CIRCUIT CIRCUS

By Charles D. Rakes

Spud Gun Application

Light Your Fire

This get together I'd like to share with you a number of electronic ignitor circuits. A simplified description of an electronic ignitor is an electronic device that generates a spark or an arc to light a fire.

Many of today's gas furnaces are lit with an electronic ignitor. That saves a considerable amount of gas normally used to keep the pilot light on all of the time. When the thermostat calls for heat, the electronic ignitor fires, lighting the pilot and thus the furnace. Many gas stoves also operate in the same manner. Other uses for ignitors include lighters for acetylene gas welders, propane torches, and just about any function that requires a spark to ignite a flame. Possibly the most common ignitor is the spark plug.

AN IGNITOR

Our first ignitor circuit, see Fig. 1, uses only three components to generate a high-voltage spark. At the heart of this circuit (and the majority of the spark generators we'll present) is a high-turns-ratio, step-up transformer, T1. When S1 is closed and released, a current pulse flows through the transformer's low-voltage primary circuit, producing a high-voltage pulse across the secondary winding.

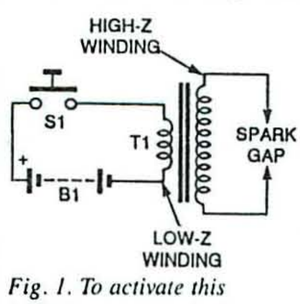

Fig. 1. To activate this ignitor, momentarily depress S1 to release current into T1. The result is a spark across T1's secondary.

You may use just about any high-turns-ratio transformer in this circuit or those that follow. For example, an audio, plate-to-speaker, output transformer will do just fine. You can find one of those in just about any old AC, table-top, AM radio from the 1950's or 1960's. Another good choice from the same time period is a low-impedance mike-to-grid transformer. An ignition coil from a small gas engine or car will also work.

THE SPARKER

Our second sparker circuit, see Fig. 2, uses the same step-up transformer as the first circuit with a power transistor, Q2, switching the current through the transformer's primary circuit. This circuit produces a more consistent output voltage with each pulse and adds

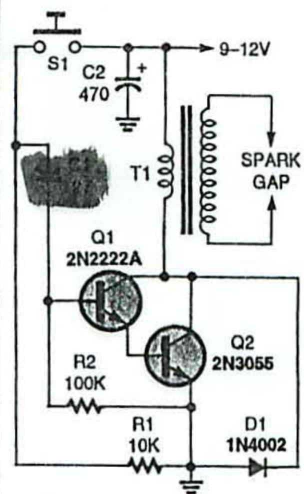

Fig. 2. This circuit uses a transistor switch to pulse T1 with current, creating a high-voltage spark at the output.

PARTS LIST FOR THE IGNITOR (Fig. 1)

B1—9- or 12-volt battery
S1—Normally closed, pushbutton switch
T1—Step-up transformer (see text)

ADDITIONAL PARTS AND MATERIALS
Perfboard, wire, solder, etc.

PARTS LIST FOR THE SPARKER (Fig. 2)

SEMICONDUCTORS
D1—1N4002 silicon rectifier diode
Q1—2N2222A NPN transistor
Q2—2N3055 NPN power transistor

RESISTORS
(All fixed resistors are ¼-watt 5% units.)
R1—10,000-ohm
R2—100,000-ohm

CAPACITORS
C1—0.27-µF, ceramic-disc
C2—470-µF, 25-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS
S1—Normally open, SPST pushbutton switch
T1—Step-up transformer (see text) Perfboard, wire, solder, etc.

to the circuit's efficiency by limiting the time that current flows through the transformer's primary circuit.

When S1 is closed, C1 quickly charges up to the positive supply voltage turning Q1 and Q2 on. After C1 charges to near supply level, the power transistor turns off, releasing energy into the transformer's secondary and producing an output spark. When S1 returns to its open position, C1 discharges through R1 and R2, readying the circuit for another cycle. Diode D1 protects Q2 from any reverse-voltage pulses produced by T1.

The pulse-timing current for T1 may be varied by changing the value of C1. Increasing the size of C1 will lengthen the pulse width, while decreasing the value will do the opposite. For the best efficiency and long battery life, use the smallest value capacitor that produces a good spark. The shorter the pulse, the longer the battery life.

A FET-BASED SPARKER

The circuit in Fig. 3 is very similar to our last circuit, but it has an IRF511 FET doing the switching. About the only difference is the parts count and the addition of a neon lamp across the transformer's secondary to indicate the presence of high voltage. The pulse timing of this circuit may be varied in the same manner as the previous circuit.

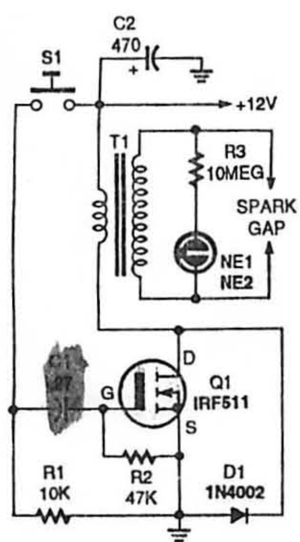

Fig. 3. This FET-based sparker has only one transistor, but needs a 12-volt power source for best operation.

PARTS LIST FOR THE FET-BASED SPARKER (Fig. 3)

SEMICONDUCTORS
D1—1N4002 silicon rectifier diode
Q1—IRF511 field-effect transistor

RESISTORS
(All resistors are ¼-watt 5% units.)
R1—10,000-ohm
R2—47,000-ohm
R3—10-megohm

CAPACITORS
C1—0.27-µF, ceramic-disc
C2—470-µF, 25-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS
S1—Normally open, SPST pushbutton switch
NE1—NE2 neon lamp
T1—Transformer, see text
Perfboard, wire, solder, etc.

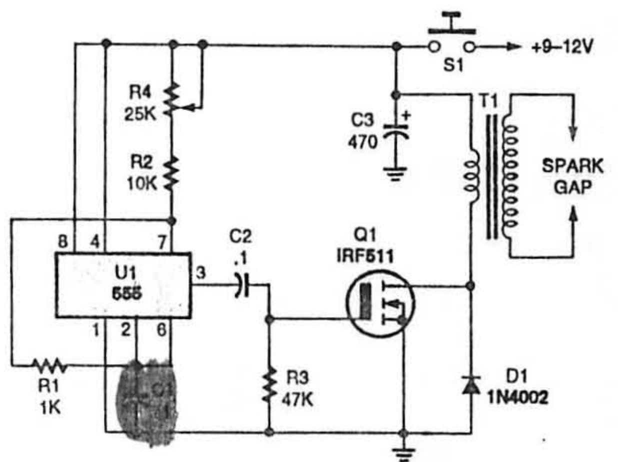

Fig. 4. The 555 timer activates Q1 over and over to produce a series of sparks. This circuit is useful for difficult ignition jobs.

PARTS LIST FOR THE IC-BASED IGNITOR (Fig. 4)

SEMICONDUCTORS
D1—1N4002 silicon rectifier diode
Q1—IRF511 field-effect transistor
U1—555 timer, integrated circuit

RESISTORS
(All fixed resistors are 1/4-watt, 5% units.)
R1—1000-ohm
R2—10,000-ohm
R3—47,000-ohm
R4—25,000-ohm potentiometer

CAPACITORS
C1,C2—0.1-µF, ceramic-disc
C3—470-µF, 25-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS
T1—Step-up transformer (see text)
S1—Normally open, SPST pushbutton switch
Perfboard, wire, solder, etc.

IC-BASED IGNITOR

Our next ignitor circuit, see Fig. 4, takes the previous circuit one step forward with the addition of a 555 oscillator/driver circuit. As long as S1 is closed, the ignitor circuit produces a steady stream of high-voltage output pulses. This circuit would be a good choice to use if you were trying to light a propane torch or a gas welder in a windy area.

Integrated circuit U1, a 555 IC, is connected as a standard astable oscillator with the pulse-repetition rate set by the values of C1, R2, and R4. The IC's output at pin 3 drives the gate of the FET. With each positive pulse, the FET switches current through the primary of T1, inducing high-voltage at the secondary.

The oscillator's frequency should be adjusted to produce the best-looking spark. If a much slower repetition rate is desired, just increase the value of C1.

REPETITIVE SPARKER

Our next ignitor, see Fig. 5, is another simple, repetitive, spark-generator circuit. In it, a unijunction transistor is connected in a free-running pulse-generator circuit with the repetition rate set by the values of C1, R1, and R2. Each time the unijunction fires, C1 is discharged through the primary of T1, producing a high-voltage pulse across T1's secondary.

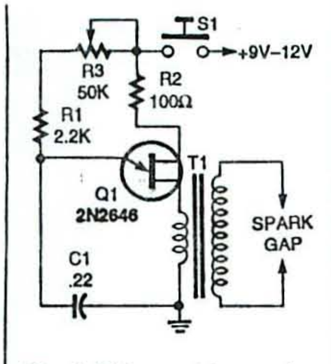

Fig. 5. This repetitive-spark generator requires few parts. That's because its unijunction transistor acts as both an oscillator component and a current switch.

The high-voltage output from this simple circuit is not as great as in the two previous circuits, but it will suffice for lighting a propane torch.

ARC IGNITOR

Our next ignitor circuit is different in that it produces an arc rather than a high-voltage spark. The drawing in Fig. 6 shows the simplicity of the arc-producing ignitor. Before the turn of the century, the arc ignitor was the most popular circuit used to ignite the fuel mixture in internal-combustion engines. The spark plug only became popular after about 1915. Even with the advent of the spark plug, the arc ignitor remained in limited use for many years.

If you would like to see how an arc is produced just take almost any 120-volt AC transformer and connect one lead of the primary to one terminal of a 6 or 12-volt battery. Connect a clip lead to the other battery terminal and wipe the other end of the clip lead across the remaining transformer lead. This should produce a nice, fat, blue arc between the clip lead and transformer wire. **Make sure that the transformer's secondary or any other windings are not connected to anything, and never strike an arc off of a wet-cell battery. Any gases coming from the battery could be ignited!**

Now back to the arc ignitor circuit. The break ignitor points are two 4-40 flat-head screws mounted in the end of a clothes pin, as shown. A wire from each screw connects the ignitor points to the circuitry. Transformer T1 is just the primary winding of almost any 120-volt power transformer; the larger the transformer, the greater the arc. All other windings must not be connected and should be taped off. To produce an arc, close S1 and open the clothes pin.

FLASH CIRCUIT

Our last entry this visit is neither a spark or an arc ignitor circuit. Take a look at Fig. 7 and you will see a circuit designed to flash a fine copper wire. Solid-fuel model rockets are a popular hobby and this circuit can be used to fire a rocket motor. A short length of fine copper wire is positioned in the rocket's motor and connected to the circuit as shown. When S1 is closed, the SCR turns on causing the fine wire to burn and ignite the solid fuel.

That's about it for this month. Hope you enjoyed our ignitor segment. Good circuitry until we meet here next time. ■

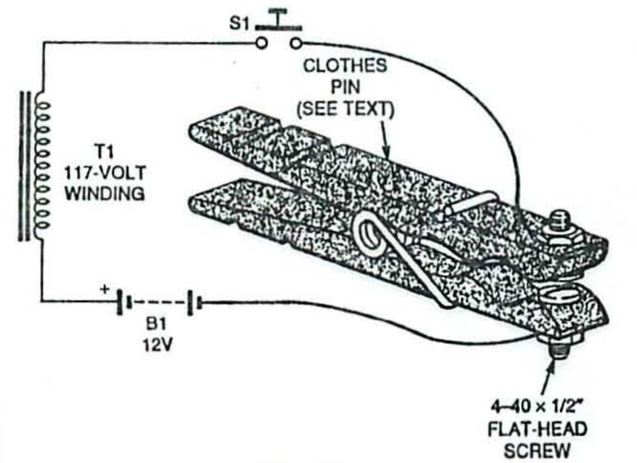

Fig. 6. This arc ignitor works by breaking the current path. This technique was used to ignite car fuel before the turn of the century.

PARTS LIST FOR THE ARC IGNITOR (Fig. 6)

B1—12-volt battery
S1—Normally open, SPST pushbutton switch
T1—Step-up transformer (see text)
Perfboard, wire, solder, two 4-40 ½-inch, metal, flat-head screws, nuts, clothes pin, etc.

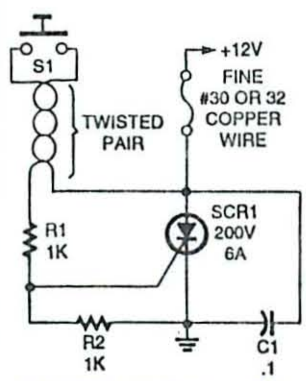

Fig. 7. This flash circuit can be used to ignite solid-fuel model rockets. The fine wire is consumed during each use, so it must be replaced.

PARTS LIST FOR THE FLASH CIRCUIT (Fig. 7)

R1, R2—1000-ohm, ¼-watt, 5% resistor
C1—0.1-µF, ceramic-disc capacitor
SCR1—6-amp, silicon, controled rectifier (Radio Shack No. 276-1067)
S1—Normally open, SPST pushbutton switch
Perfboard, twisted-pair wire, hook-up wire, solder, No. 30 or 32 copper wire, etc

PARTS LIST FOR THE REPETITIVE SPARKER (Fig. 5)

RESISTORS
(All fixed resistors are ¼-watt, 5% units.)
R1—2200-ohm
R2—100-ohm
R3—50,000-ohm potentiometer

ADDITIONAL PARTS AND MATERIALS
C1—0.22-µF, 50-WVDC, electrolytic
Q1—2N2646 unijunction transistor
S1—Normally open, SPST pushbutton switch
T1—Step-up tra: former (see text)
Perfboard, wire, solder, etc.