IN THIS CHAPTER

- Creating a fake thunderstorm
- Powering lights with a rickety old generator
- Making a skeleton's heart beat

Chapter 1
Building a Color Organ

One of the great things about Disneyland is that sometimes the long line you have to wait in to go on a particular ride is almost as good as the ride itself. One of the best examples of this is the famous *Indiana Jones Adventure: Temple of the Forbidden Eye.* Just outside of an ancient temple, you pass by a rickety steam-powered generator that is barely running. The clickity-clickity sound of the generator alternately grows louder and softer as the generator sputters and threatens. Once inside the temple, you pass through narrow tunnels and creepy caverns that are lit overhead by lights that appear to be powered by the rickety generator. The lights flicker and dim, then grow brighter for a moment, then flicker and dim again in sync with the laboring generator.

In this chapter, you learn how to build an electronic circuit that you can use to create this creepy lighting effect. I've used this circuit for many different purposes, including lighting the narrow passageways in my own haunted tomb at Halloween. I've also used the same circuit to create a thunderstorm in my front yard to add the right ambiance to my haunted Halloween graveyard. And the same circuit creates a spooky red heartbeat in the chest of a plastic skeleton that stands watch over the scene.

The circuit is called a *color organ*, and its operation is simple: It converts the volume of an audio input into an output voltage that gets higher as the sound source

gets louder. If you connect a light to the output, the light will glow brighter when the audio input is louder and dimmer when the input is quieter.

WARNING

As with most of the chapters in this minibook, I need to start with a warning that this circuit requires that you work with line-level voltages (120 VAC), so it's potentially dangerous. The circuit is designed with safeguards, but you must be careful to not bypass them. You should inspect the project every time you use it to make sure none of the wiring has come loose or frayed, and you must never work on the circuit while it's plugged in.

Examining the Color Organ Project

The completed color organ described in this chapter is shown in Figure 1-1. The project is housed in a 2-x-3-x-6-inch project box that includes a power plug that connects the circuit to a wall outlet, a power outlet that you can connect a light to (maximum 120 W), an RCA-style audio input connector that you can connect a sound source to (up to 60 W), a knob for adjusting sensitivity, and a power switch.

FIGURE 1-1: The completed color organ project.

To keep the project simple, you can build the electronics using an inexpensive kit — specifically, the Velleman MK110 Simple One Channel Light Organ kit. This kit is widely available on the internet for under $10; just search for *Velleman MK110*, and you'll find several sources.

Figure 1-2 shows how the color organ project can be hooked up to create light that varies in brightness with a sound source. You'll need a source for the sound, such as a boom box or other sound system with external speaker outputs that you can tap into.

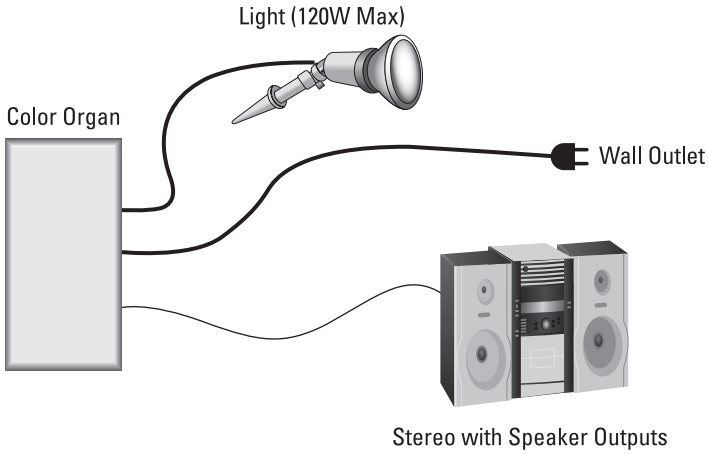

FIGURE 1-2: Connecting the color organ to a light and a sound source.

Note that the diagram in Figure 1-2 doesn't show the details of how to connect the sound system to the color organ and the speakers. The easiest way to connect the color organ to the sound system is to simply replace one of the speakers with the color organ. That way, the color organ responds to one of the stereo channels while the speaker plays the sound coming from the other stereo channel. For this type of hookup, you'll need just a single cable that has an RCA connector on one end (to plug into the color organ) and the proper connector on the other end to connect to the sound system's speaker output.

You'll also need a suitable recording for your sound source. For example, if you want to use the color organ to create a thunderstorm effect, you'll need a recording of thunder. To make a red light flash in sync with a heartbeat, you'll need a recording of a heartbeat. The internet is rife with such sound effects, so you shouldn't have too much trouble locating and downloading a sound effect to meet your needs. If you want to customize the sound effect, you can download a free audio editor called Audacity from `www.sourceforge.net/projects/audacity`.

Understanding How the Color Organ Works

There are several different ways to design a color organ circuit. Most of them rely on a special type of electronic component called a *triac,* which is essentially a transistor that's designed to work with alternating current. It has three terminals. Two are anodes, called A1 and A2, and the third is a gate. A voltage at the gate — either positive or negative — allows the anodes to conduct. The anodes are connected to the line load, and the gate voltage is derived from the audio input.

The audio input isn't connected directly to the triac gate, however. Instead, most color organs use one of two techniques to isolate the audio input from the line-voltage side of the circuit. One method is to use a transformer. The other is to use an *optoisolator,* which is a single component that consists of an infrared LED and a photodiode or other light-sensitive semiconductor. Voltage on the LED causes the LED to emit light, which is detected by the photodiode and passed on to the output circuit.

The Velleman MK110 kit uses an optoisolator triac, in which the photosensitive semiconductor is actually a triac whose gate is stimulated by light rather than by voltage. The optoisolator is an integrated circuit in a 6-pin DIP package.

Figure 1-3 shows a simplified schematic diagram for the circuit used by the Velleman MK110 kit. As you can see, the audio input is applied to the LED side of the optoisolator, controlled by a potentiometer, which lets you adjust the sensitivity of the circuit. The output from the optoisolator is applied to the gate of the triac, whose anodes are connected across the line-voltage circuit. Thus, the volume of the audio input directly controls the voltage of the output circuit.

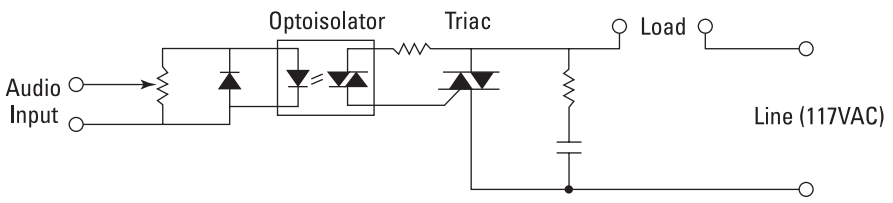

FIGURE 1-3: The schematic diagram for the color organ circuit.

Getting What You Need to Build the Color Organ

Other than the Velleman kit itself, most of the materials you need to build the color organ project can be purchased at your local RadioShack store or any other supplier of electronic components. The table below lists all the materials you'll need.

Quantity	Description
1	Velleman MK110 Simple One Channel Light Organ kit
1	2-x-3-x-6-inch plastic project box
1	20mm PC board standoffs
1	RCA-style phono jack
1	¾-inch control knob
1	Chassis-type fuse holder for 1¼-x-¼-inch fuse
1	1 A, 250 V, fast-acting 1¼-x-¼-inch fuse
1	⅜-inch 4-40 machine screw and nut (for mounting the fuse holder)
1	SPST rocker switch
2	⅜-inch grommets
2	Screw-on wire connectors
5 inches	20-gauge stranded hookup wire
1	Indoor extension cord

Assembling the Color Organ

Once you have gathered all the materials for the color organ, you're ready to assemble the project. You'll need the following tools:

- Soldering iron, preferably with both 20 W and 40 W settings
- Solder

TIP

Use thicker solder for the line-voltage wires and thin solder for assembling the MK110 kit.

- Magnifying goggles
- Phillips screwdriver
- Small flat-edge jewelers screwdriver
- Wire cutters
- Wire strippers
- Pliers
- Hobby vise
- Drill with ⅛-inch, 5⁄32-inch, ¼-inch, 5⁄16-inch, ⅜-inch, and ¾-inch bits

Here are the steps for constructing this project:

1. **Assemble the Velleman MK110 kit.**

   The kit comes with simple but accurate instructions. Basically, you just mount and solder all the components onto the circuit board. Pay special attention to the color codes for the resistors and the orientation of the diode.

   Figure 1-4 shows the completed MK110 kit.

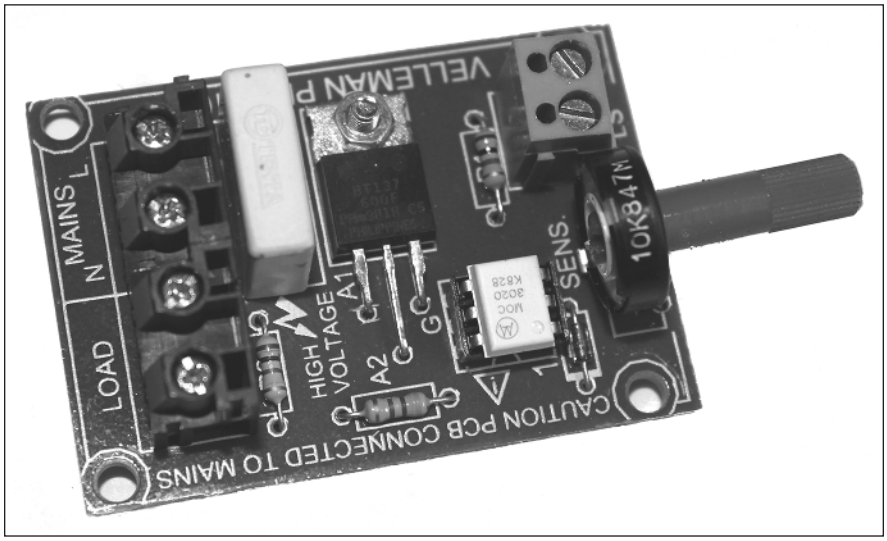

FIGURE 1-4: The assembled Velleman MK110 kit.

TIP

When I build this kit, I find it best to mount the circuit board in a good hobby vise and use an alligator clip or masking tape to hold the components in place while soldering.

2. **Drill all the mounting holes in the project box except the hole for the sensitivity control on the left side of the box.**

   Figure 1-5 shows the orientation of the approximate location of the mounting holes.

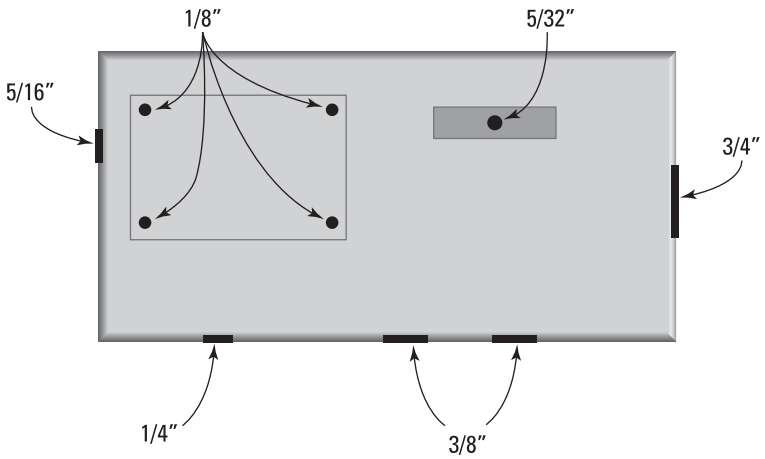

FIGURE 1-5: Drill the holes as indicated in this diagram.

   Use the assembled circuit board to determine the exact drilling locations for the four holes that will mount the circuit board. The position of the other holes isn't critical, with the exception of the hole for the potentiometer knob. Don't drill that hole until Step 4.

3. **Mount the four standoffs in the four MK110 circuit board mounting holes.**

   Use four of the machine screws that came with the standoffs.

4. **Drill the hole for the circuit board's potentiometer.**

   Set the circuit board on top of the four standoffs to determine the exact location for this hole.

5. **Insert the two rubber grommets into the two ⅜-inch holes.**

   The grommets are difficult to squeeze into the hole, but work at it and you'll get them in. If necessary, use the small edge of a flat screwdriver to push the rubber edges into the holes.

TIP

In the steps that follow, you assemble all the parts into the project box. Use Figure 1-6 as a guide for the proper placement of each of the parts.

1. **Cut the extension cord.**

   First cut the outlet end of the extension cord, leaving about 12 inches of wire attached to the outlet. Then cut the plug end, leaving about 3 or 4 feet of wire

attached to the plug. You'll have a few feet of wire left over; set this wire aside for later.

2. **Push the power cords through the grommets and tie a knot inside the box.**

   It will be a tight squeeze, but the cords will fit. Pull about a foot of the cord with the plug attached through the hole nearest the switch. Then, tie it in a knot, cinch the knot down tight, and pull the plug so that the knot is snug against the grommet. The knot acts as a strain relief.

   Repeat the same process with the cord that's attached to the outlet, passing it through the other grommet, tying a tight knot, and pulling the knot up against the grommet.

   When both power cords are in place, separate the two wires of each cord inside the project box and strip about ⅜ inch of insulation from each wire.

3. **Cut two 1½-inch lengths of extension cord wire and solder them to the switch terminals.**

   You'll need to strip about ⅜ inch of insulation from each end of both wires. Put your soldering iron on its High setting and use thick solder. Set the switch aside when the solder sets.

4. **Cut two 1½-inch lengths of extension cord wire and solder them to the terminals on the fuse holder.**

   Again, you'll need to strip about ⅜ inch of insulation from each end of both wires and solder with high heat.

5. **Cut two 2½-inch lengths of the hookup wire and strip ⅜ inch of insulation from the ends.**

6. **Solder one of the hookup wires to the center terminal of the RCA-style phono jack and the other wire to the ground terminal.**

   At this point, you're done with the soldering iron, so you can turn it off.

7. **Mount the RCA-style phono jack in the ¼-inch hole in the project box.**

   To mount the jack, you'll first have to remove the nut, the ground terminal, and the lock washer from the jack. Then, pass the wire connected to the center terminal of the phono jack through the ¼-inch hole, and then insert the threaded end of the phono jack into the hole. Slip the lock washer, the ground terminal, and the nut over the wire connected to the center terminal, and then thread them onto the threaded part of the jack. Tighten with needle-nose pliers.

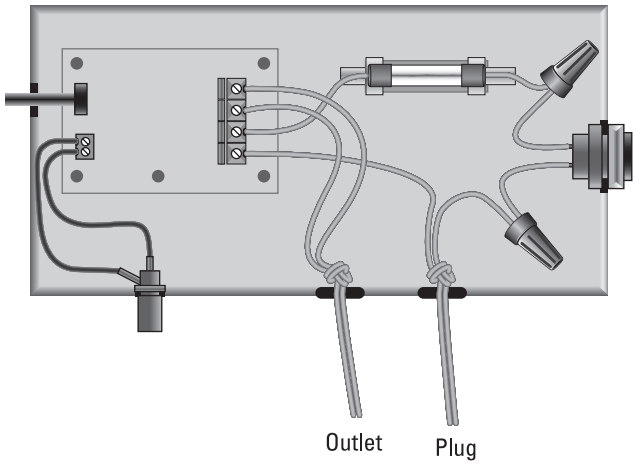

FIGURE 1-6: How the parts go together inside the project box.

TIP

In the next few steps, you attach wires to the MK110 circuit card. Do *not* mount the circuit board to the standoffs quite yet. You'll have an easier time connecting the wires if the circuit board is loose. After the wires are all connected, you mount the board.

1. **Connect the separated wires of the cord that's attached to the outlet to the two terminals marked *Load* on the back of the MK110 circuit board.**

   Use a small, flat screwdriver to tighten the terminals. Make sure the wires are securely connected.

2. **Connect one of the wires attached to the fuse holder to one of the Mains terminals at the back of the MK110 circuit board.**

3. **Connect one of the extension cord wires that's attached to the plug to the other Mains terminal at the back of the MK110 circuit board.**

4. **Connect the two hookup wires from the phono jack to the input terminals at the front of the MK110 circuit board.**

   The input terminals are labeled *LS* on the board. You'll need a very small flat-blade screwdriver to tighten these terminals.

5. **Mount the MK110 circuit board on the standoffs.**

   To mount the board, you'll need to tilt it a bit to slide the shaft of the potentiometer through the 5/16-inch hole. Once the shaft is through, set the board down on the standoffs and secure it with the remaining four machine screws that came with the standoffs.

6. **Use the ⅜-inch 4-40 machine screw and nut to mount the fuse holder.**

   Slide the machine screw through the 5⁄32-inch hole in the bottom of the project box. Then pass the machine screw through the hole in the center of the fuse holder and attach the nut. Tighten with a screwdriver.

7. **Mount the switch.**

   To mount the switch, first remove the plastic nut on the threaded end of the switch. Then, pass the wires and the threaded end of the switch through the ¾-inch hole in the side of the project box. Finally, slip the nut over the wires and tighten it onto the switch.

8. **Connect the switch to the power cord and the fuse.**

   Use one of the screw-on wire connectors to connect one of the switch wires to the unconnected wire on the fuse holder. Then, use the other wire connector to connect the other switch wire to the unconnected wire that leads to the power plug.

9. **Insert the fuse in the fuse holder.**

   Guess what — you're almost done! Figure 1-7 shows the project with all the parts assembled.

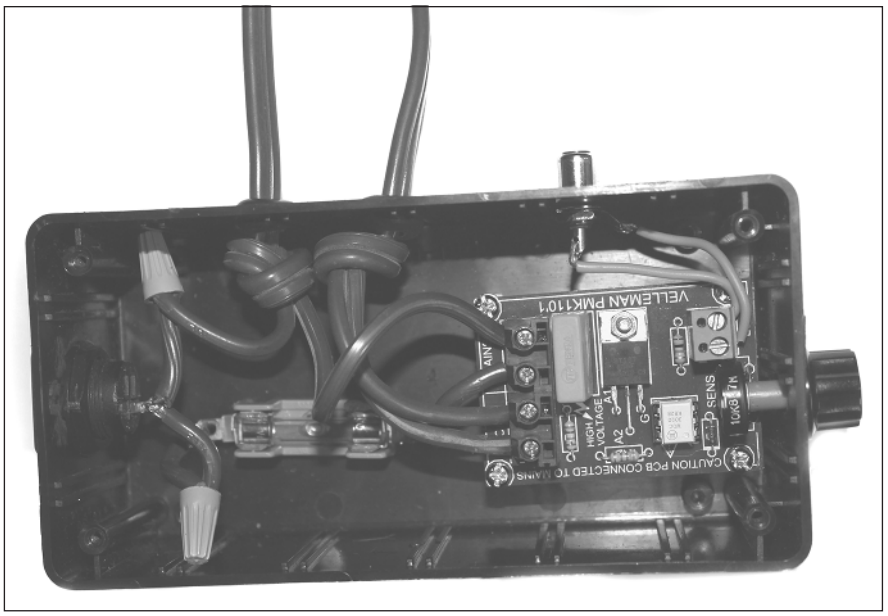

FIGURE 1-7: The color organ is almost finished.

10. **Attach the knob to the potentiometer shaft protruding from the box.**

    Use a small, flat screwdriver to tighten the set screw on the knob.

11. **Place the lid over the project box and secure it with the provided screws.**

    Now you really are done!

Using the Color Organ

Having finished the color organ, it's time to put it to use making interesting sound and lighting effects. To do that, you'll have to connect both lights and a sound system to the color organ.

The procedure for actually using the color organ is quite simple:

1. **Connect a light to the color organ's female extension cord connector.**
2. **Connect a speaker-level audio input to the RCA connector.**
3. **Plug the male extension cord connector into a power outlet.**
4. **Turn on the color organ.**
5. **Play the sound.**
6. **Turn the knob on the color organ to adjust the sensitivity.**
7. **If the light never comes on, try increasing the output volume on the stereo.**

The color organ can handle just 120 W on the output circuit, so you need to be careful not to overload the circuit. In the days before LED lighting, this limitation was often a concern. However, LED floodlights or Christmas light strings consume very little power, so you don't need to worry much about the 120 W limit.

As I mention earlier in this chapter, the easiest way to connect the color organ to the sound system is to simply replace one of the speakers with the color organ. The type of cable you'll need to do that depends on how the speakers connect to the sound system. If the speakers connect with simple post connectors, you'll need a cable with bare wire on one end and an RCA plug on the other end. If the speakers connect with RCA connectors, you'll need a cable with RCA plugs on both ends.

When you use the color organ in this way, it's important to realize that the color organ will respond to one channel of the stereo recording while the speaker plays the other channel. In most cases, you won't notice much difference. However, in some recordings, the sound on the left channel is very different from the sound on the right channel. This can affect the quality of the sound, and it can also prevent the light from flashing in perfect sync with the sound, since the light is responding to a different sound source from the one heard through the speakers.

In some cases, you can use this to improve the effect you're trying to achieve with the color organ. For example, in an actual thunderstorm, the lightning flashes well before the thunder is heard. To reproduce this effect, all you need is a sound recording of a thunderstorm in which the thunder is heard on the left channel before it's heard on the right channel. Then, if you connect the color organ to the left channel and the speaker to the right channel, the light will flash before the sound is heard.

Have fun with your color organ!