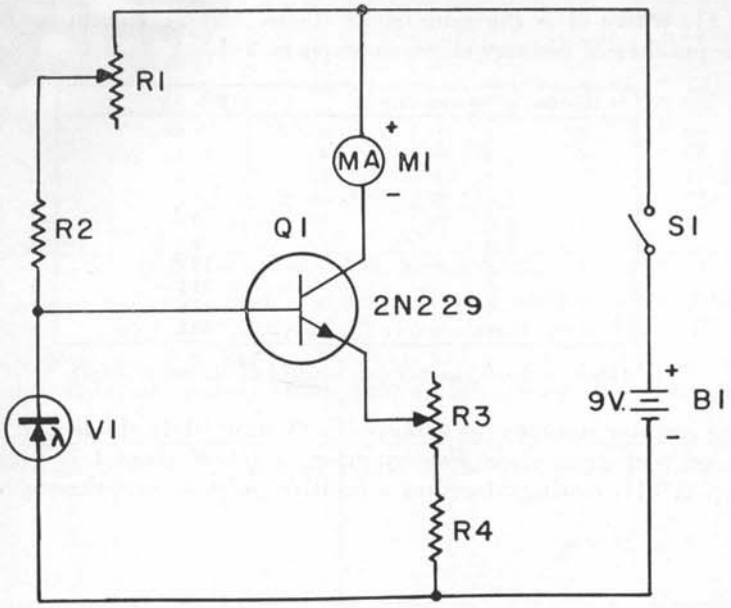

FIGURE 35—Photography Light Meter.

The photodiode V1 must be polarized correctly. The cathode end of the photodiode is indicated by a red dot on body of the unit.

PARTS LIST

B1—9V. Battery, Burgess #2N6 with snap terminals or equivalent.
M1—Meter, 0 to 15 milliamperes D.C.
Q1—Sylvania 2N229 Transistor.
R1—25K Potentiometer.
R2—27K, ½w. Resistor.
R3—250Ω Potentiometer.
R4—68Ω, ½w. Resistor.
S1—S.P.S.T. Toggle Switch.
V1—Sylvania 1N77A Photodiode.

36. BINARY COUNTER

Description of Operation:

The binary counter consists of a cascade of flip-flop circuits containing indicator lights so that the state of each stage of the counter may be observed visually. The counter might be used by science or mathematics teachers for demonstrating binary addition or by students as part of a science fair display of computer type circuits. The circuit may be operated by a relay and be used to count objects moving on a conveyor belt or persons passing a photocell, etc.

The schematic diagram shows two stages but the counter may be extended to as many stages as desired. The counter counts from 0 to

$(2^N - 1)$, where N is the number of stages. The maximum count for a given number of counter stages is given in Table I.

N (number of counter stages)	$(2^N - 1)$
1	1
2	3
3	7
4	15
5	31
6	63
7	127
8	255
9	511
10	1023

TABLE I—Count capability as function of number of stages.

The counter operates as follows. Each time S1 is closed the flip-flop of stage 1 changes state. For example, if Q1 of stage 1 is conducting (lamp I1 lit), closing S1 causes a positive pulse to pass through C1 and

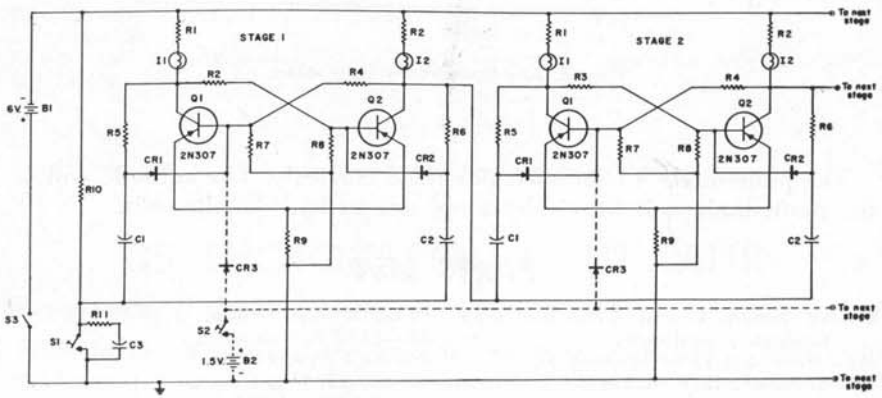

FIGURE 36—Binary Counter.

CR1 to the base of Q1 causing Q1 to be cut off and consequently Q2 to be turned on and lamp I1 to be lit. The positive pulse did not pass through CR2 because it was reverse biased through R6. The next time S1 is closed Q2 is turned off and Q1 turned on.

Each time Q2 of stage 1 is turned on the second counter stage changes state. Similarly each time Q2 of stage 2 is turned on stage 3 changes state. Thus the first stage changes state each time S1 is closed; the second stage changes state every second time S1 is closed; the third stage change state every fourth time S1 is closed, etc.

The way the count, or the number of times S1 has been closed, is displayed as shown in Table II.

Count	Stage 1		Stage 2		Stage 3	
	Lamp I1	Lamp I2	Lamp I1	Lamp I2	Lamp I1	Lamp I2
0	off	on	off	on	off	on
1	on	off	off	on	off	on
2	off	on	on	off	off	on
3	on	off	on	off	off	on
4	off	on	off	on	on	off
5	on	off	off	on	on	off
6	off	on	on	off	on	off
7	on	off	on	off	on	off
8	pattern	repeats				

TABLE II—Count display for 3 stage counter.

If one adapts the convention that lamp I1 of a particular stage being on represents 1 and Lamp I1 being off represents 0, then Table II may be written as shown in Table III. In Table III, the count is given in its binary representation written from right to left (least significant digit on right).

Count	Stage 1	Stage 2	Stage 3
0	0	0	0
1	1	0	0
2	0	1	0
3	1	1	0
4	0	0	1
5	1	0	1
6	0	1	1
7	1	1	1
8	pattern	repeats	

TABLE III—Binary representation of count (least significant digit on right).

Table III (and also correspondingly Table II) may be extended to an additional stage 4 by repeating the pattern for the two stages shown to give 15 count positions and in the stage 4 column writing 0's to count 7 and 1's to count 15. In this manner the table may be extended to any number of stages.

In the schematic diagram the part of the circuit shown in dotted lines (containing S2, B2 and diode CR3) may be included to reset the counter to zero by closing S2 momentarily.

The power dissipation in the transistors is low and they need not be mounted on a heat sink.

PARTS LIST

B1—6V. Battery, Burgess F4BP or equivalent.
B2—1.5V. Battery, Burgess #2R or equivalent.
C1, C2—.047 or .05 Mfd. Paper or Ceramic Capacitor.
C3—.1 Mfd. Paper Capacitor.
CR1, CR2, CR3—1N34A Diode.
I1, I2—Sylvania #48 or #49 2V., 60 ma. Pilot Lamp.
Q1, Q2—Sylvania 2N307 Transistors.
R1, R2—68Ω, ½w. Resistor.
R3, R4, R7, R8—1.2K ½w. Resistor.
R5, R6, R10—10K, ½w. Resistor.
R9—4.7Ω ½w. Resistor.
R11—27Ω ½w. Resistor.
S1—Switch, normally open momentary contact pushbutton type such as Grayhill Type 2201 or equivalent.
S2—Same as S1.
S3—S.P.S.T. Toggle Switch.
NOTE: C1, C2, R1 through R9, CR1, CR2, CR3, I1, I2, Q1, Q2 must be duplicate for each stage used.