

Ballantine, and others. I prefer to supply manuals to the owners of the equipment for their own use.

I worked for Tek for 41 years and collected manuals and parts, which were available through their company store. Now I spend hours on the phone helping people who come to me.—Deane Kidd, W7TYR, 27270 S.W. Ladd Hill Road, Sherwood, OR 97140.

**A** Thanks, Mr. Kidd. That reader (and his Tek 575 curve tracer) can personally attest to your helpfulness. Vintage Tektronix oscilloscopes are widely available at hamfests and are becoming collectors' items. Like Leica cameras or Zeiss microscopes, they're highly repairable, extraordinarily well-built, and capable of outstanding performance. If you can get tubes, they seem to last forever. Tektronix aficionados should also consult the book *Oscilloscopes: Selecting and Restoring a Classic* (which covers only Tek products), written and published by Stan Griffiths, W7NI, 18955 S.W. Blanton St., Aloha, OR 97007

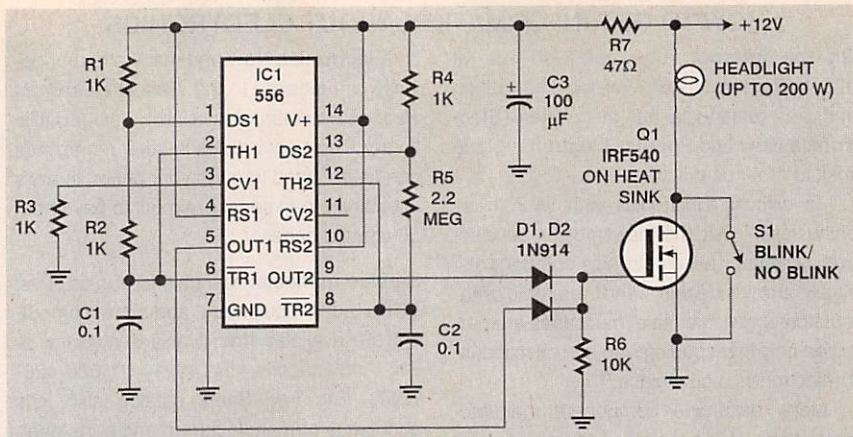
## Invisible Motorcycle?

**Q** As a motorcycle rider, I find myself invisible to many car drivers. The requirement for keeping headlights on during the day was supposed to make us more conspicuous, but now many cars also drive with their headlights on and motorcycles no longer stand out.

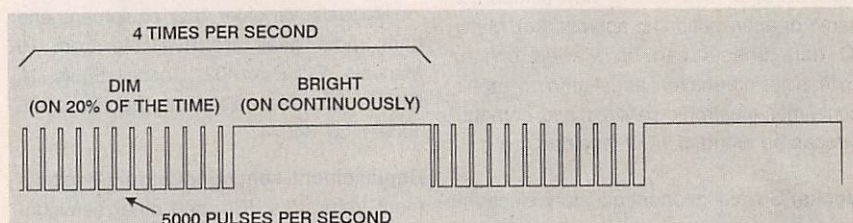
There is a headlight modulator legal in all 50 states that solves this problem; could you tell me how to build one? The requirement is to modulate the high beam (12-14 volts, 55 watts) 240 times a minute between full and 20% power.—R. A. H., Eugene, OR

**A** We'll have to take your word about the official specifications, but the circuit in Fig. 3 will probably do what you need. As Fig. 4 shows, it varies the brightness of the headlight by varying the duty cycle of a squarewave. That is, instead of consuming energy in a resistor, it switches the power on and off very fast. Since the power is always either on or off, little or no electricity is wasted, and because the switching rate is so high (5 kHz), the light-bulb filament remains at a constant temperature and doesn't suffer any extra wear.

You may have to experiment with component values to get the performance you need. Resistor R3 determines the brightness of the "dim" state; if you use a



**FIG. 3**—THIS MODULATOR CIRCUIT makes a motorcycle headlight alternate between full and 20% power at a rate of four times a second.



**FIG. 4**—THE MODULATOR IN FIG. 3 VARIES the brightness of the bulb by changing the duty cycle of a squarewave. The pulse rate in the dim state is so fast that the filament does not flicker.

CMOS 556 (such as 7556, TLC556, or LMC556), it will need to be much larger. The 4-Hz pulse rate is determined by R5 and C2. The purpose of R7 and C3 is to protect the 556 from voltage surges.

## Darkroom Timer Wanted

**Q** I have done photographic lab work both professionally and as a hobby, and for a long time I have wanted to build my own darkroom timer to suit my own needs. Now that electronics is a new hobby of mine, I am excited about the prospect of finally doing this.

I would really like to build an LED timer including both minutes (up to 99) and seconds. I need it to count down from a pre-selected time and activate a relay to switch an AC load.

I'm aware of the "Time-Off" project in your sister magazine, *Popular Electronics*, September, 1997. I can use it in some lab work, but it is not usable in the darkroom because of the LCD display.—G. A. P., Ft. Myers, FL

**A** Red LEDs are indispensable in the darkroom because they're safe for black-and-white photographic paper and orthochromatic film. In fact, big arrays of LEDs make excellent safelights; there's

no filter that can fade, and for physical reasons, all their light is confined to a narrow band of wavelengths.

You might be able to add a red LED to illuminate the Time-Off, or position neon lamp NE1 so that it illuminates the display. In that case, use a red-filtered neon pilot light (available at appliance-part stores).

What you really want, though, is a timer that was published in *Popular Electronics* back in August, 1992, pp. 53-58 and 91. It uses thumbwheel switches so you can select 0 to 99.9 or 0 to 999 seconds, and the display consists of red LEDs. Admittedly, it doesn't go up to 99 minutes, but 999 seconds are more than 16 minutes, long enough for most if not all steps in photographic processing. All of the parts are still widely available.

## Plated-Through Holes

**Q** How can I make plated-through holes on my two-sided printed-circuit boards so that I don't have to solder the same hole from both sides?—E. V., Toledo, OH

**A** As far as we know, there is no easy way. Plated-through holes involve electrolysis plating with special chemi-