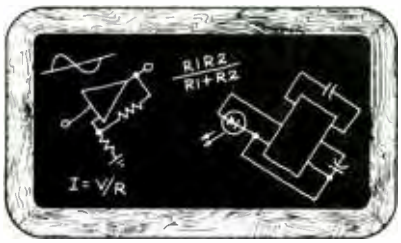

Think Tank

By Byron G. Wels

SCR PROJECTS

Back in the early days, if you wanted to control a motor's speed, you had a "brute force" rheostat with a control wheel the size of a small car's steering wheel on it. It usually took an ape of a guy with two hands on the wheel to slow down or speed up the motor. Then solid state came along, and voltages were dropped to the point where you could actually touch a contact and not draw an arc. And the steering-wheel sized rheostat gave way to a small knob that you could operate with two fingers.

To a large extent, that was due to a device called a silicon controlled rectifier. Essentially, it was a diode with an added terminal that was used as (and was called) a gate. Thanks to the SCR, small voltages could control large voltages, and not through relays that had only two steady states. You could now control a full range of voltages. As time (and science) progressed, new applications were discovered for that versatile device, and we're glad to offer a range of them here.

SCR Tester. This handy little unit will give you a visual indication, is a one-evening project, and is easy to throw together. Once you've got it, you can check the operation of all those possible duds in your junkbox, and maybe throw some of them into the scrap heap.

Figure 1 shows a 3-amp, 50-volt SCR and a test circuit. A fixed resistor can be used for R1. Points G (gate) and K (cathode) are temporary connections so that they can easily be opened. If R1 is a fixed resistor of a few-hundred ohms, when K is closed, the lamp doesn't light. When G is also closed, the lamp lights to its full intensity. The lamp remains lit even if G is opened again. But when K is opened, even momentarily, the lamp does not light again when K is closed. It does so when G is closed. That illustrates the "on" and "off" operation of the SCR.

If R1 is of a higher value, about 50,000 ohms, you can place a meter at G to show the gate current (I_G). A small gate current flows that rises as you reduce the value of R1. At some given value of I_G, the SCR begins to conduct and the lamp lights. Using a standard 3-amp, 50-volt SCR, conduction begins at an I_G of perhaps about 0.5 mA.

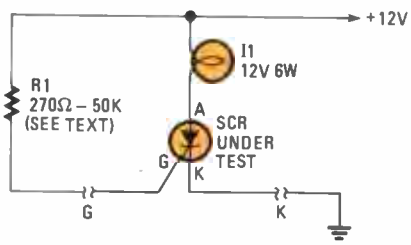

Fig. 1. The SCR Tester—which provides a visual indication—is simply a voltage source, an indicator lamp, and a resistor through which gate current is supplied.

You can make an additional test by supplying the current from an adjustable voltage source, enabling you to determine the SCR's turn-off point. Close K then temporarily close G. Reduce the anode-to-cathode supply to about 2.0 volts, return to 12 volts, and note that the lamp remains lit. Further reduce the supply to about 1.0 volt and repeat the check. You'll find a point, where if the supply is reduced under the holding level, the SCR won't conduct when full voltage is returned. It has reverted to the "off" condition.
—Brian Conklin, Enid, OK

Thanks Brian. That's a nice piece of work, and I know that you're going to enjoy the Fips book. It's on the way!

Simple Burglar Alarm. Parents usually don't have a lot of respect for the abilities of their kids. I'm in high school, and heard dad saying at the dinner table that if he'd get a burglar alarm for his store, he could cut down on the cost of his insurance premiums. Being an electronics hobbyist, I offered to build him one. I got a "That's a good boy," look and the matter was dismissed.

I worked up the enclosed circuit (See Fig. 2) but dad was too busy to go over it with me, so I built it and installed it in the store. He didn't have time for it until he heard the bell go off, and suddenly he became interested.

I figured that any crook would come through the front door, one way or another, so I put a switch mat under the carpeting just inside the front door. The alarm circuit is connected to the SCR anode and gate. Pressure on the mat closes the contacts of the mat switch, which applies current to the SCR gate, causing it to conduct.

With the SCR conducting, a path to ground is provided through BZ1 (a 6- to 12-volt bell) and SCR1, causing BZ1 to sound. The bell continues to sound, even if the crook steps off the mat. To turn the alarm off, you have to manually throw switch S1 to break the circuit. During the day, when customers are going in and out, simply open the switch and the alarm is disabled until you throw the switch on again, to arm the circuit.

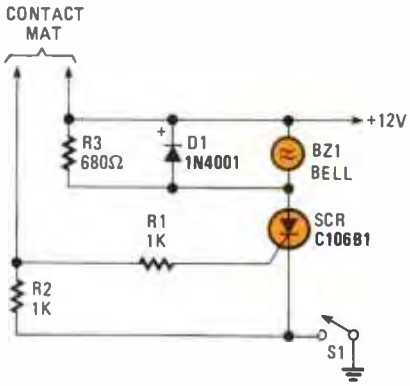

Fig. 2. This Burglar-Alarm circuit consists of a mat switch, which when stepped on, triggers SCR1.

I used diode D1 to protect the SCR from back voltage from the bell winding. As the vibrating contacts of the bell open, the circuit opens. Resistor R3 maintains a steady current through the SCR, keeping it from going back to the off state.

You really don't need R2 if leakage in the alarm circuit isn't there. Such leakage might offer sufficient current to trigger the SCR, but R2 sees to it that

such leakage would have to be heavy for that to occur. When the mat is stepped on, R2 is just across the supply and has no effect. Supplies of any other voltage can also be used.

Now that the system works (and dad is convinced), I'm adding additional mats at the back door and the rear window.

I suggest that the bell be mounted high over the front door, out of reach, where neighbors and the police can easily locate it. I also used warning stickers generously, and foil-taped all the glass.

—Barry Sherman, Seattle, WA

I'll bet your dad is looking at you a little differently these days! Also, you didn't mention whether or not he got his discount from the insurance company, but never mind. You've got a copy of the Fips book.

Rain Detector. Something good has just got to come out of this. That's why I'm sending it to you. I want one of those Fips books! It all began when I put this circuit together for my wife. I told her to leave it out with the newly-hung washing, and if it started to rain, "a plate gets wet, and the alarm sounds so you'll know to take the wash in." The very-next day, I came home to find her heating the etched plate with her blow dryer, and I didn't really care for the things she was calling me. So I added a switch, S1. (See Fig. 3.) The plate is a small (2 × 3-inch perfboard etched into strips with jumpers to the alternate strips.

Rain falling on the board reduces circuit resistance until gate current triggers the SCR. That sounds the little solid-state buzzer, which remains on until the water dries or S1 is opened. Resistor R2 provides sufficient current to keep SCR1 conducting. You can also use the circuit to operate a sump pump when water reaches a given level by connecting a sensitive relay to the circuit in place of the buzzer. With the same technique, you could hook it to a motor and use it for anything from closing windows automatically if it rains, to raising a convertible top on a car.

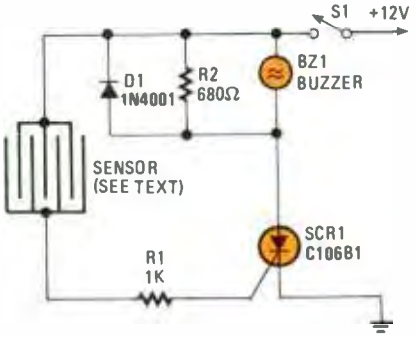

Fig. 3. A printed-circuit board, etched so as to form interweaving (but electrically separate) traces, is used as a Rain Detector sensor, which when bridged by water droplets, causes BZ1 to sound.

My young son, (a real smart-aleck) got a wooden spring-type clothespin and put a metal thumb tack at each of the joining surfaces, connected a wire to each, and thence to a battery and bell. He put an aspirin tablet between the tacks and accomplished just about the same thing. "After all," he explained, "aspirin manufacturers all boast about how fast their tablets dissolve!"

—John McFee, Denver, CO

Okay John, one (and only one) Fips book. Your son will just have to read yours!

(Continued on page 26)

THINK TANK

Battery Charger. It's a cold one out there. You get into your car, and you can't wait to warm the old bus up and get the heater working. You pump the gas peddle a couple of times, turn on the ignition key, and the most you get is a "click." The battery is as dead as a doornail.

Figure 4 is a trickle charger whose output falls as the battery voltage rises. Nice, huh? As the charge on the battery approaches the maximum, the charging rate is automatically reduced. Connect it up, and go back inside where it's nice and warm and have another cup of coffee.

The line transformer, T1; the full-wave rectifier; a bridge circuit; and SCR1 are rated for the maximum current and voltage needed. Use a 12.6-volt transformer, capable of delivering three to five amps. During maximum charge, resistor R1 and diode D1 triggers SCR1 so the full rate is there. The voltage across R6 and R3 is relatively low, so D2 doesn't conduct; that keeps SCR2 off. The voltage at which SCR2 conducts is set by potentiometer R6.

When D2 starts passing gate current to SCR2, the SCR turns on, moving diode D1 negative. The voltage for D1, drawn through R1, drops almost to zero. That keeps SCR1 from triggering. The effect is slow and the triggering angle of SCR1 is reduced as voltage rises. You can put a limiting resistor, meter, or fuse at R2.

—Frank Zabo, Palo Alto, CA

Great idea Frank, many a snowy morning I've needed just such a charger for my own car. Hey! Does it really snow in Palo Alto? Keep an eye out for your copy of the Fips book. It's on the way.

Code-Practice Oscillator. I'm really not a monster, and I really got a boot out of it when my son expressed an interest in amateur radio. While I was pleased, I told my wife that "anything—even a code-practice oscillator would be better than blasting rock 'n' roll." It seems that today's kids really don't need a volume control on their amplifiers. They blast 'em 'till the windows rattle.

But my wife didn't like the constant "beep-beep-beeping," as she called it, and she often caught the kid practicing and grinning at her at the same time, and wished she knew what he was saying! This circuit, simple as it is, solved the problem.

In Fig. 5, Capacitor C1 charges through resistor R1, and when the gate level established by potentiometer R2 is high enough, the SCR is triggered. Current flows through the SCR and earphones, discharging C1. The anode voltage and current drop to a low level so the SCR stops conducting and the cycle is repeated. Resistor R2 lets the gate potential across C1 to be adjusted, which changes the frequency or tone.

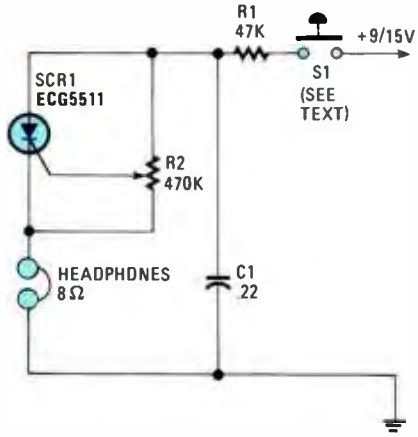

Fig. 5. Shown here is the Code-Practice Oscillator, which consists of only five components, feeding 8-ohm headphones.

Use a pair of eight-ohm earphones. The telegraph key goes right into the B+ line, a nine-volt battery.

All is quiet around the house now. Building this oscillator for my son has demonstrated that I'm a doting father, my wife now greets me at the door with a kiss instead of a scowl, and I'm saving a fortune on aspirin.

—Thomas Dickinson, Sioux Falls, SD

Okay Tom. You're also saving a fortune (a small one) on your free copy of the Fips book. Hope you enjoy it.

Automatic Lights. My family has been planning a week's vacation for several months, and didn't want to tip our being away to any unwanted visitors. We planned to stop newspaper and mail deliveries, and did all the right things. Still, the house would be completely dark at night. One of my neighbors had installed a series of timers that would automatically turn lights on and off at night, and one evening, he invited me over to check out the system. We stood across the street and watched as lights blinked on and off inside his home at random, making the place look like a pinball machine.

I didn't want that, so I built this circuit (See Fig. 6), which is controlled by a light-dependent resistor, LDR (R3), that turns on one living-room lamp when the room is dark. Period. It's enough to make a would-be burglar suspect that somebody is in the house. When the sun comes up, the light goes out. It's just enough—but not too much.

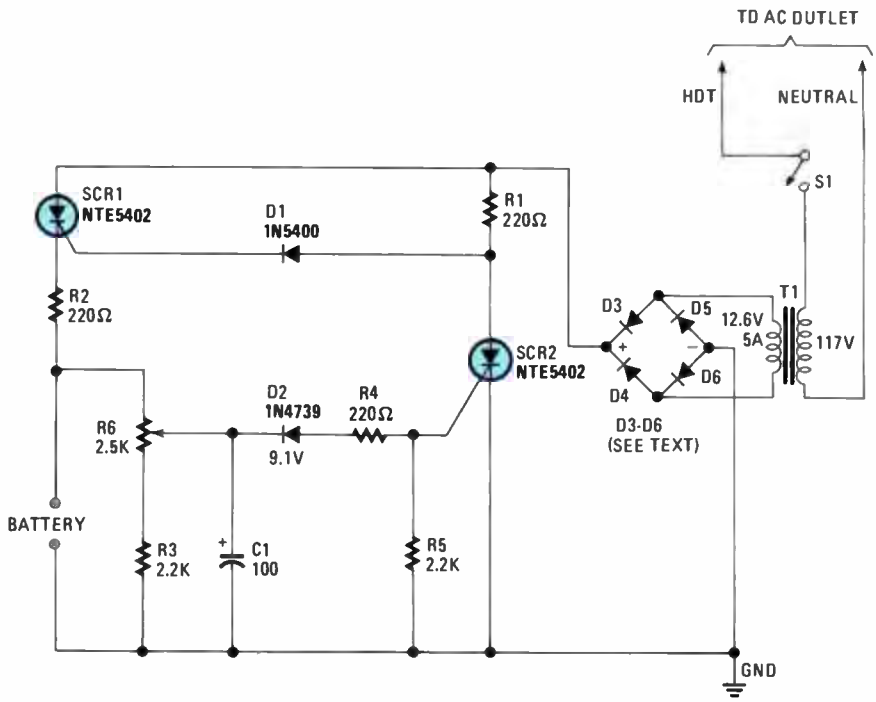

Fig. 4. This Battery Charger provides a heavy charge to depleted batteries, which diminishes as the battery advances toward full charge.

Since potentiometer R1 acts as a sensitivity control, almost any LDR is suitable for the task. The one we chose has a resistance of about 1 megohm in the dark. When light falls on it, the resistance drops to a mere few-hundred ohms.

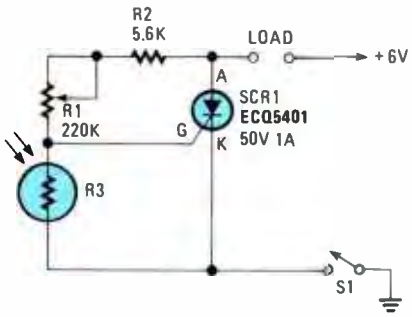

Fig. 6. The Automatic-Light circuit is controlled by an LDR, which has a high resistance in darkness, and a low resistance when exposed to light.

When light reaches the LDR, the SCR is cutoff at the gate. But when the light level striking the LDR drops, the SCR conducts, and the circuit is completed. We recommend that since the SCR is going to be controlling a lamp, it would be a good idea to use a relay to operate the lamp, rather than attempt to operate it directly from the SCR. Potentiometer R1 sets the sensitivity of the circuit.

Anyway, I hope this submission rates a copy of the Fips book. Thanks.
—*Mark Salchow, Brooklyn, NY*

Great idea, Mark. Hope you like the book too.

Every Home a Disco. Sure, music is nice, but by the addition of the simple circuit shown in Fig. 7, you can add a great deal of interest. In these days of TV, people want something to look at as well as listen to! The light modulator can be single channel, two channel (for treble and bass), or three channel, if you prefer. It will take your audio output and modulate it so that the lights seem to dance in time with the music. You can use any combination of colored lights as well, to make things even more interesting.

Line-voltage lamps of about 40 to 100 watts do nicely. And there's no reason why you can't use lower voltage lamps if you prefer. The required audio-driving power isn't large, and you can get it from a tape or record player, or an FM radio. You simply attach the speaker output through a 1:1 audio transformer.

You get the current for the lamp from an SCR. When low-level audio is present across T1, SCR1 is not triggered into conduction. A louder signal, however, triggers the SCR so that the lamp lights and follows the sounds. Since SCR1 is operated by an alternating current, the rectifier moves out of the avalanche condition when gate current is low.

If you scale the circuit down to use 12 volts, or any other lower voltage, current has to come from a line transformer. A DC supply can't be used, or SCR1 continues to conduct once it is triggered to the on condition. Variable resistor R3 lets you adjust the power reaching transformer T1 so that with normal operating volume, SCR1 triggers again and again, except during quiet passages.

When building such a circuit, safety must be kept in mind. A breakdown in T1 could slap the line voltage into your audio system; and with many of the amplifier circuits, you just cannot ground T1. A low rated fuse should be included in the live half of the line connector. A safer way to do things is with

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THINK TANK

(Continued from page 27)

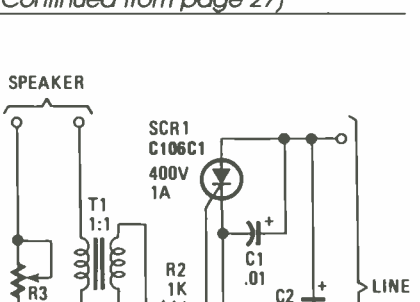

Fig. 7. This light-control circuit uses the audio out of your stereo to provide trigger current for the SCR.

24-volt transformer and lower rated lamps. Then you can ground one pole of the lamp circuit, or the center tap of the transformer. The two capacitors shown are used as interference suppressors for SCR1. The values of the capacitors are not critical and they can vary somewhat from what's shown, but be sure they have a .5- to 1-kilovolt rating. I hope you like it, and that it earns me a copy of the Fips book.

—Fred Bergmann, Chicago, IL