HOME EMERGENCY LIGHT for "BLACKOUTS"

- *Automatic "on" when ac power fails*
- *Full-wave battery-charging circuit*
- *Doubles as lantern flashlight*
- *Compact, neat design*

BY WILLIAM OLDACRE

WHEN a power blackout occurs, one is likely to get caught in the dark without ready access to a flashlight or candle. Here is a hand emergency light to solve the problem, minimizing possible injury and fear due to darkness.

This emergency light goes on *automatically* whenever ac power is interrupted for one second or more, providing several hours of light before a recharge is needed. (The 1-second delay is built in to prevent flickering.) In addition, the system includes a battery charger which maintains full charge on ordinary nickel-cadmium batteries. It can also double as a portable flashlight and is designed into a neat, small package.

This home safety device is simple to build, requiring easy-to-get parts and modification of an inexpensive lantern-type flashlight.

How It Works. The schematic of the emergency light is shown in Fig. 1. Transformer *T1*, *RECT1* (a full-wave bridge rectifier), and filter capacitor *C1* form a low-voltage dc power supply. When line voltage is applied to the circuit, *LED1* glows. Current through *LED1* is limited by *R1*. The power supply provides charging current for battery *B1*, two NiCd cells. Diode *D1* prevents the battery from discharging back through the LED. Charging current is limited by either *R3* or *R4*. When switch *S1* is in the SLOW position, *R3* allows 33 mA to flow into the battery. When *S1* is placed in the FAST position, *R4* provides 100 mA, which charges *B1* more quickly.

The dc voltage also energizes relay *K1*. Since the relay coil is energized under normal (line voltage-on) conditions, it might tend to get very warm. To keep the coil cool, resistor *R2* is placed in series with it, lowering the amount of continuous current flow. The path between the battery and the light bulb (*I1*) is controlled by the relay contacts. Under line-on conditions, no current can flow through the bulb.

When the line power drops out, however, the relay coil is de-energized, and the contacts complete the circuit between the battery and the light bulb. The bulb automatically lights up, providing emergency illumination. To prevent the emergency light from flashing on and off whenever the line voltage drops for a fraction of a second (for example, when your refrigerator compressor kicks in), we take advantage of the fact that it takes about one second for the voltage across *C1* to decay to the point where the relay drops out. The exponential properties of the RC circuit smooth out any instantaneous variation in line voltage.

The flashlight is a self-contained unit which connects to the power supply through a three-conductor power plug-jack combination. When independent flashlight operation is desired, switch *S2* takes over the relay's switching operations by pro-

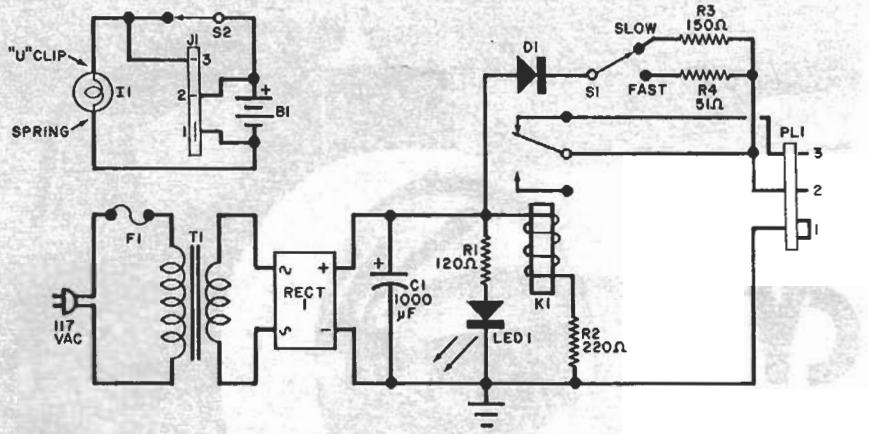


Fig. 1. Schematic of the emergency light. Power failure causes K1 to drop out, supplying power to I1.

PARTS LIST

B1—Two General Electric GC-3 1.25-volt, 1.2 A-hour nickel-cadmium batteries
C1—1000-μF, 16-volt upright electrolytic capacitor (Radio Shack 273-958 or equivalent)
D1—1-A, 50-PIV silicon rectifier
F1—¼-A fuse (Buss AGC ¼ or equivalent)
J1—Three-conductor power jack (Cinch-Jones S303AB or equivalent)
K1—6-volt SPDT relay (Radio Shack 275-004 or equivalent)
LED1—Light emitting diode (Sprague ED-123 or equivalent)
PL1—Three-conductor power plug (Cinch-Jones P303AB or equivalent)
R1—120-ohm, 1-watt resistor
R2—220-ohm, ½-watt resistor
R3—150-ohm, ½-watt resistor
R4—51-ohm, 2-watt resistor
RECT1—2-amp, 50-PIV bridge rectifier (Radio Shack 276-1151 or equivalent)
S1—SPDT miniature toggle switch
S2—SPST pushbutton switch (furnished with lantern)
T1—6.3-volt, 300-mA filament transformer (Radio Shack 273-1384 or equivalent)
Misc.—Chassis box 4" x 2⅜" x 6" (Radio Shack 27-252 or equiv.), lantern (Sears 4841, Ray-O-Vac L295 or equiv.), fuse clips (Buss 5682-41 or equiv.), metal battery holder (Radio Shack 270-1439 or equiv.), piece of 1" wood 4" sq., ¾" x ⅛" aluminum angle stock, ¼ -inch metal spacers, printed circuit or perforated board, line cord, rubber grommets, battery holder, wood screws, machine hardware, brass shim stock, adhesive-backed decorative vinyl, dry-transfer lettering, hookup wire, solder, etc.

viding an alternate path for current flow from the battery to light bulb *I1*.

Construction. The emergency light is composed of two units: a portable flashlight and the base/recharger which it plugs into.

Components forming the recharger circuit should be mounted on a printed circuit or perforated board. Etching and drilling and component placement guides for pc board fabrication are shown in Fig. 2. Mount the components on the board, paying close attention to the polarities of *C1*, *D1*, the leads to *LED1*, and *RECT*. (Align the rectifier so that the dot on the top of the case faces north. The pin facing north is the +dc output. South is negative, east and west are the ac inputs from the secondary.) Fuse *F1* can be mounted either on the back panel using a panel-mount holder, or on the circuit board using standard fuse clips. The clips require 4-40 mounting hardware. The two 4-inch (10-cm) leads should be connected from *LED1* to the appropriate pads on the circuit board. Three 4-inch (10-cm) leads should be run from the board for *S1*, and three 10-inch (25.4-cm) leads for *PL1*. Drill holes in the utility box for pc board standoffs, rubber feet, *LED1*, *S1*, and the line cord. Insert the line cord through its hole using a grommet or strain relief and connect its leads to the transformer primary. Then mount the circuit board in the utility box using ⅜-inch (0.64-cm) metal spacers.

The prototype uses Cinch-Jones three-conductor power connectors, but substitutions are OK. Drill two mounting holes in the wood block and a hole for *PL1's* leads through the cover of the utility box. Install a grommet in the hole for the leads.

Plug *PL1* is mounted on a 3½" x 3½" x ¾" (8.9 x 8.9 x 1.9 cm) block of wood, which is covered with walnut grained adhesive-backed vinyl. Drill holes on the bottom side for mounting hardware (make sure these don't go all the way through), *PL1*, and the top two metal guide rails (completely through the block). These rails should be fashioned from ¾" x ⅛" (1.9 x 0.32 cm) aluminum angle stock. Round the corners of the aluminum, and drill two holes for securing hardware. Position

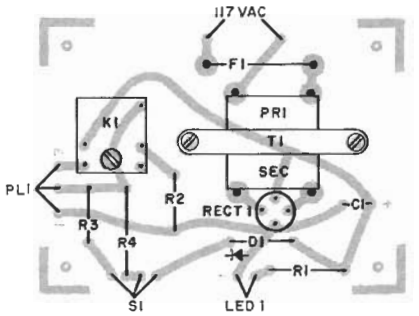
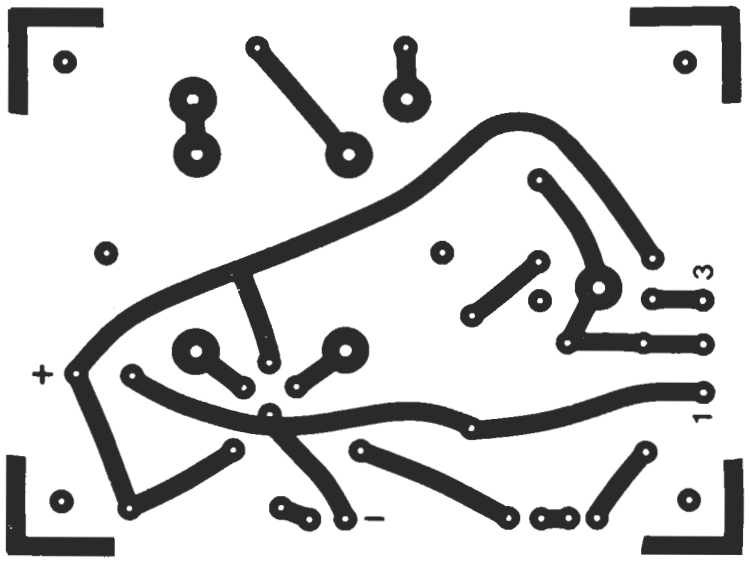


Fig. 2. Etching and drilling guide for pc board is below; component placement at right.



the rails so that they accept the flashlight you choose to use (the one in the photo is a Sears model), and then drill holes into the top of the wood block to match those in the guide rails. Give the rails a brushed appearance by rubbing them lengthwise with fine steel wool under running water. Then attach the rails to the block with ½" (1.25 cm) roundhead wood screws.

Secure plug *PL1* to the wood block and attach the appropriate leads from the circuit board. Mount the block on the top of the utility box's cover, lining up the holes you previously drilled. Secure the block to the cover with roundhead wood screws.

Final assembly of the base/recharger may now be accomplished. First, label the front panel as shown in the photo using dry-transfer letters. Then apply several light coats of clear acrylic spray. This will prevent the letters from being worn off. After the spray has dried, secure *S1* in its mounting hole. If your *LED1* has no mounting collar, use a ¼-inch (0.64-cm) O.D. rubber grommet to keep the LED secure. Slip the cover onto the utility box and secure it with the hardware provided for this purpose. This completes the assembly of the base/recharger.

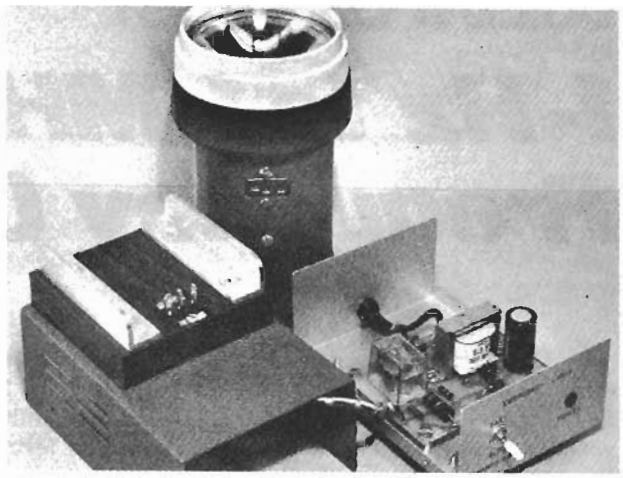


Fig. 3. Base with recharger is shown without cover. Flashlight plugs into socket on wooden block.

It is necessary to modify the hand lantern that you choose. Disassemble the lantern, and find the "molding line" running down the middle of the housing. This can be used to accurately center the power jack *J1*. Cut a hole in the bottom of the housing that conforms to the power jack you will install. Use a very sharp safety knife to cut the plastic. Drill holes for the mounting screws for the jack and for a metal battery holder. Rather than soldering inside the lantern housing, prewire the components outside the housing as shown in Fig. 4. Replace the light bulb with a lower voltage unit (see accompanying box).

Do *not* solder the light bulb lead to the brass rivet on the back of the bulb's nylon retainer nut. Instead, remove the compression spring and solder the lead to one loop of spring. Then replace the spring and feed the wire through the hole in the rivet. To make bulb replacement more convenient, install a small in-line connector in the lead between the spring and terminal of jack *J1*. A U-shaped clip which fits around the barrel of the lamp socket is furnished with the lantern. Solder two leads to the clip, one of which is connected to terminal 3 of *J1*. Connect the other to *S2* as shown in the schematic. Note that *S2* is the lamp's original ON/OFF switch. Fasten the U-shaped clip to the lamp socket base. Complete the wiring of *J1* and *S2*, and then install two 1.25-volt NiCd batteries in the metal holder. Reassemble the lantern.

Testing. Make one final check of all wiring before applying power to the unit. Then, setting the lantern aside, plug the line cord into a wall socket. A distinct click should be heard as the relay is energized, and *LED1* should glow. If all is well, plug the lantern into the base/recharger. If *I1* lights up, switch if off with *S2*. (If this doesn't turn *I1* off, disconnect the line cord and recheck all wiring.) Allow the batteries to charge for about ten minutes with *S1* in the FAST position. Then simulate a power failure by disconnecting the line cord. The lantern should light up after a one-second delay. If the lantern checks out OK, plug the line cord back into the wall socket, and allow the batteries to charge for at least 16 hours.

Operation. The lantern should be placed where fail-safe illumination is most needed. After the initial charge (with *S1* in the FAST position), use the SLOW charge rate, as this will offer extended battery life and slightly lower consumption. ◈

SELECTING AN INCANDESCENT BULB.

The battery power source used in the emergency light holds a power capacity of 1.2 ampere-hours at 2.5 volts (when fully charged). This means that it can keep a 1.2-A current flowing for one hour. Alternatively, it can sustain a 0.6-A current for two hours, 0.3-A for four hours, and so forth. Obviously, the smaller the current drain from the power source, the longer the flow can continue. You will have to decide for yourself how long you will need the light to function before the NiCd cells are completely discharged.

If you live in an area plagued with frequent (but brief) power blackouts, this discharge time is not too important. Alternatively, if your neighborhood gets rare (but prolonged) power losses, duration of the power source should be extended.

These factors will dictate your choice of lantern light bulb. The type PR-2 light bulb, which draws 0.5 A at 2.4 volts, will discharge the battery source in about 2 hours and a quarter If you choose a PR-4 bulb instead, the NiCd cells will last about 45% longer, since it draws only 0.27 A at 2.3 volts. Although the PR-4 will produce less light than the PR-2, many builders will prefer it because it is easier on the supply. If even longer duration (and a lower light level) are desired, you can choose a less demanding bulb type or add current-limiting resistors in series with the bulb.

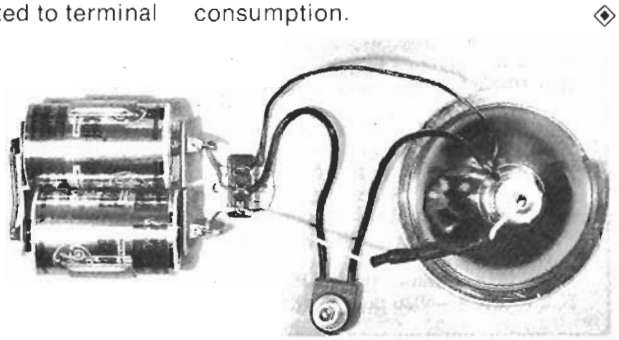


Fig. 4. Modifying flashlight is best done by working outside the flashlight housing.