- ★ Eliminates points
- ★ Maintenance free
- ★ Locks in engine tune

Build your own OPTO-ELECTRONIC IGNITION SYSTEM

The conventional automotive contact breaker is still widely used in modern petrol engines despite its shortcomings. This opto-electronic design is simple, maintenance-free and will drive almost any electronic ignition system that operates with mechanical contacts.

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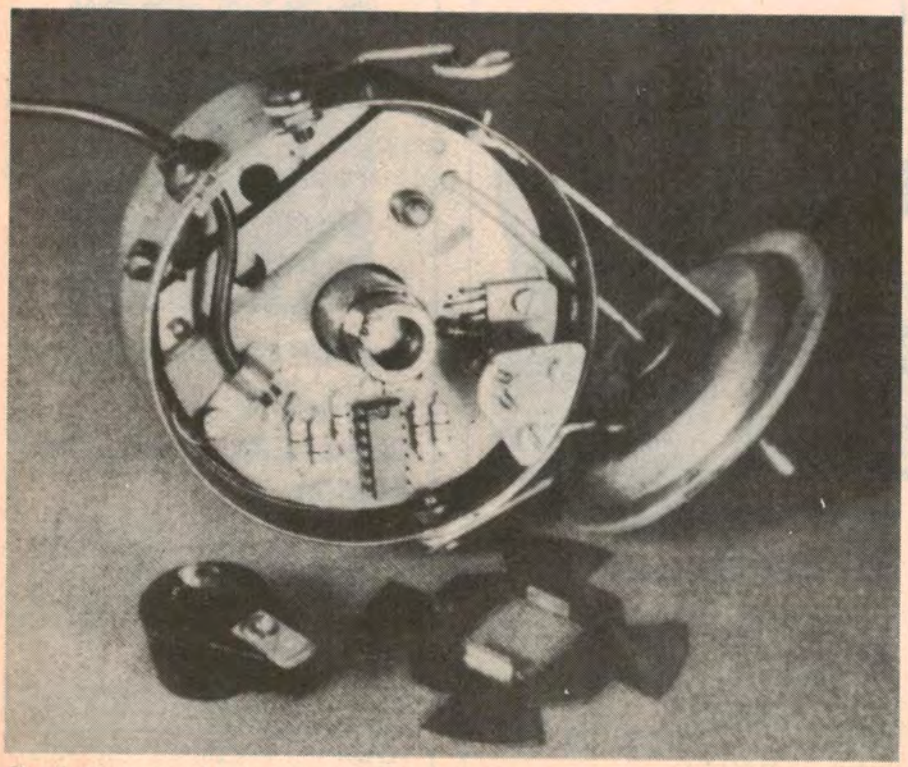

Fig. 2: the assembled printed circuit board, mounted on the action plate of a distributor. In the prototype TR1 was mounted underneath the board.

Although many electronic ignition units are available, and several well designed constructional circuits have appeared, most of them are triggered by the existing contacts and use either inductive or capacitive discharge to improve the spark and extend contact life. Some designs claim to eliminate the effect of contact bounce, but the effects of contact heel wear and timing scatter still remain.

The circuit in Fig. 1 provides an output which, for low currents, simulates the contact breaker and can trigger an electronic ignition unit without modification. The existing centrifugal and vacuum advance mechanisms are retained, and the only mechanical part which must be constructed with any precision is a chopper disc.

The light source is an infrared LED with a lens to give a well defined beam, which is received by a spectrally and physically matched phototransistor. Light passing between the two devices is interrupted by a chopper disc which produces a rough square wave. This waveform is cleaned up before it is used for timing because electronic ignition circuits often require a sharp edge to trigger an SCR. A conventional two transistor Schmitt-trigger was not used because the regenerative action only occurs if the input has a low source impedance and, in this design, the phototransistor is a current source. Instead, an open collector TTL IC with two gates connected as a set-reset bistable is used. The inputs are driven in a complementary mode by using a third gate as an inverter, and the remaining gate is used as a buffer. The regenerative action

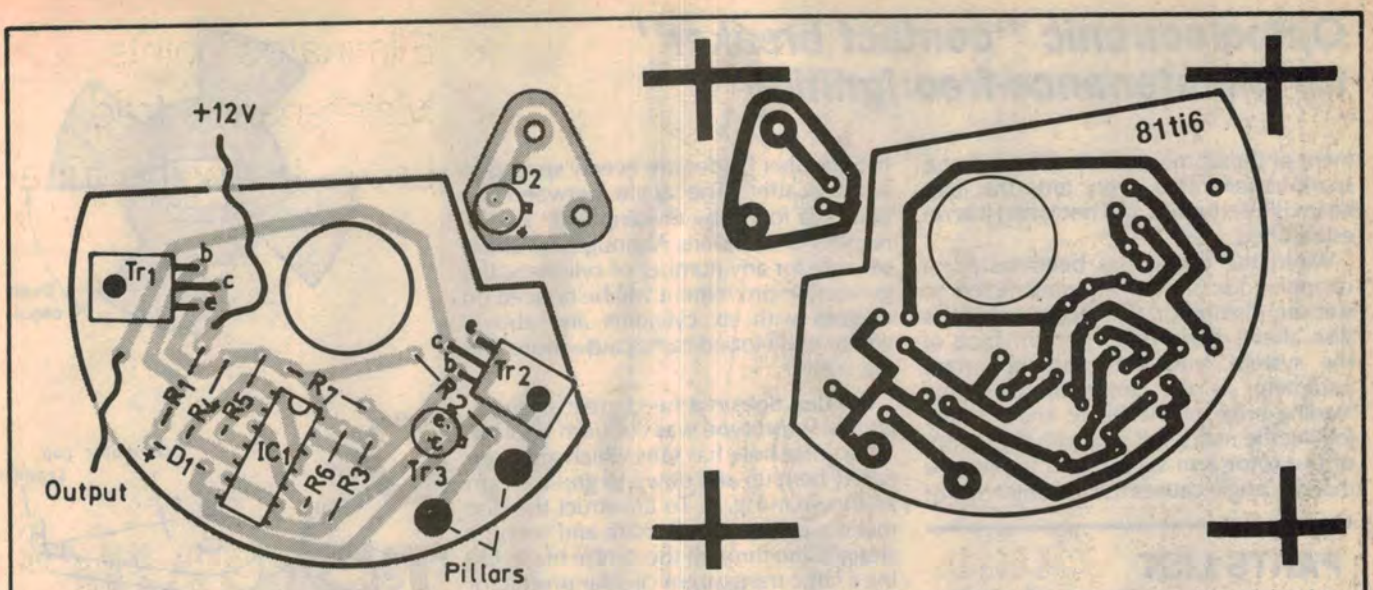

Fig. 3: component overlay and actual size PCB pattern. TR1 and TR2 do not require heatsinks, but should be secured with the screws that hold the PCB in place. The mounting screw that secures TR2 also provides the chassis return for the earth track on the PCB.

of this circuit gives fast switching, and a conservatively rated series regulator provides reliable operation.

The complete circuit can be built on a glassfibre PCB and mounted inside the distributor as shown in Fig. 2. The prototype fits a Delco distributor as fitted to many GM vehicles, but the layout can be modified to fit most other types. Some foreign vehicles use very small distributors, and for these it is best to house the circuit in a small metal box beside the distributor. Installation is much easier if a replacement distributor is used. Also, the second unit is useful to carry as a spare.

The phototransistor is mounted directly on the PCB and the LED is mounted about 2.5mm away on a small board supported by 3mm tapped pillars which also carry the LED current. The main PCB is mounted with spacers on the action plate in the distributor with 3mm screws which must have holes drilled and tapped. As the action plate is rotated by the vacuum advance mechanism, it must not be obstructed by the board or swarf, and the manufacturer's recommended lubricant should be restored. If the existing contact pivots on a pillar rivetted to the action plate, the pillar must be removed before the PCB can be installed.

Care must be taken to ensure that the small board does not foul the rotor arm or the inside of the distributor cap. When installed, the PCB is connected to the ignition unit by a length of good quality miniature three core stranded cable. The third wire is either left unused, or used to provide an additional earth path to the TAI unit. The cable should be supported by a small P clip fixed by one of the mounting screws, and by the existing grommet in the distributor body. Remember to leave enough cable loose so that the action plate can revolve.

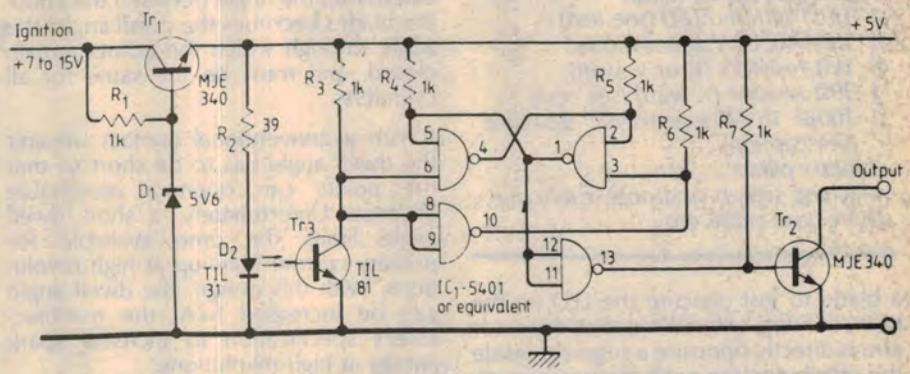

Fig. 1: trigger circuit and regulator. Readers are advised to fit a 100µF 16VW electrolytic capacitor across the zener diode (— Ed).

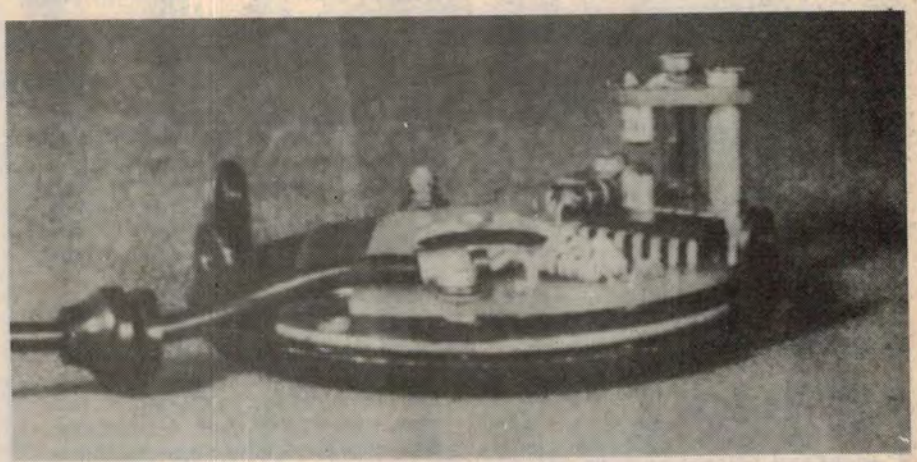

Fig. 4: phototransistor and LED mounting details. The two pillars must be metal types to carry the LED current.

The circuit can be tested by connecting +12V to the supply lead, and a low power bulb from +12V to the output lead. The lamp should remain on until the light beam is interrupted. Note that the specified device does not emit visible light. If the circuit switches the lamp correctly, connect it to the electronic ignition unit and take the high tension (HT) lead from the coil directly to one spark plug. This will avoid coil breakdown if the rotor arm is not pointing at a seg-

Optoelectronic "contact breaker" for maintenance-free ignition

ment of the distributor cap. Check that a spark is generated every time the light beam is interrupted and not when it is re-established.

When the circuit has been tested, a chopper disc should be constructed to suit the distributor. The accuracy of this disc affects the overall performance of the system, and the most important parameter is the angle between the leading edge of the blade and the line joining the mainshaft axis with the centre of the rotor arm sector. It is imperative that this angle causes the leading edge of a blade to just obscure the LED, ie the point of firing, when the end of the rotor arm is directly opposite a segment inside the distributor cap, with the vacuum advance at mid-travel. If this condition is not achieved the engine may not run.

Another important requirement is that the chopper blades are evenly spaced to avoid scatter. The angle between the blades is found by dividing 360° by the number of cylinders. Although this unit is suitable for any number of cylinders, the greatest improvement will be noticed on engines with six cylinders and above, where multi-lobed cams cause more timing scatter.

The disc does not need great strength, and the prototype was cut from tinplate. The centre hole has tabs which are alternately bent up and down to grip the cam as shown in Fig. 5. To construct the disc make a centre punch mark and scribe a straight line through the centre mark. Using a large transparent circular protractor with 0 and 180° marks on the line, mark the position of the blade edges and scribe lines to the centre. If an inductive discharge system is used (ie a transistor-assisted ignition system without dwell extension), the angle between the chopper blades becomes the dwell angle, the angle through which the points remain closed, and must be the same for all cylinders.

With a conventional contact breaker the dwell angle has to be short so that the points can open a reasonable distance. Unfortunately, a short dwell angle limits the time available for primary current build-up at high revolutions. With this design, the dwell angle can be increased from the manufacturer's specification to increase spark energy at high revolutions.

However, if the unit is used with a capacitor discharge ignition system, the angle between the blades is not important because the spark is controlled only by the leading edges of the chopper blades. This also applies to transistor-assisted systems with in-built dwell extension (see EA December, 1979).

Cutting the disc shape is made easier if the tinplate is clamped to a thin sheet of aluminium or plywood. After drilling the centre hole and filing it to shape, cut the disc to the correct diameter, cut the blades to shape and finish with a fine file. Finally, bend the tabs for a good central fit on the cam.

The disc is then fixed to the cam with epoxy resin after checking that all the parameters are correct and that the disc revolves freely. When installation is complete, the distributor can be mounted in the engine and adjusted for correct timing with a strobe light.

Although this unit will not produce a dramatic increase in performance from a correctly tuned engine, the firing at high revolutions should be smoother and tickover should be very steady even when cold, which permits sparing use of the choke. However, the main benefit is a maintenance-free ignition system. The prototype has now been in use for five years and the distributor cap is only removed to show disbelievers.

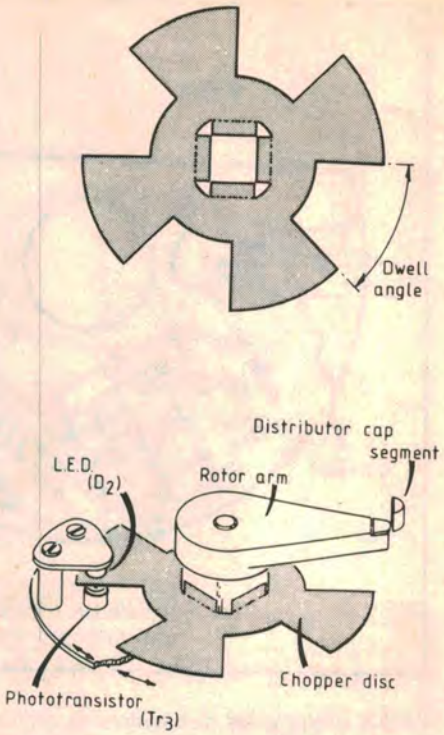

Fig. 5: typical shape and mounting for the chopper disc. It is imperative that, when the disc just interrupts the light beam, the rotor arm is directly opposite a distributor segment with the vacuum pushrod at mid travel.

PARTS LIST

- *1 printed circuit board set, code 81ti6, 74 × 58mm*
- *1 5401 quad two-input NAND gate (see text)*
- *2 MJE340 NPN transistors*
- *1 TIL81 phototransistor*
- *1 TIL31 infrared LED (see text)*
- *1 5.6V 400mW zener diode*
- *6 1kΩ resistors (¼ or ½ watt)*
- *1 39Ω resistor (½ watt) (see text)*
- *1 100μF 16VW electrolytic capacitor (see caption)*
- *2 brass pillars*

Machine screws and nuts, cable clip, three-core cable etc.

Special comments . . .

Following publication of the Transistor-Assisted Ignition system in December 1979, many readers asked us to describe a matching trigger unit to eliminate the conventional contact breaker. The above project is reprinted from "Wireless World" and is compatible with both the "Electronics Australia" TAI system and the CDI system described in July 1975.

Because we have not built and tested the project, however, we are NOT able to offer advice to readers who encounter difficulties (either electronic or mechanical). For this reason, we do NOT recommend that readers tackle this project unless they know exactly what they are doing, particularly in regard to installation and engine tuning.

Most of the parts, including the PCB, should be available through your usual supplier. The 5401 quad two-input NAND gate is being specially imported and will be available towards the end of June from Radio Despatch Service, 869 George St, Sydney 2000. Do not use the 7401 device – its temperature rating is not high enough.

Radio Despatch Service also stocks the TIL81 phototransistor, but the TIL31 infrared LED is not available. The Philips CQY89A device should be suitable however, although it may have to be fitted with a small light tube to prevent false triggering due to light scatter (unlike the TIL31, the CQY89A is not lensed). Note that R2 should be increased to 68Ω for the CQY89A.

Finally, make sure that you do the job in a workmanlike manner. If a breakdown occurs it will no longer be possible to revert quickly to the old ignition system.

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