CIRCUIT CIRCUS

By Charles D. Rakes

Test Instruments and More!

This time around, the Circus deals with a number of unrelated circuits that can be used as simple test instruments or be incorporated into a future project. In any case, get ready for some building fun. The first circuit that we'll explore is a variable-frequency pulse generator.

PULSE GENERATOR

Figure 1 is a schematic diagram of a variable-frequency, pulse-generator circuit. The circuit has a frequency range of 2 Hz to over 50 kHz, and produces narrow, 7-volt, positive-going pulses. The pulses produced by the circuit have widths of about 7 microseconds at the circuit's maximum frequency and 10 milliseconds at its lowest frequency.

The circuit's operating frequency is determined by the value of one of the charging capacitors, C1–C4 (as selected via S1, the range switch) and the values of resistors R1 and R2. The circuit's switching time is fairly rapid due to the regenerative action of the emitter-coupled transistors, Q1 and Q2. That quick switching action produces a fast rising output pulse. With S1 in position 1, the circuit oscillates in the range of 2 to 50 Hz; in position 2, the range is 15 to 500 Hz; in position 3, 120 Hz to 5 kHz; and in position 4, 1.5 to 55 kHz.

Potentiometer R8, a 5k or 10k unit (which can be omitted from the circuit if not needed) is included in the circuit to provide an adjustable pulsewidth. The pulse will increase in width as the resistance of R8 is increased.

The generator circuit isn't complicated, nor is there anything critical about the circuit, so it can be assembled on perfboard and housed in a small plastic cabinet. The circuit can be powered from a 9-volt transistor battery. Such a circuit can be a valuable aid in servicing or experimenting on an existing or future project.

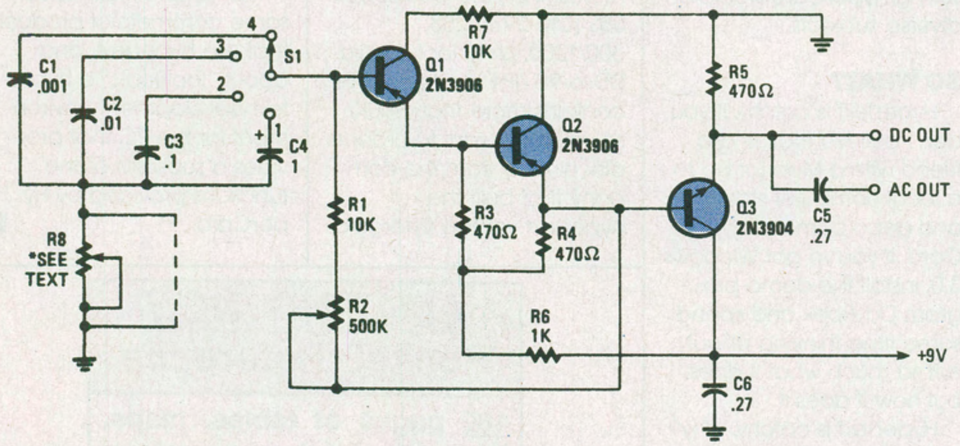

Fig. 1. The variable-frequency pulse generator produces narrow 7-volt positive-going pulses and has a frequency range of 2 Hz to over 50 kHz.

PARTS LIST FOR THE PULSE GENERATOR

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1, R7—10,000-ohm
R2—500,000-ohm potentiometer
R3–R5—470-ohm
R6—1000-ohm
R8—5000-ohm or 10,000-ohm potentiometer (see text)

CAPACITORS

C1—0.001-µF ceramic-disc
C2—0.01-µF, ceramic-disc
C3—0.1-µF, ceramic-disc
C4—1-µF, 100-WVDC, electrolytic
C5, C6—0.27-µF, ceramic disc

ADDITIONAL PARTS AND MATERIALS

Q1, Q2—2N3906 general-purpose PNP silicon transistor
Q3—2N3904 general-purpose NPN silicon transistor
Perfboard materials, enclosure, 9-volt transistor-radio battery and battery connector, wire, solder, hardware, etc.

PROXIMITY DETECTOR

Our next circuit, a proximity detector (see Fig. 2), is designed for those who enjoy modifying an existing circuit to produce a practical and working project. The detector consists of a 567 tone decoder (U1), a couple of transistors, and a few support components. The circuit's operation is simple. The 567 is configured as a decoder; R2 and C4 set its receive frequency to about 100 kHz.

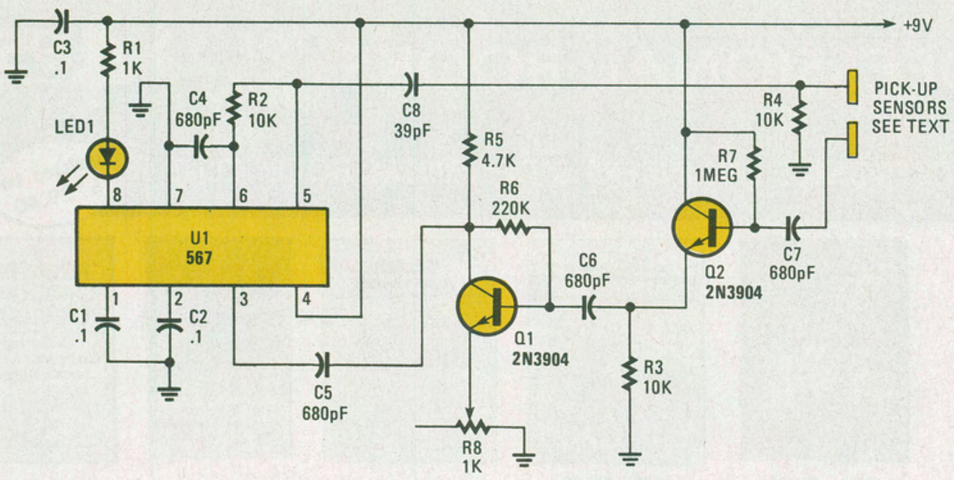

Fig. 2. The proximity detector consists of a 567 tone decoder, a couple of transistors, and a few support components.

PARTS LIST FOR THE PROXIMITY DETECTOR

SEMICONDUCTORS

U1—567 tone decoder, integrated circuit
Q1, Q2—2N3904 general-purpose, NPN silicon transistor
LED1—LED (any color)

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1—1000-ohm
R2–R4—10,000-ohm
R5—4700-ohm
R6—220,000-ohm
R7—1-megohm
R8—1000-ohm potentiometer

CAPACITORS

C1–C3—0.1-µF, ceramic-disc
C4–C7—680-pF, ceramic-disc
C8—39-pF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

Perfboard materials, enclosure, pick-up material (see text), IC socket, 9-volt transistor-radio battery and connector, wire, solder, hardware, etc.

An LED, connected to U1's pin 8 output, lights when an in-band signal is detected. The pin 5 output of U1 (a 100-kHz square-wave signal) is fed through C8 to R4 and one of the pick-up sensors. That RC combination causes the square-wave output to differentiate, shifting the phase of the signal at the pick-up sensor, and allowing U1 to detect its own output signal.

The other pick-up sensor is connected to the input of an emitter-follower amplifier, Q2, which operates like a matching transformer, offering the sensor a high-input impedance and a low-output impedance, which matches the input impedance of Q1, whose gain is set by potentiometer R8. The amplified output of Q1 is fed to U1 at pin 3. When the input signal is about 100-millivolts or greater, U1 detects the signal and lights LED1.

The detector circuit is slightly more critical in the construction scheme used than most of the circuits presented in *Circuit Circus,* so to avoid problems keep all component leads as short as possible, and avoid criss-crossing wires. The detector circuit can be used to detect metal objects, such as nails and electrical wiring in walls, objects traveling on an assembly line, and any object capable of coupling a signal from one pick-up to the other. For instance, the sensors can be attached to non-metal tubing to monitor the flow of conductive fluids.

The sensors can be made from almost any metal such as aluminum, aluminum foil, brass, copper, etc., and can be as small as two short pieces of hook-up wire or as large as needed. To achieve the best performance, breadboard the circuit and experiment with various size of sensors, the spacing between each sensor, the operating frequency, and different values for C8 and R4.

MOISTURE DETECTOR

Our next entry is a simple circuit that can be used as a "puppy puddle" detector. Now don't laugh; I know of a carpet cleaning company that paid over $80 each for a number of commercial moisture detectors that didn't perform any better than the one shown in Fig. 3. The detector can help in locating those damp spots in your carpet in time to properly clean and dry them before they do permanent damage.

The moisture detector is little more than a single 2N3904 NPN transistor (in a common-emitter configuration) that's used to turn on a piezo sounder, BZ1. The one probe is connected to the base of Q1 through a 1k resistor (R2) and the other probe is tied to the +V terminal of a 9-volt transistor radio battery through current-limiting resistor R1 (another 1k unit). A desensitizing resistor, R3, is connected to the circuit via switch S1.

Since there's zero current drain when the circuit isn't in use, an on/off switch isn't needed and the 9-volt transistor battery should last its shelf life. The detector's maximum sensitivity is about 2.5 megohms with S1 in its normal position and about 100k when S1 is activated. Those two ranges will help in mapping wet spots.

There is nothing critical about the circuit; it can be built on a small piece of perfboard, with point-to-point wiring used to interconnect the components. Two heavy-duty, sewing-machine needles can be used as probes. The circuit can then be housed in a length of 1-inch plastic pipe to give it a manufactured look. If the circuit is to be housed in a plastic pipe, the needles should be long enough to extend at least 1½-inches past the end of the pipe.

Switch S1 can be mounted to the pipe above the circuit. It's a good idea to insulate the battery to prevent its metal case from shorting out the circuit components. That's easily done by stuffing a piece of foam rubber, or similar non-conductive material, into the pipe to

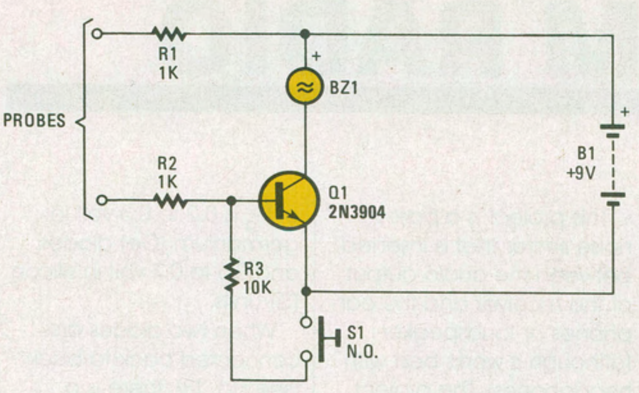

Fig. 3. The moisture detector is nothing more than a transistor (in a common-emitter configuration) that is used as a simple switch.

PARTS LIST FOR THE MOISTURE DETECTOR

Q1—2N3904 general-purpose NPN silicon transistor
R1, R2—1000-ohm, ¼-watt, 5% resistor
R3—10,000-ohm, ¼-watt, 5% resistor
B1—9-volt transistor-radio battery
S1—Normally-open push-button switch
BZ1—Piezo buzzer
Perfboard materials, enclosure, probe, battery connector, wire, solder, hardware, etc.

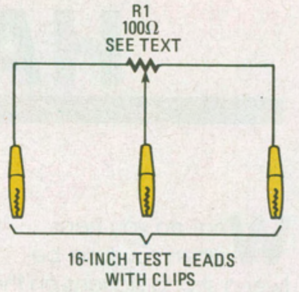

Fig. 4. The variable resistance box can be assembled from junkbox components, and will be of greater service than its simple appearance suggests.

PARTS LIST FOR THE VARIABLE RESISTANCE BOX

RESISTORS
R1—100-ohm linear potentiometer
R2—1000-ohm linear potentiometer
R3—10,000-ohm linear potentiometer
R4—100,000-ohm linear potentiometer
R5—1-megohm linear potentiometer
Cabinet, leads, alligator clips, etc. Perfboard materials, enclosure, AC molded power plug with line cord, battery(s), battery holder and connector, wire, solder, hardware, etc.

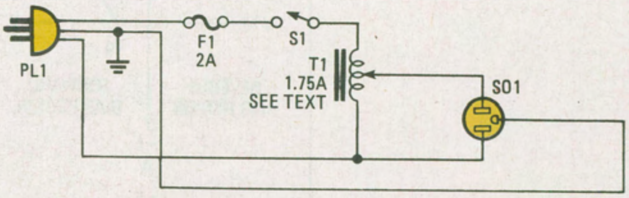

Fig. 5. A variable AC power supply is a very useful tool to have on your workbench when you're servicing malfunctioning electronic equipment, or you are preparing to put back into service equipment that has been idle for a long time.

PARTS LIST FOR THE VARIABLE AC SUPPLY

T1—1.75-amp variable transformer
F1—2-amp fuse
SO1—AC socket
PL1—AC plug
S1—SPST switch
Cabinet, wire, solder, hardware, etc.

maintain separation between the battery, switch, and perfboard-mounted components. The piezo sounder can be attached to the end of the pipe opposite the probes.

To check the circuit's operation, bridge a 2.2-megohm resistor across the probes; doing so should cause BZ1 to sound. With the 2.2-megohm resistor still in place, press S1 and the sound should cease. Remove the 2.2-megohm resistor and replace it with a 100k resistor and BZ1 should sound at full volume. Now press S1 and the volume should drop to a much lower level. If so your probe is ready for action.

VARIABLE RESISTANCE BOX

Often it seems like the simplest form of tester turns out to be one of the most valuable and frequently used gadgets on the workbench. Our next circuit—a variable resistor-substitution box (see Fig. 4)—certainly falls into that category. Note that to conserve space only one potentiometer is shown, but keep in mind that the substitution box can have as many potentiometers as desired; say, five with values of 100 ohms, 1k, 10k, 100k, and 1 megohm.

Mount the potentiometers in a plastic cabinet with a scaled escutcheon for each. Bring out three different color test leads with alligator clips for each potentiometer. That gives you a variable substitution box that can take the place of an expensive resistance decade box. Of course the potentiometer's adjustment won't be as accurate as a decade box, but it will allow you to make a smooth resistance change that's not possible with a decade box.

If your experiments require accurate resistances, a digital ohmmeter can be used to set the selected potentiometer to the needed value. I've found the variable resistance box of this type to be useful in setting up and checking single-transistor amplifiers; one potentiometer can be connected to the collector as a load resistor, another as the emitter resistor, and either one or two of the other units can be used for setting the transistor's base bias.

There are several precautions you should be aware of and follow in using that simple testing procedure. Keep the leads from the potentiometers separated as much as possible to reduce coupling and oscillations, and don't allow current levels through the potentiometers to exceed their ratings. In addition, avoid destroying the transistor by making sure that the potentiometer is at its maximum resistance setting when power is applied to the unit under test.

VARIABLE AC SUPPLY

Our last entry is another simple circuit—a variable

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AC supply—that's handy to have on the workbench. All you need is a variable 117-volt AC transformer, a power cord, fuse, switch, and an output receptacle. Wire the components together as shown in Fig. 5.

A variable AC-power source is a valuable tool to have when checking electronics gear that's been idle for years or when smoke testing a new project. It's usually a good idea to slowly bring up the AC line voltage to such equipment before attempting to use it. Try the surplus stores, flea markets, and hamfests first when trying to locate a variable transformer—a good used unit is cheaper than a new one. ■