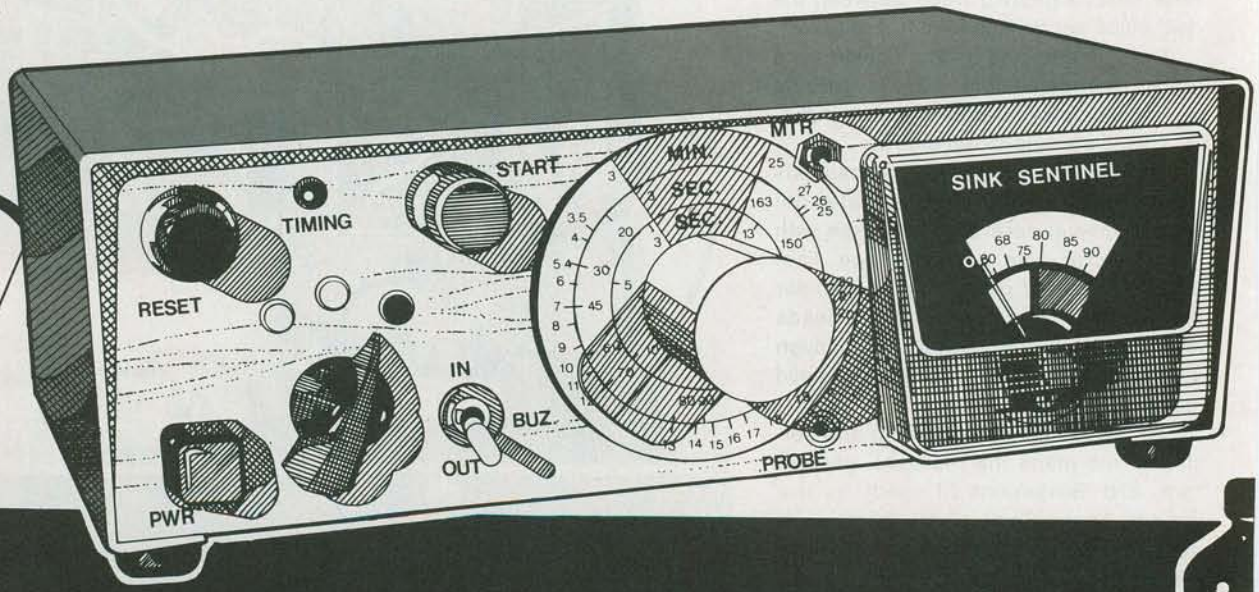
BUILD A PHOTO SINK

THERE are many reliable timers, thermometers, and quality-control devices to aid the photographer. Unfortunately, most of these commercial devices are expensive. You can, however, build the "Sink Sentinel," which serves as a photo-lab timer, thermometer, and conductivity tester, at a fraction of the cost you would expect to pay for a similar commercial device. The Sink Sentinel accurately monitors the temperature of film-processing chemicals, times film processing, and tells you when your film or paper can come out of the hypo.

About the Circuit. The timer portion of the Sink Sentinel is shown in Fig. 1. It is based on a conventional 555 timing circuit (*IC1*). TIME SET potentiometer *R2* and RANGE switch *S3*, the latter selecting the appropriate range capacitor (*C1* and *C2* shown, but more capacitors can be added, as desired), determine the timing range.

Timing is initiated by pressing START switch *S4*, which places pin 2 of *IC1* at ground potential. Pin 2 is normally held high by *R3*. The timing interval in seconds is approximately equal to 1.5 times the value of *R2* in megohms times the value of the capacitor (selected by *S3*) in microfarads. The timing values for the R



and C values shown in Fig. 1 were set in three ranges. The first and most commonly used for photographic printing and enlarging is from about 3 to 23 seconds; the second from 20 seconds to nearly 3 minutes; and the last from 3 to almost 30 minutes. If desired, the R and C values can be changed to produce any desired timing interval.

During the timing interval, the output of *IC1* at pin 3 is high and lamp *I1 and* alarm *A1* (if the latter is switched in via *S5*) will not operate, but *LED1* will be on. At the end of the timing cycle, the output of *IC1* goes low to allow *A1* and *I1* to operate. At this point, *LED1* extinguishes. If at any time you wish to terminate the timing cycle, you simply press RESET switch *S2*.

An optional enlarger/safelight powering arrangement is provided by sockets *SO1* and *SO2* and relay *K1*, as shown in Fig. 1. If you prefer not to have this option, you can eliminate *K1* and *SO1* and *SO2*. Assuming you decide to keep this option, when *K1* is not energized at the end of a timing cycle, *SO2* is powered and can be used to power your safelight. During the timing cycle, *K1* is energized, connecting *SO1* to the power line for powering an enlarger.

The temperature/conductivity section

DARKROOM SENTINEL

Moderately priced system monitors temperatures and film process time of photographic chemicals, and alerts user when film or paper processing is completed

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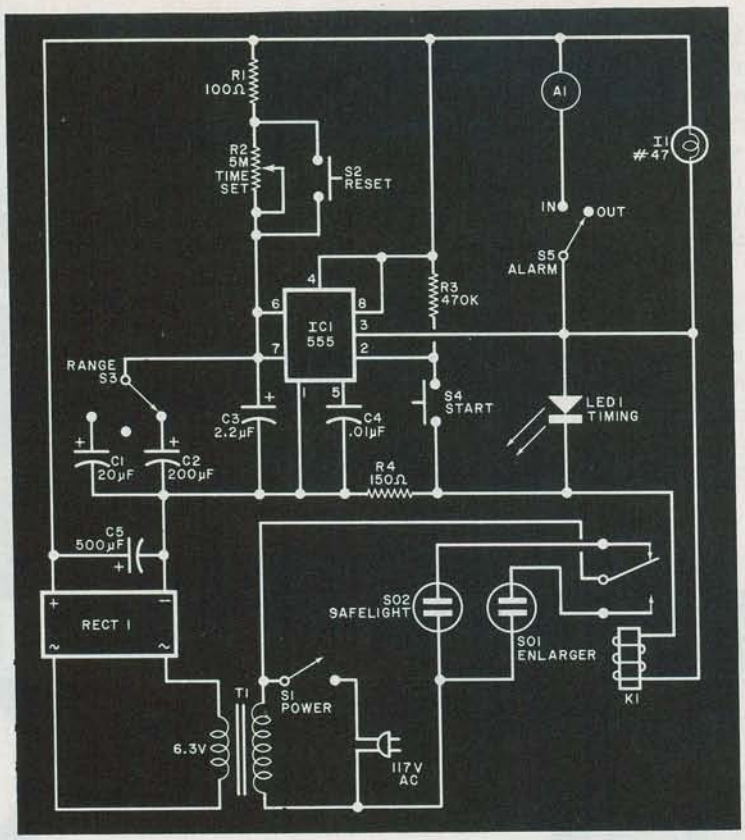

Fig. 1. Basic 555 timer can be adjusted for almost any desired timing ranges. The relay circuit allows timing an enlarger then turning on safelight.

PARTS LIST

A1—6-volt dc alarm or buzzer (Mallory Sonalert No. SC628, Radio Shack No. 273-049, or similar)
B1—9-volt battery
C1—20-μF, 20-volt electrolytic
C2—200-μF, 20-volt electrolytic
C3—2.2-μF, 20-volt electrolytic
C4—0.01-μF disc
C5—500-μF, 20-volt electrolytic
I1—6-volt lamp (No. 47 or similar)
J1—Subminiature phone jack
K1—6-volt, low-current relay (Radio Shack No. 275-004 or similar)
LED1—Red discrete light-emitting diode
M1—0-to-50-μA dc meter movement (Radio Shack No. 22-051 or similar)
P1, P2—Subminiature phone plug
Q1—Pnp germanium transistor in T01 or T04 metal case (see text)
The following resistors are ½ - watt, 10%:
R1—100 ohms
R3—470,000 ohms
R4—150 ohms
R5,R6—3000 ohms
R8—3600 ohms
R2—5-megohm linear-taper potentiometer
R7—100,000-ohm miniature potentiometer
RECT1—Rectifier (Radio Shack No. 276-1626)
S1—Spst switch
S2,S4—Normally open spst pushbutton switch
S3—Single-pole, three-position nonshorting rotary switch
S5,S6—Spdt switch
SO1,SO2—Chassis-mounting ac receptacle
T1—6.3-volt, 300-mA transformer
Misc—9″ × 6″ × 3½″ (22.9 × 15.2 × 8.9 cm) aluminum cabinet; holder for B1; ac line cord with plug; pointer knob; plain pressfit control knob; 2″ × 2″ (10.8 × 10.8 cm) perforated board; 36″ (about 1 m) stranded two-conductor speaker cable; 1/16″ clear plastic sheet; quick-set epoxy; plastic cement; silicone-rubber cement; 4″ (21.6 cm) chrome or stainless-steel wire (see text); dry-transfer lettering kit; rubber grommets (2); hookup wire; machine hardware; etc.

of the Sink Sentinel is shown in Fig. 2. It is based on the Wheatstone bridge principle. The circuit measures the relative resistance of either a plug-in temperature or conductivity probe.

The temperature probe is made up of an ordinary pnp germanium transistor with a metal TO1 or TO4 case. Sensing is performed in the emitter-collector junctions. Although such a temperature probe is limited in range, it will suffice for the 60° to 90° F (15.6° to 20° C) range required in most photographic developing situations.

Construction. The timer circuit can be assembled on a small perforated board, or you can use a printed-circuit board of your own design. A socket is recommended for *IC1* in either case.

Mount the various switches, control, indicators, and meter on the front panel of the enclosure in which the system is to be housed. This done, secure the power supply in place on the bottom of the enclosure. Pass the prepared end of the line cord into the box through a rubber-grommet-lined hole in the rear panel. Then, before connecting and soldering the line cord to the appropriate points in the circuit, tie a knot about 4″ (10.2 cm) from the prepared end on the inside of the box to prevent the cord from being torn loose.

Light-emitting diode *LED1 mounts* on the front panel via a rubber-grommet-lined hole. Note that a separate lamp and switch can be used for *I1* and *S1*, or you can use a switch with built-in lamp.

Use a dry-transfer lettering kit to label the front panel with the appropriate legends. With an ink compass, draw four concentric circles on medium-weight white cardboard. Make the circles ⅝″, 2″, 2½″, and 3″ (15.9, 51, 63.5, and 76.2 mm) in diameter. Cut a disc from the cardboard, using the 3″ circle as a guide. Next, cut a hole in the center of the disc, using the ⅝″ circle as a guide. Rubber cement the disc to the front panel, with the shaft of *R2* centered in the hole. (This "dial plate" will be inscribed later during the timer calibration procedure.)

Slip a pointer knob onto the shaft of *S3*. Properly index the pointer and tighten the setscrew.

Next, cut a 3″ disc from 1/16″ (1.6-mm) thick sheet of clear plastic. Using a metal straightedge and a sharp needle, firmly scribe a line from the center to the edge of the disc. Fill the scribed line with india ink and wipe off the excess, leaving behind a fine scribed cursor. Drill a ⅜″ (9.5-mm) hole through the center of the plastic disc.

Temporarily place a knob with a pointer on the shaft of *R2* and rotate it to locate the two stops on the pot. Locate this angular gap at the top of the cardboard disc (lightly pencil marking the two points on the cardboard disc) equidistant to both sides of an invisible vertical axis with the pot's shaft. Remove the pointer knob.

Now place the plastic disc over the pot's shaft, scribed cursor line toward

SINK SENTINEL

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the cardboard disc. Center the plastic disc over the cardboard disc and line up the cursor line with the *right* pencilled stop mark on the cardboard disc. Temporarily tape the plastic disc in place. Rotate the pot's shaft fully counterclockwise. Apply a thin bead of plastic cement to the back of a plain plastic friction-fit control knob. Slide the knob onto *R2*'s shaft and gently press it against the plastic disc. Allow the cement to set for at least 8 hours before removing tape.

Meanwhile, fabricate the conductivity probe as follows. The probe itself (see Fig. 2) consists of a pair of closely-spaced conductors, with a limiting resistor, that can be plugged into *J1*. The probe elements can be made from two 2" (5.1-cm) lengths of chrome or stainless-steel 12-gauge rod. A bicycle spoke or a length of stainless-steel antenna rod will do.

Solder *R8* to one end of one of the rods. Then trim away 1" (25.4 mm) of one of the conductors at one end of a 36" (about 1-meter) length of speaker cable. Strip away the insulation from both conductors of this end of the cable, twist together the wires and tin them lightly with solder. Connect and solder the shorter conductor to the free end of *R8* and the other conductor to one end of the remaining rod.

Now, cut two 1" × ⅜" (25.4 × 9.5 mm) strips from a sheet of 1/16" thick sheet of plastic. Drill two ⅛" (3.2-mm) holes ⅛" apart in the center of both strips of plastic. Slip the free ends of the rods through one hole in each strip of plastic and apply a drop of fast-setting epoxy cement at each hole to secure the strips to the rods.

While the cement is setting, drill a ½" hole through the center of the bottom of a plastic film or pill container. Drill eight or more ⅛" holes around this hole and 25 or more ¼" holes through the body of the container. Assuming the epoxy cement has set, slightly bend the tops of the rods apart to obviate any possibility of the two touching each other.

Pass the free end of the speaker cord through the ½" hole from the *inside* of the container and pull it through until the tips of the rods are just slightly recessed from the open end of the container. Then liberally apply silicone-rubber cement over the resistor and the three soldered connections. Just fill the space around and between the tops of the rods to fill the ½" hole. This will provide a mechanically secure mount for the conductivity probe's elements and a seal against the caustic solutions into which it will be immersed. Allow the cement to set for at least 24 hours.

To one end of a 36" length of speaker twin-lead cord, connect and solder a subminiature phone plug. Separate the cord at the other end for a distance of about 4" (10.2 cm). Strip away about ⅜" of insulation, twist together the wires, and lightly tin the conductors with solder. Plug in and turn on the Sink Sentinel. Then, making sure to prevent the tinned conductors from contacting each other, insert the phone plug into *J1*.

Temporarily connect the collector and emitter leads of a pnp germanium transistor to the tinned conductors. Make sure that the emitter connects to the *R5* junction and the collector connects to the *R7/M1* junction. Note that the meter's pointer swings upscale. In a typical 68° F (20° C) ambient room, adjust *R7* for about a one-quarter-scale pointer swing.

Bring the transistor close to a turned-on light bulb; the meter's pointer should swing to full-scale. If this does not occur, repeat the procedure with a different germanium transistor until you locate one that is relatively heat sensitive. Put a kink or other identifying mark on the transistor lead connected to the speaker cable conductor with ribbed insulation. Then disconnect the cable from the circuit and turn off the power.

Once you have your heat sensitive transistor, clip away its base lead close to the metal case that houses it. Connect and solder the emitter and collector leads of the transistor to the cable's conductors, making sure that the identified transistor lead goes to the cable conductor with ribbed insulation. This done, pack silicone rubber cement over the exposed metal connections and down to the case of the transistor. Do *NOT* coat the sides or top of the transistor's case with the cement. Put this cable assembly aside to allow the cement to set for at least 24 hours.

Calibration. The timer section can be calibrated with the aid of a stopwatch, digital watch with seconds display, or an ordinary analog watch with a sweep second hand. Plug the Sink Sentinel into the power line and turn on the power. Lamp *I1* should come on and the alarm will sound if ALARM switch *S5* is on.

Set the RANGE switch to the maximum time (*C2* in Fig. 1) and the pointer knob for minimum resistance (fully counterclockwise). Carefully mark with an awl or the point of a pin, on the plastic disc over the potentiometer dial, the points where the cursor line crosses the circles on the cardboard disc. Remove the cursor knob and drill a 1/16" hole at the two points marked. Then slip the knob back on the pot's shaft.

With the knob fully counterclockwise, push the point of a pin through both holes in the cursor disc to lightly detent the cardboard disc. Turn the knob fully clockwise and repeat the procedure. Return the pot fully counterclockwise.

Now calibrate the minutes range on the inner circle of the dial plate as follows. Simultaneously start your stopwatch (or wait for your watch to reach the zero seconds mark) and press

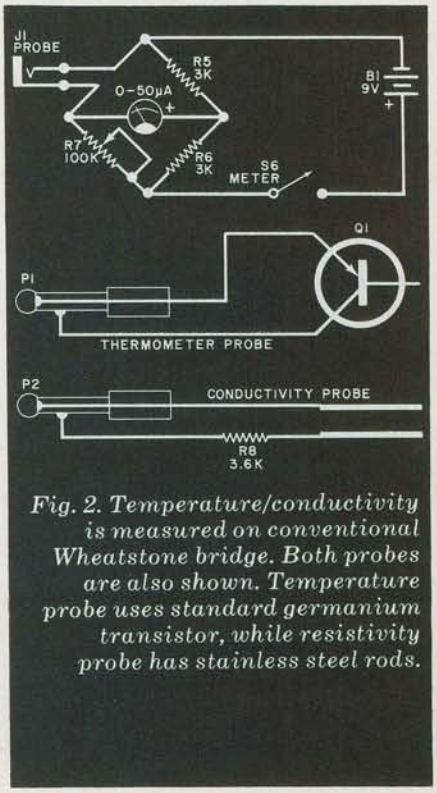

Fig. 2. Temperature/conductivity is measured on conventional Wheatstone bridge. Both probes are also shown. Temperature probe uses standard germanium transistor, while resistivity probe has stainless steel rods.

START switch *S4*. The LED should come on, *I1* should extinguish, and the alarm should cease to sound (assuming it is switched in). When the countdown is completed by the timer, *I1* will come on, the LED will extinguish, and the alarm will sound. Note how long this took on a sheet of paper under the heading "MIN." Adjust *R2*'s cursor slightly clockwise and repeat this procedure. At the end of the countdown, note the time elapsed and slightly detent the inner circle on the cardboard with a pin. Repeat this procedure until the pot is at its fully clockwise stop. Then repeat this procedure for the

other two positions of the RANGE switch and the two SEC circles on the cardboard disc. (If you prefer, you can adjust the pot's setting to coincide with exact seconds and minutes to obtain a neater dial plate. This is time-consuming but well worth the effort.)

When you have completed calibration, turn off the Sink Sentinel and remove the cursor knob from the shaft of the pot. Mark three or four points on the perimeter of the cardboard disc and on the front panel exactly in line with them. Then lift off the cardboard disc. Using a dry-transfer lettering kit (or working with a pen), place tick marks at each detented point on the circles on the disc and label each with the appropriate time in your calibration listing. Then rubber cement the disc back in place, using the marks on it and the front panel as a guide. Slip back onto the shaft of the pot the cursor knob. (A typical finished dial is shown in the lead photo.)

The temperature probe can be calibrated with the aid of an accurate mercury-column thermometer. Since the most used range will be between 60° and 90° F, leave the probe in ambient room air (about 68° F) until the meter's pointer deflection stabilizes. Then adjust *R7* for a pointer deflection of about one-quarter scale. Carefully place a pencil mark on the scale at this point. Place both the mercury thermometer and temperature probe in water and adjust the temperature for an indicated reading of 95° F on the mercury thermometer. Again, place a pencil mark on the meter's scale at this point. Reduce the temperature of the bath by 2.5° F and again make a pencil mark on the scale. Repeat reducing the bath's temperature by 2.5° F and indicating each point on the scale until you reach 60° F. Turn off the power and remove the line cord from the ac power line.

Carefully remove the dial-scale card from the meter and relabel it with a dry-transfer lettering kit for each of the pencil marks. Start with 60° F and label only in 5° F increments, placing a small but easily legible tick at the 2.5° locations on the scale. Then replace the scale card. Plug in and turn on the Sink Sentinel and replace the temperature probe with the conductivity probe.

Calibration of the meter scale for conductivity is simple. Allow a cold water tap to run for awhile. Then fill a clean container with water. Place the conductivity probe in the water and mark the meter pointer's deflection on the scale with a pencil. Add some hypo to the water and wait a few seconds; the meter's pointer should swing upscale, the amount of deflection determined by the concentration of the hypo in the water. No further marks need be made on the meter's scale. Run cold water in the container while observing the pointer deflection. As the concentration of hypo diminishes and finally is all gone, the meter's pointer will swing down-scale and ultimately come to rest at the mark you made on the scale.

Turn off the power and, using a black felt marker, place an easily legible dot at the point pencilled in just below the arc of the scale. Then replace the protective cover on the meter and assemble the project's case.

Use. When you start your film-washing cycle, set the timer for a period of slightly less than the time recommended by the chemical manufacturer. Insert the conductivity probe into the wash water. Then when the timer's alarm sounds (or *I1* lights), note the position of the meter's pointer with respect to the mark made below the scale arc. If it is at the mark, it is safe to stop the wash cycle. However, if the pointer is above the mark, continue to wash until it gets there.

To operate the complete system, turn on the METER switch (*S6*), plug in the temperature probe, and place the probe in the chemical bath. When the proper temperature is reached, set RANGE switch *S3* to the appropriate range and TIME SET control *R2* to the desired interval. Start the developing cycle and press START switch *S4*. (If you desire visual signals only, switch off the alarm with *S5*.)

When the programmed-in developing time is completed, the timer will signal with both *I1* and the alarm (if the latter is switched in). Set the time for the correct fixing period and press START switch *S6* to start the timing cycle.

During the fixing cycle, you replace the temperature probe with the conductivity probe. When the timer's alarm sounds, end the fixing and start the washing cycle. Set the timer just short of the recommended period and, when the timer signals again, immerse the conductivity probe into the wash water. Continue washing until the meter's pointer drops to the mark on the scale.

You will find that, once you become familiar with its operation, the Sink Sentinel will take the guesswork out of your photographic lab processing. It will insure accuracy and let you turn out more professional negatives and prints. ◇