

# COIL IGNITION



## INTRODUCTION

The function of the ignition system is to provide sufficient voltage at the spark plugs to ignite the petrol/air mixture in the cylinders, as each piston approaches the correct firing position, i.e. a few degrees before top dead centre on compression stroke. The exact number of degrees varies with different engines and will be specified by the engine manufacturers.

The amount of voltage needed will also vary with a number of factors such as engine temperature, compression ratio, spark plug gap.

Although the standard ignition system will quite adequately meet the requirements of a six-cylinder

engine up to approx. 8,000 rev/min, any increase in speed requirements or in the number of cylinders will place extra demand on the system.

Ignition systems can be produced to comply with these additional demands. For example, ballasted systems to facilitate easier cold starting or electronic systems to provide high speed operation on multi-cylinder engines.

The systems dealt with in this section are:

- (a) Standard coil ignition.
- (b) Ballasted ignition (easy start).
- (c) OPUS (Oscillating pick-up system - fully electronic, no contacts).

Fig. 23 shows a typical coil ignition circuit.

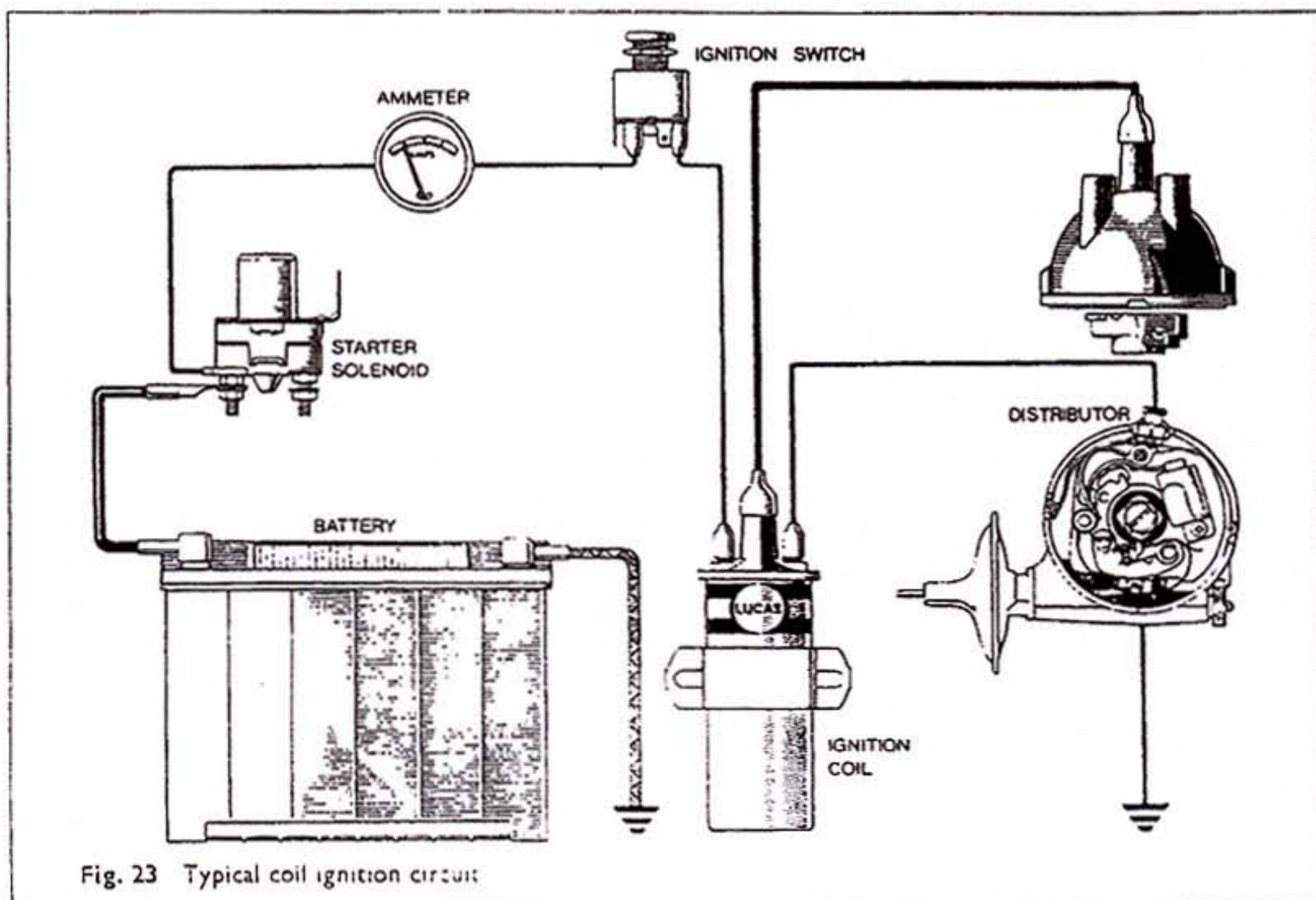
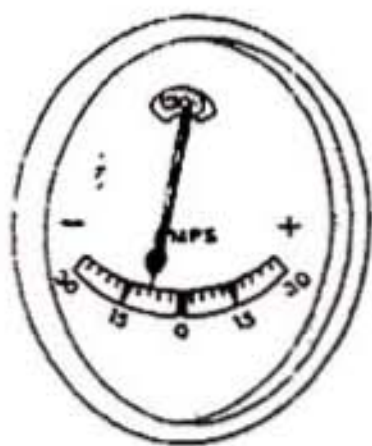


Fig. 23 Typical coil ignition circuit





Ammeter



Ignition Switch On



Lighting Switch On



Warning Light

Fig. 24 Battery — rapid check

## STANDARD COIL IGNITION SYSTEM

### TEST 1. Battery: Rapid Check (Fig. 24)

When dealing with the ignition system a quick method of checking the battery is as follows: Switch on headlights and ignition and operate the starter. If the engine is turned over at a reasonable speed and the lights remain fairly bright, (they will dim slightly) we can assume that the battery will supply sufficient current for us to be able to carry out the ignition test procedure. Should the lights dim excessively and the starter appear sluggish, the complete test procedure must be applied to the battery (i.e. hydrometer and high rate discharge).

### TEST 2. Check for H.T. Sparking

This test is to ascertain whether a good H.T. spark is being produced. Remove the main H.T. lead from the distributor cap and hold the end of the cable approx. 6 mm (0.25") from the engine block (see Fig. 25). Switch on the ignition, crank the engine and check for regular sparking.

If regular sparking occurs, this suggests a fault other than coil output, i.e. plugs, fuel system, timing etc., but if sparking does not occur, proceed with following tests.

## CHECKING THE PRIMARY CIRCUIT

### TEST 3. Voltage at '+' Terminal of Coil (Contacts Closed)

A voltmeter is connected between the '+' terminal of the ignition coil and a good earth point (for example, the engine block or chassis), see Fig. 26.

It is preferable for the contacts to be closed during the test, so that current is flowing through the primary winding.

The ignition is then switched on. If the voltmeter registers the same voltage as the battery voltage under load, i.e. ignition on, contacts closed, it proves that the supply from the battery to the ignition coil is satisfactory.

On the other hand, zero or low voltage indicates a fault between the battery feed and the '+' terminal in which case this circuit must be checked back to the source of supply.

**Note:** All tests are for negative earth systems.

It should be remembered that in a positive earth system, the supply side of the ignition coil is the '-' terminal.

### TEST 4. Voltage at '-' Terminal of Coil (Contacts Open)

Next, the primary winding is checked for continuity. The contact points must be open. A voltmeter is connected between the '-' terminal of the coil and earth (Fig. 27). When the ignition is switched on, the voltmeter should register battery voltage. If a zero reading is obtained, it indicates:

1. The primary winding of the ignition coil may be open-circuit, or
2. There may be a short-circuit to earth in the distributor or in the coil-distributor lead.

To help ascertain the actual cause of failure, the lead from the '-' 'L.T.' terminal of the coil is disconnected, and another voltmeter reading is taken.

- (a) If a zero reading is obtained, there is a break in the primary winding.
- (b) If the voltmeter registers battery voltage, the short-circuit is either on the coil to distributor lead or within the distributor.

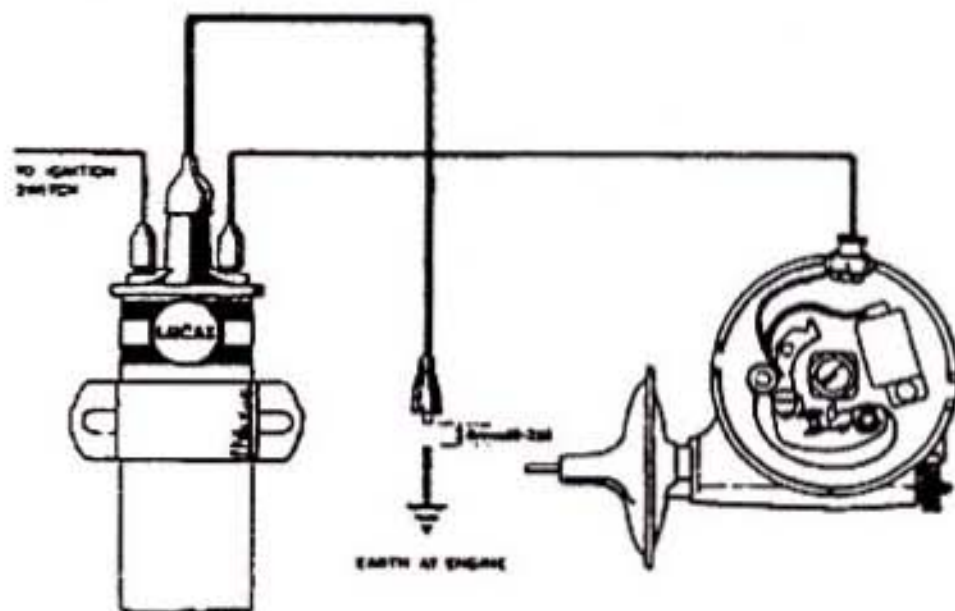


Fig. 25 Checking for H.T. sparking

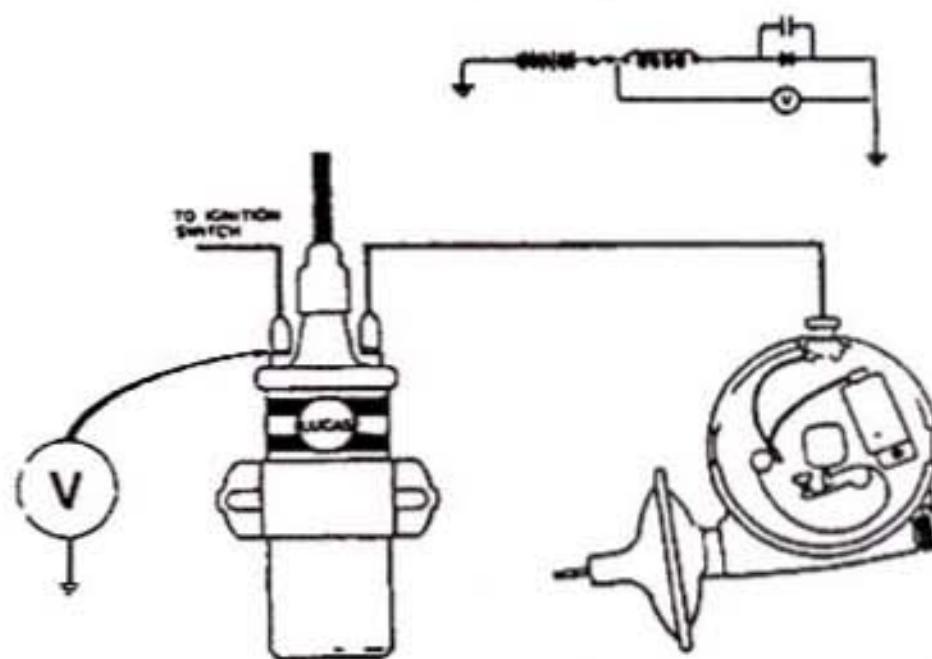


Fig. 26 Voltage at '+' terminal of coil (contacts closed)

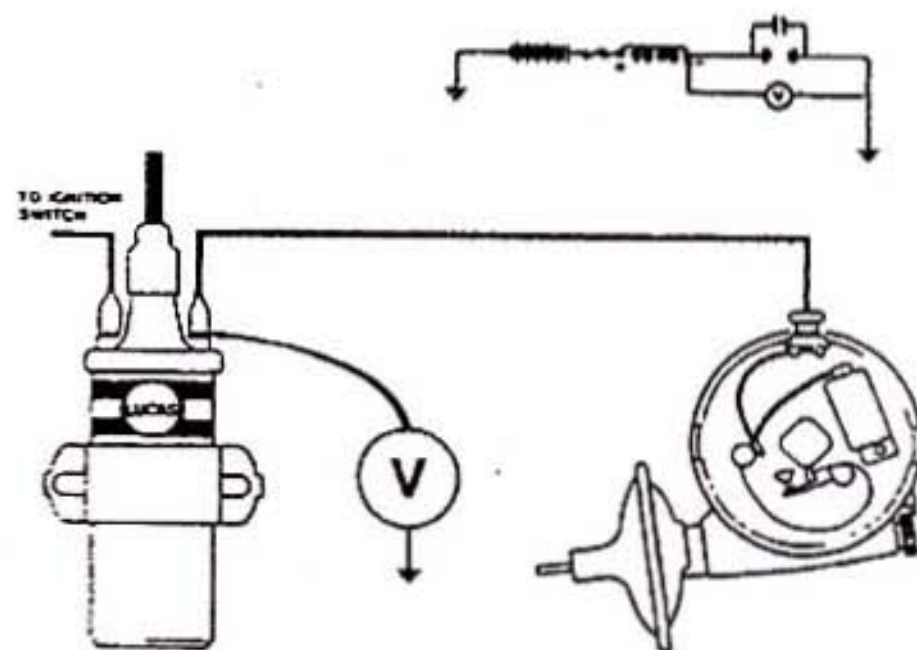


Fig. 27 Voltage at '-' terminal of coil (contacts open)



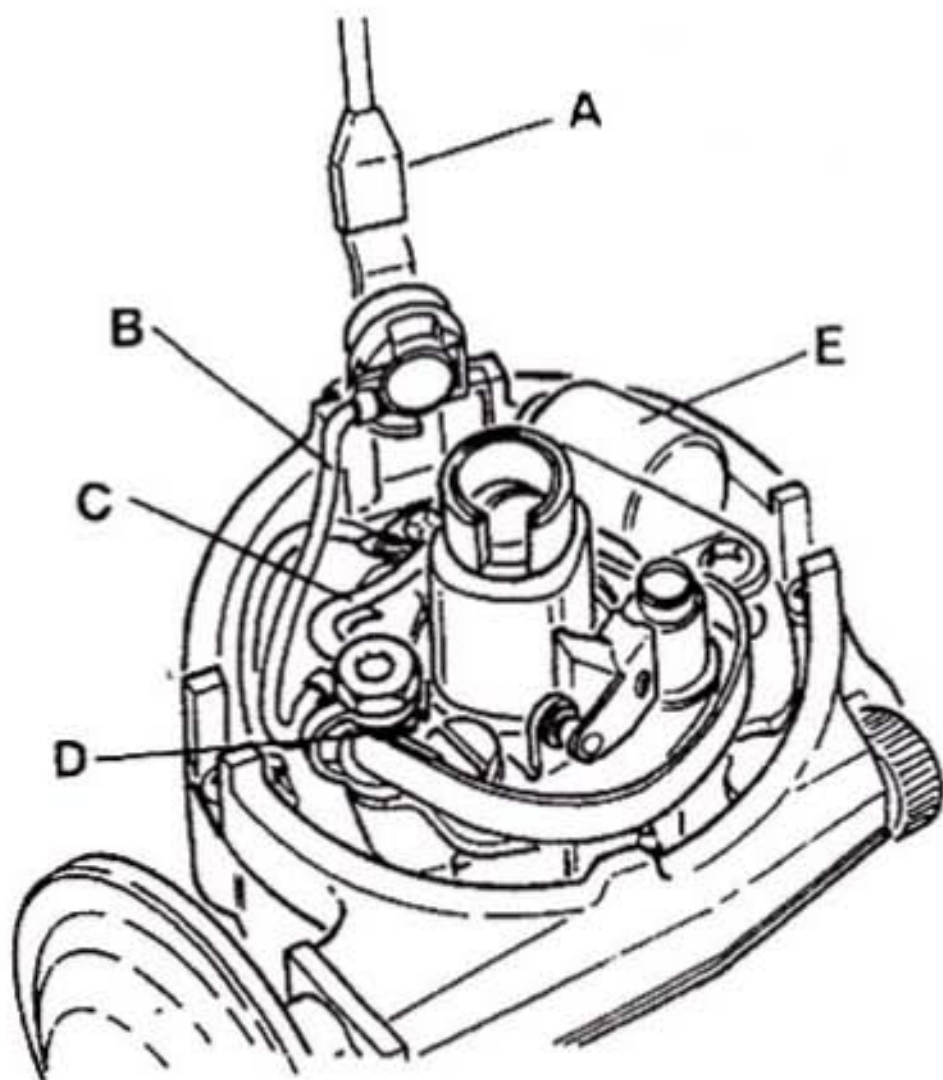


Fig. 28 Distributor: earth

#### TEST 5. Distributor - Earth

If the last test has shown that the distributor is short-circuited to earth, the following points in the 'L.T.' line should be checked, see Fig. 28.

- The lead between the ignition coil ('—' terminal) and the distributor L.T. terminal.
- The flexible lead, connecting the distributor L.T. terminal to the moving contact (terminal post).
- The flexible lead, connecting the contact breaker terminal post to the capacitor.
- Also check that the tags on the ends of the capacitor and flexible leads at the L.T. terminal post are under the shoulder of the nylon bush, and not under the securing nut.
- Finally, check that the capacitor is not earthed. This is achieved by disconnecting the capacitor from its mounting.

#### TEST 6. Voltage at '—' Terminal of Coil (Contacts Closed)

When all connections are re-made, the voltmeter is left connected as in the previous test, i.e. between the coil '—' terminal and a good earth (Fig. 29). The contact points are closed by rotating the engine. When the ignition is switched on, a zero reading should be obtained.

If the voltmeter registers a voltage, it is due to one of the following faults:

1. Dirty or oily contacts.
2. Faulty earth connection (i.e. between the distributor shank and the engine block, or the flexible lead from the contact plate to earth).
3. Contacts not closing properly.
4. A high resistance in circuit from the coil to the C.B. on the distributor.
5. Broken flexible lead between the distributor L.T. terminal and the contact breaker terminal post.
6. Open-circuit coil to distributor lead.

#### TEST 7. Checking the Secondary Circuit

The secondary circuit is checked to ensure that sufficient voltage is induced in the secondary winding to produce a high voltage spark.

One end of a known good H.T. lead is connected in the H.T. outlet of the ignition coil. The other end is held approximately 6 mm (0.25") from a clean area of the engine block (Fig. 30). With the distributor contacts closed, the ignition is switched on. The contacts are then flicked open and if a good strong spark is obtained across the gap for each flick, it proves that the ignition coil and capacitor are serviceable.

If no spark occurs until the 6 mm (0.25") gap is reduced, this indicates either a faulty capacitor or weak secondary output, proceed to next test.

#### TEST 8. Checking the Capacitor

The capacitor is checked by substitution.

The original capacitor is disconnected, and a test capacitor, known to be serviceable, is connected between the distributor L.T. terminal and earth, as shown in Fig. 31.

Switch on the ignition. If an unsatisfactory spark is obtained when the contacts are flicked open, as in the previous test, the secondary winding of the ignition coil is faulty. However, if the spark is now improved, it shows that the original capacitor was not functioning satisfactorily.

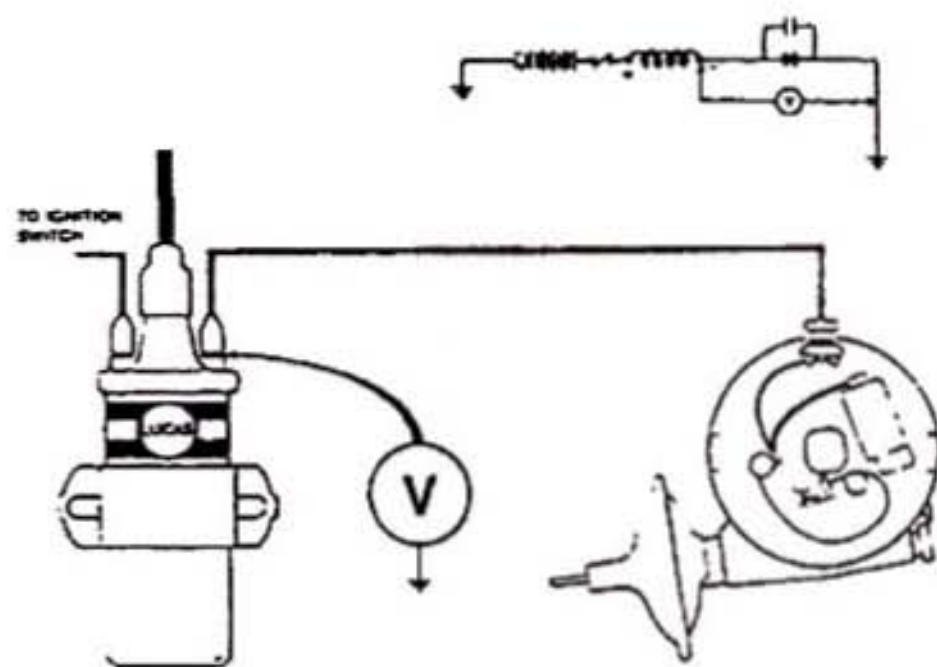


Fig. 29 Voltage at '—' terminal of coil (contacts closed)

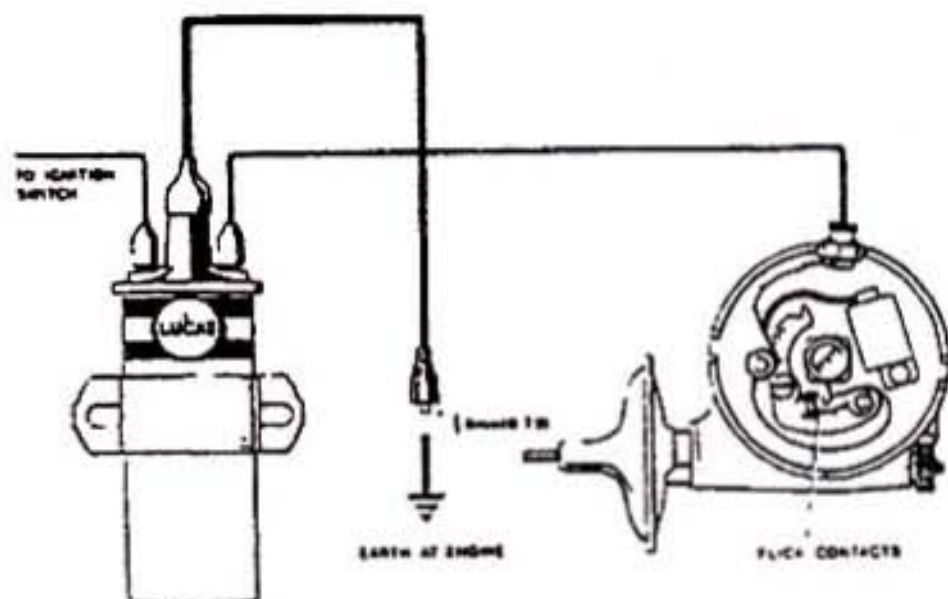


Fig. 30 Checking the secondary circuit



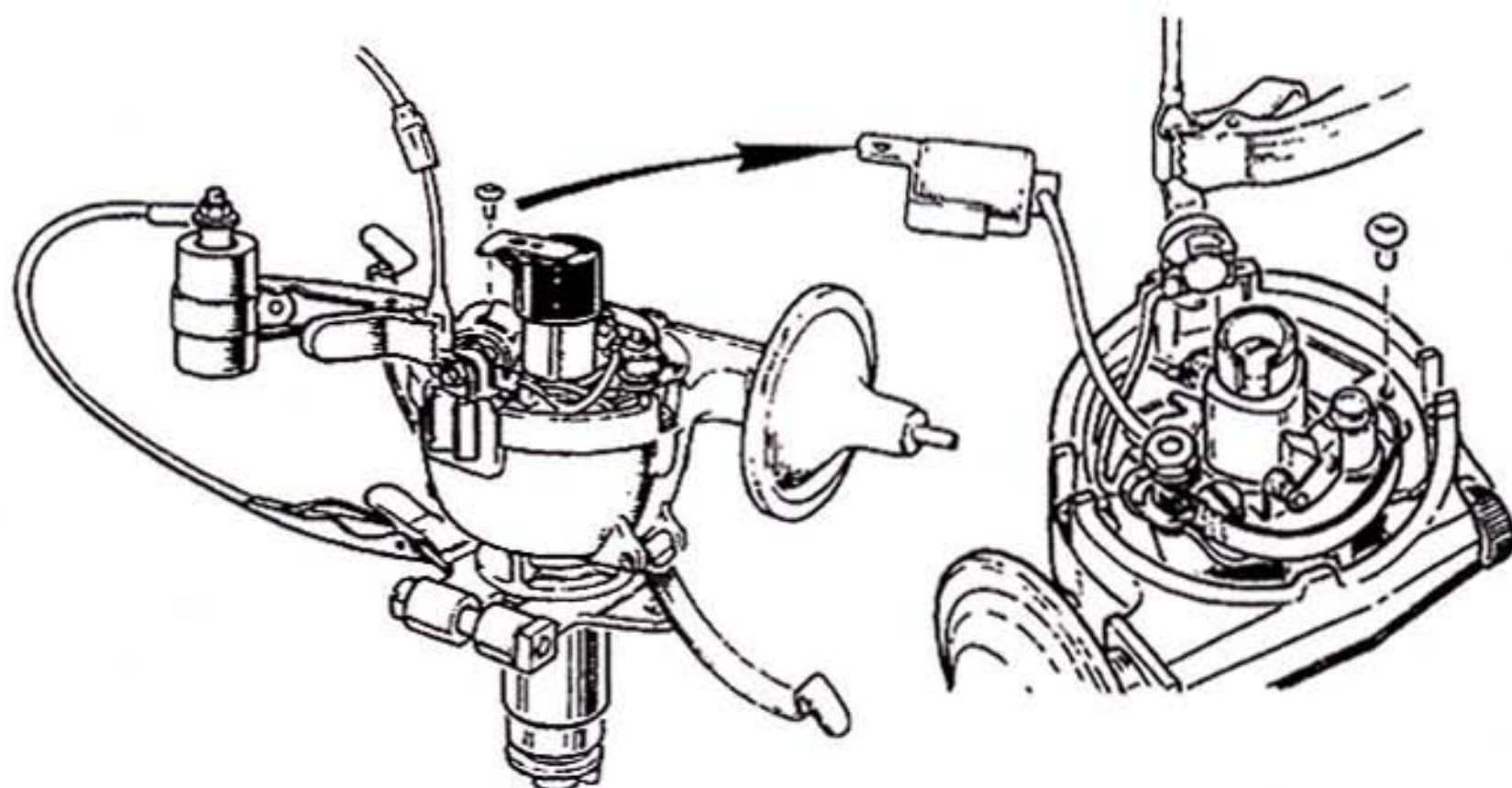


Fig. 31 Checking the capacitor

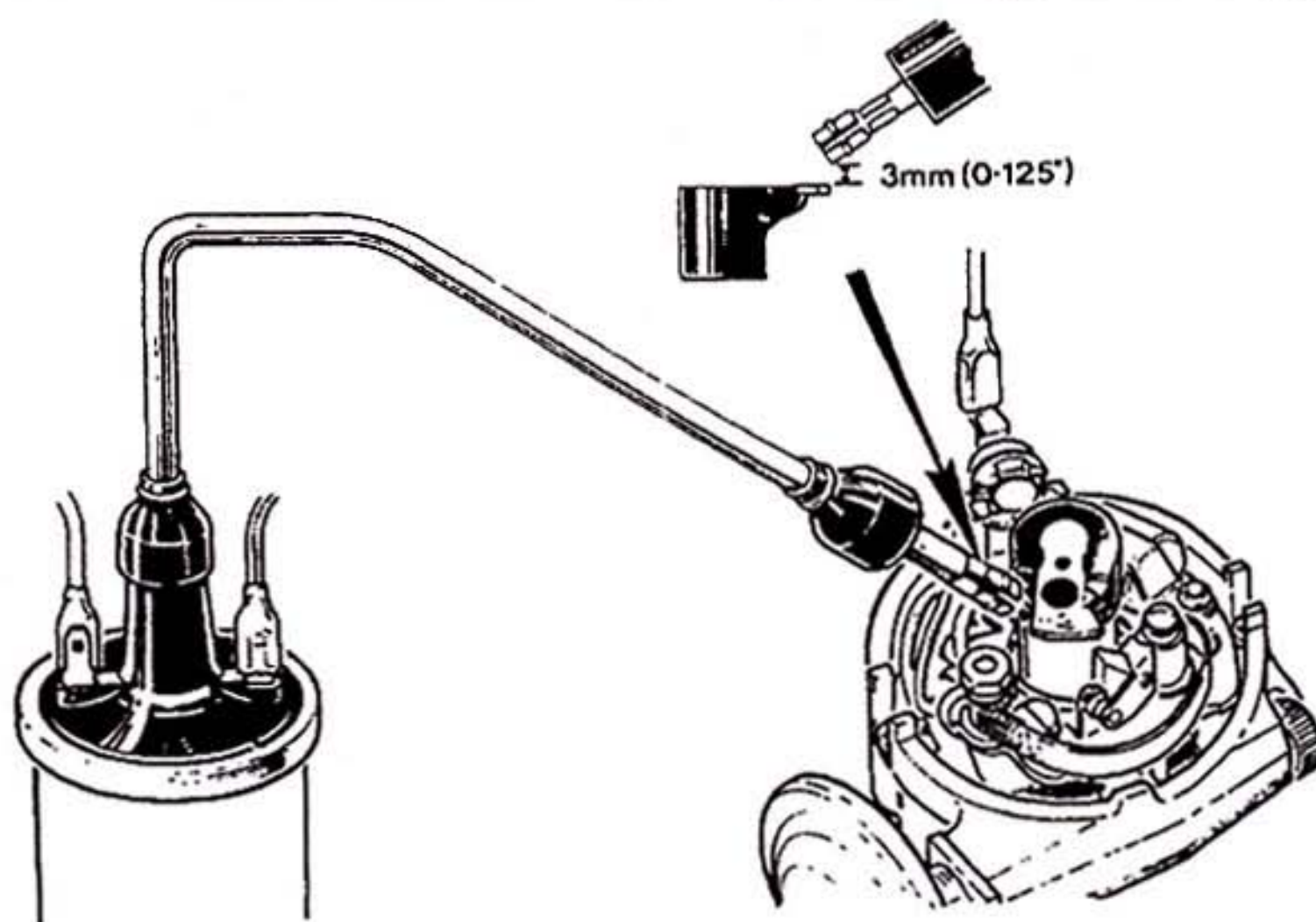


Fig. 32 Checking the rotor arm insulation

#### TEST 9. Checking the Rotor Arm Insulation

Next, the rotor arm is checked to ascertain whether it is punctured, this would cause the spark to be earthed on the cam-head. However, as the punctures are invisible to the naked eye, the following method is adopted.

An H.T. lead is connected in the chimney of the ignition coil and the other end is held approx 3 mm (0.125") from the rotor arm electrode as shown in Fig. 32. When the ignition is switched on, the contacts are flicked open. If there is a spark, it proves that the rotor arm is earthed on the cam-head. The rotor arm should, therefore, be replaced.

(The H.T. spark referred to should not be confused with the faint sparking, due to electrostatic charge and leakage)

#### DISTRIBUTOR COVER AND H.T. LEADS (Fig. 33)

The distributor cover should be thoroughly cleaned, inside and outside, with a soft, dry cloth, paying particular attention to the space between the electrodes

If the cover is "tracked" (shown by a thin, conducting track of burned bakelite between the electrodes or to earth), it should be replaced.

The condition of the H.T. cables, especially the insulation, is then checked.

When the insulation shows signs of cracking or perishing the cables must be renewed. Special care must be taken to maintain the correct firing order when replacing the H.T. cables.



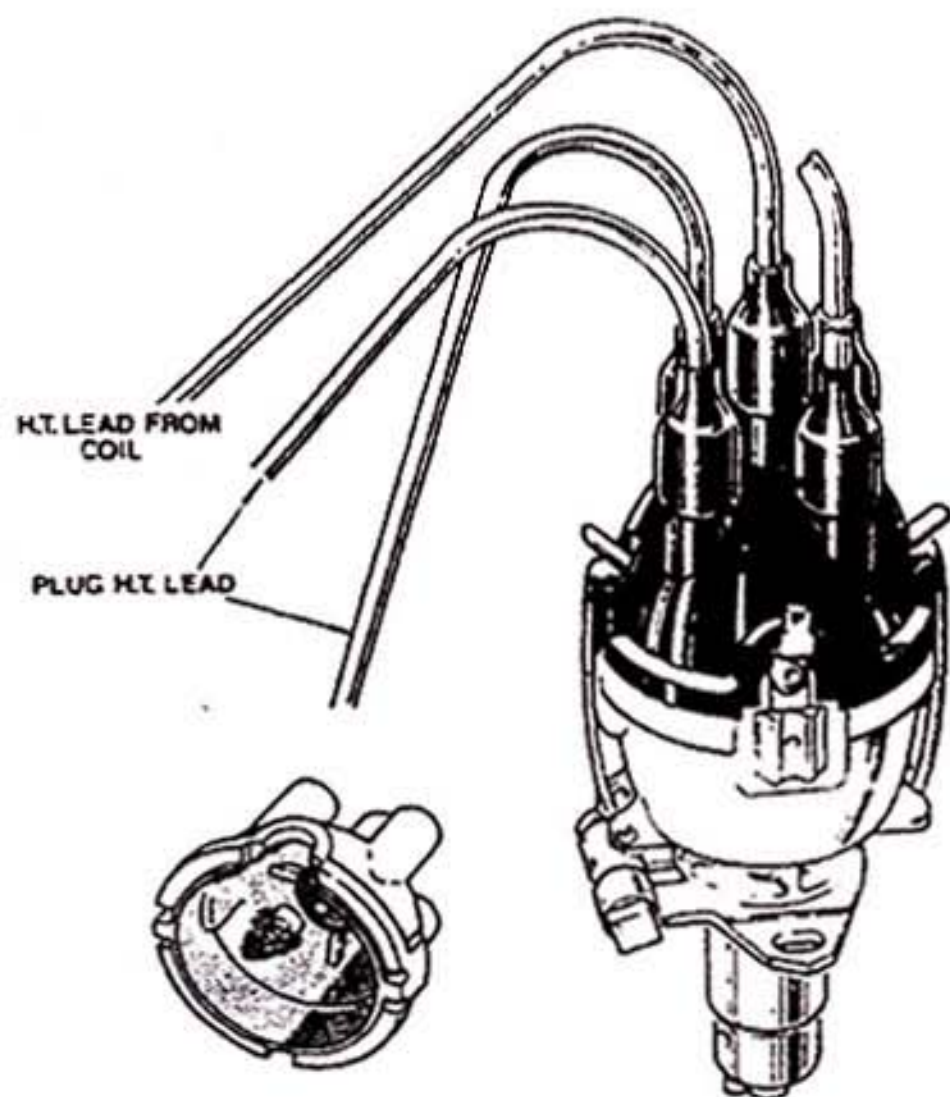


Fig. 33 Checking the distributor cover and leads

### CONTACT BREAKER ASSEMBLY AND GAP SETTING (Fig. 34)

The contact breaker must be maintained in good condition. Ensure that the contact surfaces are free from oil and grease. If the contacts show signs of excessive wear, they should be replaced.

When setting the contact breaker gap ensure that the contacts are fully open (i.e. the contact heel is on the peak of the cam lobe). A gauge of the appropriate thickness, 0.35–0.40 mm (0.014"–0.016"), should make a sliding fit between the contacts. It is advisable to re-check the gap after adjustment, to ensure no movement has taken place while the screw was being tightened.

Providing the distributor is in good mechanical condition, an alternative method of setting the contact gap is to use an accurate dwell angle meter.

### CONTACT BREAKER ADJUSTMENT FOR 35D DISTRIBUTORS

The contact breaker setting is adjusted by rotating the hexagon-shaped stud which protrudes through the distributor body. It is adjusted to give the correct dwell angle (contact closed period), see Fig. 35.

Adjustment should be carried out using a dwell meter with the engine running. The dwell angle should be set within the limits specified by the manufacturer. The hexagon-shaped stud is screwed anti-clockwise to increase the dwell angle (close the contact point gap) and clockwise to decrease the dwell angle (open the contact gap).

Note: Static and stroboscopic timing are described at the end of the chapter.

### BALLASTED IGNITION SYSTEM

Ballasted ignition systems (Fig. 36) are used to improve engine starting especially in very cold conditions, and also to provide maximum spark efficiency at high engine speeds.

Battery voltage is at its lowest when the engine is being cranked. This drain on the battery causes the terminal voltage to fall well below its normal value. Consequently, during starting the H.T. spark is obtained from an ignition coil which is operating from a reduced voltage. In these conditions the ignition performance is usually satisfactory, but in extremely cold conditions it is preferable to use a system in which the voltage applied to an appropriate coil remains constant.

A ballast resistor is connected in series with the ignition coil primary winding, and the circuit is arranged to short out the resistor when the starting motor is operating.

The ballast resistor normally comprises a coil of resistive wire housed in a porcelain block with electrical connections by means of 'Lucar' connectors.

The ballast resistor is clamped to its fixing (often an ignition coil mounting bolt) by a bracket surrounding the porcelain block.

Note: The resistor may take the form of a resistive cable on some applications.

The cold starting performance is improved by permitting the ignition coil to operate at a voltage slightly above its normal operating voltage. Slight overloading is not detrimental to the coil as it occurs only while the engine is being cranked.

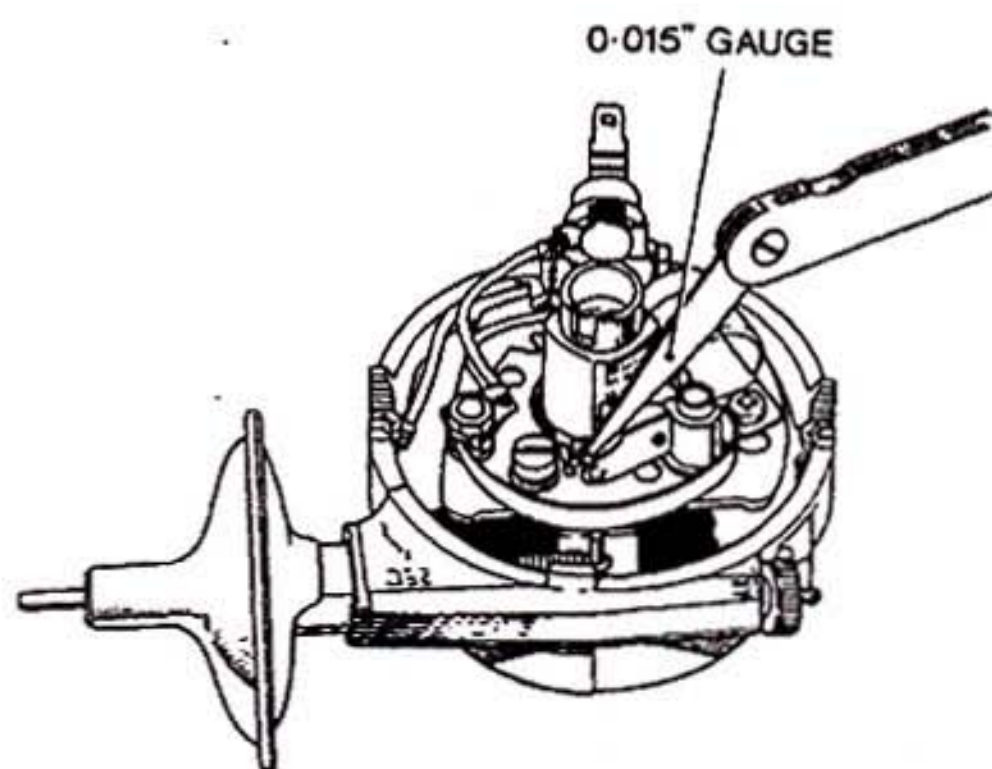


Fig. 34 Checking the contact breaker assembly and gap setting

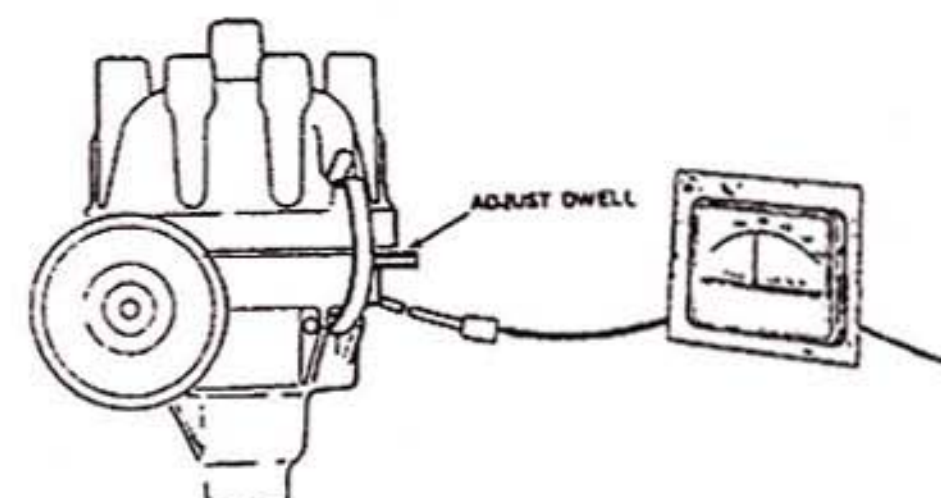


Fig. 35 Contact breaker adjustment for 35D distributors



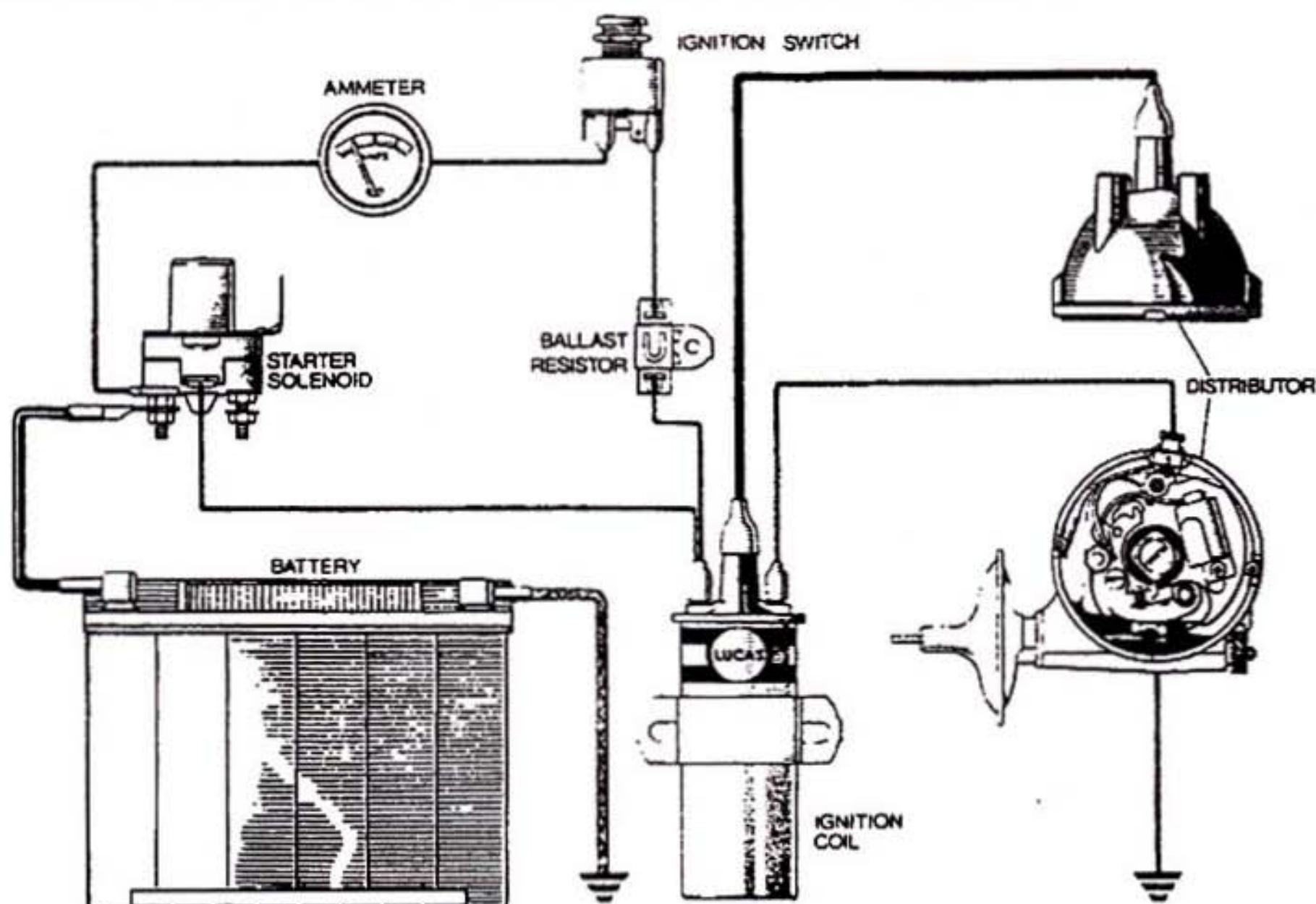


Fig. 36 Typical ballasted ignition system

The primary winding of an ignition coil (used with a ballast resistor) has a lower inductance value, which permits a more rapid build up of the magnetic field as the contact points close. There is also less heating effect inside the coil as the ballast resistor itself dissipates some of the heat produced in the circuit.

#### TEST 1. Voltage at '+' Terminal of Coil (Ballasted System) - (Contacts Closed)

To obtain a good H.T. spark it is necessary to have a good voltage supply to the coil.

Connect the voltmeter (V1) between the '+' terminal of the coil and a good earth, as shown in Fig. 37. The contacts should be closed during the test to enable current to flow through the primary winding.

Switch on the ignition and the voltmeter should register approx. 6V for a 12 volt ballasted system. If the correct voltage is indicated, the supply from the battery to the ignition coil is satisfactory. Next, temporarily earth the coil negative terminal and crank the engine by the starter, any increase in the voltage indicates a satisfactory circuit. A slight decrease indicates a faulty solenoid switch or lead from the solenoid switch. Remove temporary earth connection.

If no readings are obtained, proceed with the Tests 2 and 3. If correct readings or battery volts are obtained, proceed to Test 4.

#### TEST 2. Voltage at '+' Side of Ballast Resistor

With the contacts closed, connect the voltmeter (V2) between the feed side of the ballast resistor and a good earth (Fig. 38). On applications with resistive supply cable, connect the voltmeter between the ignition switch end of the cable and a good earth. If battery voltage is registered, proceed to Test 3. But if no voltage is indicated, check back along supply cable.

#### TEST 3. Voltage at Coil Side of Ballast Resistor

Connect the voltmeter (V3) between the coil side of the ballast resistor and a good earth (Fig. 38). The ignition is switched on. No reading indicates a faulty ballast resistor.

#### TEST 4. Voltage at '-' Terminal of Coil (Contacts Open)

With contacts open, connect the voltmeter between the coil '-ve' terminal and earth as (V4) in Fig. 39. With ignition on, voltmeter should read battery voltage. No reading indicates open-circuit coil primary winding or short-circuit on the lead from the coil to distributor or within the distributor.

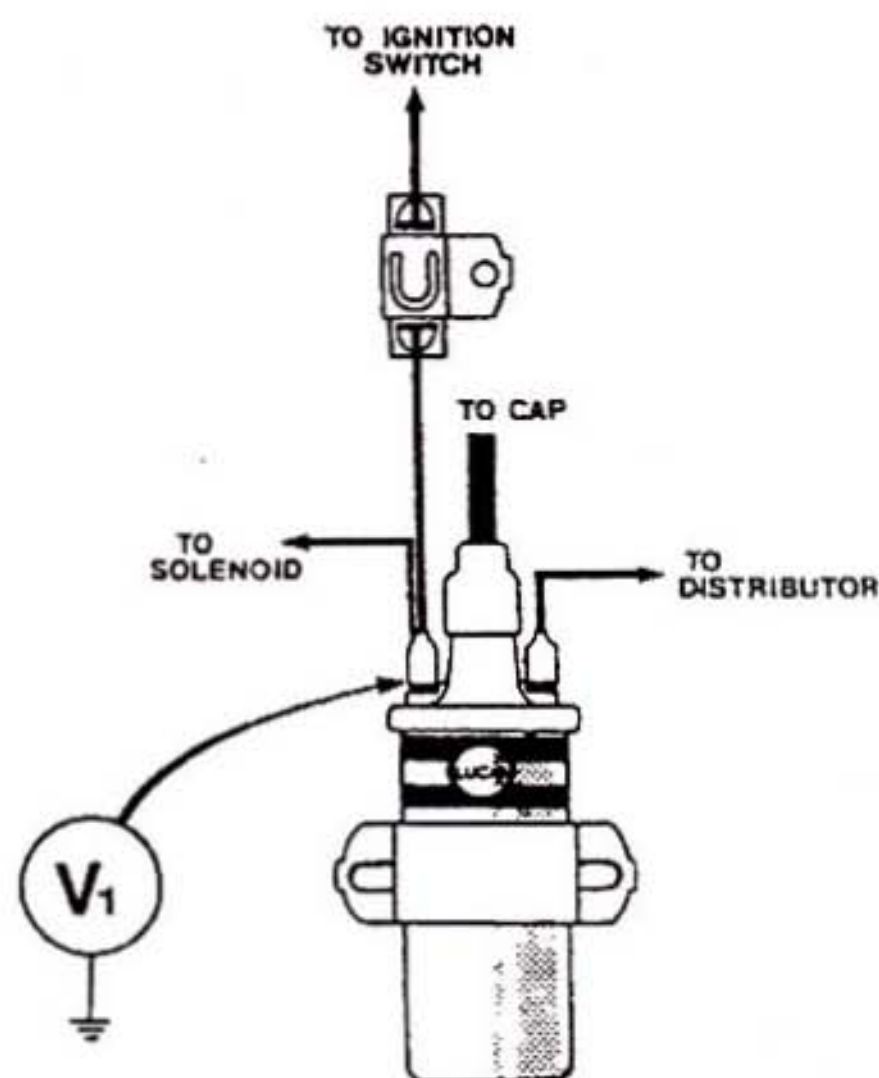


Fig. 37 Voltage at '+' terminal of coil (contacts closed)



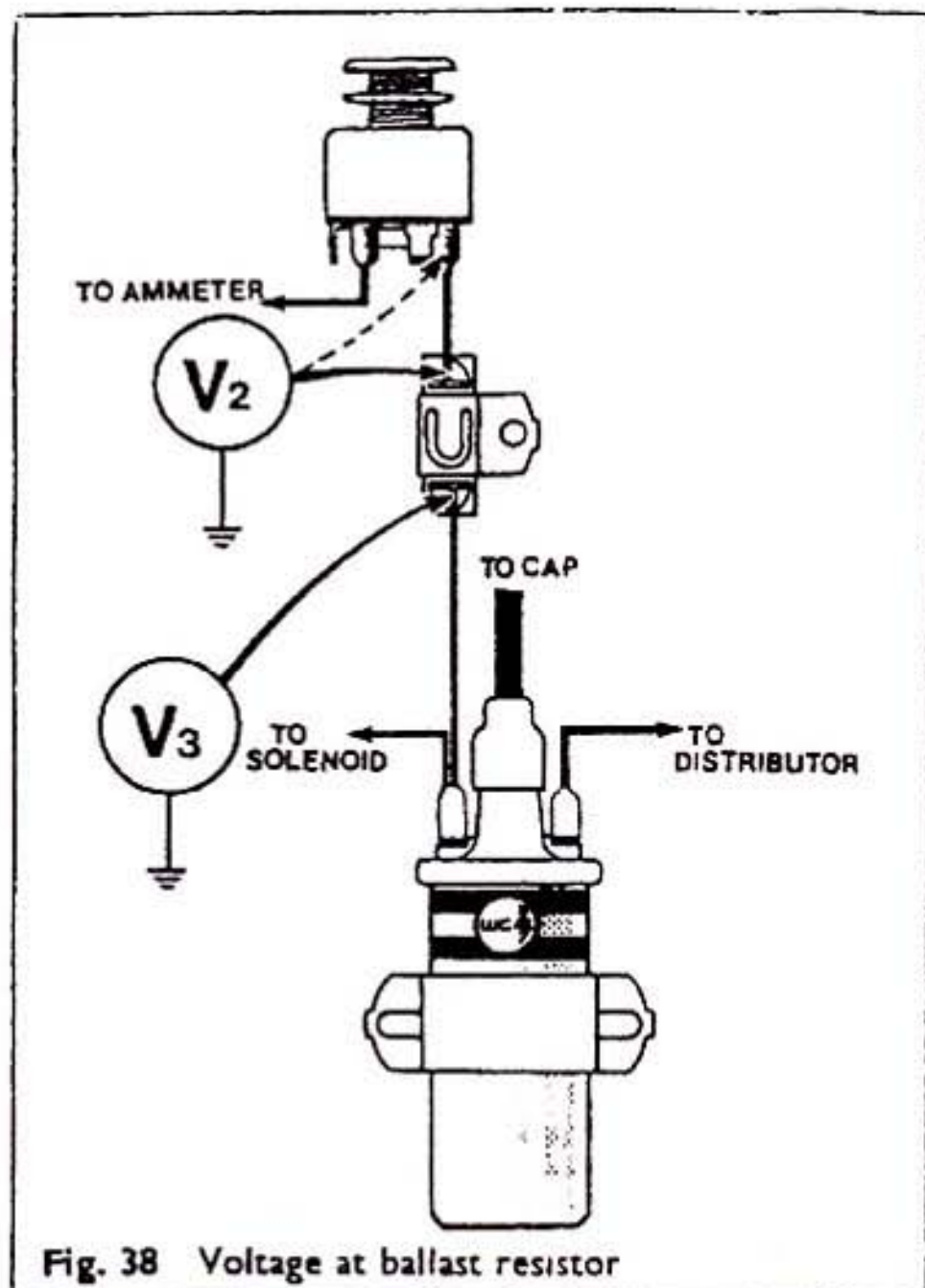


Fig. 38 Voltage at ballast resistor

Repeat test with coil '-ve' lead disconnected; if reading now appears, fault is on distributor or lead. No reading - faulty coil.

#### TEST 5. Distributor - Earth

If the last test has shown that the distributor is short-circuited to earth, the following points in the L.T. line should be checked, see Fig. 40.

- The lead between the ignition coil ('-ve' terminal) and the distributor L.T. terminal.
- The flexible lead, connecting the distributor L.T. terminal to the moving contact (terminal post).
- The flexible lead, connecting the contact breaker terminal post to the capacitor.
- Also, check that the tags on the end of the capacitor and flexible leads at the L.T. terminal post are under the shoulder of the nylon bush, and not under the securing nut.
- Finally, check that the capacitor is not earthed. This is achieved by disconnecting the capacitor from its mounting.

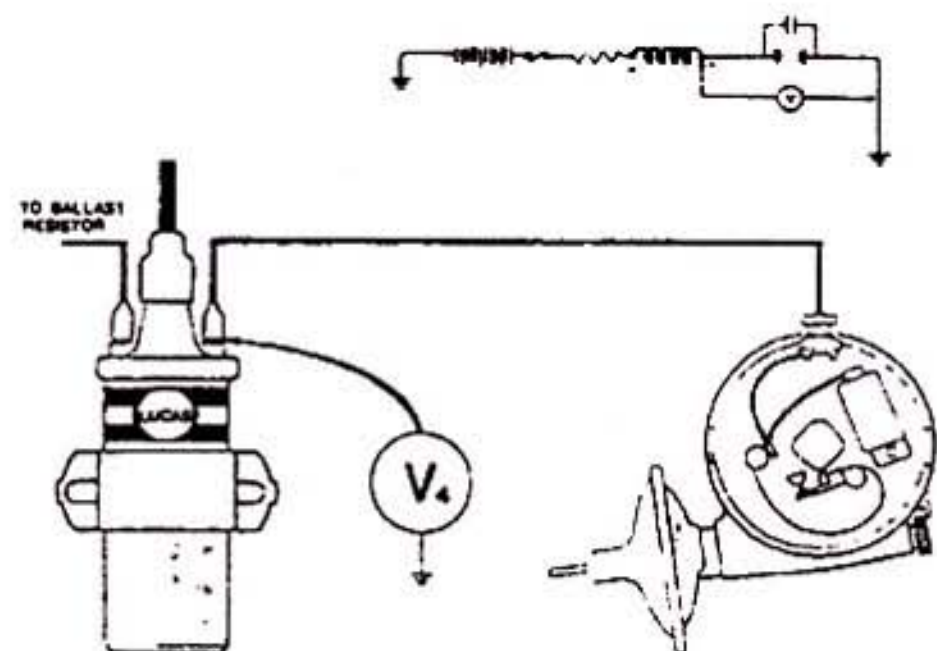


Fig. 39 Voltage at '-' terminal of coil (contacts open)

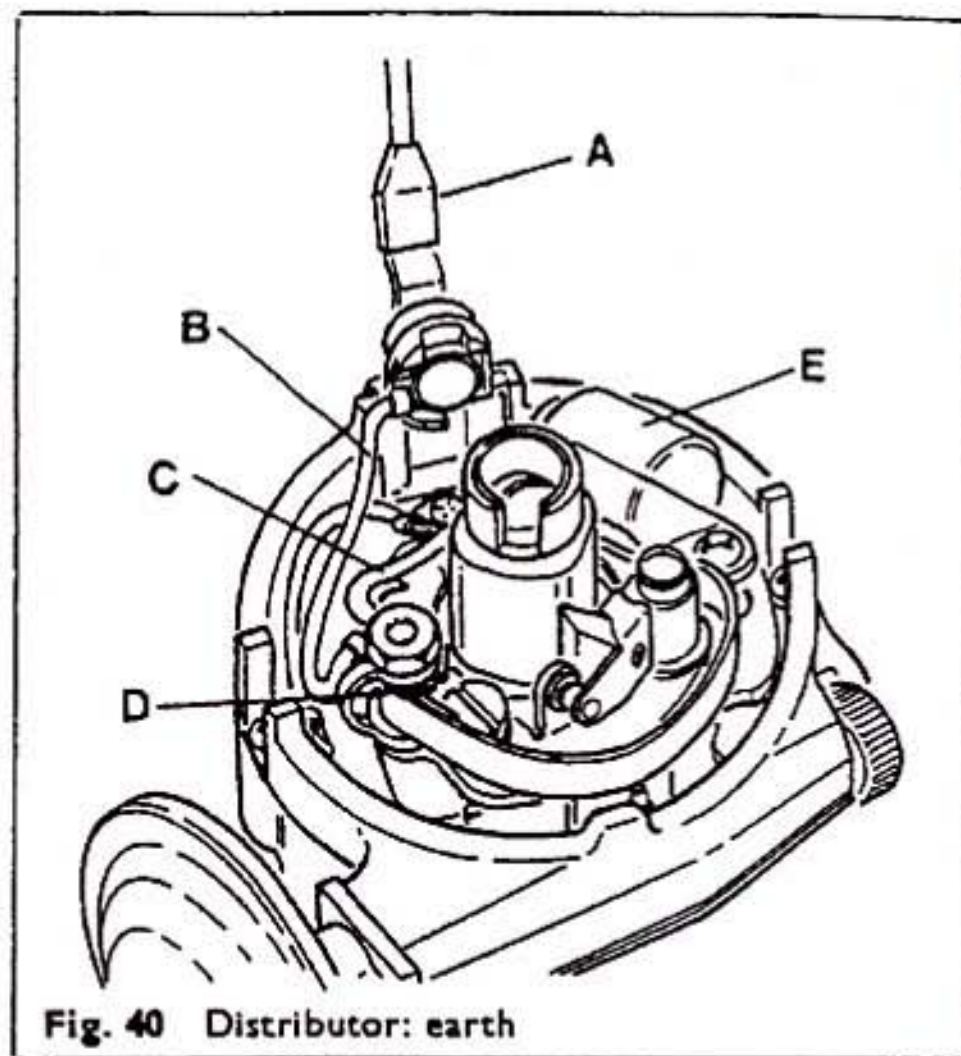


Fig. 40 Distributor: earth

#### TEST 6. Voltage at '-' Terminal of Coil (Contacts Closed)

When all connections are re-made, the voltmeter is left connected as in Test 4, (i.e. between the coil '-ve' terminal and a good earth) (Fig. 41). The contact points are closed by rotating the engine. When the ignition is switched on, a zero reading should be obtained. If the voltmeter registers a voltage, it is due to one of the following faults:

- Dirty or oily contacts.
- Bad earth connection (for instance, between the distributor shank and the engine block, or the flexible lead from the contact plate to earth).
- Contacts not closing properly.
- A high resistance in the circuit from the coil to the C.B. on the distributor.
- Broken flexible lead between the distributor L.T. terminal and the contact breaker terminal post.
- Open-circuit coil to distributor lead.

Tests for the secondary H.T. circuit are identical to those for conventional systems, as described in the previous section.

**Note:** Static and stroboscopic timing is described at the end of this chapter.

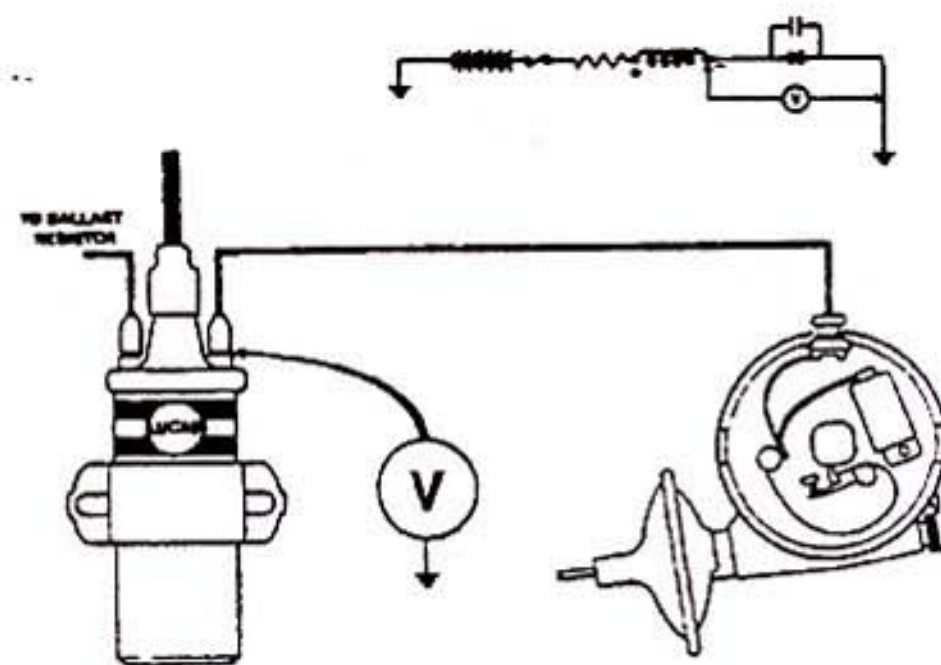


Fig. 41 Voltage at '-' terminal of coil (contacts closed)



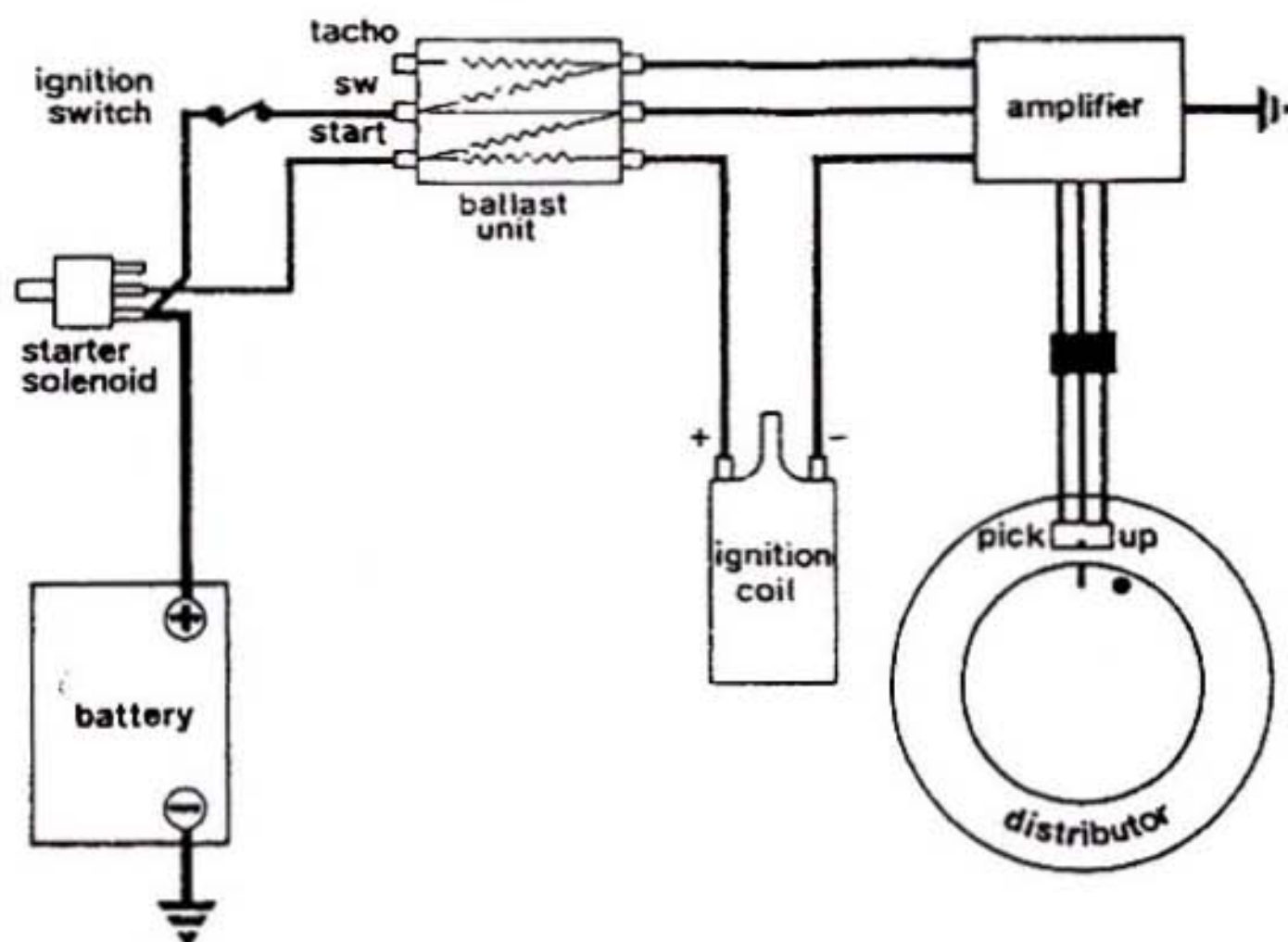


Fig. 42 Typical 'OPUS' system

## INTRODUCTION

The "OPUS" (Oscillating pick-up system) Fig. 42, is a fully-electronic system where the distributor cam and contact breaker assembly have been replaced by a pick-up module and rotating drum carrying a number of ferrite rods, one for each engine cylinder. As each rod passes in front of the module a small voltage signal is generated by the module winding, this signal is then transmitted to the amplifier. The transistorised circuits in the amplifier unit will instantly switch off the current in the ignition coil primary winding, thereby producing an induced coil secondary voltage (i.e. the 'spark').

The ignition coil used is a special low-inductance type designed for high speed operation and as such is particularly suitable for 8- and 12-cylinder engines.

As no contacts are used, the problem of contact breaker bounce at high speed is non-existent.

## OPUS IGNITION TEST PROCEDURE

### TEST 1. Battery - Rapid Check (Fig. 43)

Switch on the headlights and ignition and operate the starter. If the engine is turned over at a reasonable speed and the lights remain fairly bright (they will dim slightly), we can assume that the battery will supply sufficient current for us to be able to carry out the test procedure.

Should the lights dim excessively and the starter appear sluggish then the complete test procedure must be applied to the battery as in the battery section of this book.

### TEST 2. Check for Sparking

Connect a test H.T. lead into the coil chimney (remove vehicle H.T. lead) and hold the free end approx 6 mm (0.25") from the engine block, as shown in Fig 44.

With the ignition on, crank the engine. Regular sparking should occur. If no sparking occurs proceed with tests in sequence.

If sparking occurs, carry out Test 3a only, then proceed to Tests 9 and 10.



Ammeter



Ignition Switch On



Lighting Switch On



Warning Light

Fig. 43 Battery — rapid check

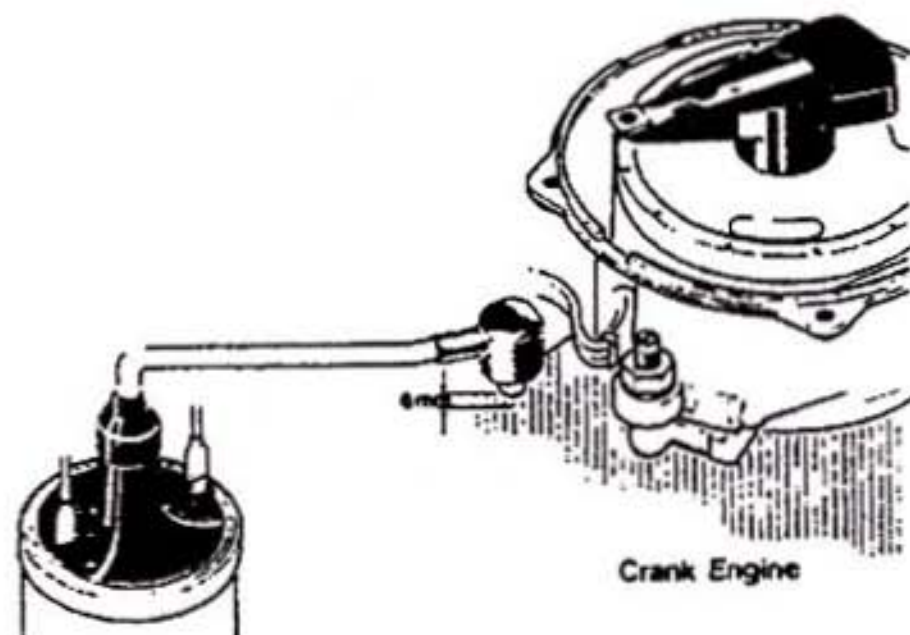


Fig. 44 Checking for sparking



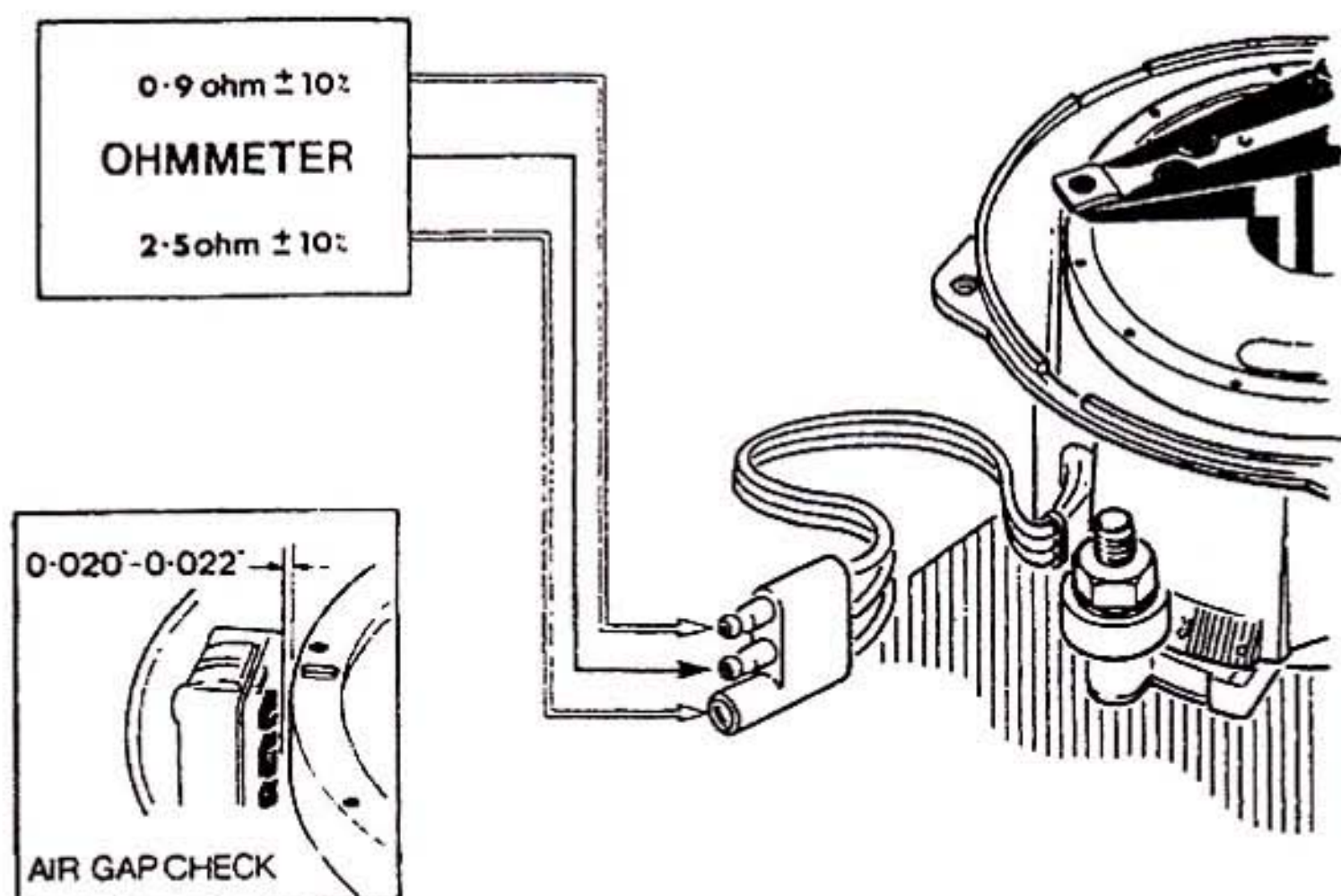


Fig. 45 Checking the distributor pick-up module

### Test 3. Distributor Pick-up Module

- (a) Module air gap - Rotate the engine so that the ferrite rod marked No. 1 cylinder on Jaguar or the rod immediately under the rotor electrode on Aston Martin, is in line with the pick-up module, see Fig. 45.

The gap between module and timing rotor should be a parallel 0.50-0.55 mm (0.020"-0.022"). If incorrect, adjust by slackening module fixing screws.

- (b) Disconnect the distributor to amplifier plug and on the distributor side, use an ohmmeter to check the resistance values between the centre and each outer terminal. The readings should be: Centre terminal to outer terminal with red cable 2.5 ohms  $\pm 10\%$ , centre terminal to outer terminal with black cable 0.9 ohm  $\pm 10\%$ . Leave plug disconnected.

### TEST 4. Check Ballast Resistor (9BR)

Withdraw socket at amplifier side of ballast resistor. Connect the voltmeter between a good earth and each terminal of the ballast resistor as shown in Fig. 46. **Caution:** Ensure that the voltmeter prod does not touch the resistor housing while in contact with the terminals.

With ignition on, reading at each terminal should be battery voltage.

If zero reading on all terminals, check supply at S.W. terminal (other side of ballast) and if zero here, trace circuit back via ignition switch.

If zero reading on one or two terminals only, replace ballast unit.

### TEST 5. Voltage at Coil '+ve'

Re-connect amplifier to ballast socket.

Connect voltmeter between a good earth and the coil '+ve' terminal (Fig. 47). With ignition on, the reading should be 4-6 volts.

A high reading indicates a faulty coil or amplifier, proceed with tests.

Zero reading indicates a fault in the amplifier to coil '-ve' lead.

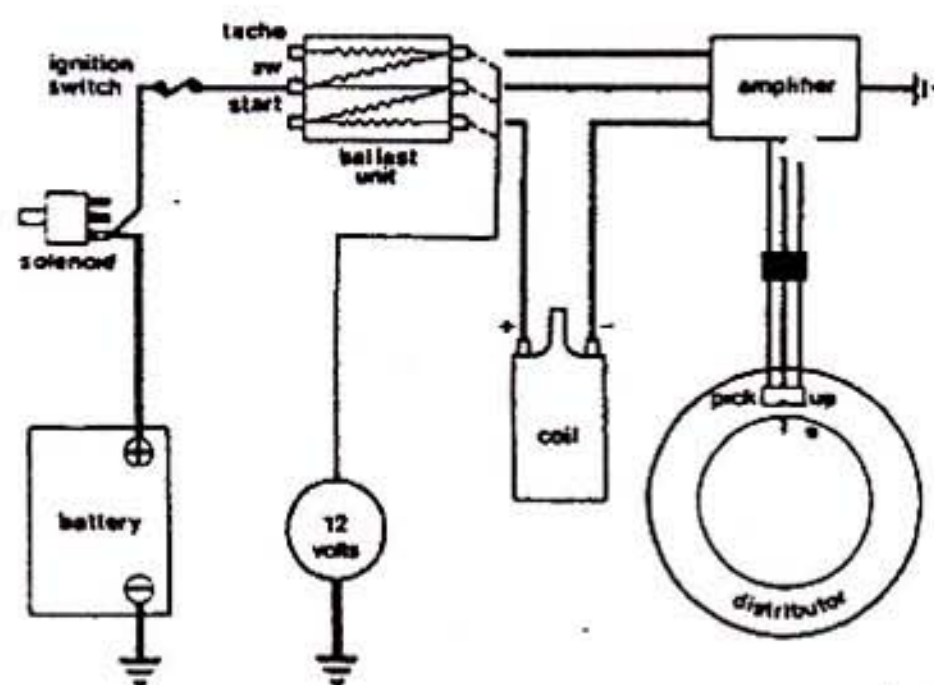


Fig. 46 Checking ballast resistor (9BR)

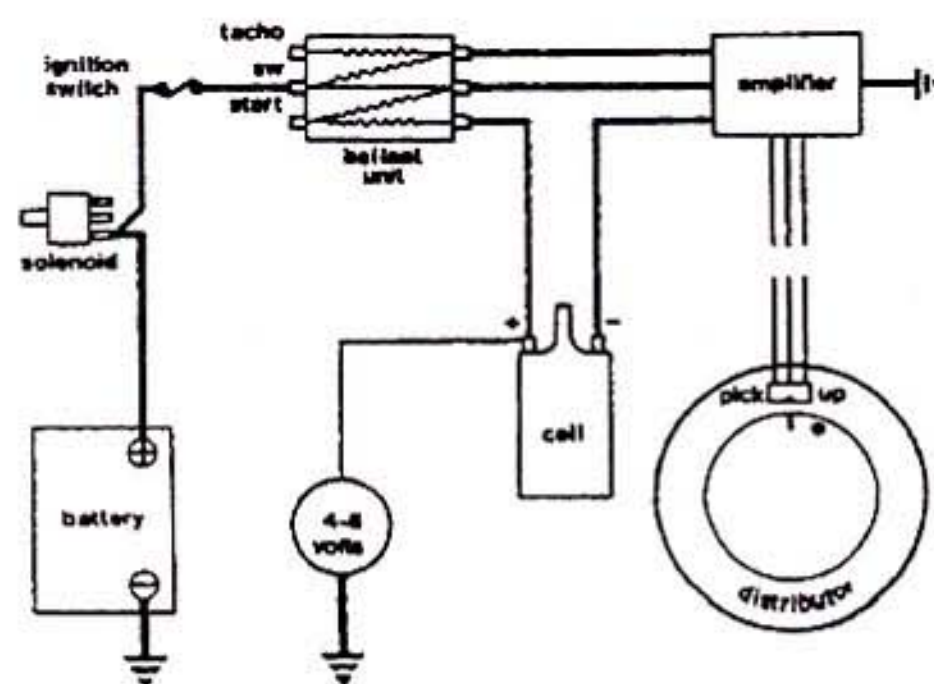


Fig. 47 Voltage at '+ve' terminal of coil



#### TEST 6. Voltage at Coil '-ve' (Open-Circuit)

Disconnect lead at coil '-' terminal. Connect the voltmeter between a good earth and coil '-ve' as shown in Fig. 48.

With ignition ON, meter should read BATTERY VOLTAGE.

Zero reading indicates that the primary winding of the coil is faulty.

#### TEST 7. Voltage at Coil '-ve' (Closed Circuit)

Re-connect lead to coil '-' terminal, leave voltmeter connected between earth and coil '-' (Fig. 49).

With ignition on, meter should read 0-2V.

If reading is battery voltage the amplifier is faulty and should be replaced together with pick-up module.

If reading is above 2 volts but below battery voltage, check volt drop on amplifier earth connection by connecting voltmeter between amplifier housing and a good earth. With ignition on, voltmeter should show 0.5V maximum. If higher, amplifier has a bad earth connection.

#### TEST 8. Amplifier Switching

Re-connect amplifier/distributor socket.

Connect voltmeter between a good earth and coil '-' terminal (Fig. 50).

With test H.T. lead connected in coil chimney hold free end 6 mm (0.25") from the engine block. Switch on ignition and crank engine, voltmeter reading should be 3-4V, fluctuating with regular sparking from H.T. lead.

A fluctuating voltmeter reading with no H.T. spark indicates a faulty coil secondary winding, replace the coil.

If voltmeter stays at low reading (below 2V) with no spark, amplifier is faulty, and should be replaced.

#### TEST 9. Rotor Arm Insulation

Hold free end of test H.T. lead approx. 3 mm (0.125") from centre of rotor arm electrode, see Fig. 51.

Switch ignition on, crank engine. No spark should occur. If a good spark occurs replace the rotor arm. (A good spark should not be confused with the very faint sparking that may be seen due to electrostatic charge and leakage).

#### TEST 10. Distributor Cover and H.T. Cables (Fig. 52)

The distributor cover should be clean and dry. The H.T. carbon brush must be free to move in its holder. If the distributor cover electrodes are badly eroded or tracking has occurred, a new cover should be fitted.

Carry out test for sparking using vehicle main H.T. lead instead of test lead, if no spark, lead is faulty.

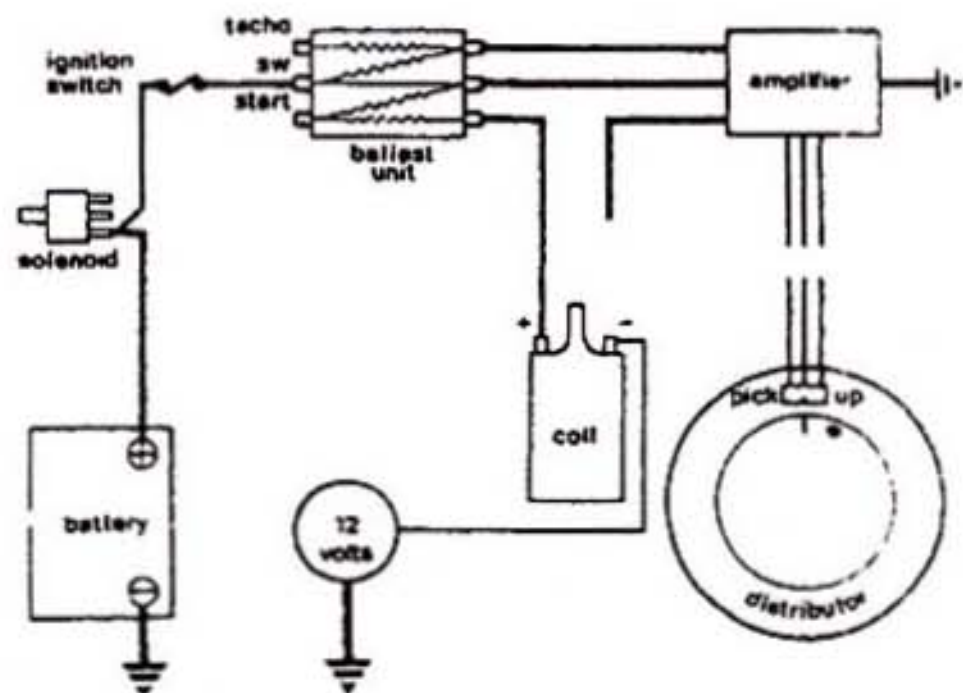


Fig. 48 Voltage at coil '-' terminal (open circuit)

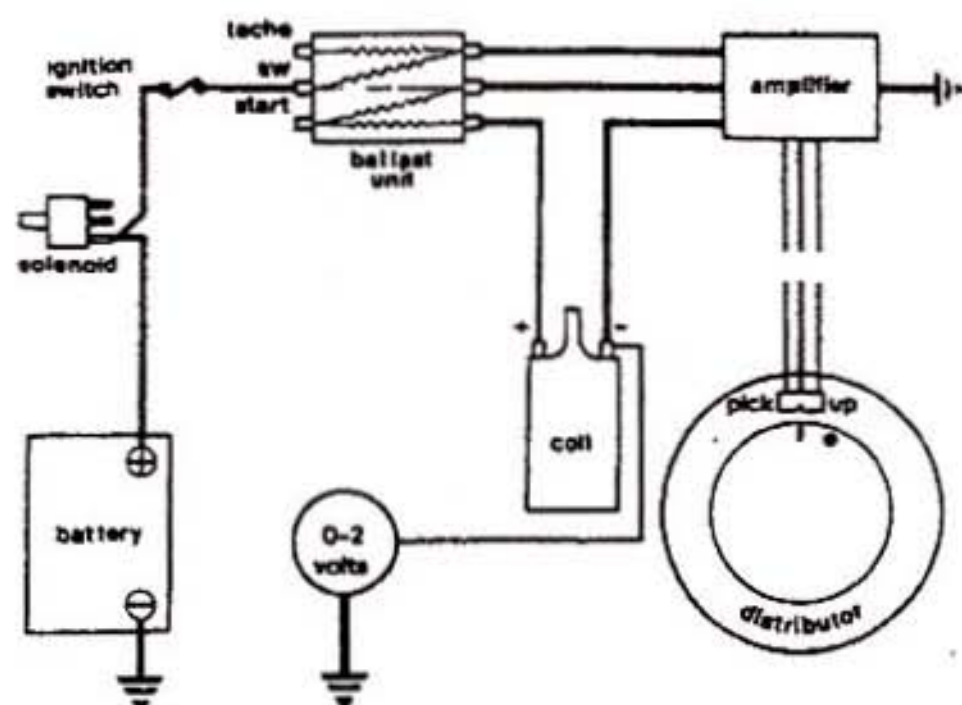


Fig. 49 Voltage at coil '-' terminal (closed circuit)

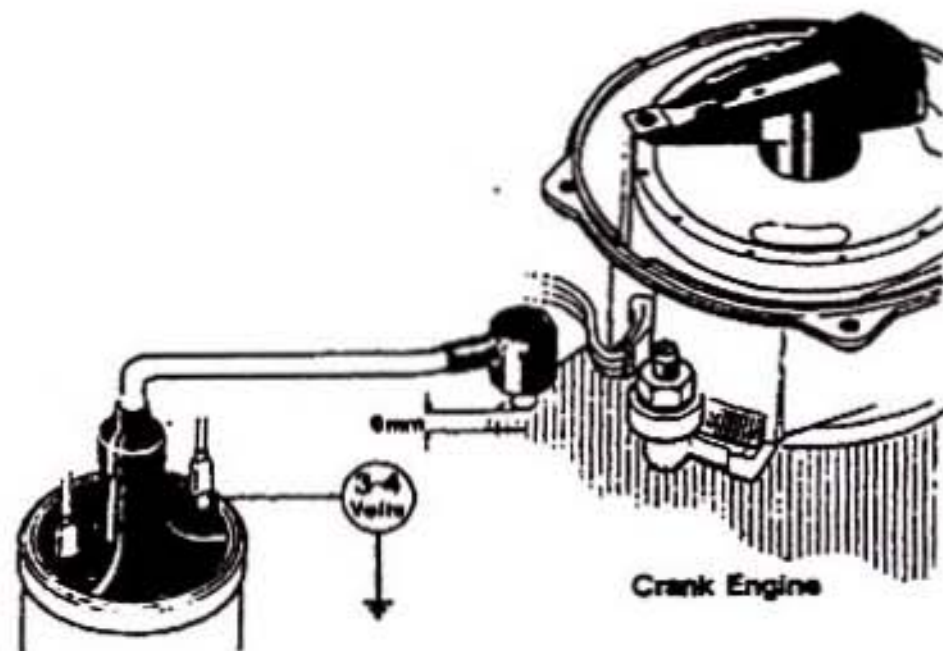


Fig. 50 Checking the amplifier switching

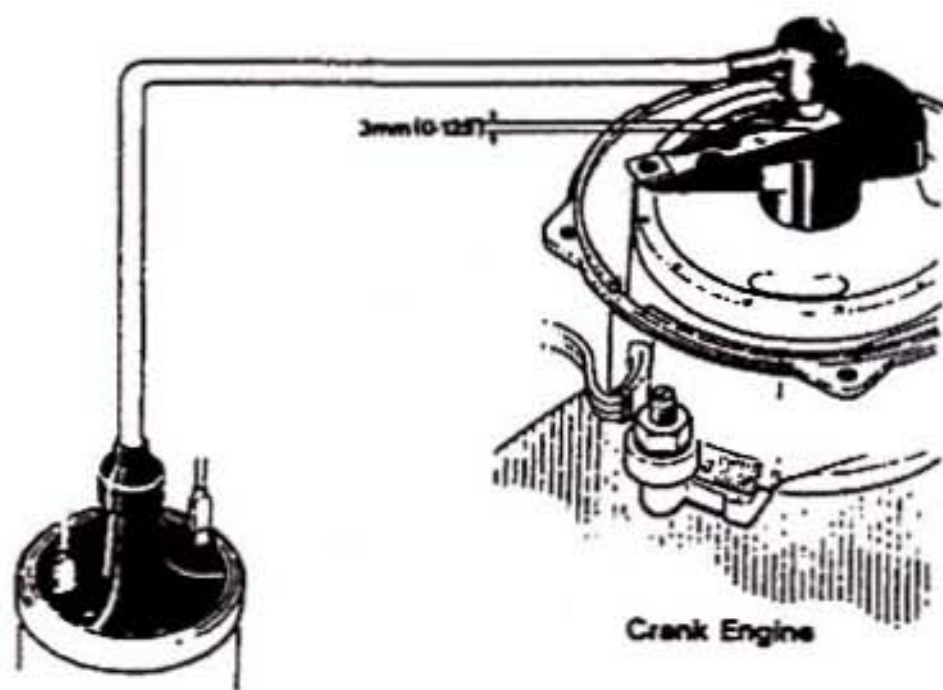


Fig. 51 Checking the rotor arm insulation

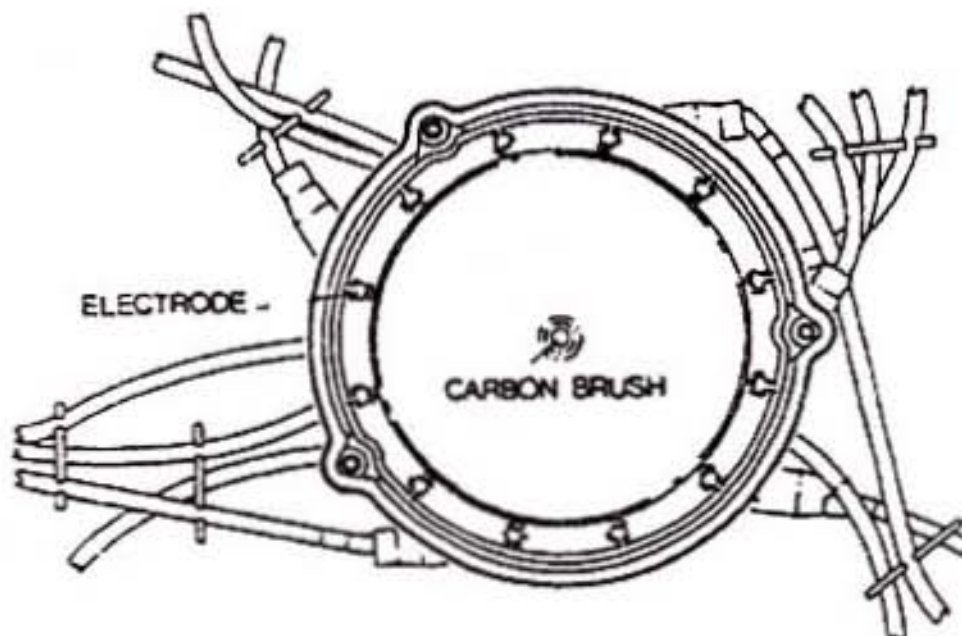


Fig. 52 Checking the distributor cover and H.T. cables



If spark occurs re-fit distributor cap and all leads. Engine should now fire. Misfiring on individual cylinders could be due to a faulty H.T. lead (to that particular cylinder) or spark plugs.

## IGNITION TIMING

After checking the ignition system, ensure the ignition timing is in accordance with the manufacturers' recommendations.

Two suitable methods are shown—

- (a) Static Ignition Timing.
- (b) Stroboscopic Timing.

### STATIC IGNITION TIMING

Rotate the engine until No. 1 piston is just before T.D.C. on the *compression* stroke, see Fig. 53. (exact position as specified by engine manufacturer). At this point the rotor arm should be pointing to the distributor cap segment connected to No. 1 spark plug. The contact breaker points should be just at the point of opening in the direction of rotation. This can be verified by connecting a voltmeter between the distributor L.T. terminal and a good earth. At the precise moment the contacts open the voltmeter will register battery voltage. Should the ignition timing be incorrect, centralise the micrometer adjuster (if fitted), slacken the distributor clamp bolt and position the

#### STATIC TIMING

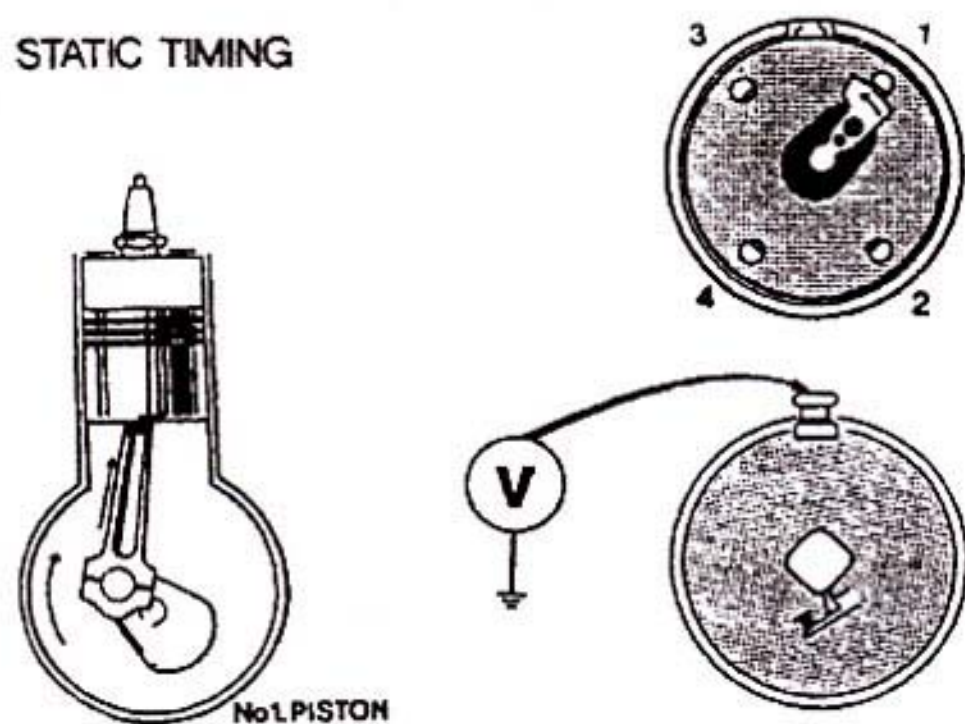


Fig. 53 Static ignition timing

distributor to the point of contacts about to open and re-tighten clamp bolt.

It must be remembered an incorrect contact gap can affect ignition timing. The contacts must be set and maintained at 0.35–0.40 mm (.014"–.016").

The ignition timing is now set with sufficient accuracy to be able to start and run the engine. Final adjustment may be carried out using the stroboscopic timing light and the micrometer adjustment.

### STROBOSCOPIC TIMING (Fig. 54)

Connect the strobe H.T. pick-up into No. 1 plug lead and disconnect the distributor vacuum pipe. In the case of a separate strobe, battery supply will also be required.

Start and run the engine at the manufacturer's specified idling speed. Direct the strobe light on the timing marks and check the degrees of advance against the recommended figures.

The strobe light can also be used to check that the centrifugal and vacuum advance mechanisms are operating, but in order to do this, the figures obtained must be compared to those specified for the particular vehicle. These figures are quoted in the engine manufacturer's workshop manual.

Timing marks and their positions will vary with different types of vehicles. These are normally quoted in the vehicle manufacturer's information.

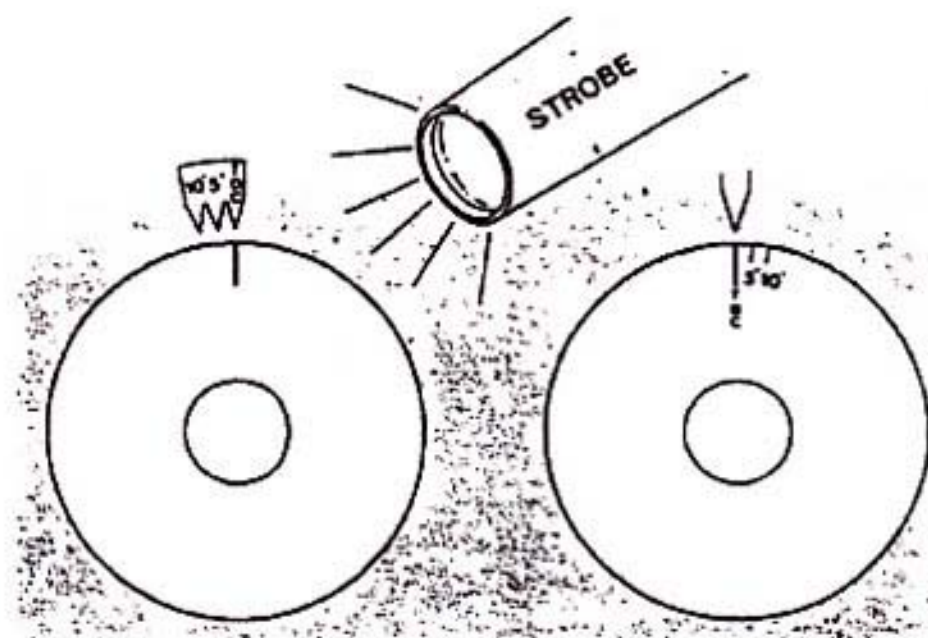


Fig. 54 Stroboscopic timing