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FENDER-LIKE FUN

Building an Optical Tremolo Box

By Will Kelly

Leo Fender's first tremolo-equipped amplifier, the Tremolux, hit the market in 1955 with a clever circuit based on a light-dependent photo resistor triggered by an actual light bulb. The circuit dimmed and brightened the bulb at a user-determined rate, triggering the photo resistor to turn off the volume circuit in a corresponding manner.

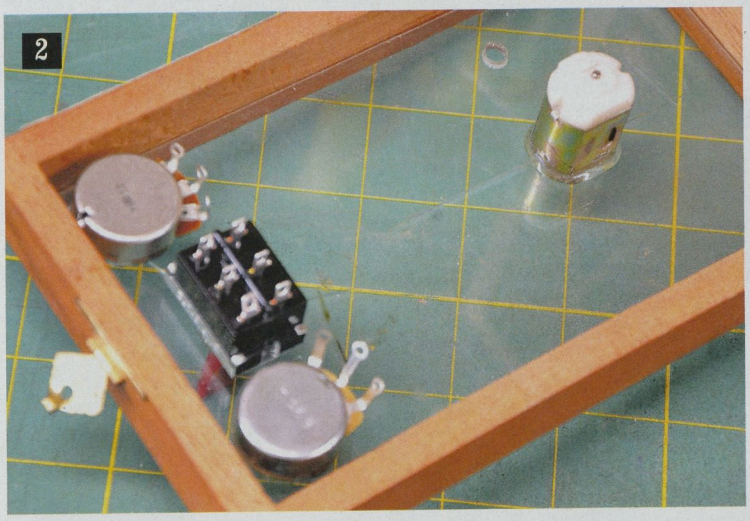
I like to experiment with tone and sounds, and effects pedals are a prominent part of my signal chain. I'm always on the lookout for new pedals and cheap/easy ways to get different sounds from my rig. I recently found this really interesting Optical Tremolo box project, and since the technology is based primarily on the vintage tremolo amplifier designs from Leo Fender, I thought I'd build it to see how it sounded. The primary difference between Fender's design and this project is the method of light attenuation. Instead of electronically altering the brightness of the lamp bulb, it *mechanically* alters the brightness with a rotating semi-transparent disc.

All parts for this, including the housing, are easily sourced from electronics supply stores, and overall cost excluding soldering iron and solder), is approximately $60. It doesn't take a lot of electronic experience to build, and you can be jamming on it within a couple hours!

I decided to use an old cigar box with a clear plastic lid. It won't hold up on the road, but will look cool in my home rig! The first order of business was to locate, drill, and mount the components that will attach to the lid of the box, then we'll concentrate on wiring after major components are installed.

1) You'll need the following electronic parts: one 25-ohm rheostat, one 10k-ohm linear taper potentiometer, one double-pole/double-throw (DPDT) center-off panel-mount switch, one DC project motor rated at 1.5 to 3 volts, two $^1/_2$" mono-tip sleeve panel-mount jacks, one 5 mm cadmium sulfide CdS) photo resistor, one 5 mm LED holder, a 3-volt bayonet-mount lamp bulb, one bayonet-mount light bulb panel jack, two four-position terminal strips, a two-AA-battery holder with leads, DC coaxial power plug, a size M DC panel-mount power jack, one 47-ohm resistor, some electrical wire. Plus, for the semi-transparent spinning discs, we'll use the clear blank CDs used to protect a new pack of writable CDs (they're usually on the bottom of a new pack). You'll also need a rubber grommet with an outside diameter of $^5/_8$" to fit in the middle hole of the clear disc. The middle of the grommet must fit the splined gear drive spindle on the DC motor's shaft.

2) To begin the build, locate, mark, drill, and mount the major components. Keep in mind the spinning CD is located on the top of the lid, and you must accommodate its $4^3/_4$" diameter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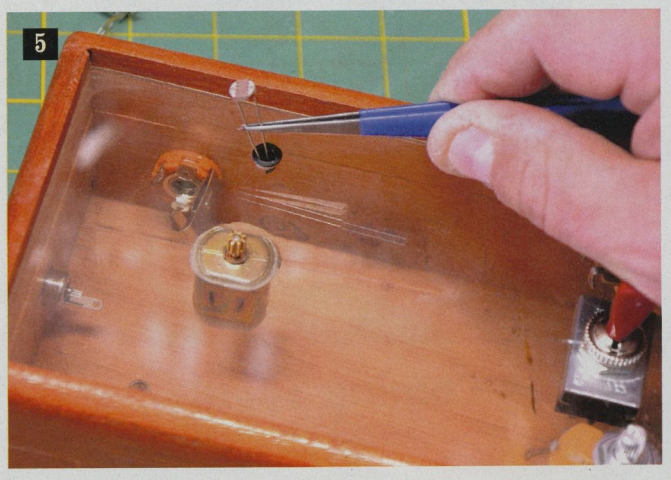

when designing the layout of the top. Mount the DC motor to the underside of the clear disc/lid, drill a 3-millimeter centered-access hole 2" from the top edge of the lid. Then, use a two-part epoxy that dries clear to secure the motor. Allow it to dry for an hour, making sure the motor body is perfectly parallel to the plane of the lid, so it won't wobble when rotating.

3) The blank CD acts as the mechanical medium through which the light source is attenuated before it reaches the photo resistor. I used two rubber grommets, stacked and glued together, to act as a hub adaptor for the motor's spindle. The rubber grommet must fit snugly in the center hole, as well as around the spindle shaft of the motor. To fit our design, it should be approximately 1" tall.

4) Drill two $^{3}/_{8}$" holes and mount the rheostat and 10k potentiometer to the lid, midway between the motor and the bottom edge of the lid, so the knobs will not interfere with the 4.5" CD-sized rotating disc mounted on the motor spindle. Mark the sides of the project box, approximately $1^{1}/_{2}$" in from the end, and drill one $^{3}/_{8}$" hole on either side to mount the $^{1}/_{4}$" panel jacks. On the top edge of the box, drill a $^{3}/_{8}$" hole to mount the size M DC power jack (for easy access on a pedalboard)

5) Locate, mark, and drill the mounting hole for the photo resistor. It has a plastic grommet holder that requires a $^{7}/_{32}$" hole. Drill this hole approximately $1^{1}/_{2}$" to the right of the center of the DC motor spindle and push the plastic grommet in the hole before inserting the photo resistor through it, leaving the two leads dangling from the underside of the photo resistor.

6) You should mount the bulb socket and lamb so it shines directly on top of the photo resistor, positioned above the CD with a 1" gap (so the CD can spin freely). I used a scrap piece of maple to carve out a pedestal to mount the lamp socket. Here's the completed wood pedestal, with the bulb and socket mounted, overhanging the spinning CD while positioned directly over the photo resistor.

7) To focus and contain the lamp, you can make a light hood. Make a template out of paper to ensure proper fit, then transfer the outline to a piece of 24-gauge aluminum. Fine-sand its edges before bending the aluminum so it rests securely on top. I stained the pedestal before attaching the shield with a small wood screw.

With the major components installed, next month we'll wire the circuit and create some semi-transparent CD discs. The schematic for this circuit is very simple, and the wiring won't take long, so be sure get your project box ready for the fun!

Will Kelly is a guitarist, engineer, repairman, and collector who loves low-budget gear. His shop, Hard Knocks Guitar, in Cary, North Carolina, has played host to countless instruments and amplifiers. You can contact him at WillKelly@nc.rr.com.

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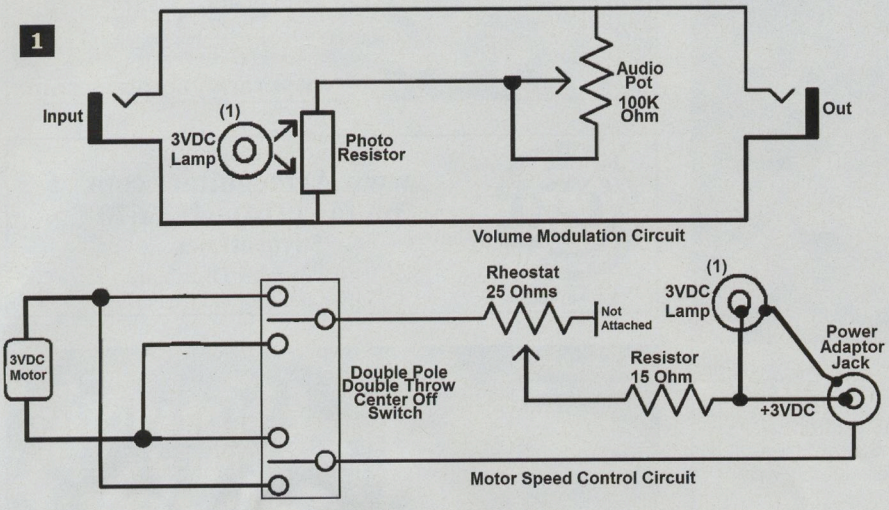

FENDER-LIKE FUN

Building an Optical Tremolo Box, Part 2

By Will Kelly

Last month, we started on a do-it-yourself optical tremolo box project. This primitive box uses a light-modulating mechanical design to produce an old-school tremolo for guitar, bass, or keys. Using a cigar box and easily sourced components, we mounted the hardware and located blank CDs to use as light attenuators. This month, we'll complete the project by wiring the components, making several attenuator discs (for different types of effect), then we'll test and fine-tune the mechanism.

1) This schematic shows the box's two circuit paths – one for motor speed and direction of the control circuit, the other for the volume-modulation circuit. The circuit works on the amount of light being received by the photo resistor. As it changes, signal volume changes accordingly. The photo resistor controls a percentage of guitar signal sent to ground (and thus not heard). When the positive and negative leads are shorted with a small-value resistor, output volume is cut because the resistor draws current rather than the lamp. If the leads are partially shorted with a large-value resistor, nothing happens because electrons moving through the circuit find the lamp easier to traverse than the circuit through the larger-value resistor.

2) Wiring the connections for the volume-modulation circuit is fairly simple. Solder the connections as shown in the schematic using 22-gauge stranded/insulated wire and the shortest possible lead, to minimize extraneous signal noise. Start with the input positive lead, and solder it to the input terminal on the "depth" pot, then continue it on to the positive terminal of the output jack. Wire the ground terminal on the output jack to the corresponding ground on the input jack before soldering it to one side of the photo resistor's leads. The other leg of the photo-resistor lead is soldered to the middle and end terminals on the 100k "depth" pot. Use tie wraps to secure the wiring harness.

3) The variable speed circuit for the 3-volt DC motor is fairly straightforward, as well. The 3-volt DC lamp and the motor are powered by an external adaptor, and the speed for the motor is controlled by the rheostat. Rotational speed of the motor determines the repeat rate of the effect. The depth of the effect is regulated by the relative amount of light shining through the spinning disc onto the receptor on the photo resistor. The three-position "center off" switch turns the lamp on and starts the motor. Position the switch so you're looking at it from the rear, with the terminals oriented as shown on the schematic. Starting with the positive terminal on the power adaptor jack, connect a 15-ohm resistor in series to the middle terminal on the rheostat. The input terminal is attached to one side of the switch and the end terminal is

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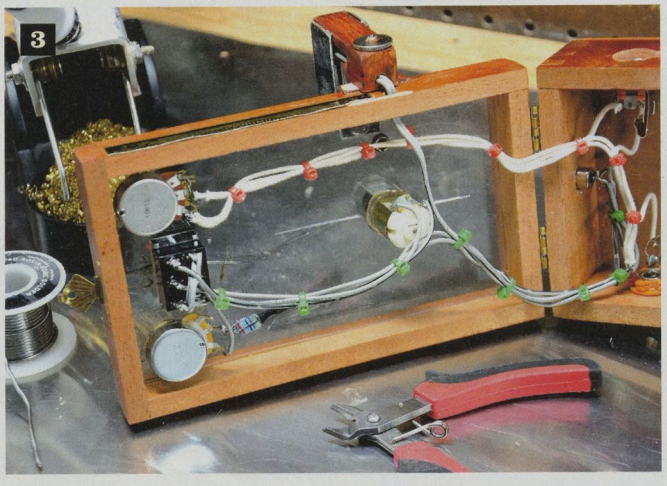


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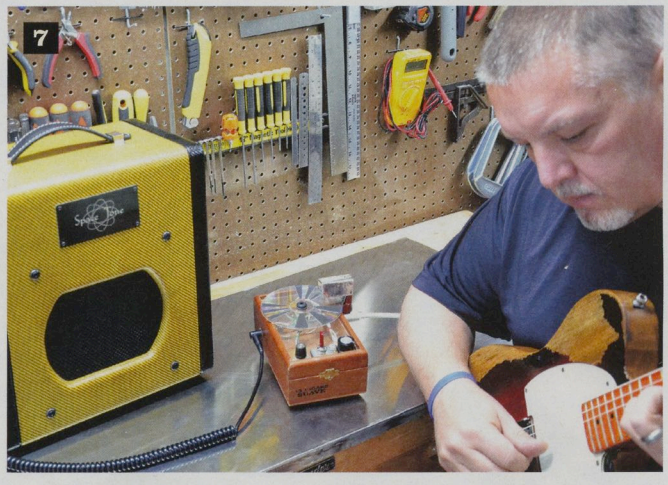
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unattached. The ground connection from the power jack is attached to the other input side of the switch. Connect all wiring as shown in the DC motor control circuit, keeping wire runs as short as possible.

4) To create various effects, we use the blank/clear discs used to protect a stack of new writable CDs. We'll apply patterns of light and dark to them, which the lamp's light to shine through to the photo resistor with differing intensities; the brighter the light, the quieter the instrument. As less light passes through the disc, it will get louder. You can download any of thousands of patterns to create effects discs. Half-black/half clear produces a square-wave tremolo, with crisp transitions. Others include a staccato pattern that produces repeating-triplet pulses and an "SOS" pattern that makes successively lengthening volume swells.

5) Print them onto white CD labels in high-quality mode (so the black areas are especially dark) and apply them to the discs using a label applicator, making sure the pattern is centered perfectly. Using an Exacto/razor knife, trim the white portions along their edges, then peel them away, leaving clear plastic; the black portions should be the only parts of the label to remain. Use a black marker to color in areas that maybe didn't get printed dark, and you're ready for a spin (pun *totally* intended)!

6) Insert a rubber grommet into the center hole of the disc, and place it on the motor spindle. The disc will rotate in place between the lamp and the photo resistor, and should spin freely without any obstructions. Plug in the power supply and turn on the switch. The lamp should brightly illuminate the area surrounding the photo resistor, the motor should start turning, and the disc should start spinning. Using the rheostat, adjust the rotational speed to a steady, slow spin.

7) Connect an instrument cable between the output jack and amplifier, plug the guitar in, and, with the "depth" control turned down, you should hear the guitar with no effect. As your turn up the control, the tremolo effect should mix with the signal. Adjust the rheostat "speed" control to obtain a pleasing repeat rate for the effect. The quality and depth of the tremolo has a lot to do with how well the spinning disc blocks the light; as more light is obscured, more dramatic volume fluctuations can be heard. Experiment with various disc patterns to create different styles of tremolo, and have fun!

Will Kelly is a guitarist, engineer, repairman, and collector who loves low-budget gear. His shop, Hard Knocks Guitar, in Cary, North Carolina, has played host to countless instruments and amplifiers. You can contact him at WillKelly@nc.rr.com.