (a) Type DFL 1925-1928, (b) Type DF 1922-1924.

Fig. 4. Cut-outs. (a) Early C.A.V. type E — aluminimum cover, (b) Late C.A.V. type E — steel cover, (c) Lucas CF 1, (d) Lucas CF3, (e) Lucas CFR, (f) Lucas CFR2.



All types had half-charge facilities in the form of a resistor wound around one of the field coils. Continuous running on half charge tended to burn this resistor out, but fortunately the main field coil windings seemed to survive and so the Dynamo struggled on. The variations were not significantly different from the electrical standpoint and the wiring diagram for them all is shown in Fig 11.

In the first two variations (those with the shorter armature) the drive from the camshaft gear wheel is via an identical gear to that used in the magneto engined cars. In the third variation (that with the longer armature) the form of the gear tooth naturally remained the same, but the shape of the casting was changed so that it became flat instead of being bell-shaped with a recess for the retaining nut (compare Figs 7(a) and (b)).

To connect these Dynamos, fit the field lead to the smallest terminal (nearest to the engine) and the output to the largest terminal D (nearest to the distributor.) Unlike the mag Dynamos before them, this Dynamo charges all the time that the engine is running.

The brushes on these dynamos are a little difficult to adjust. Owing to the fact that there are four field coils, the main brushes (D and Earth) are at 90° to each other and the third brush is between them in the remaining segment of 270°. Due to the change-over from positive to negative when the armature rotates through the field coils the position of the main brushes is fairly important. Consequently there are facilities to adjust their position in relation to the field coils However in normal maintenance the third brush is the only one that needs to be adjusted.

To adjust the third brush, loosen its retaining screw (see Fig 7) and move it as necessary before tightening the screw again. Run the engine with the charging switch on full charge and everything else switched off. Repeat the adjustment until an output of 8 amps is obtained.

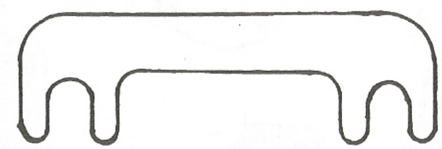
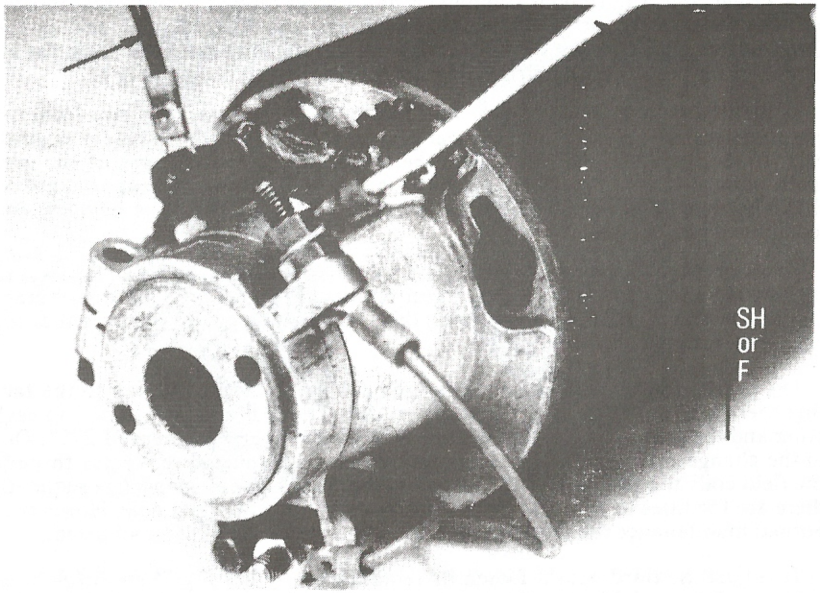
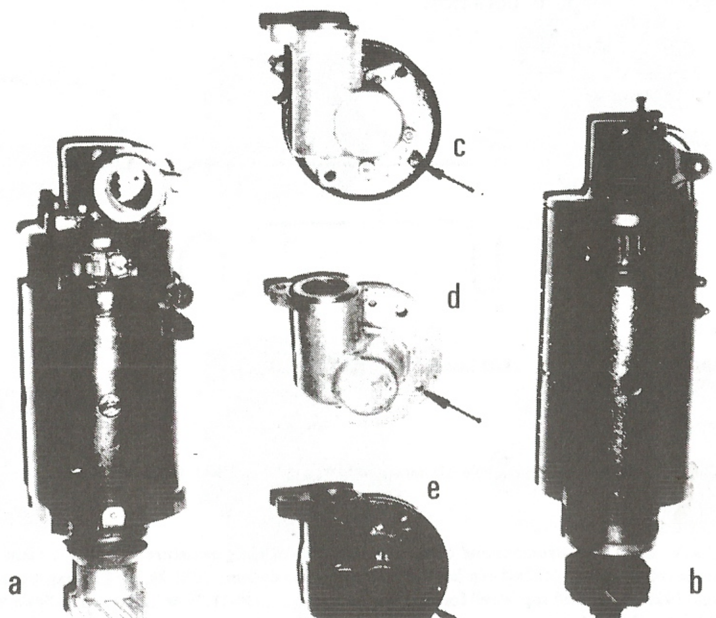


Fig. 5. Approximate shape of original fuse fitted to type CF1 Cut-outs.

Fig. 6. C.A.V. dynamo connections "To 'D' terminal", "To 'SH' or 'Field' terminal".

Fig. 7. C.A.V. and Lucas dynamos end caps — Type DEL. (a) Long armature (b) Short armature, note difference in driving gears; (c) End cap (steel) for short bodied dynamo 1928-29, (d) End cap (aluminium) for dynamo 1929-30, (e) End cap (steel) for long bodied dynamo 1930-31. Note 1. Arrows indicate position of the third brush retaining screw.





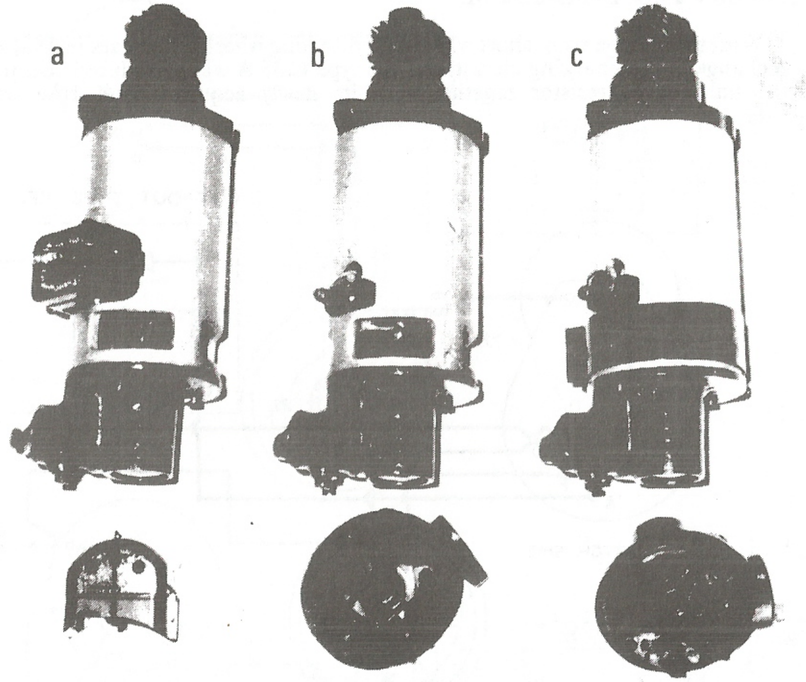


Fig. 8. Lucas dynamos: (a) Type C35A fitted with resistor pack, (b) Type C35A without resistor pack, (c) Type C35M.

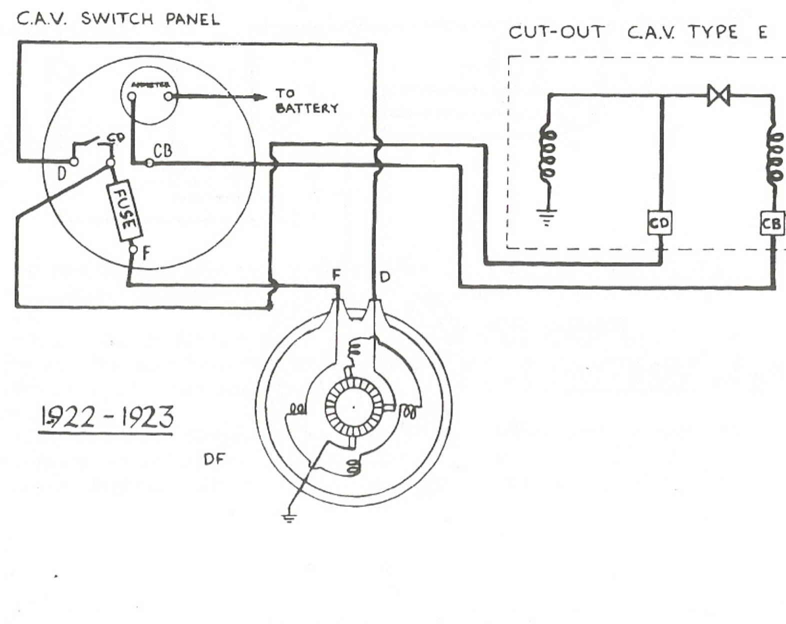


Fig. 9. 1922 - 1923

(c) **1931 - 1935** TYPE C.35 A.
1936 - 1939 TYPE C.35 M.

With the change from short wheel-based to long wheel-based cars in 1931 came a change in the charging circuit and the type C.35 A was introduced. Until 1932 the half-charge resistor together with its newly acquired field fuse were -

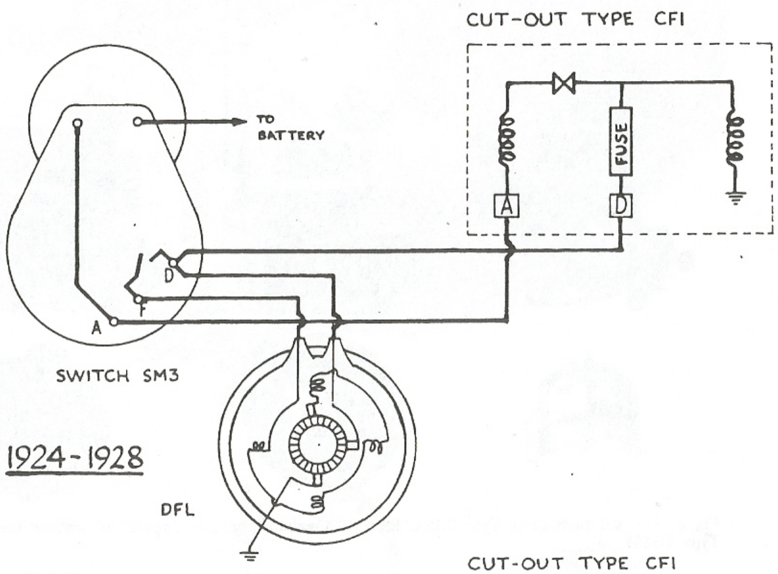


Fig. 10. 1924-1928

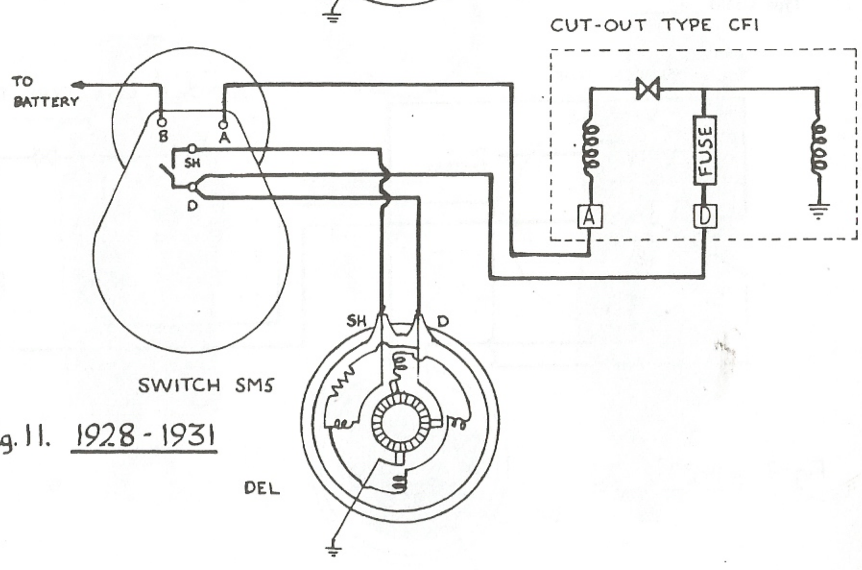


Fig. 11. 1928-1931

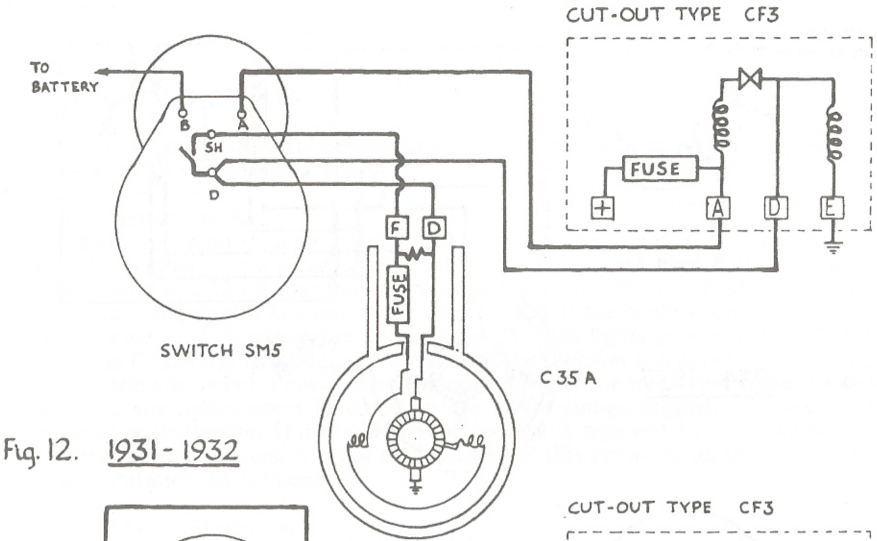


Fig. 12. 1931-1932

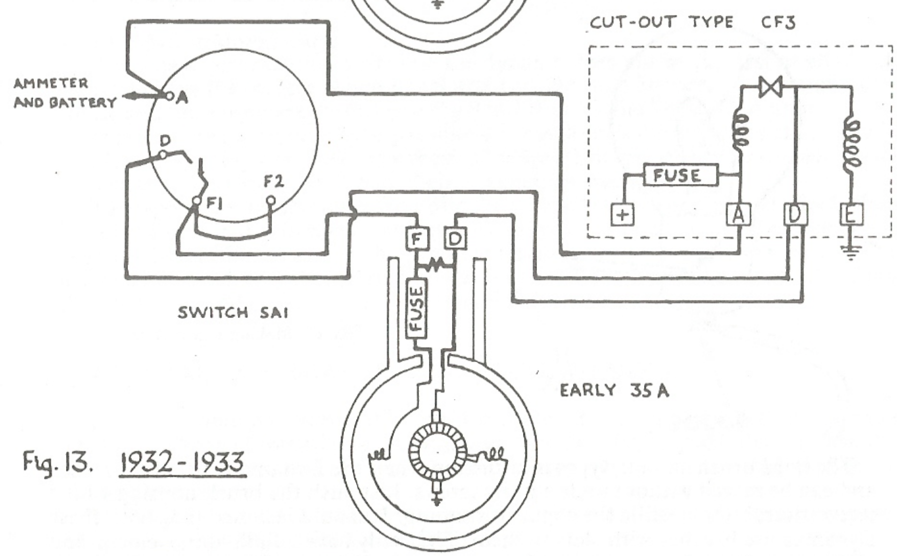


Fig. 13. 1932-1933

incorporated in a resistor pack on top of the body of the Dynamo (see Fig 8(a)). Looking from the top of this pack, the left hand connection is D and the right hand is Field.

With the four speed model cars, the switch panel was changed from type SM5 to SA1 (see Fig 2). This has a half-charge on the switch "low" or "summer" position and full charge on all other positions providing F1 and F2 on the back of the switch are linked.

About September 1933 the half-charge resistor and field fuse were replaced by those incorporated in the Cut-Out, which now became type CFR (see Figs 4(e) and 4(f)). The small connection blocks on the Dynamo are marked D and either F2 or F.

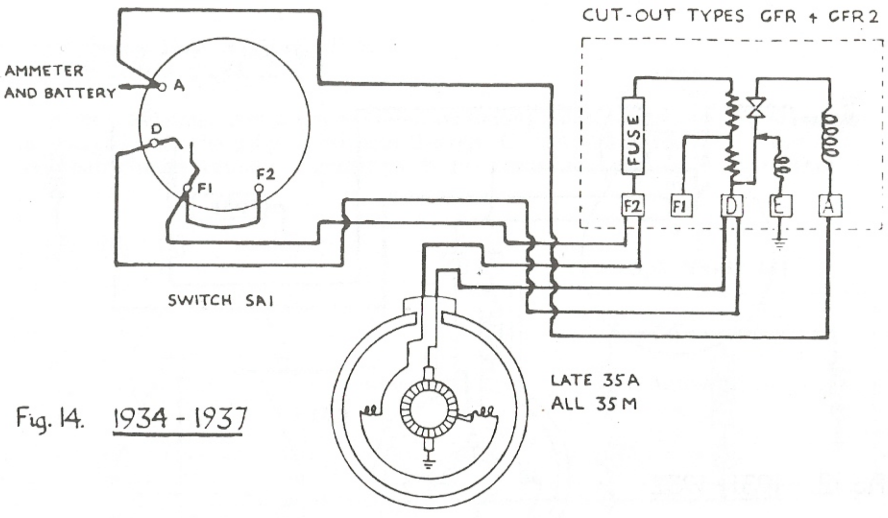


Fig. 14. 1934 - 1937

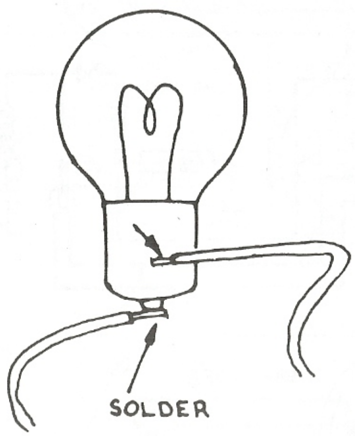


Fig. 15. Making a test light.

The third brush on both types is at the top when the Dynamo is fitted to the car and can be moved without undoing any screws. Just push the brush housing with a screwdriver, but not while the engine is running! It should be noted that both these Dynamos use brushes with slots in them. They only have a limited movement and often reach the end of their travel (and consequently cease to bear correctly on the commutator) while still giving the appearance of having a lot of wear left in them.

The change to positive earth, producing the C.35 M dynamo matched with the CFR2 Cut-Out, was made in December 1935 (see Figs 8(c) and 4(f). It will be noted that the brushes for this type of Dynamo are fitted with tags.

Both the C.35 A and the C.35 M were better electrically than their predecessors, but not as strong mechanically, having a plain brush at the distributor end. This should be oiled every 10,000 miles or so by prizing off the little thimble-shaped cap at the distributor end and inserting a few drops of clean engine oil.

LOCATING FAULTS

This section deals with determining whether the fault is in the Dynamo or elsewhere in the charging circuit.

(a) Cars in Service.
Disconnect both ingoing leads to the Dynamo and join the two vacated terminals together with a separate piece of wire. Test these two terminals with either a voltmeter or a 12 volt test bulb for voltage to earth. (See paragraph 6 (b). Cars manufactured up to 1936 were negative earth and those made subsequently were positive earth. If the meter gives a reading or the blub lights up when the engine is run, the Dynamo is functioning properly and the problem lies either with the Cut-Out, wiring or Switch Panel. If there is no reading of the meter the Dynamo is at fault. If the fault cannot be cured by any of the things suggested on the fault finding chart (section 5) it would be wise to have it repaired by someone who is skilled in these matters. It is not the intention of this article to go too deeply into the restoration of Dynamos.

(b) Newly restored cars.
If you have just restored a car and the dynamo does not work, first of all check that you have the correct switch panel and Cut-Out (see Section 7). Assuming that these and the wiring are correct (see Fig 9 to 14) check the Dynamo as above.

If this produces no satisfactory results it is possible that during the car's rebuild the field coils may have lost their residual magnetism, or, if they have been wired incorrectly, may even have had their magnetism removed.

To re-polarize the Dynamo, first disconnect the lead to the field terminal, then connect a lead in its place and short this to the positive terminal on the battery for all negative earth cars and to the negative terminal for all positive earth cars. The connection need only be shorted for a few seconds. Now re-connect the field terminal lead and check to see if the Dynamo is working.

GENERAL INFORMATION AND FAULT FINDING.

If the Dynamo has been out of use for some time it is possible that moisture could have been absorbed into the windings. It is therefore a good idea to leave the Dynamo in a warm, dry place (such as an airing cupboard) for several days to thoroughly dry out.

The mag dynamos quite often have poor insulation on the field connection post. Make sure that this is insulated from earth.

All Dynamos suffer from the fact that the third brush can be moved too far and may touch one of the other brushes. Care must be taken when adjusting it.

Check the condition of the commutator and brushes — those with slots in may not be pressing hard on the commutator. In the C35 M Dynamo the third brush is very thin and wears at about twice the rate of the other two.

End play on the C35 A can sometimes be taken up by adding to the thickness of the fibre washer under the oil thrower on the drive end.

Avoid over-lubrication, especially at the commutator end. If the commutator is greasy, clean it with carbon tetrachloride, methylated spirits or a proprietary switch cleaner. Do not use petrol. When re-packing the bearings and distributor gears use a No 2 lithium based grease — do not overpack them.

Switch panels SM3 and SM5 suffer from breakages of the internal brass connecting bars; one can be seen on the back but there is another inside.

Switch SM1 must have F1 and F2 terminals shorted otherwise the headlights might have half-charge only.

All Cut-Outs must be earthed.

If the contacts of the Cut-Out are dirty it is possible for the Dynamo out-put to be a little higher than that of the battery, so the ignition warning lamp will glow despite the amp-meter showing a good charge. To cure this problem, disconnect the battery and clean the Cut-Out contacts with very fine emery paper.

Set your amp-meter with everything switched off except the engine; most Austin Sevens now run with a discharge when the headlights are on, but should be showing a slight charge with only the side lights on.

Avoid increasing the fuse ratings if they keep on blowing, try and find out why they blow — some types of dynamo are getting very scarce!

Make sure the battery is healthy and its terminals are clean.

Clean, sound wiring produces better results than dirty, tatty wire.

TESTING DYNAMOS

Magneto engined Dynamos should be set to charge at 5 amps and those fitted to coil ignition engines at 8 amps.

Field fuse ratings should be about 5 to 7 amps.

(a) Bench Testing.

All Dynamos can be tested off the vehicle by getting them to motor. To do this for negative earthed Dynamos, connect the F and D terminals together and take a lead from this point to the positive side of a 6 volt battery. Connect another lead to the outer casing of the Dynamo and the negative side of the battery. For the positive earth Dynamo, C35 M, the connections are of course, the other way around. If all is well the Dynamo will motor and should turn in a clockwise direction as viewed from the camshaft end. If you can spin the armature easily by hand, but the Dynamo will not motor, then it is electrically faulty.

The only time that this might not work and the Dynamo still be serviceable, is when the armature is difficult to rotate by hand, but the stiffness could be overcome by the engine. If this is the problem it may be caused by collapsed bearings, the armature hitting the field poles, the driving gear being too tight on the shaft or new felt oil seals having been fitted very tightly.

(b) Making a test light.

Take a 12 volt single pole bulb and two pieces of wire at least six inches long. Solder or connect the wires to the bulb as shown by the position of the arrows in Fig 15. Providing the bulb does not touch any part of the car it does not matter which goes to earth or which goes to the live terminal.

Fig 15 appears on p.15 of 1979C.

FAULT FINDING CHART

- Dynamo not charging
  - Field fuse blown (C.A.V. Switch Panel C35A Resistor Pack
  - Output Fuse Blown (CF1 Cut-Out, D Terminal)
  - Half Charge Fuse Blown (short Fuse in CFR or CFR2 Cut-Out)
  - Switch On Panel not on or faulty
  - Wrong Cut-Out or Switch Panel
  - Broken or Loose Connections
  - Cut-Out not Earthed
  - Dynamo Faulty
- Dynamo Charging Intermittently or Low Output
  - Dynamo
    - Loose Terminal Nuts
    - Loose Dynamo
    - Wrong Type of Dynamo
    - Brushes
      - Greasy or Dirty
      - Worn
      - Tight in Holders
      - Not Bedding Evenly (especially C35A)
      - Spring Broken
      - 3rd Brush in wrong position
      - Brushes in wrong position (DL, DEL)
    - Commutator
      - Greasy or Dirty
      - Worn or Rough
      - Dust between Segments
      - Solder thrown from Commutator
  - Switch Panel
    - Wrong type for Dynamo
    - Connections loose
    - Switched to Half Charge
  - Cut-Out
    - Wrong type for Dynamo
    - Connections loose
    - Dirty Contacts
    - Cut-out badly earthed
  - Battery
    - Acid Level low
    - Loose, Corroded or Broken Connections
    - Poor earth connection
- Dynamo Charging with Excessive Output
  - Brushes
    - Third Brush in wrong position
    - Brushes not Bedding properly
    - Main Brush in wrong position (DL DEL)
  - Cut Out
    - Poor Earth
- Dynamo works on full charge but not on Half charge
  - Check Field Fuse on Cut-Outs CFR and CFR2
  - Check Field Resistance on Dynamo Type DEL
  - Check Resistor Pack on Dynamo Type C35A

This chart gives indications of faults in service and also indicates where components may have been mismatched after a rebuild.

MATCHING COMPONENTS

Year	Dynamo type	Drive Gear	Cut-Out	Switch Panel	Voltage Regulation	Armature Bearings Front	Armature Bearings Rear
1922	DF	Counterbored Driving Gear	C.A.V. Type E	C.A.V. Three button switch Fuse for field circuit	No half charge. Maximum output by third brush	L7	110
1923							
1924	DFL						
1925							
1926			CF1 Contains fuse for Dynamo Output	SM3			
1927							
1928							
1929	DEL Short Armature			SM5 Warning light incorporated	Half charge wound around Field winding. Maximum output by third brush		
1930	DEL Long Armature	Flat Driving Gear					
1931							
1932	C35 A		CF3 Contains fuse for Accessories only		Half charge resistor and field fuse in pack on Dynamo body. Maximum output by third brush.	115	Plain
1933							
1934	C35 A		CFR Contains two fuses. Small one for half charge only. Large one for accessories.	SA1 Warning light on dashboard panel			
1935							
1936	C35 M		CFR2 Contains similar Fuses to CFR		Half charge resistor and field fuse incorporated in cut-outs. Maximum output by third brush		
1937							
1938							
1939							

ACKNOWLEDGEMENTS

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MAGNETO IGNITION

By G. A. Ashwell, Service Manager, Globe & Simpson, Ltd.

THE magneto, unlike the coil, is a self-contained unit and does not have to depend on a current supply from a battery as it generates its own primary current. This fact is often argued in favour of the magneto as against coil ignition.

There are three distinct types of high tension magnetos now in use—(1) the rotating armature and permanent horseshoe magnet type; (2) the rotating magnet type with stationary armature; (3) the polar inductor type having stationary permanent magnets, stationary armature and rotating inductor.

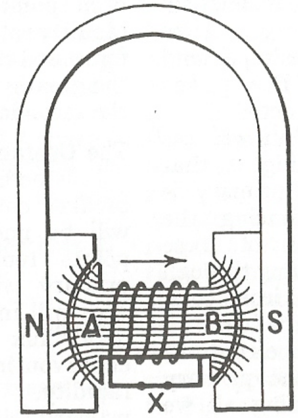

Fig. 1.—A Horse-shoe Permanent Magnet with Curved Pole Shoes, and an Armature of a Soft Iron Core Laminated in the Centre, with the Primary Winding shown.

The lines of force are flowing from the permanent magnet from N. to S.

The principles of the armature are the same as for coil ignition. There are two windings, a primary and secondary, with a condenser located across the contact breaker points.

How is the Current Induced in the Primary Winding?

This is brought about by utilising the principle of rotating a loop of wire in a magnetic f
explained in the first
of Coil Ignition (se
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shoe permanent magn
curved pole shoes to c
with the periphery
rotating armature. Th
ature is constructed o
iron core laminated
centre; this core is thor
insulated with oiled s
Empire cloth. The p
winding is then woun

For the moment, w
only consider what h
in the primary w
Referring again to Fig
will observe that the
force are flowing fro
permanent magnet fr
to S. and are conce[ntrating] through the armature core entering at the cheek A and leaving at cheek B. The reason for the lines of force concentrating through the core is due to the fact that this is the easiest path, iron being an excellent conductor of magnetic flux. Another minor point must be borne in mind —that is, the

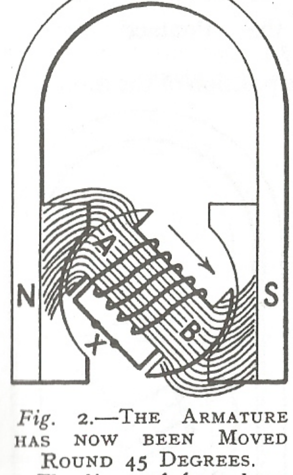

Fig. 2.—The Armature has now been Moved Round 45 Degrees.

The lines of force have been stretched like elastic, owing to the fact that the pole shoe and adjacent armature are unlike poles and attract.

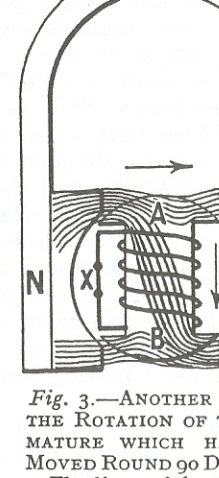

Fig. 3.—Another
the Rotation of
mature which h
Moved Round 90 D

The lines of forc
longer flowing thro
core but are
straight across th
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pole.

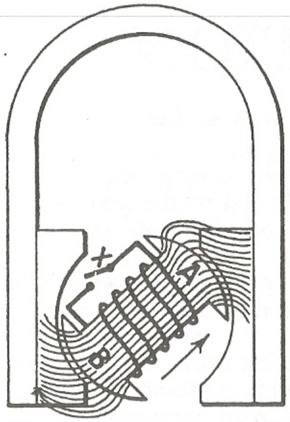

Fig. 4.—THE ARMATURE HAS NOW MOVED THROUGH 135 DEGREES.
The lines of force are entering from B and flowing out through A.

armature cheek marked A becomes a S. pole and cheek B becomes a N. pole, the law of magnetism being: like poles repel, and unlike poles attract.

You will see in Fig. 1 that the primary is embracing the lines of force flowing through the iron core, therefore to induce a current in the primary winding all we have to do is to make the winding cut the lines of force. It must be pointed out at this juncture that the primary circuit is a closed or complete circuit through the contact breaker X.

In Fig. 2 the armature has been moved round 45°—this has resulted in the lines of force being stretched like elastic, owing to the fact that the pole shoe and adjacent armature are unlike poles and attract. Fig. 3 shows another step in the rotation of the armature which has now moved round 90° from the position in Fig. 1. If you now follow the lines of force in Fig. 3 you will see that some of the lines are no longer flowing through the core but are flowing straight across the armature cheek to the opposite pole. Therefore the lines of force passing through the primary winding have decreased and a current has been induced in the primary winding. This in turn will tend to strengthen the magnetic flux in the core and attract the lines of force flowing from the permanent magnets.

Let us now turn to Fig. 4. The armature has now moved through 135° and a definite change will be seen to have taken place. The lines of force are now entering the armature core from the bottom cheek B and are flowing out through the cheek A, which is in the reverse direction to that in Figs. 1, 2 and 3. Therefore, the lines of force flowing through or embraced by the primary winding must have fallen to zero in one direction and started up in the opposite direction ; at the point of change the current in the primary will have reached its maximum. It has already been pointed out that the greater the rapidity of the collapse of the lines of force embraced by the primary winding, the greater will be the voltage induced in the secondary winding.

The Operation of the Contact Breaker.

It is here that the action of the contact breaker comes into the reckoning, as it will be understood that so long as the points remain closed, current in the primary winding will be able to flow. This will in turn tend to produce a magnetic flux in the core which we are endeavouring to decrease with the utmost rapidity. Therefore, if we break the primary circuit at the precise moment when the greatest change in flux density is taking place; we shall have an almost immediate collapse of the lines of force flowing through the armature core and windings, resulting in a very high induced voltage in the secondary winding. This is further assisted by the condenser, as explained in the chapters on Coil Ignition (see page 149).

When Should the Contact Breaker Points Open?

Fig. 5 shows the position of the armature when the contact breaker points open in the advanced position, and Fig. 6 the position of the armature when the points open in the retard position.

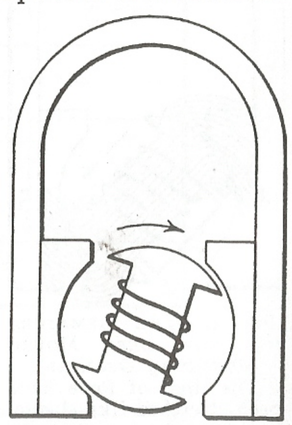

Fig. 5.—THE POSITION OF THE ARMATURE WHEN THE CONTACT BREAKER POINTS OPEN IN THE ADVANCED POSITION.

What Should be the Distance of the Air Gap?

This depends on the type and construction of the pole shoe.

The modern tendency is to use laminated pole shoes cast integral with a monobloc casting ; the earlier machines, however, had soft iron or cast iron pole shoes. The air gap for laminated pole shoes is usually between .5 mm. and 1.5 mm. ; with solid pole shoes it varies from 2 mm. to 3 mm. Some monobloc machines are provided with a small hole in the top of the casting over the armature tunnel, through which a small drill or jig-pin may be passed, as in Fig. 7, so that it will just fit between the edge of pole shoe and trailing edge of armature when the breaker points are just opening.

Fig. 8 shows the internal connections of a high tension magneto armature.

What is the Path of the Primary Circuit?

One end of the primary winding is earthed to the armature core either on the core itself before commencing the winding or at the condenser lug that is earthed to the end housing by means of a screw; the other end of the primary is brought out to the insulated side of the condenser and is in circuit with the lug receiving the centre screw of the contact breaker.

What is the Path of the Secondary Circuit?

One end of the secondary is connected to the primary winding and consequently goes to earth. The other end is brought out to the slip ring and conducted by a highly insulated conductor to the distributor.

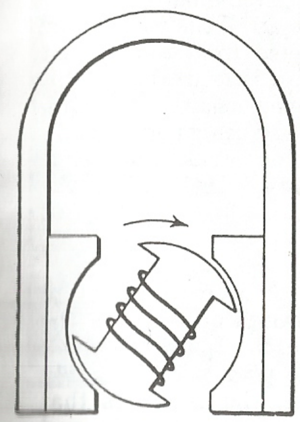

Fig. 6. — THE POSITION OF THE ARMATURE WHEN THE POINTS OPEN IN THE RETARD POSITION.

Distribution of the High Tension Circuit.

The high tension circuit is conducted to the distributor, as already stated; the conductor, however is located in a gear wheel and rotates to distribute the current to the respective plugs in turn.

If we turn back for a moment to Figs. 1, 2, 3 and 4, it will be seen that from Fig. 1 to Fig. 4 the armature has completed nearly half a revolution; by rotating the armature another 45° it will be in a similar position to Fig. 1. This being so, it will be understood that two sparks per revolution of the armature can be obtained.

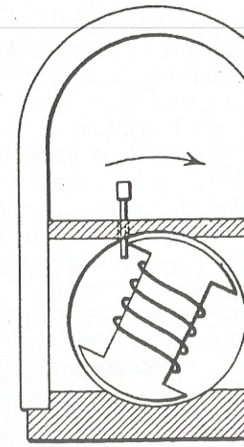

Fig. 7.—SOME MONO MACHINES ARE PROV WITH A SMALL HOLE I TOP OF THE CASTING THE ARMATURE TU
A small drill or jig- passed through the h that it will just fit be the edge of the pole sho trailing edge of the ture when the br points are just openi

A four-cylinder magneto runs at cr shaft speed but only one spark e second revolution is required for cylinder ; therefore, the distributor will need to run at half the s of the armature to obtain four sp for one revolution and so distri the sparks to the required cylinders in of the following sequences—1, 2, 4, 1, 3, 4, 2, a spark being required for half revolution of the crankshaft.

In a six-cylinder engine a spark wi required every third of a revolution o crankshaft. The magneto will t fore have to run at 1½ times the cr shaft speed. The distributor rota arm must run at half the speed of crank-shaft and fire each cylinder in of the following sequences—1, 4, 2, 6, or 1, 5, 3, 6, 2, 4.

The Operation of the Cams.

On a two, four or six-cylinder mag two cams are arranged to open contact breaker at the required mon The cams may be in the form of a cir steel ring ground away on two sides, as shown in Fig. 17, or may be two steel pieces mounted in a brass ring as shown in Fig. 18, and set at 180°.

It is very seldom that cams require renewing, but it is essential to see that the breaker points open evenly on each cam. In the case of a one-piece cam ring, it is impossible to make any adjustment to even up the cams should the points open unevenly. Repairs and adjustments are possible, however, with cams that are fitted as separate components in a brass cam ring.

To obtain the required amount of advance and retard, the cam is made moveable over a range of from 15 to 30 degrees, some makes of machines having a greater range than others. This movement is controlled by a pin or stop screw in the cam box, into which the cam ring fits, the inner lip of the cam ring being cut away to allow for the required amount of movement.

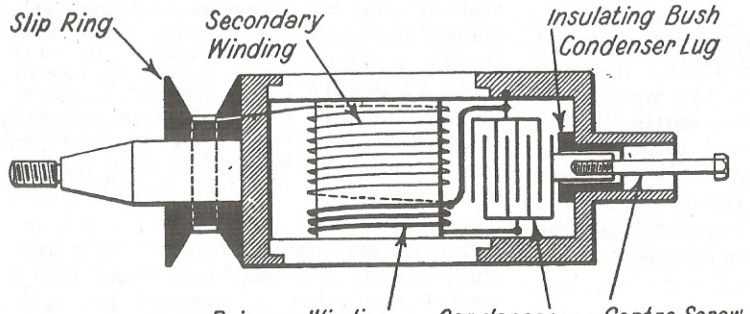

Fig. 8.—The Internal Connections of a High Tension Magneto Armature.

Modern Pole Shoe Design.

There has been a great advance in pole shoe design in recent years, and it has been found that by extending or stepping the pole shoes, as in Fig. 19, a stronger spark can be obtained in the retard position than was possible with the early type of pole shoe, as shown in Figs. 1, 2, 3 and 4. Another development has been the construction of laminated pole shoes.

Object of the Extended Pole Shoe.

The object of the extended pole shoe is to delay the reversal of the flux so that an efficient spark can be obtained in the retarded position for starting, for it is obvious that when the breaker points open in the retarded position in a magneto having pole shoes as in Fig. 1, a considerable loss of magnetic flux will have taken place in the armature core by leaking across the armature cheek to the opposite pole, therefore when the points open and the primary collapses the number of lines of force cut or changed in the winding will be less, resulting in a lower voltage being induced in the secondary winding. It must be understood that the induced voltage not only depends on the rapidity of the collapse of the lines of force but also on the quantity collapsed.

Testing and Fault Locating on H.T. Magnetos.

The usual symptoms are, of course, misfiring of the engine. A diagnosis of this complaint is not so easily located with a magneto as with coil ignition, and it is rather difficult to give rule-of-thumb methods. However, the following should be examined as a preliminary. If the engine refuses to fire at all the switch wire should be disconnected from the contact breaker as the trouble may be due to this wire having become chafed through, resulting in the primary being permanently earthed; therefore, no break would take place in the primary circuit when the points were opened.

Plugs.

Run the engine for a few minutes to warm it up, then switch off and feel the terminal top of each sparking plug; if you find that one plug is considerably cooler than the rest, this indicates that the plug has not been firing regularly, and it should be removed for inspection, and, if possible, another plug fitted for test. Very often a plug will appear to be in

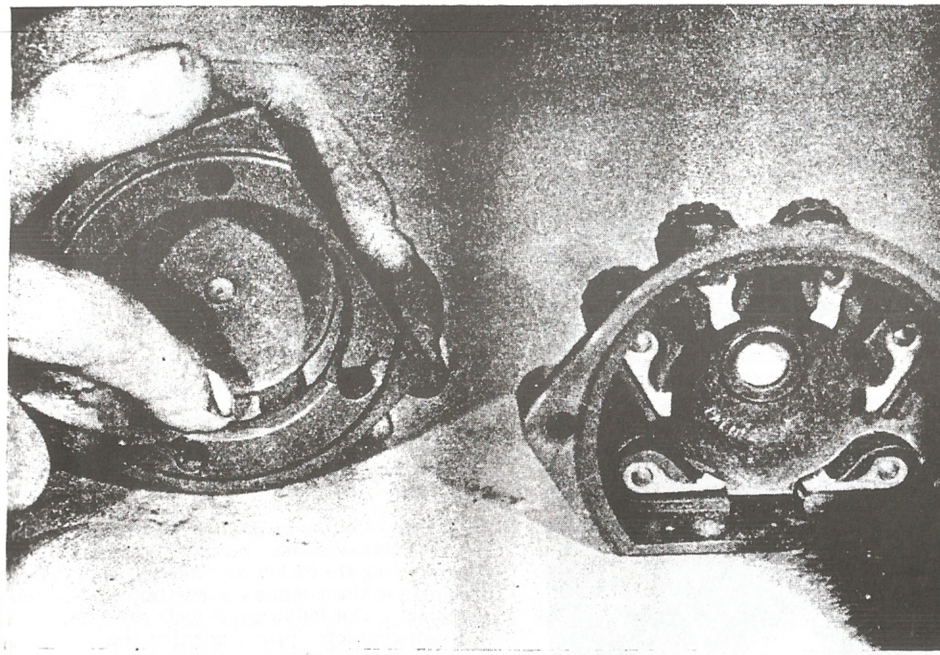

Fig. 9.—Two Types of Distributors are in General Use in Magneto Ignition, the Jump and Brush Wipe.

To clean the jump spark, a stiff dusting brush is generally used. If segments are badly pi means a new distributor as these segments are specially pinned and cannot be replaced. On the type, if it is black or sooted, a piece of fine emery is used, but if the distributor and segments are scored, it means refacing, which is a special process that has to be done in a lathe.

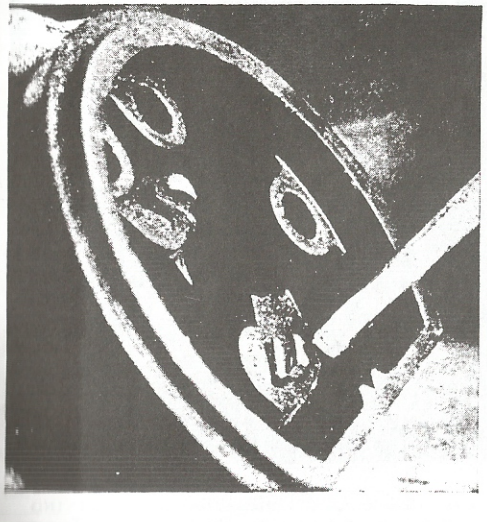

Fig. 10.—A Likely Fault to Look for in a Distributor.

This shows a badly worn distributor of the jump spark type. (*Euston Ignition Co.*)

Fig. 11.—A Possible Cause of Ma Failure.

Make sure the magneto brush has n come stuck up in the holder.

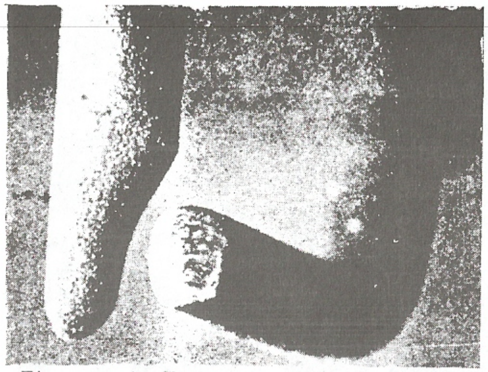

Fig. 12.—A Photo-micrograph showing How the Points of a Sparking Plug Become Worn Away After Long Use.

Fig. 13.—Note How the Round Electrode has Burnt Away Opposite Each of the Three Points.

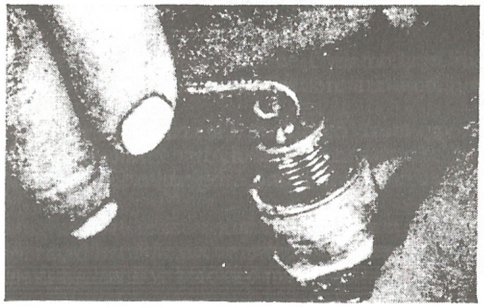

Fig. 14.—A Hacksaw Blade Provides an Emergency Gauge for Ensuring that Plug Gaps are Equal.

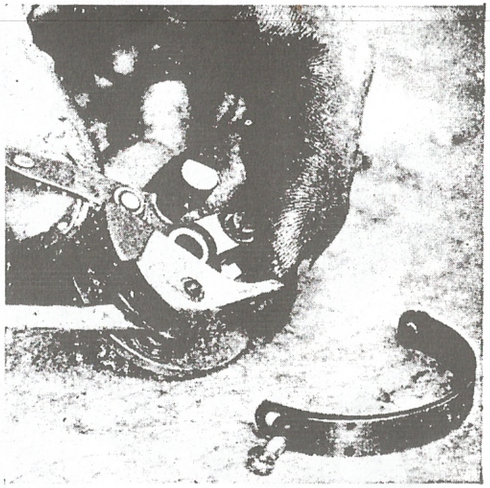

Fig. 15.—What to Do when the Contact Breaker has been Removed.
Showing the rocker arm being removed to examine the contacts after taking off the spring. The following defects are possible: Burnt contacts; points opening too wide or not wide enough; opening unevenly on cams; sticking rocker arm; or broken spring.

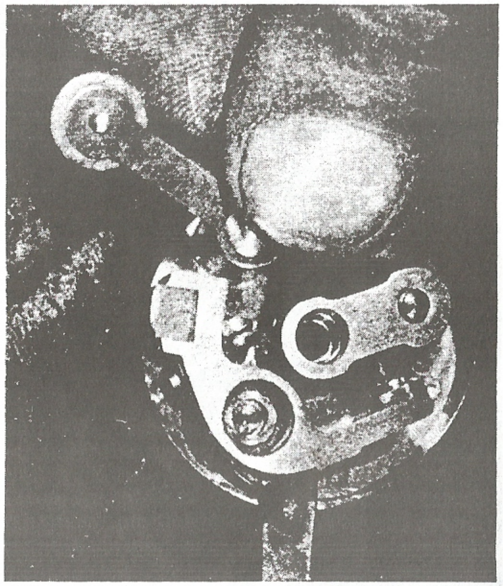

Fig. 16.—A Quick Method of Examining the Face of Contact Points is to Turn Retaining Spring and Prise Rocker Arm off the Bush.
If you find the surface of the points black or sooted it denotes dirt, petrol or oil vapour.

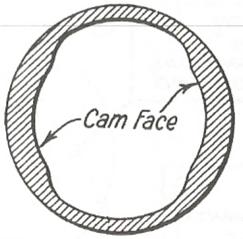

Fig. 17.—One Form of Cam Ring Used on a Two, Four or Six-cylinder Magneto.
This consists of a circular steel ring ground away on two sides.

order except for the fact that it is slightly sooted; do not confuse sooted plugs with carboned plugs. If a plug is badly carboned, you naturally rightly suspect that it is defective, but if a plug is only sooted, as though the mixture was too rich, you are apt to pass it over. This soot, however, is highly conductive, and the spark will track up the sooted porcelain or mica to the barrel of the plug and result in misfiring.

Too Great a Gap.

Another defect to look for in plugs is too great a gap due to the electrodes having burnt back. This state of affairs will reflect seriously on the secondary winding of the armature or coil, as the case may be, and is often the cause of a breakdown in the armature or coil, owing to the increased resistance to the H.T. spark.

Having made a preliminary test of the plugs as just described, and found them to be all more or less of the same temperature, a further test can be made by

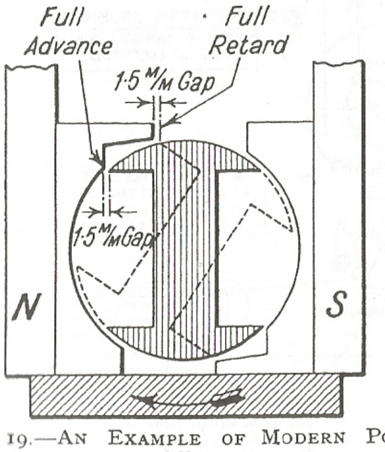

Fig. 19.—An Example of Modern Pole-shoe Design.
By extending or stepping the pole shoes, a stronger spark can be obtained in the retard position.

use of a good class neon plug
Having satisfied ourselves that the t
is not due to plugs, let us proceed
next point where trouble is likely
found.

Contact Breaker Faults.

Remove the contact breaker cove
examine the contact breaker poin
the following defects: Burnt con
points opening too wide or not
enough (the correct setting being
12 thou.); opening unevenly on
sticking rocker arm; or broken s
Any of the above defects, with the
tion of point adjustment, will neces
the removal of the contact breaker.

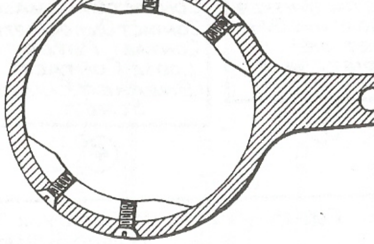

Fig. 18.—Another Form of Cam Ri
Consisting of two steel pieces mounte
brass ring and set at 180 degrees.

When removing this component,
care to see that the earthing brush
position and not stuck up. Another
elusive contact breaker fault is due
badly worn fibre heel; this is the
block attached to the rocker arm wh
is actuated by the cams. As this heel
down the points have to be adjusted
some types of contact breakers,
possible for the adjustment to be ca
so far that it allows the rocker ar
foul the centre block in which the
tionary point is fixed. When this ha
continual misfiring will take place an
only remedy is to fit a new fibre he
complete rocker arm, the latter re
mendation being the most efficient,
to the fact that by the time this sta
affairs has been reached the fulcrum
of the rocker arm will also have be
worn. A rocker arm having a
worn fulcrum pin will wobble about

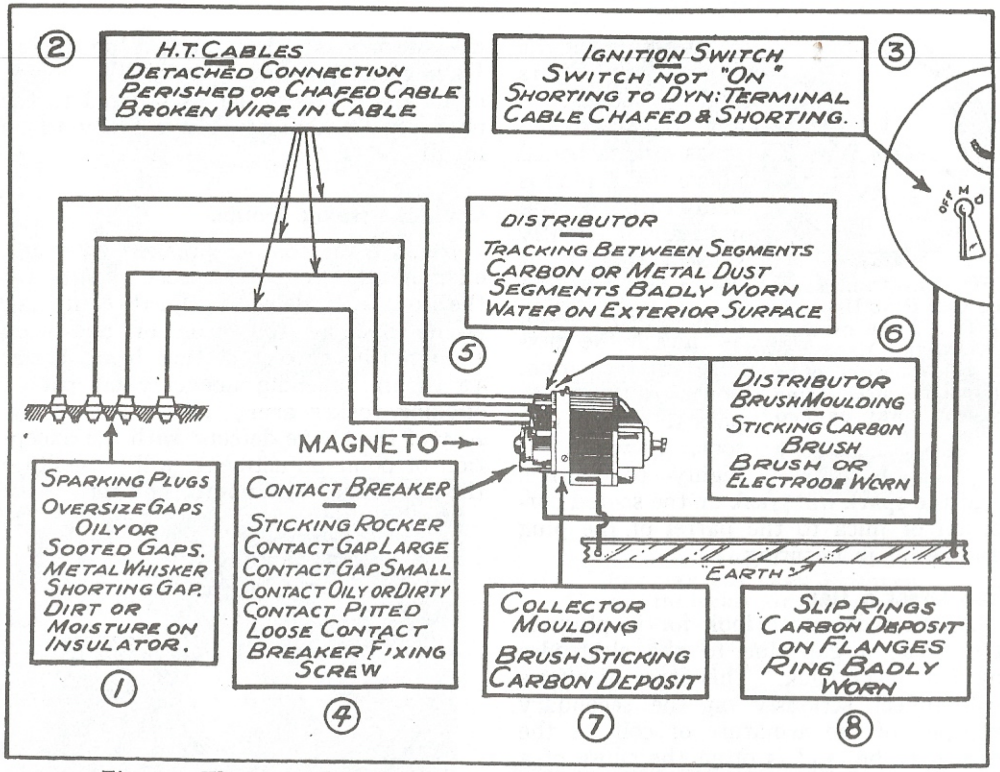

Fig. 20.—WHERE TO LOOK FOR TROUBLE IN A MAGNETO IGNITION SYSTEM. (Pictorial diagram.) See also Fig. 21.

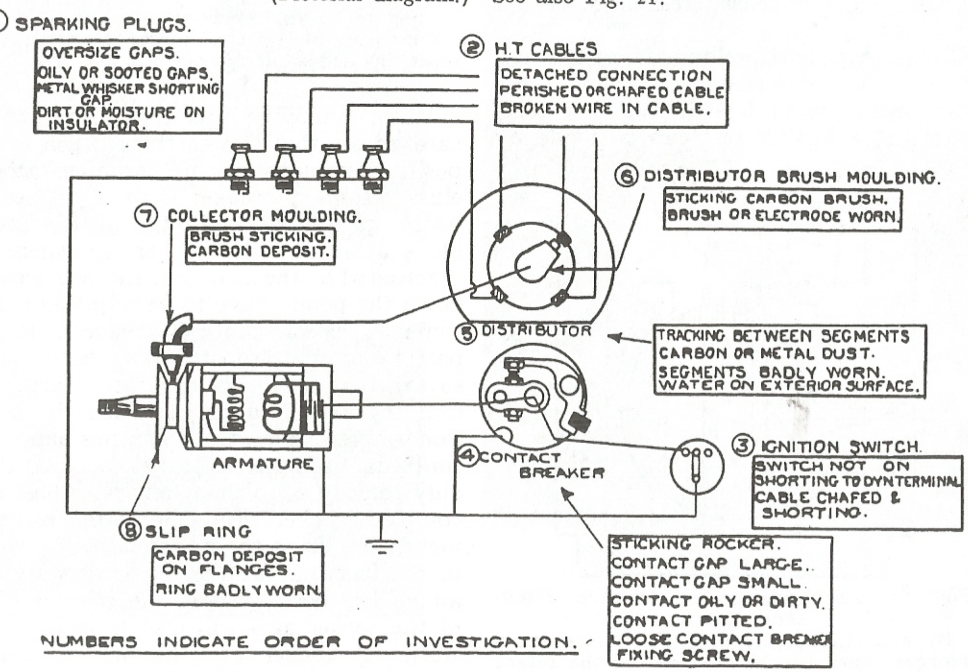

Fig. 21.—WHERE TO LOOK FOR TROUBLE IN A MAGNETO IGNITION SYSTEM. (Technical diagram.) To be studied in conjunction with Fig. 20.

FAULT TRACING CHART FOR MAGNETOS.

SYMPTOMS.	POSSIBLE CAUSES OF TROUBLE.
(A) Misfiring on one cylinder.	(1) H.T. cable detached; (2) Faulty insulation; (3) Wires broken in cable; (4) Plug fouled or defective; (5) Very large plug gaps; (6) Tracking over distributor surface—externally to earth—internally between segments
(B) Misfiring on half the cylinders.	(1) Contact gaps unequal—is timing control rod tilting cam tube?
(C) Misfiring irregularly on all cylinders at all speeds.	(1) Contacts dirty, pitted or worn; (2) Contact gaps small; (3) Loose contact screw; (4) Broken contact spring; (5) Contact lever movement sluggish; (6) Loose fixing screw; (7) Dirt or moisture on distributor surface (see A.6); (8) Plug gaps large; (9) Plugs leaky; (10) Carbon deposit on slip ring and collector moulding; (11) Carbon brush sticking; (12) Faulty collector, brush holder or slip ring; (13) Badly worn distributing electrode or segments; (14) Faulty secondary winding.
(D) Misfiring irregularly on all cylinders at high speed.	(1) Contact gaps large; (2) Contacts dirty, worn or pitted; (3) Contact screw loose; (4) Contact breaker fixing screw loose; (5) Switch cable faulty; (6) Contact lever sluggish; (7) Also as C.9 to C.14.
(E) Misfiring when ignition fully advanced.	(1) Contact gaps large or contacts worn; (2) Plug gaps large; (3) Plugs very leaky; (4) Secondary winding failing.
(F) Misfiring on hills when accelerating or timing retarded.	(1) Plug gaps large; (2) Plugs leaky; (3) As A.6 and C. 7; (4) As C.13; (5) Contact gap large; (6) As C.10; (7) As C.12; (8) Secondary failing.
(G) Misfiring at low speed and bad starting.	(1) Contacts dirty; (2) Contact breaker fixing screw loose; (3) Contact lever movement sluggish; (4) As E.1 to E.8 inclusive.
(H) Engine will not start (no spark from plug cable to earth).	(1) Excessive moisture on distributor; (2) Oil or dirt on contacts; (3) Contact lever sticking; (4) Broken contact lever spring; (5) Contact gap small; (6) Moisture or carbon deposit on slip ring and collector; (7) Switch cable earthed; (8) As C. 12, 13 and 14.
(I) Engine will not start (magneto O.K.).	(1) Plugs very leaky due to moisture externally and internally; (2) Plug gap large.
(J) Low maximum road speed	(1) Contact gap large; (2) Contacts dirty, worn or pitted; (3) Contact lever sluggish; (4) Secon

when running, causing misfiring to take place.

Assuming that we have found the contact breaker in order, let us now examine the H.T. circuit.

Testing for Faults in the H.T. Circuit.

Testing the H.T. circuit of a magneto while it is in position on the car is rather an unsatisfactory proposition, but nevertheless it has to be done when it is not convenient to remove the magneto for a bench test.

The procedure recommended is as follows: remove a wire from one plug and lay it on the cylinder so that the spark may jump to earth; start the engine, then hold the disconnected plug lead about a ½ in. from the cylinder. If the H.T. circuit is in order, the spark should jump this gap easily. If it does not, then the magneto is definitely defective. Do not be misled by the fact that you can obtain what you assume to be a good spark if you hold the plug wire say ⅛ in. from the cylinder, as this spark will not be strong enough to jump the plug points under compression. You must obtain a spark of at least ¼ in. for the plug to fire satisfactorily under compression. On no account should the engine be allowed to run with the disconnected plug lead in such a position that a spark cannot jump to earth.

From the foregoing remarks it will also be clear that the operation of removing all the plugs and laying them on the top of the cylinders with the plug leads connected, then cranking the engine and observing whether they are sparking or not, will be no criterion as to the condition of the magneto.

FAULTS WITH DISTRIBUTOR BOARDS, ROTORS AND PICK-UPS.

Should you find on testing the high tension that the spark is weak and will only jump a small gap, the following components should be examined for a possible visible fault.

Distributor Board.

Look for tracking between segments, tracking between cable terminals or puncture at base or adjacent to fixing clips (see Fig. 22). The foregoing faults are usually visible but in cases of doubt they can be tested on the H.T. test previously described (see page 154).

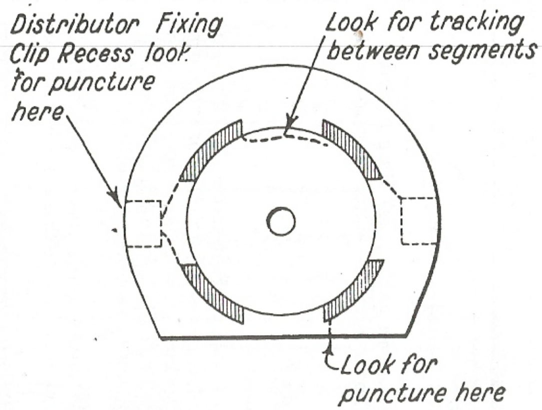

Fig. 22.—EXAMINE THE DISTRIBUTOR BOARD IF ON TESTING THE HIGH TENSION THE SPARK IS WEAK AND WILL ONLY JUMP A SMALL GAP.
Look for tracking between segments, tracking between cable terminals or puncture at base or adjacent to fixing clips.

Rotors.

This component can usually be withdrawn after removal of the distributor board; care must be taken not to let the carbon brushes fall out or fall into the magneto. The most common failure with this component is a puncture in the insulation, allowing the spark to jump to earth. A breakdown of this description is very rare and is more often brought about by the mishandling of the rotor, resulting in it becoming cracked.

The Pick-up.

This component is situated at the slip ring end of the armature and picks up the H.T. current from the slip ring.

Defects to look for in the pick-up are puncture in insulation, tracking, carbon brushes stuck up, broken or missing altogether. Let us assume that the foregoing components have tested O.K. but still we obtain no results from the magneto. The only obvious course is to remove the magneto for further bench tests,

Electrical Fault Finder

HOW TO LOCATE AND REMEDY TROUBLE

CONDITION	METHOD OF DETECTION OF POSSIBLE CAUSES	REMEDY
Engine will not fire	Starter will not turn engine and lamps do not give good light. Battery discharged.	Start engine by hand. Battery should be recharged by running car for a long period during daytime with charging switch in full charge position. Alternatively recharge from an independent electrical supply.
	Controls not set correctly for starting.	See that ignition is switched on, petrol turned on, and everything is in order for starting.
	Remove lead from centre distributor terminal and hold it about ½ in. away from some metal part of the chassis, while engine is turned over. If sparks jump gap regularly, the coil and distributor are functioning correctly. If the coil does not spark, the trouble may be due to any of the following causes.	Examine the sparking plugs, and if these are clean and the gaps correct, the trouble is due to carburettor, petrol supply, etc.
	Fault in low tension wiring. Indicated by (*a*) No ammeter reading when engine is slowly turned and ignition switch is on, or (*b*) No spark occurs between the contact points when quickly separated by the fingers when the ignition switch is on.	Examine all cables in ignition circuit and see that all connexions are tight. See that battery terminals are secure.
	Dirty or pitted contact points.	Clean with fine emergy cloth and afterwards with a cloth moistened with petrol.
	Contact breaker points out of adjustment. Turn engine until contacts are fully opened and test gap with gauge and spanner.	Adjust gap with gauge to 0·010–0·012 in.
Engine misfires	Dirty or pitted contact points.	Clean with fine emery cloth and afterwards with a cloth moistened with petrol.
	Contact breaker points out of adjustment. Turn engine until contacts are fully opened and test gap with gauge and spanner.	Adjust gap with gauge to 0·010–0·012 in.
	Remove each sparking plug in turn, rest it on the cylinder head, and observe whether a spark occurs at the points when the engine is turned. Irregular sparking may be due to dirty plugs or defective high tension cables. If sparking is regular at all plugs the trouble is probably due to engine defects.	Clean plugs and adjust the gaps to about 20 thousandths of an inch. Replace any lead if the insulation shows signs of deterioration or cracking. Examine carburettor, petrol supply, etc.

HOW TO LOCATE AND REMEDY DYNAMO TROUBLE

Symptoms	Probable Fault	Remedy
Ammeter fails to indicate charge when running with no lights in use, or gives heavy discharge with lights on.	Dynamo not charging due to: Broken or loose connexion in charging circuit causing field fuse to blow (when fitted).	Examine charging circuit wiring. Tighten loose connexion or replace broken lead. Particularly examine battery connexions. Fit replacement fuse.
	Commutator greasy or dirty.	Clean with soft rag moistened in petrol.
Ammeter gives low or intermittent charge reading.	Dynamo giving low or intermittent output, due to—	
	Loose or broken connexions in dynamo circuit.	Examine charging circuit wiring. Tighten loose connexions or replace broken lead. Particularly examine battery connexions.
	Commutator or brushes greasy.	Clean.
	Brushes worn, not fitted correctly, or wrong type.	Replace worn brushes. See that brushes "bed" correctly.
Ammeter gives high charge reading.	Dynamo giving high output due to—	
	Loose connexions in dynamo charging circuit.	Examine charging circuit wiring. Particularly battery connexions. Tighten loose connexions.
	Battery acid level low.	"Top-up" cells with distilled water.
	Brushes not fitted correctly.	See that brushes "bed" correctly.
	Control brush position altered.	Have control brush adjustment reset at nearest Service Depot.

HOW TO LOCATE AND REMEDY LIGHTING TROUBLE

Symptoms	Probable Fault	Remedy
Lamps give insufficient illumination.	Battery discharged.	Charge battery either by a l period of daytime running from independent electr supply.
	Lamps out of alignment or bulbs out of focus.	Align lamps and focus bulbs.
	Bulbs discoloured through use, or reflectors dirty.	Fit new bulbs or clean reflect
Lamps light when switched on, but gradually fade out.	Battery discharged.	As above.
Brilliance varies with speed of car.	Battery discharged.	As above.
	Battery connexion loose or broken.	Tighten connexions, or repl faulty cables.
Lights flicker.	Loose connexion.	Locate loose connexion tighten.
Failure of lights.	Fuse blown.	Examine wiring for faulty ca and remedy. Fit replacem fuse.
	Battery discharged.	As above.
	Loose or broken connexions.	Locate and tighten loose c nexion, or remake bro connexion.

Electrical Fault Finder

HOW TO LOCATE AND REMEDY STARTER MOTOR TROUBLE

Condition	Probable Fault	Remedy
Motor sluggish or fails to move engine.	If engine cannot be turned by hand, then fault is due to a stiff engine.	Locate and remedy cause of stiffness.
	If engine can be turned by hand, then trouble may be due to—	
	Battery discharged.	Start by hand. Charge battery either by a long period of daytime running or from independent electrical supply.
	Broken or loose connexion in starter circuit.	See that connexions to battery, starter, and starter switch are tight, and that cables connecting these units are in order.
	Starter commutator or brushes dirty.	Clean.
	Brushes worn, not fitted correctly or wrong type.	Replace worn brushes. See that brushes "bed" correctly.
	Starter pinion jammed in mesh with flywheel.	Rotate squared end of starter shaft with spanner. When a squared end is not provided on the starter shaft, the pinion can usually be released by putting the car in gear and rocking it backward and forward. If this method fails, remove starter from car and test its alignment. Remount starter and tighten fixing bolts.
Starter operates but does not crank engine.	Pinion of starter drive does not engage with flywheel, due to dirt on screwed sleeve.	Clean sleeve with paraffin and add a few drops of machine oil.
Starter pinion will not disengage from flywheel when engine is running.	Starter pinion jammed in mesh with flywheel.	Rotate squared end of starter shaft with spanner.