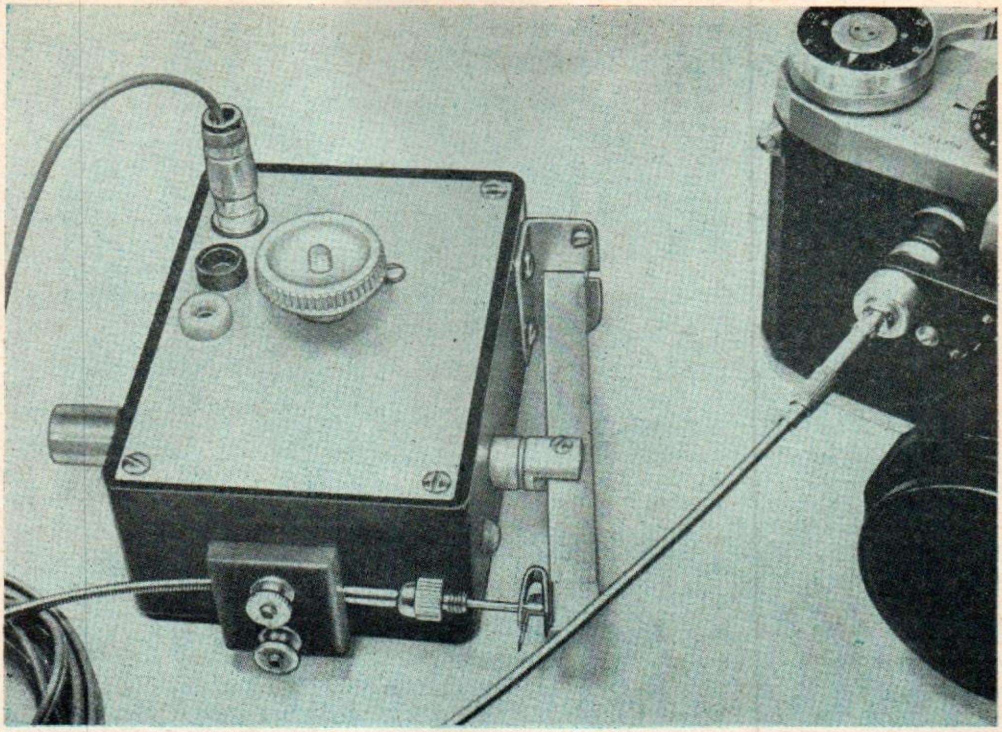


REMOTE CAMERA SHUTTER RELEA[illegible]

VARIABLE SOLENOID CONTROL CIRCUIT TRIGGERS HUNDREDS OF FEET AWAY

BY A. A. MANGIERI

IF HE IS planning wildlife or surveillance shots—or just some tricky setups in his studio—the serious camera buff knows that he has to have a remote shutter release system. Such a system need not be elaborate or expensive. In fact, the electrically operated shutter release described here is compact, easily constructed using ordinary tools, and contains a minimum of components. The system includes stroke and trip-force adjustments to match the requirements of most cameras.

Either of two control circuits can be used. One provides for more or less direct electrical operation from distances up to 50 feet. The second uses a transistor amplifier for truly remote control from hundreds of feet away.

About the Circuit. Both shutter release circuits are shown in Fig. 1. One is a simple series loop including a battery, *B1*, solenoid force control, *R1*, and solenoid, *K1*. Battery polarity in the circuit is important only when an external battery charger is used (through jacks *J1* and *J2*).

Since up to 2.5 amperes of current flows through the circuit, it is necessary that the trip cable between *PL1* and trip switch *S1* be two-conductor lamp cord. This cable actually forms part of the series loop, connecting *R1* to *K1*, and carries the full tripping current.

The power booster circuit (Fig. 1B) employs a single transistor to amplify the signal delivered to solenoid *K1*. It is inadvisable to try to trip the solenoid

PARTS LIST

B1—Four 1.5-volt, 500-mA-hr nickel-cadmium cells in series (Eveready No. BH500)
J1,J2—Banana jack (one red, one black)
J3—Phono jack
K1—6-volt d.c., 1.6-ohm solenoid (Dormeyer No. B24-755-A-1; Allied Electronics No. 41D7941)
PL1—Phono plug
Q1—30-watt, 60-volt, 3-ampere npn silicon power transistor (Motorola HEP245)
R1—3-ohm, 5-watt midget potentiometer
R2—200-ohm, 5-watt miniature potentiometer
R3—4.7-ohm, 1-watt resistor
S1—S.p.s.t. normally open, momentary-action pushbutton switch
1—4" x 2⅞" x 1⁹⁄₁₆" plastic or Bakelite case with aluminum cover
Misc.—1" x 1" x ¼" Bakelite (2); Amphenol No. 3-12 shell and No. 78-B blank insert; sheet aluminum; #24 two conductor juke box cable (or lamp cord—see text); D cell holder (see text); 4¼" x ⅜" x ³⁄₃₂" steel strip for shutter actuator arm; control knob; #6 machine hardware; hookup wire; solder; etc.

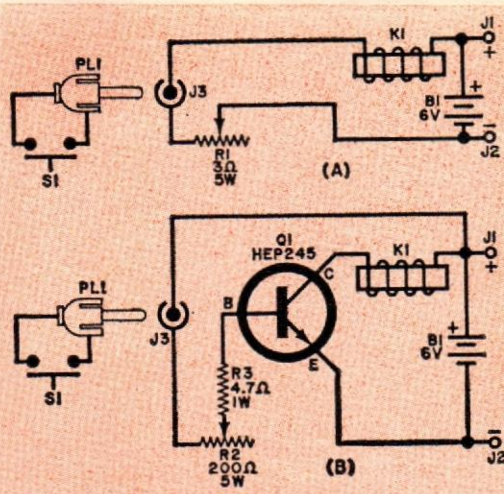


Fig. 1. Circuit in (A) is used for short runs where line voltage drop is minimal; (B) circuit provides current gain through Q1 for long runs.

from a distance of more than 50 feet through a simple series loop. The cable resistance would probably reduce the current flow enough to prevent energization of *K1*. Hence, in the booster circuit, only biasing current for transistor *Q1* is routed through the trip switch/cable assembly. This allows the use of inexpensive and less cumbersome juke box cable.

Both circuits have provision for varying the solenoid actuating force. Potentiometer *R2* accomplishes this by varying the bias on the base of *Q1*. Polarity of the battery in this circuit is critical. Not only must it match the coding of the charger jacks, it must also conform to the requirements of the transistor.

Construction. Referring to Fig. 2, lo-

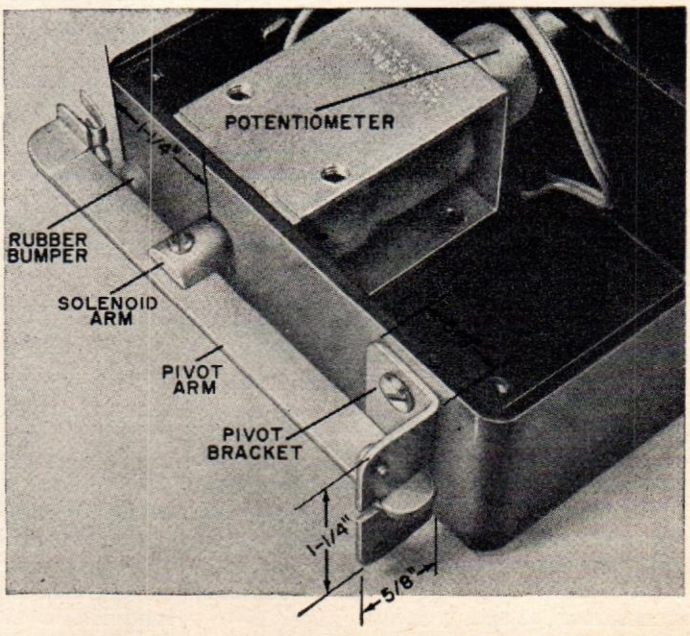


Fig. 2. Mechanical linkage between solenoid and pivot arm requires fabrication of several small metal parts. Note location of potentiometer R2 under housing of solenoid coil.

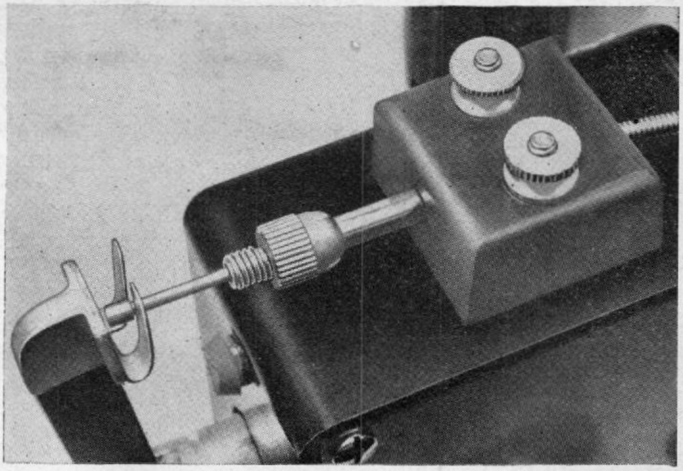


Fig. 3. Plunger consists of two blocks of Bakelite, machined to provide friction fit. Plunger retainer (far left in photo) can be soldered or brazed to pivot arm; if aluminum is used for pivot arm, use machine screw, washer, and nut.

cate and drill the exit hole for the arm of the solenoid, centering it between the two sides of the box. Then drill the mounting holes for the solenoid and actuating arm pivot bracket, and for the potentiometer (located directly opposite the exit hole for the solenoid).

Now, mount the potentiometer and solenoid in their respective locations. Use washers between the solenoid frame and wall of the box to align the solenoid arm with the exit hole. Attach a small rubber bumper (or a spot of silicone rubber compound) about ½" in from the end of the box and centered as shown. Then mount the pivot bracket in place with #6 machine hardware.

Drill and tap two 6-32 holes through the upright leg of the pivot bracket, start two #6 screws into the holes, and notch the bracket. Now, set the pivot arm into the notches in the solenoid arm and pivot bracket. Secure it to the solenoid arm with hardware, and test the movement to make sure that the pivot arm does not bind in either notch. Then place a piece of steel wire across the pivot point, route the ends of the wire under the previously started screws, and tighten down the screws. This wire is not a spring; it merely retains the arm in the pivot. Hence, it should not bind the arm.

Firmly clamp the two Bakelite blocks so that they align exactly with each other. Then, at the interface and exactly centered, carefully drill a hole large enough to accommodate (with slight binding pressure) the barrel at the plunger end of your shutter release cable.

Remove the Bakelite blocks from the clamp and, holding them mated together, drill two #8 holes through the blocks. Then drill two holes through the wall of the box in line with the holes in the blocks. (Locate the holes as close as possible to the push pad on the pivot arm with the plunger fully in but without depressing the cable release button. Loosely bolt down the block/cable assembly with #8 hardware. This allows for later stroke adjustments. If the cable release has a very short barrel, position the blocks to provide the required stroke for your particular camera.) Details for attaching the block/cable assembly to the box are shown in Fig. 3.

Now, referring to Fig. 4, fashion an L bracket out of 22-gauge aluminum. Cut up a D-cell holder to make the NiCad

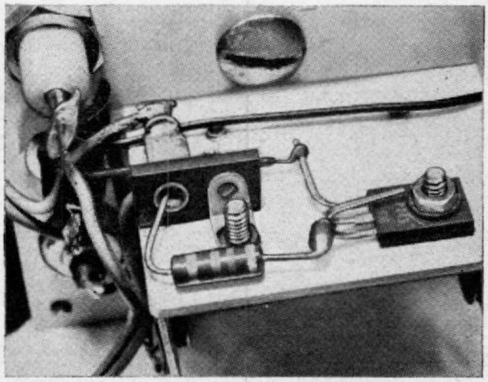


Fig. 4. Electronic components are wired together on L bracket secured to front plate of the box.

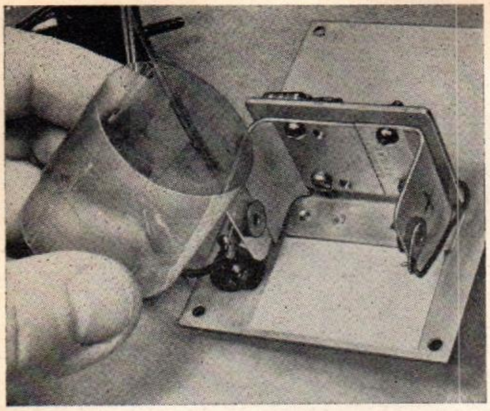


Fig. 5. Cut-down D cell holder, bolted to L bracket, and sheet plastic or card stock provide convenient method of connecting batteries to circuit.

battery holder (see Fig. 5). Mount the holder to the L bracket. Then, as shown in Fig. 4, mount the components on the opposite side of the bracket. The transistor mounts with a 4-40 screw, which also secures one point of the battery holder. Place the copper pad (collector) of the transistor against the metal bracket and tighten the screw gently.

Install charging jacks *J1* and *J2* and phono plug *PL1* on the front panel. Use shoulder fiber washers to insure that the jacks and plugs are insulated from each other. Then assemble the box.

Make the trip switch assembly from an Amphenol No. 3-12 shell and No. 78-B blank insert. Depending on which of the two circuits you plan to use, route the lamp cord or juke box cable through the side of the shell (see Fig. 6), lining the entry hole with a small rubber grommet to prevent the metal from cutting through the cable insulation. The momentary-action pushbutton switch mounts in the top hole in the shell. Connect and solder the conductors of the cable to the switch lugs, and press-fit the blank insert onto the shell. Then, at the other end of the trip switch cable, solder on a phono jack.

How To Use. With the shutter release mounted firmly next to your camera, and before loading the camera, make trial adjustments of the stroke length by moving the cable release in the clamp blocks and depressing the plunger by hand. Use just enough stroke movement to trip the camera with the plunger fully in.

Set the force control potentiometer for maximum resistance (minimum force) and plug in the trip switch cable. Advance the force control in small steps,

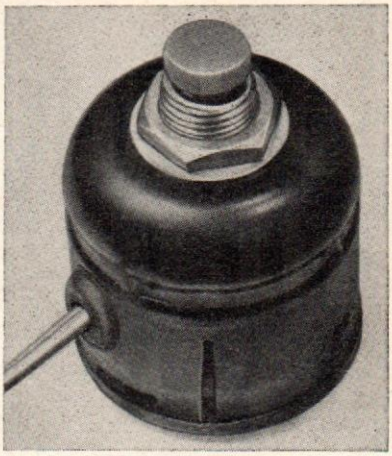
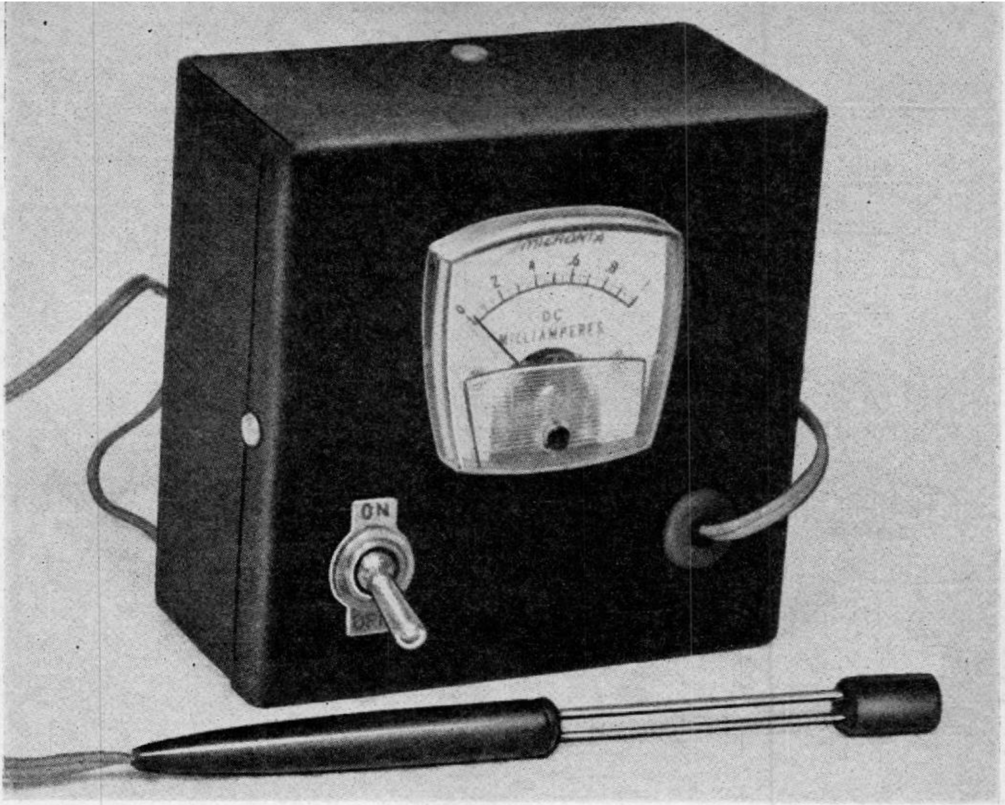


Fig. 6. Amphenol shell accommodates remote actuating switch. Cable should be routed through a grommet-lined hole.

depressing the trip switch momentarily each time, until the shutter trips. Do *not* hold down on the pushbutton more than a moment as this only wastes battery power. —30—



BUILD A PHOTOGRAPHIC WASH TESTER

FOR BETTER DEVELOPING AND PRINTING

BY ANDRE BROSNAC

AFTER a hypo bath, photographic film and paper require a thorough wash in running water to remove any residual sodium thiosulfate (the hypo chemical). There are several ways of checking the wash water to make sure that the cleansing process is complete. Some of these are complicated and some are too expensive; but now you can build your own photographic wash tester which gives good indication of the amount of hypo left in the wash water, at a cost of only $8 or less.

The principle of the wash tester's operation is simple and is based on the fact that the electrical conductance of the wash water increases with increasing strength of hypo in the wash. A comparison of meter readings for the wash water and for plain tap water enables the photography buff to determine exactly when the wash is complete.

The circuit (see Fig. 1) of the photographic wash tester is very simple, consisting of a series circuit loop. It is self-powered by battery *B1*. Power is applied and removed by switch *S1*. Meter *M1* is the visual indicator, and resistor *R1* is used to limit the flow of current around the loop to a safe value.

When the probe is immersed in the wash and *S1* is closed, *M1*'s pointer will deflect upscale by an amount proportional to the amount of hypo solution in the bath. If the hypo concentration is high, the pointer deflects to a high upscale position. As the solution becomes less and less concentrated, the meter pointer will move downscale until it reaches the preset reference.

The first step in assembling the wash tester is to machine the chassis box. Then mount the meter movement, power switch, terminal strip, battery holder, and rubber grommet as shown in Fig. 2.

Referring to Fig. 1, wire together the

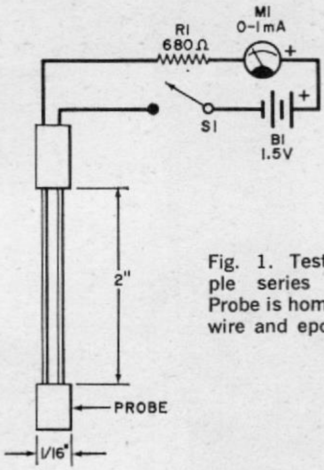


Fig. 1. Tester is simple series d.c. loop. Probe is homemade with wire and epoxy cement.

PARTS LIST

B1—1.5-volt C cell
M1—0-1-milliampere meter movement
R1—680-ohm, ½-watt resistor
S1—S.p.s.t. slide or toggle switch
1—4" x 4" x 2" metal chassis box
2—3½"-long 0.04"-0.06"-diameter stainless or galvanized steel rod for probe elements
Misc.—C-cell battery holder; old "BIC Click" ball-point pen; 4' length of two-conductor speaker cable; fast-setting epoxy potting compound; rubber grommet; ¼"-diameter neoprine tubing; #6 hardware; hookup wire; solder; etc.

chassis mounted components. Make sure that no component interferes with the others and that the meter movement is connected with the proper polarity.

Next, assemble the sensor probe as follows. Cut a ½" length of ¼"-inner-diameter neoprene tubing to size. Seal one end with masking tape. Then insert

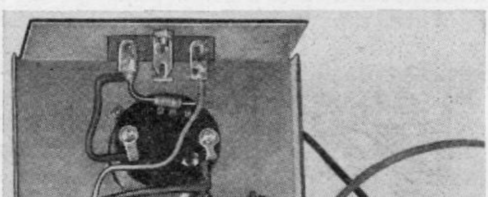
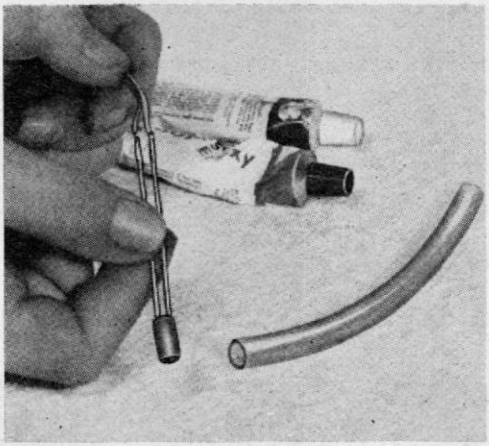


Fig. 2. Neat, open layout is facilitated by simplicity of circuit. Batteries are at bottom of case.



Taped-end neoprene tubing serves as the form when assembling the probe elements with hard-set epoxy.

the 3½"-long sensor rods (see Parts List) into the tubing, keeping them spaced 1/16" apart. Pour epoxy potting compound into the tubing and allow sufficient time for the compound to set. Then peel off the neoprene tubing.

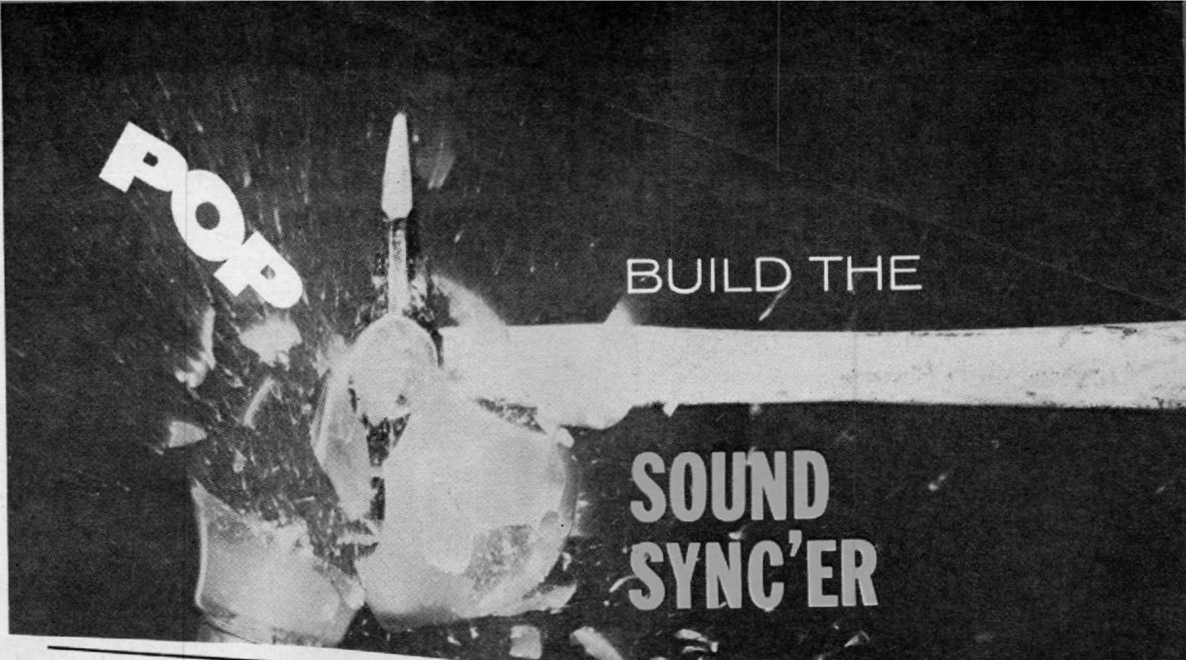
Solder one end of a two-conductor cable to the free ends of the sensor rods. Seal this end of the sensor assembly with epoxy potting compound as described above.

Remove and discard the ink cartridge, return spring, operating button, and bottom half of an old ballpoint pen. Feed the free end of the two-conductor cable through the top half of the pen shell, and epoxy cement the sensor probe element assembly to the shell.

Finally, connect the free ends of the sensor cable to the appropriate points in the circuit. Assemble the chassis box, and the tester is ready to use.

To use the wash tester, first immerse the sensor probe in plain tap water. Set power switch *S1* to the ON position. Wait about 45 seconds, and mark the position on the meter face where the pointer comes to rest. The mark represents the reference point for your tests.

Now, as you use the tester to monitor your wash, continue to wash the film or paper with the probe immersed in the wash water until the meter pointer deflects to your mark. At this point, the wash will be complete, and you can proceed to the next step in your processing. —30—



Circuit for Action Photography

Q. *I would like to have a circuit for use with a flash camera so I can take action shots such as a balloon breaking, etc. This type of photography interests me.*

A. Such a circuit was published in the December 1972 issue of this magazine. Essentially, it consists of a conventional audio amplifier that turns on an SCR when a certain sound level is picked up by the microphone. The SCR acts as the remote turn-on switch for the strobe.

The exact instant of "freezing" the picture depends on the distance from the sound source to the microphone. The shorter the distance, the sooner the strobe flash after the event. Increasing the distance between the sound source and microphone will produce a "later" picture. It is in this way that you can select just what part of the event you want to photograph.

> Have a problem or question on circuitry, components, parts availability, etc.? Send it to the Hobby Scene Editor, POPULAR ELECTRONICS, One Park Ave., New York, NY 10016. Though all letters can't be answered individually, those with wide interest will be published.

gadget which should cost less ... sawbuck.

Actually the stop-action effect is made possible by the strobe flashgun, but the trick is to fire the gun at exactly the right time. When a sound burst accompanies and coincides with the action you want to photograph, the "Sound Sync'er" "listens" to the sound and "triggers" the flashgun. Use of an open-shutter technique in a "darkened" room lets you get by with a minimum amount of photographic equipment.

How It Works. The input of the "Sound Sync'er" is connected to the amplifier in place of the speaker and the output of

When the desired ... microphone, the signal is amplified and passed on to the silicon-controlled rectifier (*SCR1*) as shown in Fig. 2. Resistor *R1* provides a suitable load for the amplifier, and *R2* acts as a gate current limiter for *SCR1*. Diode *D1* permits a "cleaner" gating action to take place by allowing only the positive pulses to hit the gate of the SCR.

The SCR acts like a thyratron tube . . . once it is fired (allowed to conduct) by an appropriate signal on the gate, it conducts until the positive voltage on the anode is dissipated or removed. It is important, therefore, that the SCR's

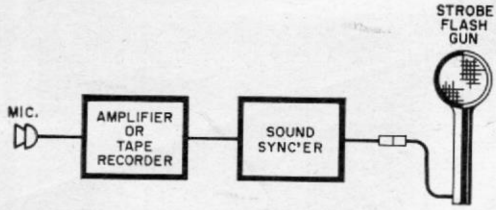


Fig. 1. Block diagram shows the setup required for using the sound from the action to be photographed to trigger the "Sound Sync'er" and strobe.

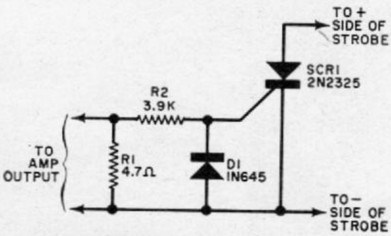


Fig. 2. Use the 2N2325 (available from Allied Electronics for $7.95) for silicon-controlled rectifier SCR1 and not the 2N2325A which costs $2 more.

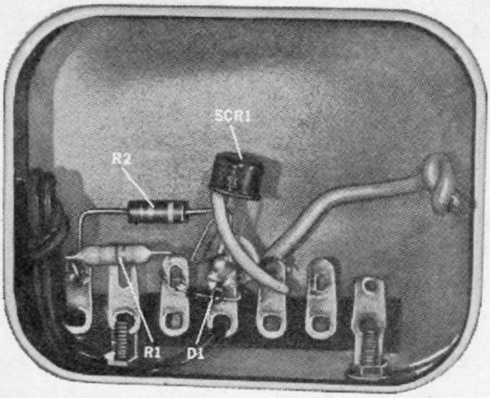


Fig. 3. The "Sound Sync'er" can be assembled on a terminal strip and mounted inside a small metal or plastic box. Use grommets to protect the cables.

anode be connected to the positive side of the strobe. The instant the SCR conducts, the strobe is fired.

Construction and Use. Layout is not critical, and you can save a lot of time by mounting the parts on a terminal strip as shown in Fig. 3. A small plastic or metal box can be used to house the parts. However, if you use a metal box, be sure to line the inside with insulating material to prevent accidental short circuits between the box and the strobe. Observe polarity of the diode as well as the SCR, and heat-sink the leads when soldering them in place.

Set up the microphone close to the object to be photographed, but not within camera view. Turn the volume control on the amplifier all the way down and slowly advance it until the amplifier will respond only to the desired sound signal. Too high a setting will trigger your strobe prematurely, and too low a setting will cause you to miss the shot. The speaker must be disconnected from the amplifier to prevent feedback howl.

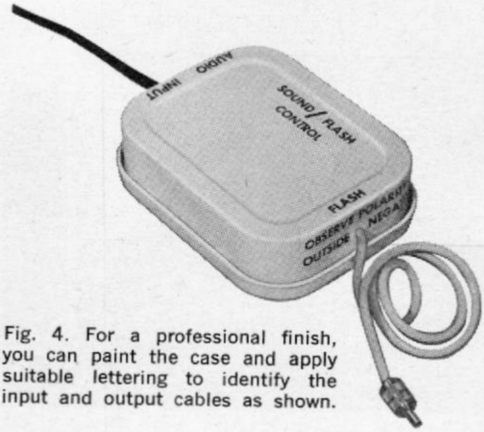


Fig. 4. For a professional finish, you can paint the case and apply suitable lettering to identify the input and output cables as shown.

PARTS LIST

D1—1N645 diode
R1—4.7-ohm, ½-watt resistor
R2—3900-ohm, ½-watt resistor
SCR1—2N2325 silicon-controlled rectifier, or similar
Misc.—Small metal or plastic box, terminal strip, wire, strobe extension cable, solder, hardware, etc.

By changing the distance between the microphone and the action being photographed, you can change the timing of the flash to capture the right "moment." Sound travels at about 1100 feet per second, so figure about a 1-millisecond delay for every foot separating the microphone and the sound source.

When you are ready to take a picture, set up your camera as you normally would for a flash shot, aim, focus, etc., and then turn off all the lights in the room, open the camera's shutter, and start the action. After the shot has been taken, close the shutter and turn the lights back on. —30—

Sound-Activated Photoflash Attachment

FREEZE HIGH-SPEED MOTION USING THIS SIMPLE CIRCUIT

BY VIC LESHKOWITZ

HAVE you ever wondered how "frozen motion" photographs are made? Like the one that shows a balloon in the process of bursting as a needle penetrates the skin? They are easily made and you can do it yourself if you have a camera with a "bulb" or "time" position, an electronic photoflash (strobe), and the circuit shown below.

Theory of Operation. An electronic strobe uses the closing of a switch within the camera to energize the flashtube circuit. This occurs automatically when the camera shutter release is operated to take a picture. As shown below, an SCR can be used to simulate the camera switch. When the SCR is turned off, it has a very high resistance; when fired, its resistance is very low.

The microphone senses the sound produced by the action to be photographed; and this signal is amplified by the high-gain audio module. Transformer *T1* steps up the output signal and generates the trigger pulse for the SCR. Sensitivity potentiometer *R1* determines the sound level required to trip the SCR and thus determines the moment of firing of the electronic strobe.

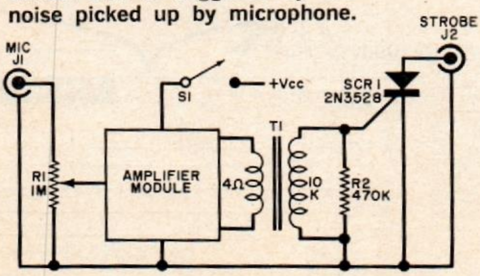
Since sound travels at approximately 1000 ft/s, each foot between the microphone and the sound source represents about 1/1000 of a second in time delay. Thus the positioning of the microphone is very important if high-speed action is desired.

Construction. The physical size and power requirements of the circuit are determined by the audio amplifier module

PARTS LIST

B1—Battery suitable for audio module used
J1—Miniature phone jack
J2—Phono connector
R1—1-megohm potentiometer with S1 attached
R2—470,000-ohm, ½-watt resistor
S1—Spst switch on R1
SCR1—Silicon controlled rectifier (2N3528, HEP621, or similar)
T1—Audio output transformer 4/10,000 ohms (Stancor A3822 or similar)
Mic.—Crystal microphone
Module—Any solid-state module capable of driving a speaker (Lafayette 19-55103 or similar)
Misc.—Electronic flash extension cable (Kaiser 1421 or similar), battery holder, phono plug, suitable chassis, multi-lug terminal strip, mounting hardware, wire, etc.

The SCR simulates camera flash switch and is triggered by the noise picked up by microphone.



used. Although a low-cost Lafayette module (19-55103) was used in the prototype, almost any transistor or IC audio module capable of driving a 4- or 8-ohm speaker will suffice. These are usually battery powered.

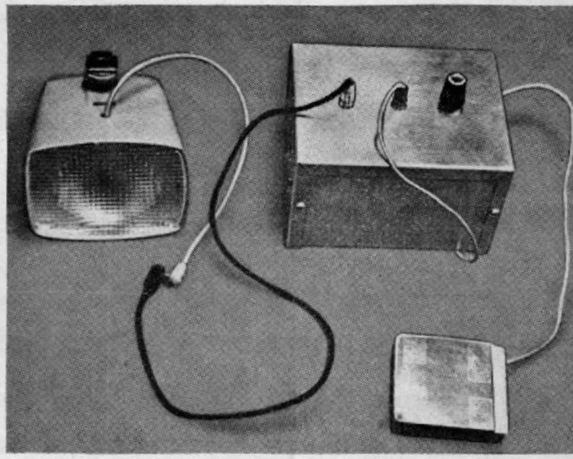
Mount the audio module and battery in a chassis with the input (*J1*) and output (*J2*) connectors, the sensitivity control, and the on-off switch on the front panel. Transformer *T1* is mounted directly on the chassis bottom with a multi-lug terminal strip to hold the remainder of the components.

Secure an electronic flash extension cable from a camera supply house and remove the jack that goes to the camera. Strip the ends of the two leads and temporarily solder-tack the two leads to the connections on a conventional phono plug, which will be inserted in *J2*.

With the microphone connected to *J1* and the strobe attached to *J2*, make sure that the strobe is charged and ready to fire. (The little red light should be on.) Turn on the power to the module and adjust the sensitivity control until a sound activates the flash. If the flash does not occur, the connections to *J2* may be wrong. Unsolder the leads on the *J2* phono connector and reverse them. If the strobe still does not fire, check that there is an audio signal across *R2* with the sensitivity control up and some sounds in the room. If there is an audio signal, then the SCR may be at fault.

Operation. The sound-triggered flash pictures should be taken in a reasonably dark room. Total darkness is not essential as you will probably have to stop the camera down to the point where a little light will not register on the film. Place the shutter speed dial in the bulb position; and, using the guide index of the film in conjunction with the indicator on the strobe, set the lens opening for the flash-camera to subject distance. If you are using an SLR, a closeup lens may be used for a more dramatic effect. Try to keep the camera and flash about the same distance from the subject because the dial on the flash is calibrated for this type of use.

With power applied to the sound module and the strobe ready to fire, slowly turn up the sensitivity control and make a sound of about the same volume as the event to be photographed. Adjust the sensitivity control to fire the flash with this sound. Make a note of the sensitivity dial setting and turn the sensitivity down.

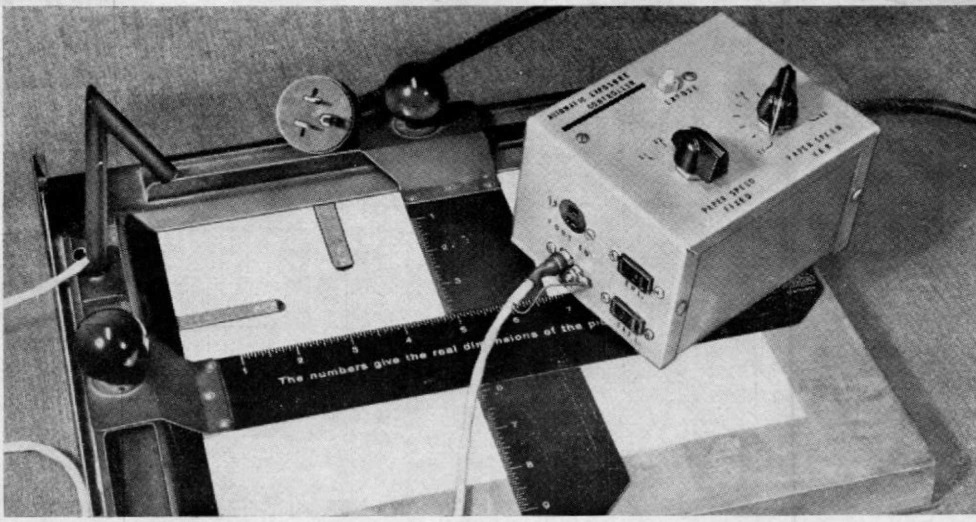


Strobe (upper left), circuit chassis, and mike are attached as shown here.

Allow time for the strobe to recharge, position the microphone near the target (but not within the photographed area), and focus the camera on the subject. Open the camera shutter by placing the shutter mechanism in the time or bulb position. Return the sensitivity control to its predetermined position, execute the event, and close the camera shutter. That's all there is to it.

Remember that the microphone-to-noise source distance represents the time delay between the action and the firing of the strobe. This can be adjusted to stop the action at almost any point. ◈

This photo was taken by dropping the sticks onto drum, triggering flash.



AUTOMATIC PHOTO ENLARGER CONTROLLER

SELECTS THE PROPER EXPOSURE TIME AND CUTS DOWN ON PHOTO PAPER WASTE

BY JOSEPH GIANNELLI

IF you're presently making photographic enlargements using a light meter, a gray scale, test strips, or some other such device, you'd probably welcome a simple pushbutton device that automatically selects the correct exposure and exposes your print for precisely the correct time. Well, with this automatic exposure controller, you can have such a device for a great deal less than you would have to pay for a professional unit.

The controller is a new device for the amateur photographer. A search through camera catalogs and visits to photo suppliers will quickly reveal that the only thing remotely resembling this device is the simple light meter—and the resemblance is remote indeed. You can build the automatic exposure controller for about $17. (*Heart of the device is a timer IC, the Signetics NE555 discussed in detail in a previous issue and widely used in timing circuits. —Editor)*

How It Works. The sensor used in the controller (*LDR1* in Fig. 1) is sensitive to the entire visible spectrum, adapting the system to color printing and multi-contrast paper. It is mounted on the edge of the easel where it "looks" down at the photographic paper and picks up the reflected light from a large area of the projected image the moment EXPOSE pushbutton switch *S2* is depressed. A certain resistance value for a given light level is then established by *LDR1*. This resistance, coupled with *C3*, determines the on time of the enlarger lamp plugged into *SO2* to extinguish.

Field effect transistor *Q1* increases the input resistance at pin 6 of *IC1*, allowing larger resistance swings for *LDR1* with smaller capacitance values for *C3*, *C4*, and *C5*. This eliminates the need of inherently leaky electrolytics for these capacitors but requires that low-leakage Mylar units be used in the fixed paper speed circuit.

When pushbutton switch *S2* is depressed, a negative-going trigger pulse is applied to pin 2 of *IC1*, sending the output at pin 3 to the high state. This, in turn, energizes *K1* and turns on the enlarger lamp plugged into *SO2*. The initiation of the expose trigger also opens up the IC's discharge circuit at pin 7, allowing the *C3*, *C4*, or *C5* (whichever is switched into the circuit via *S3*) voltage to rise through *LDR1* as a function of the reflected light level seen by the LDR.

The voltage continues to rise at pin 6, where it is compared with an intrinsic control voltage; that appearing at pin 5 of *IC1* (equal to 0.667 the supply voltage). When

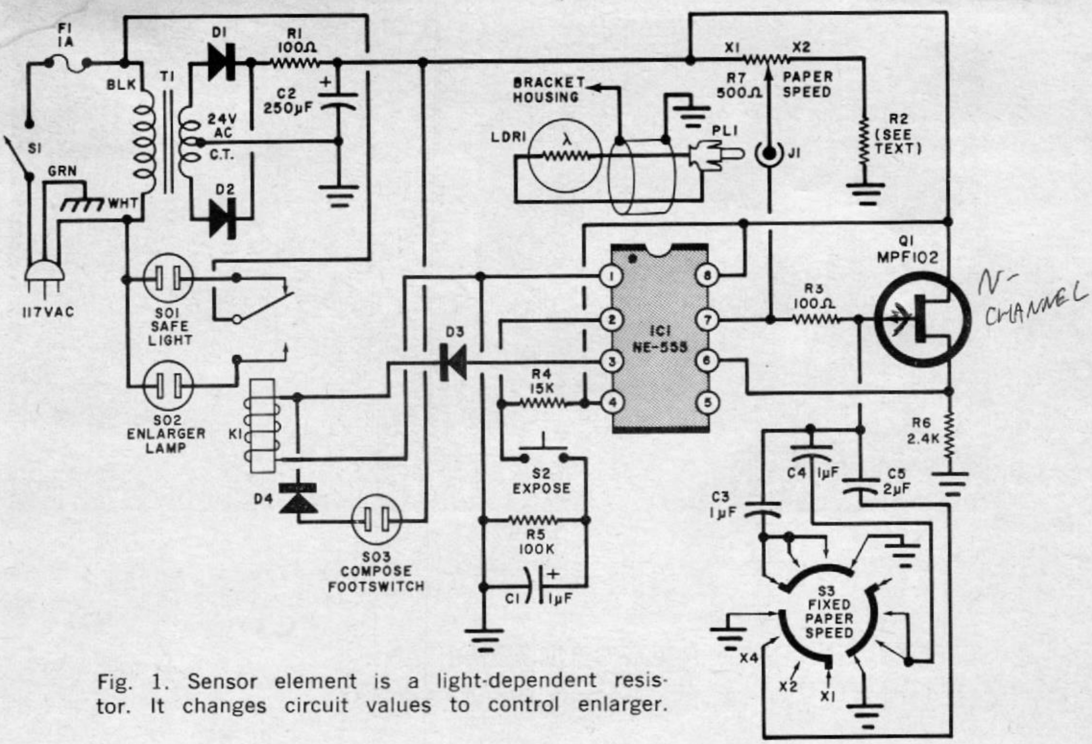


Fig. 1. Sensor element is a light-dependent resistor. It changes circuit values to control enlarger.

PARTS LIST

C1—1-μF, 25-volt electrolytic capacitor
C2—250-μF, 25-volt electrolytic capacitor
C3,C4—1-μF, 25-volt Mylar capacitor
C5—2-μF, 25-volt Mylar capacitor
D1-D4—1N458 diode
F1—1-ampere fuse
IC1—NE555 timer IC (Signetics)
J1—Phono jack, insulated from chassis
K1—12-volt, 1640-ohm relay (Sigma No. 65FP1A-12DC)
LDR1—Light-dependent resistor (Clairex No. CL605)
PL1—Phono plug
Q1—MPF-102 p-channel field effect transistor (Motorola)
R1,R3—100-ohm, ½-watt resistor
R2—See text
R4—15,000-ohm, ½-watt resistor
R5—100,000-ohm, ½-watt resistor
R6—2400-ohm, ½-watt resistor
R7—500-ohm linear potentiometer
S1—Spst switch
S2—Spst normally open pushbutton switch
S3—3-pole, 3-position nonshorting switch (Centralab No. PA1006)
SO1-SO3—Chassis-mounting ac receptacle
T1—24-volt ac, center-tapped power transformer
Misc.—5" x 4" x 3" metal chassis box; spade lugs; printed circuit board or perforated phenolic board with clips; three-wire line cord with plug; rubber grommet; two-conductor shielded cable for cell assembly; hookup wire; solder; etc.

the rising voltage at pin 6 equals the fixed control voltage at pin 5, the flip-flop in *IC1* changes state and discharges the paper speed capacitor through *R3* and de-energizes *K1*. As a result, the enlarger lamp at *SO2* extinguishes and the safe light plugged into *SO1*, if any, comes on.

VARIABLE PAPER SPEED control *R7* provides smaller changes in time (as opposed to the rough changes provided by *C3, C4*, and *C5* through *S3*). Control *R7* multiplies the fixed values introduced by the fixed paper speed capacitors by a factor of 2 or more. This control is especially useful when exposure time corrections must be made for filter packs in color work. It should be a linear potentiometer to permit easy calibration (see lead photo) after the circuit is assembled.

A simple OR circuit, *D3* and *D4*, is provided for permitting a footswitch plugged into *SO3* to be used to turn on the enlarger lamp via *K1*. This feature frees both hands for the job of focusing and composing the projected image.

The automatic exposure controller is ex-

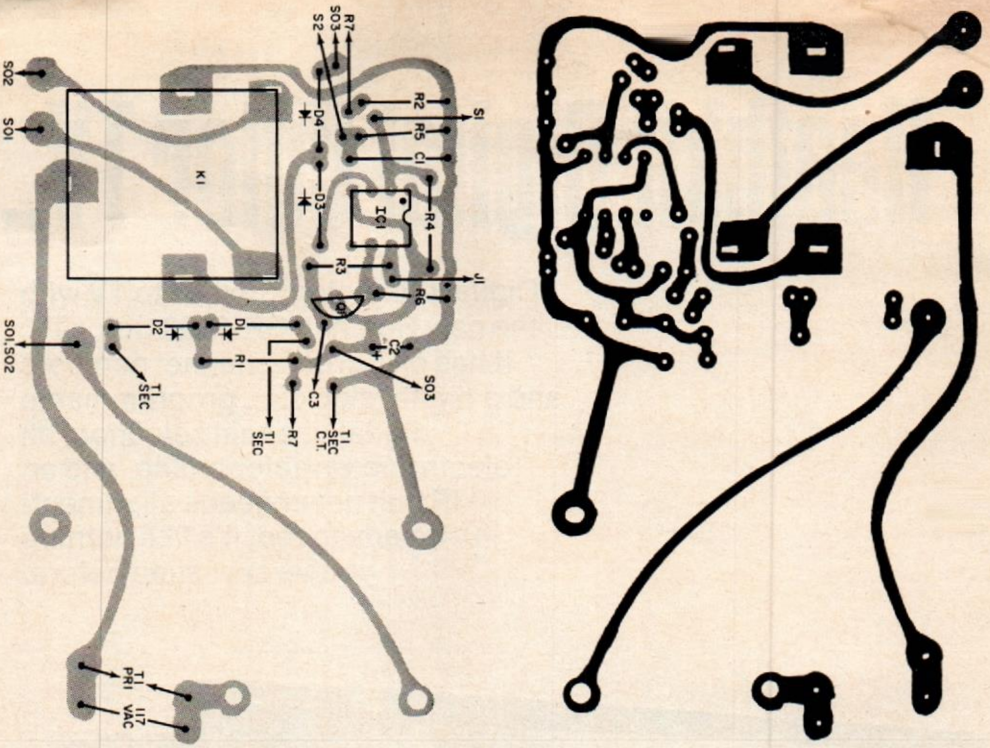


Fig. 2. Foil pattern for PC board is at right, component layout shown at left.

tremely linear in its performance. With the components specified, the timing range is from 1 second to more than 2 minutes, which more than covers the various paper speeds. Furthermore, the system is insensitive to line voltage variations.

Construction. For the sake of neatness and convenience, it is suggested that you assemble the controller on a PC board (see Fig. 2 for etching and drilling guide and components placement diagram). The prototype was assembled with two PC boards; one for the main circuitry and the other for the bulky *C3*, *C4*, and *C5* capacitors. However, you can obviate the need for the capacitor board by joining one lead of each capacitor in common, slipping a length of insulated spaghetti over the common lead, and soldering this lead to the hole marked *C3* on the main board. The free leads of *C3*, *C4*, and *C5* can now be soldered directly to their respective *S3* lugs.

Aside from the normal precautions to be taken with any solid-state circuit, assembling and wiring the PC board is simple. (If you elect to use perforated phenolic board construction, it is suggested that you use a socket with *IC1*; do not solder directly to the IC pins.)

Mount *J1*, *R7*, *SO1-SO3*, and *S1-S3* on the top half of the case, and route the line cord through a grommet-lined hole as shown in Figs. 3 and 4. Connect the earth-ground (green) power cord wire to one of the mounting lugs of *T1* and case ground. (Note: In the prototype, no power switch was used. But the use of *S1*, mounted to the case top and connected in series with the black power line lead and *F1*, is recommended.) (*Continued on page* 58)

Fig. 3. Overall view of controller. Bracket which holds the LDR sensor is extreme left.

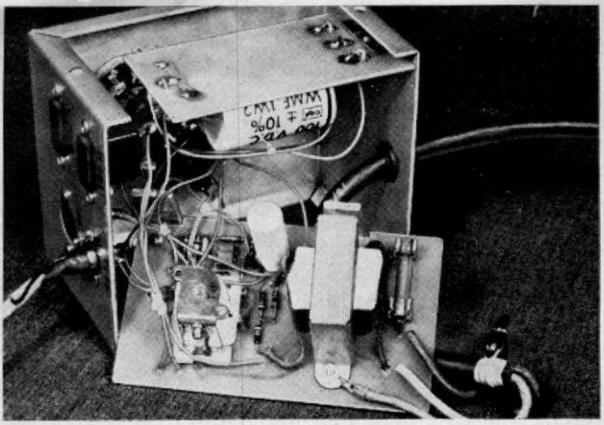


Fig. 4. Photo shows inside of prototype chassis with bottom removed and board detached.

Details for fabricating the cell bracket for *LDR1* are shown in Fig. 5. Use only solderable brass or copper tubing. You can make the cell holder as shown, cutting and soldering it as required. Alternatively, you can fill the tubing with dry sand or slide into it a tubing bender spring and heat the tubing just enough to permit its bending without crumpling. Either method should yield the same results with respect to orientation over the photographic paper when the bracket is mounted on the easel.

After drilling and deburring the cable exit hole and soldering the tubing to the modified Leica easel adaptor, spray the entire assembly with flat black paint. When the paint dries, slip the two conductors of the shielded cable up the tubing and solder them to the leads of the LDR. Slip the LDR, with enough filler around it to hold it in place, into the tubing. Solder a spade lug to the cable shield at each end and a phono plug to the insulated conductors at the end of the cable that goes to the control box.

At this point, the entire system should be assembled, minus *R2*. Tack solder a 10-megohm resistor across the lugs of *J1* and a 10,000-ohm potentiometer across the points marked *R2* on the PC board. Set the pot to its midpoint. Plug the line cord into an ac outlet and your enlarger lamp into *SO2*. Set *R7* to its minimum-resistance position, turn on *S1* and momentarily depress *S2*. Time out the cycle. Then set *R7* to its maximum-resistance position, depress S2, and time out the cycle. If there is not a 2:1 ratio between this and the first position of *R7*, adjust the tacked-in potentiometer until you get this ratio.

Turn off the power, unplug the line cord and enlarger lamp cord, and unsolder the 10-meg resistor and pot (do not disturb the latter's setting). Use an ohmmeter to measure the pot's resistance and select a fixed resistor of a value close to your reading for *R7*, soldering it in the appropriate location on the PC board. Then assemble the case. The controller is now ready to use in your darkroom.

Making A Print. It is now necessary only to determine the settings of the FIXED and VARIABLE PAPER SPEED controls for the types of paper you are using. Place the LDR bracket to look at an area of interest, avoiding hot spots, and simply make a small enlargement at different settings of the controls. Use low numbers for lighter and high numbers for darker areas. Record the best

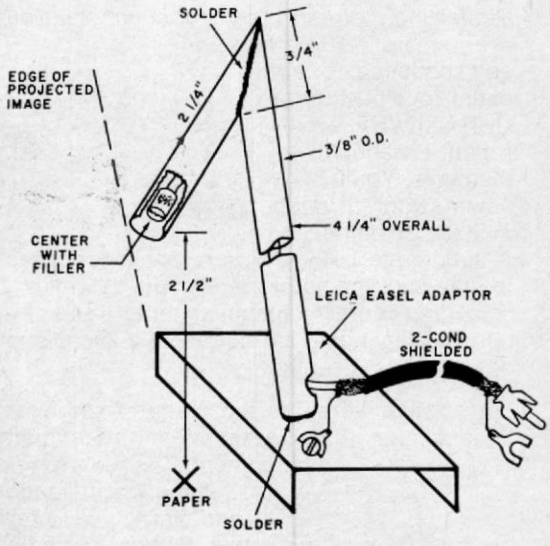


Fig. 5. Details of the cell bracket which holds LDR. Tubing is brass or copper, obtainable in hobby stores, and painted black.

setting on your package of paper. This setting is now always used for that paper, regardless of the magnification and film density. A new setting will be required for other grades of paper.

If Kodak Polycontrast paper is used, the controller will automatically adjust for filters and the inherent paper speed change, using only one setting.

Although the controller has the potential for discerning colors and their varying densities, no color prints were made with it at this time. ◈

letters

PROJECTS FOR SHUTTER BUGS

Mr. Maruk's comments in the "Letters Column" in the December 1976 issue are certainly appreciated. There is a growing need for more projects concerning photography.

The timer outlined by George R. Baumgras in the August and September 1976 issues is a prime example that meets Mr. Maruk's and my needs. As pointed out, the artist made some errors, but these apparently were more in depth than IC pins too far apart. It appears he failed to label some connections for the control board in the September issue. Being a neophyte in electronics, determination of the proper connections may be incorrect; however, my findings are from left to right: 6.3 VDC, START, CL, G, E, D4, D3, D2, D1. Also, the speaker relay and transformer were excluded from your September details. It is assumed these parts should be on the bottom of the power-supply board. Mr. Baumgras noted the prototype was installed in a custom cabinet $5 \times 8\frac{1}{2} \times 6$-inch case. However, the control boards in the article show a 9.8×6-inch board. Of course, the scale on the boards require some careful attention, particularly the alarm board which appears to be a 2:1 relationship.

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Roswell, GA

Several corrections to the Countdown Timer were published in the "Letters Column" in the March 1977 issue.

We have also received several letters from our readers telling us that production of the CT-5001 IC has ceased and requesting the name of a supplier. This IC is still available from Poly Paks, Box 942R, Lynnfield, MA 01900, for $1 each. Order number is 92CU1343. Olson Electronics, 260 S. Forge St., Akron, OH 44327, is also supplying the IC in limited quantities for $2. Order number is XM-330.—Editor