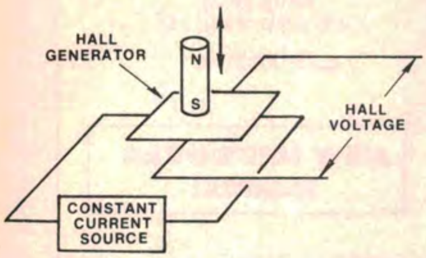


FIG. 1: HALL EFFECT PRINCIPLE

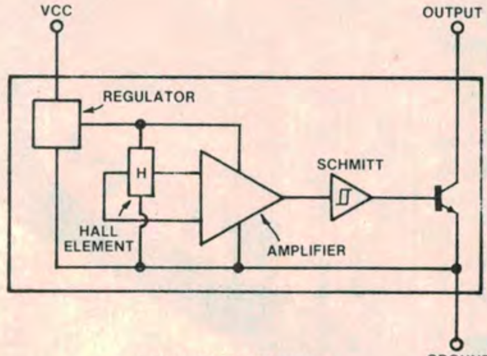


Fig. 2 HALL EFFECT SWITCH

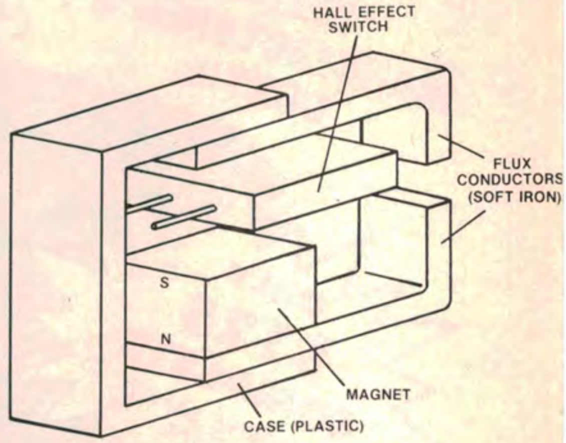


Fig. 3

by JOHN CLARKE

Breakerless ignition for your car

Designed specifically for Australian-made cars, this breakerless ignition system employs a commercial Hall Effect trigger and rotating vane assembly. It can be used with both transistor switched and capacitor discharge systems.

In December last year we provided details of a Hall Effect trigger modification for the EA Transistor Assisted Ignition and CDI units. This utilised a Hall Effect distributor kit made by EDA Sparkrite of the UK and marketed by Jaycar. Although the modification proved very popular, it had the drawback that it was not suitable for many Australian-made four, six and 8-cylinder vehicles, including the much beloved Holden Kingswood.

This dreadful omission has now been rectified with our new breakerless ignition system. It is suitable for most Holden, Ford, Chrysler and some Japanese makes which use Bosch, Delco, Lucas, Disilea, Nippon Denso and various other distributors. Included are typical Australian six and 8-cylinder cars, as well as most of the popular 4-cylinder models.

The basic mechanical concept is simple. It is based on a Hall Effect vane switch manufactured by Siemens of West Germany, and a rotating vane assembly from Bosch Australia. The Siemens device comprises both a Hall sensor and integral magnet in a slotted plastic housing which mounts in place of the contact points.

The Bosch rotating vane assembly replaces the original rotor button in the distributor. It contains a rotor button and soft iron vanes. The vanes are spaced equally and pass between the magnet and Hall effect sensor. This, in turn, provides appropriate pulses to the following electronic ignition circuitry.

The Siemens vane switch is stocked by Jaycar while the Bosch rotating vane assembly is available from Bosch automotive retail outlets such as Bennet and Wood and Repco. The latter is actually used in the Bosch Electonic Ignition system and is sold separately for about $30. Before embarking on this project, readers are advised to contact their local Bosch outlet and verify that a rotating vane assembly can be supplied to suit their particular type of vehicle.

Installation of the rotating vane assembly is very simple — just remove your rotor button from the distributor and replace it with the rotating vane assembly. It is located and held in exactly the same manner as the original rotor button.

The Hall Effect sensor, however, requires several hours of work to install. This mainly involves the fashioning of a suitable mounting plate for the vane switch, which is located on the vacuum advance plate of the distributor. It must be located so that the rotating vane assembly passes through the slot of the sensor without scraping (see installation).

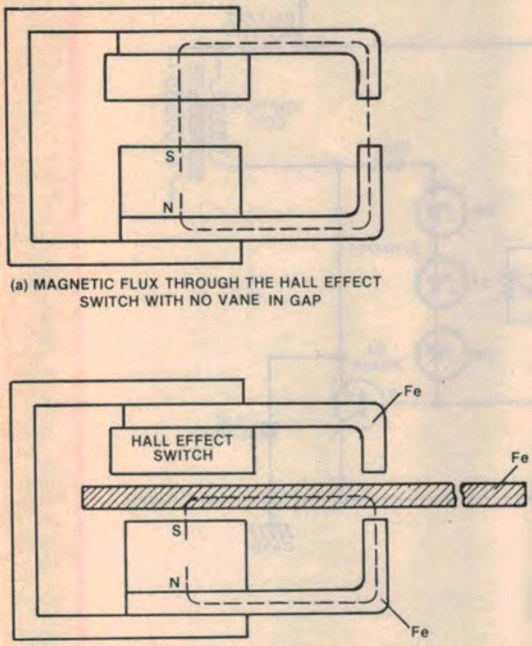
When complete, you will have the many advantages available from solid state triggering. Once set the ignition timing will always be correct. It will not vary due to the gradual wearing down of the contact breaker rubbing block and there will be no "timing scatter" due to distributor cam wobble or wear in the bearings. The engine should also run noticeably smoother, especially at idle speeds.

The Hall Effect

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 dimensions of the strip. As the magnet is removed the voltage drops to zero.

A practical Hall Effect device is depicted in Fig. 2. This comprises a voltage regulator, a Hall cell, an



(a) MAGNETIC FLUX THROUGH THE HALL EFFECT SWITCH WITH NO VANE IN GAP

(b) MAGNETIC FLUX SHUNTED BY FERROUS VANE

Fig. 4

amplifier connected across the Hall cell, and a Schmitt trigger which drives an open collector transistor.

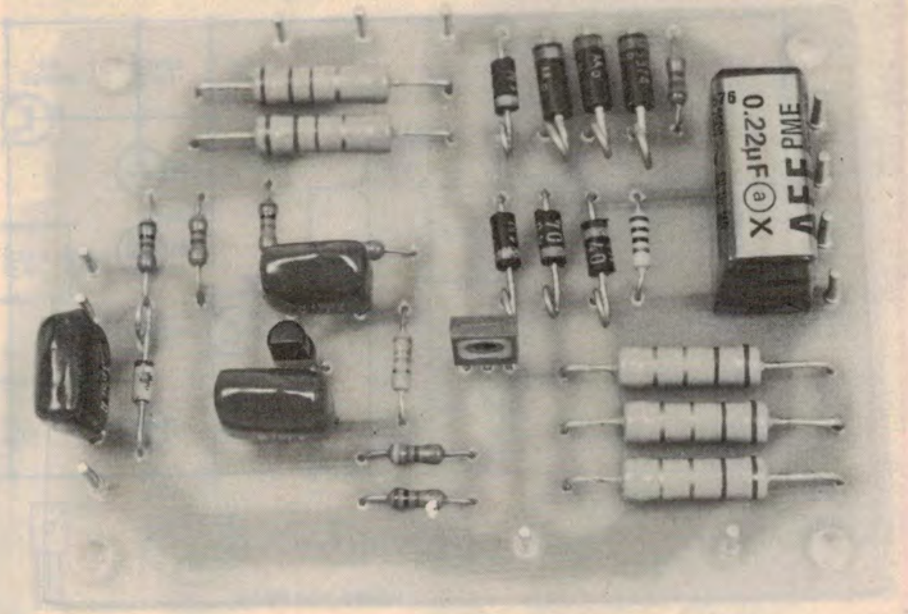
Fig. 3 shows the general construction of the Siemens Hall Effect sensor. A Hall Effect device similar to that of Fig. 2 is positioned near a permanent magnet. Magnetic flux conductors made of soft iron extend out from the magnet and the Hall Effect device to create a magnetic flux path.

Fig. 4 shows how the rotating vane assembly is used to interrupt the flux path to the Hall Effect device. When there is no vane in the air gap, the magnetic flux passes through the Hall Effect device and switches on its internal transistor. When the vane is present, the flux path is shunted away from the Hall Effect device and the output transistor switches off.

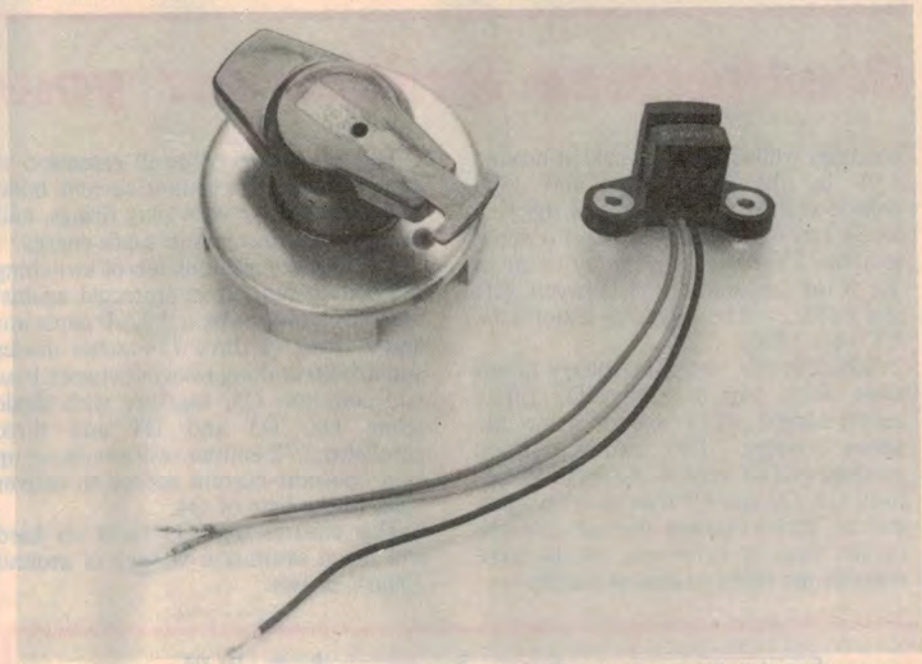
The Siemens device, designated HKZ101, is rated from −30 to 130°C and can sink up to 40mA. It is hermetically sealed, resistant to petroleum products, and incorporates two tubular rivets to facilitate mounting onto a carrier plate. Three flexible leads provide the power supply and output connections.

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 July 1975. We shall discuss the modification to the Transistor Assisted Ignition first.



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



New distributor parts: Bosch rotating vane assembly (left) and Siemens Hall Effect sensor.

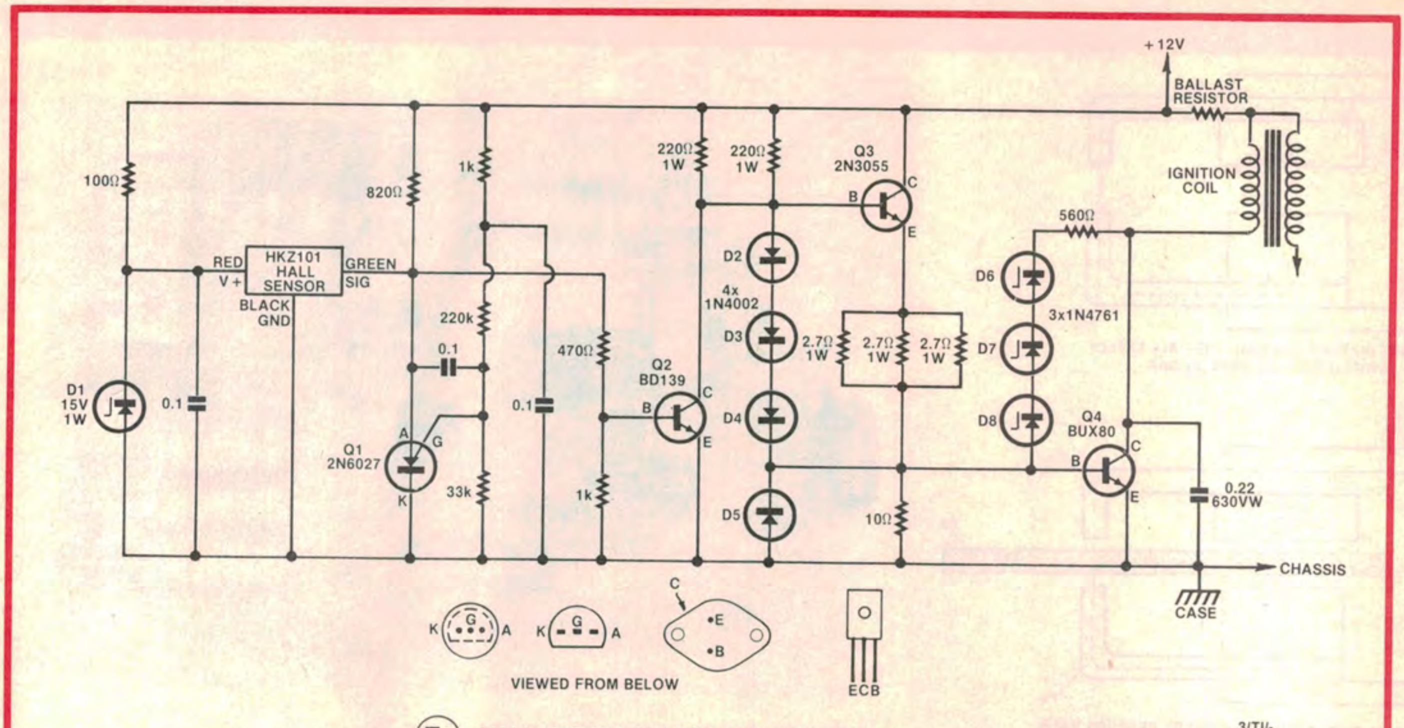
D1 is a 15V zener diode which protects the Hall sensor from the high voltage spikes that are normally evident in an automotive electrical system. The 100Ω resistor from the 12V rail and the 0.1μF capacitor in parallel with D1 provide the necessary decoupling of the supply.

With no iron vane in the Hall sensor air gap, the output of the sensor is low and so Q2 is off. This, in turn, means that Q3 and Q4 are conducting and current is flowing through the ignition coil.

When an iron vane subsequently moves into the air gap, the Hall sensor turns off and transistor Q2 turns on by virtue of current flow via the 820Ω and 470Ω resistors. This turns off Q3 and Q4 which allows the coil to fire the spark plug.

Q2 does not remain in conduction for the entire time that the Hall sensor is off, however. This is because of the dwell extension feature provided by programmable unijunction transistor (PUT) Q1. This operates as follows:

When the Hall sensor output is low, the anode of Q1 is held close to chassis



EA HALL EFFECT TRANSISTOR IGNITION

Breakerless ignition for your car

potential while its gate is held at around 1.6V by the 1kΩ, 220kΩ and 33kΩ voltage divider network. When the Hall sensor turns off, the anode of Q1 is raised to about 5V while the gate, by virtue of the 0.1μF capacitor tied between gate and anode, will be forced to about 6.6V (5V plus 1.6V).

Subsequently, the gate voltage bleeds away until, 1ms after the Hall Effect sensor turned off, it is 0.6V below the anode voltage. This causes Q1 to conduct and so remove the forward bias from Q2. Q3 and Q4 thus turn on again and so current passes through the coil earlier than it otherwise would have without the dwell extension facility.

The advantage of dwell extension is that it ensures maximum current build up in the coil between plug firings, and thus a useful increase in spark energy.

Q4 does the arduous job of switching the coil current. It is protected against excessive voltages by a 0.22μF capacitor and a string of three 75V zener diodes and a 560Ω limiting resistor between base and collector. Q3, together with diode string D2, D3 and D4 and three paralleled 2.7Ω emitter resistors, is set up as a constant current source to deliver 1.3A to the base of Q4.

This ensures that Q4 turns on hard and has a saturation voltage of around 300mV or less.

The only remaining components requiring comment are diode D5 and the parallel 10Ω resistor. The resistor effectively ties the base of Q4 to its emitter and thus improves its ability to withstand high voltages. D5 protects the base-emitter junction against reverse biasing.

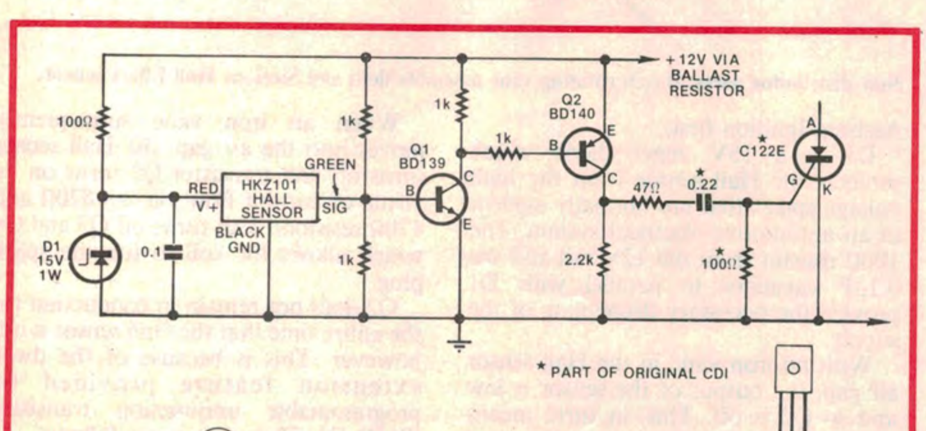
The CDI version

As mentioned in the February 1983 issue, we no longer recommend Capacitor Discharge Ignition (CDI). It has a nasty tendency to make the engine crossfire and in any case, the spark duration is too short for modern engines fitted with anti-pollution gear. For those CDI stalwarts who fail to be convinced, we have developed an adapter circuit for the CDI published in our July 1975 issue.

As with the Transistor Assisted Ignition, the Hall sensor is zener protected and the supply is decoupled using a 100Ω resistor and a 0.1μF capacitor. With no iron vane in the air gap, the signal output of the sensor is low and Q1 and Q2 are off.

When an iron vane moves into the air gap, the Hall sensor switches off and Q1 turns on. This turns on Q2 which delivers a pulse of current to the gate of the SCR via the 0.22μF capacitor, thereby triggering the SCR (C122E) into conduction.

The remainder of the CDI circuit functions as described in July 1975.



EA HALL EFFECT TRIGGERING FOR CDI

TAI Adapter kit

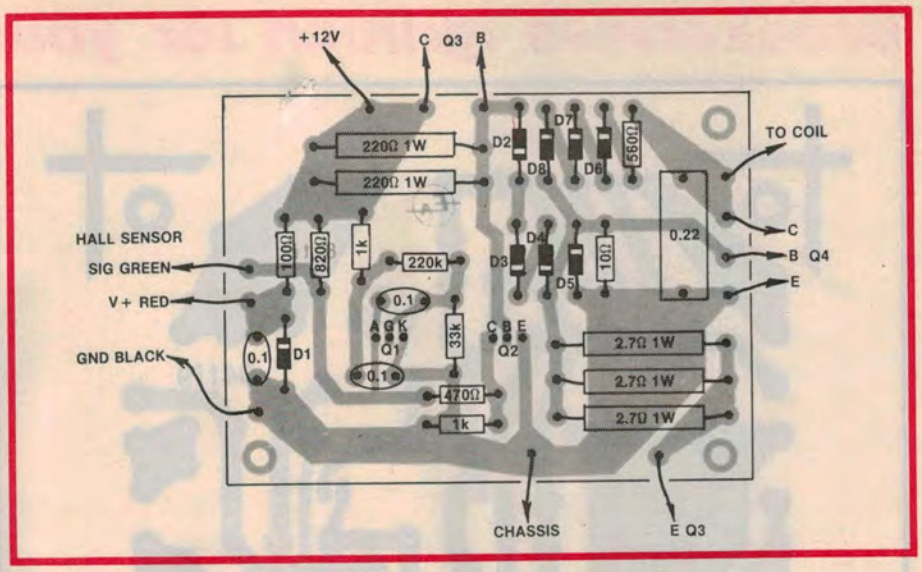
- 1 Hall Effect vane switch, Siemens HKZ101 (Jaycar)
- 1 Rotating vane assembly (Bosch, see text)
- 1 printed circuit board, code 84ti9, 93 x 69mm
- 1 15V 1W zener diode
- 1 0.1µF metallised polyester capacitor

Resistors (¼W, 5%)
1 x 220kΩ, 1 x 33kΩ, 1 x 820Ω, 1 x 470Ω, 1 x 100Ω

CDI Adapter kit

- 1 Hall Effect vane switch, Siemens HKZ101 (Jaycar)
- 1 Rotating vane assembly (Bosch, see text)
- 1 piece of stripboard (see text)
- 1 15V 1W zener diode
- 1 0.1µF metallised capacitor
- 1 BD139 NPN transistor
- 1 BD140 PNP transistor

Resistors (¼W, 5%)
1 x 2.2kΩ, 4 x 1kΩ, 1 x 100Ω, 1x 47Ω



Construction

As far as construction of these circuits is concerned, we have developed a PCB (code 84ti9, 93 x 69mm) for adapting the transistor ignition to Hall Effect triggering. Some readers, however, may prefer to modify their existing PCB by removing the unwanted parts and stringing the new parts across convenient vacant positions.

For the CDI version, we will leave it to readers to add 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 install them on the new PCB without changing lead spacings.

Follow the parts overlay diagram carefully and make sure that all polarity conscious components are correctly oriented. Note the heat expansion and shock relieving loops in the diode leads (see photograph of PCB).

The remainder of the construction is exactly as detailed in the February 1983 issue.

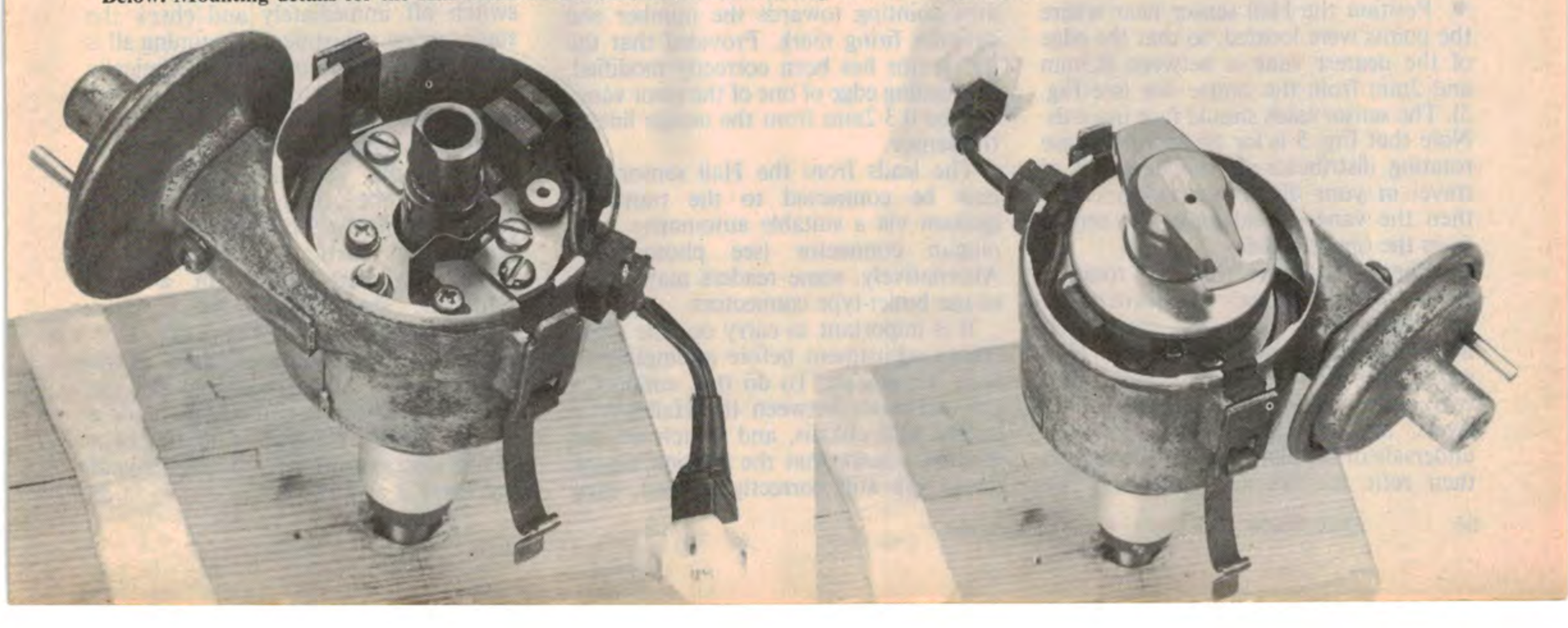
Modifying the distributor

The job of modifying the distributor is straightforward enough. What you have to do is remove the points and the existing rotor button, and replace them with the Hall sensor and the Bosch rotating vane assembly. The Hall sensor must be positioned so that the rotor vanes pass freely through the air gap at a depth of 8-11.5mm (see Fig. 5).

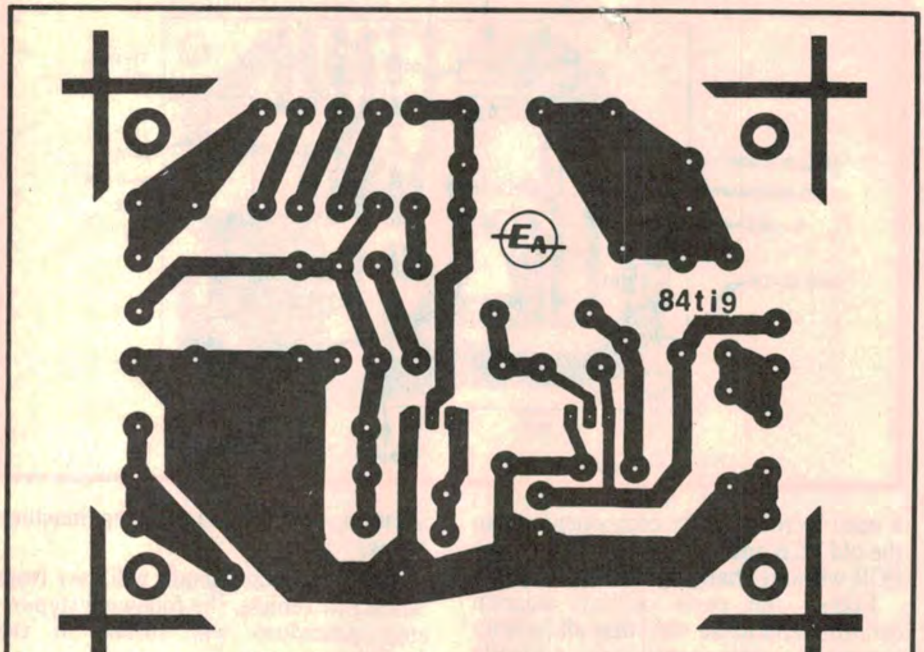
In order to achieve the correct depth, it will usually be necessary to mount the Hall sensor on an adapter plate. This is then attached to the breaker plate (or vacuum advance plate) using machine screws.

While the exact details will vary from vehicle to vehicle, the following step-by-step procedure will suffice in the majority of cases:

- Remove the distributor cap and crank the engine until the rotor button points to the high tension terminal for number one cylinder and the timing marks are aligned at the static timing setting. Check that the points have just opened or are about to open.
- Locate the number one cylinder firing mark on the distributor body (the rotor button will now be pointing towards it). This mark will usually take the form of a small arrow. If your distributor doesn't have this mark, scribe a suitable mark in the appropriate position.
- Remove the distributor from the engine block and remove the following surplus components: rotor, contact breaker points and capacitor. Some distributors have a damping rubbing


Below: Mounting details for the Hall Effect sensor (left) and Bosch rotating vane assembly (right).

Breakerless ignition for your car



Above is an actual size artwork for the PCB.

block — this should also be removed for the time being.

Important: do not disturb the engine once the distributor has been removed from the block.

- Fit the Bosch rotating vane assembly to the distributor cam and rotate the cam in the normal direction of travel so that the rotor arm points to the number one cylinder firing position. Temporarily secure the arm in this position using an elastic band.
- Measure the vane to breaker plate distance and calculate the adapter plate thickness required so that the vane will pass through the sensor at a depth of 8-11.5mm. This done, fashion a suitable adapter plate (see photograph) from scrap aluminium (you may need to use two layers) and attach it to the breaker plate.
- Position the Hall sensor near where the points were located, so that the edge of the nearest vane is between 0.3mm and 2mm from the centre line (see Fig. 5). The sensor leads should face inwards. Note that Fig. 5 is for an anti-clockwise rotating distributor. If the direction of travel in your distributor is clockwise, then the vane should enter the sensor from the opposite side.
- Check to ensure that the rotating vanes will pass through the centre of the air gap, then carefully mark the mounting hole positions for the Hall sensor. Remove the adapter plate, drill two 3.5mm holes to accept the sensor rivets, and countersink them on the underside of the plate. Mount the sensor, then refit the adapter plate and the rubbing back (where used) in the distributor.
- Feed the leads from the Hall sensor through the original grommet used for the points lead. Check that there is no fouling of the distibutor cam and that the breaker plate can move over its full range of vacuum advance. Check also that the rotating vane assembly passes freely through the Hall sensor gap at the required depth.

Refitting the distributor

That completes the distributor modification. All that remains now is to refit the distributor and carry out the timing adjustments.

The distributor must be refitted with the same orientation as previously (otherwise you won't be able to connect the vacuum advance), and with the rotor arm pointing towards the number one cylinder firing mark. Provided that the distributor has been correctly modified, the leading edge of one of the rotor vanes will be 0.3-2mm from the centre line of the sensor.

The leads from the Hall sensor can now be connected to the transistor ignition via a suitable automotive style plug-in connector (see photograph). Alternatively, some readers may prefer to use bullet-type connectors.

It is important to carry out the static timing adjustment before attempting to start the engine. To do this, connect a DC voltmeter between the Hall sensor output and chassis, and switch on the ignition. Check that the ignition timing marks are still correctly aligned, then

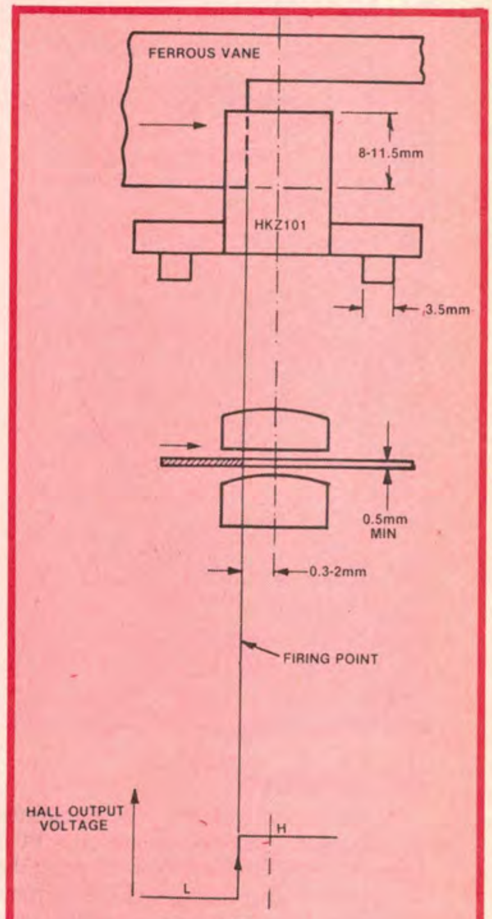


Fig. 5

loosen the distributor clamp and rotate the distributor body in the direction of rotor travel until the meter reads 0V.

Now rotate the distributor body in the opposite direction until the meter suddenly reads 5V. This 0V to 5V transition represents the firing point for number one cylinder.

Finally, refit the distributor cap and check that the engine starts and runs normally. If you do strike problems, switch off immediately and check the static timing adjustment. Assuming all is well, the engine should be dynamically timed according to the procedure set out in the workshop manual.

Before concluding, it may be as well to consider the reliability implications. Although the odds of failure are probably fairly long, it does bear thinking about. In particular, it must be emphasised that failure in a fully electronic system precludes a quick change back to standard ignition.

Fairly obviously, a breakdown in the bush could be embarrassing to say the least. Our advice, particularly if you do a lot of country driving, is to obtain a second distributor from a wrecker's yard and carry it as a spare.