



A READER BUILT IT

A capacitor-discharge transistor ignition system

In view of the healthy interest evident in transistor ignition revealed in recent correspondence, this contribution from a reader for a capacitor-discharge system is timely.

After investigating the economics and performance of the various transistor ignition systems, I have concluded that the only worthwhile set-up is the so-called "capacitor-discharge" system. This costs a little more to construct than the standard transistor ignition but the saving in not having to purchase a special coil largely compensates for this. As far as efficiency is concerned, it wins hands down every time, and must therefore be the logical choice for anyone who is dissatisfied with the standard ignition on his car.

The system to be described is reasonably inexpensive to construct and is reliable in operation. It is absolutely conventional in all respects, simple to put together and easy to get working if the layout and instruction are followed reasonably closely.

The heart of any capacitor-discharge system is the converter circuit whose function is to step up the 12V DC from the battery to 250-300V DC ready for application to the coil primary. The circuit shown here is a push-pull transformer-coupled converter utilising square-loop material for the transformer core. (3E grade ferrite is used, as it is cheap and although it does not have a strictly "square" hysteresis loop, its saturation level is well defined and it is quite satisfactory for this application). A description of the operation of the converter can be found in almost any book on transistor theory so will not be repeated here.

The transformer must be carefully hand-wound on a ferrite toroid of dimensions shown (figure 1) and of 3E grade ferrite. A suitable core is supplied by Mullard and is obtainable for about 60c. Wind the primary on first. This consists of two coils, bifilar wound, of 20 turns each of 22SWG copper wire. Wrap it up with plastic tape to hold it in place. Then wind a base-drive winding of six turns of the same wire at each end of the primary. Make sure all the ends are identified in some way, a bit of coloured sleeving is ideal for this, and tape the whole thing so far. The secondary may now be wound to fill the rest of the available space. That is several layers adding up to 450 turns of 29SWG. Having completed this the whole thing may be taped up to hold it all together, and some robust

lengths of wire soldered to the ends of the secondary to prevent the fine wire being broken in an awkward place. The transformer may then be mounted on a piece of Veroboard as shown in figure 6. Assemble the rest of the converter components on the Veroboard including the diodes and the 330K resistor, fit the transistors to the case-cum heat sink and wire them up to the board with long leads.

Check all the wiring so far and, if O.K., connect a 12-volt battery to the circuit (observing the correct polarity).

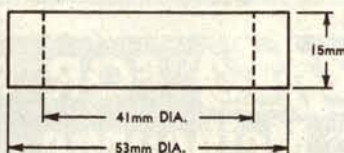
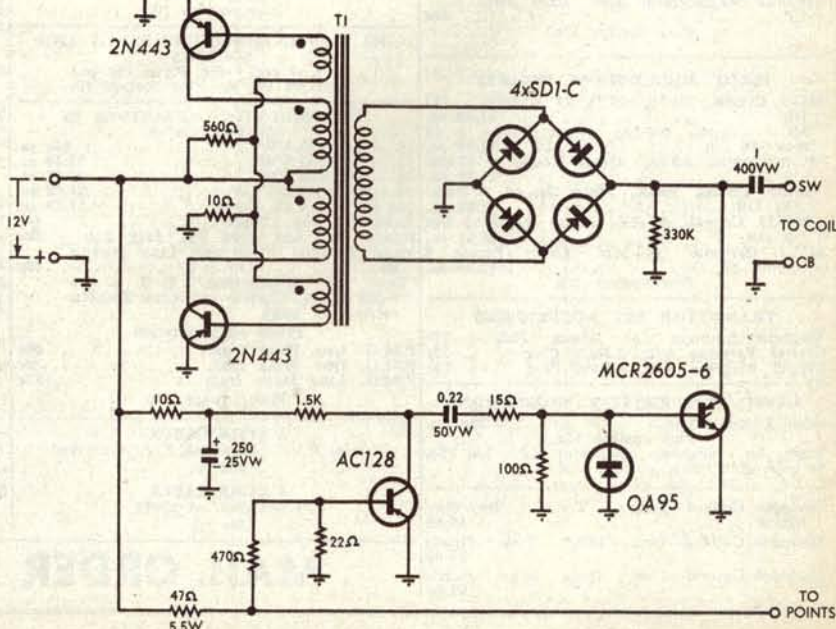


Figure 1

ABOVE: Figure 1. The ferrite toroid, with dimensions.

BELOW: Figure 2. The circuit diagram for use with a positive earth system.



Parts List

Converter transformer
Core — Mullard. (See Editor's note overleaf.)

Primary 40T CT, 22SWG bifilar wound

Base drive — 6T 22SWG (2 windings)

Secondary — 450T 29SWG.

Semiconductors

2 x 2N443 Transistors

1 x AC128 Transistor

4 x SD-1C Diodes (any 500mA 400PIV type)

1 x SCR — Motorola type MCR-2605-6 (any 400V 6A type will do)

1 x Diode, OA95, OA85, or similar.

Resistors

1 x 330K, 1 x 1.5K, 1 x 560, 1 x 470, 1 x 100, 1 x 47 (5.5 watt), 1 x 22, 1 x 15, 2 x 10 (values in ohms, all ½ watt unless otherwise stated.)

Capacitors

1 1uF/400V polycarbonate

1 0.22uF/50V polycarbonate

1 250uF/25V electrolytic

Sundries

Veroboard, screws, etc.

Aluminium case measuring 5½" x 4" x 1½".

A whistle at about 8KHz should be heard. This indicates the converter is functioning. If no whistle is heard, disconnect the power immediately and reverse the connections to one of the base-drive windings. The converter should now function and a voltmeter placed across the 330K resistor should show about 270V DC. Having got the converter working, the SCR circuit may be wired up on the board, along with the trigger circuit. This is straightforward and should be easy enough referring to the photograph of the layout and the circuit diagram.

The lay-out should be followed reasonably closely, or false triggering of the SCR may result. At one stage in the development the SCR was picking up hash from the converter and triggering continuously. Obviously a defect of this type would not improve the performance of any motor car engine. Incidentally a trigger circuit using a unijunction transistor was tried originally and although it worked 100 per cent it was discarded in favour of the circuit shown, on the grounds of cost.

When the wiring has been completed and thoroughly checked, the unit may be tested, before hooking it up to a car, by connecting a coil to the appropriate terminals with a spark gap of about $\frac{1}{4}$ in connected to the secondary. (This is important as the coil insulation may be broken down if it is omitted.) Apply power and ground the "breaker points" terminal. Upon breaking this ground connection a thin blue spark should snap across the spark gap. With a standard 100:1 coil the output voltage will be about 27KV, more than adequate for ignition purposes.

The shape of this 27KV pulse is important too. With this system a very short rise time is possible, i.e. a "sharp" pulse is generated, and this is more effective at ionising the gas at the plug points than a pulse of slower rise time, such as is produced by a conventional transistor ignition system. Note that a 250:1 or 300:1 low inductance primary transistor ignition coil will work just as well as the standard coil, but will produce an

Modifications to the basic circuit

NEGATIVE EARTH. The negative earth version is somewhat simpler, as the pulses from the breaker points are already of the correct polarity to trigger the SCR into conduction directly. (The positive earth circuit uses a transistor to invert trigger pulse polarity.)

The only requirements, therefore, are that the trigger circuit provides a pulse of the correct amplitude and duration from a sufficiently low impedance source. These factors are taken care of by the circuit in figure 3.

It should be noted that at extremely high rpm, contact bounce can cause erratic firing. It is possible to prevent this by ensuring that the SCR gate is isolated from the breaker points for a short period after each firing pulse. This can be accomplished by including a diode and discharge network as shown in figure 4.

The voltage on the capacitors reverse biases the diode immediately after firing. The voltage bleeds off in about 0.6 milliseconds and the SCR cannot be fired during this period. (At 8000 rpm, a six cylinder engine fires approximately every 2.5 milliseconds, so this delay does not impose a rpm limit.) D1 is any 150mA 50PIV (or more) silicon diode. Capacitor C (shown dotted) may be added to reduce RF interference, if this is a problem. Its value should be about 0.22uF.

CATHODE INJECTION. It may be noted in passing that it is possible to trigger an SCR with negative pulses by injecting them at the cathode.

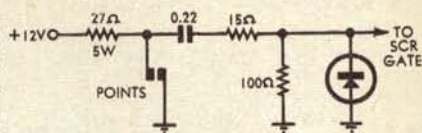


Figure 3

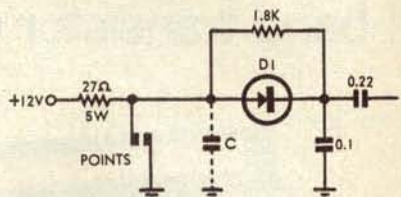


Figure 4

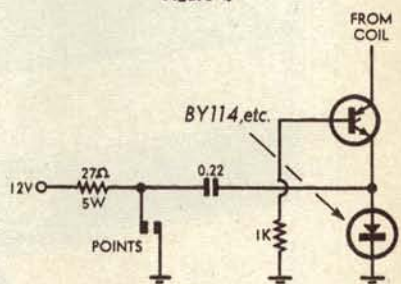


Figure 5

This has not been tried by the writer but may provide a cheaper and simpler circuit for the positive earth version. The circuit, figure 5, is suggested as a basis for experimentation.

even higher output which may cause trouble if the HT leads and distributor cap on the car are not in new condition.

The prototype has been fitted to a Mk. 3 Ford Zephyr for about 3,000 miles and has proved completely reliable. Improvements in performance that have been noted are:

1. Easier starting on cold mornings and smoother running when cold.
2. Gas mileage up from 22.6mpg to 24.4mpg (measured over 1,000 miles of everyday driving, in both cases).
3. Slightly better pulling power on hills.
4. Top speed in 3rd gear (4-speed transmission) increased from 60mph to over 70mph.

A few words on mounting the unit might not go amiss. It should be screwed to the fire wall or inside guard under the bonnet but not in such a place as to receive a blast of hot air from the radiator. The transistors do not run all that hot mounted on the case as shown but a cool airstream is desirable. Also care should be taken to ensure that mud and water cannot splash all over the unit. It should not be mounted inside the passenger compartment as the high pitched whistle emitted may be very irritating. Leads should not be run much over three feet, especially the lead to the coil SW terminal (caution — this carries 260 volts). It is not necessary to remove the condenser fitted across the car's points. Note also that a negative ground version is available if anyone is interested. (See above.)

EDITOR'S NOTE: We are advised by Mullard-Australia Pty. Ltd. that they do not use the term "3E grade" in Australia, and they recommend that home constructors making this project should use the Ferroxcube Toroid No. FA1079, of A3 material. A limited supply of these is available at present from Mullard distributors, but should demand exceed the supply, steps will be taken to obtain replacement stocks quickly.

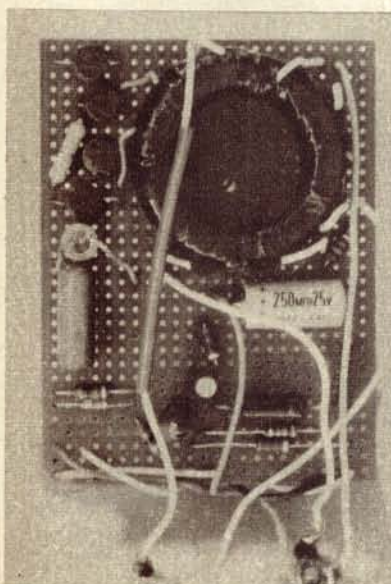


Figure 6. The layout of components here should be closely followed.

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