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Simple Test Circuits

Here are some fun little projects from a veteran Poptronics *contributor.*

Ham radio is one of the most versatile hobbies we could have, bar none. Think of it, what other hobby offers so many avenues to follow? There are so many ways to transmit and receive information, with numerous modes and modulation types including voice, video, and digital.

However, one very important fact stands out: From the very beginning, the first experimenter built his own transmitter, receiver, antenna, and anything else needed to complete a working radio station. Today, with the complexities involved in almost every rig manufactured, what can a ham do?

Building can still be one of the most enjoyable activities of being a ham radio operator. Of course, most of us are not capable of designing and building a complex transceiver, but most of us can build very useful accessories that can add to the enjoyment of our hobby and save some bucks at the same time.

No matter what we end up building, it usually requires some type of electrical power. The two common choices are batteries and AC-operated supplies. If operated in the field, away from AC power, the choice is batteries; AC is the practical choice for in shack operation.

Direct plug-in power supplies are found in great numbers powering everything from shavers, wireless phones, radios, and many other devices, which may have a useful after life in powering our ham projects.

Usually the power supplies outlast their appliances and end up in closets, drawers, and our treasured junk box. Two of the most useful types of wall-warts are the ones with built-in full-wave rectifiers. **Fig. 1A** shows a full-wave bridge rectifier circuit, and **Fig. 1B** shows a centertapped transformer full-wave rectifier circuit. Generally, the DC output voltage and current ratings are listed on the transformer; however, the actual output voltage most often will measure higher than the labeled voltage. The labeled voltage usually refers to the output under load or after being regulated by the appliance.

I have yet to find a wall-wart with an onboard regulator. **Fig. 1C** shows a simple IC regulator that can be connected to the output of most wall supplies. The wall-wart's actual supply

Continued on page 32

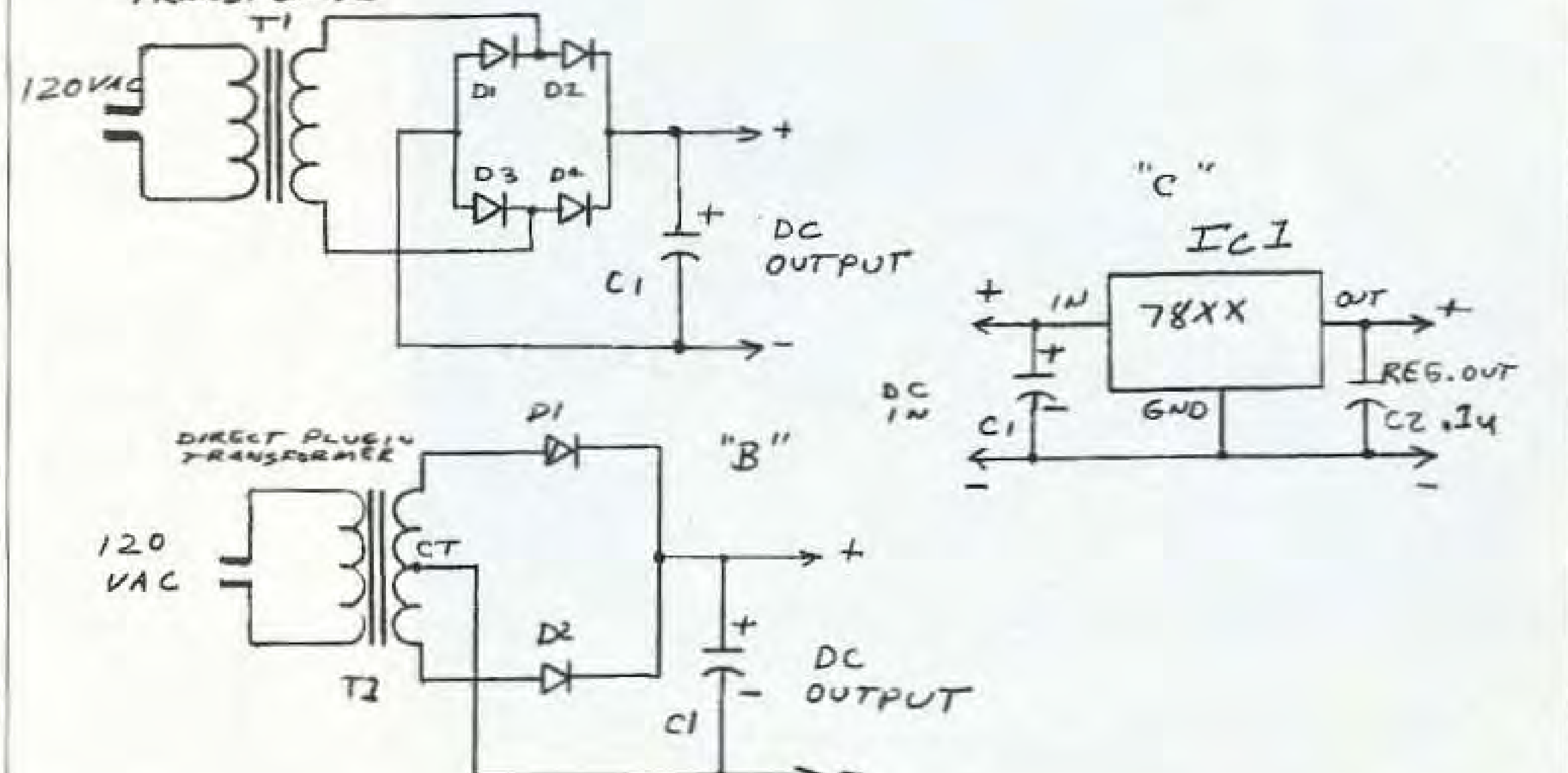

Fig. 1. Basic wall-wart circuits and add-on IC regulator.

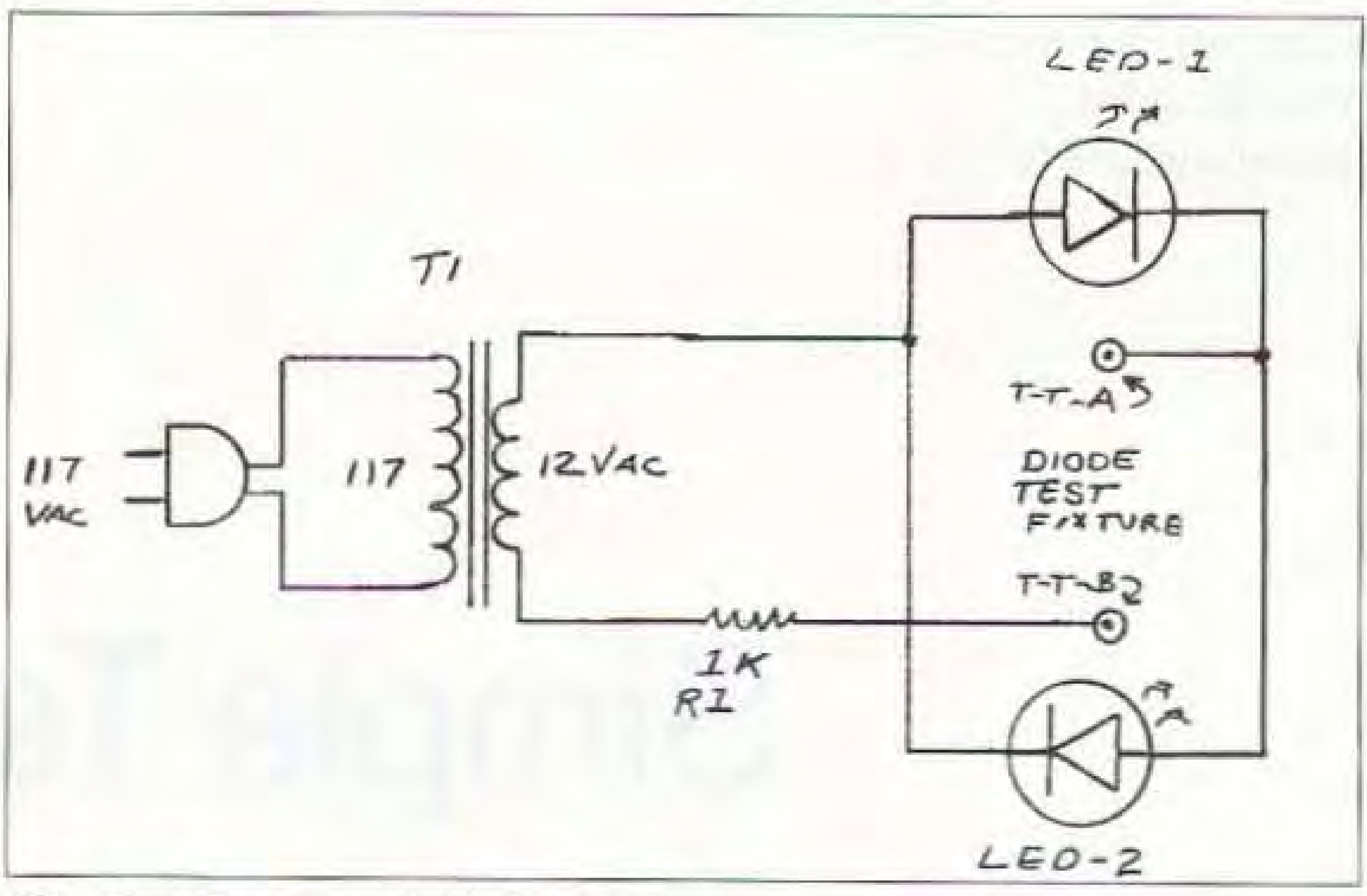

Fig. 2. AC-powered diode tester.

Simple Test Circuits

continued from page 31

voltage must be several volts higher than the regulator's output (minimum of 3 volts differential).

Most wall-warts output a raw DC voltage, relying on the appliance to supply the filter/storage capacitor. A majority of the wall-wart supplies that I've found are rated below 1 amp in output, with most in the 100 to 500 milliamp range. Adding at least 1000 μF to the raw DC output before connecting to the regulator IC is a good starting place. As the output current demand goes up, so does the need for additional capacitance.

Diodes, diodes, and more diodes fill my junk box — and so many without credentials. Since we use so many diodes in our circuits, it's always a problem to sort the good from the bad ones; however, that no longer needs to be the case. Our next three diode testing circuits will do that job just fine.

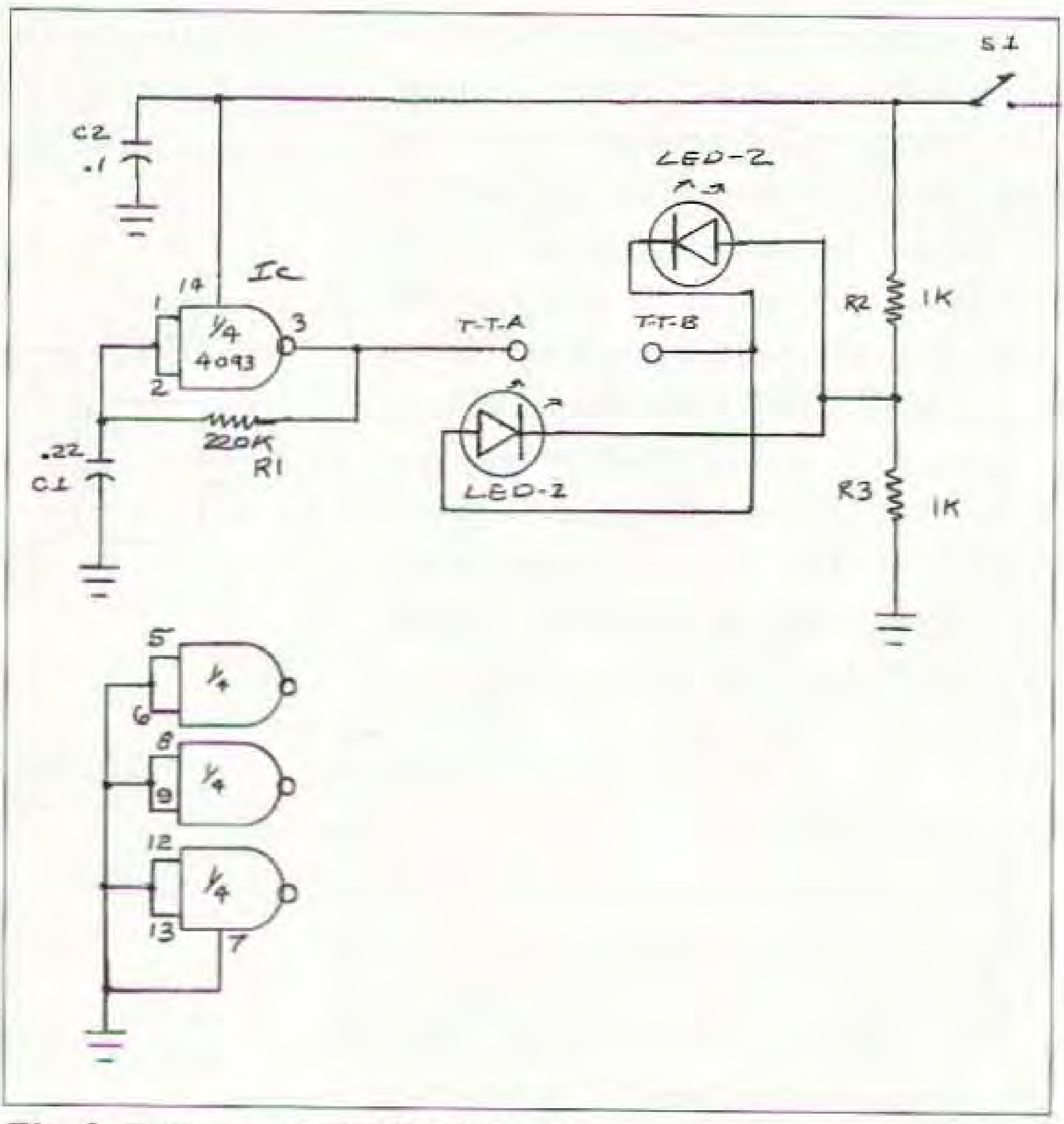

Fig. 3. Battery-powered diode tester.

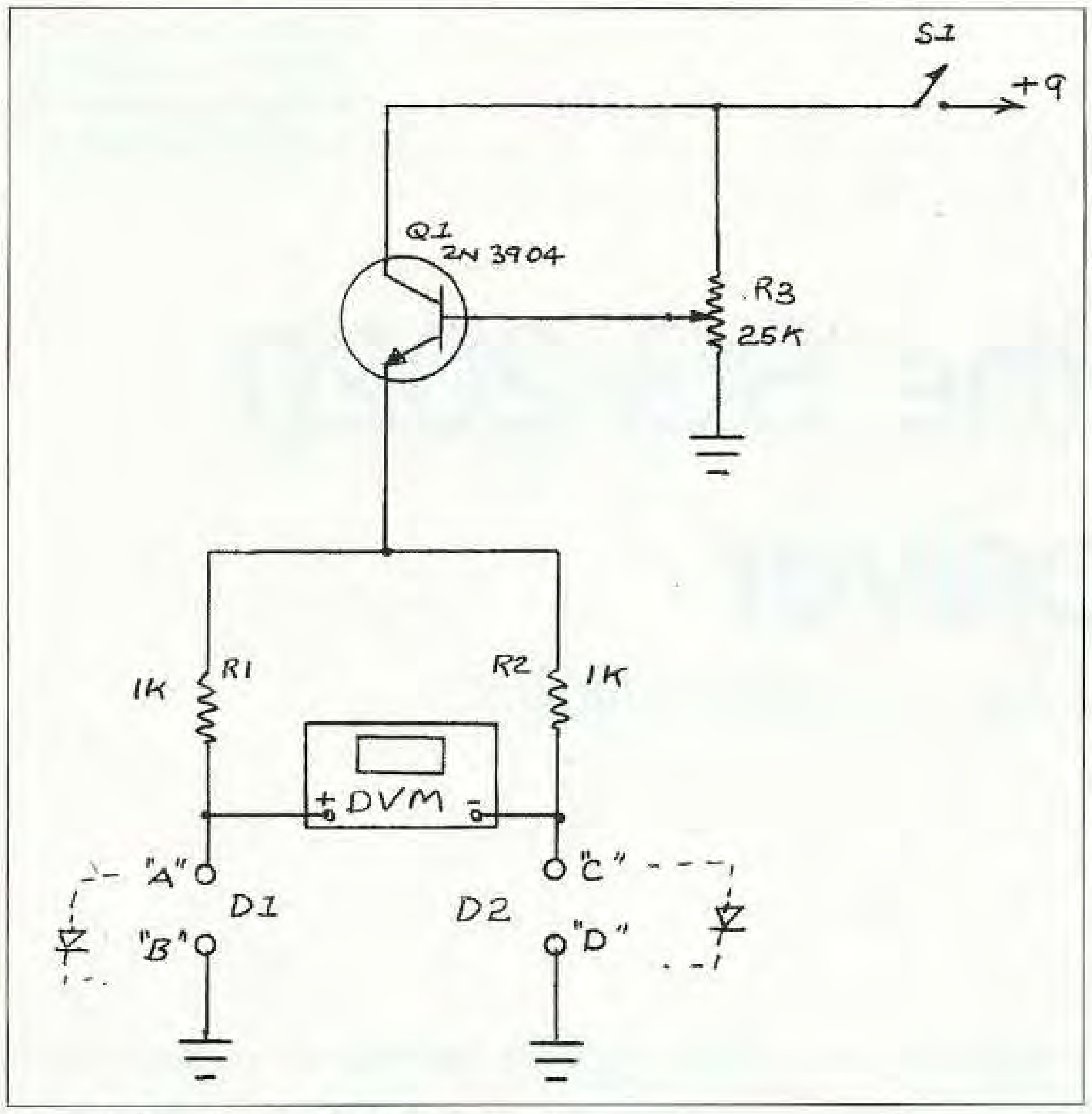

Fig. 4. Matching diode test circuit.

The first diode testing circuit — see **Fig. 2** — will help to determine the diode's anode and cathode leads and whether the diode is open or shorted. A low-current 6 to 12 volt transformer, a resistor, and two LEDs are all that are needed for this simple diode testing circuit. Here's a good place to use that wall-wart that does not have built-in diodes and is an AC-only output device. The two LEDs are connected in parallel in opposing polarity and are in series with the diode test terminals.

Connecting an unmarked diode to the test terminals will produce one of the following results. If LED-1 lights, the diode's anode is connected to test terminal "A", and the cathode to terminal "B". If LED-2 lights, the diode's cathode is connected to test terminal "A" and its anode to terminal "B". If both LEDs light, the diode is shorted, and if neither lights, the diode is open.

A battery-operated version of the diode tester is shown in **Fig. 3**. The AC supply is replaced by a single gate astable oscillator circuit, which supplies a square wave AC voltage for the test circuit.

A good diode with its anode connected to test terminal "A" and its cathode to terminal "B" will light LED-1. LED-2 lights when the cathode of the diode under test is connected to the "A" terminal and the anode to the "B" terminal. This tester will also light both LEDs when a shorted diode is tested.

Often a circuit will require a pair of matched diodes with the same forward resistance and voltage drop. The circuit in **Fig. 4**, along with a digital voltmeter, will do the trick. Q1, a 2N3904 NPN transistor, is connected in an emitter-follower circuit supplying a resistance bridge circuit with a variable voltage source. Two matched 1/4 watt, 5% 1k resistors make up one-half of a basic resistor bridge circuit, and the diodes under test make up the other half.

When R1 = R2 and D1 = D2, the voltage at the DVM will be zero, indicating a perfect balance, or match. Any voltage reading indicates a mismatch

Continued on page 53

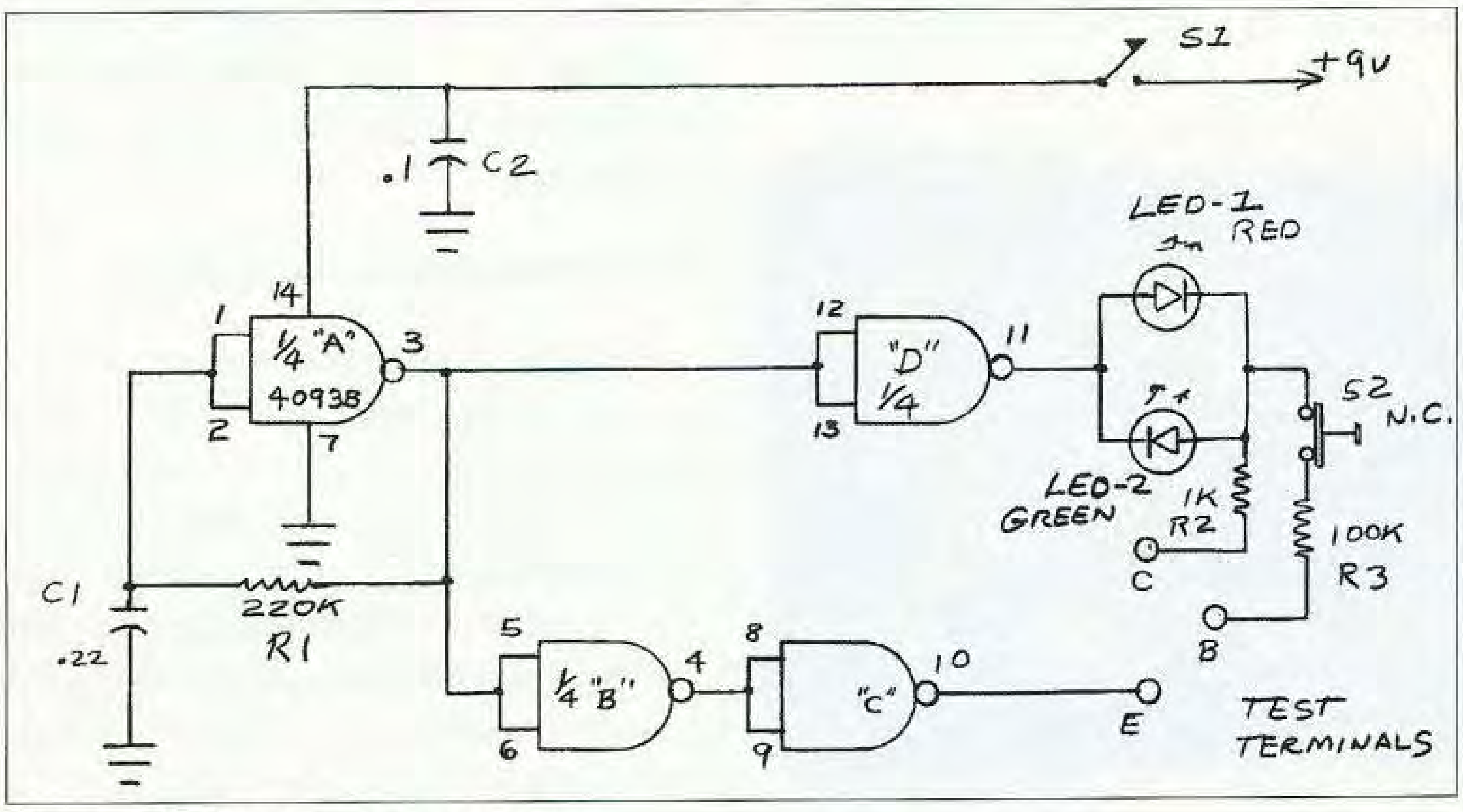

Fig. 5. NPN/PNP transistor checker.

Parts list for Fig. 1	
	Direct plug-in power supplies
	78XX-type voltage regulator suitable for wall-wart used
Parts list for Fig. 2	
T1	12 VAC wall-wart transformer with output of at least 50 mA
LED-1, LED-2	LED, any color
	Test terminals
Parts list for Fig. 3	
C1	0.1 μF disc ceramic
C2	0.22 μF disc ceramic
IC	4093 quad 2-input NAND Schmitt trigger
R1	220k 1/4 W 5%
R2, R3	1k 1/4 W 5%
S1	SPST power switch
B1	9 V transistor battery or power supply
Parts list for Fig. 4	
Q1	2N3904 NPN transistor, or similar
R1, R2	Matched 1k 1/4 W 5%
R3	25k pot
S1	SPST power switch
DVM	Digital voltmeter
	Test fixture
Parts list for Fig. 5	
C1	0.22 μF disc ceramic
C2	0.1 μF disc ceramic
LED-1	LED, red
LED-2	LED, green
IC	4093 quad 2-input NAND Schmitt trigger
R1	220k 1/4 W 5%
R2	1k 1/4 W 5%
R3	100k 1/4 W 5%
S1	SPST power switch
S2	Normally closed push-button switch
	Test terminals

***Table 1.** Parts lists for the various figures.*

Simple Test Circuits

continued from page 33

in the forward voltage drop and resistance of the diodes. The bridge voltage can be varied with R3, to check the diode's linearity. This feature will allow a dynamic matching of the diodes over a varying current range.

Resistors R1 and R2 may be matched by simply using a digital ohmmeter and selecting two resistors of the same value. The exact resistance value doesn't really matter as long as they are the same.

Using the diode matcher is easy. Select a diode and connect it to either set of test terminals. Set R3 to about midposition and then connect a diode to the other terminals and check the difference voltage on the DVM. Keep trying diodes until the best match is found. To check tracking of the diode pair, vary the applied bridge voltage by rotating R3 about 25% of rotation in both directions. A good matched pair of diodes will usually track within a few millivolts over this range.

The next most often used component we use in project circuitry is the transistor. Over the years, my junk box has become the home of dozens and dozens of orphaned three-lead semiconductors. The majority are either NPN or PNP transistors and the others could be just about anything that comes with three leads. Sorting out a good transistor for a project can be a real hassle sometimes, and our next project eases that chore.

A single 4093 quad 2-input NAND Schmitt trigger performs the active duty in the NPN/PNP transistor tester/sorter circuit. Gate "A" is connected in an astable low-frequency oscillator circuit producing a square-wave output. This output is inverted with gate "D" to supply power to the collector and base inputs of the test fixture. The oscillator's output is twice inverted with gates "B" and "C" to supply power to the emitter input test fixture. This arrangement provides an opposite polarity voltage between the base/emitter and emitter/collector test terminals during test.

Connect a good known NPN transistor to the test fixture and see how the circuit determines which LED will light. During the time gate "A"'s output is "low," the output at gate "D" is "high" and gate "C" is "low." This places a positive voltage at the collector and base test terminals, and a negative voltage at the emitter terminal. A good NPN transistor will be forward-biased and will conduct, lighting the red LED-1. Base current is supplied through S2 and R3 to the test fixture. Opening S2 will remove the base current, which will cause the LED to go dark. A leaking or shorted transistor can cause the LED to stay on or possibly only dim some when S2 is opened.

During the time that gate "A"'s output is "high," the voltages at the transistor's text fixture are of the opposite polarity for an NPN transistor to conduct and neither LED will light. The time that gate "A"'s output is “high” sets the test circuit voltages up to check PNP transistors. A good PNP transistor will light the green LED-2.

The output test results may be somewhat confusing if the transistor is connected to the test fixture incorrectly. However, for most devices no harm will come during testing. (NOTE: The maximum current will be about 5–7 mA through the device.) I’ve found the circuit also handy in determining the emitter, base, and collector leads on orphan transistors. Just remember that there are other three-legged semiconductors that are not transistors and cannot be tested with this circuit.

Hopefully one of these simple projects will get you digging into your junk box and building something fun and useful for the shack. 73