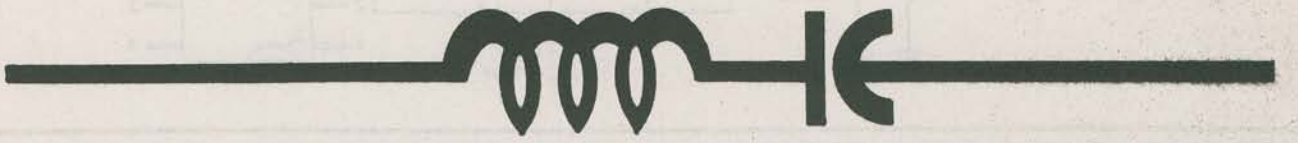
WORKBENCH PROJECTS



The projects we've prepared for you in this section are more complicated than those in our **Circuit Fragments** section, but they are less complicated than the ones in our **IC Testbench** section.

As with any electronics assembly work, be sure you understand how the various parts of the circuit work together and the objective of each component before you start gathering the components together and assembling them. As with any project that uses ICs (integrated circuits) or transistors, be careful to observe precautions regarding overheating their leads. If possible, use sockets instead of soldering directly to their wire leads. If you can't do that, be sure to protect the IC and transistor leads by using long-nose pliers as a heat sink when soldering those leads.

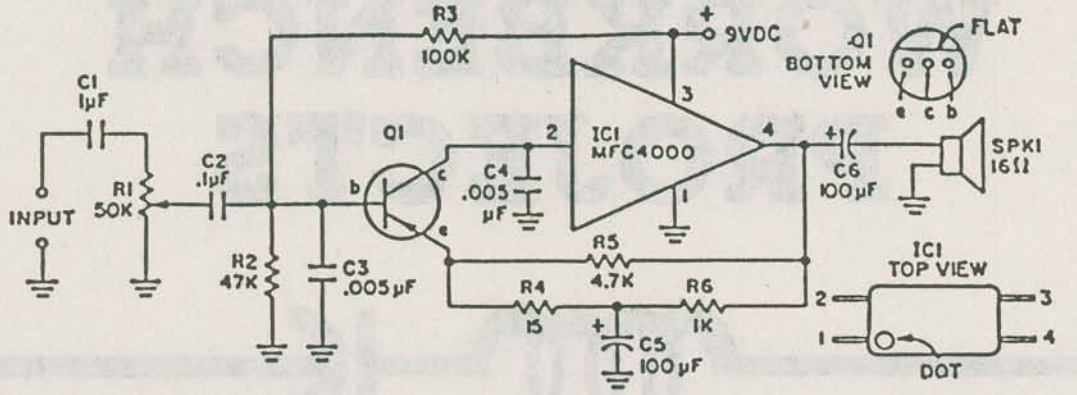
MINIATURE IC SIGNAL TRACER

Featuring extremely high gain suitable for tracing signals directly from microphones and magnetic pickups, our signal tracer can be made small enough to sit directly on the back of the speaker magnet. Though intended for checking transistor circuits, it can be used with tubed equipment if capacitor C1 has a 600 VDC minimum rating, and if volume control R1 is always started from its off position. Regardless of the size speaker used, the speaker impedance must be 16 ohms minimum though higher impedances work better. Power output is approximately 250 mW; more than sufficient output level from a solid-state signal tracer small enough to hide on the back of a speaker magnet.

PARTS LIST FOR MINIATURE IC SIGNAL TRACER

C1—0.1-uF, 600 VDC capacitor (see text)
C2—0.1-uF, 10 VDC capacitor
C3, C4—.005—uF, 10 VDC capacitor
C5—100-uF 3 VDC
C6—100-uF, 10 VDC capacitor (250 uF for better low-frequency response)
IC1—Motorola MFC-4000
R1—Potentiometer, 50,000-ohms audio taper
R2—47,000-ohms, resistor
R3—100,000-ohms, resistor
R4—15-ohms resistor
R5—4,700-ohms resistor
R6—1,000-ohms resistor
Q1—PNP transistor, Radio Shack 276-2021
SPK1—Miniature speaker (see text)

MINIATURE IC SIGNAL TRACER



STEREO SPEAKER PROTECTOR

The advent of the superamplifier, capable of supplying 100 to 200 watts per channel on a continuous basis, has been both a blessing and a curse to the audiophile. The blessing is that a recording's dynamic range can now be more faithfully reproduced, even with inefficient loudspeakers. Unfortunately, these amps are so powerful that loudspeakers can often be overdriven and eventually destroyed, if sufficient care is not exercised. If your amp lacks provisions for speaker protection, you may want to build the speaker protector diagrammed here.

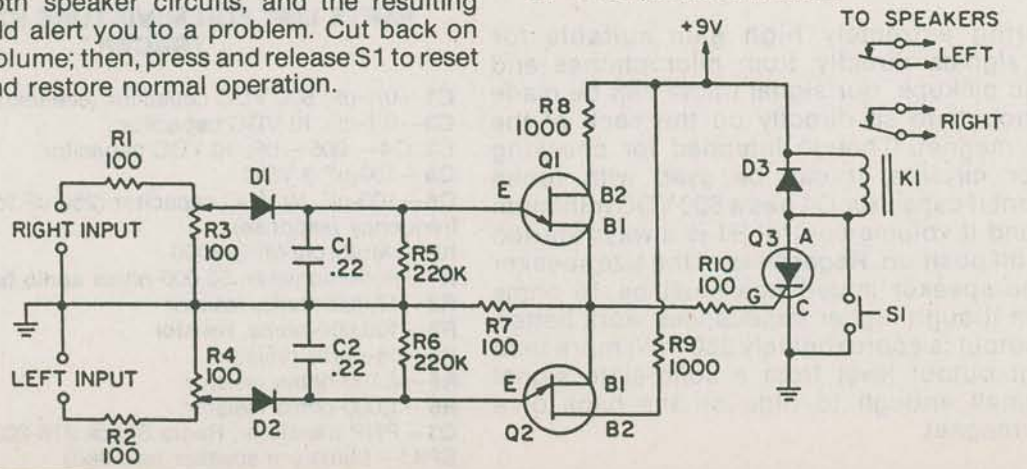
The contacts of relay K1 are hooked in series with your right-and left-hand speakers in such a way that, when K1 is unenergized, its contacts close and complete the circuit to each loudspeaker.

Inputs to the protection circuit come from your amp's outputs (the same outputs that drive the speakers). If the signal feeding the 'right' input is sufficiently large to charge C1 to a potential greater than the breakdown voltage of Q1's emitter, a voltage pulse will appear across R7. Similarly, excessive inputs to the 'left' channel will also produce a pulse across R7, this time due to the discharge of C2 by Q2. The pulse across R7 triggers SCR Q3, which latches in a conducting state and energizes K1. This interrupts both speaker circuits, and the resulting silence should alert you to a problem. Cut back on your amp's volume; then, press and release S1 to reset the circuit and restore normal operation.

The circuit can be adjusted to trip at lower levels from 15 to 150 watts rms. To calibrate, feed a deliberately excessive signal to the 'right' input, and raise R3's wiper up from ground until K1 pulls in. Disconnect the signal from the 'right' input, and apply it to the 'left' input. Press S1 to reset the circuit, and raise R4's wiper up from ground until K1 pulls in again. The circuit is now calibrated. Your calibration signal should preferably be a continuous tone, but a musical passage of fairly constant loudness will probably suffice. K1's contacts should be rated to carry a 3- to 5-amp load.

PARTS LIST FOR STEREO SPEAKER PROTECTOR

C1, C2—.22 uF capacitor
D1, D2, D3—1N914 diode
K1—6-volt relay, DPDT contacts (see text)
Q1, Q2—2N2646 unijunction transistor (Radio Shack RS2029)
Q3—2N5060 sensitive-gate SCR
R1, R2—100-ohm, ½-watt resistor 10%
R3, R4—100-ohm linear-taper potentiometer
R5, R6—220K-ohm, ½-watt resistor
R7, R10—100-ohm, ½-watt resistor
R8, R9—1,000-ohm, ½-watt resistor
S1—N.O. pushbutton switch

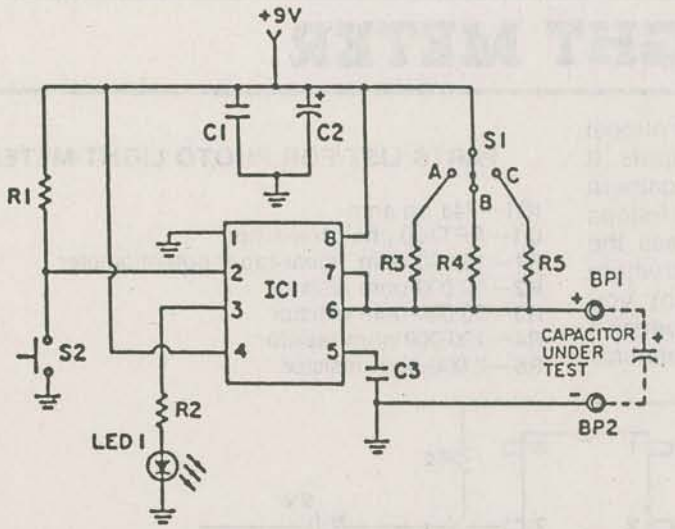


ELECTROLYTIC CAPACITOR TESTER

Here's a quick and simple way to check out all those old electrolytic capacitors in your junkbox. Besides this simple 555 timer circuit, you will need a timepiece with a readout in seconds; the readout may be digital or just an ordinary sweep-second hand. Connect the capacitor to be tested to the binding posts, being careful to observe proper polarities. Now, press S2 and note how long LED 1 stays lit. Multiply the time by the appropriate scale factor to obtain the capacitance. For example, suppose you happen to be checking a very large filter capacitor, which would require that scale C, 100 uF/sec, be used. If the LED remains lit for 67 seconds, the capacitance is 67×100 or 6700 microfarads.

PARTS LIST FOR ELECTROLYTIC CAPACITOR TESTER

BP1, BP2—binding post
C1, C3—0.1-uF capacitor, 35 VDC
C2—100-uF electrolytic capacitor, 16 VDC
IC1—555 timer
LED1—light-emitting diode
R1—100K-ohm resistor
R2—560-ohm resistor
R3—910K-ohm resistor
R4—91K-ohm resistor
R5—9100-ohm resistor
S1—single-pole, 3-position rotary switch
S2—normally open SPST pushbutton switch



TIME SCALE TABLE

Range	Scale
A	1uF/second
B	10uF/second
C	100uF/second

PHOTOELECTRONIC ANNUNCIATOR

Momentarily interrupt the beam of light shining on Q1, and you get a one-second "beep" from this circuit. Most likely you've encountered circuits of a similar nature in retail stores, where the buzzing sound signals your entrance and alerts salesmen to their prey. Obviously, a great many other applications are possible as well.

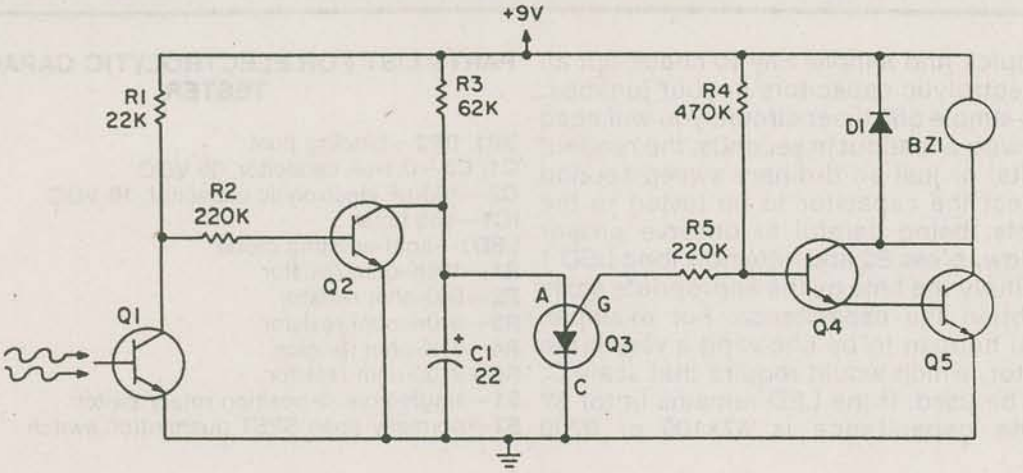
With light shining on Q1's sensitive face, the phototransistor conducts heavily and shunts current away from the base of Q2. But when the beam of light is interrupted, Q1 ceases to conduct—thus allowing current to flow through R1 and R2 into Q2's base. The collector of Q2 then conducts current and rapidly discharges capacitor C1. This allows Q3's gate lead (G) to swing high, thereby turning on Q4, Q5 and the buzzer.

Assuming that the interruption of the beam was only temporary, Q2's collector will now have ceased to conduct current. This allows C1 to charge until it reaches a level sufficient to trigger Q3, a programmable unijunction transistor (PUT). When that happens (in about 1 second), Q3's gate potential drops, which turns off Q4, Q5 and buzzer. Another interruption will repeat the whole process and yield one more "beep."

PARTS LIST FOR PHOTOELECTRONIC ANNUNCIATOR

BZ1—piezoelectric buzzer, 6-9 VDC
C1—22 uF, 16V electrolytic capacitor
D1—1N914 silicon diode
Q1—FPT-100 NPN phototransistor
Q2, Q4, Q5—2N3904 NPN transistor
Q3—2N6027 programmable unijunction transistor
R1—22,000-ohm, ½-watt resistor, 10%
R2 R5—220K-ohm, ½-watt resistor, 10%
R3—62,000-ohm, ½-watt resistor, 10%
R4—470K-ohm, ½-watt resistor, 10%

PHOTOELECTRONIC ANNUNCIATOR

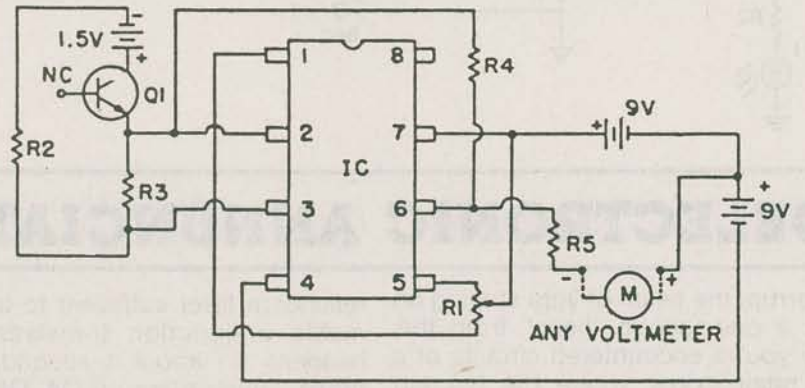


VOM PHOTO LIGHT METER

The beauty of this light meter is that it is almost perfectly linear over a wide range of light inputs. It provides you with the basic operation of a camera light meter and can be made to read directly in f-stops and shutter speed. Phototransistor Q1 senses the light level and passes that on to the 741 op amp where the small voltage is amplified. Meter M is any you currently have around the house, or any inexpensive meter you can buy. R1 provides a zero adjustment for the meter.

PARTS LIST FOR PHOTO LIGHT METER

IC1—741 op amp
Q1—FPT100 phototransistor
R1—10,000-ohm, linear-taper potentiometer
R2—10,000-ohm resistor
R3—30,000-ohm resistor
R4—100,000-ohm resistor
R5—2,000-ohm resistor



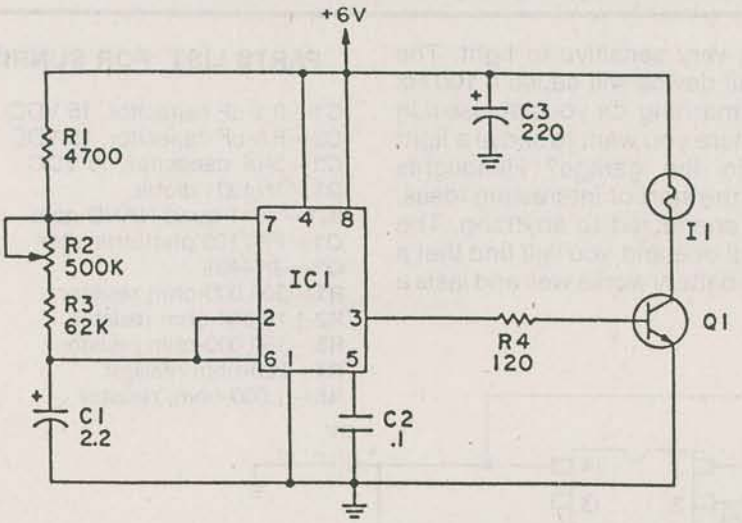
MINI-STROBE LITE

Connect a small 6-volt lamp to a 555 timer, and what do you get? A mini-strobe, that's what! Although the light from lamp I1 is nowhere near as intense as that from the xenon flashtubes used in commercial strobes, you can still obtain a stroboscopic effect in a darkened room. Because incandescent lamps cannot be swtiched on and off as quickly as flashtubes, IC1's maximum frequency has been limited to 5Hz. Still, you can stop human motion for a novel effect. Use a 6-volt lantern battery or four D cells in series to power the circuit.

PARTS LIST FOR MINI STROBE

C1—2.2 uF, 10V electrolytic capacitor
C2—.1 uF ceramic disc capacitor
C3—220 uF, 10V electrolytic capacitor
IC1—555 timer
I1—type PR-12-6-volt, 500-mA lamp (Radio Shack 272-1123)
Q1—2N2222 NPN transistor
R1—4,700-ohm, 10%, ½-watt resistor
R2—500,000 linear-taper potentiometer
R3—62,000-ohm, 10%, ½-watt resistor
R4—120-ohm, 10%, ½-watt resistor

MINI-STROBE LITE

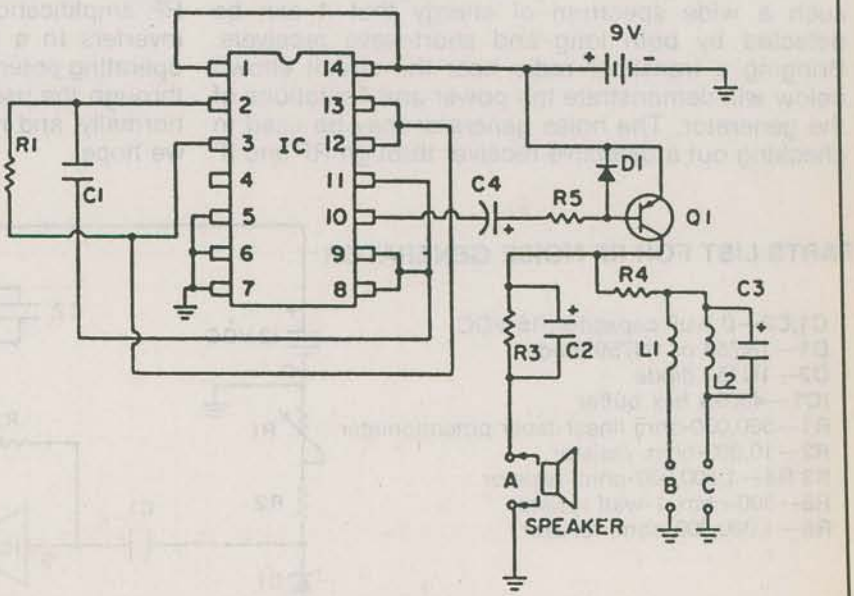


ORGAN-PLUS TONE GENERATOR

Musical organ-like sounds can be generated with this CMOS circuit. The IC generates a nearly square-wave output from pin 11 and the spacings on that output stream of pulses can be varied by changing R1 and R2. If you change them smoothly, you can get a slide-trombone effect. Outputs A, B, and C are different from the pin 4 output in that the square wave now becomes a sawtooth, a spike and a complex combination of both. Rich overtones result that you can hear with the loudspeaker.

PARTS LIST FOR ORGAN-PLUS TONE GENERATOR

C1—0.2-uF capacitor, 15 VDC
C2—4.7-uF capacitor, 15 VDC
C3—6.8-uF capacitor, 15 VDC
C4—2-uF capacitor, 15 VDC
D1—1N4001 diode
IC1—4011 quad NAND gate
L1—2.5-millihenry RF choke
L2—2.5-millihenry RF choke
Q1—2N4403
R1—20,000-ohm resistor
R2—100,000-ohm resistor
R3—220-ohm resistor
R4—220-ohm resistor
R5—1,000-ohm resistor
SPKR.—8-ohms

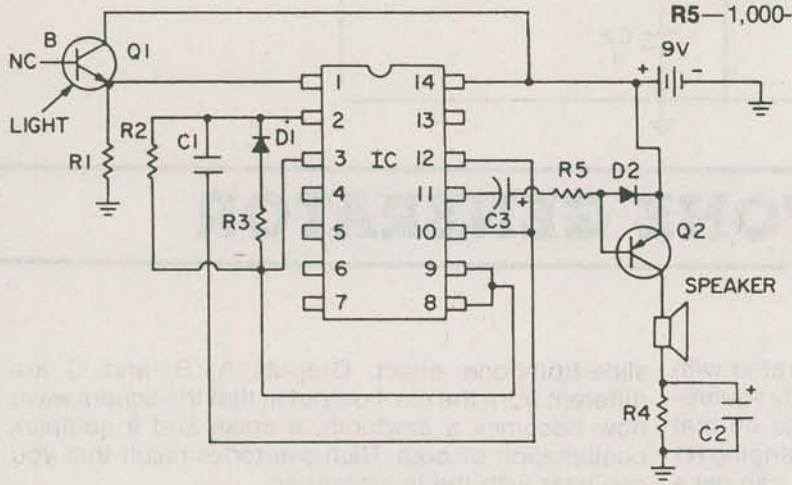


SUNRISE ALARM CLOCK

Phototransistor Q1 is very sensitive to light. The sun shining on this small device will cause a 100 Hz tone to wake you in the morning. Or you can use it in many other ways, anywhere you want to sense a light beam. Light left on in the garage? Headlights working? This circuit is the start of interesting ideas. The base of Q1 is not connected to anything. The speaker can be any small one and you will find that a small 9V transistor radio battery works well and lasts a long time.

PARTS LIST FOR SUNRISE ALARM CLOCK

C1—0.1-uF capacitor, 15 VDC
C2—6.8-uF capacitor, 15 VDC
C3—2-uF capacitor, 15 VDC
D1—1N4001 diode
IC1—4011 quad NAND gate
Q1—FPT100 phototransitor
Q2—2N4403
R1—300,000-ohm resistor
R2—15,000-ohm resistor
R3—150,000-ohm resistor
R4—220-ohm resistor
R5—1,000-ohm, resistor

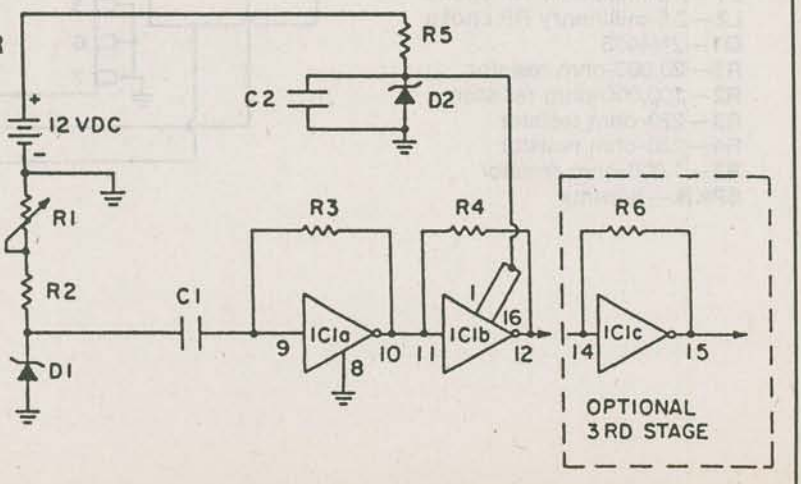


RF NOISE GENERATOR

The diode-generated radio-frequency noise has such a wide spectrum of energy that it can be detected by both long and short-wave receivers. Bringing a transistor radio near the circuit shown below will demonstrate the power and limitations of the generator. The noise generator may be used in checking out a defective receiver through RF and IF stages by injecting it at various points. In the circuit, RF amplification was provided by running CMOS inverters in a linear mode. To reduce heating, an operating potential of about five volts was established through the use of a 1N751 zener diode, functioning normally, and not a noise generator in its own right, we hope!

PARTS LIST FOR RF NOISE GENERATOR

C1,C2—0.1-uF capacitor, 15 VDC
D1—1N758 or 1N759 diode
D2—1N751 diode
IC1—4009A hex buffer
R1—500,000-ohm linear-taper potentiometer
R2—10,000-ohm, resistor
R3 R4—1,000,000-ohm, resistor
R5—300-ohm, 1-watt resistor
R6—1,000,000-ohm, resistor

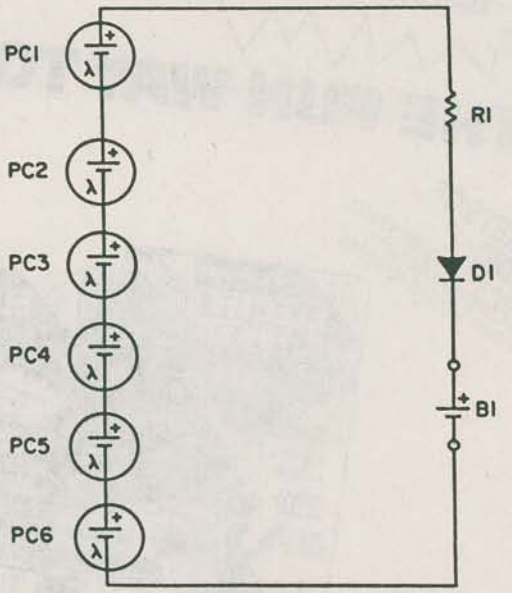


SOLAR BATTERY CHARGER

Tired of charging your NiCd cells? Then let Old Sol do the work for you free-of-charge. In this circuit, photovoltaic cells supply the charging current, which is limited to a safe level by R1. Diode D1 prevents the battery from discharging through the solar cells during periods of darkness.

NiCd cells of different sizes require different maximum charging currents for best results. Currents in excess of the recommended values result in rapid evolution of oxygen gas within the cell. When this happens, oxygen gas pressure is relieved through vents, and a significant portion of the cell's chemical contents may be lost in the process. The net effect is reduced cell life; therefore, resistor R1 should be selected to limit the charging current to a safe level.

To do this, break the circuit and insert a DC milliameter in series with B1. (Watch those polarities!) Expose the solar cells to the brightest sunshine they can expect to receive, and make note of the charging current. The recommended charging rates for various NiCd cells are: 50 mA for AA cells, and 100 mA for C or D cells. To obtain these currents, the suggested values of R1 are approximately 18 ohms (for AA cells) and 9.1 ohms (for C or D cells). With your milliameter, measure the actual charging current produced by your circuit with the resistor appropriate to your chosen cell size. If the current exceeds the safe level, replace R1 with a larger resistance. As a final note, be sure to select solar cells capable of supplying the desired charging current.



PARTS LIST FOR SOLAR BATTERY CHARGER

B1—1.25V rechargeable NiCd battery
D1—1N4001 rectifier diode
PC1 thru PC6—.5-volt silicon photovoltaic cell (see text)
R1—current-limiting resistor (see text)

THE 80 TUNE COMPUTER

The 80-Tune Computer is a project which is not only easy to build but also fun to use. Its uses are many and are limited only by the imagination of the builder. This is an excellent beginner's project because of its simplicity. A masked microprocessor (special Integrated Circuit, or IC) does all the work.

Any of the 80 songs can be selected by the telephone-style keypad. A push of the *Play* button makes the selection. The *Stop* button resets the microprocessor. The selected tune will start each time the *Play* button is pushed as long as power is on and no *Reset* (or *Stop*) occurs.

Complete plans to build the "80-Tune Computer" $2.95

U1 Custom Microprocessor $9.00

PCB Printed Circuit Board $4.95

Add $2.00 for postage & handling

For each combination of the above items, send check or money order (U.S. funds) to: C&E Hobby Handbooks, Inc. P.O. Box #5148, North Branch, N.J. 08876

80 TUNE COMPUTER SONG LIST

0 AMERICA
1 ANCHORS AWEIGH
2 BATTLE HYMN REPUBLIC
3 CAISSONS GO ROLLING
4 CALL TO COLORS
5 CAVALRY CHARGE
6 DIXIE
7 HAIL BRITTANIA
8 YANKEE DOODLE DANDY
9 LA MARSEILLAISE
10 MARINE HYMN
11 REVEILLE
12 STARS & STRIPES
13 TAPS
14 WILD BLUE YONDER
15 ALOUETTE
16 ARLVEDERCHI ROMA
17 CAMPTOWN RACES
18 CANDY MAN
19 CHATTANOOGA CHOO-CHOO
20 CLEMENTINE
21 DALLAS THEME
22 EL PASO
23 THE ENTERTAINER
24 JOLLY GOOD FELLOW
25 FUNERAL MARCH
26 HAVA NAGILAH
27 IN HEAVEN IS NO BEER
28 JIMMY CRACK CORN
29 JINGLE BELLS
30 KING OF ROAD
31 LA CUCARACHA
32 LONE RANGER
33 MODEL T
34 THE OLD GREY MARE
35 POPEYE
36 RAINDROPS
37 SAILORS HORNPIPE
38 SAN ANTONIO ROSE
39 SEE THE USA
40 OUT TO THE BALLGAME
41 TIJUANA TAXI
42 TWO BITS
43 WABASH CANNONBALL
44 SAINTS GO MARCHING
45 WOODY WOODPECKER
46 YELLOW ROSE OF TEXAS
47 ACROSS THE FIELD
48 AGGIE WAR HYMN
49 ARKANSAS FIGHT SONG
50 BE SHARP
51 BOOMER SOONER
52 BOW DOWN WASHINGTON
53 BUCKLE DOWN WINSOCKI
54 CHARGE
55 DEAR OLD NEBRASKA U.
56 THE EYES OF TEXAS
57 ABOVE CAYUGA'S WATERS
58 FIGHT ON USC
59 GO, NORTHWESTERN
60 HAIL PURDUE
61 HEY LOOK ME OVER
62 HOLD THAT TIGER
63 ILLINOIS LOYALTY
64 INDIANA, OUR INDINA
64 I'M A JAYHAWK
66 IOWA FIGHT SONG
67 LOVE YA BLUE
68 MICHIGAN STATE FIGHT
69 MINNESOTA ROUSER
70 NITTANY LION
71 NOTRE DAME FIGHT
72 OLE MISS
73 ON, BRAVE ARMY TEAM
74 ON WISCONSIN
75 WRECK FROM GA. TECH
76 ROLL ON TULANE
77 THE VICTORS
78 WASHINGTON/LEE SWING
79 YEA ALABAMA

☐ **Payment enclosed. to: C&E Hobby Handbooks**

PLEASE PRINT V6

NAME: _____

ADDRESS: _____

CITY: _____

STATE: _____ **ZIP** _____

Foreign Postage add $8.00...U.S. Funds

Please allow 4 to 6 weeks for delivery