BUILD A DIGITAL CAMERA SHUTTER TIMER

BY R.S. HEDIN

Low cost digital timer provides accurate check of camera shutter speeds from 1/1000th of a second to 1 second.

HAVE YOU ever wondered why a camera whose diaphragm opening and shutter-speed setting are adjusted perfectly according to an exposure meter should regularly produce overexposed or underexposed negatives or prints? Too often, the cause is a shutter speed that deviates too much from the camera's speed markings.

Now you can check your camera's actual shutter speed by building the electronic shutter tester presented here. If the camera displays a gross speed inaccuracy, you'll know that you must compensate for it by modifying the camera's control adjustments (say, an f stop greater or smaller than the exposure meter's indication) or having the camera serviced professionally.

With your own shutter tester, you can test your camera at any time you feel it needs adjustment. The shutter tester described here uses digital circuits and has six decades of display to give a high order of accuracy.

About the Circuit. The sensor/control circuit for the tester is shown in Fig. 1, while the counting circuit is shown in Fig. 2. The two circuits are coupled together via the +V and GND buses and the points marked K going to each other.

When light strikes phototransistor *Q2* and not *LDR1* in Fig. 1, the Darlington circuit made up of *Q2* and ordinary transistor *Q1* triggers on and supplies current to timer *IC6*. This causes the timer IC to generate pulses at a frequency of 10,000 Hz. (Potentiometer *R1* is provided for adjusting the operating frequency of the oscillator to exactly 10,000 Hz.)

If at any time light strikes *LDR1*, the

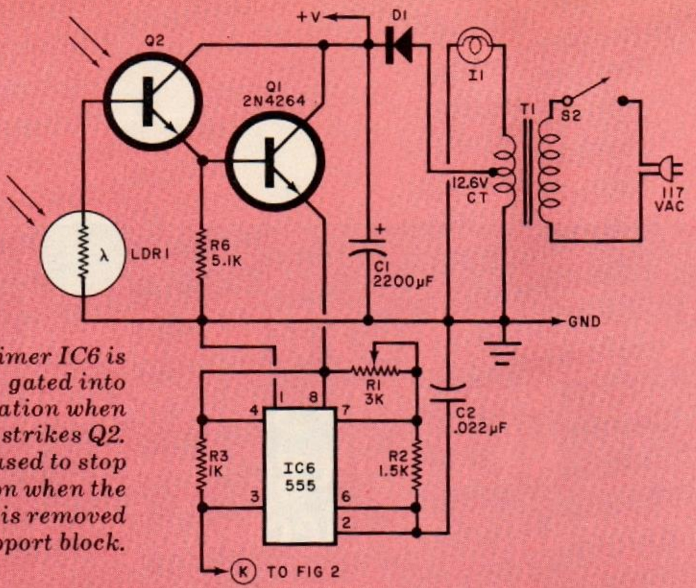


Fig. 1. Timer IC6 is gated into oscillation when light strikes Q2. LDR1 is used to stop operation when the camera is removed from support block.

PARTS LIST

C1—2200-μF, 16-volt electrolytic capacitor
C2—0.022-μF Mylar capacitor
DIS1 through DIS5—½" common-anode, seven-segment LED display (DL-704 or similar)
D1—100-volt, 1-ampere silicon rectifier diode
I1—12-volt high-intensity lamp with arm and reflector (see text)
IC1 through IC5—4033A CMOS decade counter
IC6—555 timer
LDR1—Light-dependent resistor (Vactec No. VT-214 or Clairex CL-903)
Q1—2N4264 transistor
Q2—FPT-100 phototransistor
R1—3000-ohm trimmer potentiometer
The following resistors ¼ watt, 10% tolerance:
R2—1500 ohms
R3,R4,R5—1000 ohms
R6—5100 ohms
S1—Normally open, momentary-action spst pushbutton switch
S2—Spst toggle switch
T1—12-volt, 1.2-ampere transformer (see text)
Misc.—Printed circuit or perforated board; 16-pin DIP sockets (5); 14-pin DIP sockets (5); 8-pin DIP socket; chassis with cover (9" × 5" × 2½"); line cord; pine block (3½" × 1¾" × 1¾"); soft vinyl sheet; rubber feet (4); contact cement; machine hardware and spacers; hookup wire; solder; etc.

resistance in the base circuit of *Q2* drops to a low enough value to cause the Darlington circuit to cut off. This, in turn, turns off the timer circuit. Under normal operating conditions, no light will fall on either *Q2* or *LDR1* initially. After pressing reset switch *S1* (Fig. 2), light is allowed to reach only *Q2*. This allows the timer circuit to generate a 10,000-Hz pulse output that is counted by the totalizer circuit shown in Fig. 2. The displays continue to count upward until the light to *Q2* is interrupted or light falls on *LDR1*. At this time, the displays "freeze" to indicate the total number of pulses counted. When the tester is used with a camera, the camera's body covers *LDR1* to exclude all light and the shutter/lens mechanism is positioned directly above *Q2*, in line with a high-intensity light source. Switch *S1* is momentarily depressed to reset the counters to zero. Then, when the shutter is tripped, the system counts the number of pulses generated between the opening and closing of the shutter.

The counting circuit shown in Fig. 2 consists of five decade-counter IC's (*IC1* through *IC5*) and their companion seven-segment displays (*DIS1* through *DIS5*). Note that *DIS2* is the only display whose decimal point is active. This decimal point comes on whenever the tester is powered. Note also that the decade counters are wired to suppress the zeroes to the left of the decimal point. Since the display indicates the number of pulses counted during a discrete interval of time, it does not indicate time. To obtain the time indicated by the number in the display, you must divide that number by 1000. Hence, displays of 1.0, 8.0, 16.6, and 33.3 translate to 0.001, 0.008, 0.0166; and 0.0333 second or, in photography terminology, 1/1000, 1/125, 1/60, and 1/30 second, respectively. (It is a good idea to make up a table of conversions that can be affixed to the completed project, as shown in the lead photo.)

The power supply for the tester is line operated. Dc power for the system is obtained from a conventional rectifier-diode/filter-capacitor (*D1*/*C1*) setup that is driven from the center tap of transformer *T1*. This circuit assumes that high-intensity lamp *I1* is an integral part of the system. If you prefer, you can use a separate line-powered high-intensity lamp and substitute a 6.3-volt transformer for *T1*.

Construction. The entire circuit, except *T1* and the two switches and *Q2*

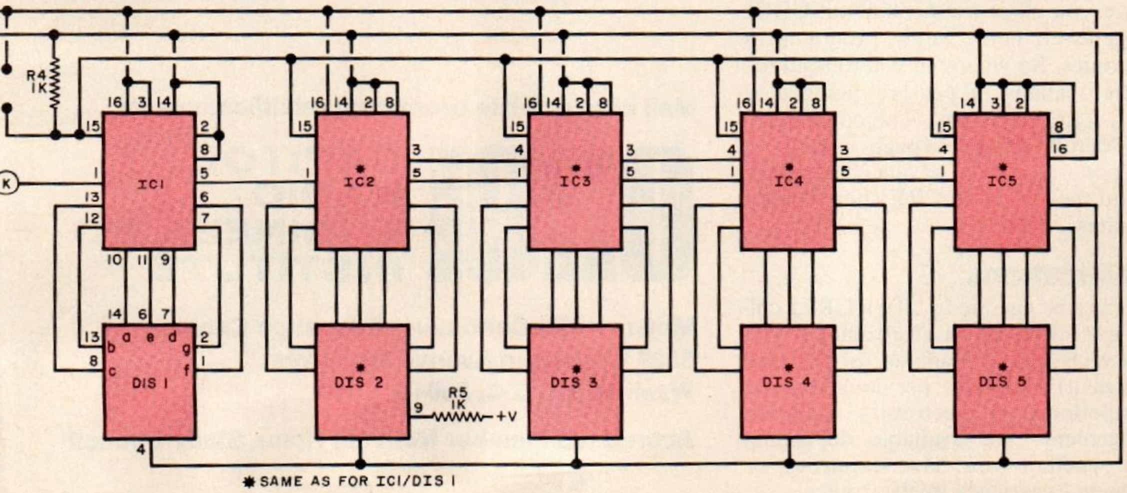
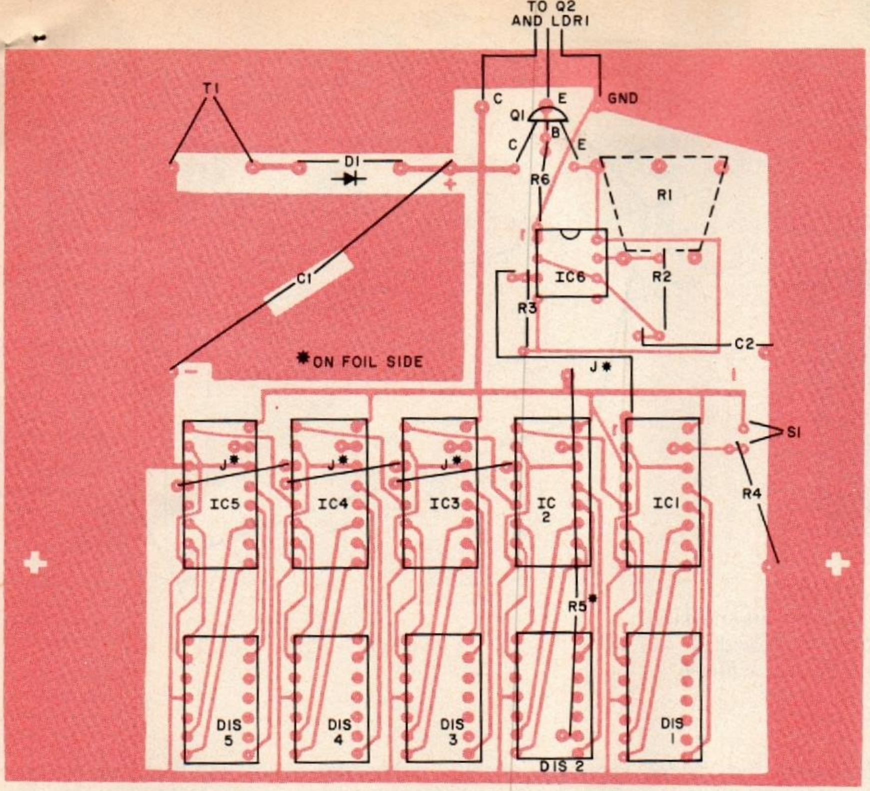


Fig. 2. The five decade counters are formed from IC's that also include 7-segment decoded outputs. Note that DIS2 has the decimal point.



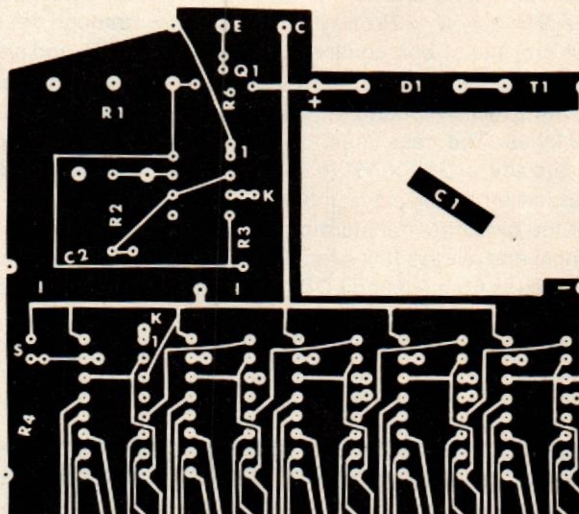


Fig. 3. Foil pattern and component installation. Pin 15 of IC1 through IC5 are connected together by a common jumper on the foil side of the board. Note that R5 and the other jumpers are also located on the foil side.

and *LDR1*, can be assembled on a single printed circuit board, the etching and drilling and component-placement guides for which are shown in Fig. 3. Alternatively, you can assemble the circuit on perforated board, using appropriate solder hardware. In either case, the use of sockets for the IC's and displays is recommended.

Install the components on the circuit board as shown in the component-placement guide, taking care to properly orient them. Note here that the four jumper wires labelled J and *R5* mount on the *foil* side of the board. To avoid the possibility of short-circuiting the board, be sure to use insulated sleeving on the resistor leads and wire jumpers.

Phototransistor *Q2* and light-dependent resistor *LDR1* mount in a block of pine as shown in Fig. 4. The holes in which these two components mount must be stepped as indicated to permit easy routing of the hookup wires that interconnect them with the rest of the circuit. Note that *LDR1* mounts in the hole at the lower left corner and *Q2* mounts in the hole in the center of the block.

Before you mount *Q2* and *LDR1* in the block of wood, apply a coat or two of flat black paint to all exterior surfaces of the block. Allow the paint to completely dry, and then mount the components in their respective holes, fixing them in place by force fitting. (If the fit is too snug, very carefully ream out the holes; if it is too loose, sparingly apply a drop or two of clear plastic cement to the component edges. Both components mount flush with the top surface of the block. When

CONVERSION TABLE

NUMBER		SHUTTER SPEED
1.0	=	1/1000 sec
2.0	=	1/500 sec
4.0	=	1/250 sec
8.0	=	1/125 sec
10.0	=	1/100 sec
16.6	=	1/60 sec
20.0	=	1/50 sec
33.3	=	1/30 sec
40.0	=	1/25 sec
100.0	=	1/10 sec
125.0	=	1/8 sec
250.0	=	1/4 sec
500.0	=	1/2 sec
1000.0	=	1.0 sec

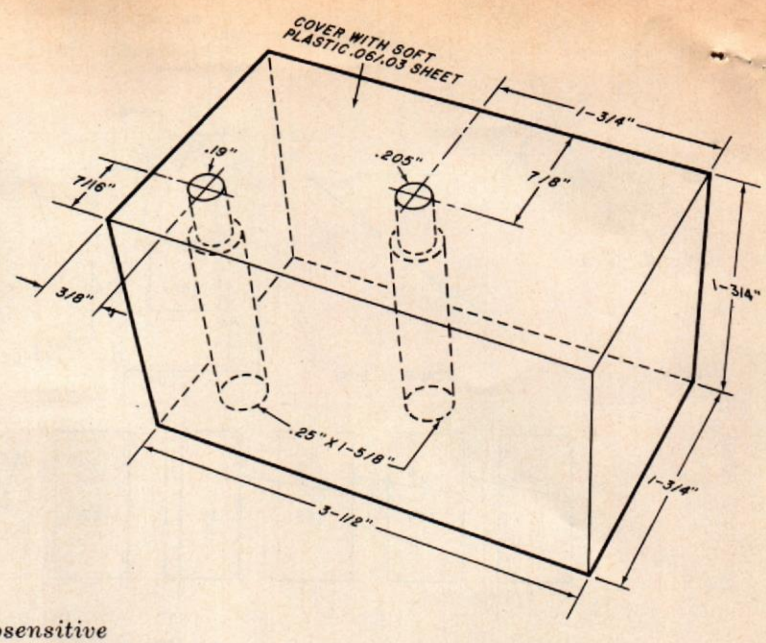


Fig. 4. Details of the camera mounting block. The two photosensitive devices (Q2 and LDR1) are mounted close to the upper surface of the block.

this is done, use contact cement to fasten a thin sheet of soft matte black vinyl to the top of the block after first punching holes in it for *Q2* and *LDR1*.

A 9"D × 5"W × 2½"H (22.9 × 12.7 × 6.4 cm) metal box comfortably accommodates the circuit board assembly, power transformer and its line cord, and switches. The case must be machined to provide a 2⅝" × ½" (6.7 × 1.3 cm) window for the displays; mounting holes for the switches, transformer, and wood block; and access holes for the line cord and leads from *Q2* and *LDR1*. Once the case has been machined, spray two or three coats of matte black paint over all exterior surfaces. When the paint has dried, cement a red filter over the window from the inside. Then mount the wood block with screws, followed by *T1*, *S1*, and *S2*. Next, interconnect the switches, transformer, line cord (passed through the case via a rubber grommet), LDR, and phototransistor. Finally, mount the circuit board assembly in place with machine hardware and spacers, making sure its displays are properly oriented behind the filter.

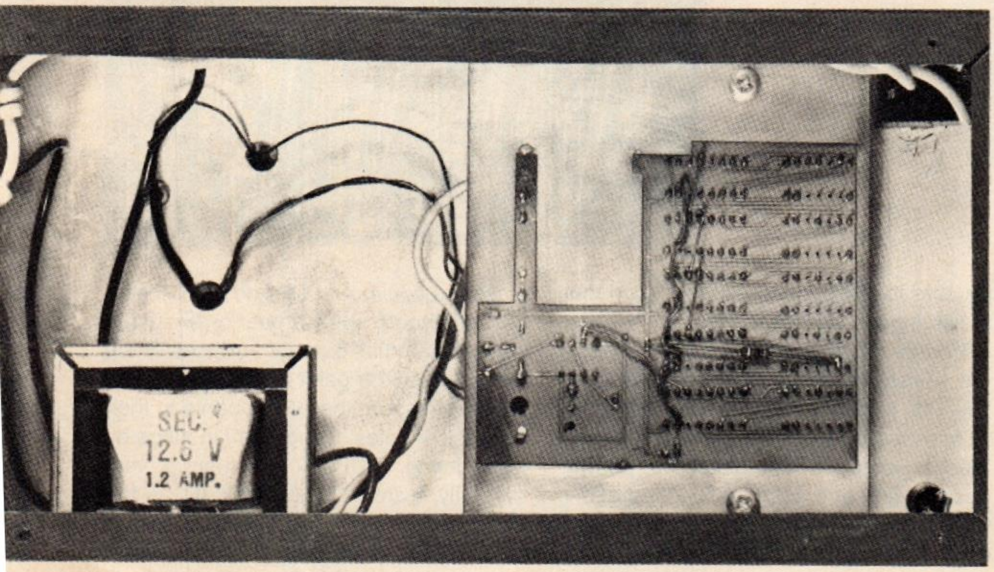
Checkout and Use. Place a piece of black plastic tape over *LDR1*, plug the line cord into a convenient ac outlet, and turn on the tester's power. Now, using an oscilloscope or a frequency counter, adjust potentiometer *R1* for an exact 10,000-Hz output from timer *IC6*. This completes calibration. Remove the tape from *LDR1*.

Open the back of the camera you wish to test and place it on the wood block so that the lens opening is directly over *Q2*. Make sure that the camera body covers *LDR1*. Then set the camera's lens diaphragm for maximum opening, set the shutter speed, and cock the shutter. Depress reset switch *S1* so that all displays read zero. Trip the camera shutter. The displays should rapidly count up and freeze at a number that is the shutter speed in thousandths of a second.

Check each shutter speed at least three times, resetting the display at the start of each test. The most accurate reading is with the lens on the camera because the light is somewhat collimated. Without a lens on the camera, the light can diffract around the shutter curtain and indicate a longer than actual shutter speed time. This is important at fast shutter speeds when the curtain opening is narrow. This does not pertain to between-the-lens leaf shutters.

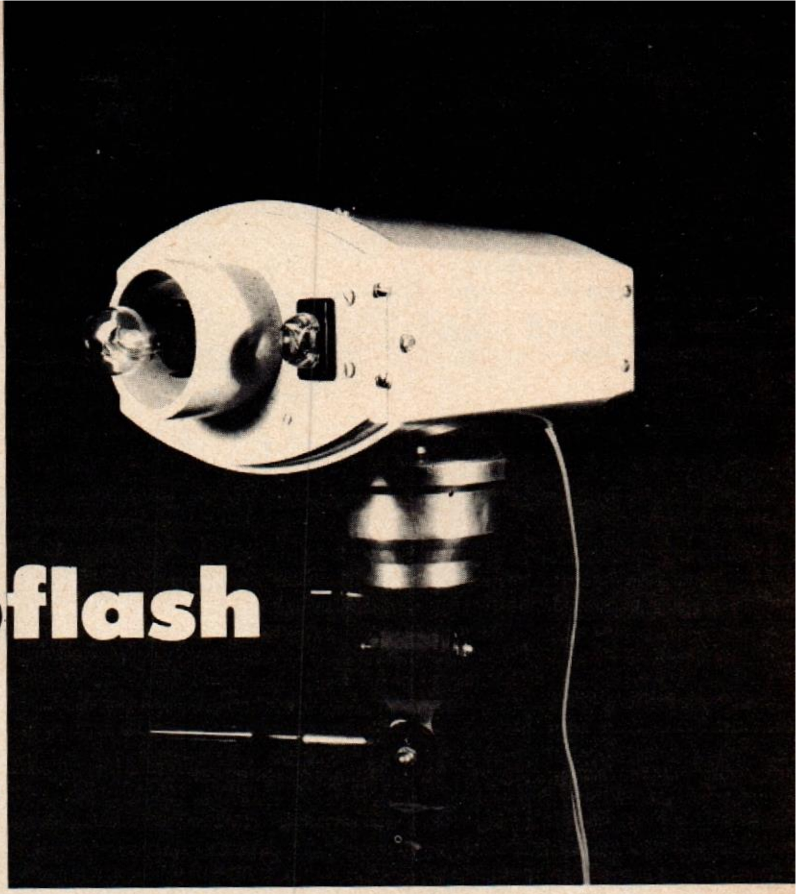
Do not be disappointed if your shutter speed is not close to its camera setting. Up to 1/500 of a second, the allowable error may be as great as ±25%; at higher settings, the allowable error might be ±35%. These figures would depend on the tolerance of the film used, of course.

With the aid of the camera shutter timer described here, you can eliminate some of the uncertainties you have about the accuracy of your camera's mechanism. Additionally, it can tell you why your latest batch of photos did not turn out as they should have. ◇



Underside of timer reveals pc board and transformer mounting.

BUILD 200 Watt-Second Photoflash



Build any of the three bare-bulb photoflash units described in this article. An optional optical trigger is also described.

by JIM GUPTON

BARE-BULB ELECTRONIC PHOTOFLASH units are becoming increasingly popular with amateur and professional photographers. Soft shadows and wide angle coverage increase the versatility of any camera and make those "Impossible" group shots... possible. Add a Lawson Enterprises "Reflectasol" to a bare-bulb photoflash and you have a professional studio light source for color portraits. By obtaining power from the standard 117-volt ac line, you eliminate the weight and expense of batteries and have the fastest recycling time of any electronic photoflash on the market.

This article contains the construction details for three bare-bulb photoflash units. The first unit uses computer-grade capacitors and has an output of 200 watt-seconds. The second unit has an output of 100 watt-seconds and uses standard photoflash capacitors. A selectable output unit having 50, 100, 150, and 200 watt-second outputs is also described.

All three photoflash units can also be used as slave units with an optical trigger circuit that is described. As a slave unit, the photoflash is triggered with the light from a photoflash mounted on your camera. This eliminates the need for sync cords and permits the placement of the slave unit anywhere in the picture taking area. Optically triggered slave units are commonly used among professional photographers.

Of all electronic construction projects, none can be more deadly than the electronic photoflash unit. Voltages ranging between 400 and 500 Vdc, at a current of 1 ampere, can kill you! Therefore, every step of the construction, including the final assembly and testing, must be and is, engineered to protect you against accidental shock hazards and possible fatal injury. It is imperative that no deviation from the specified material be attempted. When constructing one of the three alternate photoflash circuits, observe capacitor polarity at all times.

Plastic canister housing

The electronic circuits for the bare-bulb electronic photoflash must be housed in a shock-proof container. Metal cases offer considerable physical protection, yet the metal exterior is likely to become charged and it will create a shock hazard when contact is made with a common ground circuit. The ideal case to house the bare-bulb photoflash can be found in the household section of most any department store or discount house. The article's housing was originally one of a set of four kitchen canisters. It has rigid side walls and ample inside dimensions to house the electronic circuits securely with complete protection from accidental shock hazards.

To eliminate the molded handle grips and bottom depressions of the canister's top and bottom, simply cut away the surface containing the raised handle and bottom depressions, and replace it with a matching contour section of fiber glass printed-circuit board. The fiber glass board provides a metal shielding surface and is rigid and thin enough to support the flash tube circuits. They are easily attached to the plastic top and bottom with epoxy cement and small aluminum angle sections to assure firm attachment and rigidity. In my model, a metal ring surrounds the flash tube to provide mechanical protection to the tube and to serve as support for a large reflector. Remember that the wall thickness is an important item in selecting your plastic canister. The plastic walls must have enough strength to support the photoflash when mounted on a tripod. Flexible plastics should not be substituted as they cannot meet the support requirements.

Power-capacitor bank circuits

The schematic circuit diagram in Fig. 1 illustrates two types of capacitor banks. One type of capacitor bank is series connected, provides a 200 watt-second output, and is shown in Fig. 1-a. Figure 1-b shows the alternate, parallel circuit which provides a 100 watt-second output.

The series circuit takes advantage of high-capacitance computer-grade capacitors for high output power at a minimum of space requirements. However, there are some who may be apprehensive about the ability of computer-grade capacitors to hold up under rapid discharge cycling and of the higher leakage rate common with this type of capacitor. The alternate, parallel circuit employs the standard photoflash capacitors for maximum power output and requires a larger canister housing.

Computer grade capacitor circuit

The circuit board illustrated in Fig. 2 can be used for computer-grade ca-

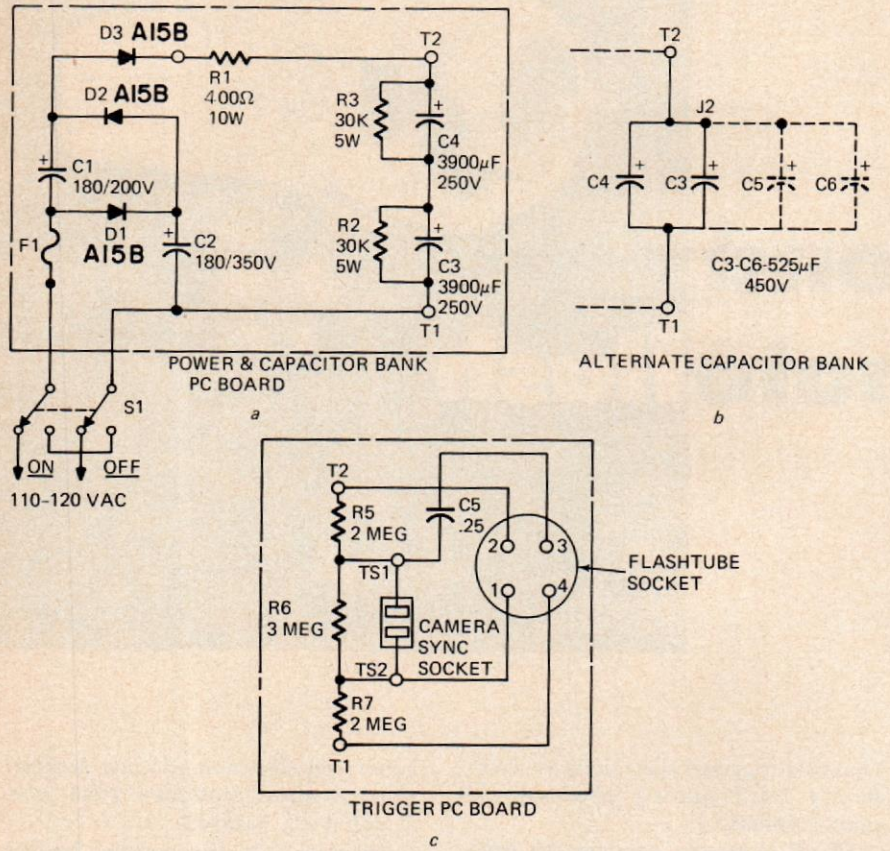


Fig. 1—BARE-BULB PHOTOFLASH CIRCUIT. Circuit a shows the series capacitor bank which provides a 200 watt-second output. Circuit b shows the alternate capacitor bank which provides a 100 watt-second output. With the optional addition of capacitors C5 and C6, circuit b provides 200 watt-seconds. An optional switch wired between the positive terminals of the capacitors in circuit b will also provide multiple power output ratings. Circuit c is the trigger circuit.

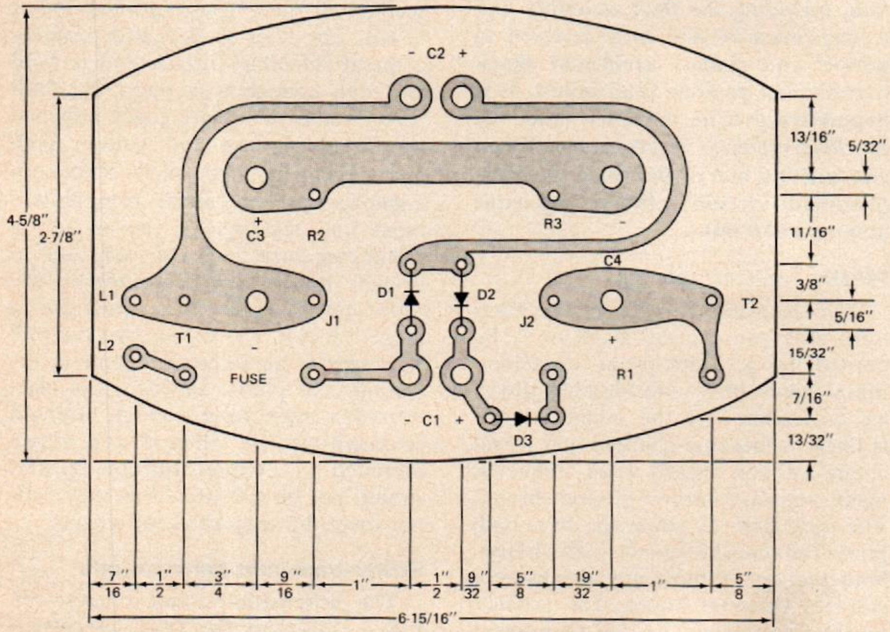


FIG. 2—FOIL PATTERN for series capacitor bank which provides 200 watt-second output. This foil pattern is also used for the parallel capacitor bank, having an output of 100 watt-seconds, with a jumper connected between J1 and J2 and other modifications (see text).

SLAVE TRIGGER PARTS LIST

SC1—National Semiconductors Ltd. NSL-701-3, 3-element, series-connected silicon cell
C1—0.01 μF ceramic disc capacitor 50 Vdc
R1—39K; ¼-watt resistor
SCR—General Electric C106B3 SCR Ac plug

TRIGGER CIRCUIT PARTS LIST

R5, R7—2-megohm 1-watt resistor
R6—3-megohm 1-watt resistor
C5—.25μF Mylar capacitor 400 Vdc
Flash tube socket, standard 4 pin radio socket
Flash camera sync socket, standard ac socket
Flashtube DX-5—Kemlite Laboratories, 1819 W. Grand Ave., Chicago, Ill. 60622

200 WATT-SECOND SERIES CAPACITOR POWER PARTS LIST

S1—Dpdt switch-rocker or toggle type, Allied Electronics No. 700-5110 or equal
F1—1¼ amp. Slow-Blow
D1, D2, D3—General Electric A15B or equal 1A 200V silicon rectifier
R1—400-ohm, 10-watt resistor
R2, R3—30K, 5-watt resistor
C1—180 μF/200 Vdc Mallory No. CG181T200A1
C2—180 μF/350 Vdc Mallory No. CG181T350B1
C3, C4—3900 μF/250 Vdc Mallory No. CGS393T250FH1
Ac line cord and plastic strain relief.

PARALLEL CAPACITOR—POWER PARTS LIST

S1—Dpdt switch, rocker or toggle type, Allied Electronics No. 700-5110
F1—1¼ amp. Slow-Blow
D1, D2, D3—Silicon rectifier GE type A15B or equal
R1—400 ohm, 10 watt resistor
C1—180 μF/200 Vdc Mallory No. GC181T200A1
C2—180 μF/350 Vdc Mallory No. GC181T350B1
C3, C4, C5, C6—525 μF/450 Vdc Mallory type FF45052 or equal

pacitors in series or standard photoflash capacitors in parallel with minor changes. The series circuit employs Mallory 3900-μF. computer-grade capacitors. This amount of capacitance will produce a 200 watt-second output to the flash tube. Resistors R2 and R3 serve to equalize the voltage across the capacitor discharge bank, C3 and C4. To produce the charging dc voltage for C3 and C4, capacitors C1 and C2, in conjunction with the silicon diodes D1, D2, and D3, form a voltage-tripler circuit to transform 117 volts ac into 450 volts dc. Fuse F1 is rated at 1 ampere and must be of the Slow-Blow type due to the greater current drain during the initial forming of computer-grade capacitors. Likewise, the current limiting resistor R1 is rated at 10 watts and must be mounted no less than ⅛ inch above the circuit board to properly radiate the heat generated in the initial forming operation.

A jumper is indicated at J1 and J2 of Fig. 2. The jumper is only used when modifying the circuit board for standard photoflash capacitors and is not required for series capacitors. The dimensions indicated on Fig. 2 are to locate drill centers for components and capacitors. All electrolytic capacitor terminal holes are ¼ inch in diameter. When mounting the capacitors, be sure that the number 10 washer is between the copper circuit and the capacitor terminal with the mounting screw inserted through the ¼-inch hole from the component side of the circuit board. Be sure the correct polarity is observed in mounting the capacitors.

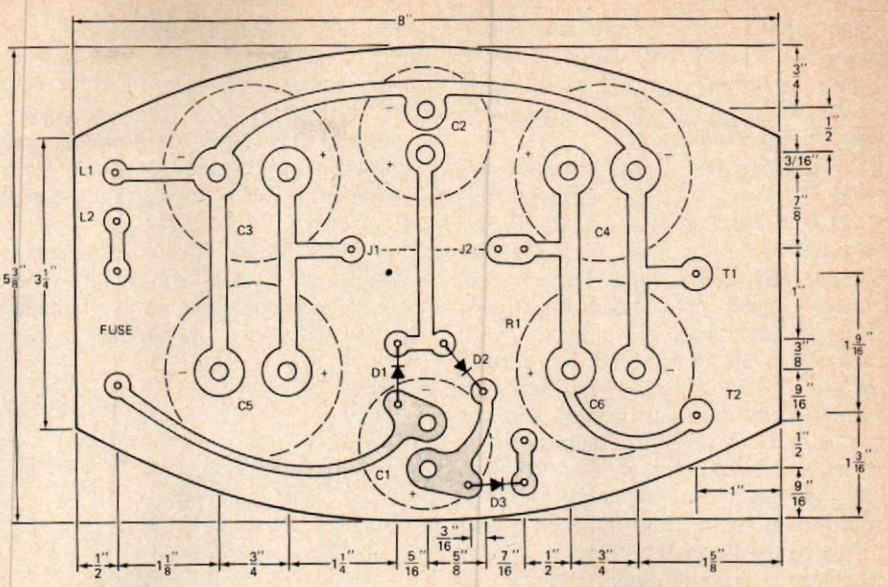


FIG. 3—FOIL PATTERN for parallel capacitor bank which provides 200 watt-second output (connect jumper between J1 and J2). With modifications, the foil pattern is also used for the multiple power output flash (see text).

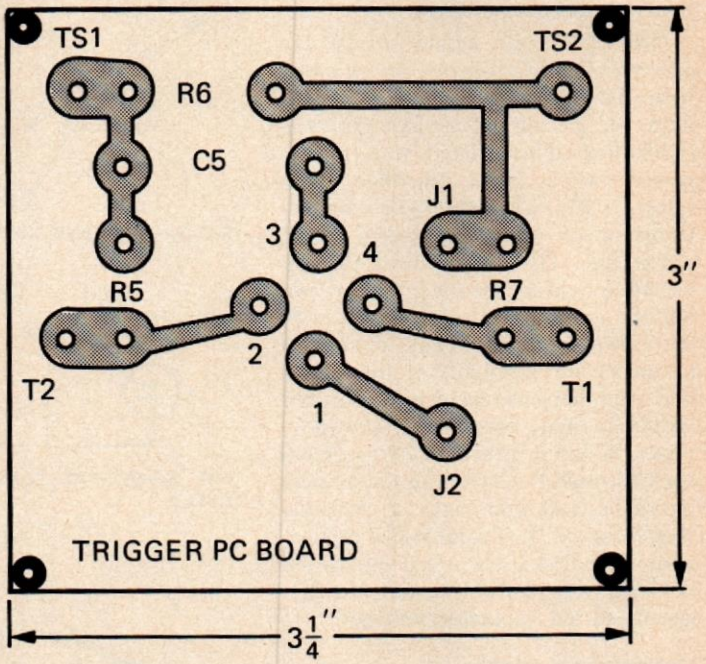


FIG. 4—FOIL PATTERN for the trigger circuit.

Parallel standard photoflash capacitors

Only minor modifications are needed to convert the circuit board in Fig. 2 to the parallel-connected standard photoflash capacitor bank. The 1050 μF capacitance (525μF + 525μF) will produce an output of 100 watt-seconds or, if you prefer, you can use the larger circuit board in Fig. 3 with four standard photoflash capacitors. This will produce a 200 watt-second output similar to the computer-grade series capacitor circuit. In parallel use, the circuit board in Fig. 2 does not require R2 and R3. The 10-watt resistor R1 must now be connected between the cathode of D3 and the heavy foil strip running across the top of the board. (Use the holes provided for R3 in the series-capacitor circuit.) Capacitor C4 *must be reversed* in polarity so that the positive terminals of C3 and C4 are attached to the plus bus circuit. Now connect a number 18 wire between jumper terminals J1 and J2. Trigger terminal T2 cannot be used as shown. Move it to the positive terminal bus at point R2. No change is made to the voltage-tripler circuit or its associated capacitors or diodes.

The four-capacitor parallel circuit (Fig. 1-b, using the circuit board in Fig. 3) can be modified to provide selectable light output. For a choice of either 100- or 200-watt-second output, connect a single-pole, heavy-duty toggle or rocker switch instead of the jumper between points J1 and J2 in Fig. 3. For a choice of 50, 100, 150 or 200 watt-seconds, modify the circuit board by removing the copper foil paths between the positive terminals of C3 and C5 and C4 and C6. Install a heavy-duty single-pole, 4-position *progressive-shorting* switch on the housing top. Connect the four terminals to the positive terminals on C3—C6 and the arm to point T2.

WARNING: ONLY POWER-CAPACITOR BANK (Fig. 1-b) CAN BE MODIFIED WITH OPTIONAL POWER SELECTION SWITCH. UNDER NO CIRCUMSTANCES SHOULD A POWER SELECTION SWITCH BE ATTEMPTED ON FIG. 1-a SERIES-CONNECTED COMPUTER-GRADE CAPACITOR CIRCUIT. PLACING ONLY ONE CAPACITOR ACROSS 450 VOLTS DC WILL PRODUCE A DANGEROUS OVERLOAD OUTPUT AND CREATE A POTENTIAL EXPLOSIVE CONDITION IN THE CAPACITOR.

Trigger circuit board

The trigger circuit shown in Fig. 1-c is simple with only 4 components. The PC board for the trigger circuit is shown in Fig. 4. Since the flashtube socket is on the component side of the circuit board, some minor difficulty may be encountered in connecting the flash tube socket to the circuit connections 1, 2, 3, and 4. All that is necessary to make the proper connections is to attach number 16 solid wires to the 4 tube socket pins and insert the other end of the wires in the corresponding print board contact holes and solder. Firm mechanical connections must be made to the tube socket pins to prevent solder heat from breaking a solder-only connection.

To mount the trigger board to the housing's top, attach 4 stand-off terminals to top and solder stand-off pins through 4 corner holes of the trigger circuit board. TS1 and TS2 connect to the camera sync socket which consists of a standard ac connector, with either number 16 or 18 flexible, stranded wire. The camera sync socket is mounted on the housing's top and can be either a push-in, snap-lock, or screw-mounted socket. This location for the sync socket minimizes the number of connections between trigger circuit board and the power-capacitor bank and places the sync socket in the most advantageous position for use with an optical slave trigger.

Power input connections

Ordinarily, one would expect the power switch discussions to be along with the 117-volt ac tripler circuit. However, because there is a potential shock hazard associated with the ac power switch, it is described separately. Only a double-pole double-throw switch should be used in the ac power line. The ac line must be connected to either the two top or two bottom terminals of the switch with the power-capacitor bank connected to the center terminals of the switch and a jumper connected to the unused terminals. This connection, shown in Figs. 1-a and 5, prevents voltage feedback through the switch to the ac plug terminals and eliminates a potential shock hazard. It also provides a capacitor discharge shunt when the switch is in the OFF position, to remove dangerous stored capacitor voltages.

Optical slave trigger

The most valuable accessory to electronic photoflash photography is the optical slave trigger for your photoflash (Fig. 6). It triggers the photoflash with the light from your camera mounted photoflash and eliminates the use of two sync cables. Figure 7 illustrates how the four components are assembled on the prongs of an ordinary ac plug and encapsulated in a clear plastic or epoxy resin. The General Electric C106B3 SCR is specified not only for the electrical specifications but for the anode terminal position opposite the gate and cathode terminals. This is most convenient for mounting the SCR on the prongs of the sync plug.

The light-sensitive device is a National Semiconductors Ltd. type NSL-701-3 silicon photodiode. It consists of three 0.1 x 0.2 in. silicon chips connected in series to provide sufficient voltage output to trigger the SCR when struck by the light from the master flashgun. The NSL-701-3 can be purchased for $6.00 from National Semiconductors Ltd., 331 Cornelia Street, Plattsburgh, NY 12901.

(The NSL-701-3 is sold as an assembly of bare silicon chips. These are very fragile and easily damaged. If you wish, you can purchase a com-

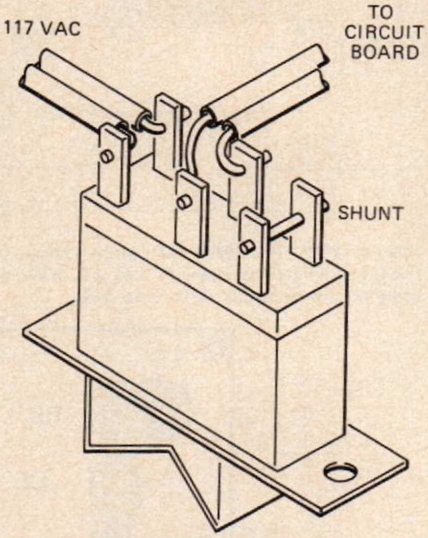


FIG. 5—AC POWER SWITCH wiring.

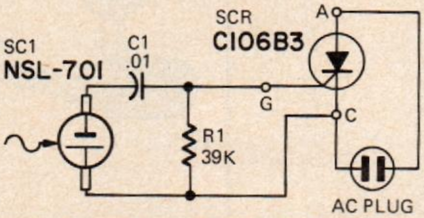


FIG. 6—OPTICAL SLAVE TRIGGER CIRCUIT.

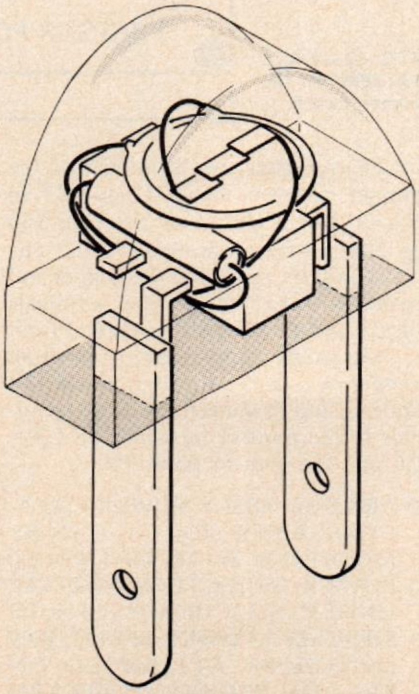
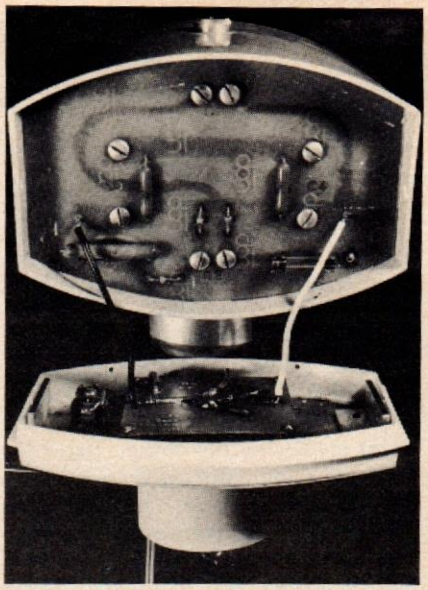


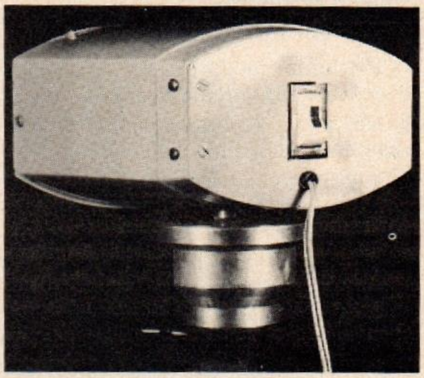
FIG. 7—OPTICAL SLAVE TRIGGER component placement diagram.


CAPACITOR BANK CIRCUIT board can be seen from component side of board.

plete optical trigger—ready to plug into the flashgun from most photo equipment supply houses for approximately $15.00. The device is the Wein Micro Slave.—*Editor)*

Final assembly

Upon completion of the power-capacitor bank and trigger circuit


REAR VIEW OF PHOTOFLASH unit mounted on tripod shows power cord and ac switch.

boards, the final mounting of components in the plastic housing is begun. Figure 8 shows the side view of the component mounting inside the canistor housing. The ac power switch is mounted on the bottom plate of the housing with the 117 volt ac line connected to the end terminals on the switch and a shorting jumper connected across the opposite end terminals (see Fig. 5). Connect a 10-inch section of ac cord from the two center terminals of the switch and run it towards the top of the housing. Next, insert the power-capacitor bank circuit board to locate the tripod mounting position. The correct position for the tripod mount is slightly below the bottom of capacitor C1, with enough space below C1 for adequate backplate support. The tripod socket can

If you select the variable-output circuit for your flashgun, you'll find a progressive-shorting switch almost impossible to obtain because it appears that they're now being made only on special order.

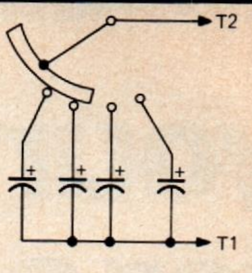
Do not be misled by the terms "shorting" and "non-shorting" in switch catalogs. A shorting-type switch has its arm or wiper arranged so it establishes a new contact before breaking the old. In a non-shorting switch, the wiper breaks contact with one terminal before it makes contact with the adjacent one.

A progressive-shorting switch has a long wiper that progressively connects or shorts the fixed terminals until all are tied together. Your best chance at a suitable switch of this type is to salvage one from a surplus radio transmitter or antenna tuning unit. Diagram *a* shows how to connect it. (I have a hunch that the burners on electric ranges have a similar switch so you might look into this.)

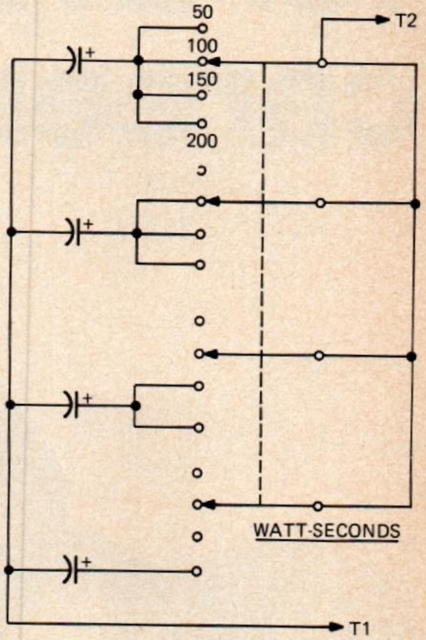
If you can't find a progressive-shorting switch, you can make an equivalent from by wiring a 4-pole, 4-position rotary switch as in diagram *b*. It should have ceramic wafers and contacts rated at at least 5 amps at 350 volts dc.

The DX-5 flash tube is rated at 150 watt-seconds maximum, However, the author assures us that he has not noticed any shortening of the tube life due to its operation at 200 watt-seconds. Furthermore, this tube is used in several commercial 200 watt-second flash guns.

—Editor



a



b

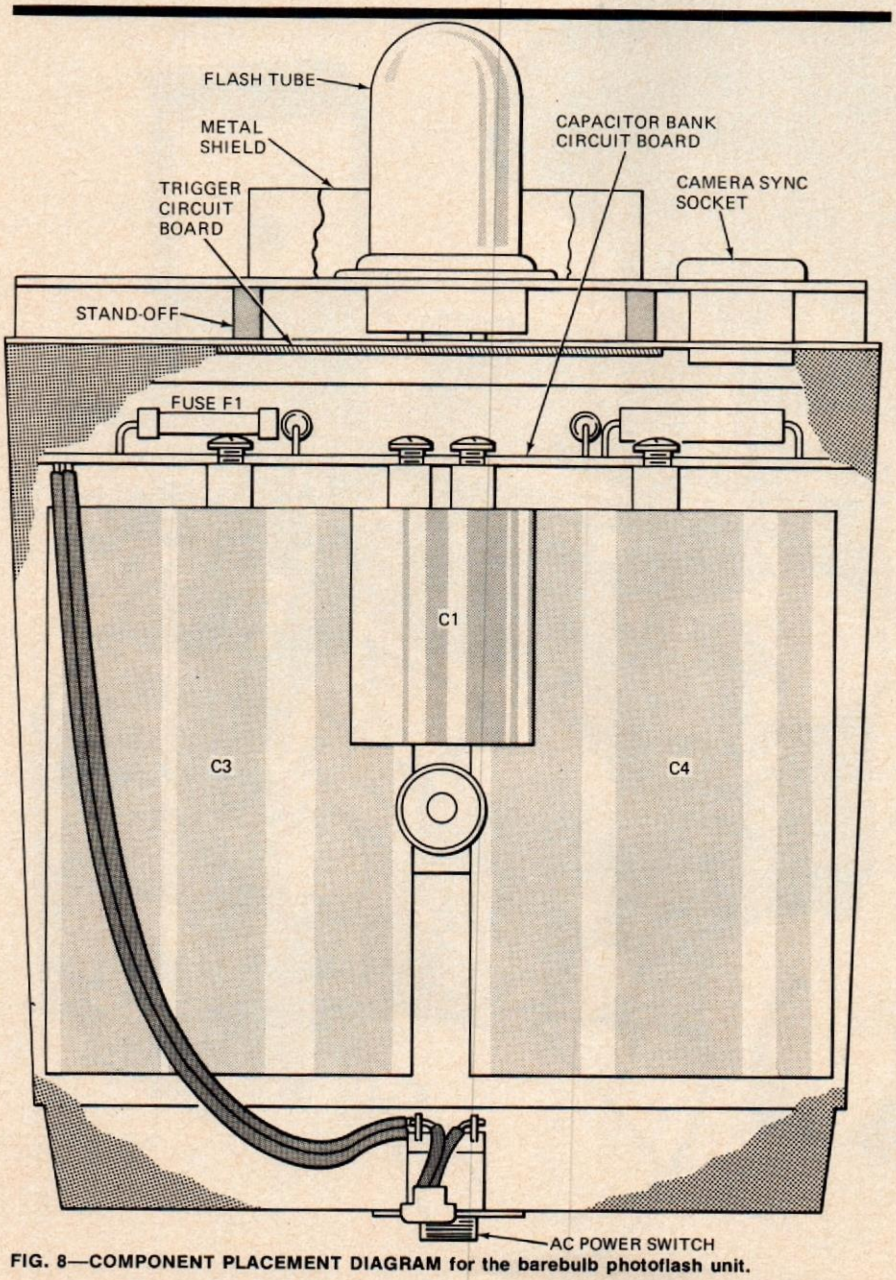


FIG. 8—COMPONENT PLACEMENT DIAGRAM for the barebulb photoflash unit.

be made from a 1-inch circle or square plate of aluminum or brass, ¼ inch thick and with a ¼-20 threaded hole in the center point of the plate. Or, if you prefer, a tripod socket may be purchased from your local camera store or a quick-release tripod base is available from Edmund Scientific Co., 101 East Gloucester Pike, Barrington, N.J. under catalog number 40941. With the tripod socket installed, wrap the capacitor bank, below the print board, with plastic film or acetate sheet and tape securely. This wrapping offers additional electrical shielding and will contain capacitor electrolyte should a capacitor rupture for any reason.

Insert the power-capacitor circuit into housing and firmly seat the pc board to housing sides. A small piece of tape is sufficient to secure the entire assembly if the pc board has been accurately contoured to the housing's interior dimensions. Attach the trigger circuit connections and insert the top of the housing onto the housing body. However, do not secure the top to the body at this point. Insert the flash tube in the flash tube socket.

(continued on page 80)

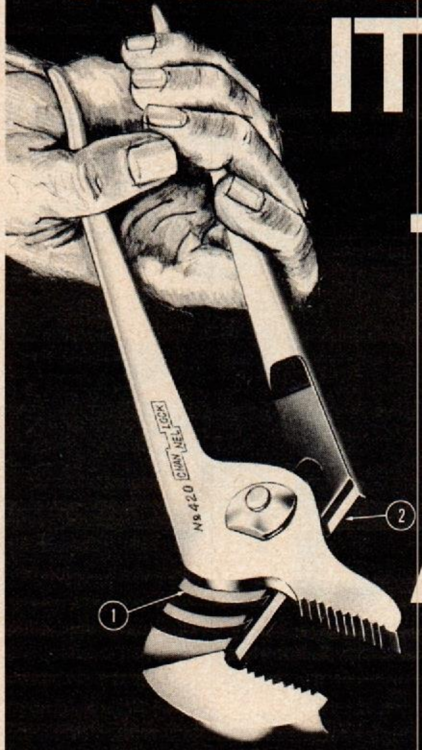
BUILD A PHOTOFLASH
(continued from page 37)

Series capacitor bank forming operation

Plug in the ac power line and turn the power switch to ON. Before triggering the photoflash unit, allow the unit to charge for no less than three hours, overnight is even better.

After the minimum charging period, or overnight, attach a camera sync cord to the camera sync socket and with a pin or small piece of wire, short the end terminals to trigger the flash. Then allow 3 to 7 seconds for the recycle power to build-up. Then re-trigger the unit for approximately 30 flashes. The combination of 3 hour charge and repeated flashing will complete the forming operation and the flash unit will be ready to use with your camera.

Always trigger your flash unit several times before beginning to take pictures to assure maximum power output. Unused units will gradually de-form with age, and it is recommended that the forming operation be followed once every two to three months for better operation and to extend the life of the capacitors.



Operation

Bare-bulb operation, without a reflector, usually has a guide number of 30 for a 200 watt-second power output, and as high as 150 with reflector for ASA 25 film. Guide numbers are just that . . . a guide to use as a starting point for proper exposure. I recommend running a test film of varied exposures and shutter speeds to determine the proper guide number for your type of use. This involves shooting a series of pictures on a good resolution film, one rated at ASA 30 to ASA 65. Bracket your exposures 4 stops up and 4 stops down from f-8 at a shutter speed of 1/100-second.

Always use a maximum shutter speed of 1/60th of a second for cameras with focal plane shutters since the photoflash triggers at X or zero-delay shutter setting.

Troubleshooting the photoflash unit.

If you have properly made the circuit boards and installed each component properly, there should be no difficulty encountered in operating the unit. Usually, during the initial forming operation, considerable heat will be radiated from R1, and the possibility of the fuse blowing exists. This can be caused by excessive leakage of capacitors C3 and C4 that will correct its-self after completing the forming operation. It can also be caused by connecting the polarity of the capacitors incorrectly. Should your fuse blow, check the capacitor polarity FIRST.

Should the flash tube fail to fire, remove the flash tube from it's socket and measure across the socket pins with a DC Voltmeter. The positive lead of the voltmeter to pin 2 and the negative lead to pin 4. It should measure 450 volts. Should you be unable to measure the voltage; turn off power switch, open top, and check the following:

check 1	Open fuse
check 2	Open R1
check 3	Incorrect polarity of capacitors C3 and C4
check 4	Open or shorted D1, D2, D3
check 5	Incorrect polarity of capacitors C1 or C2
check 6	Open connection between power circuit and trigger circuit

For those who would like to construct a bare bulb electronic photoflash unit but would prefer to assemble a kit, there is a kit for the Uniflash barebulb photoflash produced by Mitchell Enterprises, P.O. Box 1372, San Francisco, CA. 94101. **R-E**

Thyristor Circuitry for ELECTRONIC Photoflashers

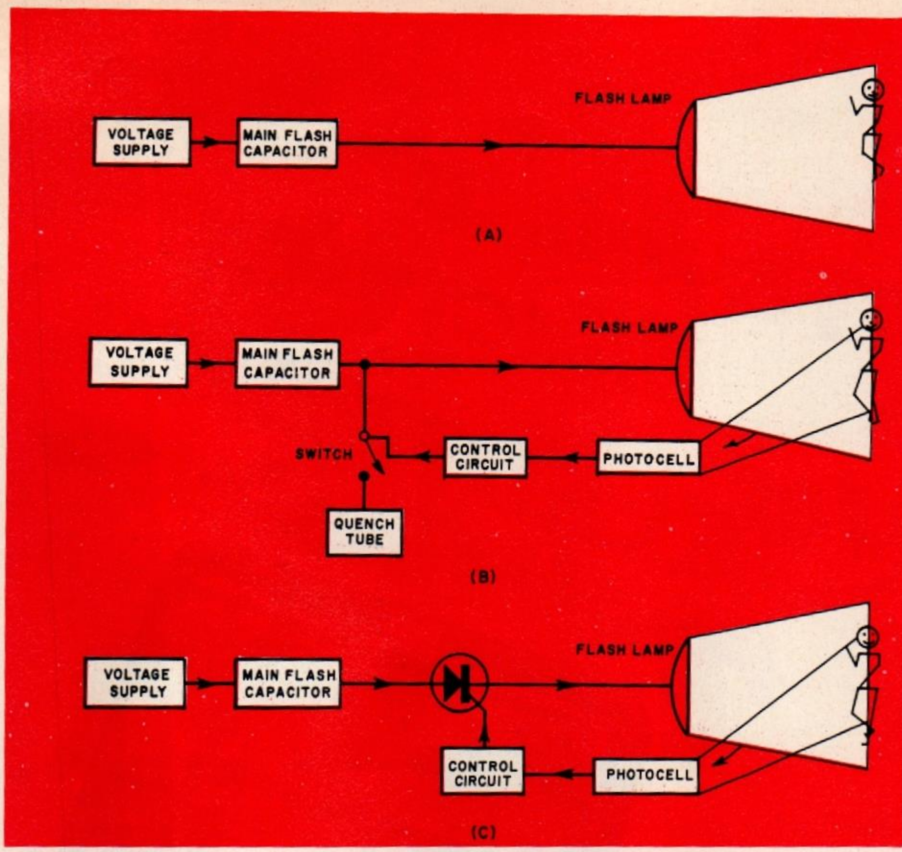
BY MICHELE FRANK

How a simple SCR trigger provides faster recycling, more flashes per charge and quick recharge for the latest breed of automatic electronic flashers

THE ELECTRONIC flash system brought "stop action" photo opportunities to camera enthusiasts. It also eliminated the need for changing spent flashbulbs thanks to the storage properties of the electrolytic capacitor and the use of long-life gaseous lamps. The next major advance in electronic flash technology can be pinpointed to 1965 when Honeywell Photographic introduced an automatic electronic flash, freeing photobuffs from having to set f-stops for each shot that was at a different distance.

Now electronics has created another plateau in automatic flash technology by adding thyristor control—an SCR that both triggers the flash and stops capacitor discharge when the subject receives sufficient light. The result? More flashes per battery charge, faster recycling time for the next shot, and short recharge time.

A Flash of Light. For background, here are the various steps that go into producing the electronic flash of light. First, voltage from a battery, the usual power source in an electronic flash, is converted to ac by means of an oscillator circuit. (This oscillator, by the way, is what causes the characteristic "whine" you hear in the electronic flash unit.) Once the ac is generated, it is stepped up to a higher voltage by a transformer. Then the ac is converted back to dc by a rectifier, after which it is stored in the flash unit's main electrolytic capacitor. (Capacitors in modern flash units are capable of storing potentials of about 350 volts.) The flash capacitor is connected to a gas-filled tube. Xenon is the usual gas used, although some other types are available.

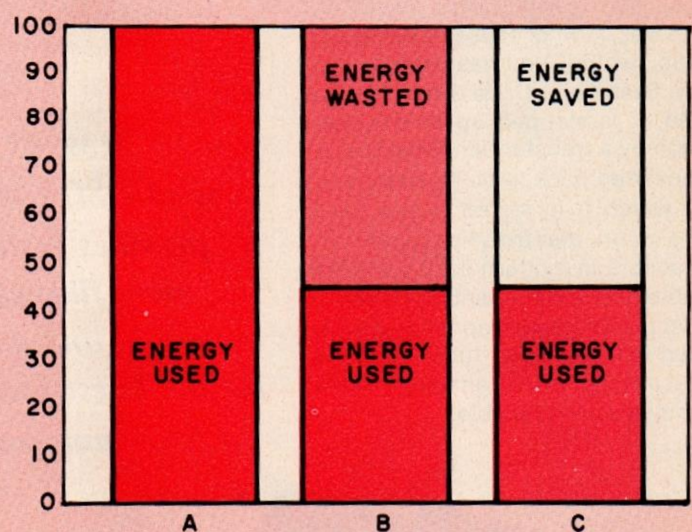


Three greatly simplified block diagrams show the major components of the various types of electronic flashers. At (A), a manual unit is the least complex. Diagram (B) shows how a photocell is added with control circuit and quench tube to dump surplus energy. At (C), a thyristor unit adds an SCR to trap voltage from the main flash capacitor.

At this stage, everything is set for triggering the flash. What is now needed is a high-voltage pulse to ionize the gas in the flashtube to make it conductive so that energy can flow through the tube, where it will be converted to light. This high-voltage pulse is created as the camera's shutter contacts close, causing a small trigger capacitor to release its charge into a spark coil connected to the wall of the flashtube. After the charge on the flash capacitor has been exhausted, the gas becomes de-ionized and no longer conductive. The recharging cycle can then begin. Once the cycle is complete, as indicated by the ready lamp on the flash unit, the flash can again be fired.

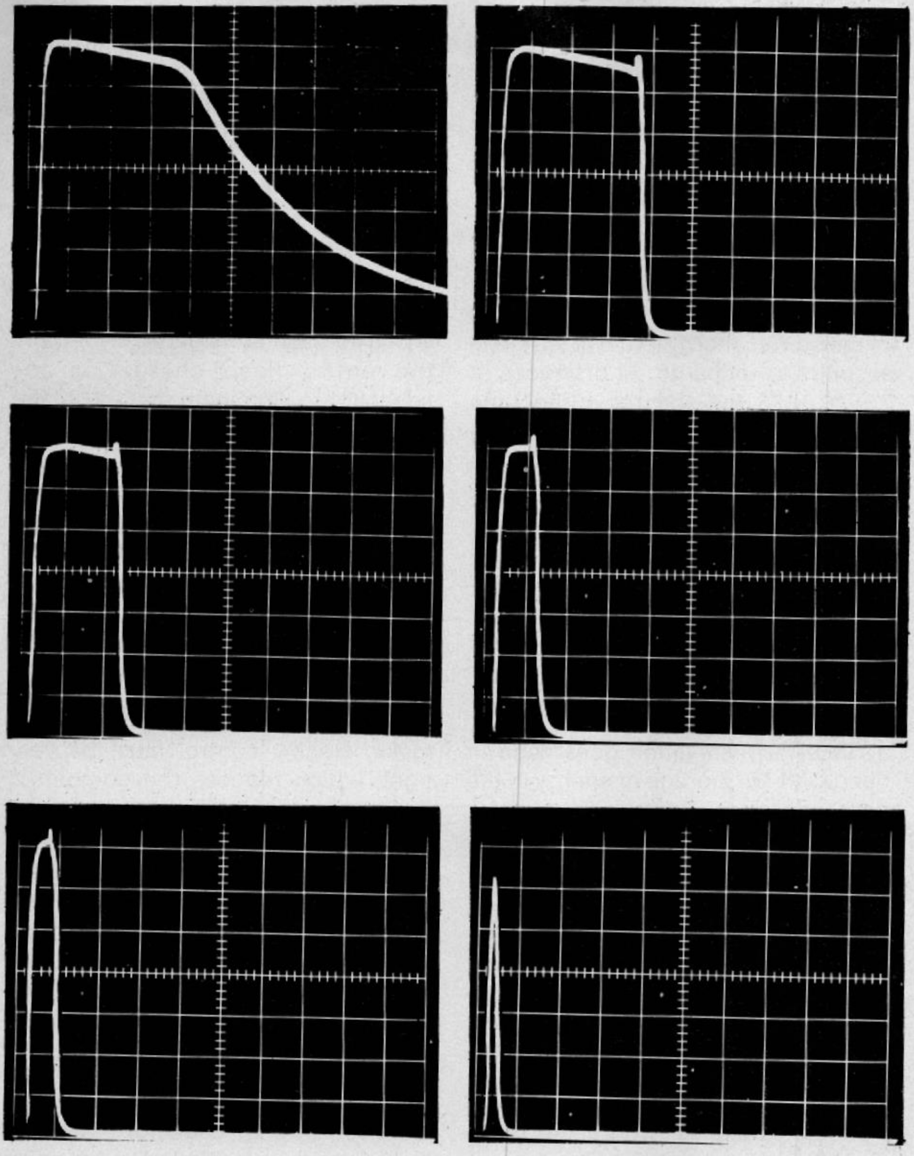
Automatic Flash. Film exposure is based on two factors: time and intensity. With the pre-1965 photoflashers, the time factor (flash duration) was fixed at about 1/1000 of a second for most units. Hence, intensity had to be controlled by changing the camera's lens opening (f-stop).

The Honeywell 660 automatic flash employed the first "quench circuit" and operated on the variable of time. Now, instead of just one flash duration of perhaps 1/1000 second, the flash unit would give a burst of light with a duration of anywhere between

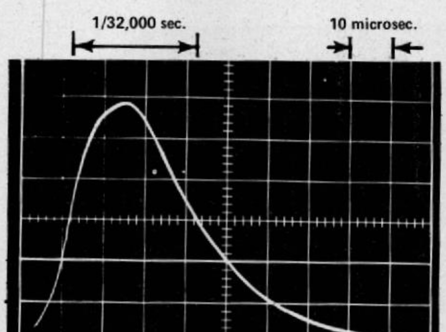


Energy used by three electronic flash units shooting the same scene. At (A), the manual unit uses all the voltage stored in flash capacitor to illuminate the scene. Proper exposure is obtained by setting the f-stop on the camera. In unit (B), a quench-tube type, exposure was controlled by the flash unit. Only 45 percent of the energy was used to expose the film. Flash unit (C) used the same amount of time and energy as (B) to illuminate the subject properly but unused energy remained in the flash capacitor, resulting in less battery drain as well as a faster recycling time between shots.

TRACES FROM AN ENERGY-SAVING FLASH UNIT



Oscilloscope traces show results of synthesizing various working distances by regulating a set of baffles in front of a Braun 2000 flash unit, then measuring the resulting flash waveform with a photomultiplier and scope set to 0.2 ms per division. Effective flash duration varies from maximum of 1/1000 s (equivalent to using unit on manual or at its maximum working distance) to minimum of 1/32,000 s (using unit at closest working distance). Peak in the waveform on middle four traces is from firing of the flash tube. This is a characteristic of some, but not all, of latest energy-saving flash units using thyristors.



We used a high-speed oscilloscope to check flash duration of the Braun 2000, set to give briefest flash of 1/32,000 s. Measurement from pulse width at half height.

1/1000 and 1/30,000 second. The exposure control was taken from the camera, and the photographer put in the flash unit. The photographer had only to set an f-stop on his camera, following the recommendations of the manufacturer based on the light intensity from the flash unit and the ASA of the film. The flash unit would then control the duration of the light.

Here's how it works. Light emanating from the flash tube is reflected from the subject back to the flash unit, where it is detected by a photocell. The photocell is connected to a small timing capacitor whose value has been carefully selected based on known criteria (f-stop to be used with a given ASA of film, light intensity, and distance) that add up to an exposure analog. The amount of light falling on the photocell can be biased either by using small apertures or neutral-density filters placed before it. By so doing, the photocell can be fooled into believing that it takes two, three, or four times as long to illuminate the scene. Responding to the amount of light falling on it, the photocell regulates the charging of the timing capacitor. Once the timing capacitor has reached its full charge in a quench-tube circuit, it closes another switch that allows the current flowing from the flash capacitor to be shunted to another tube, with a lower series resistance. Here, the energy is expended in the form of light and heat.

This second tube is never seen by the photographer, and its light never plays a part in the photographic process. It is just a convenient way of dumping the unneeded energy flowing from the flash capacitor. With this approach, flash durations of up to 1/70,000 second have been obtained with small electronic flash units, permitting us to record such things as bullets piercing wood, balloons breaking, etc.

All of this was enough to send most photographers into fits of ecstasy, but it still left one problem. Even though the quench-tube idea brought enormous flexibility to electronic flash units, they were still energy wasters. There was no feasible way to dam up the energy flowing from the flash capacitor to the flash tube. The result was that a photographer could obtain only a limited number of flashes per battery or charge. In the case of the rechargeable nickel-cadmium battery, this was usually about 40 to 60 flashes.

Enter Thyristor Control. In the fall of 1972, Braun introduced the first series-circuit, thyristor-controlled flash units. The much-sought-after breakthrough came in the form of a small silicon controlled rectifier (SCR) called a "thyristor." Operating as an electronic switch, this little solid-state wonder can handle the load flowing from the flash capacitor and stop it at the precise moment that the exposure control circuit says the subject has received enough light. Instead of having a parallel circuit that simply reroutes the energy from the flash capacitor, we now have a series circuit that allows the leftover energy to remain in the flash capacitor.

The thyristor has many advantages, among them: It can switch on and remain on until the current flowing through a dc circuit drops to zero (or near zero). It can be made to open if it receives a very brief low-energy pulse from the opposite direction. The pulse to shut down, of course, comes from the timing circuit with its small capacitor connected to the photocell.

Used in an electronic flash unit, the thyristor performs two jobs. First, it stops the current flowing from the main flash capacitor, thus regulating the duration of the flash in the same manner the parallel quench circuit did. And it allows the unused energy to remain in the flash capacitor, rather than being wasted. This, in turn, provides another advantage. Recycling times can be shortened because the battery can very quickly supply the small amount of energy necessary to recharge the capacitor. Battery power can be conserved —meaning more flashes per charge.

One series-type thyristor flash unit known to us recycles in about 2.5 seconds after illuminating a scene 10 ft (3.05 m) away. In doing so, it uses only 22 percent of the energy in the flash capacitor. However, if this same unit is fired at a subject 20 ft (6.1 m) away, it will have used up 90 percent of the stored energy and will require 6 seconds to recharge. At distances of 2.5 ft (0.76 m), the recycling time would be only about 0.25 to 0.33 second. In the manual mode (with the photocell covered), or at distances at the very end of the electronic flash's ability to properly illuminate the scene, the thyristor does not receive the reversing pulse from the timing circuit. Instead, it opens after the voltage in the flash capacitor has dropped to near zero (usually about 1.5 volts).

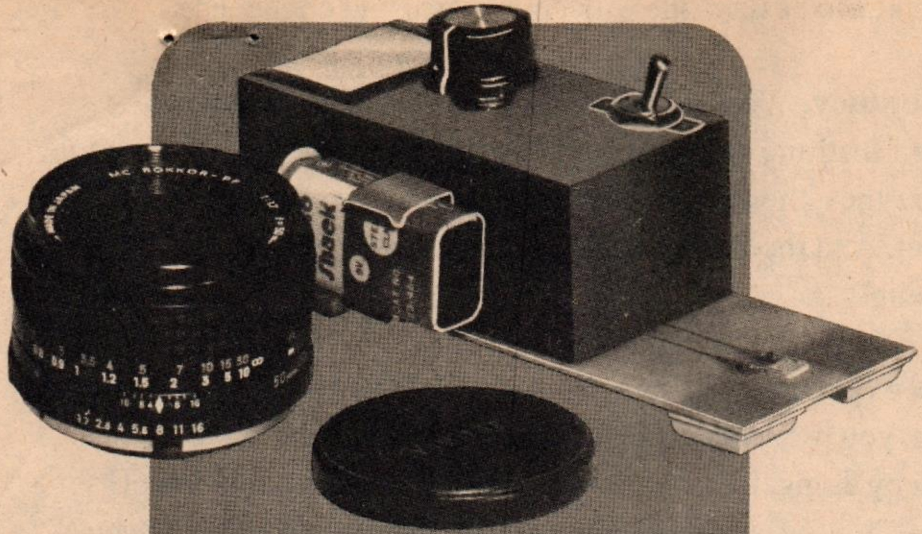
Battery conservation goes hand in hand with the storage of energy in the flash capacitor. Before the thyristor made its appearance in flash units, it was necessary each time to supply enough power to bring a fully depleted capacitor up to full charge. Now, the thyristor has reduced the requirement so that only fractions of the earlier power are required to recharge a partially discharged capacitor. In some cases, if the flash unit is used exclusively at the closest working distances (where the duration of the flash is briefest), it is not uncommon to obtain 700 to 1000 flashes per nickel-cadmium battery charge. (On manual, these same batteries would deliver only about 60 flashes per charge. Since no one shoots exclusively at distances of 2.5 ft (0.76 m), the more usual number of flashes per charge is about 100 to 200.

Thyristor-controlled electronic flashes are not likely to glut the market in the near future. This type of flash makes sense only with the more high-powered flash units. The low-powered flash units generally require the entire flash charge on the capacitor to illuminate scenes greater than 10 ft (3.05 m) away; so, there would be no energy savings by building into them a thyristor circuit. Only flash units where a small amount of energy would be used in a shot would make the thyristor circuit practical and necessary.

Another thing barring the universal use of the thyristor in electronic photoflash units is that this type of SCR is expensive and can be tricky to make. Quality control must be very tight, which reduces the number of devices available. This means that thyristor suppliers are having a rough time trying to keep up with the demand. Manufacturers tell us that they are having troubles trying to get enough thyristors just to meet the demand for flash units now in production.

When you do see a thyristor-controlled flash unit, you can bet you will have to pay more for it than you are accustomed to do for "conventional" flash units. The type of sophistication built into these flash units does not come cheap. Perhaps when semiconductor manufacturers can crank out this type of SCR the way other manufacturers crank out resistors, a price reduction can be anticipated—but not before then.

Who Makes Them. If you want to look for one of the new thyristor-controlled flash units, ask for any of the following in your local photo store: Argus Model 1272 or Model 1275; Auto Spiralite Thy 1000; Bell & Howell Model 880; Braun Vario Computer 2000 F022 or F027; Honeywell Auto Strobonar 470; Metz Mecablitz 402 or 217; Rollei Model 36 RE or Model 140 RES; or the Vivtar Auto Thyristor Model 292 or Model 352. Canon, Minolta, and Nikon also market this type of electronic photo flash unit outside the U.S. ◈



USE THIS LED/CHIP PHOTO HELPER

Easy-to-build indicator uses two ICs and Stop-Go readout for perfect enlargements every time!

by David A. Duncan

Quality control is especially important in operating a darkroom, and of all the various meters, controls and other instruments employed in making enlargements, the most important and useful one is the photometer.

This light-measuring instrument indicates numerically, via a meter movement or other readout indicator, the amount of light from an enlarger lens striking the enlarging paper on the easel below the lens. This is done by using a light-sensitive device to generate or regulate an electrical signal, which in turn is amplified and indicated by a display mechanism. After reading the indication of light intensity coming from the enlarger, one opens up (or closes down, as required) the diaphragm opening of the enlarger to get the right amount of light. After that, each time a new negative is put in the enlarger the photometer is placed under the enlarger for a moment, the photometer readout is examined, and the enlarger diaphragm is again made larger or smaller to produce the desired reading on the photometer. This ensures that the same amount of light will come from the enlarger on exposures made with the new negative.

During several years' use of such instruments, it was found that most photometers on the market today have at least one drawback. If the meter uses a mechanical movement, the meter face is difficult to read accurately. Even with special glow-in-the-dark face-plates or internal illumination one still has to get inconveniently close to the meter to be able to read it in the subdued illumination of the darkroom. Some meters employ a special mechanism on the meter movement that will lock the needle in place during a measurement, allowing the user to turn on the room lights to read the meter. However, these are expensive, and are thus out of the question for most experimenters. Another system often found in darkroom equipment employs digital readout with seven-segment LEDs for the display. While this is fine, being very easy to read in the dark, it also carries a high price tag, as it requires elaborate analog-to-digital (A-D) converters and digital circuitry. Still another, and from the author's experience the best, is the LED/chip Photo-Helper described here.

The most noticeable feature of this LED/chip meter is, of course, the display. In place of a meter or number readout, one of five light-emitting diodes (LEDs) indicates the degree and the direction the aperture of the enlarger lens must be stopped in order to project a predetermined amount of light to the easel, and subsequently to the photographic paper. By using the calibrated control on the LED/chip the projected light can be accurately measured.

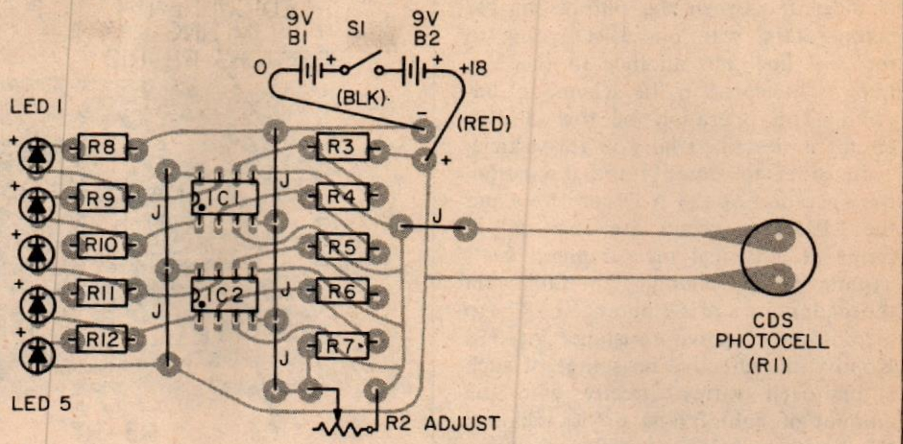
The display comprises five red LEDs, each of which represents a deviation of one f/stop from the values indicated on either side. The center LED represents the null—the desired light intensity. Those to the right indicate that a high f/stop is being used (not enough light projected) and those to the left signify a low f/stop (too much light projected). This system has recently been adopted by a major camera manufacturer in Japan in one of its cameras as a light-metering system.

About the Circuit. Refer to the schematic diagram of the LED/Chip. The heard of the meter is the simple A-D (analog-to-digital) converter, and the LED display which it controls.

The A-D converter uses four operational amplifiers (OP-amps) as voltage comparators, and a voltage-dividing ladder made up of resistors R3 through R7. The voltage divider supplies positive reference voltage ratios of 0.78, 0.68, 0.58 and 0.47, which amount to 14, 12.2, 10.4 and 8.5 VDC, respectively, when used with an 18-volt supply, to the inverting (—) inputs of comparators A, B, C, and D. Photocell R1 and control R2 make up a second voltage divider, the tapped voltage of which is dependent on the amount of light striking R1, and the setting of R2. The output of this divider is applied commonly to the noninverting (+) inputs of all four comparators. The LEDs tween comparator B (V—) to comparator C (which is now at V+). The voltage difference between these two outputs causes current to flow through LED3, turning it On. LED4 is positioned between the outputs of comparator C and comparator D, both of which are at V+. This LED sees no current between the two V+ (leveled) outputs, and therefore does not come On. Finally, LED5 is located between the V+ output of comparator D and the V+ line itself, and also remains Off. This system will result in one (and only one) LED being lit at any one time, under normal conditions. (Under a fluorescent or Xenon light source, which flashes at a rate of 120 Hz, the LED/chip meter sees the lights as both On and Off and will display this by turning On two or more LEDs).

As the intensity of light at the photocell is altered, or control R2 is changed, each comparator will go from V— to V+, or vice versa, according to the change in voltage level at the output of the R1-R2 voltage divider. If each situation is carefully analyzed it can be seen that only one LED will be On, all others remaining Off.

Note that since the two voltage dividers R1/R2 and R3 through R7 are connected to the same V+ source, and since the resultant output of the A-D converter is dependent only on the voltage differences between the various points in these dividers, changes in the supply voltage will not affect the operation or calibration of the LED/Chip Photo-Helper unless of course such extremes are reached that the circuits cannot operate or are destroyed). Also, since no "ground" reference is needed, a single voltage supply, such as a single battery, may be used.



Location of components on printed circuit board. Foil is placed on top of board, as are components.

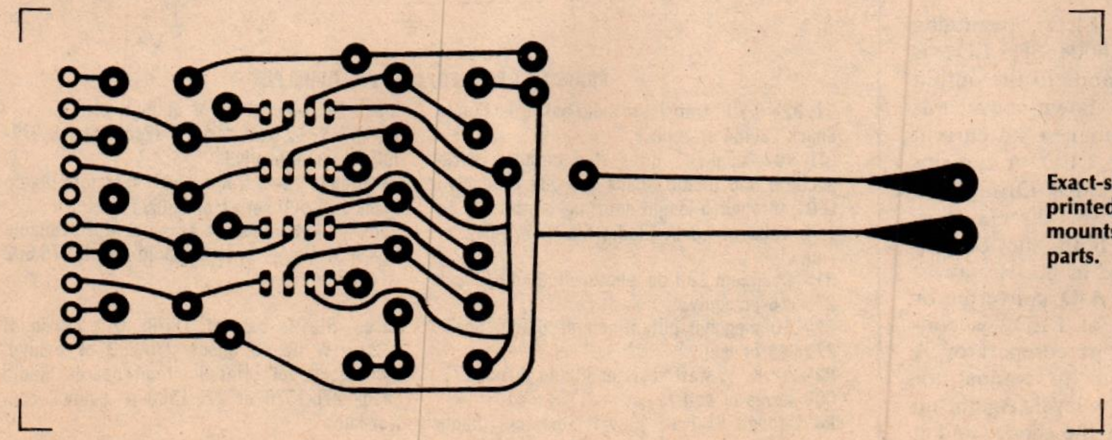
Construction. Except for the battery, power switch S1 and control R2, the entire circuit of the LED/chip is built on a single one-sided printed-circuit board. Any means of construction may be used, as dress is relatively unimportant. However, the LED/chip using a printed-circuit board is easier to build and to use in the darkroom.

Position and install the resistors, jumper wires, integrated circuits and LEDs on the circuit board as indicated in the component location chart immediately following the printed-circuit foil pattern. Pay special attention to the polarities of the light-emitting diodes, and **use heat sinks** (such as a pair of longnose pliers) when soldering these devices in place, as they are easily destroyed. Also note the orientation of the integrated circuits. IC sockets may be used for the ICs if desired, and they make it easy to construct with no danger of destroying the ICs while soldering them in place.

Prepare a suitable enclosure for the LED/chip by drilling holes for control R2 and switch S1. Drill or cut a window at the position where the five LEDs will be visible when the PC board is mounted in place, and another opening to allow the light from the enlarger to reach the photocell. The cabinet for our prototype was prepared so that the end of the PC board bearing the photocell projects beyond the side of the enclosure. The prototype's printed circuit board was manufactured as a mirror-image (reverse) of the foil pattern shown here, and the components mounted on the foil side, so the PC board itself is the bottom of the cabinet, and is secured to the cabinet just as its original bottom was, using the same hardware. Mount four rubber feet to the underside of the cabinet to prevent the cabinet marring the easel of the enlarger.

Testing and Using. To test the

(Continued on page 100)

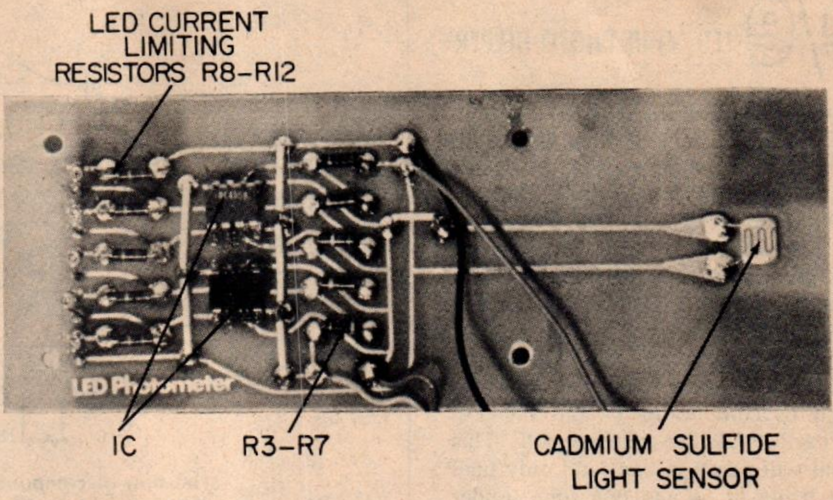


Exact-size template for printed circuit. Foil mounts same side as parts.

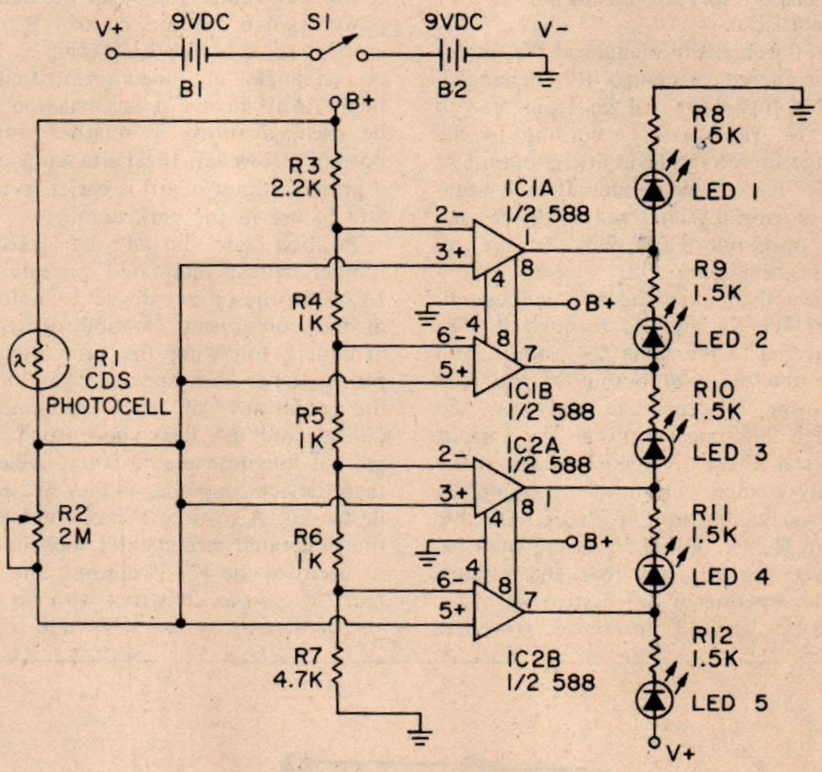
and their current-limiting resistors are connected between the outputs of the comparators, with one LED going to the V+ line and another to the V— line, as indicated in the schematic diagram. The operation of this display circuit is described later in this article.

In order to simplify the discussion, the operation of the A-D converter and the LED/chip meter are analyzed in terms of a typical measurement. Let's assume there is enough light falling on the cadmium sulfide photocell, R1, to give it an effective resistance of 318 Kohms (the effective resistance of such a photocell varies directly with the amount of light falling on it). Control R2 is set for half a megohm, resulting in an output of 11 volts which is applied to the + inputs of the comparators. On the — inputs, remember, there is 14-volts at the comparator A, 12.2-volts on comparator B, comparator C has 10.4-volts, and 8.5-volts is being applied to comparator D. These voltages come from resistor ladder R3-7, derived from the 18-volt V+ supply. With each comparator, if the voltage level on the + input is greater (more positive) than the voltage on the — input, the output of the comparator will go to the level of V+. If however, the + input sees less voltage than does the — input (— input is more positive), the output will drop to the value of V- (zero). With this in mind, consider the example. Comparators A and B have 11 volts on their + inputs, but have 14 volts and 12.2 volts on their — inputs. Since the — inputs are more positive than are the + inputs, the outputs of these comparators will be at zero. However, while comparators C and D also have the common 11 volts applied to their + inputs, only 10.4-volt and 8.5-volt signals are being sent to their — inputs. As the + inputs of these comparators are the more positive, their outputs will go to V+ (18 volts).

Now consider the LEDs, beginning with LED1. The cathode of LED1 is tied to V—, and its anode to the output of comparator A. As shown above, this output is at V— potential, so no current can flow through the LED: it remains Off. Limiting resistors R8 through 12 can be disregarded in this discussion as they only serve to limit the current through the LEDs and in no way affect the operation of the A-D converter or display. The cathode of LED2 is connected to the output of comparator A (at V—) and its anode to comparator B, which is also at V— level. Again, no current flows through the diode, and it remains unlit. LED3 is connected be-



Assembled LED/chip Photo-Helper has light sensor on board, at right. Five LEDs are mounted under the transparent window at left. Only one LED lights at a time. View of the printed circuit board with components in place. Light sensor is at right end, five LEDs at left.



PARTS LIST FOR LED/CHIP PHOTO-HELPER

B1, B2—9-VDC transistor radio batteries (Radio Shack 23-464 or equiv.)
IC1, IC2—dual-741 integrated circuits, packaged as 558 (Radio Shack 276-038 or equiv.)
LED1 through 5—Light-emitting diodes 1.6 to 1.75 volts at 20mA (Radio Shack 276-042 or equiv.)
R1—Cadmium sulfide photocell (Radio Shack 276-116 or equiv.)
R2—2.0 megohm potentiometer (Radio Shack 271-093 or equiv.)
R3—2.2 K, ½-watt resistor (Radio Shack 271-000 series or equiv.)
R4 through 6—1 K, ½-watt resistors (Radio Shack 271-000 series or equiv.)
R7—4.7 K, ½-watt resistor (Radio Shack 271-000 series or equiv.)
R8 through 12—1.5 K, ½-watt resistors (Radio Shack 271-000 series or equiv.)
Note: ¼-watt resistors acceptable if available
S1—SPST toggle switch (Radio Shack 275-602 or equiv.)

Misc.—Plastic cabinet 3¼-in. D x 1¼-in. H x 2-in. W (Radio Shack 270-230 or equiv.), etching kit for printed circuit boards (Radio Shack 276-1576 or 276-1560 or equiv.), control knob.

Classified Continued

PERSONAL — Cont'd

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(Continued from page 96)

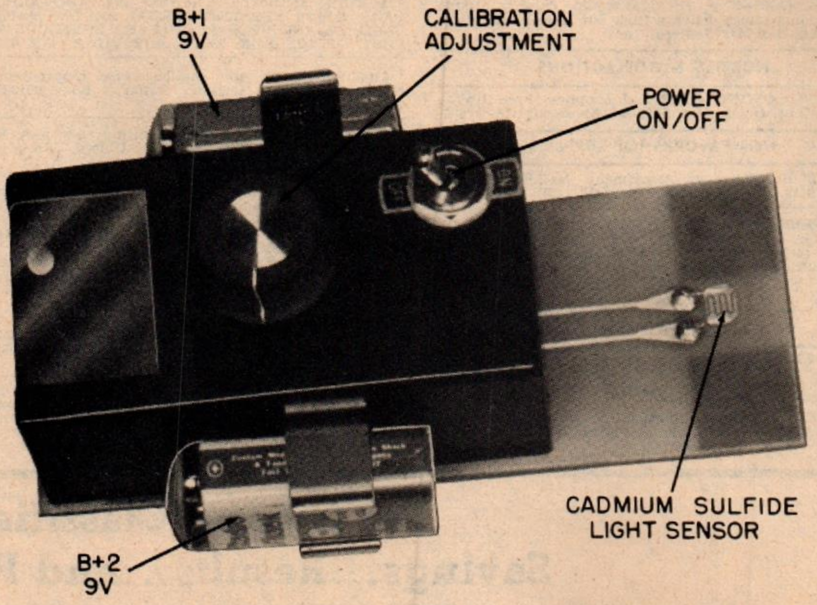
be easily connected to the sockets.

Choosing Fuses. Fuses should never be rated higher than the maximum rated current of the associated power supply. For example, if you are using an *external* 5-ampere/5-volt supply the fuse should be no larger than 5-amperes. If you are using the internal 1.5-ampere/5-volt supply the fuse should be no larger than 1.5 amperes. But fusing for the supply's maximum rating protects only the power supply, not the circuit you're building. Such fusing in the presence of a wiring error could lead to an undamaged power supply—with crispy-fried experimental components! It is better to fuse so that the experimental circuit gets full protection, or as much protection as you can give it. For example, assume you are building a TTL project whose maximum current including the readout display is 150 mA. Using the next higher fuse value, in this instance 3/16 or 2/10 ampere, will protect both the project and the power supply. Thus, whenever you use the Rig-Kwik for breadboarding a project you can protect the project, as well as the power supply, by choosing a fuse just large enough for the project itself (each time). You now have a fast, convenient, and inexpensive laboratory breadboard. Enjoy! ■

LED/Chip Photo-Helper

(Continued from page 72)

LED/Chip Photo-Helper, connect the batteries and turn the power switch On. One LED should immediately come On. Rotate the control from one extreme to the other, and note that at some point each LED will come On in succession, but only one LED will be On at any given time. If more than one LED lights at a time, check whether you are working under fluorescent lighting. If so, move to a room lit with an incandescent lamp and repeat the test. If there is no fluorescent light near, the



Assembled LED/chip Photo-Helper has light sensor on board, at right. Five LEDs are mounted under the transparent window at left. Only one LED lights at a time.

fault is in the circuit itself. Check the PC board for solder bridges, loose pigtails or wires, or defective foil traces. If none of these can be found, the fault is in one of the integrated circuits, and it should be replaced with another of the same type. If one of the LEDs fails to light, but otherwise the circuit operates normally, exchange the LED for another one known to be good. When the LED/chip meter is operating properly, proceed with calibration.

The Photo-Helper was designed to be used with a photographic enlarger, to ensure making black-and-white and color prints with repeatable success. If a good-quality enlarger is available, and you have access to a transparent step-tablet (gray scale), calibrate the LED/chip as follows.

Calibration. With the step-tablet in the enlarger's negative slide, measure each segment, using the LED/chip by noting the setting of the control that causes the center LED (LED3) to come On. Next, make a series of test prints, using different exposures and development times, to produce a succession of prints of the step-tablet of differing contrasts. Note on the print the exposure and development used, and beside each segment of the step-tablet note down the setting of the LED/chip control.

When ready to print a negative, measure the lightest and darkest areas of the negative with the LED/chip. Select the test print (made earlier) with the most desirable contrast range within the measured values, and use the exposure and development information recorded on the test print to determine the exposure to be used.

When setting the LED/Chip control with light from the enlarger, you can use a diffusion lens in conjunction with the enlarger lens to average out the illumination from the various parts of the negative. This ensures that the light being measured is a fair sampling from the entire area of the negative, and avoids measuring a too-dark, or too-light part of the picture. Of course the diffusion lens is swung out of the way after the LED/Chip Photo-Helper is calibrated, so that the negative may be properly exposed.

Transparent step-tablets can be purchased at any photo-supply shop or graphic-arts store for a few dollars. They come in a number of types, from some with 25 or more segments to those that include a color analyzing section containing color spots. Most low-cost step-tablets are not calibrated for their photographic densities but nave instead an arbitrarily-numbered scale on one side. Calibrated step-tablets are available, of course, but their high cost makes them unreasonable for use with the LED/Chip. An inexpensive step-tablet can be calibrated by placing each segment under a transmission densitometer and recording each reading. Most newspaper and many color printing shops usesuch a desitometer.

Another useful function the photometer has is to ensure that a constant amount of light will reach the enlarger easel, regardless of the lens used or the magnification (enlargement). Make a mark on the LED/Chip control scale at the setting that corresponds to the desired light intensity, reading the LEDs as before. In most cases, this may be a particular segment in a step-tablet. When making a print or, in the author's case, a process color separation, include the step-tablet with the negative. With the desired lens in place and the enlarger set to the correct enlargement, locate the photocell under the same segment in the step-tablet that was used earlier. Adjust control R2 to the mark made earlier, and then set the lens aperture until the center LED comes on. This feature is especially useful in the graphic arts, where a common set of exposures is desired for any type of halftone or color-separation work done on a particular enlarger.

Using the components in our parts list, the LEDs will automatically respond at increments of one f/stop (f/stop is the term used to describe the setting of the lens aperture, one f/stop higher or lower means that either half or double the amount of light is transmitted by the enlarger lens.) If another type of CdS cell is used in place of the photocell listed in the Parts List, the values of resistors R3 through 7 may have to be changed to allow for the different response characteristics of the new photocell. All the components are easy to come by, and the total cost of the LED/Chip Photo-Helper should not be more than $10.00—considerably less if parts are scrounged from your junk box. ■

ELEMENTARY ELECTRONICS INDEX TO ADVERTISERS

The following project has been submitted by a reader

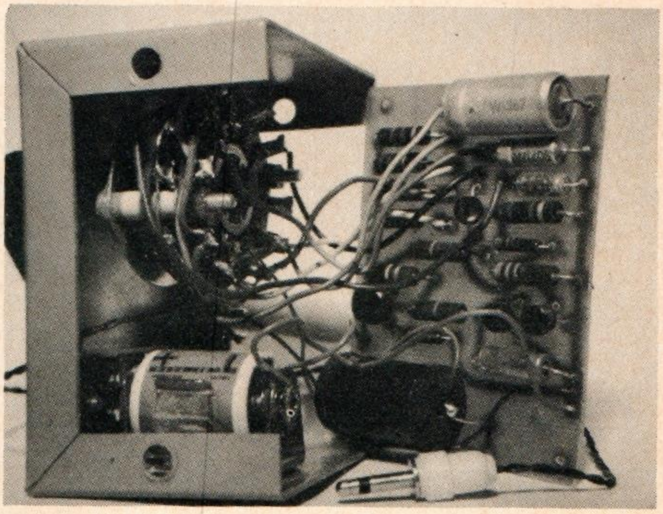
PULSER FOR TIME LAPSE PHOTOGRAPHY

by P. J. Bunge

Most Super 8 cameras today are fitted with facilities for single-shot, time-lapse or remote operation. If the camera is set on single-shot and an exposure is made once every few seconds, then the elapsed time is compressed when the film is projected. In this way pictures of clouds drifting by, sunrise or sunsets, flowers opening and tides going in or out can be captured on ten or fifteen seconds of film and shown in speeded up motion.

This pulser uses a programmable unijunction transistor (P.U.T.) for its timer and a reed switch to operate the camera. R1, R2, R3, C1, C2 and C3 are switched to provide appropriate time constants. When the voltage at the anode of the PUT charges to the same voltage as that at the junction of voltage divider R4 and R7 then the PUT fires in much the same way as an ordinary unijunction transistor does. D1 temperature compensates the PUT. Q1 and Q2 discharge C4 and stretch the pulse from the PUT to ensure reliable camera operation. Q3 is switched on by this pulse and energises the reed switch. Almost any reed switch will work; if the coil is unsuitable, or is missing, simply keep adding turns around it (about no. 30 wire) until the switch closes when the coil is placed across 4.5 volts, then add 10% more turns for reliability.

Nearly any silicon transistors and diodes should work for Q1, Q2, Q3, D1 and D3. R1, R2 or R3 may need changing a value or so if the timing is off. C1, C2 and C3 must be Tantalum types for low leakage or the PUT will not fire. SW3 permits using the pulser as a remote switch. The reed switch could be replaced by a sensitive relay, and either could operate a mechanical camera release solenoid with its own battery supply (these are usually 12 volt high current solenoids). In this case C4 can be adjusted to determine the number of frames exposed per pulse.

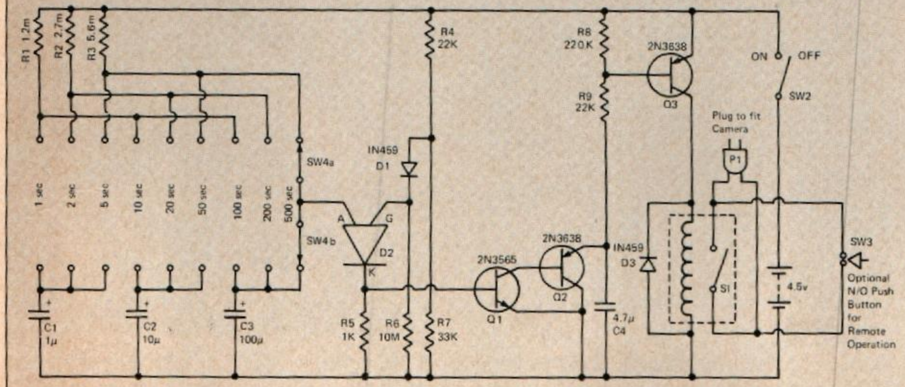


spacing	Seconds of projection time 5	10	15	20	30
1	1min 30secs	3min	4min 30secs	6min	9min
2	3min	6min	9min	12min	18min
5	7min 30secs	15min	22min	30min	45min
10	15min	30min	45min	1hr	1hr 30min
20	30min	1hr	1hr 30min	2hr	3hr
50	1hr 15min	2hr 30min	3hr 45min	5hr	7hr 30min
100	2hr 30min	5hr	7hr 30min	10hr	15hr
200	5hr	10hr	15hr	20hr	30hr
500	12hr 30min	25hr	37hr 30min	50hr	75hr

Chart showing relationship between exposure spacing, the amount of elapsed time, and the amount of projection time for a completed film.

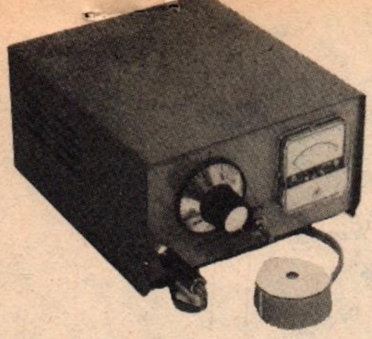
Parts list

C1	1u 6v Tantalum
C2	10u 6v Tantalum
C3	100u 6v Tantalum
C4	4.7u 6v Tantalum
R1	1.2m
R2	2.7m
R3	5.6m
R4, R9	22K
R5	1K
R6	10m
R7	33K
R8	220K
D1, D3	1N459
D2	D13T2 Programmable Unijunction Transistor (PUT)
Q1	2N3565
Q2, Q3	2N3638
SW1	Reed switch (see text)
SW2	SPST
SW3	SPST mom. pushbutton. N.O.
SW4	2 pole 9 position rotary



Battery and holder, case, knob and miniature earphone jack to fit camera.

The author's Pulser was built into a Hammond 1411D Handy Case.



DARKROOM PRINTING METER.

Print-paper saver gives you fine B&W prints sooner!

by Herb Friedman

TRY TO grind out wallet-size prints or enlargements from a full 36-exposure roll in only one evening and you'll know just how frustrating life can be. Every change in magnification and negative density means a different exposure. And if you use test strips or exposure guides to hit the correct exposure you're making at least two prints for every one you need.

The way to take all this drudgery out of your darkroom work is to use an electronic printing meter, a device that takes only seconds to indicate the correct exposure, regardless of whether the enlarger is at the top or bottom of the rack, or whether the exposure and negative development is over or under.

A quick example will illustrate how easy it is to make prints with a printing meter. Let's assume you have just chocked the negative in the enlarger and have cropped the picture exactly the way you want it. Now you take the probe from a printing meter—which you have previously calibrated for a 10 or 20-second exposure—place it on the easel at the point of maximum light transmission through the negative (the black reference in the print—deepest shadow) and adjust the lens diaphragm until the printing meter's pointer indicates some reference value you have previously selected.

That's the whole bit. Expose the paper for your normal 10 or 20-second exposure and the first print will be a good print. Maybe even a great print. If you're grinding out wallet-size jobs for the whole family, each print from each frame will have the same excellent quality.

A Hint. The key to successful use of a printing meter lies in the fact that, except for some particularly artistic work, any print will look decent to excellent if there is some deep black, even if it's just a spot of black; for the black to highlight or border-white contrast gives the visual appearance of a full contrast range, even if the greys are merged. For those who do portraiture, a printing meter can be user-calibrated for "flesh tones."

The printing meter shown in the photographs has been especially designed for construction and use by the typical e/e photographer/electronics hobbyist. It features a calibration—called "speed"—adjustment to accommodate slow to fast enlarging papers (such as Polycontrast and Kodabromide) and readily available parts, many of which will be found in the typical experimenter's junk box. The layout is non-critical—any cabinet can be substituted; there are no critical shielded circuits (not even shielded wire is used); and except for the photoresistor sensor, just about any component quality will do. There is absolutely no sense in building the project with the best components money can buy because the best components won't affect the final performance one iota.

Construction. The unit shown is assembled in a 5¼ x 3 x 5⅞-in. metal utility cabinet. Connecting jack J1 is optional as the photoresistor sensor, PR1, can be hard-wired into the circuit. If you use a jack, note that it must be the three-terminal type such as is used for stereo connections; the ground connection is not used since neither PR1 lead is grounded. Do not use an ordinary phone or phono jack as they will ground one of the PR1 leads. Plug P1 must similarly be a matching three-terminal stereo type. Either miniature or full-size jacks and plugs can be used.

Power switch S1 can be anything you care to use—lever, slide, or toggle. Use the least expensive slide switch if you're trying to keep the cost down.

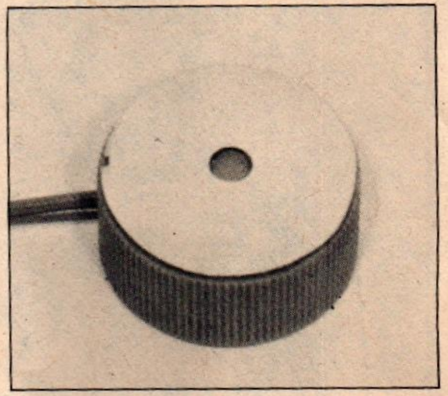
The meter, M1, is a Lafayette Radio 99-26262 illuminated 0-1 mA S-meter. This meter was selected because it has built in pilot lamps with 6 and 12-volt connections. When 12-volt-connected to T1, which is 6 volts, the pilot lamps are dim enough not to affect the sensor and bright enough so that you can see the pointer in the darkroom. Meter M1 mounts in a 1½-in. hole, which can be cut with a standard chassis punch (if you have the punch).

Sort Them. The meter scales are jammed with numerals that can be confusing in the darkroom so the best bet is to paint out the unwanted "calibrations" using Liquid Paper or Liquid KO-REC-TYPE, products used to correct typewriter errors (available in stationery stores). First, snap the plastic cover off the meter. It might feel secure but it's not. Grasp the top of the cover and force the cover outward and down, taking care that when it snaps free the pointer isn't damaged. Next, remove the scale by taking out the two small screws and sliding the scale out from under the pointer. Do not attempt to paint the scale while it is mounted in the meter as a single drop of the fast-setting correction fluid can ruin the meter if it gets into the pivot bearing. When reinstalling the scale, hold the screws with a tweezer or long-nose pliers until you "catch" the first few threads. When the scale is secure, snap the meter's cover into position. (On the unit shown all scales and markings other than 0-to-1 have been painted out, as the 0-to-1 scale is the most convenient to see under dim lighting.)

Note that meter M1, power switch S1, and jack J1 have been positioned on the front panel so as to provide the maximum room for the speed control's calibrated knob. Use the largest possible knob as the greater the calibrations the easier it is to reset the control to a desired paper speed.

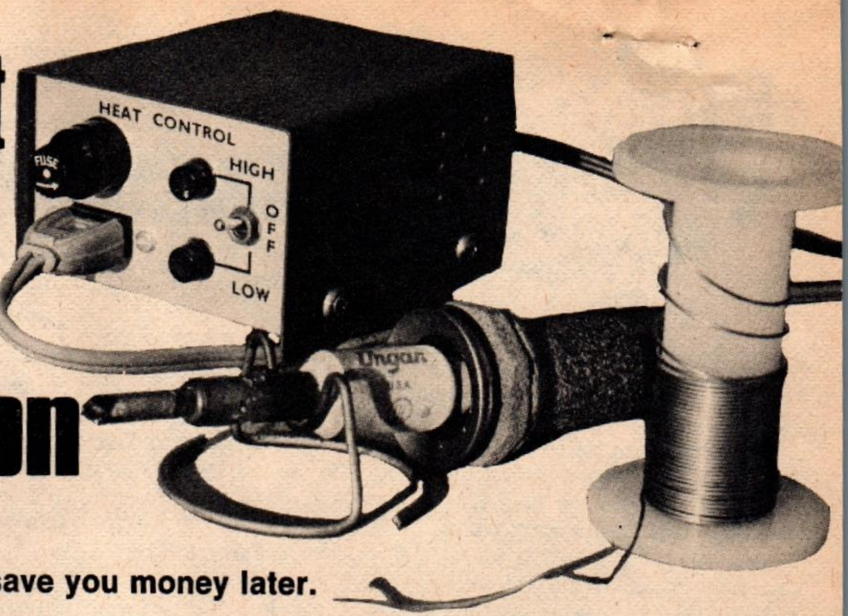
Power transformer T1 can be any 6.3-volt filament transformer rated 50 mA or higher. (A 6-volt transformer scrounged from a portable cassette recorder will work just fine.)

Power Filter. If the line voltage in your home is known to be reasonably constant, assemble the unit as shown in the schematic. If your local utility likes to bounce the line voltage, or if appliances cause your line voltage to vary (indicated by dimming lights), install zener diode D5 across points A and B.



The sensor is really a large tuning knob with photoresistor PR1 embedded in epoxy, plastic or RTV rubber adhesive.

Build a Heat Controller for Your Soldering Iron

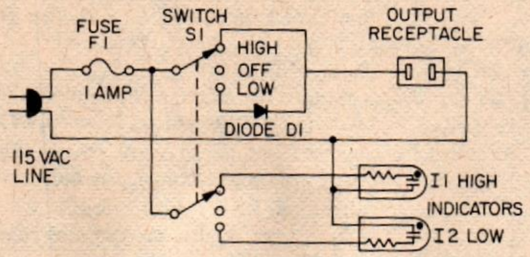


By John Keidel and Frank Cicchiello

Inexpensive and easy to build, it will save you money later.

One trick that old timers have used for years is to connect a diode in series with a medium-to-heavy duty soldering iron. This halves the value of the iron's wattage rating, making it especially useful for soldering transistors, integrated circuits and low-wattage resistors.

But this arrangement limits the versatility of the iron, since there are times when one may wish to solder to a metal chassis or make other heavy-duty type connections. The soldering iron Heat Controller described here provides low/high-wattage versatility in a compact case, with a convenience outlet.



Schematic diagram of two-position heat controller for 50-watt soldering iron. It's easy to wire up—should take about an hour for entire project.

PARTS LIST FOR HEAT CONTROLLER

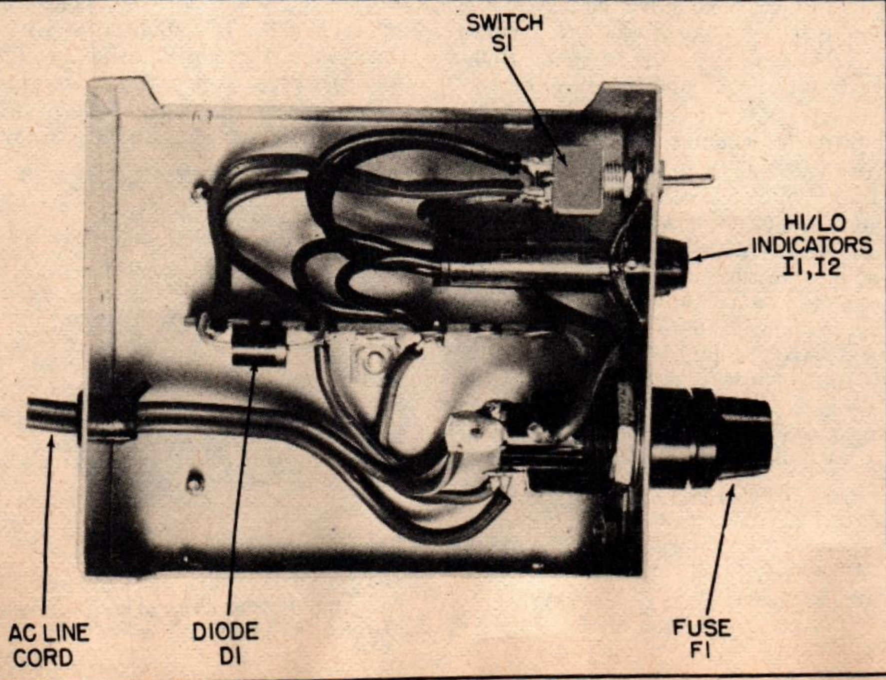
D1—1-amp, 200-volt silicon diode (Radio Shack 276-1137 or equiv.)
F1—1-amp, fast-acting fuse (Radio Shack 270-1273 or equiv.)
I1, I2—Panel Lamp Indicators, 115-volt AC (Radio Shack 272-1501 or equiv.)
S1—SPDT, Neutral Center, switch (Radio Shack 275-325 or equiv.)
Hardware Items and Misc.—Case 3¼-in. x 2¼-in. x 4-in. (Radio Shack 270-251), 4-lug terminal strip (Radio Shack 274-687), Fuse Holder (Radio Shack 270-364), AC Outlet (Radio Shack 270-642), Line cord with plug, strain relief or grommet, solder, wire.

How It Works. Diode D1 shown in Fig. 1 provides half wave rectification of the AC line voltage when switch S1 is in the *Low* position. Throwing switch S1 to the *High* position allows full line voltage to be applied to the soldering iron receptacle. The center OFF position removes power from the outlet. Fuse F1 prevents any harmful effect if the iron's element should become short-circuited. Indicator lamps I1 and I2 add a professional touch to the equipment, and also act as On-Off pilot lights.

Construction. All components except diode D1 are mounted on the case. Diode D1 is soldered to a terminal strip, which also provides terminal points for the various interconnecting wires. Wiring is point-to-point and not critical. The photo illustrates the location of the components. Transfer letters are used for the individual panel markings.

This is a very easy project, and the hour or so it takes to assemble it (once you've got the parts together) will be quickly repaid by the added convenience of having two different iron heats to work with.

Using the Heat Controller with a 50-watt soldering iron which takes various tips will handle about 95 percent of all your soldering iron work. It's only the very occasional super-heavy job that will require anything else, and that would require a much bigger iron anyhow. ■



Mechanical layout of heat controller. Putting this project together is not only good practice for beginners—it gives you a versatile tool which will make future projects easier.

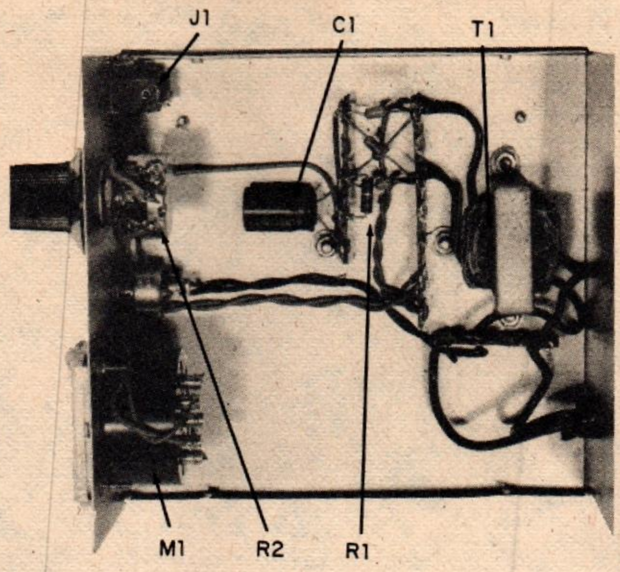
The zener will provide a regulated 6 volts, with the slightly lower circuit voltage (6 VDC rather than 9 VDC) providing slightly reduced sensitivity. Normally, you will not need D5, so there's no need to get it unless you're certain you need it.

In order to get speed control R2 to increase sensitivity in the expected clockwise direction, its ground terminal is opposite to the usual volume control ground. Facing R1's shaft with its terminals sticking up, the ground terminal is the one on the left.

Meter M1 has five terminals. The one designated "+" and the one adjacent to it are the meter terminals. The three terminals above the meter terminals are the pilot lamps. The extreme end pilot lamp terminals are the 12-volt connections. The center terminal is not used for the 12-volt connection.

The Eye. The only assembly that requires some care is the sensor. The sensor itself is a photoresistor; however, the photoresistor doesn't have enough heft to maintain its position on the easel, so it must be mounted in a support that can maintain its position without falling over. The sensor assembly shown consists of PR1 epoxy-cemented into a relatively large knob. The knob must be plastic—not metal, though it can have a metal decorative rim—and it's best if there is a recess on the top even if the recess is produced by a rim. Remove the set screw and drill out the set screw hole with a bit approximately 3/16-in. (not critical). Then, using a ⅜-in. bit, drill through the shaft hole clear through the top of the knob. If the shaft hole has a brass (or other metal) bushing make certain the drill bit removes all the metal.

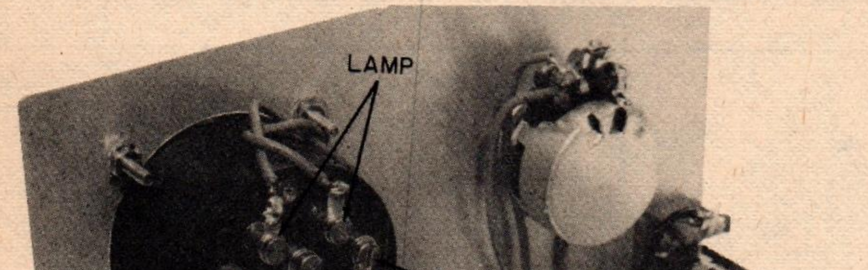
Pass the PR1 leads through the hole in the knob from the top. Tape it in position. Feed a section of linecord or speaker wire through the setscrew hole and solder the wires to PR1 as close as possible to the knob. Trim away the excess PR1 leads; they should not protrude below the knob. Remove the tape holding PR1, get PR1 as close to the center of the knob as possible, and then pour in a quantity of fast-setting epoxy or liquid plastic from a knob repair kit or plastic modeling kit, and let it set a few minutes until the plastic hardens. Keep the level of the epoxy or plastic below the top of PR1—use less rather than more. If you can't get epoxy or plastic you can use G.E.'s silicon RTV rubber (adhesive, caulk, window sealer, etc.); but the RTV rubber must cure for at least 24 hours. Similarly, pack the bottom of the knob with epoxy, plastic or rubber.



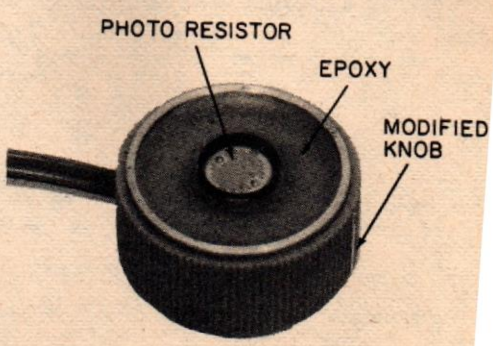
Nothing is critical so don't crowd the layout. Two parallel terminal strips provide the tie points for the rectifier diodes and power supply

Mask Down. Now, the surface area of the photoresistor is too large for small prints—4 x 5 or smaller—and even some 8 x 10s. So cut a disc the diameter of the knob from shirt cardboard or a manila file folder (but not oak-tag) and using a standard hand punch (such as used in schools) punch a hole in the center of the disc. Apply rubber cement to the rim of the knob and the inside rim of the disc. When the cement is dry drop the disc on the knob so the hole exposes a small part of the photoresistor's surface. It's not all that critical; the hole doesn't have to be precisely over the center of the photoresistor. However, the unit is calibrated for a punch-size hole and might not work properly if the disc is not used, or if the hole is a hand made "pinhole." Use the punch.

Using the Meter. The first step is to select a decent reference negative and make a good print using a 10, 15, or 20-second exposure. We suggest 20 seconds as it will become your standard exposure, and will be



The specified meter has five terminals. The two on the bottom row are for the meter movement. The top row terminals are for the 12-volt lamp connection. The remaining terminal is for a 6-volt lamp connection and is not used.



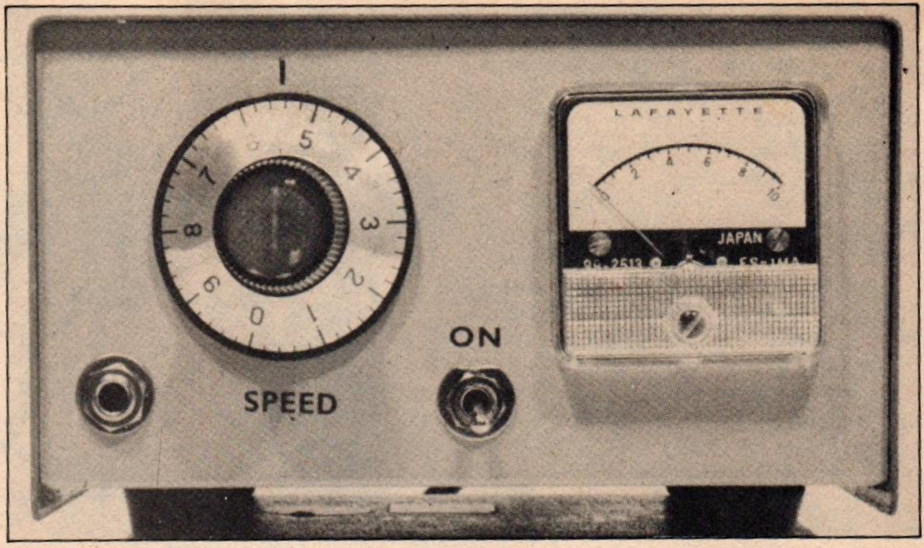
After the sensor is completed, punch a hole in a matching cardboard disc and cement the disc over the sensor. The hole provides a smaller sensitive area required for prints 4 x 5 or smaller. Better results with larger prints are also obtained with the mask.

DARKROOM PRINTING

sufficiently long to allow moderate dodging. When you are certain you have a print exactly the way you want it, and without disturbing the enlarger's controls, place the printing meter's sensor under the *brightest* light falling on the easel—it produces black (maximum shadow) on the final print. Now turn on the printing meter and allow about five seconds for warm up. Adjust speed control R2 so the meter pointer indicates any meter reading you want to use as a reference. It doesn't matter what the reading is as long as you always use the same reference for the standard exposure time. For example, 0.2 on the meter scale is a good choice because it is well illuminated by the meter lamps. But you might just as easily select mid-scale as the reference meter reading. It doesn't make any difference; just be consistent.

Once you have adjusted the speed control for the reference meter reading note on a piece of paper or in a notebook the dial reading from the speed control's calibrated knob. This is the reference speed value for the particular printing paper. For example, let's say you made the test print on Polycontrast using the #2 filter, and the speed knob indicates 5.6. Next time you want to print using Polycontrast with a #2 filter you simply set the speed knob to 5.6, put the sensor under the darkest shadow area and adjust the lens diaphragm for a reference meter reading. Everything will be set for your standard exposure time.

Changing Filters. Kodak provides a speed rating for all their papers and you can easily work out the correct (or close) speed control settings without making a "perfect" test print for each



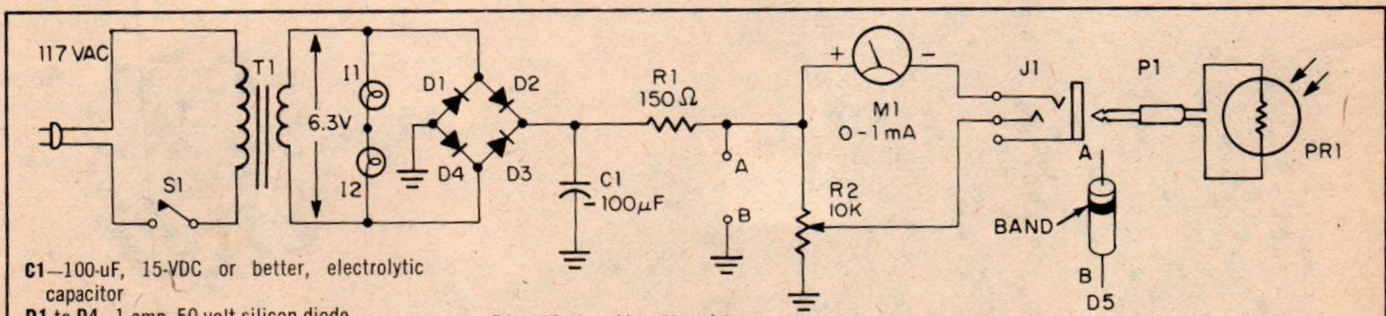
Use the largest calibrated knob you can install without interference by other-panel components. The greater the calibration area on the knob the easier it is to preset the paper speed with accuracy.

type and grade of paper. For example, changing from a #2 to #4 filter usualy means increasing the exposure by a 3.5X factor. If your #2 exposure is 10 seconds, the #4 exposure will be 35 seconds—somewhat long. You can, however, open up the lens diaphragm for a 3.5X light increase (close enough value) and adjust the speed control for the reference meter reading. The new speed control setting is the speed value for the #4 filter. You can do this with variable contrast filters or numbered printing paper.

While the most pleasing print usually has some black. there are times when there can be no black, such as snow scenes, portraits, etc. You can peg the speed control's calibration to a grey corresponding to a skin tone, or any other degree of grey you might desire. The only thing you cannot do is calibrate the meter for highlights, since the meter might not have enough sensitivity for slow papers, and highlights can completely fool the meter.

If desired, you can take a speed control calibration reading for each type of paper (using your standard negative) for both shadow detail and intermediate grey. This way, you can quickly set up for typical snapshots, scenics, or portraits.

Keep In Mind. The sensor has a slight light memory, so we suggest the sensor be turned face down when not being used and the power switch be turned on and off in the dark, though you can keep the darkroom illuminated by a safelight with the power switch on. Meter readings, however, must be taken with all room lights off; only the enlarger should be on and the print meter should be positioned so that its meter lamps do not illuminate the sensor (even slightly). ■



C1—100-uF, 15-VDC or better, electrolytic capacitor
D1 to **D4**—1-amp, 50-volt silicon diode
D5—6-volt, 1-watt zener diode (optional, see text) (Radio Shack 276-561 or equiv.)
I1, I2—meter lamps, part of M1 (see text)
J1—3-circuit jack and plug set (optional, see text)
M1—0-1 mA movement, illuminated S-meter (see text)
PR1—photoresistor (National 4941 or equiv.)
R1—150-ohm, ½-watt resistor
R2—10,000-ohm audio taper potentiometer
S1—spst switch
T1—transformer: 117 volt primary, 6.3 volt at 50 mA or better secondary
Misc.—large knob for mounting photoresistor, case 5¼ x 3 x 5⅞-in., 5-lug terminal strips for mounting components, wire, etc.

The National 4941 photoresistor is available from the Electronic Hobby Shop, Box 192, Brooklyn, NY 11235 for $3.75 postpaid. New York state residents add sales tax; Canadian orders add $2 for extra postage. No foreign orders, please.