By Forrest M. Mims

Model-Railroad Crossing Light

MODEL railroad enthusiasts can add a touch of realism to their layout with this flashing signal light. It includes two red LEDs which begin flashing alternately when a train approaches and continue flashing until the train has passed. The signal does so no matter which direction the train is moving.

Circuit Description. Figure 1 is the schematic diagram of the crossing light. Phototransistors *Q1* and *Q2* are installed on either side of the protected crossing as shown in Fig. 2. Both transistors are illuminated by a dc-powered light source. A single incandescent lamp can illuminate both *Q1* and *Q2*, or individual lamps or infrared LEDs can be used. Fig. 3 shows how to connect a pair of infrared emitters so that a forward current of 30 mA will flow.

When both *Q1* and *Q2* are illuminated, the inverting inputs of both op amps are slightly above ground. The outputs of *IC1* and *IC2* are at +9 volts. These outputs are applied to NAND *IC3A* whose output is at logic 0 under these conditions. This disables the dual LED flasher comprising gates *IC3B* and *IC3C*. Gate *IC3D* turns off *LED2* when the flasher is disabled. If *LED2* were connected directly to the output of *IC3C*, it would glow continuously when the flasher was disabled.

Should the light path between the light source(s) and either *Q1* or *Q2* be blocked by an arriving train, the output of gate *IC3A* goes high. This allows the dual flasher to oscillate, and LEDs 1 and 2 begin flashing alternately. The flasher continues to oscillate as long as either *Q1* and *Q2* or both are blocked. When the train has passed and light again strikes both *Q1* and *Q2*, the flasher circuit is again disabled.

Using the Circuit. Operation of the circuit is fairly straightforward. If the flasher fails to operate properly, substitute a 0.1-μF disc capacitor for *C1*. If the LEDs then flicker rapidly when the flasher is enabled, the electrolytic capacitor you previously used as *C1* is the culprit. Reconnect it to the circuit, making sure to observe its polarity. If the LEDs still fail to flash, use another electrolytic capacitor.

If your train layout is brightly

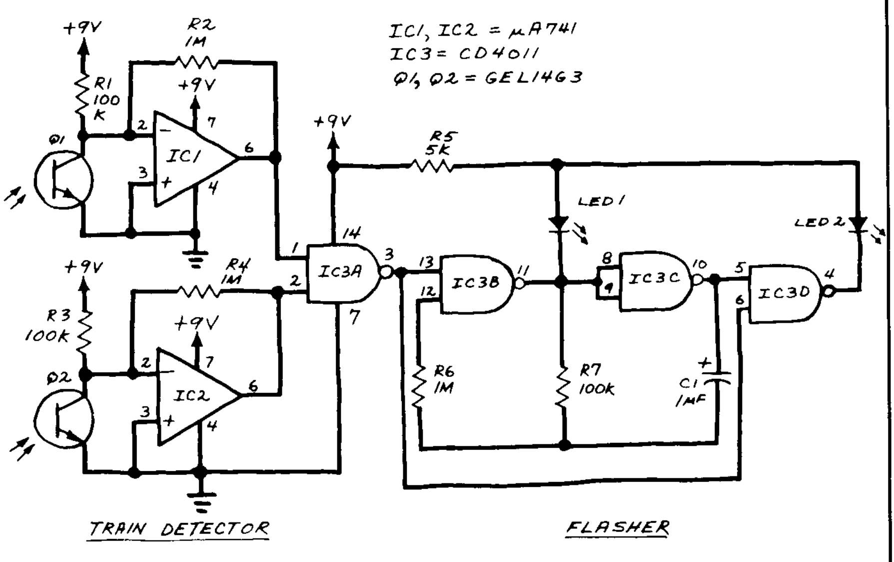

Fig. 1. Schematic diagram of a circuit for a model railroad crossing signal light.

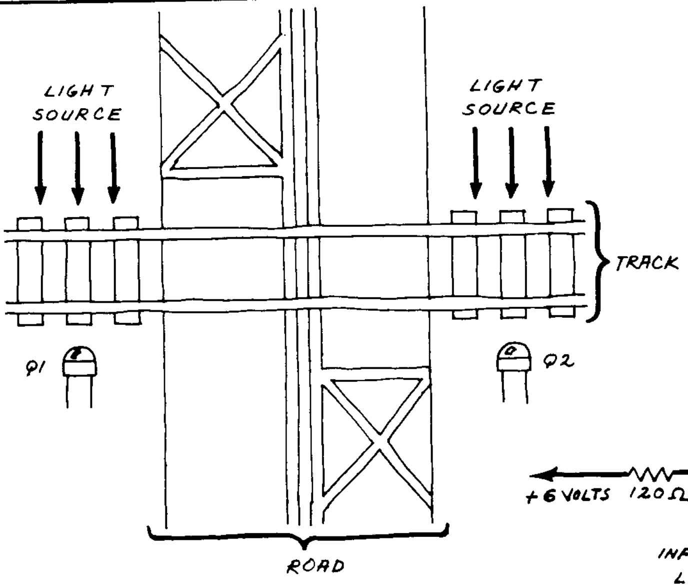

Fig. 2. Suggested positioning for phototransistors for railroad crossing lights.

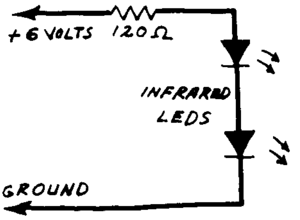

Fig. 3. A possible infrared illuminator circuit.

lighted, you may need to place light shields or infrared bandpass filters over the apertures of the phototransistors. One-inch lengths of quarter-inch black heat-shrinkable tubing work well. Unexposed, processed pieces of Kodachrome or Agfachrome color slide film make excellent, inexpensive infrared bandbass optical filters. They can be secured with glue.

Be sure the distance between the two phototransistors is either greater or less than the length of one of your pieces of rolling stock. Otherwise, the warning signal might be deactivated if both phototransistors are simultaneously illuminated by light passing between adjacent cars. Also, install the phototransistors at heights low enough so that the light paths will be blocked by low-lying rolling stock such as flatcars.

Going Further. For best results, you should install the two LEDs in a miniature replica of a signal-crossing light. Avoid the temptation of increasing the brightness of the LEDs by reducing resistance of *R5*. If you want the LEDs to flash more brightly, parallel two of the gates in a second 4011 to drive each LED. You can then use series resistors of, say, 270 ohms to limit the forward current through each LED to approximately 25 mA. This will result in plenty of brightness.

Referring again to Fig. 1, note that the outputs of *Q1* and *Q2* are compared and then the result put through a NAND gate. Separate op amps are used to reduce the chance of stray noise pick-up. You can combine the two op amps into a single chip to reduce the parts count by using a dual op amp. A more efficient modification, however, is to eliminate one op amp entirely by wire-ANDing the outputs of the phototransistors.

Fig. 4 shows how this is done. Phototransistors *Q1* and *Q2* are connected in series. NAND gate *IC3A* of Fig. 1 is converted to an inverter to achieve the NAND operation required for proper control of the flasher circuit.

Flip-flops and timer chips can also be used to make railroad crossing lights. Perhaps you can use them to design custom circuits on your own. ◇

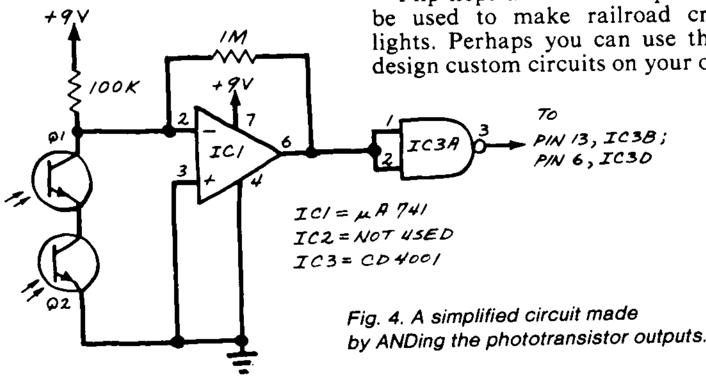

Fig. 4. A simplified circuit made by ANDing the phototransistor outputs.