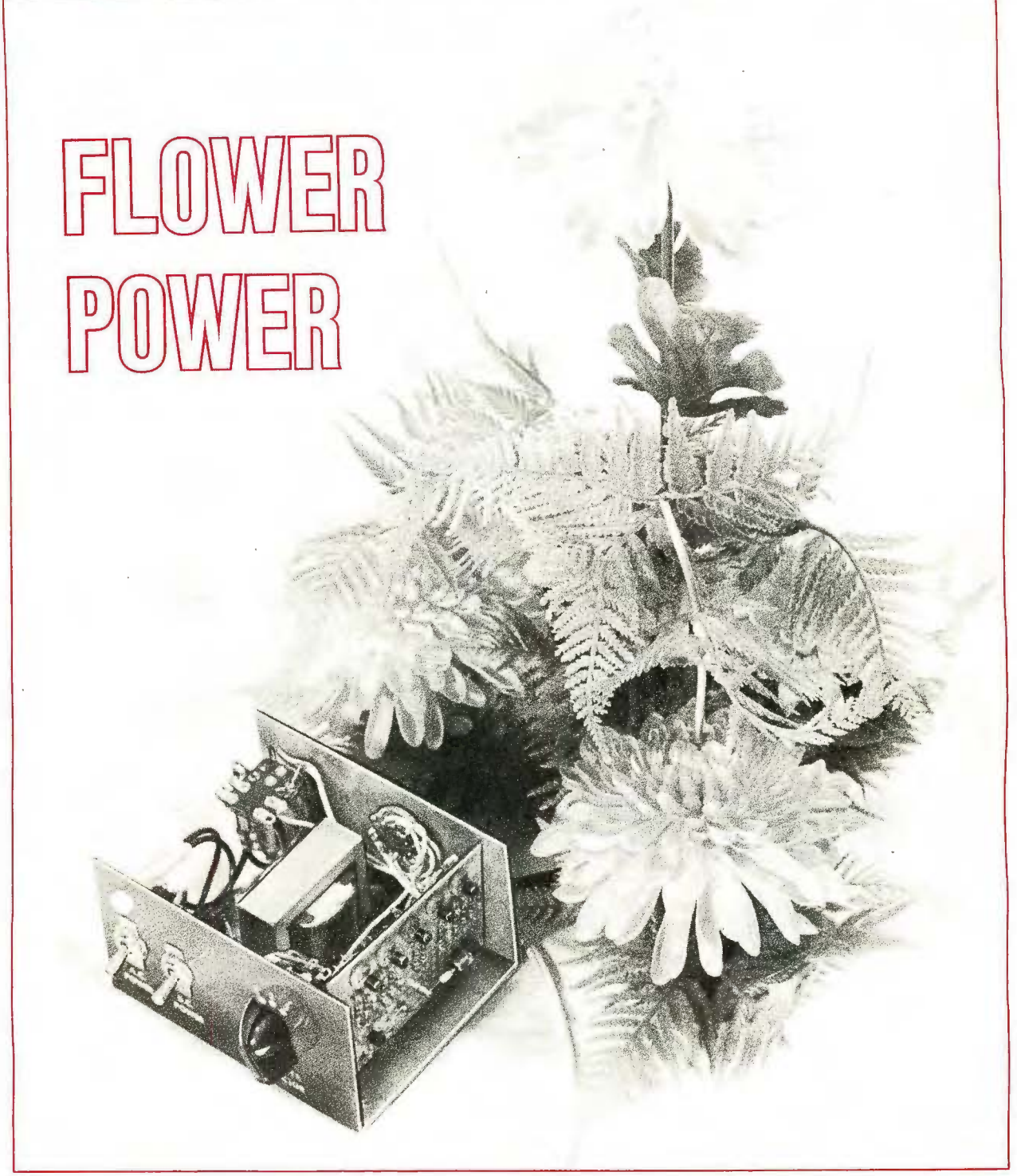
FLOWER POWER

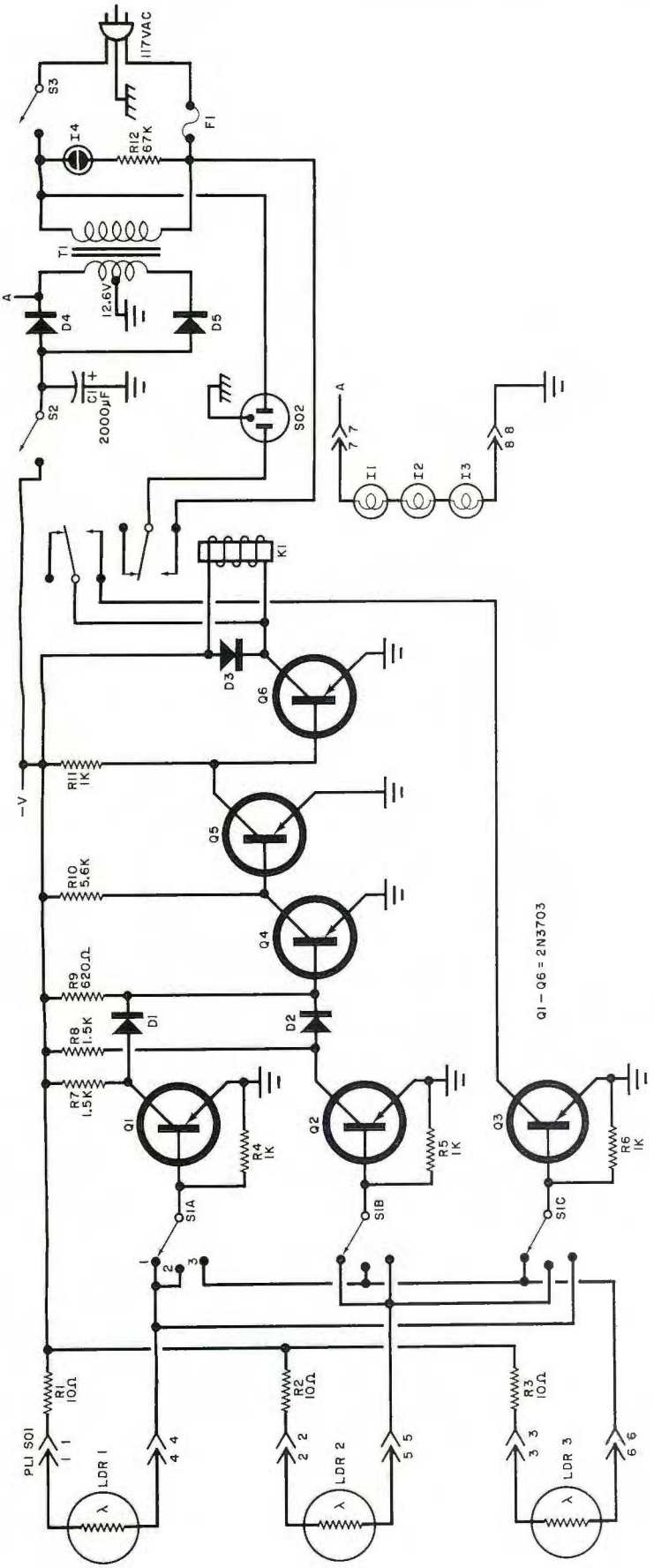


Photocell, transistor-diode ac power control system

BY JIM SQUIRES

HERE is an electronic system which can be used to control up to 350 watts of ac power simply by varying the amount of light applied to a set of three photocells (light dependent resistors or LDR's). The latter can be mounted in any convenient location—in the case of the prototype, they were concealed in an arrangement of artificial flowers. (Hence the name, "Flower Power.") The system acts as a safety device to prevent the activation of a potentially hazardous appliance by young children. The illuminated flowers also provide a decorative control system which can function as a night light.

About the Circuit. In the project (see schematic diagram), pilot lamps *I1* through *I3* are attached to the bottoms of plastic flowers in line with light dependent resistors *LDR1* through *LDR3* mounted at the base of the arrangement. When an LDR is illuminated, its resistance is relatively low, on the order of a few hundred ohms. But when the LDR is placed in the dark or shade, its resistance goes up to a megohm or more. This in-



Light dependent resistors are energized by light from three lamps hidden among the flowers.

PARTS LIST

C1—2000-μF, 15-volt capacitor
D1,D2,D3—Germanium diode (1N56A, HEP R9134, or similar)
D4,D5—Silicon Diode (1N692, HEP R0052, or similar)
I1,I2,I3—#222 lensed incandescent lamp
I4—NE-2 neon lamp
K1—6-volt dc relay, 15-A contacts (Lafayette 30 27042 or similar)
LDR1—LDR3—Hobby-type photocell (Radio Shack No. 276-116 or similar)
Q1-Q6—Silicon pnp transistor (2N3703, HEP S0019, or similar)
PL1—Octal plug
All resistors ½W, 10%
R1,R2,R3—10-ohm resistor
R4,R5,R6,R11—1000-ohm resistor
R7,R8—1500-ohm resistor
R9—620-ohm resistor
R10—5600-ohm resistor
R12—67,000-ohm resistor
S1,S2—Spst toggle switches, 125-V, 3A
S3—4-pole, 3-position, non-shorting rotary switch
SO1—Octal socket
SO2—Three-conductor power receptacle
T1—12.6-volt center-tapped 1-A filament transformer
Misc.—Power cord; perforated board; metal utility box (5" x 4" x 3" or 12.7 cm x 10.2 cm x 7.6 cm); fuse holder; green stranded hookup wire; solder; press-on heat sinks; sheet aluminum wire; plastic flowers and leaves; silicone cement; vinyl tape; florist's crepe green stem tape; florist's wire; terminal strips; machine hardware; solder; etc.

crease in resistance is used to turn transistors on and off to control appliance power.

Three combinations of two illuminated LDR's and one shaded LDR are afforded by switch *S1*. With switch *S1* (the "Flower Selector" on the front panel) in position 1, shading *LDR1* and *LDR2* but not *LDR3* causes *Q1* and *Q2* to cut off, leaving only *Q3* conducting. Thus, the outputs (V_{CE}) of *Q1* and *Q2* are high. They are combined by diode AND gate *D1*/*D2* to produce a high input to the base of *Q4*. This transistor saturates, and its V_{CE} goes low, cutting off *Q5*. In turn, V_{CE} of *Q5* is high, and *Q6* energizes *K1*.

One set of the relay's contacts is wired across *Q6* through *Q3*. Since *LDR3* permits base current to flow, *Q3* saturates, keeping the bottom of *K1*'s coil at ground potential regardless of *Q6*'s state. Only by shading *LDR3* will the relay drop out, since *Q3* will cut off current through *K1*'s coil. Diode *D3* protects the switching transistors from the coil's inductive "kick".

The other set of *K1*'s contacts apply line voltage across power socket *SO2* when they close. Fuse *F1* should be chosen to fit the peak current demand, while neon lamp *I4* monitors the voltage on the fused side of the ac line.

The switching and lighting circuits

derive their power from a supply consisting of *T1*, and the full-wave rectifier/filter circuit made up of *D4*, *D5*, and *C1*. When only night light or TV light operation is desired, ac power switch *S3* should be closed and dc switch *S2* left open.

As mentioned earlier, three combinations are possible. Two LDR's, when momentarily shaded, turn the appliance on, while the remaining one cuts off *Q3* when its surface is shaded. This deenergizes *K1* and removes line voltage from *SO2*, turning the appliance off. The proper grouping for positions of FLOWER SELECTOR switch *S1* follow:

S1	FLOWER 1	FLOWER 2	FLOWER 3
1	ON	ON	OFF
2	ON	OFF	ON
3	OFF	ON	ON

That is, shading the LDR's below flowers 1 and 2 will turn the appliance on when *S1* is set to position 1. Shading the LDR below flower 3 will turn it off. The two other positions dictate similar patterns — but note that both on LDR's *must* be shaded simultaneously. Another safety feature is the protection given the appliance from power surges after a power failure.

If the project is supplying ac line current to an appliance when power fails, it keeps the load isolated from the line even after power has returned. In such a case it will be necessary to go through the correct shading procedure to restore power to the appliance.

Construction. Flower Power is composed of two units — the power board and the flower assembly. Most of the components are mounted on the power board. Only the switches, LDR's and lamps are off the board.

Since the circuit is relatively simple, it can be wired on a piece of perforated board. For safety purposes, the board should be mounted inside a metal utility box. The box can be concealed inside a clay flower pot for a more aesthetic appearance. Mount two sockets on the utility box. Octal socket *SO1* provides dc power for the LDR's and ac power for *I1*, *I2*, and *I3*. Socket *SO2* is a standard three-conductor power receptacle, into which the appliance should be plugged.

You will probably find that *Q3* and/or *Q6* get a bit hot in continuous operation. If desired, use press-on heat sinks. Allow clearance when mounting the board in a metal box for the leads from *F1*, *T1*, and the neon bulb *I4*.

Form three support flanges from sheet aluminum about 10" (25.4 cm) long to begin the flower assembly. Drill a ¼" (6.35 mm) hole at the straight end of each flange, and form a y-shaped base by securing the flanges with machine hardware. Also bolt three lengths of aluminum wire, such as used for clothesline to this point. Mount a cluster of plastic leaves on each flange and cement an LDR (avoid shorts) to the center of each cluster. Then remove the wire stem from each of three plastic flowers and slide the piece onto the aluminum wires to form a three-flower arrangement.

Solder a 36" (1-m) length of green stranded hookup wire to each contact of three #222 lensed lamps and LDR's. Then, with a small bead of silicone cement, mount a lamp at the *bottom* center of each flower. Wrap a layer of vinyl tape around the base of each lamp and LDR lead.

Next, route the wire pairs along the stems, wrapping them securely with florist's crepe stem tape (green) to the stems. Tie all wires into a neat bundle at the base of the arrangement. Cut the free ends of the wire bundle flush and prepare for soldering. Identify the leads using an ohmeter across the LDR's and a 6-volt battery across the lamps and connect and solder the appropriate leads to an octal plug (*PL1*). Be sure to secure the bundle every few inches with florist's wire. Finally, bend the stems so the lamps are directly over and about 2" to 5" (5.1 to 12.7 cm) above the LDR's.

Testing. Double check all wiring and physical assembly. If everything looks OK, insert *PL1* into *SO1* and turn on ac power switch *S3*. All lamps including *I4* should glow. Follow this by closing dc power switch *S2*, and place FLOWER SELECTOR switch *S1* in position 1. Shade *LDR1* and *LDR2* — you should hear the relay click as it latches on. Then shade *LDR3* — you should hear another click as the relay deenergizes.

Now, plug a lamp into power receptacle *SO2*. Repeat the shading procedure. The lamp should turn on and off in step with the relay. Open *S2* and check each of the three combinations. As a rule, open *S2* before changing the combination or opening *S3* (when turning the system off) and close *S3* before *S2* when activating the system. And remember — *please* don't water the flowers! ◈