Convert your car to . . .

Breakerless ignition

by JOHN CLARKE

Are you one of those hobbyists who would like to have a breakerless ignition system on your car but do not wish to make your own optical system? Then here is your chance to change over to a breakerless system using a Hall Effect device in your distributor.

Our Transistor Assisted Ignition system published in February of this year included details of an optical breakerless system using a phototransistor, LED and a suitable interface circuit but the reader had to solve the mechanical problems. He had to make his own optical breaker plate which requires very precise metalwork and he had to make up a mounting arrangement for the LED and phototransistor.

Now these mechanical problems have been solved with a new Hall Effect distributor kit. Made by EDA Sparkrite of the UK, it is marketed by Jaycar. The kit includes all the hardware necessary for the distributors in most cars sold in Australia. There are a couple of glaring exceptions unfortunately, including the much venerated six-cylinder Holden Kingswood. A crying shame.

Of course, there's nothing to stop you from making your own hardware to match the distributor in your car.

The basic mechanical concept is simple. A Hall Effect switch is mounted in place of the contact points and a ring magnet is fitted over the distributor cam. The magnet has the same number of poles as the cam has faces and these are equally spaced to provide the appropriate timing pulses from the Hall Effect device to the following electronic ignition circuitry.

The advantage of using an all-electronic system such as this Hall Effect system rather than a hybrid system utilising the distributor contact set is that, once set, the ignition timing will always be right. It will not vary due to the gradual wearing down of the contact breaker rubbing block and there will be no "timing scatter" due to distributor cam wobble or wear in the bearings.

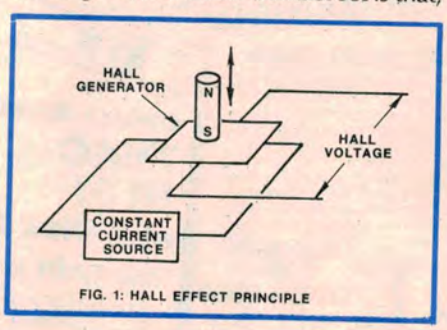
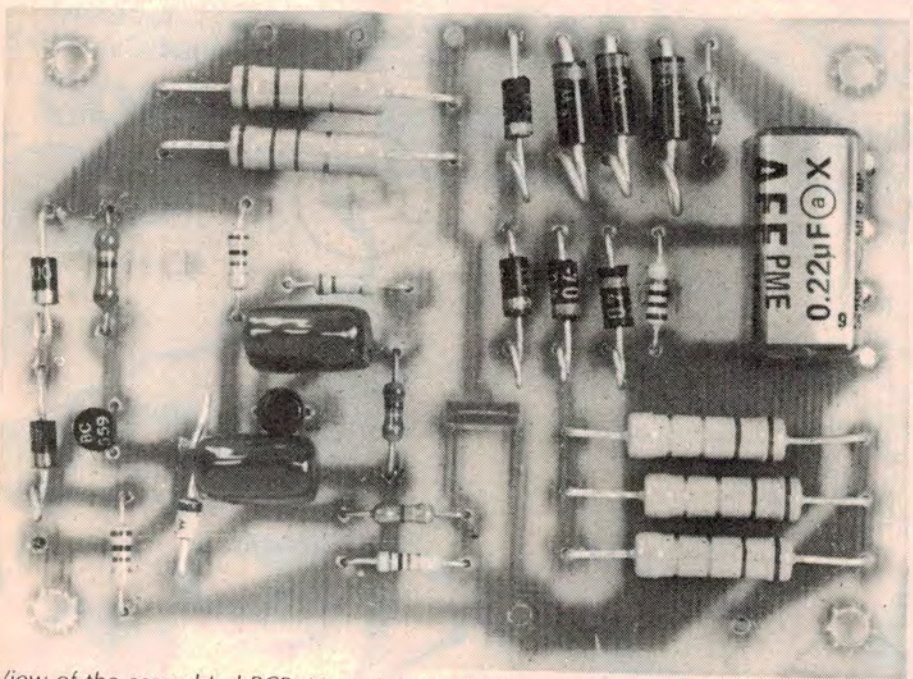


FIG. 1: HALL EFFECT PRINCIPLE

Even with a brand new distributor the timing differences from cylinder to cylinder can be as much as 5% and this does contribute to uneven running, particularly at idle speeds. With the Hall Effect system installed the engine will run noticeably smoother and it will stay that way.

One small point to remember is that even an all-electronic ignition system is not completely maintenance free. The spark plugs still have to be checked for fouling and correct gap setting at regular intervals of say 5000 to 10,000 kilometres. And at these times it would probably also be wise to do a routine check of timing, just to satisfy yourself that it is still "spot-on".



View of the assembled PCB. Note the shock relieving loops in the diode leads.

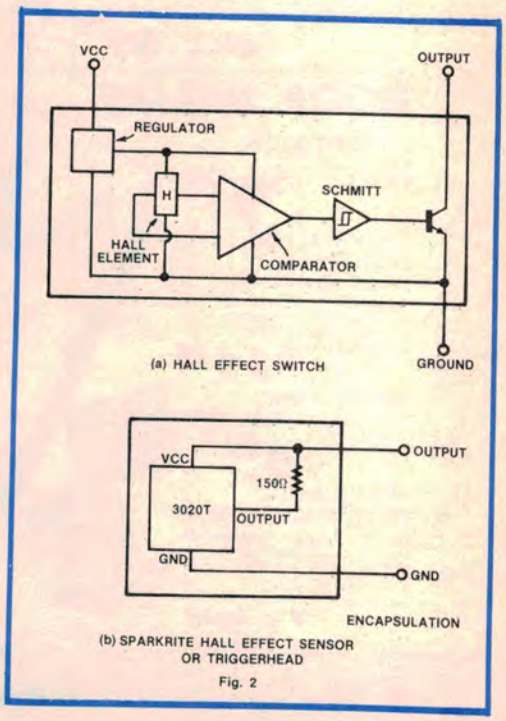


Fig. 2

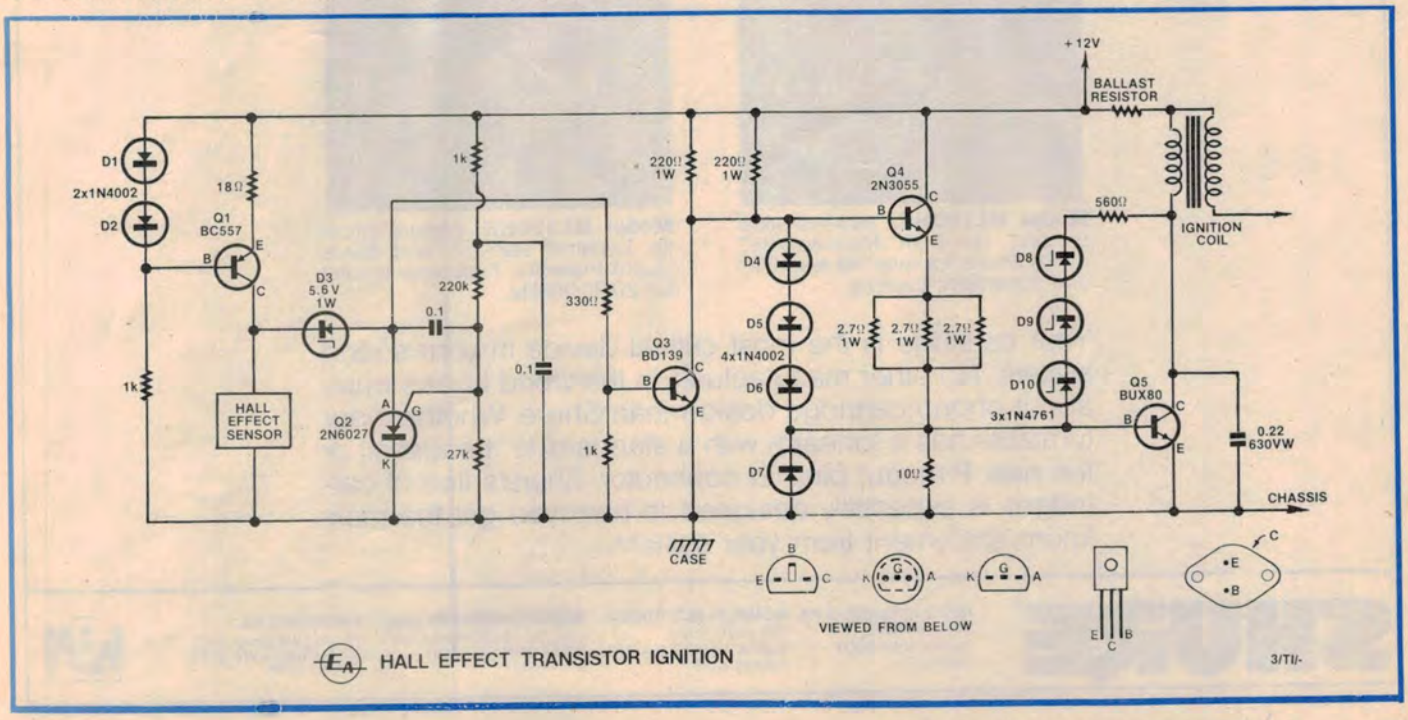
The distributor kit comes packed in a plastic wallet and is suitable for use with most distributors.

What is the Hall Effect?

The Hall Effect sensor principle is shown in Fig. 1. It consists of a thin strip of semiconductor material through which a current is passed. When a magnet is brought near, such that its field is directed at right angles to the face of the semiconductor, a small voltage appears at the contacts placed across the narrow dimension of the strip. As the magnet is removed the voltage drops to zero.

A practical Hall Effect device is depicted in Fig. 2a. This comprises a voltage regulator, a Hall cell, a comparator connected across the Hall cell and a Schmitt trigger which drives an open-collector transistor. The comparator and Schmitt trigger render the Hall Effect switch characteristics less dependent on the magnetic flux.

Fig. 2b shows how the three-terminal Hall Effect device has been used by Sparkrite in their sensor. Effectively, the



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three-terminal device has been converted to a two-terminal device by the connection of a 150Ω resistor between the output and Vcc. By making the GND terminal of the sensor the metal foot, the device has only one lead connection which makes it equivalent to a standard contact breaker, although it is not intended to switch the coil directly or carry heavy currents.

The Sparkrite sensor is actually an epoxy encapsulation of a Sprague UGS-3020T Hall Effect switch (or equivalent) together with the aforementioned 150Ω resistor. The Sprague device is very similar in appearance to a TO-92 plastic transistor, although perhaps a little smaller, and is rated for an operating temperature range from −40 to 125 degrees Celsius.

Sparkrite operate the Hall Effect device by use of a ring magnet. In fact it consists of a number of radial magnets with all north poles on the inside of the ring and the south poles used to turn on the Hall Effect device.

The circuits

Two circuits are shown, one using the Hall Effect sensor to trigger the Transistor Assisted Ignition first described in December 1979 and subsequently updated in February 1983 and the other showing adaptation for the Capacitor Discharge Ignition first described in August 1970 and updated in July 1975. We shall discuss the modification to the transistor ignition first.

Q1 is a constant current source which feeds the Hall Effect device and zener diode D3. The current from Q1 is set at about 33mA by diodes D1 and D2. Strictly speaking a single resistor could have been used instead of Q1 but the constant current source makes the switching of the Hall Effect device independent of battery voltage fluctuations which would otherwise lead to changes in ignition timing.

PARTS LIST

TAI Adapter Kit

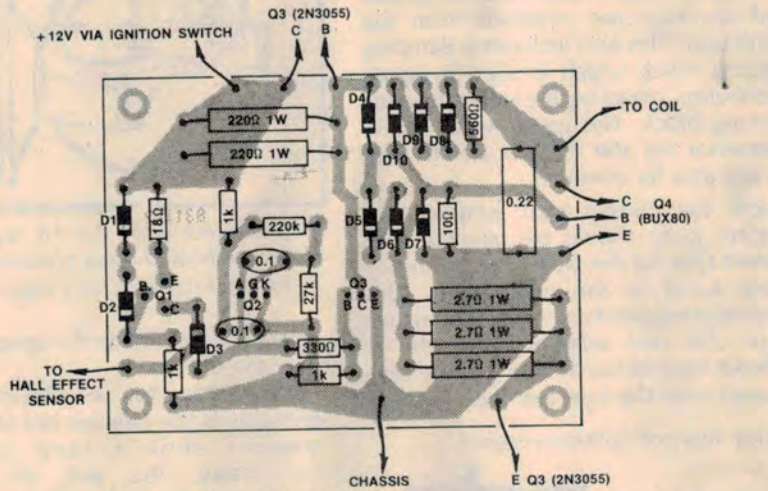
1 Hall Effect distributor kit (EDA Sparkrite)
1 printed circuit board, code 83ti12, 93x69mm
1 BC557 PNP transistor
1 5.6V zener diode
2 1N4002 diodes

RESISTORS (¼W or ½W, 5%)
1x220kΩ, 1x27kΩ, 1x1kΩ, 1x330Ω, 1x18Ω.

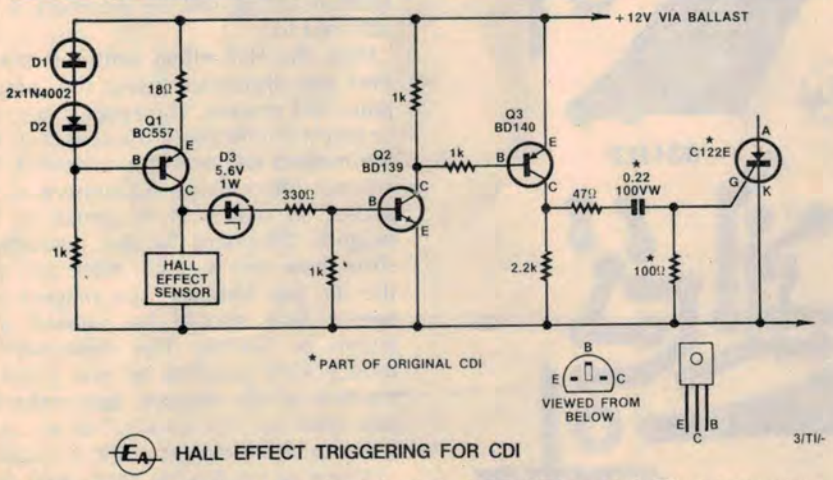
CDI Adapter Kit

1 Hall Effect distributor kit (EDA Sparkrite)
1 piece of stripboard (see text)
1 BC557 PNP transistor
1 BD139 NPN transistor
1 BD140 PNP transistor
2 1N4002 diodes
1 5.6V zener diode

RESISTORS
1x2.2kΩ, 4x1kΩ, 1x330Ω, 1x47Ω, 1x18Ω.



Parts overlay diagram for the new Transistor Assisted Ignition PCB.



This circuit shows how to adapt the July 1975 CDI to Hall Effect triggering.

When one of the south poles of the ring magnet is adjacent to the Hall Effect device it is turned on and so the voltage at the collector is less than 5 volts. This means that no current flows through zener diode D3 and so Q3 is not biased on. In turn, this means that Q4 and Q5 are conducting and current is flowing through the ignition coil.

When the magnet south pole moves away, the Hall Effect device stops conducting and the voltage at the collector of Q1 rises so that D3 conducts, turning on Q3. This turns off Q4 and Q5 which allows the coil to fire the spark plug.

Q3 does not remain in conduction for the whole time that the Hall Effect device is off. This is because of the dwell extension feature provided by the programmable unijunction transistor (PUT) Q2. This operates as follows:

When D3 is not conducting, the anode of Q2 is essentially held at chassis potential by the base resistors of Q3. Then, when the Hall Effect device turns off, D3 conducts and raises the voltage on the anode of Q2. Because of the 0.1μF capacitor connected to the anode, this also jacks up the voltage on the gate of Q2 which would otherwise be held at around 1.3 volts by the 220kΩ and 27kΩ resistors. Subsequently, the voltage at the gate bleeds away until, 0.9ms after the Hall Effect device turned off, the gate voltage has fallen to 0.6V below the anode. This causes Q2 to conduct and so remove the forward bias from Q3. This causes Q4 and Q5 to turn on again and thus current passes through the coil earlier than it otherwise would have without the dwell extension facility.

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The rest of the circuit operates the same as the original circuit which was fully described in the February 1983 issue.

The CDI version

As mentioned previously this version suits the CDI circuits described in August 1970 and July 1975 but it could probably be adapted to suit any CDI system which used a similar method for triggering the SCR.

As with the version for the Transistor Assisted Ignition, Q1 is a constant current source which supplies around 33 milliamps to the Hall Effect device and D3. When the Hall Effect device is off, D3 is not conducting and so Q2 is biased off as is Q3. When a south pole of the ring magnet moves away from the Hall Effect device it switches off and allows D3 to conduct. This turns on Q2 and Q3 and delivers a pulse of current to the gate of the SCR via the 0.22μF capacitor. This triggers the SCR into conduction.

For further information regarding the CDI circuit refer to the articles as previously mentioned.

Construction

As far as construction of these circuits is concerned, we have developed a PCB (code 83ti12, 93 x 69mm) for adapting the transistor ignition to Hall triggering. For the CDI conversion, we will leave it to readers to add on the extra circuitry using Veroboard or matrix board.

The new Transistor Assisted Ignition PCB is very similar to the previous PCB and is only modified for the input circuitry. Consequently, readers will find it easy to remove the components from the old PCB and place them on the new PCB without changing the lead spacings. Note the heat expansion and shock relieving loops in the diode leads.

Follow the parts overlay carefully, making sure that the polarity conscious components are oriented correctly. The mounting holes and wiring positions are the same as before so no wiring modifications will be necessary. Mounting details are the same as in the previous article.

Modifying the distributor

The Hall Effect device has been designed by Sparkrite to suit most vehicles with these distributors: Motorcraft or Autolite (4 and 6 cylinders), Bosch (all 4 cylinder), Lucas (4 and 6), AC Delco D202 and D204 (4 cylinder), Toyoto Nippondenso (4 cylinder), and Hitachi Datsun (4 cylinder).

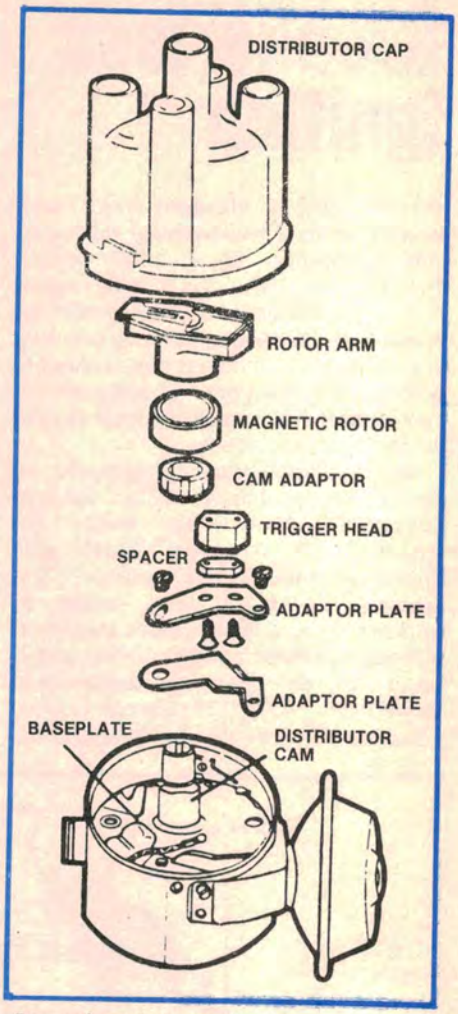
Each kit as supplied from Jaycar includes comprehensive installation instructions. Basically the installation is as follows. First, the contact breaker points and capacitor are removed from the distributor. This also includes a damping rubbing block which is used in some distributors opposing the contact points rubbing block. The grommet or screw connector for the contact points lead should also be removed.

Now the correct cam adapter and adapter plate should be selected, the correct type for the particular distributor being listed in the instructions. The 6-cylinder magnet has four keys to locate it on the cam adapter while the 4 cylinder magnet has three. Place the cam adapter over the cam and then the ring magnet, which holds the adapter tightly over the cam.

Note that for clockwise-rotating distributors the painted dot side of the magnet should face upwards. Conversely, the dot should face downward for anticlockwise rotating distributors. This is important since ignition timing will be incorrect if not adhered to.

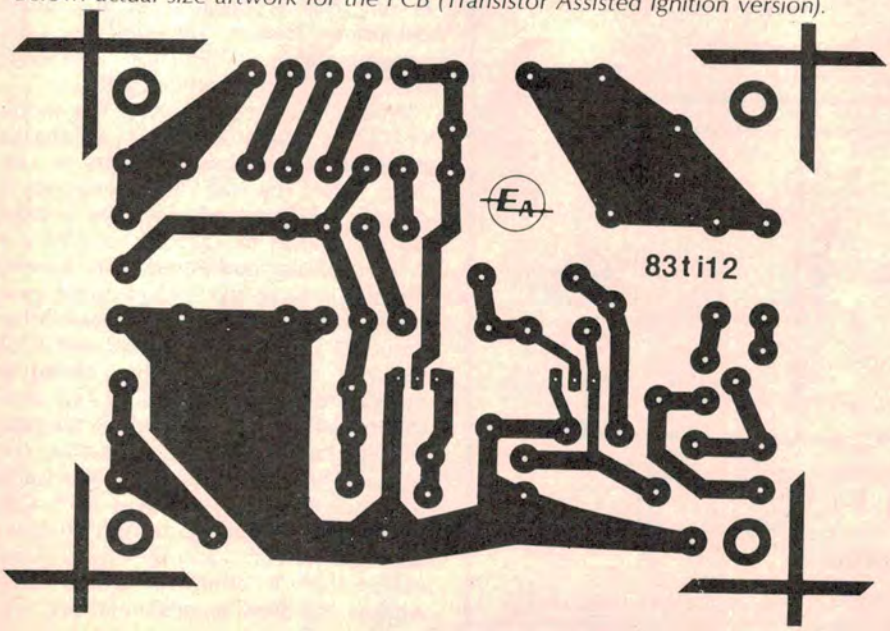
How the Hall effect sensor is placed into the distributor using the adapter plate and spacers. The spacers are used to adjust the height of the sensor so that the magnet and sensor are centred. The adapter plate allows adjustment of the sensor so that it is tangential to the magnet. Diagrams in the instructions show how this is done. Note also that the air gap between the magnet and sensor face should be around .015 inches or 0.4mm. This adjustment is usually only possible at one point of rotation of the magnet. Just make the gap small but not so small as to cause scraping at the closest point of rotation.

Note that the flexible earth lead must be reconnected.



Reproduced from the kit manual, this diagram shows how a typical distributor is adapted to Hall Effect triggering.

Below: actual size artwork for the PCB (Transistor Assisted Ignition version).



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Now the lead from the Hall Effect device can be fed through a suitable grommet to the electronic ignition. In most cases, it should be possible to use the original grommet used with the points lead. The lead from the Hall Effect sensor can either be soldered directly onto the electronic ignition input, or you may prefer to use suitable plug-in connectors. Make sure that the lead from the sensor to the grommet has sufficient slack to allow for full vacuum advance.

Timing the engine initially can be difficult so we recommend this method. Simply connect the lead from the Hall sensor to the positive of the battery via a 220Ω resistor. Now connect a multimeter between ground and the Hall sensor lead. Rotate the distributor by rotating the engine by hand and watch the voltage reading on the meter. It should read about 4V when the south pole is activating the sensor and about 11 to 12 volts when the magnet has passed. This transition from low (4V) to high (11V) is the firing point.

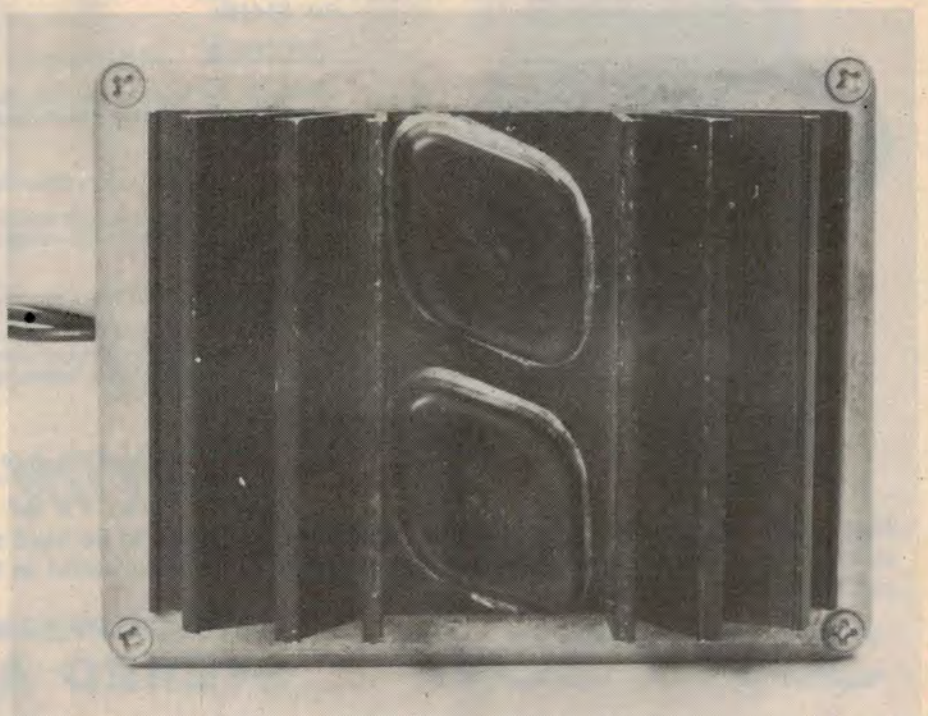
Loosen the distributor and rotate it so that the transition from high to low occurs at the correct static ignition timing point for your vehicle. Note that the engine should always be fully rotated in the correct direction and not reversed when performing this timing. This is important since there is considerable hysteresis in the Hall Effect sensor and you are likely to find the wrong firing point if you reverse the engine and then bring it forward again.

When the firing point is correct, check that the rotor arm is facing the relevant cylinder position (usually cylinder 1) on the distributor cap, or the timing mark for number 1 cylinder on the distributor body. The distributor should only have to be moved slightly from its original position. The rotor arm should now be located so that, at maximum and minimum settings of vacuum and centrifugal advance, the distributor cap contact is always located within the range of the rotor arm.

If this is not the case and you find the rotor arm positioned between two adjacent distributor cap contacts, then the Hall adapter plate will have to be modified so that firing occurs at the correct point. Clamp the sensor with a small G-clamp and position the distributor so that the centre of the rotor arm is opposite the appropriate distributor cup contact. Now move the Hall sensor so that the device goes from low to high at this firing point.

A bracket can now be made to support the sensor in this position. Alternatively, holes can be directly drilled in the advance plate to locate the sensor.

Finally, the engine should be dynamically timed according to the procedure in the workshop manual.



This circuitry is all mounted in a metal diecast case measuring 118 × 93 × 56mm. A finned heatsink is essential for transistors Q4 and Q5.