SOLID STATE MADE EASY

YOUR LEISURE-TIME PROJECT GUIDE FOR 101 NIGHTS

101 ELECTRONIC PROJECTS

By the Editors of Elementary Electronics

CC 02272

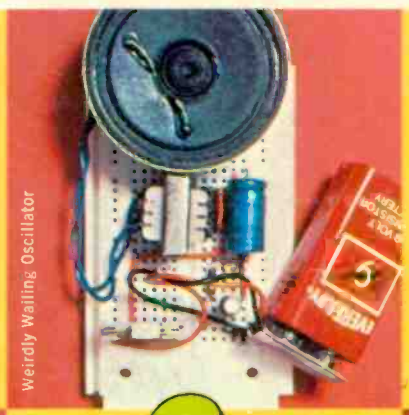
1978 EDITION $1.50

For Under $15-All Easy To Build

SURE-FIRE CIRCUITS PRACTICAL FOR THE BEGINNER AND PRO

9 Frequency Generators

Square Wave Generator
Wide-Range Oscillator
Staircase Generator
DC Controlled Oscillator

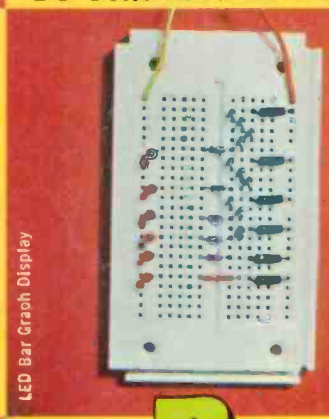


8 Servicing Aids

Logic Probe
Quick Diode Checker
Transistor Tester
Continuity Checker

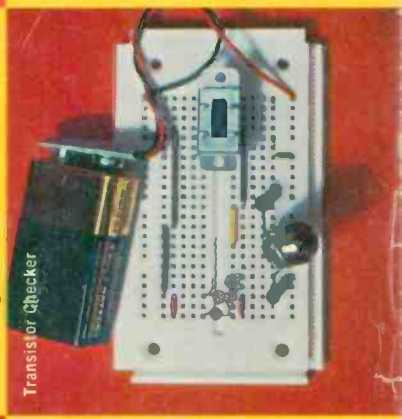
7 Solid State Warners

Attache Alarm
Wet Basement Squealer
Highway Nightfall Alert
Photoelectric Tattletale



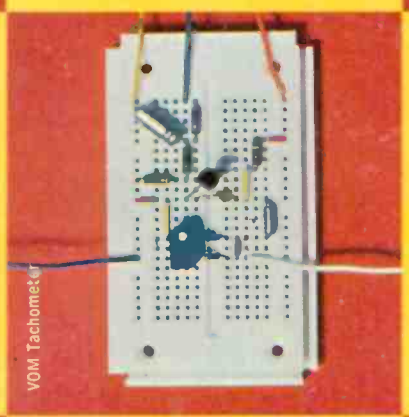
6 Amplifiers

Penny-Pincher's Amplifier
Ceramic Cartridge Preamp
Dynamic Mike Amplifier
Broadband Amplifier



5 Certain Switches

Signal Operated Switch
Poor Man's Hold Switch
The Light Touch
Turn-On Delay

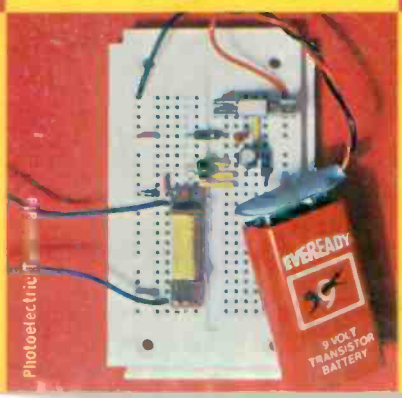


EXTRAS-

SWL's Super Calibrator
Groove Booster
SCA Adaptor

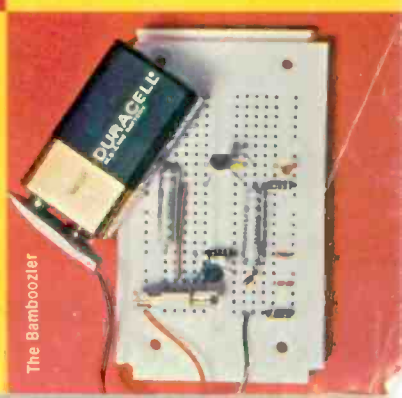
PLUS-

Lots more build 'em projects for workbench, home and car!



Construction Project Quickies

Channel Changer
Super DXer Signal Booster
Add Tone to Your Phone
See-Through Crystal Radio

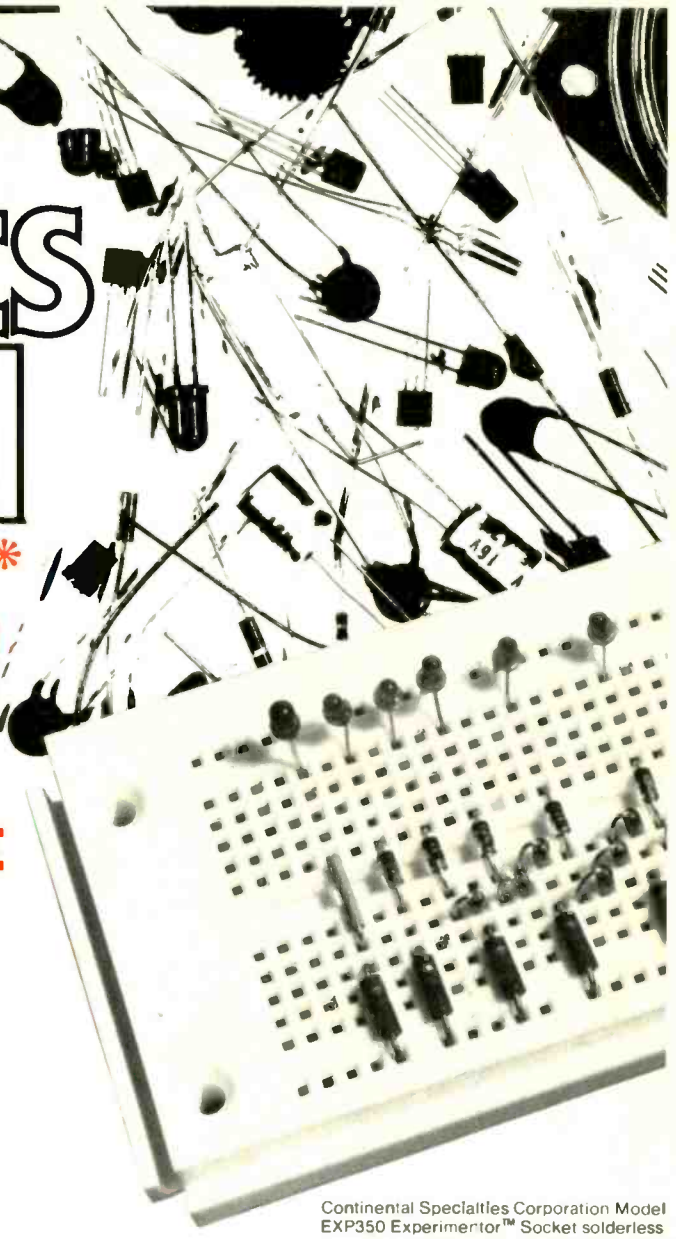


101. projects special

$69.95*

*Plus $2.00 postage and handling. Connecticut residents add sales tax.

PLUS THIS CSC SOLDERLESS BREADBOARDING SOCKET **FREE**



Continental Specialties Corporation Model EXP350 Experimentor™ Socket solderless breadboard included free with your order.

No need to scavenge parts from old projects, or run yourself, your car and your telephone bill ragged trying to locate that one *#@&=! part you don't have. WE PACKAGED IT ALL!

Build one, two, three or more projects without soldering or damaging components. When you are done, unplug the parts and set them aside for your next building session. Interconnections between components made with #24 PVC-covered solid hookup wire, again without soldering. Easy—fast—simple—have fun with electronics without burning your fingers or your dining room table!

After you have mastered the 101 Projects, use the components and solderless breadboard to bring your own ideas and designs to life.

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CIRCLE 5 ON READER SERVICE COUPON

You can turn the CB boom into income... with NRI's Complete Communications Course

NRI can train you at home for a part-time job or a full-time career in communications.
The field of communications is bursting out all over. More than 25 million CB sets are in operation with millions more being sold annually. That means countless careers in design, installation, and maintenance. Start training at home now, the NRI way.

Get your all-important FCC License.
FCC rules require that CB transmitters be serviced only by the holder of a First or Second Class FCC Radiotelephone License, or under the supervision of a license holder when the transmitter is connected to a "radiating antenna." NRI will give you the necessary training to get that all-important First or Second Class FCC Radiotelephone License so that you can qualify for one of the many available openings.

Learn on your own 400-channel digitally-synthesized VHF Transceiver.
The 48-lesson NRI Complete Communications Course teaches you to service and adjust all types of two-way radio equipment (including CB), using the one unit that is best equipped to train you for CB, Commercial, and Amateur Communications...a "designed-for-learning," 400-channel, two-meter VHF Transceiver and AC power supply. Then we help you get your FCC Amateur License, with special instructions so you can go on the air. The unit can be mounted in your car, or you can use it as a base station.

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TM McGraw Hill CEC

CB Specialist's Course also available.
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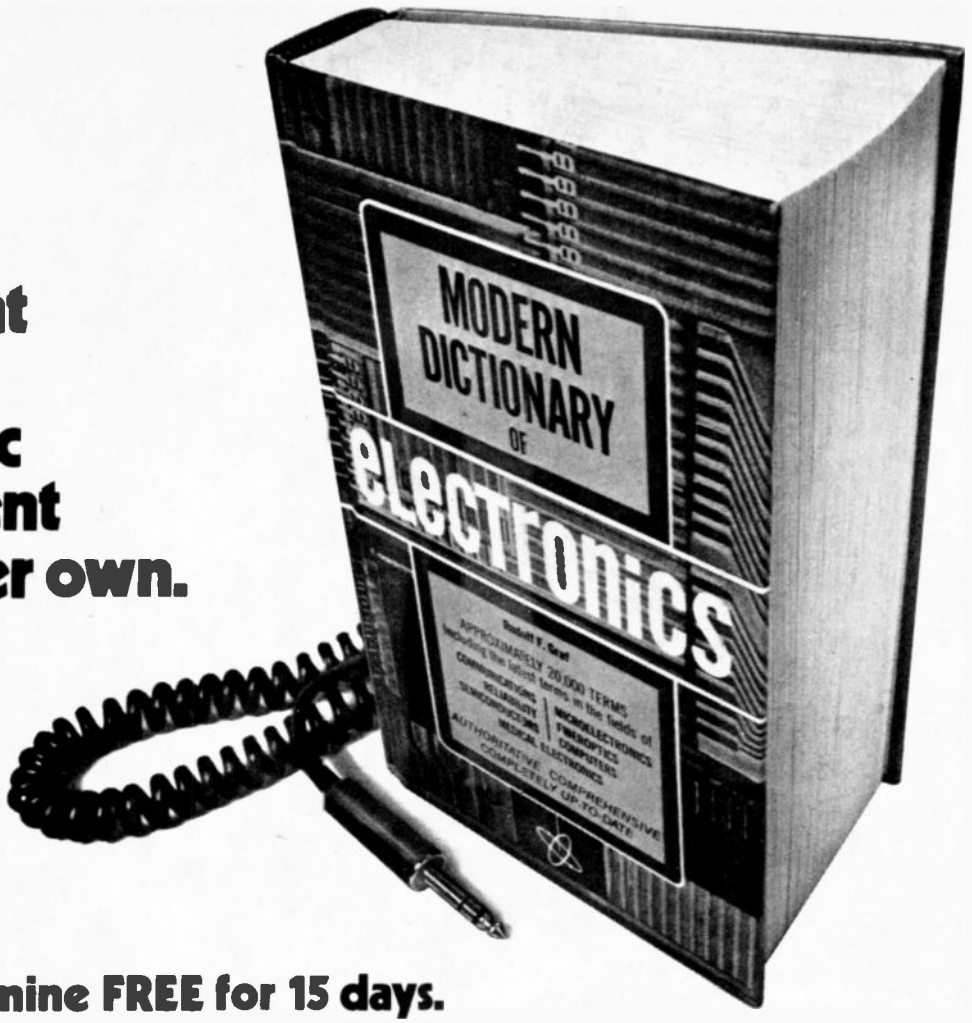

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- CROSS-REFERENCED to aid you in locating those terms which you might look for in more than one place. Example: When looking up "Esaki diode" you'll be referred to "tunnel diode."
- Helpful PRONUNCIATION GUIDE of more than 1100 often-mispronounced electronic terms showing syllabic division as well as the newest, most-accepted pronunciation of each term.
- A newly-revised list of SEMI-CONDUCTOR SYMBOLS AND ABBREVIATIONS for use in semiconductor device data sheets and specifications.
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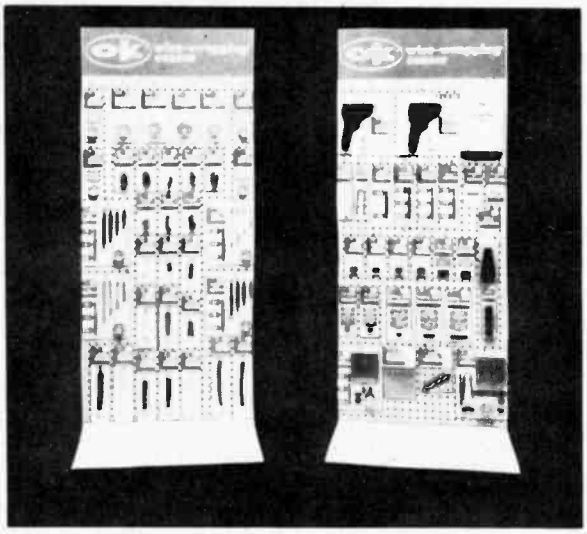

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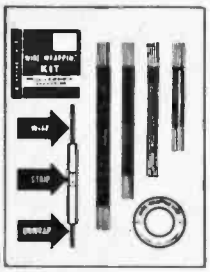
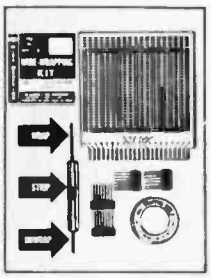


WIRE-WRAPPING KITS

Contains: Hobby Wrap Tool WSU-30, (50 ft.) Roll of wire Prestripped wire 1" to 4" lengths (50 wires per package) stripped 1" both ends.

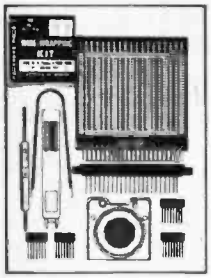
Wire Wrapping Kit (Blue)	WK-2-B	$12.95
Wire Wrapping Kit (Yellow)	WK-2-Y	$12.95
Wire Wrapping Kit (White)	WK-2-W	$12.95
Wire Wrapping Kit (Red)	WK-2-R	$12.95



WIRE-WRAPPING KIT

Contains: Hobby Wrap Tool WSU-30, Roll of wire R-30B-0050, (2) 14 DIP's, (2) 16 DIP's and Hobby Board H-PCB-1.

Wire-Wrapping Kit	WK-3B (Blue)	$16.95



WIRE-WRAPPING KIT

Contains: Hobby Wrap Tool WSU-30 M, Wire Dispenser WD-30-B, (2) 14 DIP's, (2) 16 DIP's, Hobby Board H-PCB-1, DIP/IC Insertion Tool INS-1416 and DIP/IC Extractor Tool EX-1

Wire-Wrapping Kit	WK-4B (Blue)	$25.99

HOBBY WRAP TOOL

Wire-wrapping, stripping, unwrapping tool for AWG 30 on .025 (0,63mm) Square Post.

Regular Wrap	WSU-30	$6.95
Modified Wrap	WSU-30M	$7.95

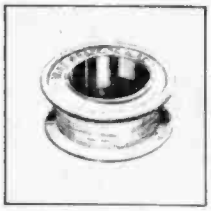
WIRE-WRAPPING TOOL

For .025" (0,63mm) sq. post "MODIFIED" wrap, positive indexing, anti-overwrapping device.

For AWG 30	BW-630	$34.95*
For AWG 26-28	BW-2628	$39.95*

Bit for AWG 30	BT-30	$3.95
Bit for AWG 26-28	BT-2628	$7.95

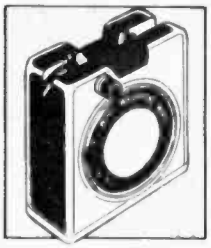
*USE "C" SIZE NI-CAD BATTERIES (NOT INCLUDED)



ROLLS OF WIRE

Wire for wire-wrapping AWG-30 (0.25mm) KYNAR® wire, 50 ft. roll, silver plated, solid conductor, easy stripping.

30 AWG Blue Wire 50ft. Roll	R-30B-0050	$1.98
30 AWG Yellow Wire 50ft. Roll	R-30Y-0050	$1.98
30 AWG White Wire 50ft. Roll	R-30W-0050	$1.98
30 AWG Red Wire 50ft. Roll	R-30R-0050	$1.98



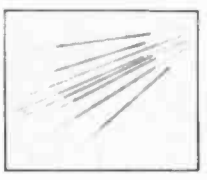
WIRE DISPENSER

- With 50 ft. Roll of AWG 30 KYNAR® wire-wrapping wire.
- Cuts the wire to length.
- Strips 1" of insulation.
- Refillable (For refills, see above)

Blue Wire	WD-30-B	$3.95
Yellow Wire	WD-30-Y	$3.95
White Wire	WD-30-W	$3.95
Red Wire	WD-30-R	$3.95

PRE CUT PRE STRIPPED WIRE

Wire for wire wrapping, AWG-30 (0.25mm) KYNAR® wire, 50 wires per package stripped 1" both ends.



30 AWG Blue Wire 1" Long	30-B-50-010	$.99
30 AWG Yellow Wire 1" Long	30-Y-50-010	$.99
30 AWG White Wire 1" Long	30-W-50-010	$.99
30 AWG Red Wire 1" Long	30-R-50-010	$.99
30 AWG Blue Wire 2" Long	30-B-50-020	$1.07
30 AWG Yellow Wire 2" Long	30-Y-50-020	$1.07
30 AWG White Wire 2" Long	30-W-50-020	$1.07
30 AWG Red Wire 2" Long	30-R-50-020	$1.07
30 AWG Blue Wire 3" Long	30-B-50-030	$1.16
30 AWG Yellow Wire 3" Long	30-Y-50-030	$1.16
30 AWG White Wire 3" Long	30-W-50-030	$1.16
30 AWG Red Wire 3" Long	30-R-50-030	$1.16
30 AWG Blue Wire 4" Long	30-B-50-040	$1.23
30 AWG Yellow Wire 4" Long	30-Y-50-040	$1.23
30 AWG White Wire 4" Long	30-W-50-040	$1.23
30 AWG Red Wire 4" Long	30-R-50-040	$1.23
30 AWG Blue Wire 5" Long	30-B-50-050	$1.30
30 AWG Yellow Wire 5" Long	30-Y-50-050	$1.30
30 AWG White Wire 5" Long	30-W-50-050	$1.30
30 AWG Red Wire 5" Long	30-R-50-050	$1.30
30 AWG Blue Wire 6" Long	30-B-50-060	$1.38
30 AWG Yellow Wire 6" Long	30-Y-50-060	$1.38
30 AWG White Wire 6" Long	30-W-50-060	$1.38
30 AWG Red Wire 6" Long	30-R-50-060	$1.38

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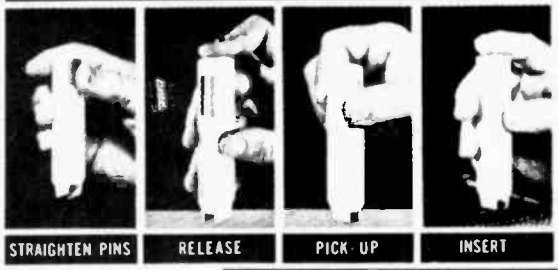
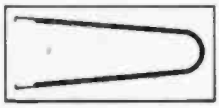
CIRCLE 6 ON READER SERVICE COUPON

ok®

DIP/IC INSERTION TOOL WITH PIN STRAIGHTENER



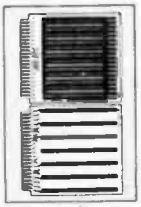
14-16 Pin Dip IC Inserter	INS-1416	$3.49



DIP/IC EXTRACTOR TOOL

Extractor Tool	EX-1	$1.49

P.C. BOARD

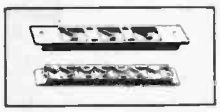


The 4 x 4.5 x 1/16 inch board is made of glass coated EPOXY Laminate and features solder coated 1 oz. copper pads. The board has provision for a 22/44 two sided edge connector, with contacts on standard .156 spacing. Edge contacts are non-dedicated for maximum flexibility.

The board contains a matrix of .040 in. diameter holes on .100 inch centers. The component side contains 76 two-hole pads that can accommodate any DIP size from 6-40 pins, as well as discrete components. Typical density is 18 of 14-Pin or 16-Pin DIP's. Components may be soldered directly to the board or intermediate sockets may be used for soldering or wire-wrapping.

Two independent bus systems are provided for voltage and ground on both sides of the board. In addition, the component side contains 14 individual busses running the full length of the board for complete wiring flexibility. These busses enable access from edge contacts to distant components. These busses can also serve to augment the voltage or ground busses, and may be cut to length for particular applications.

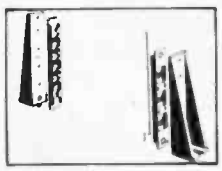
Hobby Board	H-PCB-1	$4.99



PC CARD GUIDES

Card Guides	TR-1	$1.89

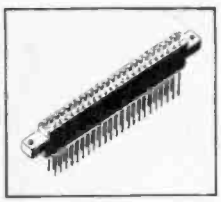
QUANTITY – ONE PAIR (2 pcs.)



PC CARD GUIDES & BRACKETS

Guides & Brackets	TRS-2	$3.79

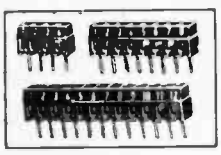
QUANTITY – ONE SET (4 pcs.)



PC EDGE CONNECTOR

44 Pin, dual read out, .156" (3,96 mm) Contact Spacing, .025" (0,63 mm) square wire-wrapping pins.

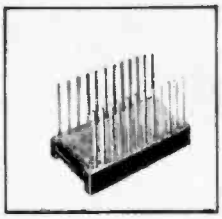
P.C.. Edge Connector	CON-1	$3.49



P.C.B. TERMINAL STRIPS

The TS strips provide positive screw activated clamping action, accommodate wire sizes 14-30 AWG (1, 8-0, 25mm). Pins are solder plated copper, .042 inch (1mm) diameter, on .200 inch (5mm) centers.

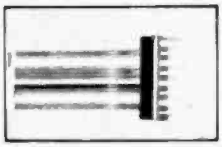
4-Pole	TS- 4	$1.39
8-Pole	TS- 8	$1.89
12-Pole	TS-12	$2.59



DIP SOCKET

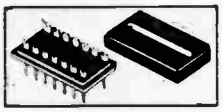
Dual-in-line package, 3 level wire-wrapping, phosphor bronze contact, gold plated pins .025 (0,63mm) sq., .100 (2,54mm) center spacing.

14 Pin Dip Socket	14 Dip	$0.79
16 Pin Dip Socket	16 Dip	$0.89



RIBBON CABLE ASSEMBLY SINGLE ENDED

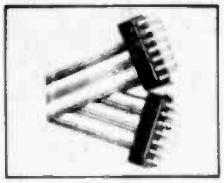
With 14 Pin Dip Plug 24" Long (609mm)	SE14-24	$3.55
With 16 Pin Dip Plug 24" Long (609mm)	SE16-24	$3.75



DIP PLUG WITH COVER FOR USE WITH RIBBON CABLE

14 Pin Plug & Cover	14-PLG	$1.45
16 Pin Plug & Cover	16-PLG	$1.59

QUANTITY: 2 PLUGS, 2 COVERS



RIBBON CABLE ASSEMBLY DOUBLE ENDED

With 14 Pin Dip Plug -2" Long	DE 14-2	$3.75
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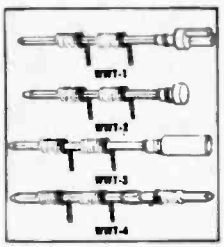
With 16 Pin Dip Plug -2" Long	DE 16-2	$4.15
With 16 Pin Dip Plug -4" Long	DE 16-4	$4.25
With 16 Pin Dip Plug -8" Long	DE 16-8	$4.35

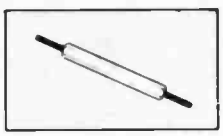


TERMINALS

- .025 (0,63mm) Square Post
- 3 Level Wire-Wrapping
- Gold Plated

Slotted Terminal	WWT-1	$2.98
Single Sided Terminal	WWT-2	$2.98
IC Socket Terminal	WWT-3	$3.98
Double Sided Terminal	WWT-4	$1.98

25 PER PACKAGE



TERMINAL INSERTING TOOL

For inserting WWT-1, WWT-2, WWT-3, and WWT-4 Terminals into .040 (1,01mm) Dia. Holes.

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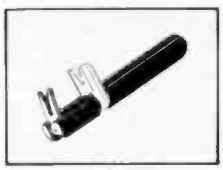

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Strip length easily adjustable for your applications.

DESCRIPTION	MODEL NUMBER	ADJUSTABLE "SHINER" LENGTH OF STRIPPED WIRE INCHES TO INCHES	Price
24 ga. Wire Cut and Strip Tool	ST-100-24	1/16" — 1 3/16"	$ 8.75
26 ga. Wire Cut and Strip Tool	ST-100-26	1/16" — 1 3/16"	$ 8.75
26 ga. Wire Cut and Strip Tool	ST-100-26-875	7/8" — 1 1/8"	$ 8.75
28 ga. Wire Cut and Strip Tool	ST-100-28	7/8" — 1 1/8"	$11.50
30 ga. Wire Cut and Strip Tool	ST-100-30	7/8" — 1 1/8"	$11.50

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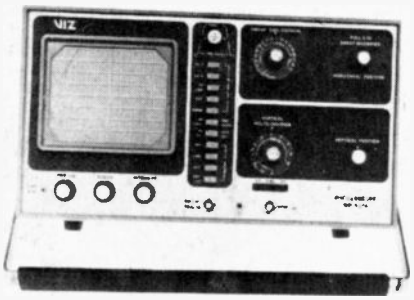
New Products

Triggered Oscilloscope

VIZ has introduced a high-caliber triggered oscilloscope, the WO-527A. The scope is five inches in diameter with vertical-amplifier frequency response to 15 MHz; the bandwidth of the horizontal amplifier is from DC to 1 MHz. Front-panel pushbutton switches make the display-mode and sweep-function selection fast and easy. The scope has a trigger-level adjustment system that uses LEDs to indicate trigger polarity at a glance. Horizontal-amplifier input impedance is 1 megohm shunted for trace expansion by 30 pF. A special TV line selector function permits line-by-line display of video



CIRCLE 75 ON READER SERVICE COUPON

frames. The triggered sweep system provides calibrated time bases from 0.5 usec/cm to 0.5 sec/cm, and a 10X sweep magnifier provides sweep speeds up to 50 nsec for trace expansion. Other features include preset TV, vertical and horizontal sweep settings for stable, automatic TV video waveform lockin; a 0.4-V peak-to-peak square-wave calibrating signal for convenient voltage measurement and probe compensation at a front-panel terminal; choice of AC or DC vertical amplifier coupling; selection of adjustable or automatic trigger mode; AC, DC, or ground reference for the input signal; and a divide-by-ten trigger source function to ensure stable lock-in. The WO-527A scope is available at VIZ distributors at the dealer-optional price of $479.00. For more information, write to VIZ Mfg. Co., 335 E. Price Street, Philadelphia, PA 19144.

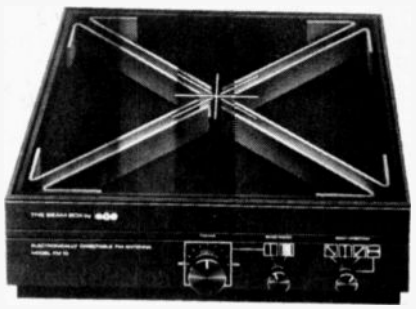
Electronic Keyer

Ham Radio Center's new Electronic Keyer, Model HK-5A, features a trim cabinet colored-keyed to match most modern amateur radio equipment with all front mounted controls (*speed, weight, tone* and *volume*) and jacks for external paddle and/or keyer, plus external power. Inside, this battery operated unit has an iambic circuit for squeeze keying, self-completing dots and dashes, a dot memory, built-in tone monitor and grid block and direct keying. Batteries not included. Also, it can be used as a code practice oscillator with a straight key. Sells for $69.95. For more information about Model HK-5A, write Ham Radio Center, Inc., 8340-42 Olive Boulevard, P.O. Box 28271, St. Louis, MO 63132.

CIRCLE 63 ON READER SERVICE COUPON

The Beam Box

B.I.C. introduced an indoor FM antenna which they call The Beam Box. It is actually a new type of high fidelity component, specially designed to be permanently positioned alongside, above, or beneath the other components in a music system. In describing The Beam Box, Andrew Carduner, Vice-president of B.I.C. explained, "Most owners of FM receivers and tuners never realize or enjoy the full reception capability of their equipment simply because the antenna is unable to deliver a proper signal to the antenna terminals of the set. The wire-dipole antenna generally used with most FM receivers cannot easily be oriented in the proper direction to pick-up reflection-free, strong signals from all the stations in a given area. Outdoor antennas are costly to install, impractical or prohibited for apartment dwellers and require a rotator in order to receive adequate signals from more than one direction. The Beam Box solves these problems and more." The Beam box is equipped with a passive electronic circuit that directs its sensitivity pattern towards any one of four geographic quadrants at the turn of a switch, without the antenna itself ever having to move. Unlike a wire dipole, it is able to receive optimum signals from any direction. By electronically directing its reception pattern towards the signals you want, multipath signals are suppressed so that stereo separation and signal-to-noise performance are improved. The Beam Box carries a suggested retail price of $89.95. For more info, write to B.I.C., Westbury, NY 11590.



CIRCLE 58 ON READER SERVICE COUPON

FM on 2-Meters

A solid-state, fully-synthesized 800-channel 144-148 mHz two-meter FM transceiver, Model FT-227R by Yaesu, features a memory circuit to put you on any preset channel with a flip of the memory switch; it has been designated the Yaesu Memorizer. Frequency readout is by

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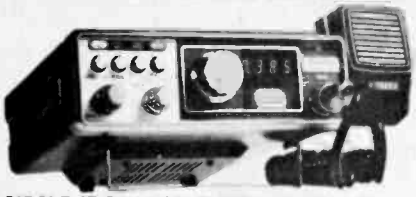
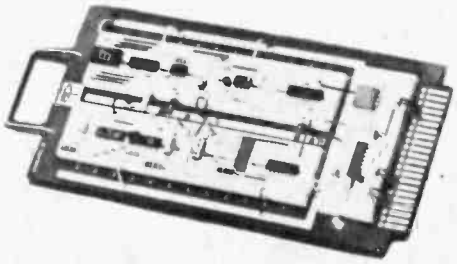


CIRCLE 47 ON READER SERVICE COUPON

means of four large LED's. Optical sensing eliminates switch problems in frequency selection. PLL techniques are used for fully synthesized frequency control in 5 kHz steps, and a special memory circuit allows instant return to any preselected frequency within the two-meter band. Offsets of ±600 kHz, plus any odd split within the two-meter band can be achieved using the memory circuit. The new FT-227R has automatic final protection, PLL unlock protection and a busy-channel indicator. It provides built-in tone burst, plus optional squelch-decoder and selectable ten- or one-watt output. The FT-227R requires 800 mA, on receive and 2.5 A on transmit at 13.8 VDC. Priced at under $300. Available at all authorized Yaesu dealers. For more info, write to Yaesu Electronics Corp., 15954 Downey Avenue, P.O. Box 498, Paramount, CA 90723.

Solderless Cards

AP Products' new version of their popular Unicards are reuseable solderless cards for a modular approach to systems breadboarding. These new versions utilize AP Terminal Strips with double rows of terminals each having 5 tie-points. This configuration is ideal for breadboarding LSI integrated circuits. These Unicards provide solderless, plug-in tie-points on a universal .1-in. x .1-in.



CIRCLE 52 ON READER SERVICE COUPON

matrix and require no special patch cords. They plug into standard 5¼-in. card racks and are compatible with AP extender cards. The new version of Unicard I has 960 tie-points (192 terminals each with 5 points) while Unicard II offers 1,620 tie-points (324 terminals each with 5 points). The continuous matrix of terminals on .100-in. centers accepts all DIP's, TO-5's or discrete components with lead diameters up to .032-in. As many as fourteen 12-pin DIPS can be accommodated on Unicard I, twenty-two 14 pin DIPS on Unicard II or any mix of packages or components. Prices start at $31.50 for the Unicard I. For more complete information, write to AP Products, 72 Corwin Drive, Box 110, Painesville, OH 44077.

Highway Time

An electronic quartz LED digital clock by Sparkomatic is reported to be accurate to within a one-minute variance per year. Solid-state technology has eliminated the need for moving parts. Hour and minute buttons on the front display window permit easy time setting, while the clock's highly illuminated digital numer-

CIRCLE 45 ON READER SERVICE COUPON

als, which can be read in any light, show the hours and minutes concurrently. The new clock can be installed in any car, camper, van, pickup, boat or other vehicle and it can be mounted on-dash, in-dash, or under-dash to produce a factory equipment look. Sells for $19.95. For more details, write to Sparkomatic Corp., Milford, PA 18337.

Heavy-Duty Rotator

The Beam Master antenna rotor was designed specifically for CB beam antennas with up to 5 square feet of wind loading area and large TV antenna arrays. It features a heavy-duty tool steel gear system; strong, weather-protected housing with a snaplock cover for easy installation; and a contemporary, low-profile rotor control unit. Beam Master can withstand 8,400-in. lbs. of vertical force.

CIRCLE 64 ON READER SERVICE COUPON

It has a built-in thrust bearing that can handle loads up to 250 lbs. The mast support can accommodate masting from 1- to 2-in. outside diameters and comes equipped with all stainless steel hardware. Beam Master's rotor control unit combines smoother, quiet action with pinpoint positioning, and uses synchronized motors for on-target accuracy in the desired direction. The console has a modern, easy-to-read faceplate and com-

Lab Test Elementary Electronics For Yourself

Get switched-on with - the magazine for electronics fans and hobbyists

In case you're not all that familiar with us, we're *not* a publication for electrical engineers and other wizards. *No way.* ELEMENTARY ELECTRONICS is expressly for people who like to build their own projects and gadgets—and maybe get a little knee-deep in tape, solder and wire clippings in the process.

In fact, we have a sneaking suspicion that our readers like us because they think we're just as bug-eyed and downright crazy over great new project ideas as they are. And I guess they're right!

E/E thinks of you who dig electronics as the last of a special breed. It's more than just the "do-it-yourself" angle—it's also the spirit of *adventure.* In this pre-packaged, deodorized world, building your own stereo system, shortwave receiver, darkroom timer or CB outfit is like constructing a fine-tuned little universe all your own. And when it all works perfectly—it really takes you to another world.

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Ever hanker to build a sharp-looking digital clock radio? Or to hook up an electronic game to your TV? Or an easy-to-build photometer that makes perfect picture enlargements? Or a space-age Lite-Com so you and the family can talk to each other on a light beam? We've got it all to get you started.

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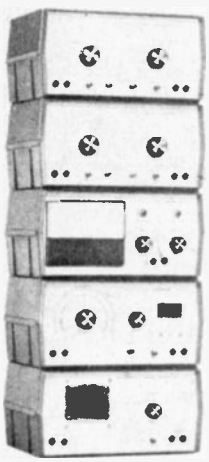
New Products

pact, low-profile design. It comes with a strip guide for easy installation, plus, terminal barriers, a strain-relief, and furniture-protecting base pads. Beam Master provides plenty of torque for all-season performance even under the heaviest of ice-load conditions. The rotor's brake system has a built-in storm-load safety feature to prevent drive-train damage and protect the rotor's gear system. Beam Master is available in 115 volt AC (Model 9515) or 220 Volt AV (Model 9508). The Model 9515 suggested retail price is $89.95. For more information, write to Channel Master, Ellenville, NY 12428.

Starter Instrument Package

Five new test instrument kits by Heath comprise a "starter" test bench oriented primarily toward the electronics newcomer. The IT-5283 Signal Tracer provides AF and RF signal tracing, audible volt/ohm indication and substitute speaker functions for general radio and hi-fi servicing. The IM-5284 Multimeter measures AC and DC voltage to 1000 volts, DC current flow to 1000 mA and has four ranges for impedance measurements to 100 meg. Output of from 310 kHz to 110 MHz, divided into five bands, and usable to 220 MHz with harmonics, is the feature of the IG-5280 RF Oscillator. The IG-5282 Audio Generator fea-



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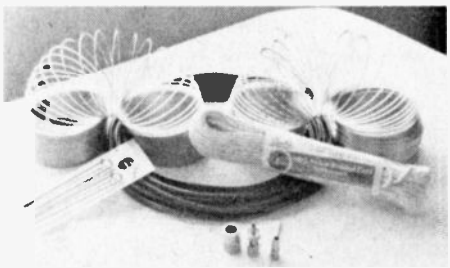
tures sine and square wave functions and switchable ranges from 10 Hz to 100 kHz. Separate resistance, inductance and capacitance ranges are all features of the IB-5281 RCL bridge. Power requirements for each of the five units are met by an internal battery supply (two nine volt batteries are required plus one "C" cell for the IM-5284) or by the IPA-5280-1 power supply. This power supply operates from an AC outlet and five separate outputs allow simultaneous operation of all five instruments. For further information on these units, mail-order priced at $37.95 each (IPA-5280-1 power supply is $24.95), write for a free catalog to Heath Company, Dept. 350-500, Benton Harbor, MI 49022.

New Slinky Dipole

The Slinky Dipole model SWL-1 is a new ultra-broadband adjustable length short wave antenna that may be used in either the tuned or un-tuned mode. In many cases, even the untuned mode is reported to give excellent performance, and the tuned mode will further peak the antenna efficiency right at your desired band. The special Slinky coils, which form the heart of the antenna, are used as the arms of the dipole. These giant coils look like the toy



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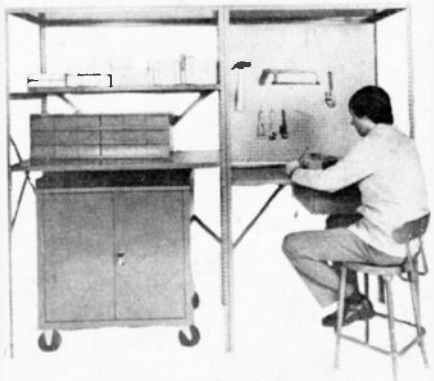
coils, but are five times the size and contain 335 feet of conductor. When in use, the spiral arms of the dipole provide the special distributed helical loading. This acts like distributed inductance, enabling the electrical length to be as much as five times the physical length. Complete Slinky Dipole Kit, Model SWL-1, mail-order priced at $39.95 postpaid. The Slinky may also be used for transmitting on the ham bands. Order from Teletron Corp., Suite 602, Box 84, Kings Park, NY 11754.

Mini-Shop

A new self-contained mini-shop that affords organization and easy access to tools is now available from Penco Products Inc., Oaks, PA. Called Shopcrafters, the mini-shop can be used by home craftsmen, electronic hobbyists, and do-it-yourselfers. The mini-shop is composed of two sections: Section A includes a work bench with drawer and a peg-board back for hanging tools; section B includes standard accessories—rollable machine cabinet, drawer case with 18-drawer insert, work stool and an extra shelf. The two sections are attached side-by-side so that all tools can be stored easily within arms' reach. Machine cabinet and drawer case allow organization of tools and other equipment, to avoid time-consuming searches



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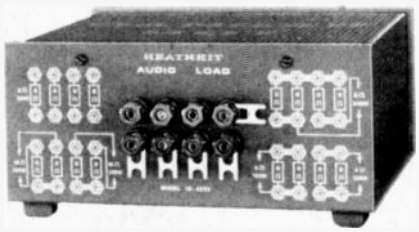
over the odd-sized tables, drawers and shelves that comprise most homeowners' tool storage facilities. The two work units are each 75-in. high, 48-in. across, and 24-in. deep. The shelves and workbenches can be easily adjusted vertically on 2-in. increments. The mini-shop lists for $413.00 with individual parts sold separately. For further information, contact Penco Products Inc., Oaks, PA 19456..

Audio Load Kit

Heath has introduced an Audio Load Kit for service technicians and audiophiles. The ID-5252 provides audio loads of 2, 4, 8, 16 and 32 ohms for amplifier testing according to the specifications of the manufacturer and the Institute of High Fidelity Manufacturers (IHFM). A series of five-way binding posts allow it to handle up to 240 watts mono or four 60 watt inputs, both into 8 ohms. In addition to the various resistor values,



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there are jacks for connecting a voltmeter, oscilloscope or other instrument at the load in use. The ID-5252 includes four 3-foot #12 gauge leads with spade lugs. The kit is mail-order priced at $44.95. For further information, write for a free catalog to the Heath Company, Dept. 350-21, Benton Harbor, MI 49022.

Cartridge Maintenance Kit

Robins Industries has introduced their "Stylee" Phono Stylus and Cartridge Maintenance Kit. The kit includes everything needed for the audiophile to inspect, maintain, install and replace delicate needles and cartridges. The integral kit components are: precision stylus hand-held microscope, screwdriver, tweezers, and stylus cleaning fluid and brush, all packaged in plastic storage

CIRCLE 69 ON READER SERVICE COUPON

case. The nucleus of the "Stylee Kit" is its unique hand-held microscope. Its especially designed lens is of sufficiently high powered magnification to thoroughly examine all styli for imperfections and wear points, yet is purposely limited in

(Continued on page 115)

ASK HANK, HE KNOWS!

Got a question or a problem with a project—ask Hank! Please remember that Hank's column is limited to answering specific electronic project questions that you send to him. Personal replies cannot be made. Sorry, he isn't offering a circuit design service. Write to:

Hank Scott, Workshop Editor
101 ELECTRONIC PROJECTS
229 Park Avenue South
New York, NY 10003

Racing With the Amp

I see a lot of raceways in buildings that add wiring on the internal wall. Is this a good practice?

—A.M., Silver Springs, MD

You bet it is! It may not look good in your living room, but in the office, garage, shop, and maybe the kitchen, it's alright. The raceway is a metal conduit that is secured to the wall. It is an inexpensive way to add outlets without breaking up walls and floors. Raceways can also be used to cheaply interconnect air conditioners to the main fuse panel.

One Score and Four Years Ago

Hank, what happened to the good old days? My old Dual turntable bit the dust after 12 years of faithful service, and while looking for a new one I must have seen over 100 different models. How can a guy chose?

—L.S., Elmwood Park, NJ

My dad had a 1927 Ford that lasted up until World War II, when he sold it because he couldn't get gas. You know what he bought after the war? That's right, a Ford. Once you like a brand, and its products are still very competitive and high in quality, why gamble and change.

Antenna Blues

I have a Kenwood KR-77 with quite a few years on it. We have cable TV here and I am not too thrilled with their choice of FM stations. So, I put an omnidirectional antenna up on the roof—the best I could find. I still have difficulty "bringing in" some of the few stations I think worth listening to. Can I piggy-back an additional FM directional antenna on the omni I now have and direct the new antenna toward the few stations I think are super up here in the mountains of western North Carolina? Will this improve either or both? Should I go the whole way and get a rotor?

—J. C., Hendersonville, NC

You can piggy-back an FM directional antenna, but use an antenna switch to reduce the multipath reception the omni would be adding to the signal. A rotator? I would prefer it, but before you try it, install an MATV system (it works for FM signals, too!). Maybe your directional antenna is broad beam enough to be pulling those hill signals and get signal boosting by the MATV amplifier. If not, go rotator. I suggest you write to The Finney Company, 34 West Interstate Street, Bedford, OH 44146. They're hotshots in MATV and their literature may offer a better solution to your problem. As for that Kenwood KR-77, it's a good unit, but have it checked out for it may need a front end alignment.

Meters Lie

On my hi-fi receiver, when tuning FM, the signal strength is not at maximum position when the tuning indicator is centered. For maximum signal, the tuning indicator is about 1/32-in. to the left of zero. What should I do?

—W.D., Chatsworth, CA

You didn't say a thing about how the unit sounds! Tune for minimum distortion. I think you'll discover this occurs when the tuning meter is centered. If the sound is poor, then alignment is necessary. I know this should not happen, but it is fairly common.

Lost TV

I hooked up an unamplified MATV system in my house. These are long runs of RG-59/U cables. Can you tell me the kind of losses I will experience.

—J.K., Van Nuys, CA

Let me give you the dB losses for both RG-59/U and RG-59/U Foam (or low loss cable) per 100 feet of run.

	TV Channels						
Cable	2	6	7	13	14	47	83
RG-59/U	2.8	3.6	5.3	5.9	9.3	11.8	13.0
RG-59/ U-Foam	1.8	2.4	3.8	4.0	5.9	7.9	8.6

RG-11/U has slightly less loss but because of its price and thickness, I find it unsuitable for most home installations. Your best bet may be to install a remote amplifier near the antenna.

Match Maker

What is the "matchbox" I hear CBers talk about?

—B.M., Blacksburg, VA

They are talking about an antenna matcher that electrically matches the antenna impedance with the transmitters impedance for maximum power transfer. Effectively, the matchbox is an impedance matching transformer that helps to reduce the SWR to near 1:1.

Loop the Tape

Where can I get a surplus or inexpensive tape transport for making short-loop tape machines? I want to build my own telephone answering machine.

—J.S., Cleveland, OH

Poly Paks is offering an 8-track transport for under $13.00. See their ad in ELEMENTARY ELECTRONICS. Also, look to the cheap cassette players that are available—it may be the cheapest way out considering the cost of electronics that is included.

Lightning's Too Fast

This may sound stupid, but can you use the thunderbolt sound-activated flash switch to take pictures of lightning when thunder sounds?

—H.F., Gainsville, FL

No, because by the time you hear the thunder, lightning is long gone. Sound travels 1100 feet per second, approximately. Lightning one mile away creates thunder that is heard about 5 seconds later, which is much too late to take the picture. Actually, what you need is a light actuated switch—a circuit very much like a photographic slave that will trip your camera when a flash of light trips it. Now that is a project worth designing.

Shocking

My electronics shop teacher says I have to install an isolation transformer in my three-transistor, AC operated receiver before I can bring it to school. Is it that important?

—B.J., Washington, DC

I assume that you are dropping the AC line voltage through a resistor, then rectifying it for some low level DC supply. If this is so, half the time the set's ground will be connected directly to the hot side of the AC line. This is dangerous. A 1:1 time ratio power transformer will isolate the set from the AC line and reduce possible shock. Listen to your teacher and ask him to explain next time.

The FM Noise Killer

Why pre-emphasis, and then de-emphasis, in FM transmissions in hi-fi?

—A.M., Santa Barbara, CA

Noise levels increase for higher-frequency audio signals. If the level of the audio signal is raised as frequency increases, the level of audio above the noise remains high enough to insure adequate signal-to-noise ratios. That's why pre-emphasis at the transmitter occurs. At the home FM receiver, the signal goes through a process of de-emphasis to provide a flat frequency response. When this is done, the high frequencies are reduced (as much as 17 dB at 15,000 Hertz) also reducing the noise to a level below that produced by the receiver. Thus, transmission noise is effectively reduced.

Why D.C. Amps

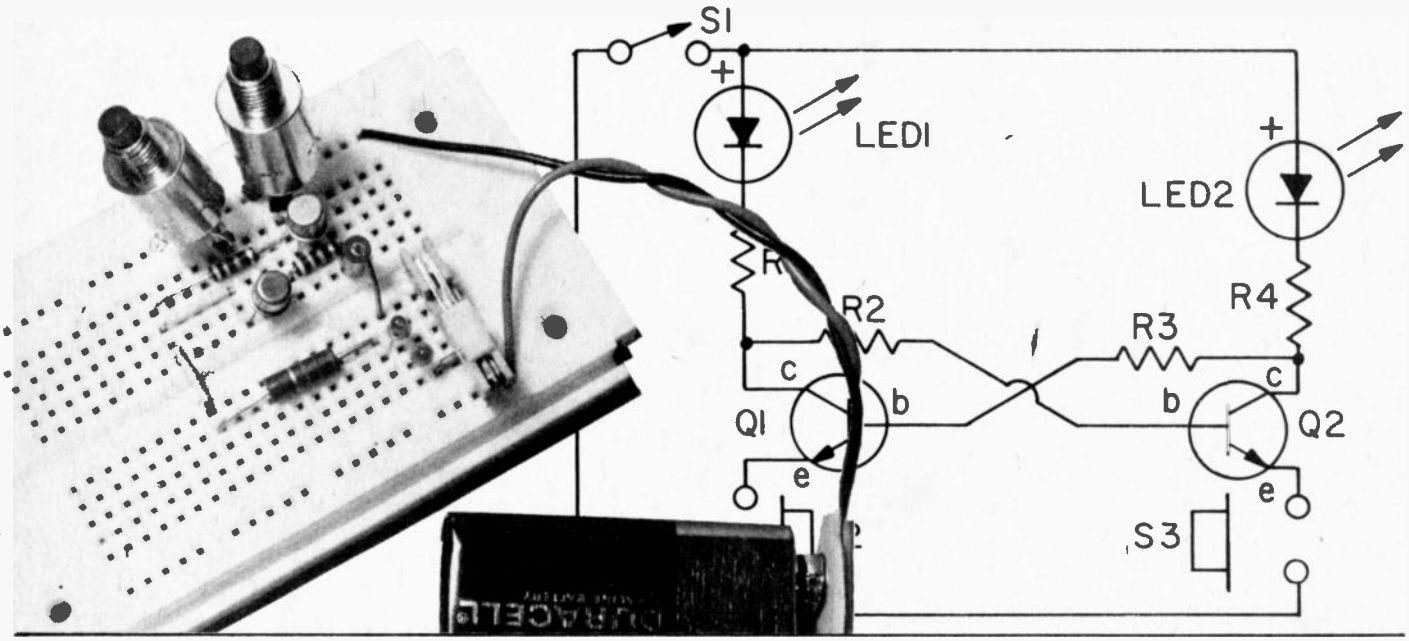
What is the advantage of a direct-coupled amplifier?

—H.L., Reston, VA

A coupling capacitor has a varying reactance for different frequencies that is quite noticeable at an amplifier's lower frequency limit. In fact, the coupling capacitor size determines the lower frequency limit. Direct coupled amplifier circuits use a copper wire or a direct connection, effectively reducing the lower frequency limit to zero. This type of circuit is simple to design when using complementary pnp and npn transistors down the signal amplification line. Direct coupled amplifiers are now common in audio components where low frequency reproduction without phase-shift is important.

(Continued on page 113)

101 ELECTRONIC PROJECTS



FOR UNDER $15—ALL EASY TO BUILD

WE THINK YOU'RE GOING to find this year's 101 ELECTRONIC PROJECTS the most interesting edition yet. We've added scores of useful new circuits and weeded out many of the dog-eared old veterans. We've added a series of informative logic demonstrators, a number of exciting telephone accessories, a smattering of alarm circuits, a bunch of useful automotive circuits, and a wealth of other projects.

And we've made these the easiest-to-build projects ever.

Plug-and-Chug Projects. Throughout these pages, you'll see many of these projects actually built up on solderless breadboards. These make our projects simpler to build and easier to understand.

If you've never tried solderless breadboards before, you'll find a treat in store for you. Components plug right into them. Inside, spring clips connect each row of five "holes" together. Simple hookup wire jumpers then complete the circuit. And long "bus" connectors along each edge are naturals for carrying supply (battery) voltages.

So, everything hooks together in a few minutes. You can try different part values immediately. Checking out different transistors, for example, is even quicker to do than it is to talk about.

The solderless breadboard we used is the Continental Specialties Corporation *Experimentor™* Socket model EXP350. It's very versatile and very inexpensive. You can order one from CSC or buy one from one of their dealers. Other suitable solderless breadboards are available from Radio Shack or from GC Electronics (Calectro) dealers.

Or, if you wish, you can build your projects following the more traditional methods, like printed circuits.

Surprise—A 101 ELECTRONIC PROJECTS Kit. We've made special arrangements to offer a kit of all the parts you'll need to build any of the 101 ELECTRONIC PROJECTS in this edition. The inside front cover has the details.

Or, you can buy your parts through any of the traditional sources. We've made a special effort to design our circuits so that, in many cases, substituting close but wrong part values, or different transistors (of a type—NPN, PNP, PFET, UJT, etc.), will still result in a working circuit. Some of the parts we tried were bought in plastic bags at hamfest flea markets—and *they* worked.

The electronics dealers who advertise regularly in the back of ELEMENTARY ELECTRONICS and other leading electronic hobby magazines are good sources for parts. So are your local electronic and radio parts stores. In many cases, you can get parts from your own "junkbox" after stripping them off old, broken equipment. Chances are a local TV repair shop can give you a junker to start you on your way.

A Plug for Safety. One thing that's different about this year's 101 ELECTRONIC PROJECTS is that none of our projects attach to the AC power line. Instead, they're powered by battery, by your car, by the phone line or by a signal.

This doesn't mean that you're completely free from trouble, it just reduces the chance of an accident. But, there are still a few procedures to follow to avoid trouble.

For one, always check across the power leads with an Ohmmeter before you connect power. If it reads less than 20-30 Ohms, you're going to be drawing too much current. That can drain your battery, blow your car's fuse, burn out your stereo's output or mess up the phone company lines all around you, depending on the project.

Don't attach anything to the phone lines unless and until you're very sure it won't disturb service. Make sure your parts can withstand a several-hundred-volt de-icing surge, and never leave anything attached for more than a few minutes.

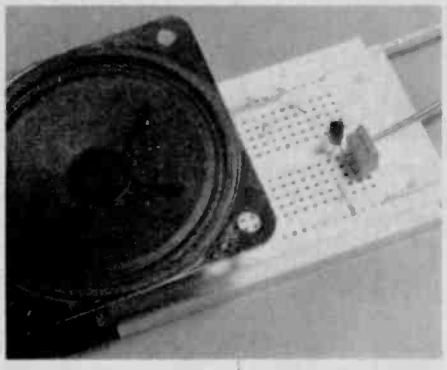
New Devices. One of the best aspects of these projects is that they represent a great opportunity to gain hands-on experience with a variety of different electronic components.

JFETS (*J*unction *F*ield *E*ffect *T*ransistors) are more sensitive than standard bipolar transistors. They respond to voltage changes at very small currents (in other words, they offer a high input *impedance*), and operate much more like vacuum tubes than transistors. Yet, they are small, easy to work with, and very versatile.

SCRS (*S*ilicon *C*ontrolled *R*ectifiers), the solid state equivalent of a latching relay, can be thought of as a transistor with a built in "gotcha." Bring an SCR's gate voltage to its turn-on point and you'll have to open the circuit to turn it off again.

Phototransistors let light (sometimes voltages too) control their output. You can use them to detect light, signal with light, and more.

UJTs (*U*nijunction *T*ransistors) are natural-born relaxation oscillators. This is due to an unusual quality they possess called "negative resistance." They're small, inexpensive, and easy to work with.



Beep-beep, boop-boop, some of the sounds you know and love from out of the mouths of 555 chips. But, to really hear it all, you'll need this 555 Loudspeaker for sure.

Zener diodes work like regular diodes when hooked "frontwards" (forward biased), but act as voltage regulators when hooked "backwards." This can lead to interesting applications, as you'll see on the pages that follow.

And, you'll find many new ways to apply transistors, LEDs, diodes, switches, relays and more.

Secret Formulas for Success. Just for the record, here are a few of the formulas that tell you how much a part value can change and what that will do to circuit operation.

E=IR. This is Ohm's law. E is Voltage in Volts, I is current in Amps, R is resistance in Ohms. You can figure any one when you know the other two:

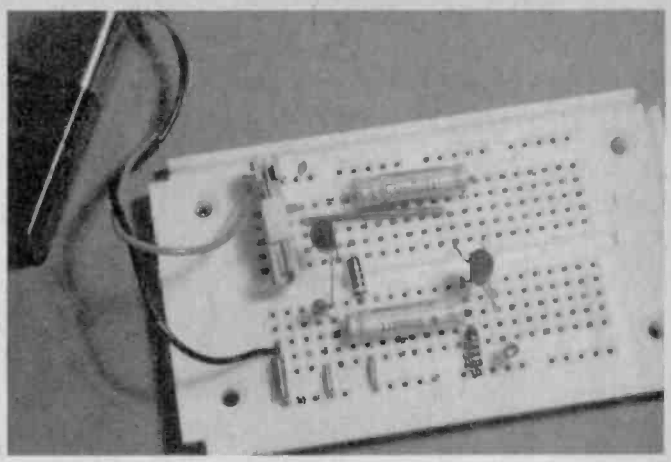
E=IR I=E/R R=E/I

P=EI. This is Watt's law. It says that the power in Watts is the product of the current in Amps and the Voltage. If you use it to figure resistor wattage, add a 50% safety margin. You can also combine it with Ohm's law:

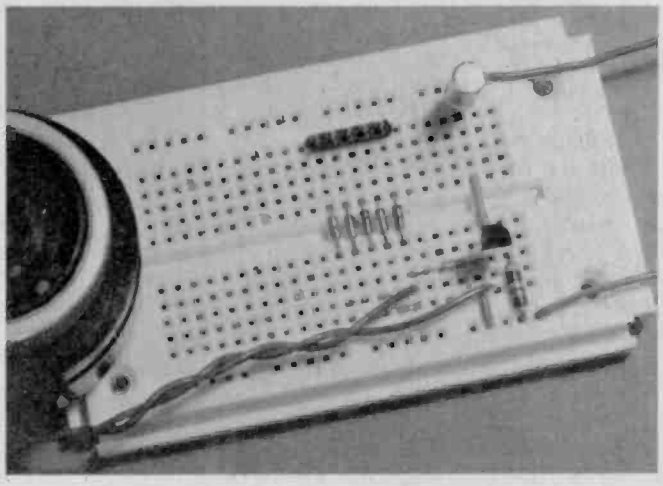
$P=EI=I^2R=E^2/R$

$I=P/E=\sqrt{P/R}$

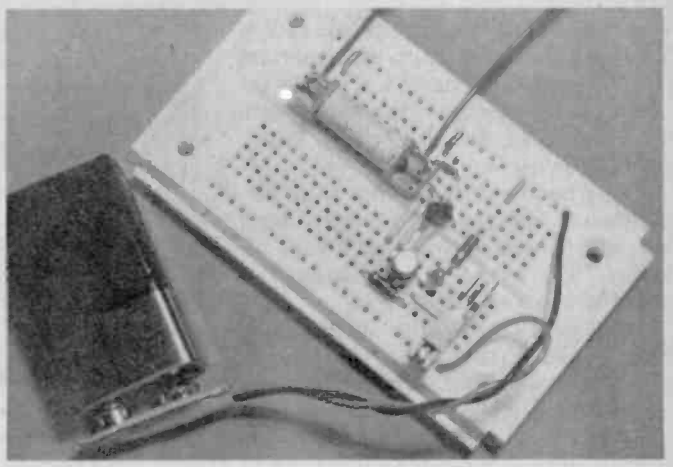
$E=P/I=\sqrt{PR}$



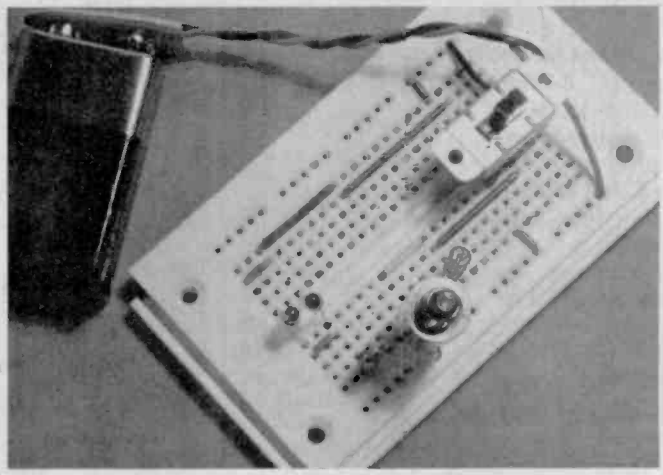
The Bamboozler blinks two lights, but does it with style. It's up to you to tell your friends why. Don't worry, you'll come up with some explanation.



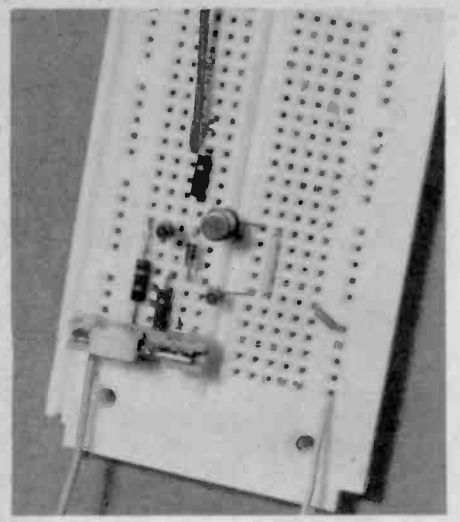
Idiot's Delight? Well, it turns those idiot lights on your dashboard into delightful little buzzers. It has a built-in delay so you can start the car without noise.



This Photoelectric Something's There Tattletale will serve you in many ways. It uses a phototransistor to do your spying for you.



Transistor Checker will make it pushbutton easy to check on those transistors you have floating in your junk box. Do it before you build that transistor project, not after when it's too late—all you need is right here.



Here's a Logic Probe to help you mind your 1's and 0's. It's sensitive enough to be of a real help around the home workshop.

T RC. This will help you figure out the speed of timer circuits and the frequency of R-C oscillater circuits. The time delay in seconds is roughly the product of the resistance in Ohms and the capacitance in Farads. (1 microfarad=1/1,000,000 of a Farad; 1 picofarad = 1/1,000,000,000,000 Farad). And since R (frequency in Hertz) is the reciprocal of T (period in seconds):

F=1/T T RC F 1/RC

Buy Cheap. There's really no reason to get super critical about the parts in these projects We grabbed whatever was handy when we built them, and so can you. Besides—and more important—when you don't have too much invested it's easier to experiment with variations and not worry too much about blowing out a part.

Don't be afraid to combine these circuits with each other. The worst thing that can happen is they won't work together. The best that can happen is you'll learn something.

And don't worry too much about part values. If the circuit calls for an 8-Ohm speaker, for example, chances are anything from 4 to 40 Ohms will do. A 22 microfarad capaciter can probably be any value from 10 to 50.

Take what you've got and give it a shot.

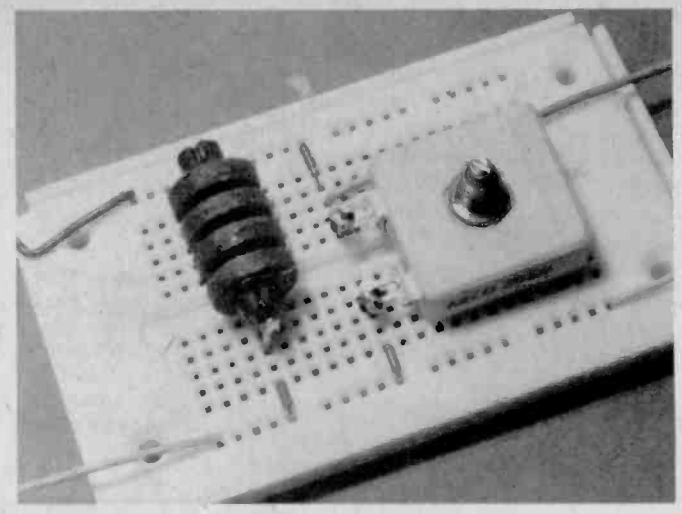
Discovery Is The Name of The Game. And, like a game should be, its fun. You'll find ways to use your VOM as a field strength meter or thermometer.

You'll find instant insight into AND, OR, NAND, NOR and EXCLUSIVE NOR logic gates—and learn how your home's two-way switch works.

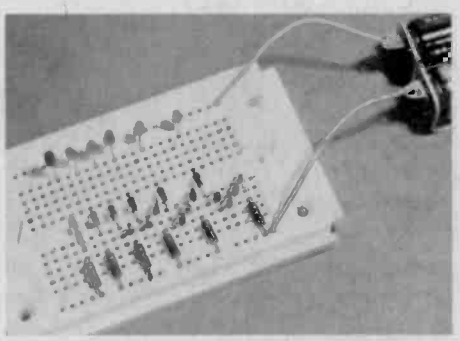
You'll build an LED bargraph, an LED null meter, and use an LED as part of a switch.

You'll listen to radio stations, walkie talkies and your plants. You'll build sound changers that electronic instrumentalists love. And more.

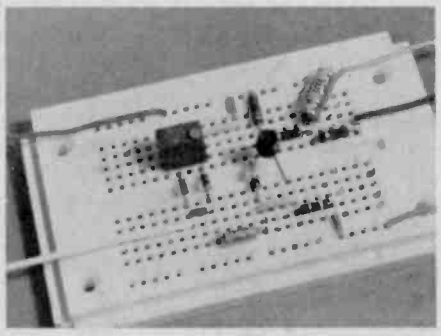
It's all just a turn of the page away. ■



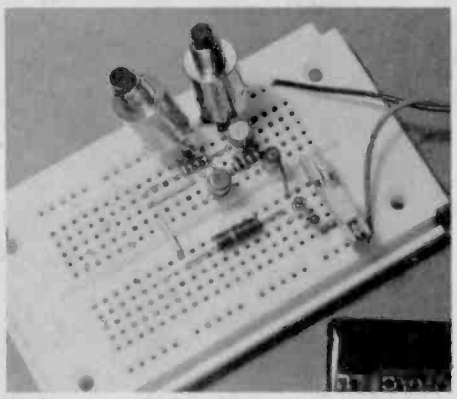
Turn your VOM into a Field Strength Meter. The sensitivity of the circuit is determined by the type of diode.



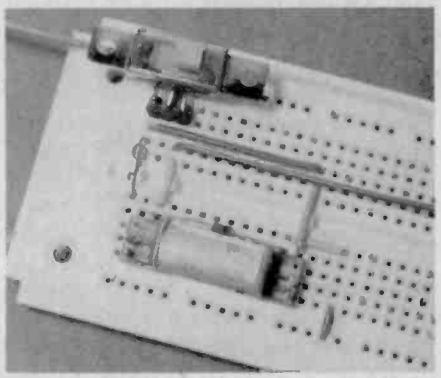
A LED Bar Graph takes any kinds of light emitting diode and turns it into an interesting display to monitor the range of voltage presented at the Graph's input.



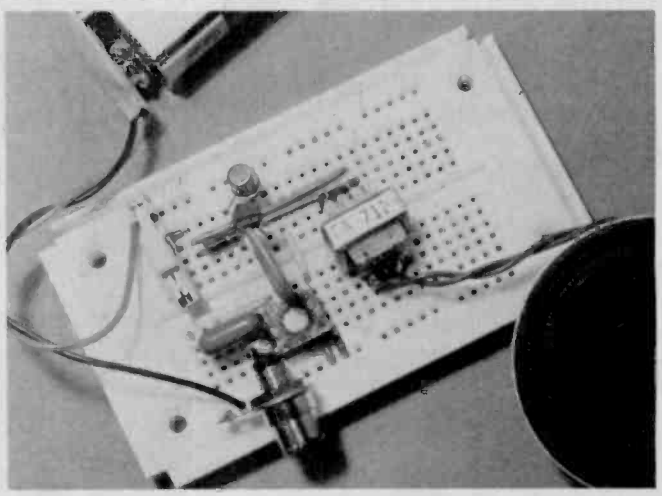
It won't help you to win the Indy 500, but turning your VOM into a Tachometer will help you to do your own tuneups. So save on money and gas with this project.



Add this Quick Draw Game #1 to your old homestead for laugh-a-minute action. Light your light before opponent outdraws you.



Overvoltage Protector works hard so that your circuits can be protected against too much voltage just as a circuit breaker will protect them against too much current.



Okay tightwad—this Penny Pincher's Utility Amplifier is for you! There are over a hundred uses and for about a penny a use!

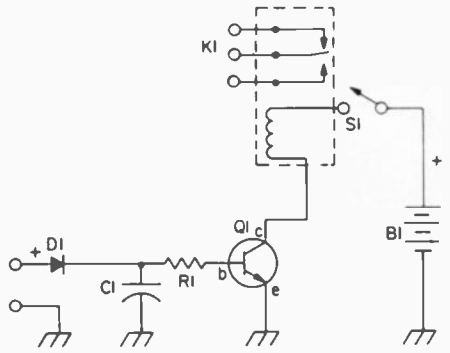
101 ELECTRONIC PROJECTS
FOR UNDER $15

1 Signal Operated Switch

☐ If a VOX is a voice operated switch, is this signal operated switch a SOX?

You can take a signal, like the earphone jack output from a radio or tape player, and use it to trigger the relay operation. If used with an FM wireless mike, an FM radio and a cassette recorder, for example, this circuit could start the recorder whenever the FM radio receives the wireless mike signal. D1-R1-C1 form an R-C delay network that delays the turn-off of the relay until some time (the number of seconds of delay is roughly the number of ohms of R1 times the number of microfarads of C1 divided by a million) after the signal stops.

The signal charges C1 through D1, which keeps it from discharging back through the signal source. C1 then holds the base of Q1 high until it discharges enough through R1 and the base-emitter circuit of Q1 to reach a turn-off point. Q1 completes the circuit for K1's coil, and you can do whatever you want with the contacts (turn on a light, start a motor, honk a horn, fire up a computer, light up your TV).



PARTS LIST FOR SIGNAL OPERATED SWITCH

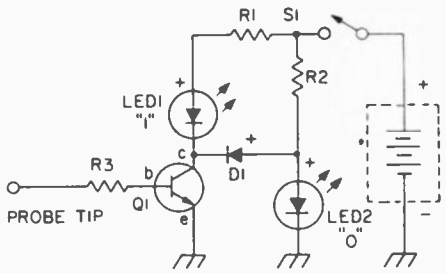
B1—6-15 VDC
C1—2.2-150-uF capacitor
D1—Silicon diode (1N914 or equiv.)
K1—Small, sensitive relay (reed relays are ideal); voltage compatible with B1; coil impedance greater than B1 voltage by Q1 collector current rating
Q1—NPN switching transistor; collector current rating greater than relay current (2N2222 handles 800 mA and most small relays)
R1—4700-470,000-ohm resistor, ½-watt

2 Logic Probe

☐ While not as sophisticated as some of the very sensitive and much more expensive professional logic probes, you'll be able to see the 1's and 0's in your logic circuits as you probe. The probe tip is connected to the base of Q1 through resistor R3. When the probe tip is reading a high, or "1" signal, the transistor will conduct, turning on LED1. It will also conduct the current from R2 through D1 and Q1, effectively shorting out LED2.

If the probe tip is connected to ground (a logical low or "0"), transistor Q1 will not conduct, so LED1 will not light. The R2 current will then be "steered" into LED2 instead of D1 and Q1, lighting LED2. Some logic families switch states in circuits with "1" and "0" levels very close together, near a value of half the supply voltage; this probe may not work with those families. For TTL and most CMOS circuits, you should get good results. The probe is powered by the circuit under test.

One more caution: if you find this probe loading the lines in a CMOS or other low-power logic circuit, try either increasing the value of R3, or adding an additional logic buffer between the probe and the circuit you wish to monitor.



PARTS LIST FOR LOGIC PROBE

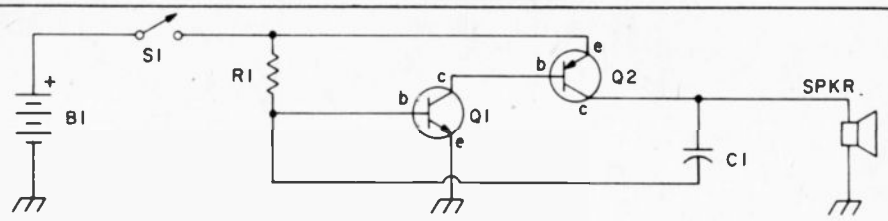
D1—Silicon signal or switching diode (1N914 or equiv.)
LED 1, LED 2— Light emitting diodes
Q1—General purpose NPN transistor (2N2222, 2N3904 or equiv.)
R1—100-180-ohm resistor, ½-watt
R2—150-330-ohm resistor, ½-watt
R3—1000-3300-ohm resistor, ½-watt
S1—SPST (may not be needed)

3 Simple Squealer

☐ Back when transistors were brand new and everybody wanted to see how they worked, one of the favorite circuits was very similar to this one. It put out an ear-piercing squeal. The only way anybody could put up with it was to use it with a telegraph key as a code practice oscillator, often in a very large room. The components you choose will have a great effect on the output of this circuit, and you can take it from a whine to a whisper, from a ticking to a squeal.

Just one precaution: it's possible that the components you use could allow too much current to pass through Q1 or Q2. So if the case of either transistor becomes too hot to touch, replace it with a transistor with a higher collector current rating, even a power transistor if you wish.

The editors can not be held responsible for the sanity of you or your neighbors after prolonged experimentation with this circuit.



PARTS LIST FOR SIMPLE SQUEALER

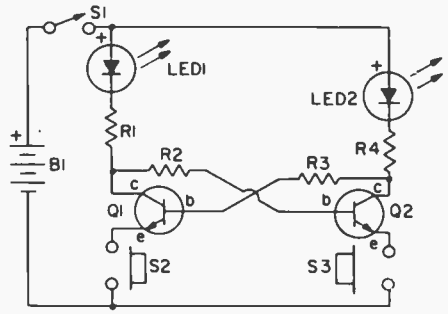
B1—3-15 VDC battery
C1—.005-.05-uF
Q1—NPN silicon transistor (2N3904 or equiv.)
Q2—PNP transistor (2N3906 or equiv.)
R1—82,000-120,000-ohm resistor, ½-watt
S1—SPST switch or telegraph key
SPKR—4-16-ohm speaker

4 Quick Draw Game #1

☐ Okay, podner, the fust one to push the button lights the light on his side, and blocks the other light from turning on.

You can yell "draw" by closing S1. But instead of a switch, you can find a trickier way of closing the contacts.

Try rolling a steel ball bearing down a channel with the contacts on the bottom. When the ball completes the circuit, go for your trigger buttons. Or you can just leave S1 closed. Once both "triggers" (S2 and S3) are released, this game is automatically set to be played again.



PARTS LIST FOR QUICK DRAW GAME #1

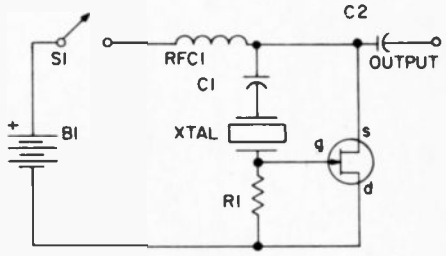
B1—6-15 VDC battery
LED1, LED2—Light emitting diodes
Q1, Q2—NPN transistors (2N2222 or similar)
R1, R4—150-390-ohms resistors, ½-watt
R2, R3—22,000-56,000-ohm resistors, ½-watt
S1—SPST switch (see text)
S2, S3—Normally open momentary, or micro, switches

5 Pierce Crystal Oscillator

☐ This JFET Pierce oscillator is very stable, very simple, and can prove very useful. With a suitable crystal, this oscillator can be the clock of a microprocessor, a digital timepiece or a calculator. With a probe attached at the output, it can be used as a precise injection oscillator for troubleshooting. You can attach a small length of wire at the output to act as an antenna and use this circuit as a micropower transmitter. With suitable crystals it can then provide reference marker frequencies for short wave listening, receiver tuneup, tv repairs and more. Transistor Q1 can be a Siliconix 2N5458, a Motorola MPF102 or similar.

PARTS LIST FOR PIERCE CRYSTAL OSCILLATOR

B1—6-15 VDC battery
C1—.001-.01-uF capacitor
C2—100-pF-.001-uF capacitor
Q1—N-channel JFET (Junction Field Effect Transistor) (2N5458 or equiv.)
R1—1-2.2 Megohm resistor, ½-watt
RFC1—Radio frequency choke, 2.5-mH
S1—SPST switch
XTAL—Crystal

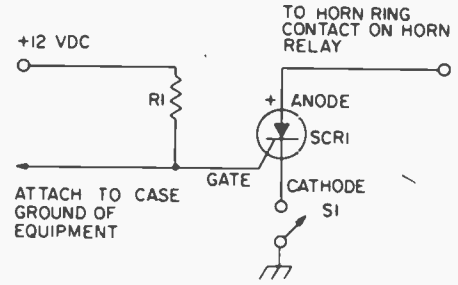


6 CB Saver

☐ Here's a simple little trick to blow the whistle on a would-be purloiner of your car's under-dash radio or tape player, as well as any Citizens Bandit. Most thieves, in order to keep their derring-do as brief as possible, simply cut all the wires attached to whatever it is they wish to steal. Unknown to them, one of the wires in the bundle has been keeping the SCR in your CB Saver from firing. No sooner is the wire cut than resistor R1 pulls the gate of the SCR high and allows it to conduct, which pulls in the horn relay and honks your hooter until you come and stop it, by opening S1.

To be fair, if left honking for too long, your horn can burn out or your battery can die. But if, like most of us, you're never too far from your car, this inexpensive circuit can save you valuable time in knowing that something's awry.

A number of CB Savers can be hooked up independently of each other to protect all of your equipment. If you like, they can all share the same hidden defeat switch. Another nice trick is to connect a fender-mounted *normally closed* switch between the "case" terminal and ground. Then if a burglar tries to pick the keyswitch or cut the wires to the switch, he'll set off your horn immediately.



PARTS LIST FOR CB SAVER

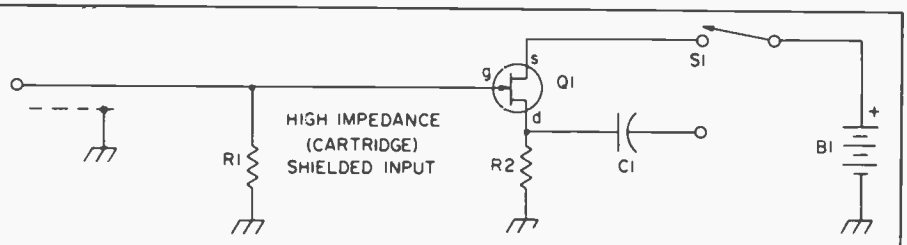
R1—820-1800-ohm resistor, ½-watt
SCR1 — Silicon-controlled-rectifier, 20-volts or more at 1-amp. or more
S1—SPST switch (hidden defeat switch)

7 Ceramic Cartridge Preamplifier

☐ Here's the answer to how to marry that old ceramic cartridge phonograph with the amplifier that isn't quite hot enough to be able to accept it. It's a common enough problem, found by a lot of people when they attempt to upgrade a system. Here's the solution.

The circuit is really acting as an impedance converter, converting a high impedance input, such as a ceramic cartridge, into a low impedance. Choose an input resistor (R1) to match the impedance of your phono cartridge; the circuit's output impedance will be very close to the value of R2.

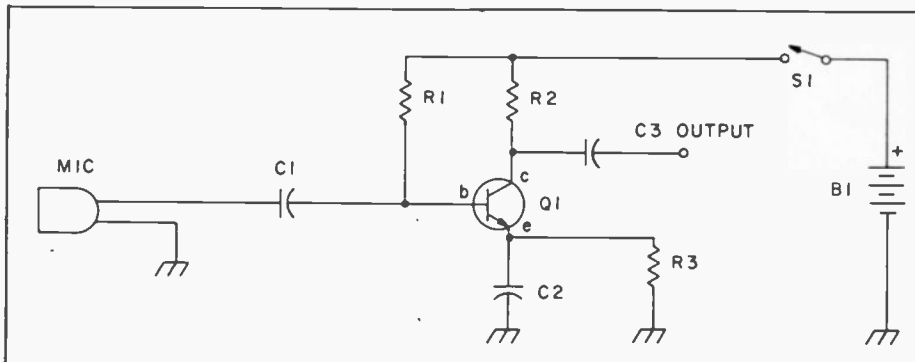
This same circuit, of course, can be put to other uses involving magnetic tape heads or piezoelectric transducers (used in ultrasonics), for example, or other high impedance sources. If installed inside the amplifier, B1 and S1 may not be necessary.



PARTS LIST FOR CERAMIC CARTRIDGE PREAMP

B1—6-15 VDC battery
C1—5-15-uF capacitor
Q1—N-channel JFET (Junction Field Effect Transistor) (2N5458 or equiv.)
R1—1-10 Megohm resistor, ½-watt
R2—820-150-ohm resistor (see text), ½-watt
S1—SPST switch

8 Dynamic Mike Amplifier



PARTS LIST FOR DYNAMIC MIKE AMP

B1—6-15 VDC battery
C1—5-25-uF capacitor
C2—50-250-uF capacitor
C3—2-15-uF capacitor
Q1—NPN transistor (2N2222, 2N-3904 or equiv.)
R1—33,000-68,000-ohm resistor, ½-watt
R2—2700-5600-ohm resistor, ½-watt
R3—82-150-ohm resistor, ½-watt
MIC—Low impedance microphone, 8-600-ohms

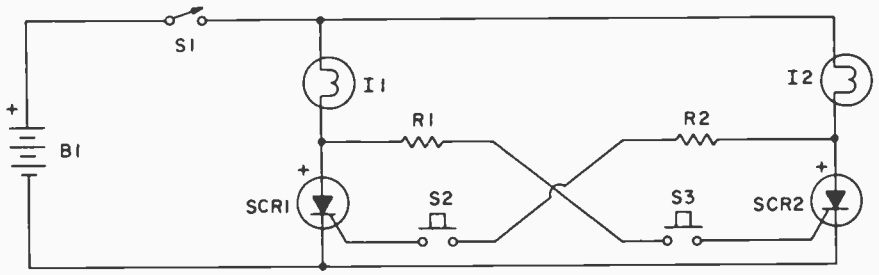
☐ This simple one-transistor preamp will get a little more signal out of even a tired old microphone. And the circuit is small enough to build right into a microphone, if you want to. If you use this circuit at the microphone, it will let you use a longer run of cable to the input of your cassette recorder, for example, or whatever you're using. The added amplification of this circuit should more than offset the additional line losses.

If your microphone includes a push-to-talk switch, you might want to investigate making it do double duty as a power switch as well. In most cases, this will be easier if you include S1 in the negative battery connection rather than the positive, as shown here.

9 Quick Draw Game #2

PARTS LIST FOR QUICK DRAW GAME #2

B1—6-15 VDC battery
I1, I2—Pilot lights (see text)
R1, R2—1000-3900-ohm resistors
SCR1, SCR2—Silicon controlled rectifiers (see text)
S1—SPST switch
S2, S3—Normally open pushbutton, or micro, switch

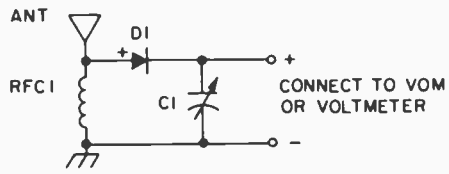


☐ Here our Quick Draw Game goes Hollywood. The bright, incandescent pilot lights can be used with colorful jewels, and the SCRs give the game a "memory." Choose a lamp type for I1 and I2 that is compatible with the voltage you select for B1. And select an SCR type for SCR1 and SCR2 that is compatible with both the voltage of B1 (or greater) and the current requirements of I1 and I2 (or greater). S1 turns the game on. Then the first player to push his "trigger" switch will light his lamp and block his opponent. To reset, turn S1 off.

10 Make Your VOM a FSM

☐ This simple RF (radio frequency) detector circuit will permit you to measure RF on any meter that can measure a few volts. The antenna can be a length of wire, a telescoping whip or a real antenna. A foot or so of stiff wire should do for most purposes. The sensitivity of the circuit is determined mostly by the forward voltage drop of the detector diode D1. Silicon is worst, germanium (such as the inexpensive 1N34) better, hot carrier diodes better still. In a strong RF field, you can even use an LED and watch the RF make it glow.

C1 can be a broadcast tuning capacitor or almost any variable capacitance of a couple of hundred pf range. In operation, tune C1 for the largest swing on your meter. Adjusting the length of the antenna may help, too. Then watch the reading change as either you or the transmitter moves.



PARTS LIST FOR VOM INTO FSM

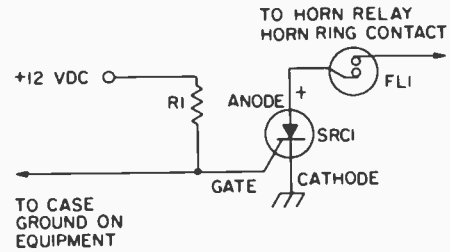
ANT—Antenna (see text)
C1—205-pF variable or trimmer capacitor (see text)
D1—Signal diode (1N34 or similar), or silicon diode (1N914 or similar)
RFS1—RF choke, approx. 2.5 mH

You can use this device with a simple chart to mark down your readings at different points around a signal source. The chart can then show the RF pattern characteristic of the antenna transmitting the signal.

11 Pulsing CB Saver

☐ If there's anything that will attract attention better than a honking car horn, it's an intermittently honking car horn. This circuit is an adaptation of the CB Saver that interrupts the horn relay contact with a flasher cartridge. Make sure you get the multiple-load flasher, as others require too much current to operate.

Notice there is no hidden defeat switch. There are two ways to defeat-



PARTS LIST FOR PULSING CB SAVER

R1—820-1800-ohm resistor, ½-watt
SCR1 — Silicon-controlled-rectifier, 20-volts or more at 1-amp. or more
FL1—Multiple load turn signal flasher cartridge

this alarm. You can either reground the protection lead, or pull the flasher out of its socket (assuming you use a socket). If you want to protect several pieces of equipment, use separate protection leads, resistors and SCRs for each, and parallel all of the SCR anodes at the SCR end of the flasher.

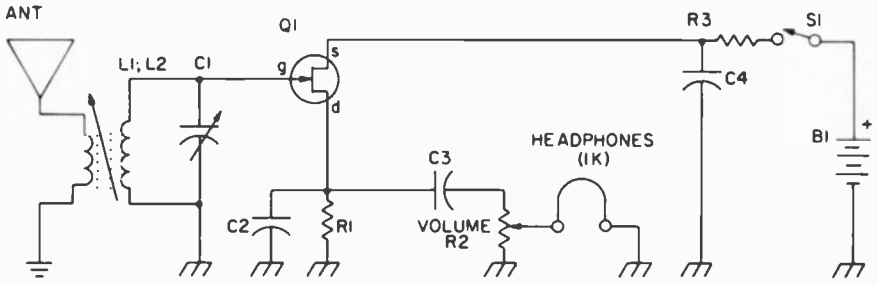
12 High Performance Transistor Radio

☐ Here's a neat way to update your crystal set, assuming you can still find it. Or use these few inexpensive parts to build from scratch. Instead of using a cat's whisker or a diode, this radio uses the very sensitive junction of a junction FET as its detector. This makes it a very "hot," very sensitive high impedance detector. Then the JFET does double duty by converting the high input impedance to a lower output impedance–low enough and with enough drive to power a set of high impedance headphones or a high impedance earphone (about 1K or so).

The antenna coil is one of those simple loopsticks you've seen at the parts stores. (Or you might want to wind your own on an oatmeal box). The broadcast variable capacitor is one of the tuning capacitors taken from an old, defunct radio. You can use any long wire for the antenna, but if you string it outdoors, be sure to use a lightning arrestor. You can also clip an alligator clip to your bedspring, a windowscreen, or the metal part of a telephone.

PARTS LIST FOR HIGH PERFORMANCE TRANSISTOR RADIO

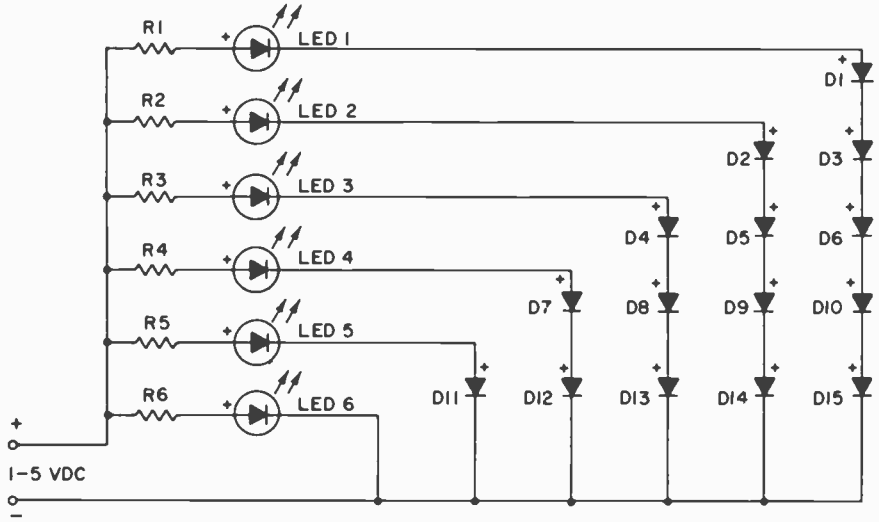
B1—6-15 VDC battery
C1—Approx. 356-pF broadcast-type variable capacitor
C2—300-600-pF capacitor
C3—.05-.5-uF capacitor
C4—.22-1.0-uF capacitor
L1/L2—Ferrite loopstick, or ferrite-bar BCB antenna coil
Q1—N-channel JFET (Junction Field Effect Transistor) (2N-5458, MPF102 or equiv.)
R1—18,000-47,000-ohm resistor, ½-watt
R2—20,000-100,00-ohm potentiometer
R3—4700-10,000-ohm resistor, ½-watt



13 LED Bar Graph Display

☐ This circuit takes advantage of the forward voltage drop exhibited by silicon diodes. Each leg of the circuit shows a light emitting diode in series with a current limiting resistor and a different number of diode voltage drops, from 0 to 5. You may use any kind of diode you wish, including germanium, silicon, even expensive hot carrier types (although they won't exhibit quite as much drop, they're very expensive, and too large a current could burn them out).

Depending on the diodes you choose, each will exhibit a forward voltage drop between 0.3 and 0.7 volts. For consistency, stay with diodes of the same type, or at least the same family. Those twenty-for-a-dollar "computer" diodes will do just fine. To expand the range of this LED "meter," use two resistors as a voltage divider at the input. Connect one across the + and – terminals, the



PARTS LIST FOR LED BAR GRAPH DISPLAY

D1-15—Silicon diodes (such as 1N914)
R1, R2, R3, R4, R5, R6—120-270-ohm resistors, ½-watt
LED1, LED2, LED3, LED4, LED5, LED6—Light emitting diodes

other from the + terminal to the voltage being measured. The LEDs will then be monitoring a range determined by the ratio of those resistors, as determined by this formula:

The voltage across the input equals the resistance across the output, divided by the sum of the resistances and multiplied by the voltage being measured. Or:

$$Ein = Em \times \frac{Rin}{Rsum}$$

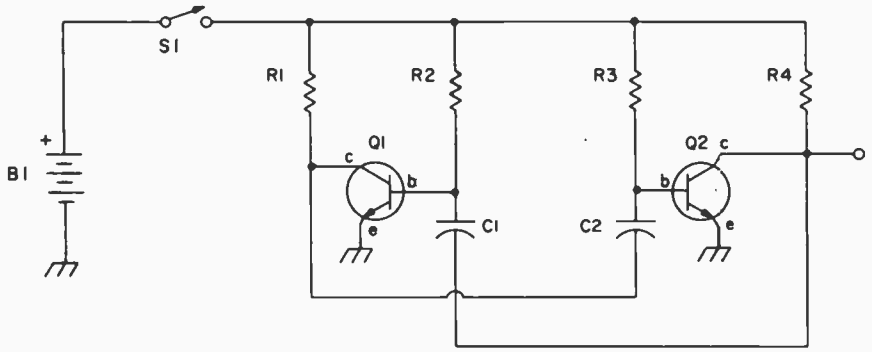
14 Multivibrator Tone Hummer

☐ This multivibrator produces an audio tone rich in harmonics. If you were to look at the output on an oscilloscope, you would see it is a square wave. Because it is so rich in harmonics, you can use this circuit as a signal injector for tracing signals in audio, if (intermediate frequency), and even some rf stages. Just how high the harmonics will go depends on the particular transistors you choose, the voltage you operate them at, and the specific values of the other components.

You can also use this circuit to provide very fast clock pulses to logic circuits, with pulse width in the fraction-of-a-millisecond range, if you like. Remember, the higher in pitch the tone that you hear, the shorter each pulse width. You can also use this as a signal injector or signal source in setting up stereo or intercom systems.

PARTS LIST FOR MULTIVIBRATOR TONE HUMMER

B1—6-15 VDC
C1, C2—.05-.5-uF capacitors
R1, R4—2200-4700-ohm resistors, ½-watt
R2, R3—4700-100,000-ohm resistors, ½-watt
S1—SPST switch
Q1, Q2—NPN transistor (2N2222, 2N3904 or equiv.)



15 High Impedance Mike Amplifier

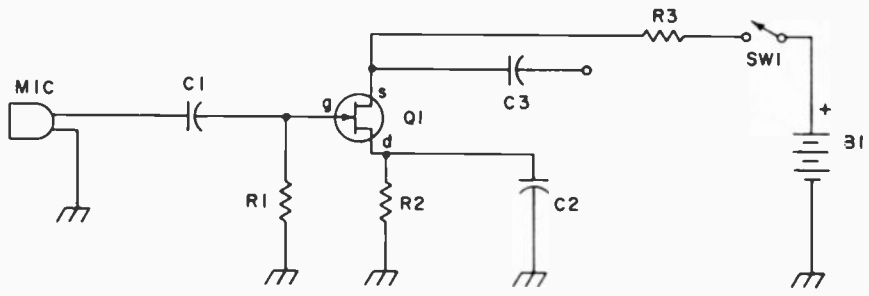
☐ This high-to-low impedance converter will let you use a high impedance crystal, ceramic or dynamic microphone with conventional (around 5K) microphone inputs. It will also let you use a high impedance mike over a longer run of cable with less danger of introducing hum.

Q1 is a general purpose N-channel JFET, like the Siliconix 2N5458, Motorola MPF102 or similar. Choose R1 to match the impedance of your microphone.

If you choose to mount this circuit in or near the microphone case (where it will do the most good), and the microphone is a push-to-talk type, investigate using the PTT switch in place of S1. This may work better if S1 is placed in the negative battery lead rather than the positive (as shown).

PARTS LIST FOR HIGH IMPEDANCE MIKE AMPLIFIER

B1—6-15 VDC battery
C1, C3—.001-.01-uF capacitors
C2—25-100-uF
Q1—N-channel JFET (Junction Field Effect Transistor) (2N5458 or similar)
R1—1-10 Megohm resistor, ½-watt
R2—1800-330-ohm resistor, ½-watt
R3—4700-10,000-ohm resistor, ½-watt
S1—SPST switch (see text)



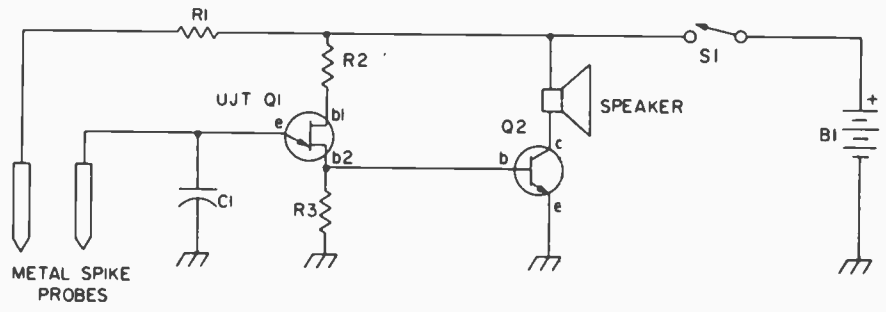
16 Plant Moisture Monitor

☐ Some people don't believe that plants can listen, talk, sing and play musical instruments. But you can prove, at least, that they sing out when you water them. This circuit lets you use the soil near your plants as a variable resistor that changes value as you add more water to it. Just stick the metal spikes into the soil, a few inches from each other. For best results, cut flat, skinny wedges out of thin copper or alumi-

num or out of printed circuit board stock. Depending on the soils resistance, the sound will vary from slow clicking noises to a high pitched shriek.

PARTS LIST FOR PLANT MOISTURE MINDER

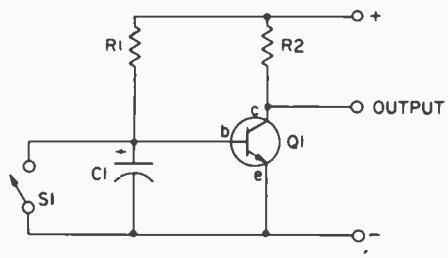
B1—6-18 VDC
C1—5-25 uF capacitor
R1—2200-5600-ohm resistor, ½-watt
R2—3300-5600-ohm resistor, ½-watt
R3—82-120-ohm resistor, ½-watt
Q1—Unijunction (UJT) transistor (2N2646 or equiv.)
Q2—NPN transistor (2N2222, 2N-3904 or equiv.)
S1—SPST switch
SPKR—4-32-ohm speaker



17 Switch Contact Debouncer

☐ Today's logic circuits are so quick that even the fast, tiny bouncing of switch contacts can be counted as separate switching events. This simple circuit adds a tiny delay to the switching to keep those bounces from reaching your logic. It gets its power right from the logic circuit you're using it with. Most logic requires switching between some input and ground. For those cases, use the circuit the way it's shown. It goes in the lead from the ungrounded side of the switch to the logic input (which is then connected to the Output shown).

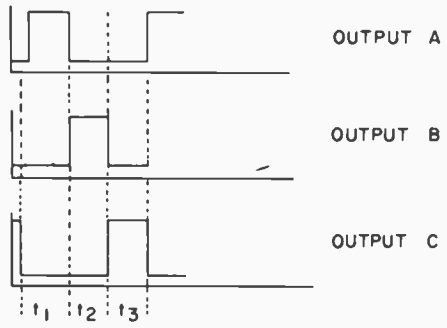
Should your application require switching to the positive supply (assuming ground is negative above), simply swap the + and – leads and make Q1 a PNP transistor (2N3906, for example). Also, if the capacitor you're using for C1 is polarized, an electrolytic, for example, reverse its polarity as well.



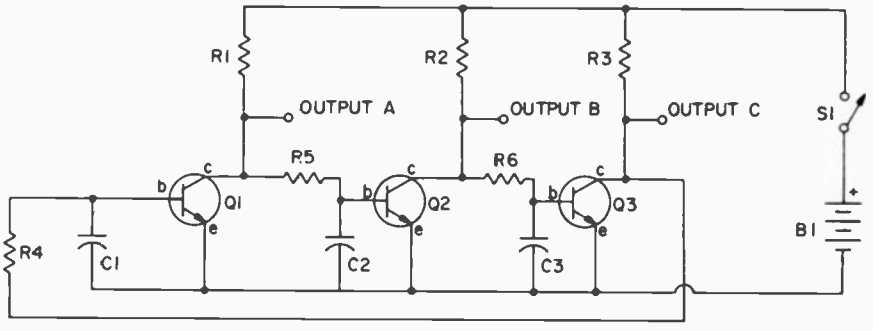
PARTS LIST FOR SWITCH CONTACT DEBOUNCER

C1—.5-2.2-uF capacitor, electrolytic, (VDC greater than your power supply)
R1—10,000-56,000-ohm resistor, ½-watt
R2—270-1000-ohm resistor, ½-watt
S1—SPST (switch to be debounced)
Q1—NPN transistor (2N2222, 2N-3904 or equiv.

18 Square Wave Generator



$t_1 = t_2 = t_3$ WHEN R1 = R2 = R3
C1 = C2 = C3 AND R4 = R5 = R6



PARTS LIST FOR SQUARE WAVE GENERATOR

B1—6-15 VDC battery
C1, C2, C3—.5-uF capacitor
Q1, Q2, Q3—NPN general purpose transistor (2N2222, 2N3904 or equiv.)
R1, R2, R3—500-2700-ohm resistors, ½-watt
R4, R5, R6—10,000-47,000-ohm resistor, ½-watt
S1—SPST switch

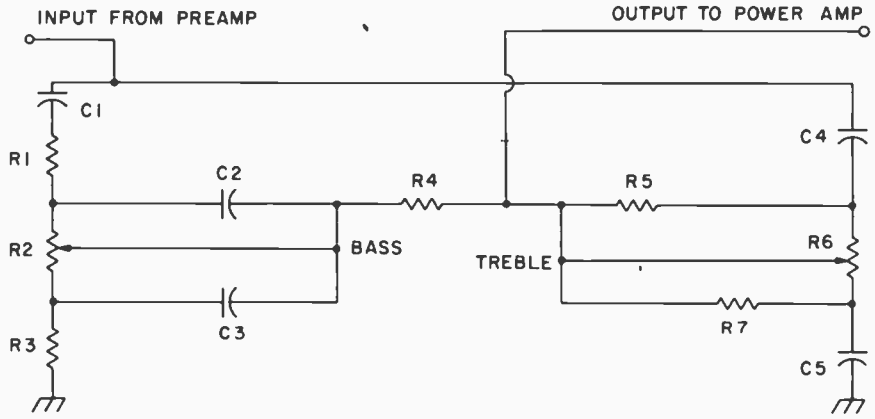
☐ Here is a versatile square wave generator capable of surprising performance. It can deliver clock or switching pulses, act as a signal source, and more. And because the outputs take turns switching, it can be used as a simple sequence generator or as a multiple-phase clock.

The component values indicated will support a range of output frequencies from a few pulses per second up into the high audio range. And this square wave ouput is rich in harmonics. If you use a 5-volt power supply, this circuit can trigger TTL logic directly.

19 Tone Control Network

☐ Since there are no active devices in this circuit, like transistors or ICs, it can provide no amplification on its own to offset the very lossy characteristics of these networks. Fortunately, most audio systems have more than enough oomph to accommodate this network loss.

Once you have learned, by experimenting with the effects of various component values, just how you can alter the characteristics of these networks, you may want to construct your own graphic equalizer. Just include more stages similar to the two basic types of filters you see here: R1, R2, R3, R4, C1, C2 and C3 form one of the filters, the rest of the components the other. Just remember, the more stages of passive filtering you add, the more loss you introduce into your system. For that reason, most commercial graphic equalizers include built-in amplifiers. And, of course, you will have to duplicate your filter(s) for each channel if you're working in four or more tracks.

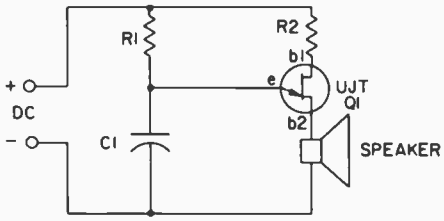


PARTS LIST FOR TONE CONTROL NETWORK

C1, C5—.068-.2-uF capacitors
C2—.033-.068-uF capacitor
C3—.33-.68-uF capacitor
C4—.005-.02-uF capacitor
R1, R4, R5—1500-ohm resistors, ½-watt
R2, R6—50,000-200,000-ohm potentiometer, logarithmic or audio taper
R3, R7—820-1500-ohm resistors, ½-watt

20 Voltage Controlled Audio Oscillator

☐ Unijunction transistors are very interesting. They love to be used in oscillators, and it doesn't take too many parts or very much coaxing to get their sawtooth outputs going. This little squealer will tell you how much voltage it's connected to. The higher the voltage, the lower frequency output you'll hear. 5 or 6 Volts should start its high squeal going; 25 or 30 volts and it'll be ticking like a metronome. You can take advantage of this voltage to frequency conversion and use this circuit as an audible voltmeter. Or, with a resistor across the input, it can be an audible current meter.

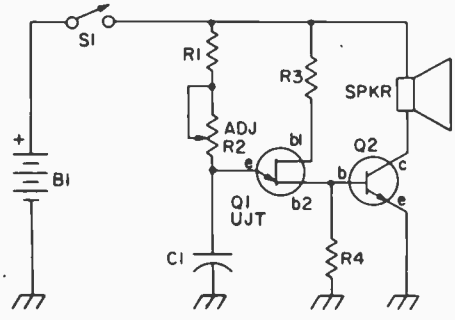


PARTS LIST FOR VOLTAGE CONTROLLED OSCILLATOR

C1—.5-2.2-uF capacitor
R1—10,000-47,000-ohm resistor, ½-watt
R2—82-150-ohm resistor, ½-watt
Q1—unijunction transistor (2N-2646 or equiv.)
SPKR—8-40-ohms

For a slightly stranger effect, connect a large value capacitor (say 50-100 uF with a voltage rating larger than the voltages you intend to apply). You'll hear a swooping effect. Many different components can be placed across the input for different effects when voltage is applied. Experiment and have fun.

21 Wide Range Oscillator



PARTS LIST FOR WIDE RANGE OSCILLATOR

B1—6-15 VDC
C1—5-25-uF capacitor
Q1—Unijunction (UJT) transistor (2N2646 or equiv.)
Q2—NPN transistor (2N2222, 2N-3904 or equiv.)
R1—2200-5600-ohm resistor, ½-watt
R2—500,000-5 Megohm potentiometer
R3—3300-5600-ohm resistor, ½-watt
R4—82-120-ohm resistor, ½-watt
S1—SPST switch
SPKR—4-32-ohm speaker

☐ You may need an audio signal for any of a number of reasons: as a warning tone, as a test oscillator to check microphones and recorders, as part of a toy, as an annunciator or as one of an endless list of things.

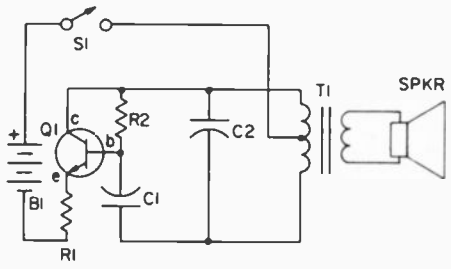
This circuit will give you the tones you need, even tones above and below frequencies you would expect. It will produce the steady click-click-clicking of a metronome, for example. Then, with a twist of the control and a responsive enough speaker, you can use it to silently call your dog.

The frequency of the sawtooth waveform this circuit produces depends mostly on the value of C1, the battery voltage, and the combined series value of R1 and R2. Transistor Q2 acts as a speaker driver and isolates the UJT from speaker loading.

22 Weirdly Wailing Oscillator

☐ Once you hear the nifty sound effect this tiny circuit puts out, you'll be dreaming up places to use it. The combination of C1 and C2 causes this oscillator to work at two widely separated frequencies at once. One, determined mostly by C2, determines the basic tone the oscillator will produce. The other, determined mostly by C1, governs the number of times per second the basic tone will be interrupted.

The output sounds very much like a pumping whistle—it's a sound effect associated with toy ray guns, tv and the movies. If you wish to build this as a toy, try using a momentary switch or microswitch for S1.



PARTS LIST FOR WEIRDLY WAILING OSCILLATOR

B1—6-15 VDC
C1—100-500-uF capacitor
C2—.1-.5-uF capacitor
Q1—NPN transistor (2N2222, 2N-3904 or equiv.)
R1—15-27-ohm resistor, ½-watt
R2—8200-15,000-ohm resistor, ½-watt
S1—SPST switch (see text)
T1—250-1000-ohm primary, center tapped; 4-16-ohm secondary

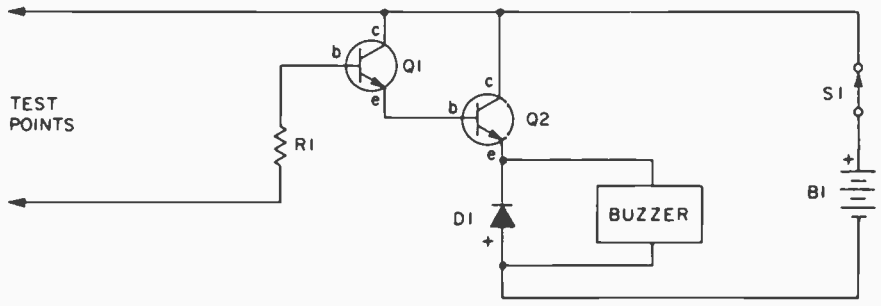
23 Quick Continuity Checker

☐ There are times when just knowing whether or not a complete circuit is present, whether a particular path is an open or a short, can provide the solution to a nasty troubleshooting chore. Here, the buzzer tells all. The use of two transistors in a Darlington configuration, as this circuit arrangement is called, provides more gain than could a single transistor.

As a result, this checker is sensitive enough to indicate continuity even when substantial resistance is present. Diode D1 protects the transistors from the potentially lethal (to transistors) inductive kickback of the buzzer. In much the same fashion as the single coil in a car's ignition can create a high voltage from a low one, the surges of current through the buzzer can destroy a transistor unless some protection is afforded. D1 shorts this inductive kickback out.

PARTS LIST FOR QUICK CONTINUITY CHECKER

B1—9VDC battery
D1—Diode, 1N914 or equiv.
Q1, Q2—NPN transistor, 2N2222 or equiv.
R1—1000-ohm resistor, ½-watt
S1—SPST switch

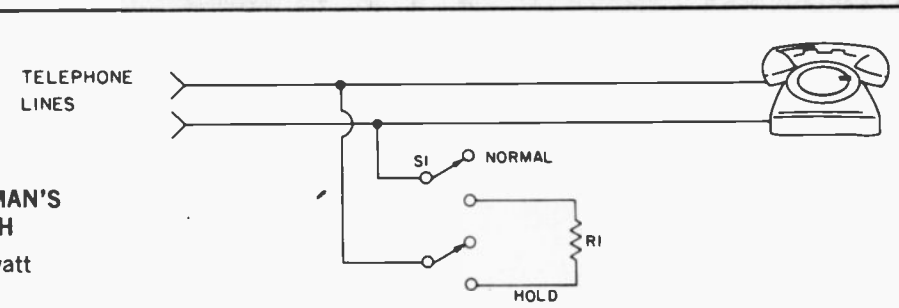


24 Poor Man's Hold Switch

☐ This is just one step more sophisticated than holding your hand over the telephone mouthpiece. We all find occasions when we would like to discuss something with the people in the room without sharing it with the party on the phone. This circuit provides dc continuity for the phone line to keep from losing a call when you hang the phone up. There is some danger, though, of putting the phone on "terminal hold," if you forget. Because as long as you are switched to hold, it's just like leaving a phone off the hook: no one can call in, you can't call out.

Only two of the lines that reach your telephone are really part of the phone line, and these are most often the red and green wires that are in the cable between your phone and the wall. Other wires in the cable may carry power for lighting your phone, or may carry nothing. Check carefully. Also understand that if you make a connection to the phone line that inhibits the phone com-

pany's ability to provide service, they have the right to disconnect you for as long as they like. This is a proven, simple circuit that should cause no difficulty. But be careful.



PARTS LIST FOR POOR MAN'S PHONE HOLD SWITCH

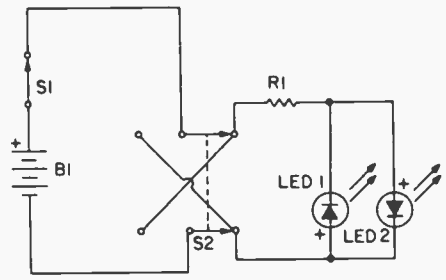
R1—650-ohm resistor, ½-watt
S1—DPDT switch

25 LED Simple Signaller

☐ Here's a tricky way to send three different codes down just two wires. You can signal LED1 only, LED2 only, or neither. It all depends on the polarity of the voltage to the right of S2, which S2 controls, and whether or not S1 is on.

You can also omit the two LEDs from the circuit and use it as a LED checker. Just connect the LED you want to check where LED1 and LED2 are shown. Then one or the other position of S2 will cause a good LED to light.

You can even add a fourth mode of operation by substituting a low voltage ac supply, like the plug-in small transformer variety. This will cause both LEDs to light. If you substitute a signal source for the battery, the relative brightness of the LEDs will give some indication of the duty cycle of the waveform.



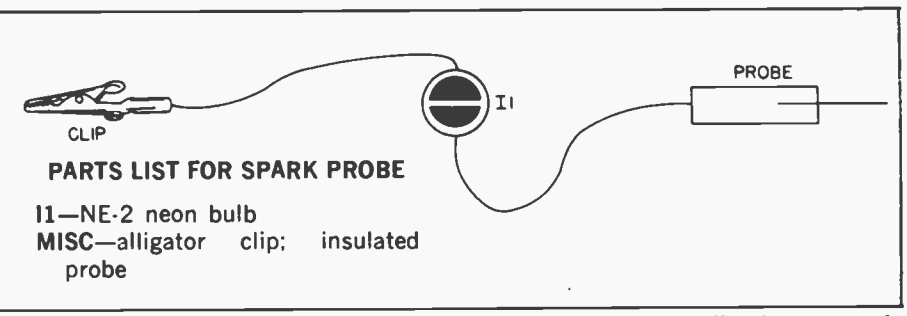
PARTS LIST FOR LED SIMPLE SIGNALER

B1—9VDC battery
LED1, LED2—Light emitting diodes
R1—470-ohm resistor, ½-watt
S1—SPST switch
S2—DPDT switch

26 Spark Probe

☐ Interested in a bright orange light you can turn on without batteries or a power supply? This gadget and your sweater on a dry winter's day can do it. Because the tiny currents and high voltage, static electricity can easily light this neon gas discharge lamp. So can the high voltage on the face of your TV's picture tube. The spark high voltage near your car's spark plug wires. The RF potential near a transmitter or antenna. And a lot more things you'll have fun finding.

In many cases, especially where direct contact and electronic sources of high voltage (such as power supplies and ignition circuits) can be *avoided,* you can attach the alligator clip to your watchband as you bring the probe near your sweater, your comb, or the face of your picture tube. For other applications, attach the clip to ground and make sure your probe is a very good insulator and thick enough to keep the high voltages from conducting through *you.*



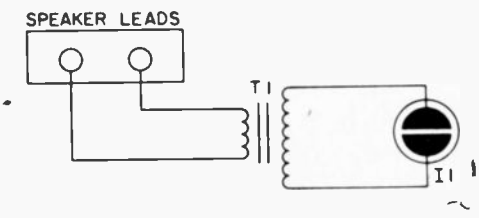
PARTS LIST FOR SPARK PROBE

I1—NE-2 neon bulb
MISC—alligator clip; insulated probe

27 Cheapskate's Light Show

☐ Here's one for small spenders. It takes the sounds that just about anything will turn out, through speaker terminals, headphone jacks or almost any audio output, and turns them into a bright, pulsating orange glow on an inexpensive neon lamp.

Transformer T1 can be almost any interstage transformer. The primary



PARTS LIST FOR CHEAPSKATE'S LIGHT SHOW

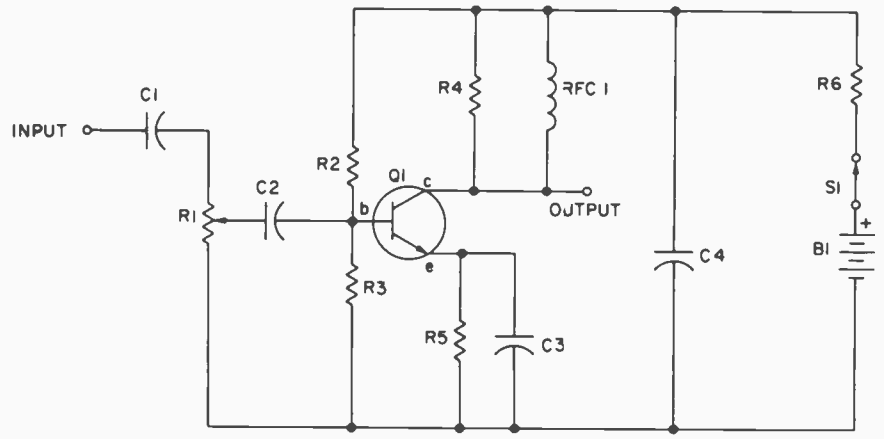
I1—NE-2 neon bulb
T1—1000:10,000-ohm transformer

must be a small fraction of the secondary's impedance. You may be able to check this by looking at the DC resistance of the primary and secondary of almost any junk box transformer with your ohmmeter. T1 multiplies the audio output voltage to a value high enough to light the NE-2. Be careful, the voltage across the NE-2 is high enough to give you quite a kick if you touch it.

28 Broadband Amplifier

☐ This simple one-transistor amplifier is capable of handily boosting signals from audio through high frequency RF.

The design is stable, well-bypassed, and a neat little performer. And its applications are endless. Connect it to a crystal checker, for example, add a short length of wire at the output for a flea-power marker signal source. Use it as a preamp to your frequency counter or oscilloscope with a short length of wire at the input to observe signals you couldn't see before. Hams can use it as a building block to simple QRP transceivers. SWLs can use it to pep up tired receivers. The circuit is fairly straightforward and trouble-free. You can help keep it trouble free by laying it out as the schematic.



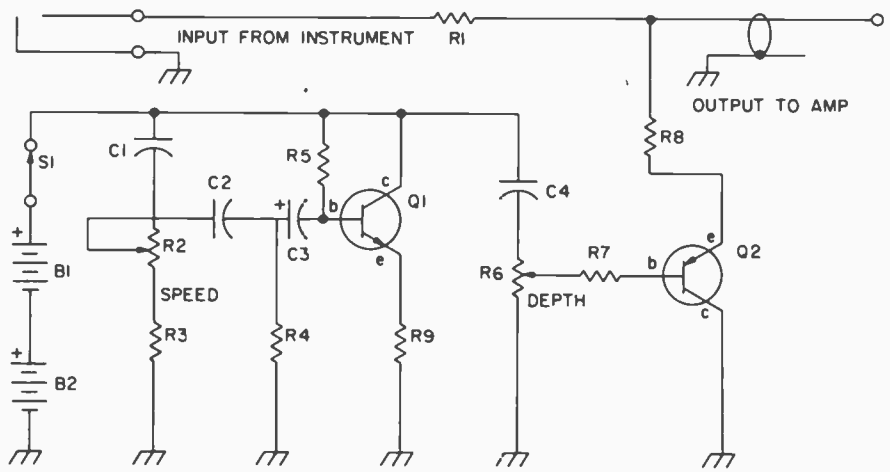
PARTS LIST FOR BROADBAND AMPLIFIER

B1—9VDC battery
C1, C3, C4—.01-uF capacitor
C2—100-pf capacitor
Q1—NPN transistor, 2N2222 or equiv.
R1—10,000-ohm potentiometer
R2—100,000-ohm resistor, ½-watt
R3—10,000-ohm resistor, ½-watt
R4—4700-ohm resistor, ½-watt
R5—470-ohm resistor, ½-watt
R6—100-ohm resistor, ½-watt
RFC1—2.5-mH choke
S1—SPST switch

29 Super Vibrato

☐ This professional-sounding circuit adds vibrato to almost any electronic musical instrument. Now you can play all the vibrato effects the big, Top 40 groups have been using on their albums and singles for years. Q1, R2-5, and C1-3 form a phase shift oscillator. Speed control R2 varies its output frequency, which is coupled through C4, R6 and R7 to Q2. Q2 and R8 then amplitude modulate the signal in the line between the instrument and the amplifier. The amount of modulation applied is varied by Depth control R6.

You may also want to try this circuit out between a mike and your tape recorder to experiment with strange vocal effects. If driven hard enough, it can even make you sound as if you're talking under water. If the range of R6 doesn't permit this, try either adding a third battery or reducing the value of R8. You may decide to make S1 a momentary or push-push foot pedal switch and build this entire circuit into the foot pedal housing.



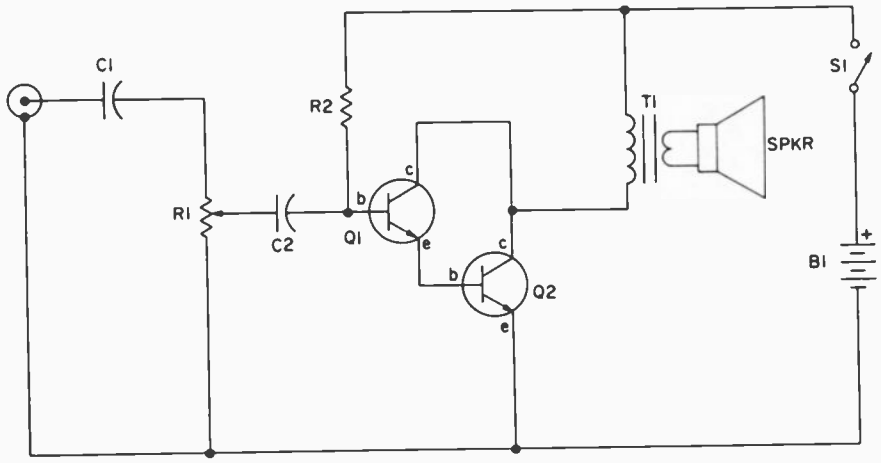
PARTS LIST FOR SUPER VIBRATO

B1, B2—9VDC battery
C1—.5-uF capacitor
C2—2.3-uF capacitor
C3—5-uF, 25VDC electrolytic capacitor
C4—.05-uF capacitor
Q1—NPN transistor, 2N2222, 2N3904, or equiv.
Q2—PNP transistor, 2N3906 or equiv.
R1, R8—100,000-ohm resistor, ½-watt
R2—10,000-ohm potentiometer
R3—2700-ohm resistor, ½-watt
R4—3300-ohm resistor, ½-watt
R5—560,000-ohm resistor, ½-watt
R6—500,000-ohm potentiometer
R7—470-ohm resistor, ½-watt
R9—4700-ohm resistor, ½-watt
S1—SPST switch

30 Penny Pincher's Utility Amplifier

☐ Here's high gain with just a handful of parts for a zillion audio applications. Q1 and Q2 are Darlington connected to deliver a lot of gain and make this a really hot circuit. Transformer T1 reduces the loading on the transistors to help assure a strong, clean output. This amplifier has many test bench applications, from signal tracing to loudness boosting to checking out new sound effects.

Add it to an inexpensive record or tape player for a quick and easy checkout. Or tie a high output crystal mike to the input and use it as an electronic stethoscope.



PARTS LIST FOR PENNY PINCHER'S UTILITY AMPLIFIER

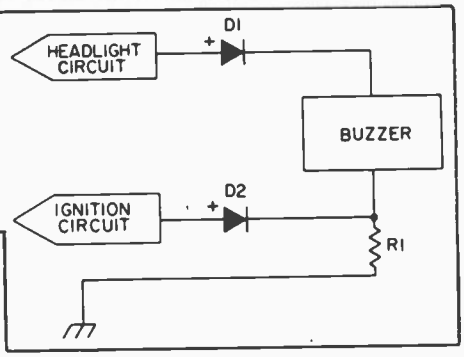
B1—9VDC battery
C1, C2—.1-uF capacitor
Q1—PNP transistor, 2N3904 or equiv.
Q2—PNP transistor, 2N2222 or equiv.
R1 — 1-Megohm potentiometer, audio taper
R2—1.8-Megohm resistor, ½-watt
S1—SPST switch
SPKR—8-ohm speaker
T1—500:8-ohm transformer
J1—RCA phono jack (or any two-conductor jack)

31 Easy Headlight-On Warning

☐ Nobody has to tell you about the time and money you can get stuck going through if you forget and leave your headlights on when you leave your car. This circuit reminds you your lights are on the instant you turn your key off. The Detroit warning circuits wait until you open the door. You can connect to the voltages you need right at the fuseblock. Try the "radio" fuse for the ignition circuit, the "instrument" fuse connects you to the dashboard night lights, on whenever the headlights are on.

PARTS LIST FOR EASY HEADLIGHT-ON WARNING

D1, D2—Diode, 1N914 or equiv.
R1—150-ohm resistor, ½-watt



32 Wet Basement Alarm

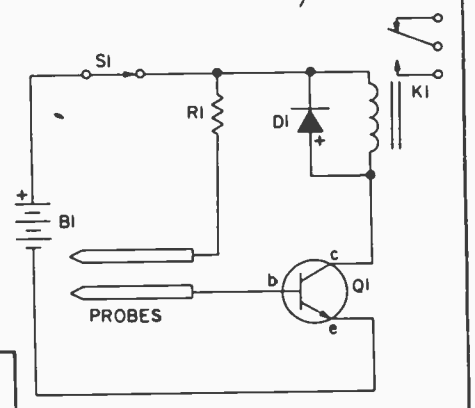
☐ For those of us with basements plagued by dampness, an early warning of wetness is our best, first line of defense. This tiny circuit monitors for wetness between its two metal probes. When it senses the wet, it pulls in relay K1.

Relay K1 can be connected to buzzers, bells, pumps, whatever your situation demands. Just make sure the relay contacts are rated for the load you wish to use.

Where actual liquids are to be sensed, the probes can be simple metal spikes driven into the most moisture-prone section of the basement floor. To monitor for dampness, etch or scrape a zigzag pattern through the middle of a blank copper-coated pc board and connect to each isolated area. Position the board along the floor or wall you wish to monitor.

PARTS LIST FOR WET BASEMENT ALARM

B1—12VDC battery
D1—Diode, 1N914 or equiv.
K1—SPDT relay, 12VDC
Q1—NPN transistor, 2N3904 or equiv.
R1—2700-ohm resistor, ½-watt
S1—SPST switch



33 Metal Detector

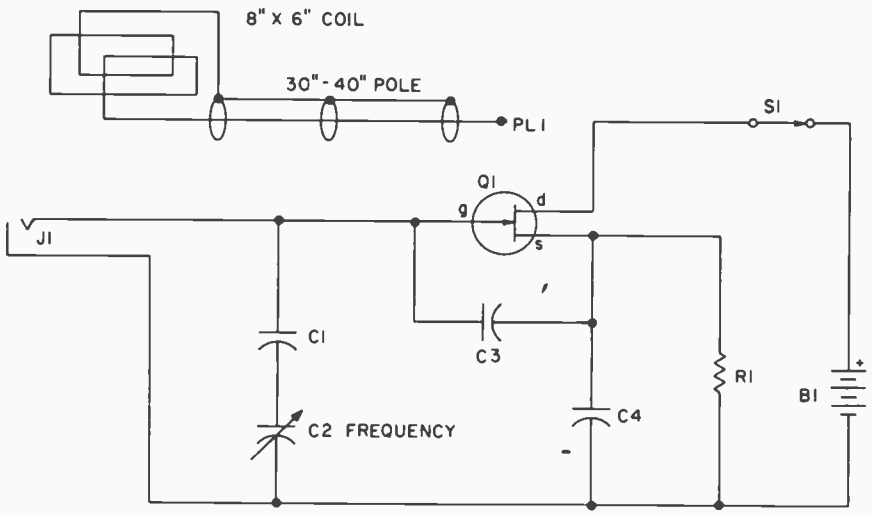
☐ This not only demonstrates how metal detectors work, it actually will detect metal—with the help of a transistor radio.

The search coil, C1 and C2 form a tuned circuit for oscillator Q1, which can be tuned to operate near the center of the broadcast band. Tune your portable radio to a station near the middle of the band, then turn on the metal detector and tune C2 until you hear a squeal as the two signals mix to produce a beat (heterodyne) note.

Metal near the search coil will detune the circuit slightly, changing the pitch of the squeal. The spot that exhibits the biggest change is where you dig for your treasure. The search coil is 20 turns of number 30 enameled wire, wound on a 6"x8" wood or plastic form. It is affixed at the end of a 30" to 40" wooden pole, and connected to the remainder of the metal detector circuit through a coaxial cable.

PARTS LIST FOR METAL DETECTOR

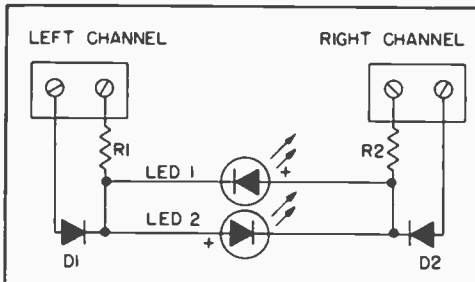
B1—9VDC battery
C1—500-pf capacitor
C2—365-pf variable capacitor
C3—47-pf capacitor
C4—120-pf capacitor
J1—SO239 jack
PL1—PL239 plug
Q1—FET (Field Effect Transistor), 2N5458 or equiv.
R1—5600-ohm resistor, ½-watt
S1—SPST switch
MISC—#30 enameled wire, 6" x 8" wood or plastic form, 30" to 40" wooden pole, coaxial cable



34 Nulling Stereo Balance Checker

☐ Ever get frustrated trying to guess where the center of your stereo's balance control really was? A few components and a few minutes of time can take the guesswork out of it.

Set your stereo on MONO, put something on and you're ready. Now adjust the balance control from side to side. You'll see first one LED light, then the other. When you get near the transition point, go slowly. At some point, both LEDs will be off. This is the center balance position. This circuit may also be adapted to finding zero beat for hams and SWLs. Omit D1 and D2 and connect the leads of R1 and R2 across the receiver's speaker terminals. At zero beat, both LEDs will be dark.



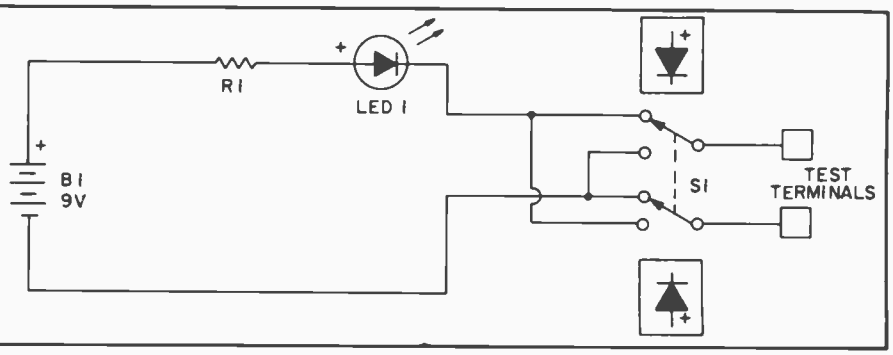
PARTS LIST FOR NULLING STEREO BALANCE CHECKER

D1, D2—Diode, 1N914 or equiv.
LED1, LED2—Light emitting diode
R1, R2—1000-ohm resistor, ½-watt

35 Quick Diode Checker

PARTS LIST FOR QUICK DIODE CHECKER

B1—9VDC battery
LED1—Light emitting diode
R1—470-ohm resistor, ½-watt
S1—DPDT switch

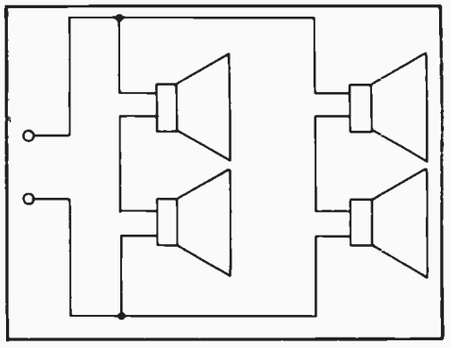


☐ This not only tells you whether or not a diode is good, it checks the polarity for you as fast as you can flick a switch.

The diode under test completes the circuit through B1, R1 and the LED when inserted in the proper polarity. Switch S1 reverses the polarity of the diode under test. A good diode will light the LED only in one switch position. An open diode will not light it in either position. A shorted diode will light it in both positions. To use the circuit as a polarity indicator, connect the diode to the test terminals. The diagrams above refer to the polarity of the diode when the LED lights in the switch positions.

36 Speaker System Expander

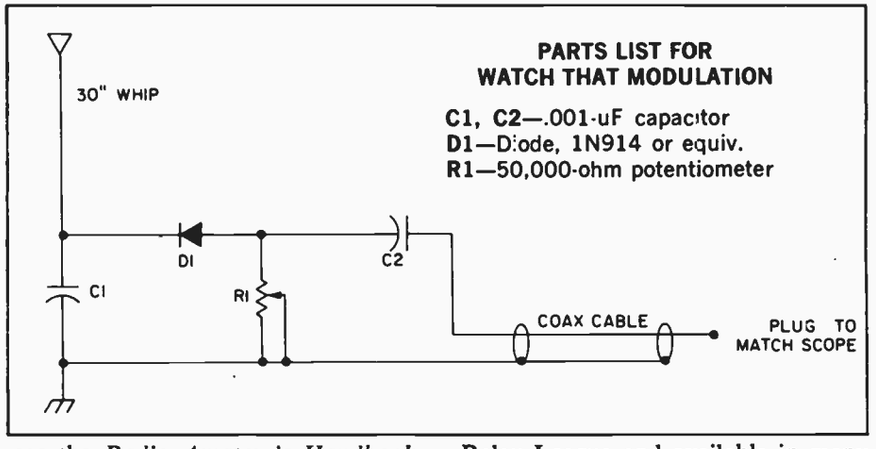
☐ This neat arrangement lets you connect multiple speakers to your system's speaker terminals without upsetting the impedance match. This series-parallel arrangement of speakers exhibits the same impedance as a single speaker, assuming all speakers are of equal impedance and individually match the rating of the system. And inasmuch as the bass response of arrayed speakers is somewhat additive, you will find more bottom to your sound than any one of the speakers could have delivered alone. Of course, it takes more power to drive an array than a single speaker, but most modern music systems have plenty to spare.



37 Watch That Modulation

☐ If you own a transmitter and an oscilloscope, this will let you see what your signal looks like. A short whip antenna, about the size of a walkie talkie whip (30" or so) picks up a sampling of your transmitted signal. D1 acts as a detector and couples the demodulated RF (in other words, your modulation without the carrier) through a coaxial cable to your oscilloscope's vertical input.

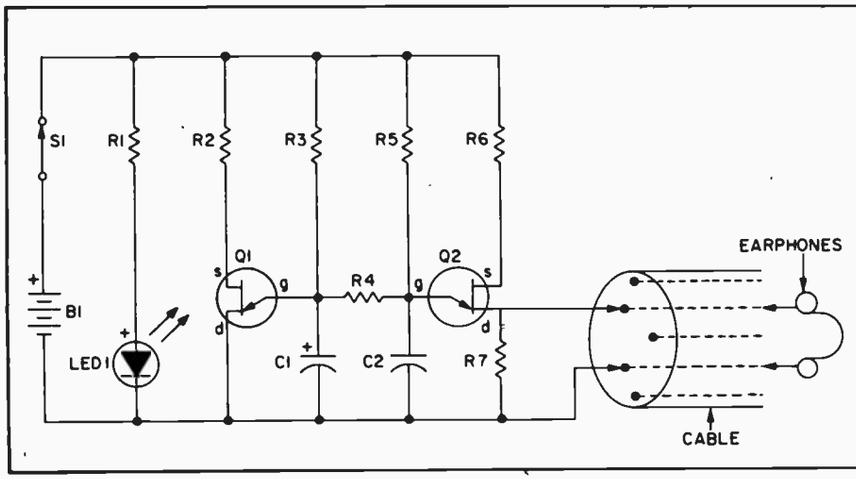
Resistor R1 acts as a variable load on the signal to control its level as it feeds to your scope. For an excellent discussion of how to read the meaning of the pattern that appears on your oscilloscope with this circuit, see the *Radio Amateur's Handbook*, published by the American Radio Relay League and available in many electronics stores.



PARTS LIST FOR WATCH THAT MODULATION

C1, C2—.001-uF capacitor
D1—Diode, 1N914 or equiv.
R1—50,000-ohm potentiometer

38 Wire Wringer



PARTS LIST FOR WIRE WRINGER

B1—9VDC battery
C1—10-uF, 15VDC electrolytic capacitor
C2—.001-uF, 15VDC electrolytic capacitor
LED1—Light emitting diode
Q1, Q2—FET (Field Effect Transistor), 2N2646 or equiv.
R1, R2, R5, R6—470-ohm resistor, ½-watt
R3, R7—47-ohm resistor, ½-watt
R4—220,000-ohm resistor, ½-watt
S1—SPST switch

☐ There you are with your million conductor un-color-coded cable resisting the temptation to hang yourself with it because you can't match the ends.

This should make it easier. Using one long lead of its own or one wire you've already identified in the cable, clip its other lead to the next wire in the bundle.

Then, with a simple utility amplifier or even just a high impedance earphone at the other end of the cable, listen for the characteristic be-be-be-beep of the twin UJT relaxation oscillators. Oscillator Q1 runs at about 2 beats a second; oscillator Q2 at about 2000 Hz. In addition to ringing wires, this novel tone generator can be used as an audio signal injector for troubleshooting.

39 Wide Range Voltage Pilot

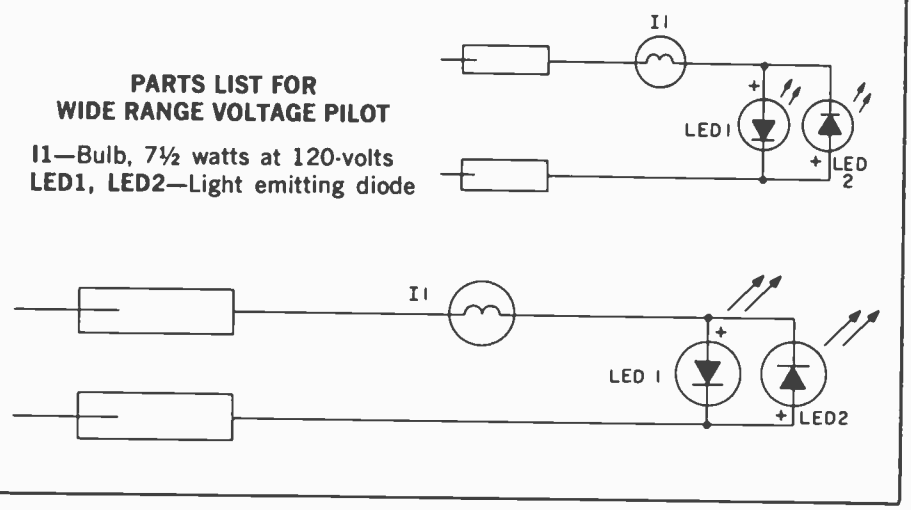
☐ Believe it or not, this simple tester will verify voltages between 2 and 120 Volts, AC or DC—and tell you which!

It's easy to understand if you can think of the filament of a small nightlight bulb as being a wirewound resistor. It provides the current limiting that LED 1 and LED 2 need to operate safely. And, of course, when the voltage at the probe tips is high enough, I1 lights as well.

You can choose different colors for LED 1 and LED 2 and the probe tips for very quick polarity indications in the case of DC voltages. And seeing both LEDs glow is quick confirmation of an AC voltage.

PARTS LIST FOR WIDE RANGE VOLTAGE PILOT

I1—Bulb, 7½ watts at 120-volts
LED1, LED2—Light emitting diode

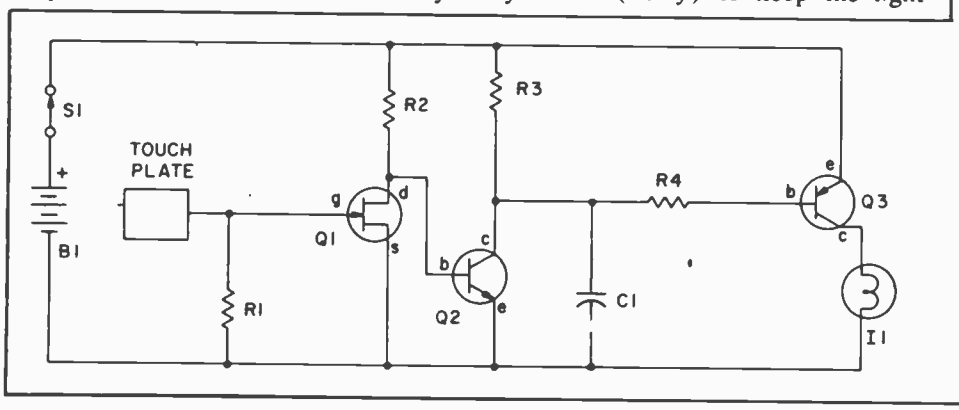


40 The Light Touch

☐ Here's an intriguing substitute for that light you're always flicking on for just a second, then right off again. This touch-actuated switch stays on only for as long as you need it, just as long as you keep your finger on the touch plate.

R1 sets the input impedance of the very sensitive JFET Q1 to a very high 10 Megohms. Q1 picks up stray signals coupled through your body to the touch plate and amplifies to turn on Q2, which turns on lamp driver Q3. Lamp I1 is any small 12 Volt lamp, such as are found in auto dashboards.

R4 and C1 add a small amount of hysteresis (delay) to keep the light from constantly flickering. If a light isn't what you need to switch this way, try substituting a relay for I1. You may want to raise B1 to 12 or 15 Volts.



PARTS LIST FOR THE LIGHT TOUCH

B1—9VDC battery
C1—15-uF capacitor
I1—Any 12 volt lamp
Q1—FET (Field Effect Transistor), 2N458 or equiv.
Q2—NPN transistor, 2N2222, 2N3904 or equiv.
Q3—PNP transistor, 2N3906 or equiv.
R1—10-Megohm resistor, ½-watt
R2—47,000-ohm resistor, ½-watt
R3—120,000-ohm resistor, ½-watt
R4—470-ohm resistor, ½-watt
S1—SPST switch

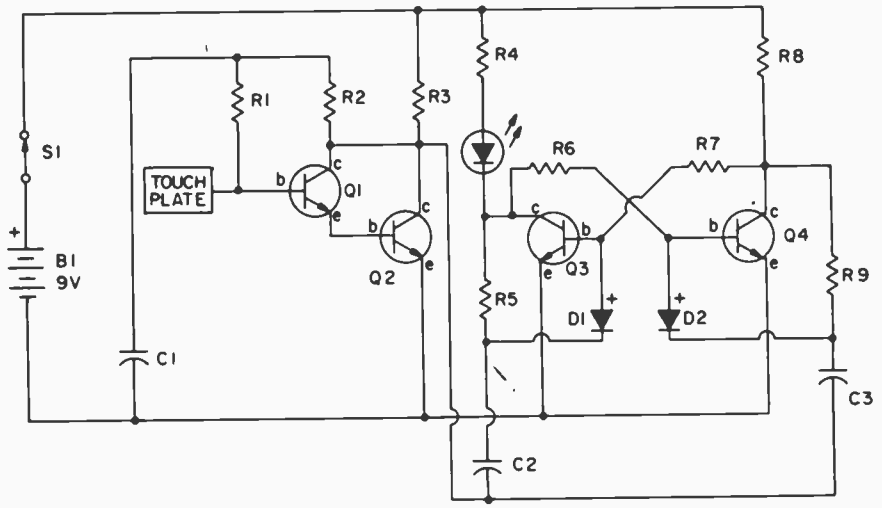
41 A Touchy Gamble

☐ Any bets on whether the LED winds up on or off when you take your finger off the touch plate? The odds are even with this little bandit.

Your body acts as an antenna, picking up power line hum and other stray signals and coupling them through your fingertip to the touch-plate and the input of high gain Darlington transistor pair Q1-Q2. Their output starts bistable multivibrator Q3-Q4 flip-flopping faster than the

eye can follow. Because it's symmetrical, the chances of stopping with Q3 on or off are equal.

When the multivibrating stops with Q3 on, it lights the LED. When Q3 is off, so is the LED. Now that you can let an LED call heads or tails for you, you can save your pennies for the gum machine.



PARTS LIST FOR A TOUCHY GAMBLE

B1—9VDC
C1—2.2-uF capacitor
C2, C3—.01-uF capacitor
D1, D2—Diode, 1N914 or equiv.
LED1—Light emitting diode
Q1, Q2, Q3, Q4—NPN transistor, 2N3904 or equiv.
R1, R2—2.2-Megohm resistor, ½-watt
R3—10,000-ohm resistor, ½-watt
R4, R8—1000-ohm resistor, ½-watt
R5, R9—47,000-ohm resistor, ½-watt
R6, R7—22,000-ohm resistor, ½-watt
S1—SPST switch

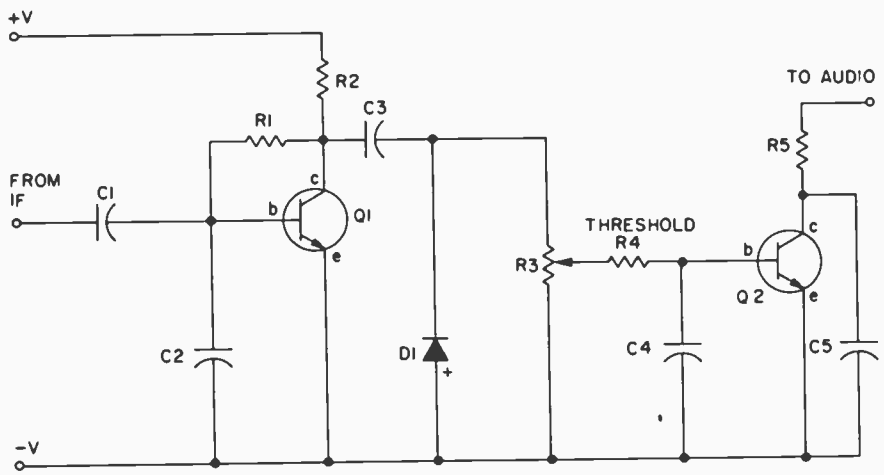
42 Transistor Squelch

☐ Here's a simple squelch circuit you can add on to most radios and it's as versatile as any.

Transistor Q1 acts as a noise amplifier, operating on signals from the receiver IF. The noise signal is amplified, then detected by D1. The resultant voltage appears across R3, which acts as a voltage divider at the input of switch Q2. When enough signal-derived voltage reaches Q2's base, it turns on, switching off the receiver audio output.

This audio squelching can be accomplished simply by connecting the input terminal of the receiver's audio stage to the R5 connection. This is a noise-operated squelch best suited for use with FM communications systems. On FM, signals tend to quiet the ever-present noise, and FM IFs are designed with noise outputs.

For use with AM systems, use the IF or detector signal output as the squelch input. Locate the -V connection of your receiver's first audio amplifier, break it, and connect it to the top of R5. Then increasing signal will enable receiver audio, and that's what squelches are supposed to do.



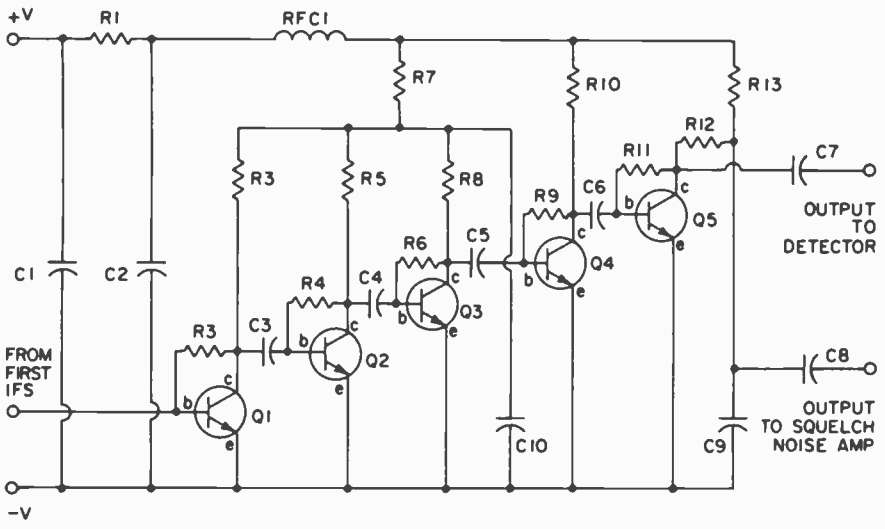
PARTS LIST FOR TRANSISTOR SQUELCH

C1, C3—.1-uF capacitor
C2—.01-uF capacitor
C4—33-uF capacitor
C5—47-uF capacitor
D1—Diode, 1N914 or equiv.
Q1, Q2—NPN transistor, 2N3904 or equiv.
R1—180,000-ohm resistor, ½-watt
R2, R3—10,000-ohm resistor, ½-watt
R4—680-ohm potentiometer
R5—330-ohm resistor, ½-watt

43 IF Amplifier

☐ This IF module doesn't offer any selectivity, but it has a tubful of gain to offer, so it's perfect for following mechanical filters or other highly selective stages.

Q1 through Q5 act as individual gain stages, providing a great deal of overall gain for the system. R1, C1, C2 and RFC1 keep the supply line clearly filtered and by passed to avoid annoying parasitics and other bugaboos of high gain receivers. You can also use this circuit as a preamplifier for your test equipment. Oscilloscopes, counters and the like can become supersensitive to help you dig even the really weak signals out of the 455 kHz jungles.



PARTS LIST FOR IF AMPLIFIER

C1, C2, C7, C8, C9—.1-uF capacitor
C3, C4, C5, C6—.001-uF capacitor
C10—.01-uF capacitor
Q1, Q2, Q3, Q4, G5—NPN transistor, 2N3904 or equiv.
R1—47-ohm resistor, ½-watt
R2, R4, R6, R9, R11—180,000-ohm resistor, ½-watt
R3, R5, R8—27000
R3, R5, R8—27,000-ohm resistor. ½-watt
R7—680-ohm resistor, ½-watt
R10—10,000-ohm resistor, ½-watt
R12—6800-ohm resistor, ½-watt
R13—2200-ohm resistor, ½-watt
RFC1—2.5-mH choke

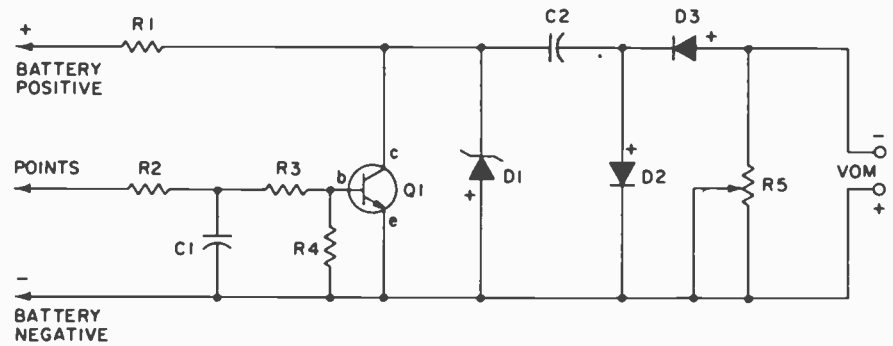
44 Make Your VOM a Tachometer

☐ Most of us don't need dashboard tachometers to drive by. But a tachometer can be invaluable as a tune-up aid. And it's a lot handier to have under the hood when you need it there than behind the wheel where you can't see it.

But is a tach worth the investment? With this arrangement, there isn't enough investment to worry about.

Pulses from the distributor points are amplified by Q1, limited by D1, coupled by C2, rectified by D2 and D3, and impressed as a voltage across R5. You could use R5 to calibrate this circuit to one of your VOM's voltage ranges, but that often isn't necessary. Much of the time, we are looking more for *changes* in engine speed than for a *specific* engine speed. If you do need to know specific speeds, of course, you can always borrow a known-good tach and calibrate with R5.

This same circuit can also be applied as a frequency to voltage converter for many other purposes.



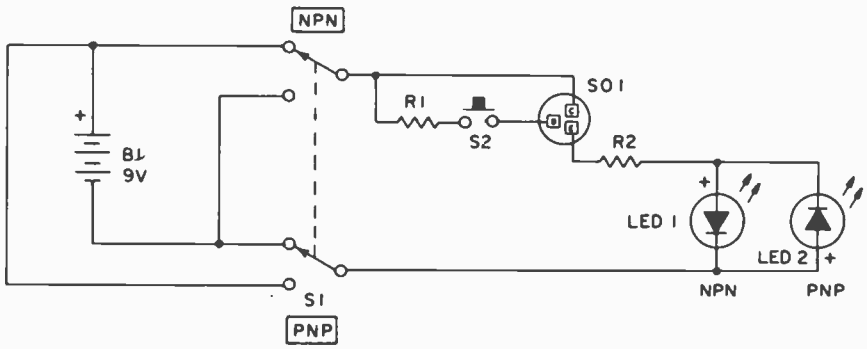
PARTS LIST FOR VOM INTO TACHOMETER

C1—2.2-uF capacitor
C2—.47-uF capacitor
D1—Zener Diode, 9.1V at ¼-watt
D2, D3—Diodes, 1N914 or equiv.
Q1—NPN transistor, 2N3904 or equiv.
R1—390-ohm resistor, ½-watt
R2, R3—220-ohm resistor
R4—1800-ohm resistor, ½-watt
R5—1000-ohm potentiometer

45 Transistor Checker

PARTS LIST FOR TRANSISTOR CHECKER

B1—9 VDC battery
LED1, LED2—Light emitting diode
R1—1000-ohm resistor, ½-watt
R2—470-ohm resistor, ½-watt
S1—DPDT switch
S2—Momentary push button switch
SO1—Transistor socket



☐ It's pushbutton-easy to check transistors with this tiny marvel. Just plug the transistor in and push S2. If it's good and you set the PNP-NPN switch S1 properly, the appropriate LED will light.

Don't know the type? That's okay. Plug it in and try both S1 switch positions while you watch for the appropriate LED to light. You can even test diodes using the collector-emitter leads on the socket. The collector-emitter leads can also be used to check continuity.

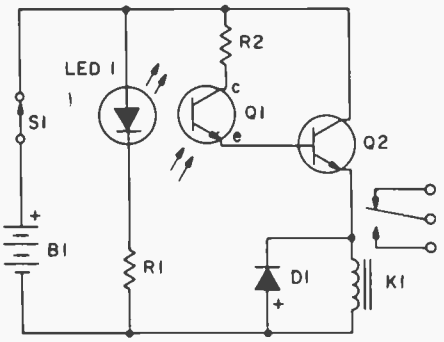
46 Photoelectric Tattletale

☐ How would you like to know whether or not the postal person brought you any post? Or how about a circuit to start something going whenever you put a card in a slot? That's what this little photorelay is all about. Whenever the phototransistor sees the LED, it pulls up the base of relay driver Q2 and pulls in the relay. Stick something between the LED and Q1 and the relay releases. D1 shunts out the relay's inductive kickback.

If you point the LED and Q1 in the same direction, they will act together as a reflective sensor. Then if anything comes close enough to bounce the light from the LED back into Q1 (assuming both are kept in the dark—any light will trigger Q1), the relay will pull in. The circuit can also be used without R1 and LED1 as a light- or no-light-operated alarm.

PARTS LIST FOR PHOTOELECTRIC SOMETHING'S THERE TATTLETALE

B1—12VDC battery
D1—Diode, 1N914 or equiv.
K1—SPDT relay, 12VDC
LED1—Light emitting diode
Q1—Phototransistor, FPT100 or equiv.
Q2—NPN transistor, 2N2222 or equiv.
R1—150-ohm resistor, ½-watt
R2—2700-ohm resistor, ½-watt
S1—SPST switch



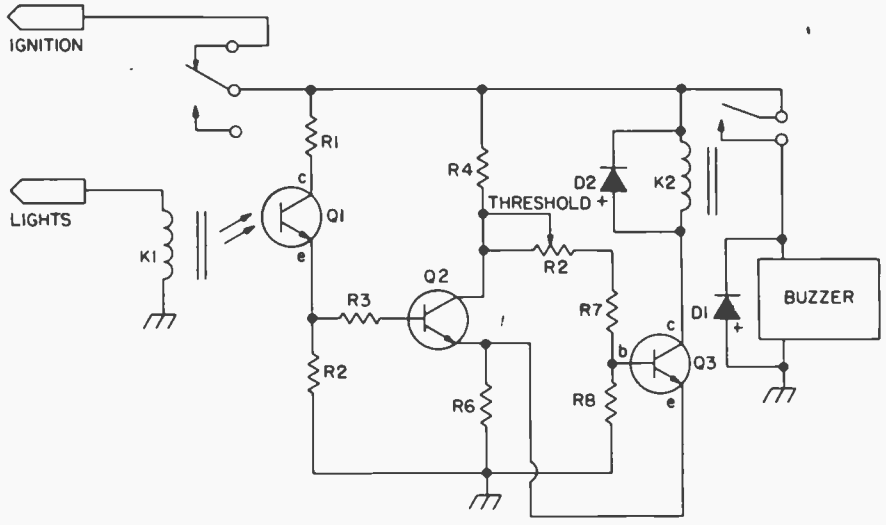
47 Highway Nightfall Alert

☐ When it gets dark out, you don't always notice the change. So it isn't hard to get caught driving in the dark without your headlights on. This little project buzzes a friendly reminder until you turn the lights on, turn the car off, or morning comes.

K1 turns on with your headlights. When it's on, it disables the rest of the circuit. So a warning can only sound with your headlights off. As long as light strikes Q1, Q2 remains on, holding Q3 off. Voltage divider R5-R7-R8 determines the turn-on point for Q3. Q3 drives K2, which triggers a buzzer or other signalling device. A photoconductor may be substituted for R1-Q1, if desired.

PARTS LIST FOR HIGHWAY NIGHTFALL ALERT

D1, D2—diode, 1N914 or equiv.
K1—SPDT relay, 12VDC
K2—SPST relay, 12VDC
Q1—Phototransistor, FPT100 or equiv.
Q2—NPN transistor, 2N3904 or equiv.
Q3—NPN transistor, 2N2222 or equiv.
R1, R4, R7—4700-ohm resistor, ½-watt
R2—560-ohm resistor, ½-watt
R3, R5, R8—10,000-ohm resistor, ½-watt
R6—220-ohm resistor, ½-watt



48 Level Detector

☐ There are times when voltages are allowed to vary widely in a given system, so long as they do not exceed some preset limit. This might happen in speed or temperature controls, for example, or even simple R-C timers.

This circuit is based upon a two-transistor comparator. An input voltage (which must not exceed B1 in either positive or negative value) at Q3 is compared to a preset divider R3-R4 at Q2. When the input volt-

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In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio and Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, in addition to F.C.C. Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, a High Fidelity Guide and a Quiz Book. You receive Membership in Radio-TV Club, Free Consultation Service, Certificate of Merit and Discount Privileges. You receive all parts, tools, instructions, etc. Everything is yours to keep.

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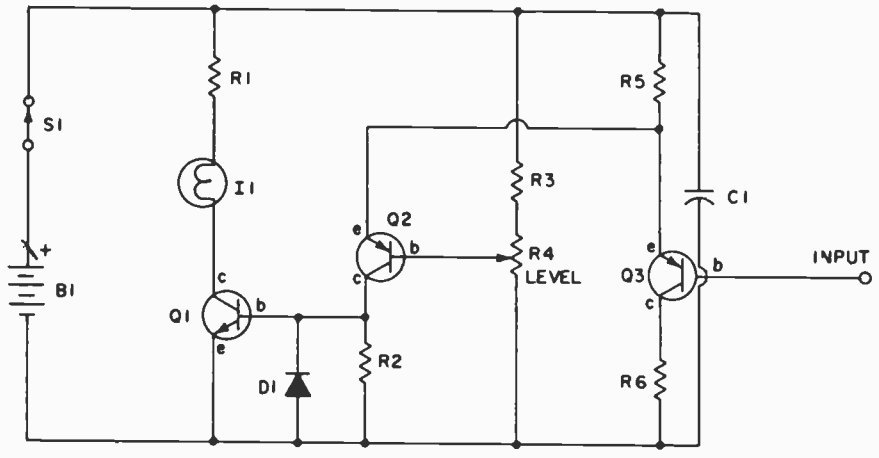
age equals or exceeds the preset voltage, Q1 turns on, driving pilot lamp I1 on. Resistor R1 permits the use of a #47 type lamp with a standard 9 volt battery.



PARTS LIST FOR LEVEL DETECTOR

B1—9VDC battery
C1—.1-uF capacitor
D1—Diode, 1N914 or equiv.
I1—Bulb, #47-type
Q1—NPN transistor, 2N2222 or equiv.
Q2, Q3—PNP transistor, 2N3906 or equiv.
R1—27-ohm resistor, ½-watt
R2—5600-ohm resistor, ½-watt
R3—100,000-ohm resistor, ½-watt
R4—1-Megohm potentiometer
R5—3300-ohm resistor, ½-watt
R6—1000-ohm resistor, ½-watt
S1—SPST switch

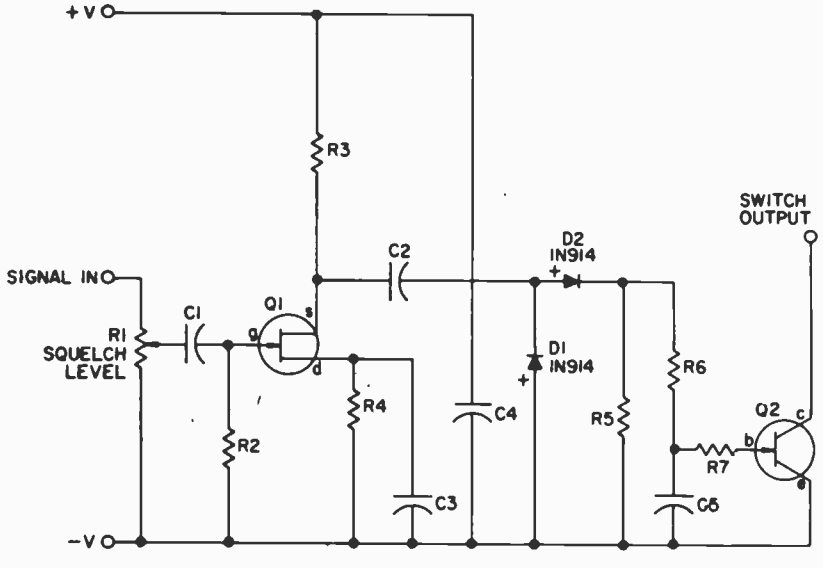
49 Sensitive Squelch

☐ The high sensitivity of this circuit is due to the use of a JFET at Q1. With R2 at just 47K, the high impedance input JFET is just loafing along. (If you need more sensitivity, try values up to 10 Megohms for R2). The signal input from a detector or other audio signal or noise source within your circuit is applied through voltage divider R1 and C1 to the gate of Q1. Q1 amplifies this signal and passes it through C2 to D1-D2, which convert it to a DC voltage. This is used to drive switch Q2 on, with a delayed turn-off provided by R7-C5. R6-C5 delay turn-on. These delays prevent picket-fencing.

FM squelches are noise operated, where the more noise there is, the less signal. So an FM squelch must *disable* with increasing input. In an FM system, Q2 would shunt the audio signal to ground at the first audio stage. An AM system would be designed to *enable* with increasing input. In an AM system, Q2 would be used.

PARTS LIST FOR SENSITIVE SQUELCH

C1—33-pF capacitor
C2—.05-uF capacitor
C3—4.7-uF capacitor
C4—10-uF capacitor
C5—.22-uF capacitor
D1, D2—Diode, 1N914 or equiv.
Q1—FET (Field Effect Transistor), 2N5458 or equiv.
Q2—NPN transistor, 2N2222 or equiv.
R1—100,000-ohm potentiometer
R2—47,000-ohm resistor, ½-watt
R3—12,000-ohm resistor, ½-watt
R4—3300-ohm resistor, ½-watt
R5—3.3-Megohm resistor, ½-watt
R6, R7—1000-ohm resistor, ½-watt



50 Idiot's Delight

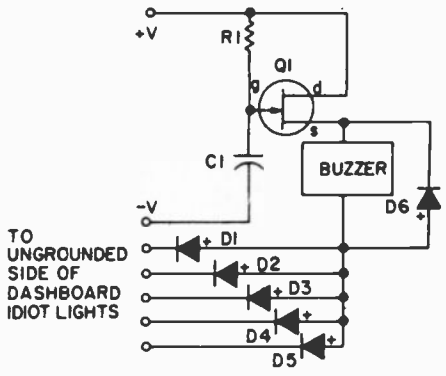
☐ Sometimes the dashboard idiot lights aren't warning enough that something's gone awry. Bright sunlight, a burned-out lamp or simply a lack of attention can obviate Detroit's brilliant efforts. But this simple gizmo adds a buzz to their blink, plus a luxurious extra. R1, C1 and Q1 give you about 7 seconds when

you first get into the car to get yourself going and let the idiot lights douse before the buzzer can sound.

D1-D5 can be added to or subtracted from to fit the number of dashboard dimwits on your car. You can use something other than a buzzer, if you wish, to help you keep from getting confused about your door being ajar, your key being in, your lights being left on, or your seat belt being unfastened.

PARTS LIST FOR IDIOT'S DELIGHT

C1—15-uF capacitor
D1, D2, D3, D4, D5, D6—Diode, 1N914 or equiv.
Q1—FET (Field Effect Transistor), 2N5458 or equiv.
R1—470,000-ohm resistor, ½-watt



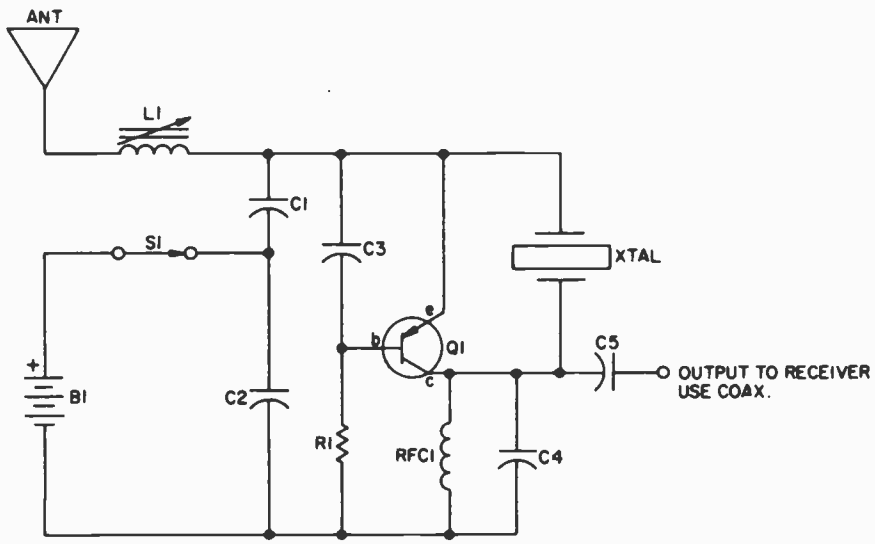
51 SWL's Low Band Converter

☐ Ever listened in on the long waves, from 25-500 kHz? It's easy with this simple converter. It'll put those long waves between 3.5 and 4.0 MHz on your SWL receiver.

Q1 acts as a 3.5 MHz crystal oscillator, mixing the crystal frequency with the long wave input from the antenna and forwarding the mix to your receiver.

L1 is a standard broadcast loopstick antenna coil. The crystal is available from many companies by mail order, or is likely to be at a ham radio store near you. You could also use a 3.58 MHz TV color crystal.

Adjust the slug of L1 for your best signal after tuning to a strong station.



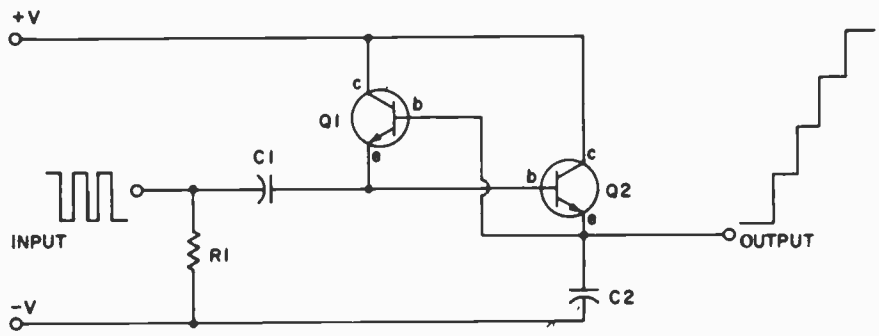
PARTS LIST FOR SWL'S LOW BAND CONVERTER

B1—9VDC battery
C1, C4—470-pf capacitor
C2—.1-uF capacitor
C3—.001-uF capacitor
C5—50-pf capacitor
L1—Loopstick coil
Q1—PNP transistor, 2N3906 or equiv.
R1—470,000-ohm resistor, ½-watt
RFC—2.5 mH choke
S1—SPST switch
XTAL—3.5 MHz crystal

52 Staircase Generator

☐ This circuit can be used as a staircase generator, a ramp generator, or a primitive frequency-to-voltage converter. Each pulse appearing at the input adds to the voltage at the output in step fashion, the height of the step being about the height (voltage amplitude) of the input pulse.

The pulses are passed through Q1 and Q2 and integrated in C2. This type of circuit can be used to set a level, based on the length of a constant-amplitude pulse train at its input. In this fashion, it lends itself to remote control applications.



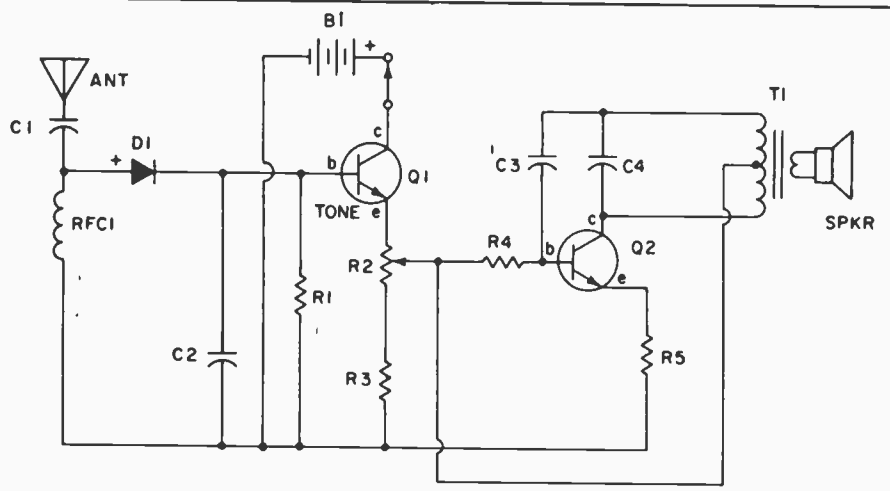
PARTS LIST FOR STAIRCASE GENERATOR

C1, C2—2.2-uF capacitor
Q1, Q2—NPN transistor, 2N2222 or equiv.
R1—10,000-ohm resistor, ½-watt

53 Sidetone Oscillator

☐ CW (continuous wave, the form of modulation involving a simple turning on and off of the RF carrier) is the simplest way for a beginning ham to transmit to his fellow hams. And the famous Morse Code is how he gets his message across. But Morse is a lot easier to send if you can hear what you're sending. This circuit lets you do just that.

A short length of wire near the transmitter picks up RF as it's transmitted and acts as the antenna for our circuit. This RF is detected by D1, smoothed by C2, and used to turn Q1 on and off, following the transmitted signal exactly. Q1 switches the positive supply through R2 to beep oscillator Q2 through the center tap of T1. The values shown produce a pleasant, easily distinguishable tone.



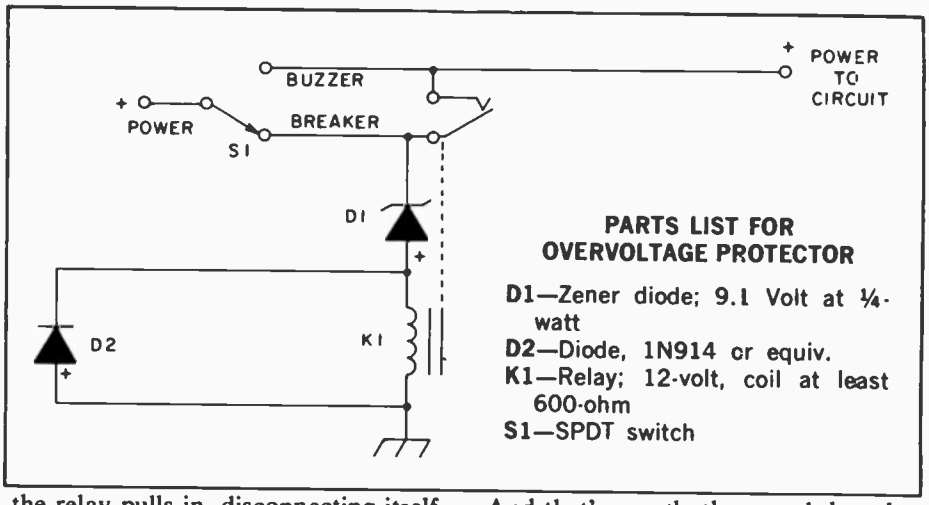
PARTS LIST FOR SIDETONE OSCILLATOR

B1—9VDC battery
C1—50-pf capacitor
C2—470-pf capacitor
C3, C4—.01-uF capacitor
D1—Diode, 1N914
Q1, Q2—NPN transistor, 2N2222 or equiv.
R1—470,000-ohm resistor, ½-watt
R2—5000-ohm potentiometer
R3—4700-ohm resistor, ½-watt
R4—100,000-ohm resistor, ½-watt
R5—100-ohm resistor, ½-watt
RFC1—2.5-mH choke
T1—1000; 8-ohm transformer, centertapped
SPKR—8-ohm speaker

54 Overvoltage Protector

☐ Too high a voltage can damage any number of electronic components. Many other components can withstand high voltages, but only for a limited time. This circuit provides either protection against too much voltage in much the same way a circuit breaker protects against too much current, or a warning that an overvoltage condition is occurring.

In the *Breaker* position, power is applied to the protected circuit only so long as relay K1 is not energized. K1 *will* energize whenever the input voltage exceeds the Zener voltage of diode D1, because above its zener voltage, a reverse-biased Zener diode like this one will conduct. In the *Buzzer* position, power remains applied to the circuit through the relay itself. When an overvoltage is present, the relay pulls in, disconnecting itself, which allows it to release and re-establish connection, which causes it to pull in and break connection and so on—exactly the action of a buzzer. And that's exactly the sound the relay will make—with enough noise generated to carry the buzz into the audio and IF circuits of almost anything connected or nearby.



PARTS LIST FOR OVERVOLTAGE PROTECTOR

D1—Zener diode; 9.1 Volt at ¼-watt
D2—Diode, 1N914 or equiv.
K1—Relay; 12-volt, coil at least 600-ohm
S1—SPDT switch

55 Cigar Lighter Power

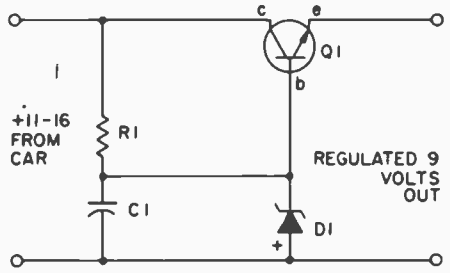
☐ When you want to run your radio or some other low-power 9 volt device in your car, here's a way you can do it and save on batteries. This is a simple shunt regulator using a 2N2222 and 9.1 Volt Zener. With a 2N2222, you can power devices requiring as much as 800 ma; to drive devices requiring more current, use a 2N3055. With either device, unless the equipment you are driving is very low power, use a heat sink.

There are two easy ways to determine how much current your transistor radio or whatever draws (more to the point, whether or not the amount of current it draws will necessitate heat sinking). One is to connect your

VOM in series between one of the battery posts and its associated clip connector. You will want to check the *maximum* amount of current drawn. Another way is to connect this circuit for only a few seconds and touch Q1 with your finger. If it gets too hot to hold your finger on, use a heat sink. You may want to use a heat sink in any case. You may also want to include a small fuse (try ½ amp).

PARTS LIST FOR CIGAR LIGHTER POWER

C1—100-uF capacitor
D1—Zener diode, 9.1 V at ¼-watt
Q1—NPN transistor, 2N2222 or equiv.
R1—560-ohm resistor, ½-watt



56 Two-Transistor Radio

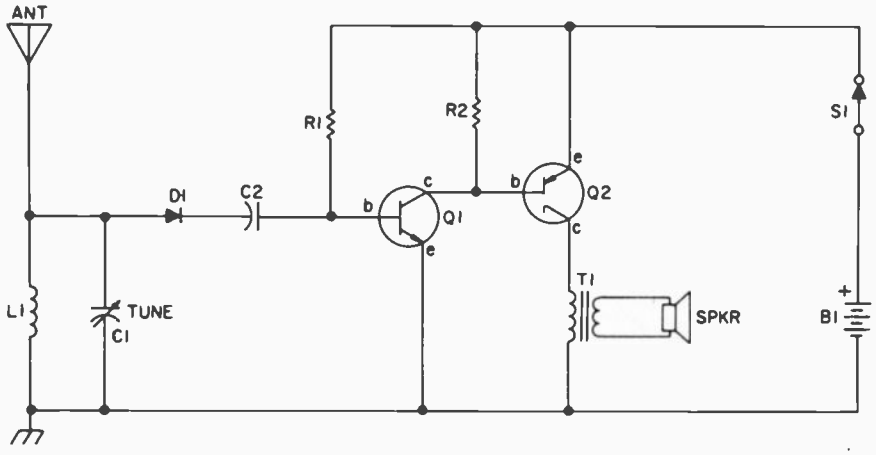
☐ Crystal sets are a lot of fun. Trouble is, their little earphones aren't. This is a nice little compromise, a loudspeaking crystal set.

L1 is a standard broadcast loopstick antenna, C1 a standard broadcast band variable capacitor. Chances are you can pull both parts from the carcass of an old radio. For an antenna, try attaching a length of wire with an alligator clip to any exposed metal part on a telephone, like the finger stop of a dial phone. You can also try window frames, bedsprings or bed frames.

(If you do construct any kind of outdoor antenna, keep far away from power and telephone lines and install a good lightning arrestor with a sound ground lead. It's also a good idea to ground the antenna when you're not using it, and not to use it in bad weather.) L1 and C1 form the tuned circuit that tunes the radio. Diode D1 acts as a detector. For better performance, substitute a germanium diode (such as a 1N34 or 1N60) or a hot carrier diode. Q1 and Q2 provide the amplification needed to drive the speaker.

PARTS LIST FOR TWO-TRANSISTOR RADIO

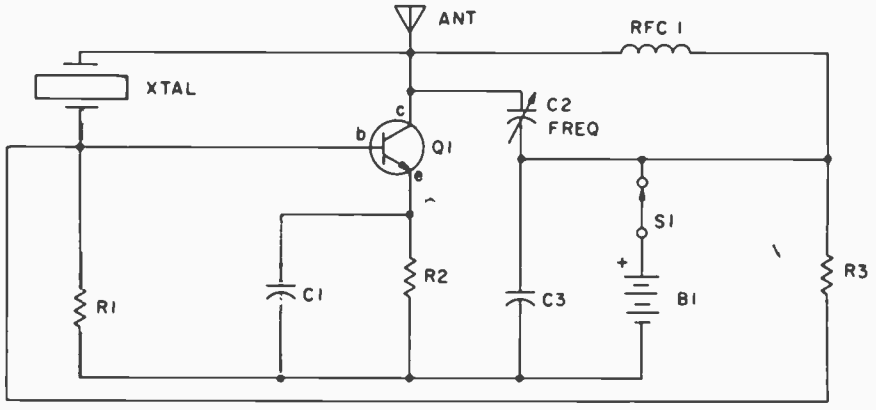
B1—9 VDC battery
C1—365-pF variable capacitor
C2—.1-uF capacitor
D1—Diode, 1N914 or equiv.
L1—Standard broadcast loopstick antenna
Q1—NPN transistor, 2N3904 or equiv.
Q2—PNP transistor, 2N3906 or equip.
R1—100,000-ohm resistor, ½-watt
R2—4700-ohm resistor, ½-watt
S1—SPST switch
T1—500:8-ohm matching transformer
SPKR—8-ohm speaker



57 Fox Hunt Transmitter

PARTS LIST FOR FOX HUNT TRANSMITTER

B1—9 VDC battery
C1, C3—.001-uF capacitor
C2—260-pF variable capacitor
Q1—NPN transistor, 2N2222 or equiv.
R1—10,000-ohm resistor, ½-watt
R2—470-ohm resistor, ½-watt
R3—47,000-ohm resistor, ½-watt
RFC1—2.5 mH radio frequency choke
S1—SPST switch
XTAL—crystal cut for the 49 MHz band



☐ Ever been to a radio foxhunt? Everyone brings a portable radio and a very directional antenna and tries to find where a small transmitter has been hidden. First one to find it wins. And here's just the transmitter to bring this old ham radio game to the rest of us. Transistor Q1 acts as a crystal oscillator in the new 49 MHz walkie-talkie band. The output of this oscillator is very low, and no license is required if you keep your antenna down to just a few inches in length.

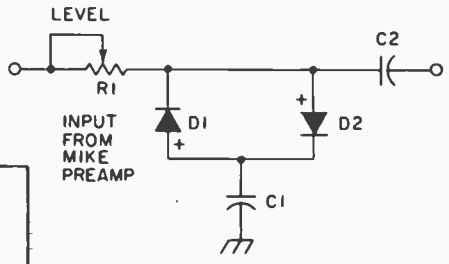
Trimmer capacitor C2 lets you tweak the frequency of this transmitter right into the middle of the channel. Use a walkie talkie and listen for carrier; when you hear it best, you're on frequency. This same circuit can be used as a wireless mike. Connect a carbon microphone, like an old telephone handset mike, in series with R2 and ground.

58 Mike Clipper

☐ If you were to look at your voice on an oscilloscope, you would see a very ragged waveform with a lot of "hot" peaks. These peaks are not very valuable in terms of getting across the words you're saying, but they can affect the average power of your voice. This circuit lets you increase the amount of *sock* (voice power) in your voice when placed between the first and second mike amp stages of a PA or transmitter.

PARTS LIST FOR MIKE CLIPPER

C1—100-uF capacitor
C2—.1-uF capacitor
D1, D2—Diode, 1N914 or equiv.
R1—10,000-ohm potentiometer

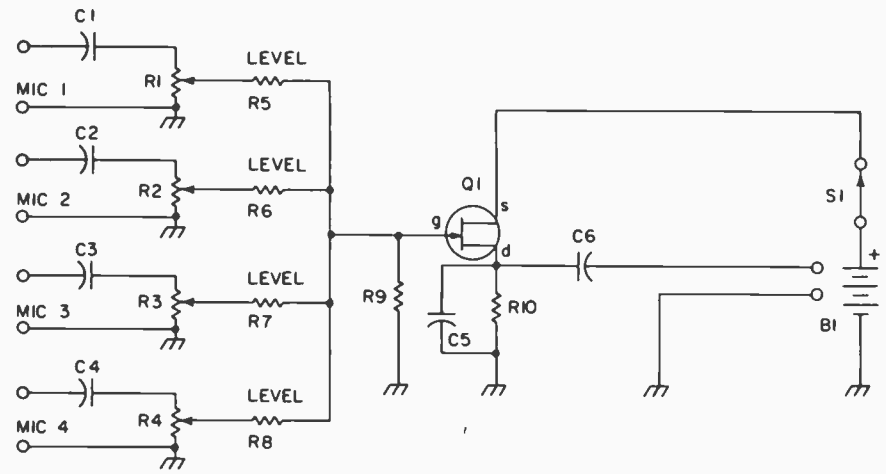


Clipping control R1 sets the level at which clipping begins. D1 and D2 then knock out the most positive and most negative half volt of voice signal, killing the peaks.

59 Conference Mike Mixer

☐ After trying for several years, I finally came to the conclusion that there's no way to tape record a conference or roundtable discussion with one mike. This scheme allows four, and can be expanded.

JFET transistor Q1 is used as a high-to-low impedance converter. The input of the amplifier-impedance converter is between about ½ and 1 Megohm as shown, but can be increased by increasing R5-8 to 10 Megohms if necessary. The output is about 1000 ohms impedance, but can be increased or decreased by changing the value of R9. Use 560, 620 or 680 Ohms, for example, to feed a 600 Ohm input; use 100K-1 Meg for a high impedance input. You will want to use shielded cable on all input and output leads, of course.



PARTS LIST FOR CONFERENCE MIKE MIXER

B1—9 VDC battery
C1, C2, C3, C4—.1-uF capacitor
C5, C6—10-uF capacitor
R1, R2, R3, R4—1-Megohm potentiometer, audio taper
R5, R6, R7, R8—2.7-Megohm resistor
R9—10-Megohm resistor
R10—1000-ohm resistor
Q1—FET (Field Effect Transistor), 2N5458 or equiv.
S1—SPST switch

60 Nine Volt Neon

☐ Wait a minute! Don't neon lamps need ninety volts to fire? Neon lamp I1 *gets* that kind of voltage—possibly more, depending on the state of your battery and the actual value of T1. Because T1 and Q1 act together to form a DC-to-AC converter.

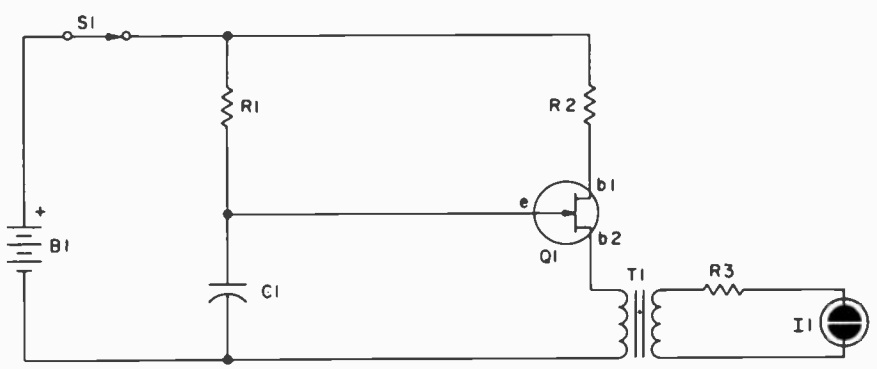
R1 and C1 set the frequency of UJT oscillator Q1 to about 1000 Hertz. Actually, any frequency near the middle of the audio range (300-5,000 Hz) would be okay, so feel free to take some liberties with R1 and C1's values. That's because those are the frequencies that are easiest to handle for T1, a transistor-type interstage transformer. You may find something suitable in one of your old junker radios or amplifier boards.

T1 acts as a step-up transformer, raising the input voltage to a level

where it can fire the NE-2. You may not need R3, but it limits the amount of current that I1 has to handle. For an interesting variation, use a large electrolytic capacitor between about 10 and 1000 microfarads for C1, or increase the value of R1 to 1-10 Megohms (this won't work with every UJT you try). This will cause the UJT oscillator to pulse at a rate somewhere between a few pulses a second and a pulse every few seconds. You'll know because I1 will flash with every pulse.

PARTS LIST FOR NINE VOLT NEON

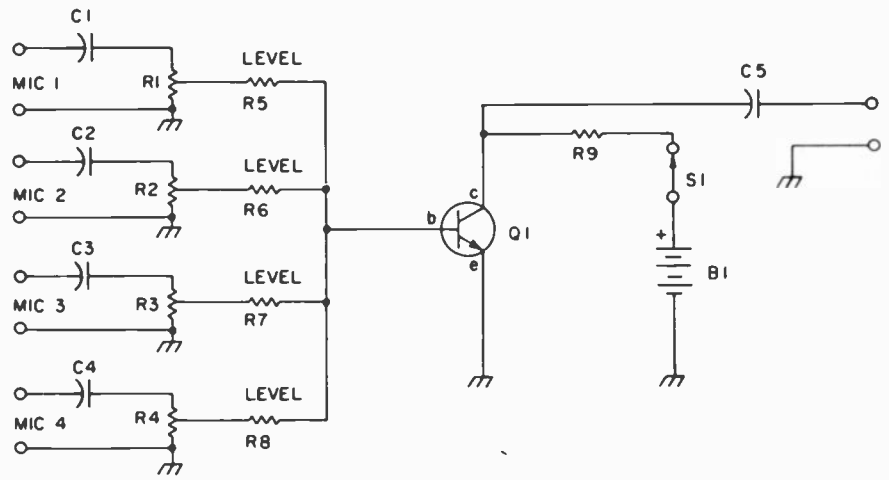
B1—9 VDC battery
C1—.1-uF capacitor
I1—Neon bulb, NE-2 type
Q1—UJT (Unijunction Transistor), 2N2646 or equiv.
R1—10,000-ohm resistor, ½-watt
R2—100-ohm resistor, ½-watt
R3—470,000-ohm resistor
S1—SPST switch
T1—Transformer, 10,000-ohm primary and 100,000-ohm secondary



61 Low Impedance Mike Mixer

☐ There's no reason to limit yourself to using just one mike at a time when you have this circuit to help you with your recording—or any other purpose. You can set up a small microphone mixing console. For pizzazz, you could use slide-style controls for R1-4; for miniaturization, you could use tiny trimmer resistors.

Each control adjusts the level of its associated microphone as they are mixed together. This gives you the versatility of making one mike louder or softer without upsetting the level of any of the others. Transistor Q1 provides a bit of amplification to compensate for losses in mixing, and to assure good level at the input.



PARTS LIST FOR LOW IMPEDANCE MIKE MIXER

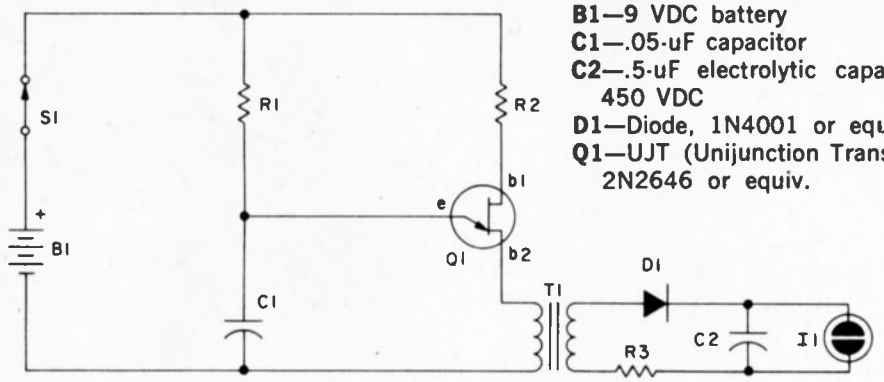
B1—9 VDC battery
C1, C2, C3, C4—.1-uF capacitor
C5—10-uF capacitor
Q1—PNP transistor, 2N3904 or equiv.
R1, R2, R3, R4—1-Megohm potentiometer, audio taper
R5, R6, R7, R8—100,000-ohm resistor, ½-watt
R9—15,000-ohm resistor, ½-watt
S1—SPST switch

62 Blinking Neon Night Light

☐ UJT oscillator Q1 feeds a tone of about 2000 Hz to transistor transformer T1, which steps it up to a level where it can fire a neon lamp, I1. But the circuitry to the right of T1 does something a little more interesting. Diode D1 (which makes this circuit a true DC-to-DC converter) rectifies the AC signal and applies it to C2. Resistor R3 limits the rate at which C2 can charge. When C2 finally reaches a voltage high enough to allow I1 to light, I1 fires and discharges C2, starting the action over again.

Use a 200 PIV diode for D1 and a 250 Volt (or more) capacitor for C2, or just make sure both are rated for more voltage than appears across the secondary of T1. D1, C2, R3 and I1 form a circuit called a relaxation oscillator. Interestingly, that is exactly the kind of oscillator Q1 is. Both rely on some R-C combination charging a capacitor at a restricted rate, then discharging it at some determined time. Just as you can multiply the values of R1 and C1 to get a fix on the frequency of Q1 (f=1/R1C1, more or less), you can mul-

PARTS LIST FOR BLINKING NEON NIGHT LIGHT



B1—9 VDC battery
C1—.05-uF capacitor
C2—.5-uF electrolytic capacitor, 450 VDC
D1—Diode, 1N4001 or equiv.
Q1—UJT (Unijunction Transistor), 2N2646 or equiv.
R1—10,000-ohm resistor, ½-watt
R2—100-ohm resistor
R3—470,000-ohm resistor, ½-watt
S1—SPST switch
T1—Transformer, 10,000-ohm primary and 100,000-ohm secondary

tiply R3 and C2 to determine that the NE-2 will blink about four times a second. You can also connect the circuit to the right of T1 to 110 Volt household power tc see the same action.

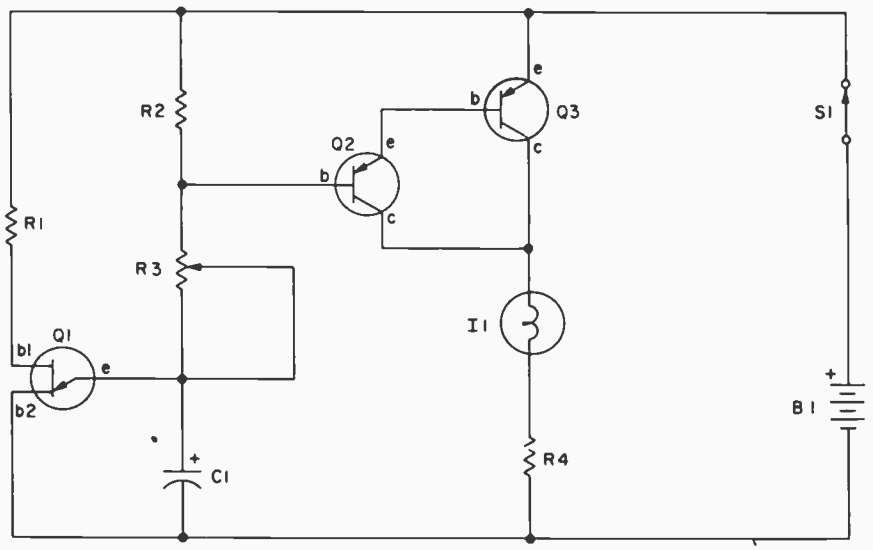
63 Low-Power Light Blinker

☐ Need a flashing pilot light in something? A blinking warning light for when some special condition occurs? Here's an easy way to add blinking action to a #47 lamp.

UJT Q1 is used as a relaxation oscillator delivering pulses at speeds varying from about five per second to about 1¼ seconds-per pulse. Q2 and Q3 are arranged in a Darlington configuration to reduce loading on Q1 while providing drive for I1. Resistor R4 serves several purposes. It drops the voltage across I1, a 6-volt lamp, permitting it to be used with a 9 Volt battery. It limits the current through I1 and the system, prolonging both battery and bulb life. For a brighter blink, reduce the value of R4. For a slower blink rate range, increase the values of either R2 or C1.

PARTS LIST FOR LOW-POWER LIGHT BLINKER

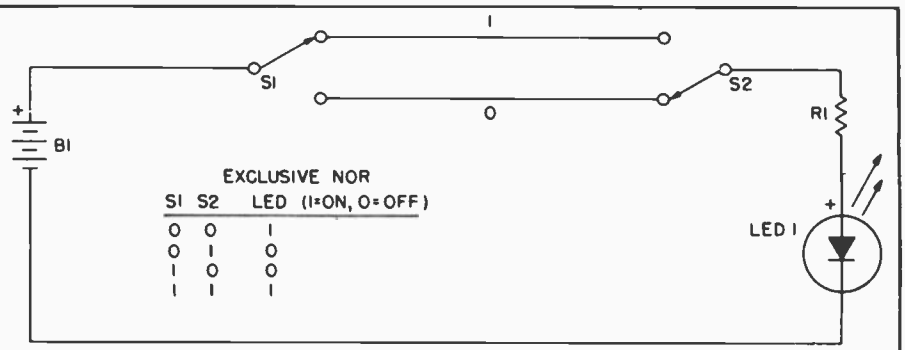
B1—9 VDC battery
C1—100-uF capacitor
I1—Pilot light, #47 type
Q1—UJT (Unijunction Transistor), 2N2646 or equiv.
Q2, Q3—PNP transistor, 2N3906 or equiv.
R1, R2—2200-ohm resistor, ½-watt
R3—10,000-ohm resistor, ½-watt
R4—27-ohm resistor, ½-watt
S1—SPST switch



64 Three-Way Switch Demonstrator

PARTS LIST FOR THREE-WAY SWITCH DEMONSTRATOR

B1—9VDC battery
LED1—Light emitting diode
R1—470-ohm resistor, ½-watt
S1, S2—SPDT switch



EXCLUSIVE NOR

S1	S2	LED (1=ON, 0=OFF)
0	0	1
0	1	0
1	0	0
1	1	1

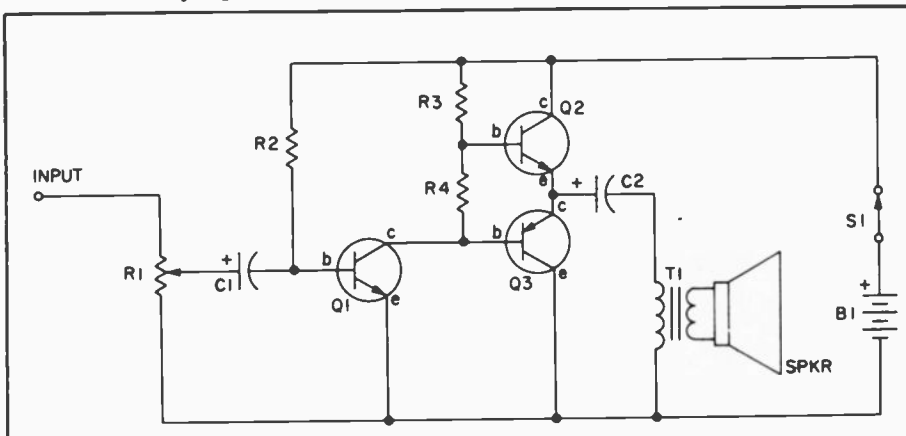
☐ If you live in a house with a stairway, you've probably experienced this circuit before. If the light is on, flicking either switch will turn it off. If the lights is off, flicking either switch will turn it on. Usually, in a home, one switch will be at the bottom of a stairway, the other at the top. The switches then operate a pair of lights, in tandem.

In logic, his configuration is called an Exclusive nor. It does the opposite of what an exclusive or circuit would do. In an exclusive or circuit, the output is true (=1=on) if either but not both inputs (the switches) are true. The chart shows the Truth Table for an exclusive nor circuit.

65 Audio Utility Amp

☐ This circuit may look familiar if you're in the habit of glancing at the schematics of your portable radios and recorders. This is a very popular way of getting a signal to a speaker. Transistor Q1 acts as a driver for complementary pair Q2 and Q3. Q2 and Q3 take turns conducting as they follow the input signal, so they can deliver a healthy signal through C2 to T1. T1 is suggested to reduce the loading that a low speaker impedance would cause if connected directly between C2 and ground; a higher impedance speaker or headphone could connect directly.

You can also use this circuit as a signal tracer to listen in on what's happening inside some of the other circuits on these pages. Just clip a lead between the minus leads of both projects and use one lead of a .01 microfarad capacitor in series with the input as a probe.



PARTS LIST FOR AUDIO UTILITY AMP

B1—9 VDC battery
C1—15-uF electrolytic capacitor, 15 VDC (or greater than needed)
C2—100-uF electrolytic capacitor, 15 VDC (or greater than needed)
Q1, Q2—NPN transistor, 2N3906 or equiv.
Q3—PNP transistor, 2N3906 or equiv.
R1—1-Megohm potentiometer
R2—270,000-ohm resistor, ½-watt
R3—1200-ohm resistor, ½-watt
R4—100-ohm resistor, ½-watt
S1—SPST switch
T1—500:8-ohm matching transformer
SPKR—8-ohm speaker

66 A VOM Thermometer

☐ Almost all electronic components change characteristics as temperatures change. In the case of silicon diodes, like the 1N914, the characteristic that changes is the amount of *forward voltage drop*.

Diodes aren't perfect conductors, you see, because they must take advantage of the bias (voltage) across a semiconductor junction (the place where the two different kinds of semiconductor material, *p* and *n*, meet) in order to operate.

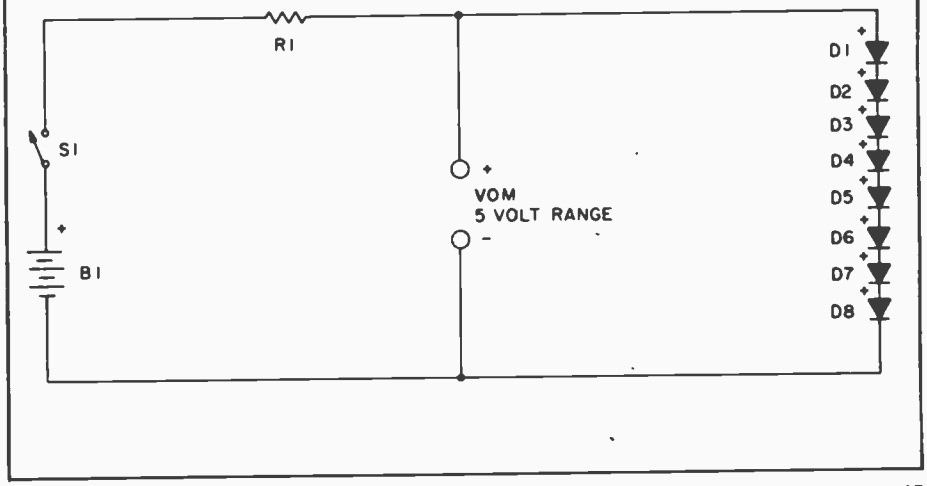
Almost every semiconductor device shows a junction voltage drop of about ½ Volt when forward biased, as the diodes here are. But the exact amount of that voltage drop changes with temperature.

So if you string eight diodes in series, like these, and measure the voltage across the string on the 5 Volt scale of your VOM, you'll see the voltage varying up and down around 4 Volts as you change the temperature the diodes are exposed to.

You could calibrate a separate meter to give you actual degree readings, but for many purposes, just knowing the temperature is changing is enough.

PARTS LIST FOR A VOM THERMOMETER

B1—9 VDC battery
D1, D2, D3, D4, D5, D6, D7, D8, D9—Diode, 1N914 or equiv.
R1—4700-ohm resistor, ½-watt
S1—SPST switch

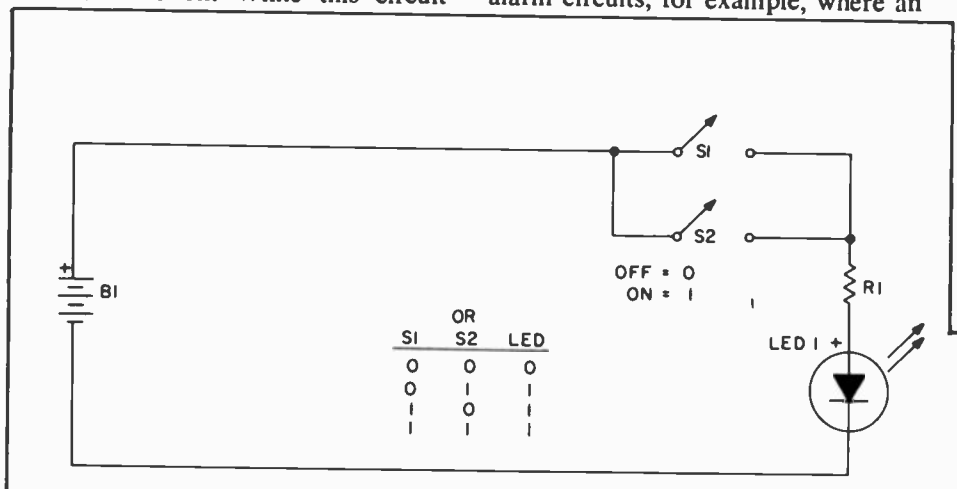


67 Logical OR Demonstrator

☐ In digital logic, an OR statement is true if any one of the statements leading to it is true. Parallel switches are a good analogy for the OR logic function. If any of the parallel switches are on (=true="1"), the L.E.D. turns on. While this circuit demonstrates the operation of a "two-input OR gate," you may add as many parallel switches as you like to demonstrate the action of "wider" OR gates.

OR gates are very widely used in alarm circuits, for example, where an alarm should be sounded whenever anything occurs at any one of the several inputs. The chart of numbers is known as a "Truth Table." The columns at the left identify the states of the various inputs, the column at the right the state of the output. Compare the results (right column) of this Truth Table with the results of other types of logic and you will see why digital logic systems can be so versatile.

The nice thing about this circuit is that it's so visual. You'll find that it's so much easier to understand digital logic when you can watch what's happening rather than reading about it.



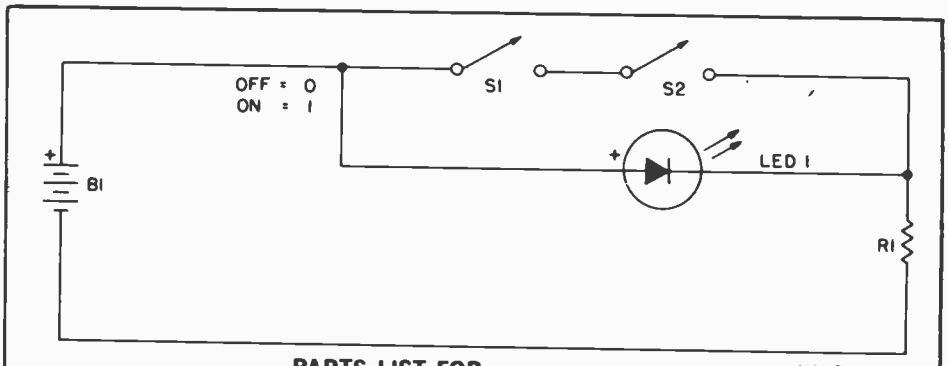
PARTS LIST FOR LOGICAL "OR" DEMONSTRATOR

B1—9 VDC battery
LED1—Light emitting diode
R1—470-ohm resistor, ½-watt
S1, S2—SPST switch

68 Logical NAND Demonstrator

☐ NAND is logic shorthand for "Not And." So a NAND gate has an output of 1 only when an AND gate would not. Compare the right column (results, or output) of an AND gate truth table to that for the NAND gate above and you will see that they are exactly opposite.

Here, the L.E.D. will turn on only if the two switches are *not* both turned on. Be careful that the series combination of S1 and S2 can short out only the L.E.D. and not R1 as well or your battery will not last more than a few seconds. R1 limits the current drain on the battery to about 20 milliamps.



PARTS LIST FOR LOGICAL "NAND" DEMONSTRATOR

B1—9 VDC battery
LED1—Light emitting diode
R1—470-ohm resistor, ½-watt
S1, S2—SPST switch

NAND		
S1	S2	LED
0	0	1
0	1	1
1	0	1
1	1	0

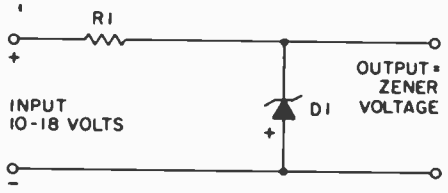
69 Easy Instrument Calibrator

☐ How accurate is your VOM? Your oscilloscope? Your other voltage-measuring test gear? You can find out in seconds with just these two parts.

You can use any Zener you have on hand. Of course, the calibrator is only as accurate as your Zener, and your input voltage has to be greater than your Zener voltage. For a wider

PARTS LIST FOR EASY INSTRUMENT CALIBRATOR

D1—Zener diode; 9.1-volt at ¼-watt
R1—1000-ohm resistor, ½-watt

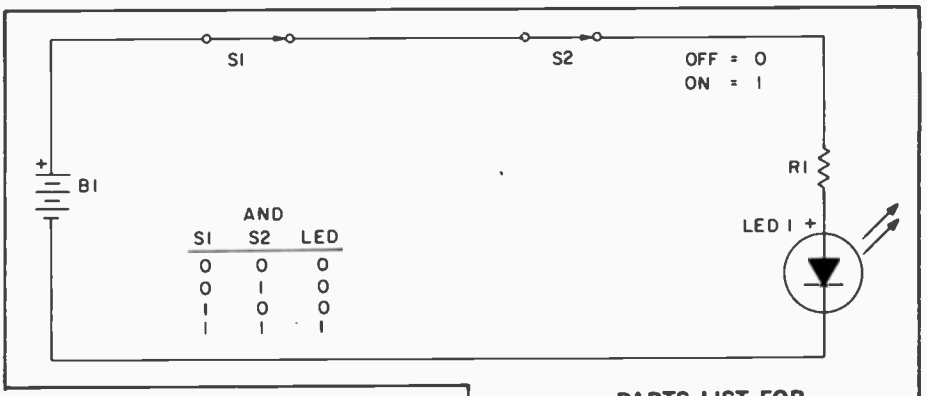


range of input voltages, use Ohm's Law to calculate the maximum safe Zener current (I=P/E, but use only about half the rated I) and the value of R1 (The maximum input voltage minus the zener voltage, all divided by the Zener current). You'll know in a flash how your meters are doing, and you'll be glad you do.

70 Logical AND Demonstrator

☐ In digital logic, an AND statement is true only if all parts of the logic leading to it (its inputs) are all true. If we take "true" to mean "on", a logic state we define as "1" (and not true = off = 0), we can see that a series switch configuration is a good way to illustrate the AND logical statement.

In integrated circuit logic, instead of actual mechanical switches, transistors are used as switches. Specifically, this circuit demonstrates the action on a "two-input AND gate." Only if both switches are on will the L.E.D. turn on. Similarly, you can expand the demonstrator to demonstrate as many inputs to an AND gate as you have switches to connect in series.



Once again, we present the "truth table" of this particular circuit which will tell you exactly what's happening and when. Truth tables are often used in digital design, and can be indispensable. Depending on the device they can be quite long.

PARTS LIST FOR LOGICAL "AND" DEMONSTRATOR

B1—9VDC battery
LED1—Light emitting diode
R1—470-ohm resistor, ½-watt
S1, S2—SPST switch

71 Logical NOR Demonstrator

☐ Just as the output of a NAND gate is the opposite of that for an AND gate, this NOR gate produces results opposite those of an OR gate.

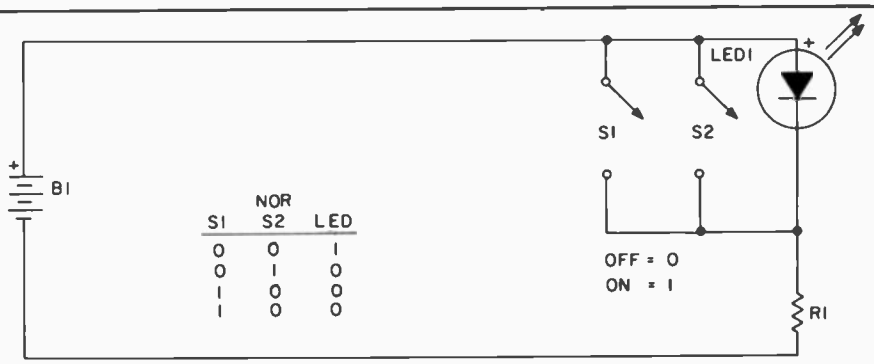
LED1 will turn on when neither S1 *nor* S2 are on.

A NOR gate is a good way to handle a failsafe system in which a circuit cannot operate unless all systems are "go"; in other words, if any of the inputs are on, the system cannot be.

This truth table compares the operation of different types of logic gates:

Think of 0=off=not true,
1=on=true

Digital logic is certainly in the forefront of modern electronics. Circuits such as this NOR Demonstrator can help to prepare you in understanding complex circuitry. The principles you learn remain the same as in actual digital circuitry—only the method of achieving demonstrable results changes.



PARTS LIST FOR LOGICAL "NOR" DEMONSTRATOR

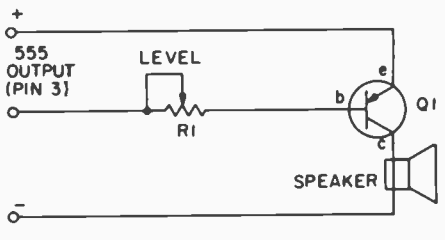
B1—9 VDC battery
LED1—Light emitting diode
R1—470-ohm resistor, ½-watt
S1, S2—SPST switch

72 "555" Loudspeaker

☐ Uncontested champ of the beep and boop brigade is the beautifully versatile "555" series of timer ICs. For clicks, squeaks and squawks, more and more circuits ask for them, and more and more experimenters enjoy playing with them in new designs. But, by itself, the 555 doesn't put out as much signal as many of us would like, requiring a boost somewhere be-

PARTS LIST FOR "555" LOUDSPEAKER

Q1—PNP transistor, 2N3906 or equiv.
R1—5000-ohm trimmer potentiometer
SPKR—8-ohm speaker



fore it can drive a speaker. Here, the boost and the speaker come together.

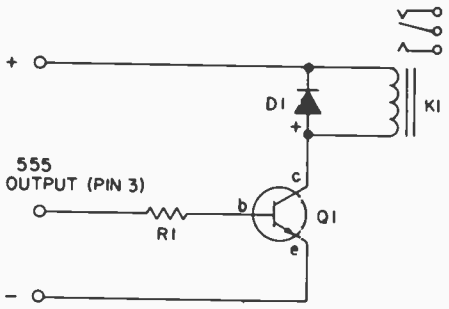
Q1 acts as an amplifier and speaker driver, working directly from the 555 output (pin 3) through a level control, R1. You may wish to substitute a fixed value or eliminate R1 entirely.

73 "555" Switch Hitter

☐ The "555" is a very versatile timer when you need a time delay or any kind of regular timed event. But if you try to draw more than 100 or 200 milliamps through it, you'll soon be drawing a blank and a new 555 from your parts drawer. With these simple additions, you can draw as many amps as your relay's contacts will carry. Q1 acts as a relay driver, triggered by the output of the 555 (pin 3) through a 1000 Ohm resistor (R1). Relay K1 can be driven from the 555's power supply (choose an appropriate coil voltage for K1) or from a separate positive power supply if the 555's supply can't handle the extra load. Q2 can handle up to 800 milliamps itself, so any relay coil that draws less than that (100 Ohms or so more than satisfies this) will work fine. Similarly, other loads can be substituted for K1-D1.

PARTS LIST FOR "555" SWITCH HITTER

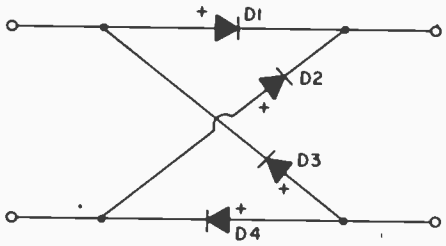
D1—Diode, 1N914 or equiv.
Q1—NPN transistor, 2N2222 or equiv.
R1—1000-ohm resistor, ½-watt
K1—Relay, (rated at least equal to system voltage)



74 Wrong-Way Battery Protector

☐ Want to ruin an expensive piece of solid state equipment? Just hook the battery or supply up backwards. But by adding these four diodes to your equipment, you can say goodbye to backwards forever. This diode arrangement is one you may recognize as a full wave bridge. In power supplies, it's used to rectify both halves of the AC waveform.

Here, it makes sure that no matter which way you connect the battery, the positive and negative supply terminals in your equipment get the right polarity voltage. Remember, since the forward bias of two diodes are introduced, your equipment will be getting about a volt less than your battery is delivering. And remember, choose your diodes so they're rated for all the current your circuit will draw.



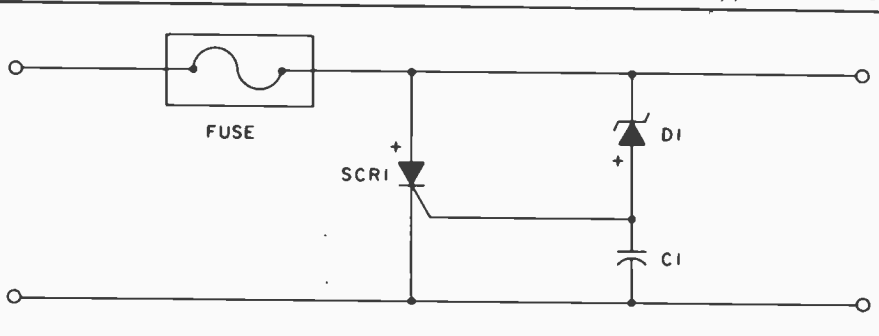
PARTS LIST FOR WRONG-WAY BATTERY PROTECTOR

D1, D2, D3, D4—Diode, 1N914 or equiv.

75 Old Crowbar

☐ Fuses protect your circuits by reacting to too much current. A *crowbar* is a special kind of protective circuit that blows your fuse when there's too much voltage. It puts a stop to everything, including potential damage. This crowbar works by using the SCR as a dead short across the supply leads, which blows the fuse. Your SCR should be rated for a little more current than the fuse is rated for.

When a voltage over the rating of Zener D1 occurs, capacitor C1 quickly charges to trigger SCR1 into conduction (turn it on), which shorts



PARTS LIST FOR OLD CROWBAR

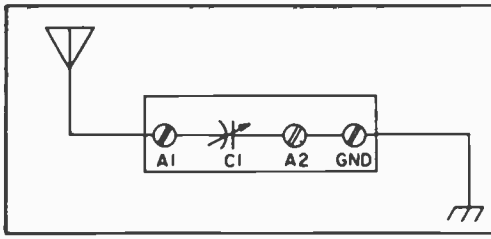
C1—22-uF, 16 VDC electrolytic capacitor
D1—Zener diode, 9.1-volt, ¼-watt
SCR1—See text

the supply and blows the fuse. Unfortunately, the circuit is only as accurate as the components, and it isn't easy to change the trip point; however, for many applications, it can save a lot of grief.

76 Add An Antenna Trimmer

☐ One part? That's all, but it can make a big difference in your shortwave listening. The American Radio Relay League's *ARRL Handbook*, the ham operator's "bible," can help you understand the complex nature of radio waves and how this circuit (is one part a circuit?) helps your antenna match your receiver at any given frequency.

But for right now, all you need to know is that when you add this trimmer (or connect it to these leads through coax, but only a very short length), you can adjust it to make your receiver really hot wherever it's tuned. It works by helping your receiver take advantage of all the signal your antenna can pick up. Try it and see.



PARTS LIST FOR ADD AN ANTENNA TRIMMER

C1—60-pf trimmer

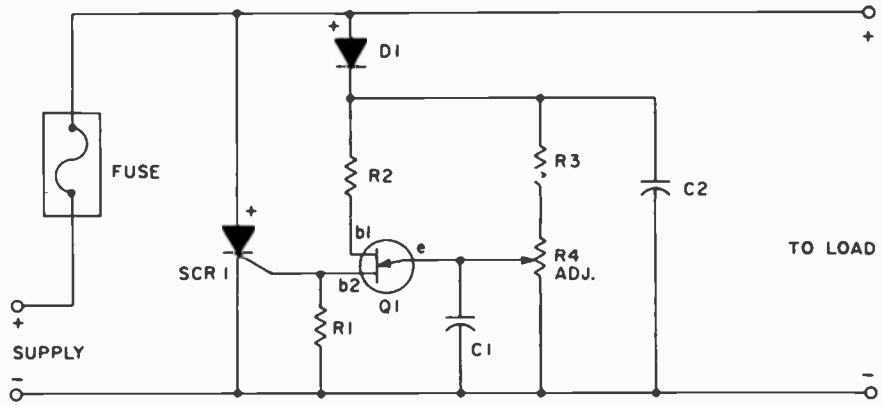
77 Adjustable Crowbar

☐ This crowbar circuit takes advantage of the electrically well-defined switching point of UJT (unijunction transistor) Q1. Q1's actual trip point voltage is set by trimmer R4. The Q1 circuit is isolated from the load by D1. When Q1 conducts, it triggers SCR1, shorting the supply and blowing the fuse. Choose SCR1 to handle more than the rated fuse current at the maximum supply voltage.

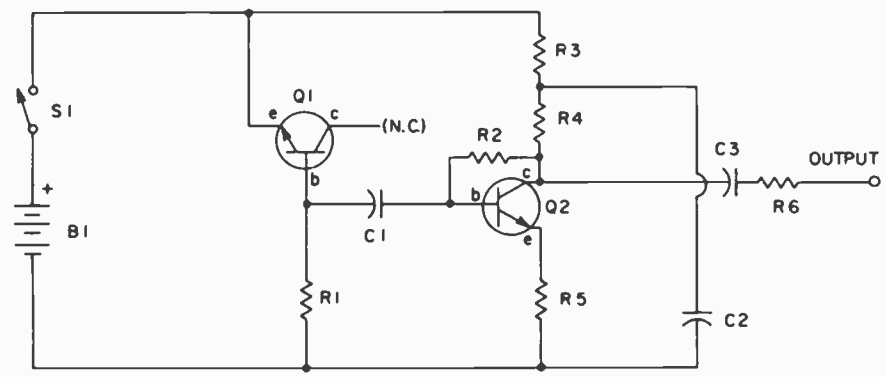
To test for your trip point (when setting it, for example), disconnect the LOAD. Substitute a lamp of the proper voltage (the supply voltage or a little more) for the fuse. Set the voltage at the supply voltage terminals for the trip point you desire, then adjust R4 until the test lamp just lights.

PARTS LIST FOR ADJUSTABLE CROWBAR

C1—.02-uF capacitor
C2—2.2-uF capacitor
D1—Diode, 1N914 or equiv.
R1—47-ohm resistor, ½-watt
R2—330-ohm resistor, ½-watt
R3—3300-ohm resistor, ½-watt
R4—10,000-ohm trimmer potentiometer
Q1—UJT (Unijunction Transistor), 2N2646 or equiv.
SCR1—See text



78 Noise Generator



PARTS LIST FOR NOISE GENERATOR

B1—9 VDC battery
C1—.05-uF capacitor
C2—220-uF capacitor
C3—.005-uF capacitor
R1—1-Megohm resistor, ½-watt
R2—1.8-Megohm resistor, ½-watt
R3, R5—150-ohm resistor, ½-watt
R4—120,000-ohm resistor, ½-watt
R6—56,000-ohm resistor, ½-watt
Q1, Q2—NPN transistor, 2N3904 cr equiv.
S1—SPST switch

☐ Audio buffs often refer to their systems as having color or temperature. One that is rich in low end response is said to be warm and red; a bright high end on a system means it's cool and blue.

The mixture of all these characteristic colors is white, and white noise generators produce a whooshing shound that is randomly distributed throughout the spectrum. Likewise, pink noise generators are just a bit warmer. This simple noise generator is one we might call off-white. It takes advantage of the junction noise generated in a reverse-biased semiconductor junction (here, a base-to-emitter junction in NPN transistor Q1).

The noise generated by current through Q1 is amplified by Q2 and made available at the output. For a simple demonstration of tonal coloring, patch this noise into your sound system and see how manipulating your tone controls alters the nature of the noise your hear.

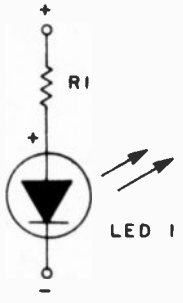
79 Let There Be Light

☐ Whether or not this makes sense for you depends on you. This is a pilot light that you can use with battery operated equipment. Connect it just after the power switch and it will be on whenever the equipment is on. Of course, this adds about 20 milliamp additional current drain to a circuit powered by a 9 Volt battery, and that could shorten your battery life.

But if you tend to forget that things are on—especially silent battery-operated things—the light could remind you and help save your battery. You will find other places in a circuit where adding these two parts can be useful or interesting. Go ahead and look.

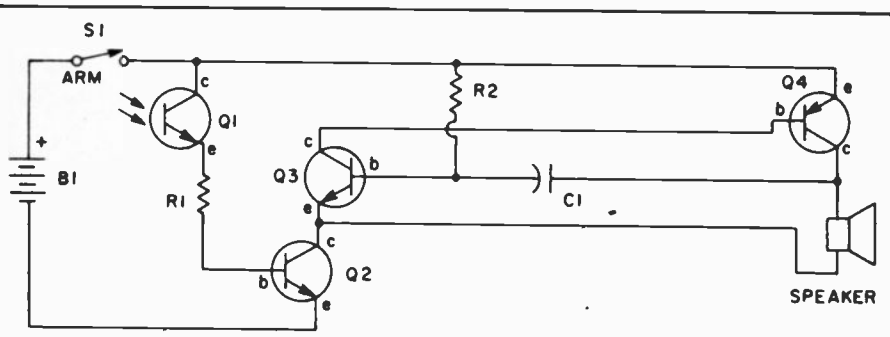
PARTS LIST FOR LET THERE BE LIGHT

LED1—Light emitting diode
R1—470-ohm resistor, ½-watt



80 Attache Alarm

☐ Who knows what evils lurk, ready to pilfer the Twinkies out of your attache case when you're not looking? This squealer does. Because when you arm the alarm by turning on S1, the lightest touch will set it off. More accurately, the touch of light. Light striking Q1 turns on transistor switch Q2, which energizes oscillator Q3-Q4. And that blows the whistle on the bad guy.



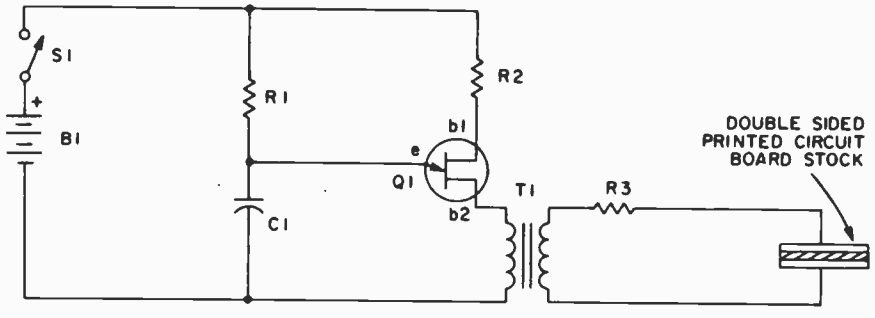
PARTS LIST FOR ATTACHE ALARM

B1—9 VDC battery
C1—.01-uF capacitor
Q1—Photoelectric transistor, FPT 100 or equiv.
Q2—NPN transistor, 2N2222 or equiv.
Q3—NPN transistor, 2N3904 or equiv.
Q4—PNP transistor, 2N3906 or equiv.
R1—2200-ohm resistor, ½-watt
R2—100,00-ohm resistor, ½-watt
S1—SPST switch
SPKR—8-ohm speaker

81 Gotcha Generator

PARTS LIST FOR GOTCHA GENERATOR

B1—9 VDC battery
C1—.1-uF capacitor
Q1—UJT (Unijunction transistor), 2N2646 or equiv.
R1—10,000-ohm resistor, ½-watt
R2—100-ohm resistor, ½-watt
R3—470,000-ohm resistor, ½-watt
S1—SPST switch
T1—Transformer, 10,000:100,000-ohm



☐ Want to play a game of Hot Potato with a double sided printed circuit board stock? Just add this and you could be putting just under a hundred volts across it—but at only a few hundred microamps of current. (Change R3 to 10 Meg for just under 10 microamps of current). Transformers can be used to step up voltages, as you know. That's the way power transformers are designed. But power transformers have to be able to handle a great deal of current at only 60 Hertz, which requires a bulky package.

The AC supply for this transformer is generated by Unijunction transistor oscillator Q1. It only has to supply current in the milliamp range, and works at about 1000 Hertz, so we can use a small "transistor" interstage transformer for T1. A blank piece of copper coated double sided pc board stock is a good way to keep the stepped-up AC signal from shorting while close—one lead is attached to each face of the board. Bet a friend he can't hold it in his hand for a minute, then throw the switch.

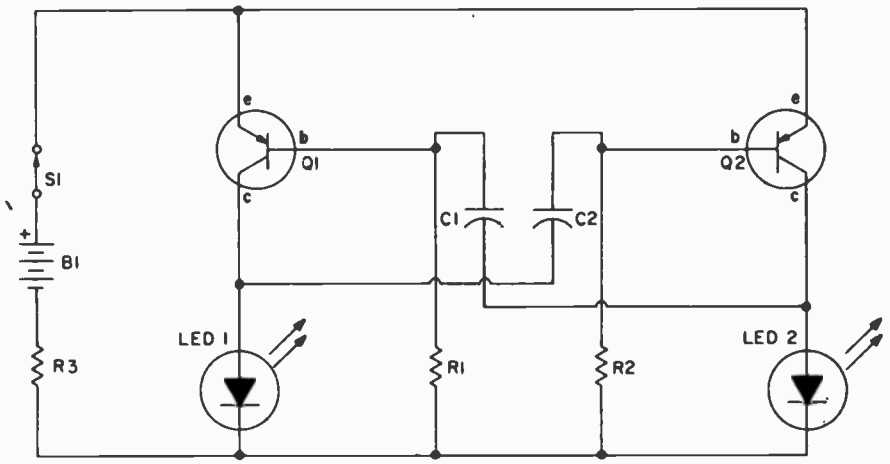
82 The Bamboozler

☐ Officially, this is a slow speed astable multivibrator with state-indicating photo-optic outputs. Unofficially, it's just a circuit to alternately flash two L.E.D.s. But you don't have to tell anybody that. Tell them it's counting Ekno Rays from the planet Nerd. Or it remotely controls your pacemaker. Or it can tell a person's innermost secrets. Or you'll think of something. R3 limits the current the whole circuit can draw. If you find the flashing too dim or unreliable, reduce the value of R3 to 150, 100 or 47 Ohms. If you could handle even dimmer blinks, increase R3 to a maximum of about 100 Ohms.

You could also use different color LEDs, add a magnetic reed switch in series with each capacitor, and hide a magnet between your fingers. Then, by careful positioning, you can control whether both flash, one stays on or both stay on.

PARTS LIST FOR THE BAMBOOZLER

B1—9 VDC battery
C1, C2—10-uF capacitor
LED1, LED2—Light emitting diode
Q1, Q2—PNP transistor, 2N3906 or equiv.
R1, R2—47,000-ohm resistor, ½-watt
R3—220-ohm resistor, ½-watt
S1—SPST switch



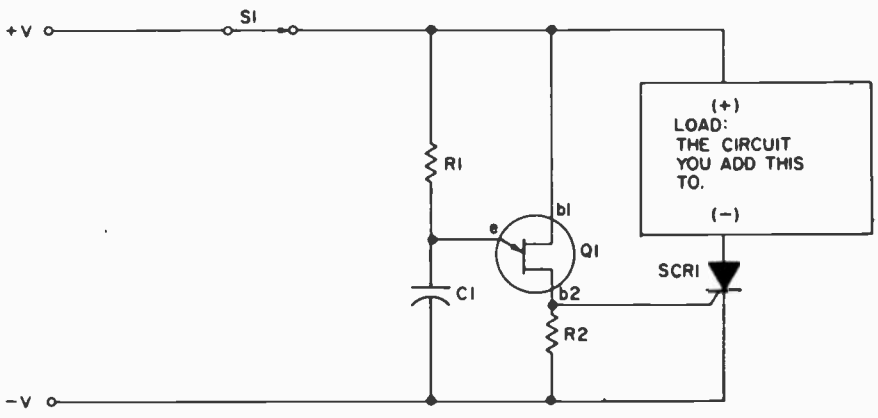
83 Turn-On Delay

☐ Turn the switch on and the circuit you're controlling (LOAD) won't turn on until 10 seconds later with this UJT delay. The SCR is the "switch" that eventually permits current to flow through the load. But the SCR won't turn on until the UJT timer circuit delivers a pulse to its gate. This happens after a time delay determined by the product.

Choose a value for SCR1 that can easily handle the maximum current the load will draw, plus a margin for safety, and the voltage of the power supply, plus a margin for safety. For a 9-12 Volt circuit drawing up to ½ amp or so, a 20 Volt 1 Amp SCR should do nicely. Since S1, when turned off, interrupts the flow of current through the SCR, turn-off for the load happens immediately.

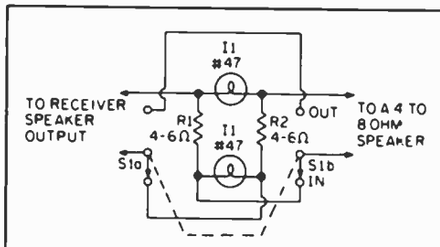
PARTS LIST FOR TURN-ON DELAY

C1—220-uF capacitor
Q1—UJT (Unijunction Transistor), 2N2646 or equiv.
R1—47,000-ohm resistor, ½-watt
R2—22-ohm resistor, ½-watt
SCR1—See text
S1—SPST



84 SWL's Simple Squelch

☐ It's almost a universal rule that two-way radios have a squelch control, a device that mutes the background noise until a station is received. Even public service radios now include a squelch, so why put up with ear-jarring noise when listening on your SWL receiver. Just a couple of #47 pilot lamps scrounged from old tube radios and two resistors are all that's needed to squelch your SW receiver. And if you can't scrounge the lamps, they're available at just about every radio parts distributor and service shop. Switch S1 is needed only to bypass the squelch for very weak signals.



PARTS LIST FOR SWL'S SIMPLE SQUELCH

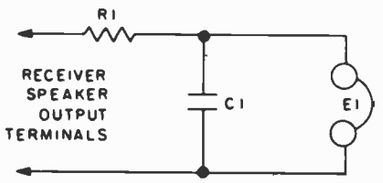
I1, I2—#47 pilot lamp
R1, R2—4 to 6-ohm resistor, 1-watt, 10 percent
S1—Dpdt switch

In many instances, the circuit will provide a basic attenuation of the noise background, not complete squelch. But it's a substantial squelch considering the low cost and ease of construction. Just about any enclosure, plastic or metal, can be used. The components can even lie on the table.

85 29¢ Mag. Phone Filter

☐ If you're tired of copying CW signals through the grind without a Q-multiplier on your receiver, the 29¢ Mag. Phone Filter is the next best answer. It's the cheapest route to greater selectivity.

Capacitor C1 plus the inductance of a magnetic headset form a parallel resonant circuit at approximately 1 kHz. All other signals are sharply attenuated so you hear mainly the signal you want. Resistor R1 isolates the resonant circuit to prevent a receiver's low output impedance from reducing the "Q" of the headset circuit.



PARTS LIST FOR 29¢ MAG. PHONE FILTER

C1—0.005-.05-uF capacitor (see text
E1—2000-ohm magnetic headset
R1—100,00-ohm, ½-watt resistor

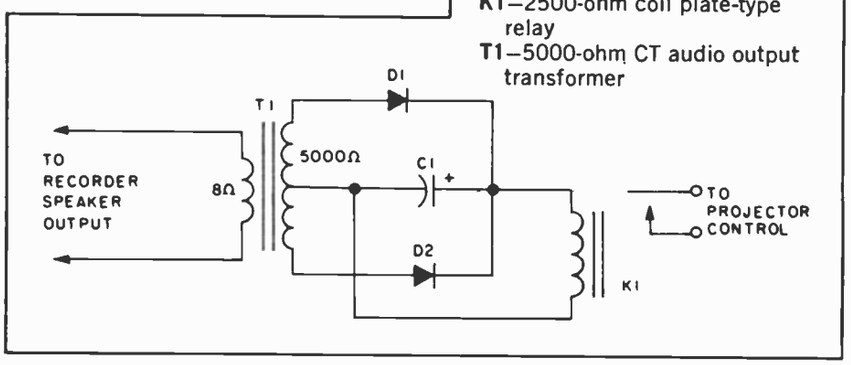
The exact value of C1 depends on the particular headset. Try different values in the range shown until the desired resonant frequency or peaking action is obtained.

86 Slide Show Stopper

☐ Soundless slide shows are dull, dull, dull! But a stereo recorder can automate the whole show so slides change automatically in step with the commentary.

Record your commentary on the left track. At the instant you want slides to change, record a one-second noise or tone burst on the right track. Connect the programmer between the recorder's right speaker output and the projector's remote control cable. Make a test run to determine the right-track volume setting to make noise or tone bursts activate relay K1. No fancy tone generators needed here. Just give a hearty Bronx cheer into the mike of the left channel only!

Then start the tape from the beginning. The audience will hear your commentary or spectacular music-and-sound reproduction through a speaker connected to the recorder's left channel, while the signal on the right channel automatically changes the slides.



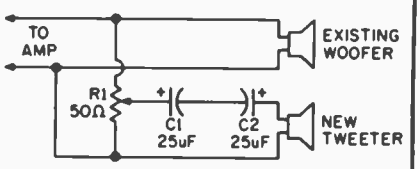
PARTS LIST FOR SLIDE SHOW STOPPER

C1—25-uF, 50-VDC electrolytic capacitor
D1, D2—1-A/400-P!V silicon rectifier, Motorola 1N4004
K1—2500-ohm coil plate-type relay
T1—5000-ohm CT audio output transformer

87 Add-A-Tweeter

☐ Any single-voice coil speaker is hard pressed to handle both low and high frequencies simultaneously—and it's the highs that suffer most. A much cleaner sound can usually be obtained from speakers 6 inches or larger if the highs are pumped through a tweeter. It can be any small speaker rated 4 to 6 ohms of approximately 2 to 3 inches in diameter.

The back-to-back capacitors, C1 and C2, permit only the highs from about 1500 Hz up to pass into the tweeter. By keeping the lows out of the tweeter, the highs come out cleaner, and there's no chance of the greater low frequency power "blowing" the tweeter. Potentiometer R1 is used to match the tweeter's output level to that of the woofer—because small speakers are generally much more efficient than large speakers. If you eliminate R1, the highs will literally scream in your ears.



PARTS LIST FOR ADD-A-TWEETER

C1, C2—22-uF electrolytic capacitor, 50 VDC
R1—50-ohm wirebound potentiometer, 1 or 2 watts.
Misc.—Cone type tweeters are suitable for use with this circuit.

88 FlashTester

☐ Even if you spend $18 or $20 for a super-duper professional remote flash tripper, you'll get little more than this two-component circuit. Price is important if the results are equal.

Transistor Q1 is a light-activated silicon-controlled rectifier (LASCR). The gate is tripped by light entering a small lens built into the top cap.

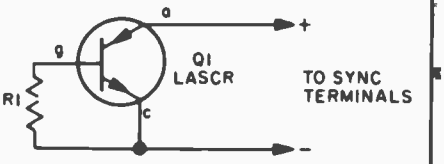
To operate, provide a 6-in. length of stiff wire for the anode and cathode connections and terminate the wires in a polarized power plug that matches the sync terminals on your electronic flashgun (strobelight). Make certain the anode lead connects to the *positive* sync terminal.

When using the device, bend the connecting wires so the LASCR lens faces the main flash. This will fire the remote unit.

No reset switch is needed. Voltage at the flash's sync terminals falls below the LASCR's holding voltage when the flash is fired, thereby turning *off* the LASCR.

PARTS LIST FOR REMOTE FLASH TRIGGER

Q1—200-V light-activated silicon-controlled rectifier (LASCR)
R1—47,000-ohm, ½-watt resistor



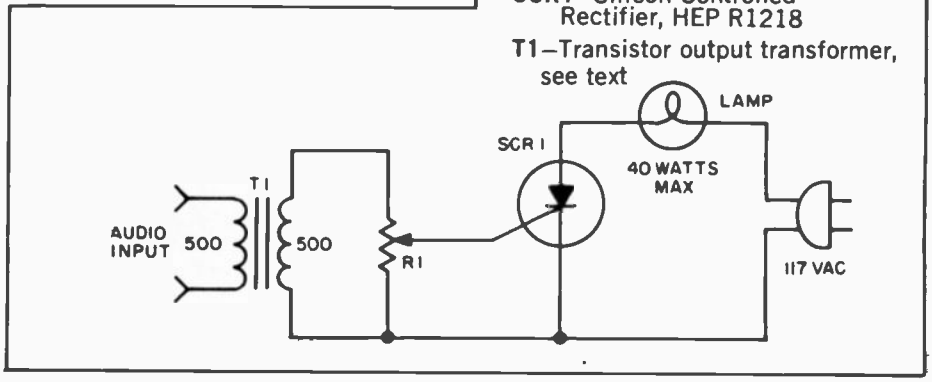
89 Basic Color Organ

☐ This simple color organ is certain to keep your party from becoming a drag. Connected to your hi-fi amplifier's speaker output (across the speaker terminals) it will throb in time to the music. Paint the bulb red or deep blue and your party room will take on the atmosphere of a rock club.

Transformer T1 can be any matching transistor type in the range of 500/500 to 2500/2500 ohms. Note that none of the connections from SCR1 or its components are connected to ground. For safety's sake, you must keep the 117-volt line voltage from the amplifier connections—that's the reason for T1. To adjust, set potentiometer R1 "off" and adjust the amplifier volume control for a normal listening level. Then adjust R1 until lamp I1 starts to throb in step with the beat.

PARTS LIST FOR BASIC COLOR ORGAN

I1—117V lamp, not to exceed 40 watts.
R1—Potentiometer, 500 to 5000 ohms
SCR1—Silicon Controlled Rectifier, HEP R1218
T1—Transistor output transformer, see text



90 Photo Print Meter

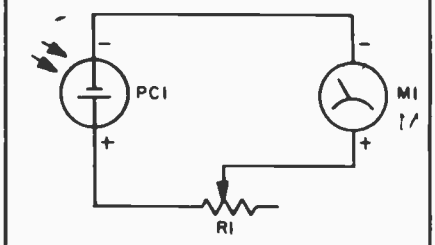
☐ Every print a good print! That's what you get with the photo print meter.

Meter M1 can be just about anything up to 0-1 DC mA. But if you prefer low light levels and long exposures, install a sensitive meter of 500 *u*A or less.

When light from the enlarger falls on the solar cell (PC1), a voltage is generated that is in proportion to the amount of light. Sensitivity control R1 allows the user to set the meter indication to a convenient value.

To use the meter, first make a good normal print in your normal manner from a No. 2 or No. 3 negative. Then, do not disturb the enlarger setting, but integrate the light by placing a diffusing disc or opal glass under the lens. Place the solar cell on the easel and adjust R1 for a convenient meter reading, say, full scale. The meter is now calibrated.

When using it, focus the enlarger, use the diffuser, and adjust the lens diaphragm until you get the reference meter reading. Then use the exposure time previously found for the calibration print. Suggested reading: Ilford Manual of Photography, obtainable from any photo store. Also, check Kodak publications available at the same place.



PARTS LIST FOR PHOTO PRINT METER

M1—100, 250, or 500-uA DC meter
PC1—Solar cell (Calectro J4-801)
R1—5000-ohm potentiometer linear taper

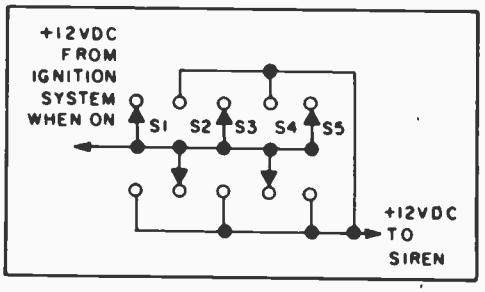
91 Auto Ignition Maze

☐ Install a combination lock on your car's dashboard and a thief would have a better chance playing Russian roulette.

Switches S1 through S5 are spdt rather than spst only to keep all external switch markings the same.

Tracing the circuit will show that only if switches S2 and S4 are down is the siren disabled. The siren sounds if any other switch is down or if S2 or S4 is up when the ignition is turned on. A simple wiring change lets you set any combination.

The switches can be "sporty" auto accessory switches sold individually or in switch banks such as G.C. 35-916. Provide labels such as "Carburetor Heater," "Window Washer," etc. and no one will know the car is wired for "sound."



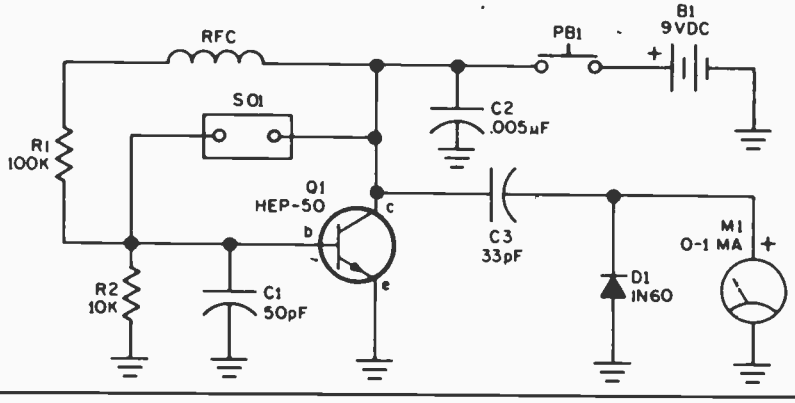
92 Crystal Checker

☐ A fast way to see if the crystal from your transmitter or receiver is properly "active" is to compare its output against that of a known good crystal. This crystal checker will handle both fundamental and overtone type crystals. Socket SO1 should match the pins on your crystals. If you use more than one type of crystal, install two (or more) sockets in parallel. The unit can be assembled in any type of cabinet.

To test a crystal's activity, first plug in a known good crystal, depress push button switch PB1 and note the meter reading. Then install the questionable crystal, press PB1 and note its meter reading; if it's good its output should approximate that of the reference crystal. Take care that you don't compare apples with oranges;

PARTS LIST FOR CRYSTAL ACTIVITY CHECKER

B1—9-volt transistor radio battery
C1—50-pF disc capacitor, 100 VDC or better
C2—0.005-uF disc capacitor, 25 VDC or better
C3—33-pF disc or mica capacitor, 100 VDC or better
D1—Diode, 1N60
M1—Meter, 0-1 mA DC
PB1—Normally open push button switch
Q1—NPN transistor, HEP-50 (Radio Shack 276-2009)
R1—100,000-ohm, ½-watt resistor
R2—10,000-ohm, ½-watt resistor
RFC—2.5-mH RF choke
SO1—Socket to match crystals, see text



the reference crystal should be the exact same type as the crystal to be tested. If good crystals drive the meter off scale, install a 1000-ohm, ½-watt, 10 percent resistor in series with meter M1.

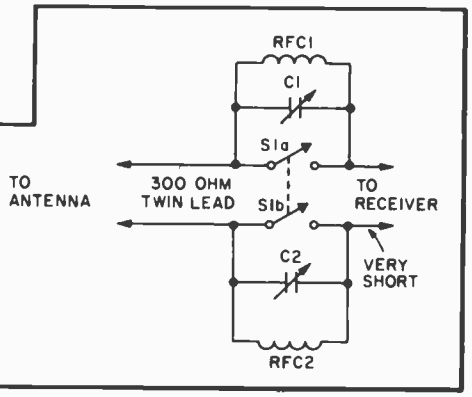
93 FM Overload Filter

☐ A simple filter is all it takes to remove a strong, local FM signal that is blocking or cross modulating other FM stations. The filter connects in series with the FM antenna's downlead. Just be sure to use the shortest possible length between the filter's output and the receiver.

The filter *must* be assembled in a metal cabinet with ¼-in. access holes so you can adjust the trimmer tuning capacitors. The metal cabinet is grounded to the receiver's chassis. Switch S1 by-passes the filter for normal operation. If your antenna's downlead is coaxial cable, only one filter is installed—in series with the center (hot) conductor. To adjust, tune in the offending station and use an insulated alignment screwdriver to adjust trimmer capacitors C1 and C2 for *minimum* signal strength.

PARTS LIST FOR FM OVERLOAD FILTER

C1, C2—40-pF trimmer capacitor
RFC1, RFC2—0.22-uH RF choke, any type
S1—Dpst slide switch
Misc—300-ohm twinlead, metal cabinet

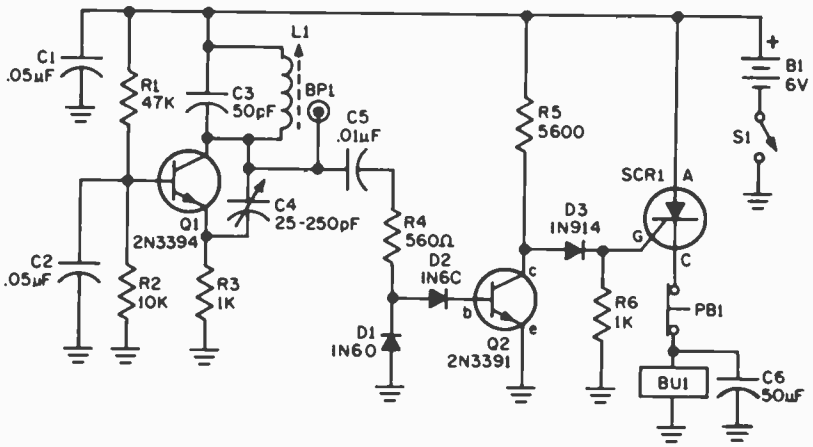


94 Doorknob Security Alarm

☐ Here's security for the traveler. Just connect this alarm to the doorknob of your motel room and a loud buzzer will sound if anyone touches the doorknob.

PARTS LIST FOR DOORKNOB SECURITY ALARM

B1—6-volt battery, Burgess Z4 or equiv.
BP1—Binding post
BU1—6-volt buzzer
C1, C2—0.05-uF disc capacitor, 25 VDC or better
C3—47-pF silver mica capacitor (Allied Electronics 782-0860)
C4—300-pF trimmer capacitor
C5—0.05-uF, 25 VDC capacitor
C6—50-uF electrolytic capacitor, 25 VDC or better
D1, D2—Diode, 1N60
D3—Diode, 1N914



L1—15-uH adjustable RF coil (Miller 4205, or equiv.)
PB1—Pushbutton switch (reset)
Q1—2N3394
Q2—2N3391
R1—47,000-ohm, ½-watt resistor
R2—10,000-ohm, ½-watt resistor
R3, R6—1000-ohm, ½-watt resistor
R4—560-ohm, ½-watt resistor
R5—5600-ohm, ½-watt resistor
S1—Switch, spst (on-off)
SCR1—800-mA/30-V silicon controlled rectifier, HEP R1001

Transistor circuit Q1 is an oscillator with a connection through binding post BP1 to the doorknob. As long as Q1 oscillates, its rectified output is applied to Q2 which holds the SCR1 gate almost at ground potential. When someone touches the doorknob, hand capacitance "kills" the oscillator, thereby removing that cut-off (holding) bias from the SCR1 gate; the SCR conducts and sounds alarm buzzer BU1. The alarm can only be turned off by opening reset switch PB1.

The alarm should be assembled in a small metal cabinet with insulated binding post BP1 at the top. A small wire loop attached to BP1 secures the alarm to the doorknob—the alarm actually hangs on the knob. To adjust, carefully set C4 in small increments until touching your finger to BP1 causes the buzzer to sound. If C4 is overadjusted, hand capacitance will not "kill" the oscillator. Best operation is obtained if the door is made of wood.

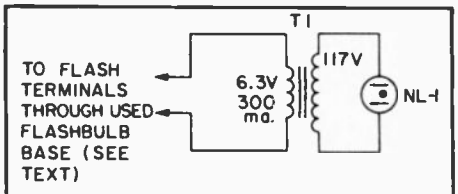
95 Remote Flash Trigger

☐ The way film and flashbulb prices are going these days, if your flash fails to fire you're stuck with almost half a buck in wasted polaroid film, and if you fire a flash to check the flashgun battery you've just burned up at least 25-cents worth of flash. But worse, if the flash fails to fire you might have missed the picture of a lifetime.

You can't check a flash battery with a voltmeter because the meter doesn't apply the heavy surge current needed by the flashbulb, and just about any fully dead battery that isn't leaking acid will check okay when tested without load.

This little flash tester you can probably build from junk-box parts will give you a quick load-check on flashgun batteries. T1 can be any 6.3-volt filament transformer rated from 300-mA up. NL-1 is just about any neon lamp of the NE-2 or NE-86 variety. Solder T1's terminals to those of a used flashbulb or flashcube.

To check the battery, just plug in the flash tester and trip the camera shutter (cover the lens if the camera has film). Lamp NL-1 will flash if the battery is okay (T1 requires a high inrush current, as does the flashbulb).



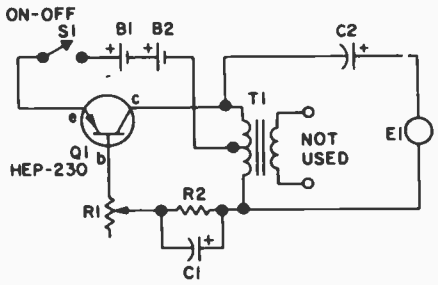
PARTS LIST FOR FLASH TESTER

T1—6.3-volt filament transformer
NL-1—Neon lamp, see text
Misc.—Used flashbulb base.

96 Angler's Bite Booster

☐ Click-click might not sound like much to you but to a fish it's the dinner bell. That's the lure of this electronic circuit. Shove the whole works in a watertight container, lower it over the side, and wait for the fish to hit the hooks.

For proper operation T1 must be subminiature type about half as large as your thumb. E1 must be a crystal headphone.



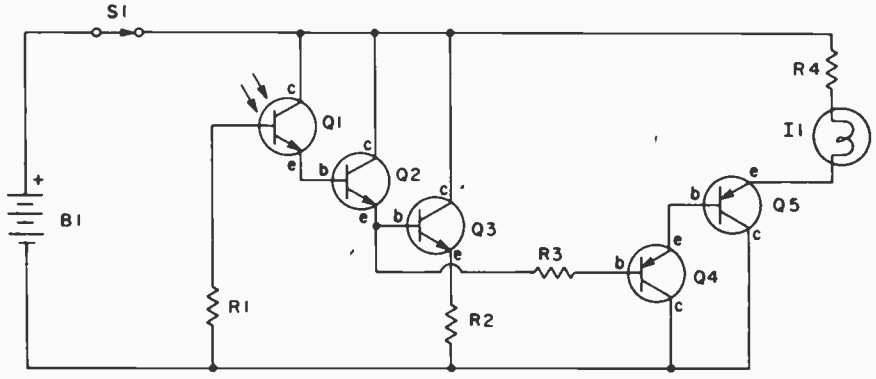
PARTS LIST FOR ANGLER'S BITE BOOSTER

B1, B2—1.5-V AAA battery
C1, C2—50-uF, 12-VDC electrolytic capacitor
E1—Crystal earphone
Q1—Motorola HEP-230 pnp transistor
R1—5000-ohm pot
R2—27,000-ohm, ¼-watt resistor
S1—Spst switch, part of R1
T1—Subminiature transistor output transformer; 500-ohm center tapped primary to 8-ohm secondary

97 Nifty Night Light

☐ It's automatic! Let the face of Q1 get dark, and I1 turns on. Phototransistor Q1 turns on buffer switch Q2-Q3, which activates Darlington switch pair Q4 and Q5 to turn on I1. I1 is current limited by R4 to deliver long life and reduce the circuit's overall current drain.

Don't make the mistake a brilliant engineering school made years ago. They installed a sophisticated system based on a circuit much like this. It was designed to turn their area lights on at dusk, off at sunrise, and had delays built in to keep the lamps from flickering when a cloud, for example, temporarily blocked the sun. The mistake came when they placed the circuit at the bottom of the light poles.



PARTS LIST FOR NIFTY NIGHT LIGHT

B1—9 VDC battery
I1—Bulb, #47-type
Q1—Photoelectric transistor, FPT-100 or equiv.
Q2, Q3—NPN transistor, 2N3904 or equiv.
Q4, Q5—PNP transistor, 2N3906 or equiv.
R1—10-Megohm resistor, ½-watt
R2—1000-ohm resistor, ½-watt
R3—100,00-ohm resistor, ½-watt
R4—27-ohm resistor, ½-watt
S1—SPST switch

The first night, the lights came on fine, but after a delay the circuit mistook them for sunlight and turned them off again. Which started the whole process over and had the campus blinking all night.

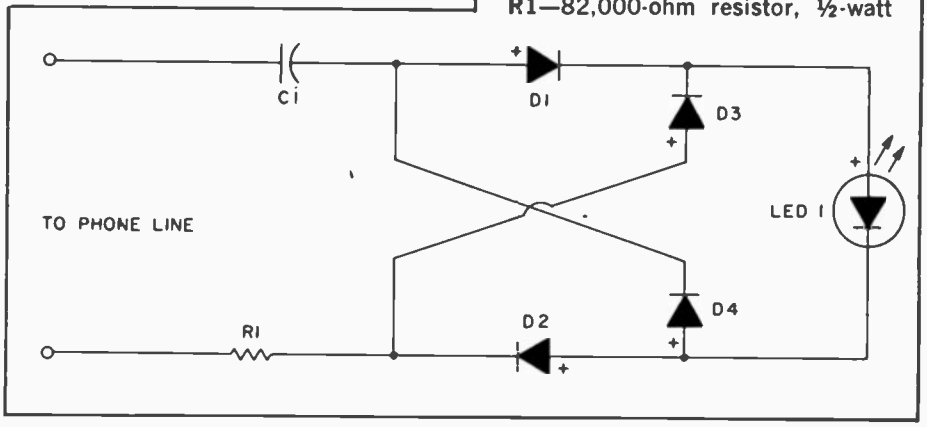
98 LED Telephone Ring Indicator

☐ Know what makes your phone ring? A 20 Hertz AC signal at anywhere from 60 to 120 Volts, depending on your phone company. That same bell-ringing signal can be used to light an LED with the circuit shown here, without significantly loading the telephone line. C1 provides DC isolation to help foolproof this project. The .1 value shown works, but you may want to increase it to .5 microfarads. Use a mylar capacitor (like the Sprague "Orange Drop" series) rated at 250-450 working volts or more.

Why so high? The telephone company keeps its lines clear of ice and trouble by daily sweeping a pulse of high voltage throughout the system. Too low a working voltage could mean trouble for them, and that is absolutely the last thing you want to cause. We might even suggest connecting to the telephone lines only temporarily to verify circuit operation. This will help avoid accidents and trouble. D1 through D4 act as a full wave bridge to deliver the AC ringing voltage as DC to LED1. R1 limits the current through the circuit.

PARTS LIST FOR LED TELEPHONE RING INDICATOR

C1—.1-uF capacitor
D1, D2, D3, D4—Diode, 1N914 or equiv.
LED1—Light emitting diode
R1—82,000-ohm resistor, ½-watt



99 Current Tattletale

☐ Ever have to check a line to see whether or not any current was flowing within it, and which way? Here's an easy answer. Any current flow here will build up a voltage in R1. If the voltage in R1 is more than about 2 volts, one or the other (or both, if AC) of the LEDs will light.

Different systems may require different values for R1. Use Ohm's Law to calculate R1. For example, if we wanted to know whether or not a car's taillight bulb had burned out, we could connect this circuit in series with the lamp's supply lead. Assume the particular lamp requires typically ½ Amp to light. We then need to know what value for R1 will provide a 2 Volt drop.

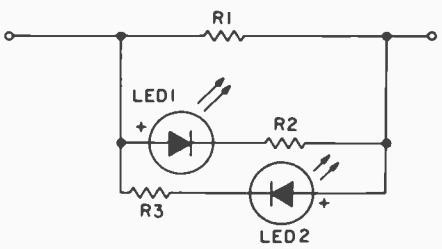
Using Ohm's Law, $E=I\times R$, or $R=E/I=2\div\frac{1}{2}=4$ Ohms (you would want to use a 4 or 5 Watt resistor to comfortably handle this 1 Watt power dissipation).

In a 100 Volt B+ supply drawing 100 ma, $R=E/I=2/.100=20$ Ohms.

The circuit drawn above is sensitive enough to detect a few milliamperes of current flow.

PARTS LIST FOR CURRENT TATTLETALE

LED1, LED2—Light emitting diode
R1, R2, R3—470-ohm resistor, ½-watt

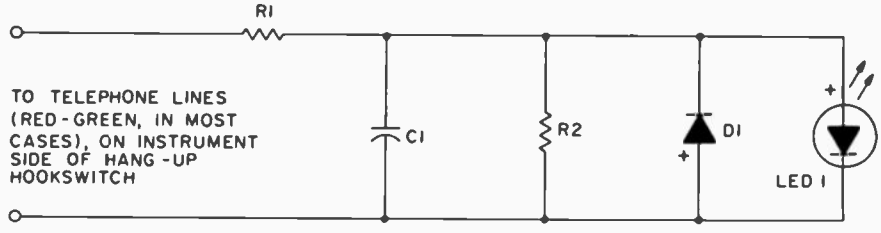


100 Telephone Dialing Blinker

☐ It's fun watching each dial pulse flash the LED on this simple circuit. And it may lead you to experimenting with some remote control ideas. When your phone is off the hook, roughly 50 VDC appears across the phone lines. This is interrupted during dialing, once for each value (for example, 7 times when you dial a

PARTS LIST FOR TELEPHONE DIALING BLINKER

C1—33-uF capacitor
D1—Diode, 1N914 or equiv.
LED1—Light emitting diode
R1—2700-ohm resistor, ½-watt
R2—180-ohm resistor, ½-watt



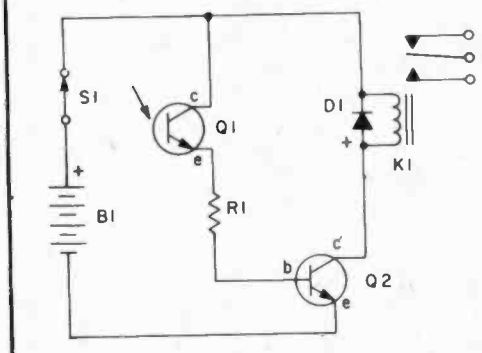
"7") of the number you dial. R1 and R2 act as a voltage divider (and current limiter) to plaec a few volts across LED1. C1 acts as a filter.

Try using LED1 with a photoelectric switch circuit to turn the blinking light back into a digital signal. You can then devise a counter or other device to accept dialing input as data. This can lead to a versatile telephone intercom system, independent of the telephone company's lines and equipment. If you use a lower DC line voltage for your private system, reduce the value of R1 accordingly.

101 Flashlight Remote Control

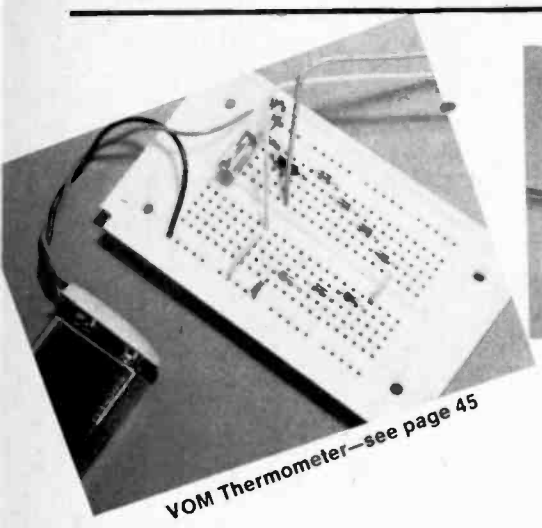
☐ This is the kind of circuit that has always been called a TV commercial killer, but I happen to like TV commercials, so I put it to work doing other things. Whenever a beam from a flashlight hits Q1 (mounted in a short piece of plastic or cardboard tube to keep ambient light from affecting it), it conducts, pulling up the base of Q2. This turns Q2 on and pulls in the relay.

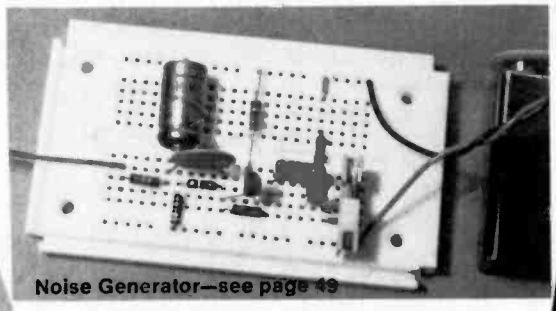
The relay can be hooked to any number of things. You can use it to start and stop a cassette machine, buzz someone into your apartment building, or answer a speakerphone. If you use it to turn on a lamp and let Q1 "see" the lamp, the lamp will stay on until you pass something over the lens of Q1 to shut the light out. Or attach a noisemaker or radio and let it point out your window for an electronic cock's crow that sounds when the sun comes up. ■

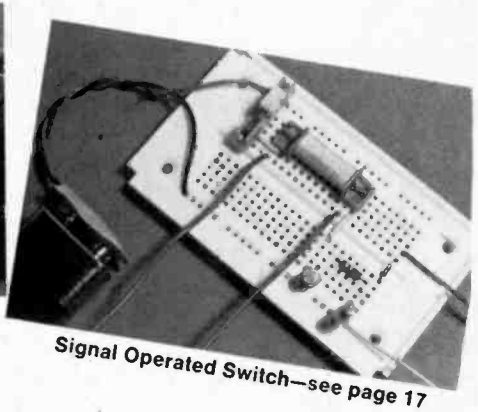


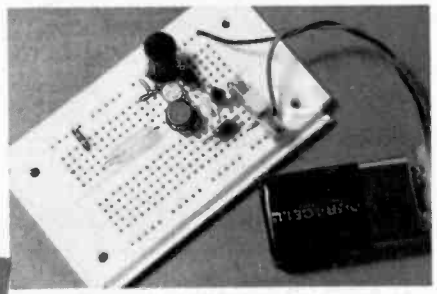
PARTS LIST FOR FLASHLIGHT REMOTE CONTROL

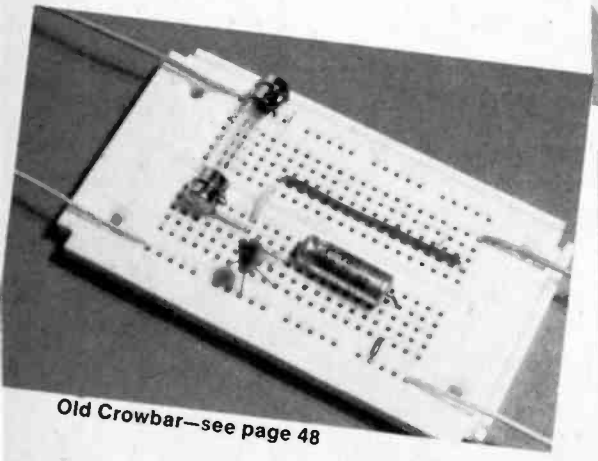
B1—12 VDC battery
D1—Diode, 1N914 or equiv.
Q1—Phototransistor, FPT100 or equiv.
Q2—NPN Transistor, 2N2222 or equiv.
K1—Relay, 12 VDC
R1—2200-ohm resistor, ½-watt
S1—SPST switch

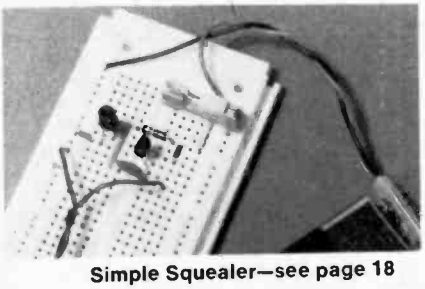


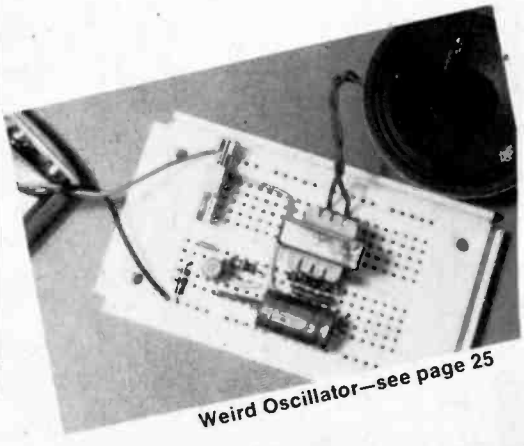












30 INTEGRATED CIRCUIT PROJECTS

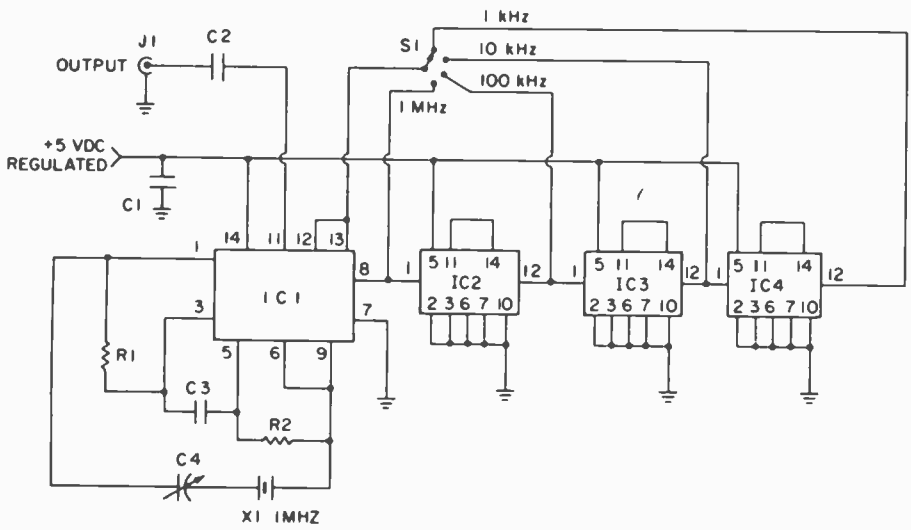
IC1 SWL's Super Calibrator

☐ Providing WWV referenced outputs at 1 MHz, 100 kHz, 10 kHz and 1 kHz, this super calibrator looks quite difficult to assemble, but if you lay it out for a printed circuit board you'll find it's one of the easiest projects to build and get working because there's very little that can go wrong if the ICs and the crystal are okay.

IC1 serves as both the oscillator and buffer amplifier. Another buffer amplifier is used for the output amplifier (terminals 11, 12 and 13), IC1's output at pin 8 is a buffered 1 MHz. ICs 2, 3 and 4 are *divide by 10 frequency dividers* providing outputs of 100 kHz, 10 kHz and 1 kHz. Since all outputs are square waveform, all output signals are rich in harmonics and so can be used to calibrate receiver dials to well above 60 MHz for the 1 MHz output and to at least 30 MHz for the 100 KHz and 10 kHz outputs. The 1 kHz harmonics can range up to 30 MHz depending on your receiver's sensitivity. The calibrator's output at jack J1 can be connected directly to the receiver's antenna input terminals without affecting the calibrator's output frequency.

The unit is set to zero-beat with WWV with trimmer capacitor C4. It can be assembled in any type of cabinet, but a PC board is specifically recommended for circuit stability.

Power must come from a 5-volt regulated source and we recommend the LM340 5-volt three-terminal regulator for this project. Make certain capacitor C1 is installed as close as possible to IC1 pin 14.



PARTS LIST FOR SWL'S SUPER CALIBRATOR

R1, R2—220-ohms, ½-watt, 10%, resistor
C1, C2, C3—0.01-uF, 10-VDC or higher, capacitor
C4—5-50-pF trimmer capacitor
X1—1-MHz crystal, Calectro J4-1900 or equiv.
IC1—Integrated circuit type SN7400
IC2, IC3, IC4—Integrated circuit type SN7490
S1—SP4T switch
J1—Output jack (phono type suggested)

IC2 Lie Detector

☐ When a person is under mental stress one of the physiological changes includes a lowering of the body's skin resistance, and one of the characteristics measured by the modern lie detector is skin resistance.

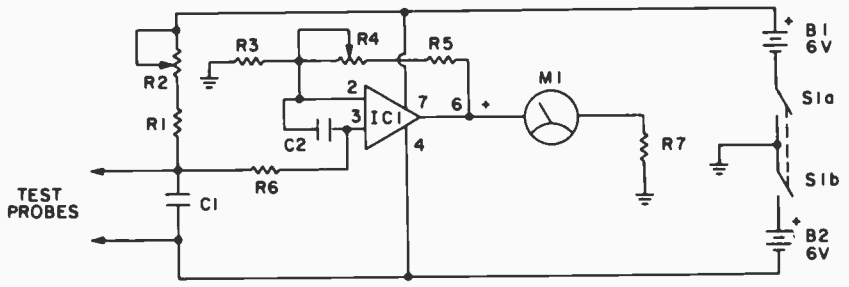
Our "lie detector" works the same way: it measures the body's skin resistance. In typical use you would connect one test probe, actually a length of non-insulated wire taped to the skin, to each hand, arm, or wrist, adjust control R2 for a meter null (zero meter reading), and then ask your questions. If a question causes the subject mental stress you will usually see this stress indicated by an increase in the meter reading.

Potentiometer R4 serves as a sensitivity control. To avoid pinning the meter start with R4 at about the mid position: increasing the resistance increases the gain, while decreasing the resistance reduces the gain and the meter reading.

If you want to avoid taping the probes to your subject you can use

the inexpensive, less-than-$1-a-pair bicycle clips available in most department and sporting goods stores. Solder the test probe wires to the clips and then bend the clips so they hold onto the hand or arm gently but firmly. Wiping the area under the clips with alcohol will improve overall sensitivity.

If long test probes are used, say in excess of 3-feet, shielded wire is suggested, with the shield for each test probe wire connected to the chassis ground—the junction between switches S1a and S1b. You can also use two-wire shielded cable (two wires in one shield) and fan the wires out a foot or so from under the probe end.



PARTS LIST FOR LIE DETECTOR

Resistors ½- or ¼-watt, 10%, unless otherwise specified
R1, R5—10,000-ohms
R2, R4—1-megohm potentiometer
R3, R6—1,000-ohms
R7—560-ohms
C1, C2—0.01-uF, 25 VDC or higher
IC1—Operational amplifier, type 741
S1—Switch, DPST
B1, B2—6 volt battery, Burgess Z4 or equiv.
M1—Meter, 0-1 mA DC

IC3 CB Mobile-to-Base Power Unit

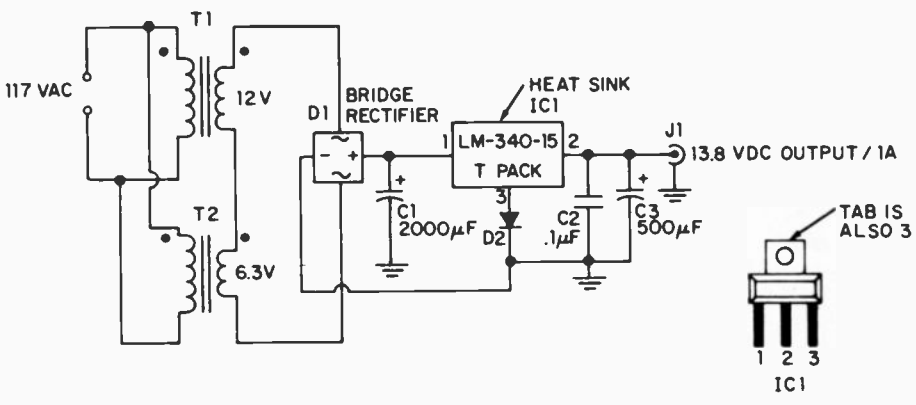
☐ CB mobile transceivers and 3 to 5-watt CB handie-talkies are easily converted to base station operation with this 13.8 volt regulated power unit. Transformers T1 and T2 should be rated 2 amperes. When T1 and T2's secondaries are connected, test the transformer(s) output voltage with an AC voltmeter. If the meter indicates approximately 6.3 volts, reverse the connections of *either* transformer's *primary or secondary*, but *not both*. The meter will then read about 18 VAC. Complete the rest of this project only after you are certain the output voltage from the transformer(s) is about 18 VAC.

IC1 must be heat sinked to the cabinet. Note that IC1's tab is a "hot" terminal; make certain it is insulated from the cabinet with a power transistor insulator or a mica washer. Coat both sides of the insulator (washer) with silicon heat sink grease. And make certain the mounting screw is insulated from the cabinet; use fiber shoulder washers under the screw.

Connect rectifier D2 exactly where shown in the circuit. D2 should be rated at least 50 PIV at 3 amperes. Bridge rectifier D1 is rated 50 PIV at 6 amperes. Do not substitute a 3 ampere bridge rectifier for D1 unless you heat sink it to the chassis. (Heat sinking for D1 is suggested for both the 3 and 6 ampere types.)

PARTS LIST FOR CB MOBILE-TO-BASE POWER UNIT

C1—2000-uF, 25-VDC electrolytic capacitor
C2—0.1-uF Mylar capacitor
C3—500-uF, 25-VDC electrolytic capacitor
D1—Bridge rectifier, see text
D2—Silicon rectifier, 50 PIV, 3 amperes
IC1—Voltage regulator, LM-340-15 (T-package)
T1—12-volt, 2-ampere filament transformer
T2—6.3-volt, 2-ampere filament transformer

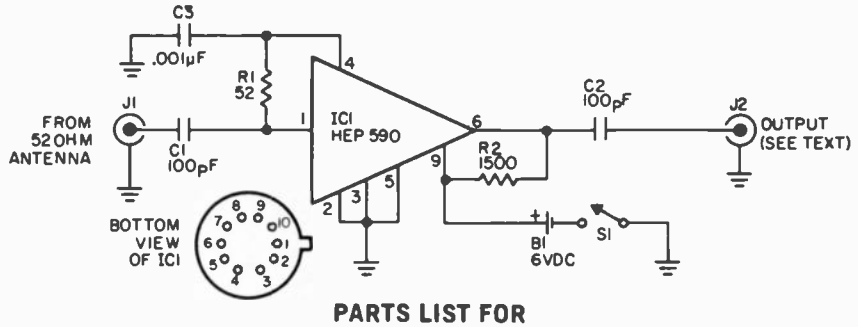


IC4 CB Channel Booster

☐ Connect the CB Channel Puller ahead of a low cost receiver, and you'll hear CB signals as if they were coming from your backyard. Using no tuned circuits, this CB signal booster delivers approximately 15dB overall gain—that's about 3 S-units! Only restriction is that this little rf amplifier be used with a communications-type receiver having an antenna trimmer. It cannot be used in front of a low-impedance-input type

CB transceiver. Seems the low impedance antenna input common to CB units will sharply reduce the booster's gain.

Typical of all RF amplifiers, the booster requires very short connecting leads. In particular, solder capacitor C3 right at pin 4. Integrated circuit IC1 can be soldered directly into the circuit or a socket can be used. Battery B1 is a 6V Z4 type or larger.



PARTS LIST FOR CB CHANNEL BOOSTER

B1–6V battery
C1, C2–100-pF, 15 VDC capacitor
C3–0.001-uF, 15 VDC capacitor
IC1–HEP 590 (Motorola)
J1, J2–Phono or coaxial jack
R1–52-ohms, ½-watt resistor
R2–1,500-ohms, ½-watt resistor
S1–SPST switch

IC5 5V/3A for Digital Projects

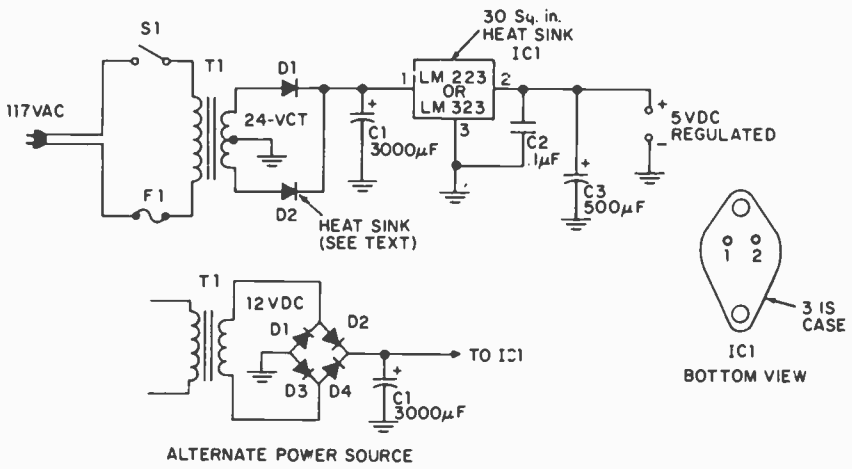
☐ The 5-volt power supply is almost the universal power source for digital projects. Only problem is the 5 volts must be highly regulated, for a power line transient riding through the supply can zap a board full of ICs. This supply gives you full protection against transients, as well as providing tight regulation. The entire regulator is contained in IC1; no other components other than the filter capacitor and rectifier are needed. For full 5 ampere output IC1 requires a heat sink of 30 square inches; but if you use a metal cabinet 3 x 4 x 5 inches or larger the cabinet itself serves as the heat sink. Since pin 3 on IC1 is grounded (to the cabinet), all you need is some silicon heat sink grease between the IC and the cabinet—no insulator.

Power transformer T1 must be rated for the maximum current you will use or need. If you want the full 5 amperes T1 must be rated 5 amperes. But if you will need less current, say 2 amperes, T1 can be rated 2 amperes.

Rectifiers O1 through O2 are available with ratings up to 3 amperes in the standard coaxial mounting. For greater current capacity the rectifiers must be heat-sinked (electrically isolated) to the cabinet, or other sink. A 10-ampere bridge rectifier such as sold by Calectro and Radio Shack can be substituted, but make certain it is heat sinked to the chassis.

PARTS LIST FOR 5V/3A FOR DIGITAL PROJECTS

C1–3000-uF, 25 VDC electrolytic capacitor
C2–0.1-uF Mylar capacitor
C3–500-uF, 10 VDC electrolytic capacitor
D1-D4–See text
F1–¼ ampere, 3AG
IC1–5-volt regulator, LM223 or LM323
S1–Spst slide or toggle switch
T1– see text



IC6 Bi-Polar Power Supply

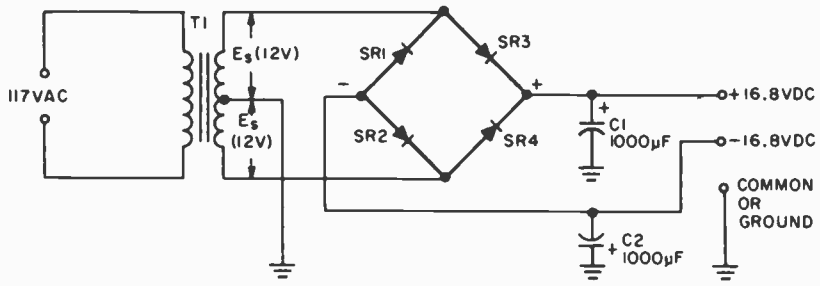
☐ Most IC circuits require a Bi-Polar power supply. That is, a power source with two outputs—one positive with respect to ground and the other negative with respect to ground. A standard bridge rectifier circuit will provide a Bi-Polar output if the transformer's secondary is center-tapped to ground.

Filter capacitors C1 and C2 should be at least 1000 uF (2000 uF preferred) at a voltage rating at least equal to the supply's output voltage.

The supply's output voltage is equal to 1.4 times Es. Voltage Es equals one-half Transformer T1's peak secondary voltage. For example, assume that T1's secondary voltage is 24 volts (rms) center-tapped; the voltage on each side of the center-tap (Es) is 12. The supply's output voltage is therefore 12 x 1.4 or ± 16.8 VDC. Always remember that each Bi-Polar output is derived from half T1's secondary voltage.

PARTS LIST FOR BI-POLAR POWER SUPPLY

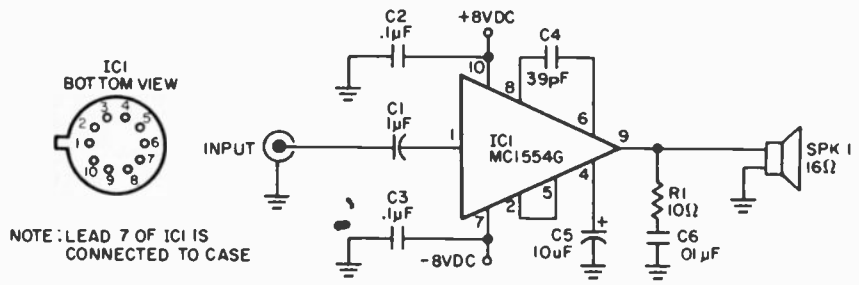
C1, C2—1000 or 2000-uF capacitor at the supply's output voltage
SR1-SR4—Silicon rectifiers PIV rated to at least twice the supply's output voltage
T1—Power transformer with center-tapped secondary (Calectro D1-752)



IC7 Bi-Polar Power Amplifier

☐ It is incovenient when working with IC preamplifiers requiring bi-polar power sources to convert to a single-ended power source for the power amplifier. Our Bi-Polar Amp, however, can be driven from a bi-polar power supply. One of the benefits enjoyed by Bi-Polar Amp is that a large, expensive output coupling capacitor isn't needed. Since the device responds well into the high frequency range, capacitors C2 and C3 must be placed directly at the IC terminals to prevent high frequency oscillation. While capacitor C1 can be an electrolytic type, a non-polarized 1 uF is suggested.

The amplifier's input impedance is 10,000 ohms, a suitable value for solid-state projects. Voltage gain is 36. If less overall gain is required (say, 10X), disconnect pins 2 and 4 and connect pin 5 to ground through capacitor C5.



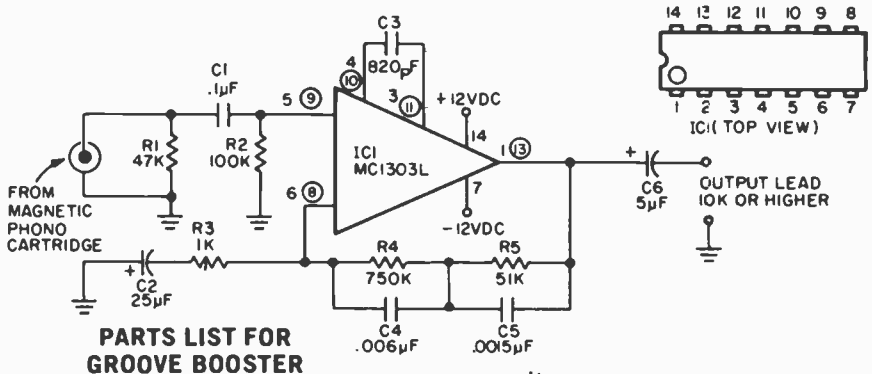
PARTS LIST FOR BI-POLAR POWER AMP

C1—1-uF, voltage rating at least equal to peak input voltage from preceding stage, capacitor
C2, C3—0.1-uF, 10 VDC capacitor
C4—39-pF, 100 VDC cisc capacitor
C5—10-uF, 10 VDC capacitor
C6—0.01-uF, 25 VDC capacitor
IC1—Motorola MC-1554G
R1—10-ohms, ½-watt resistor
SPK1—16-ohm speaker

IC8 Groove Booster

☐ Using a dual operational amplifier IC, the Groove Booster will provide a fully equalized 1 V rms output from standard phono magnetic pickups. The terminal numbers which are circled on the schematic are the connections for one of the two independent stereo amplifiers on the single IC chip.

The uncircled numbers are the terminals for the stereo second IC. Power supply terminals #14 and #7 are common to both stereo amplifiers. Note that the power supply is ±12 volts to ground. Two 6-volt batteries in series can be used for each side of the power supply. If batteries are used, connect 25-uF capacitors from pins 7 and 14 to ground—and get their polarity correct.



PARTS LIST FOR GROOVE BOOSTER

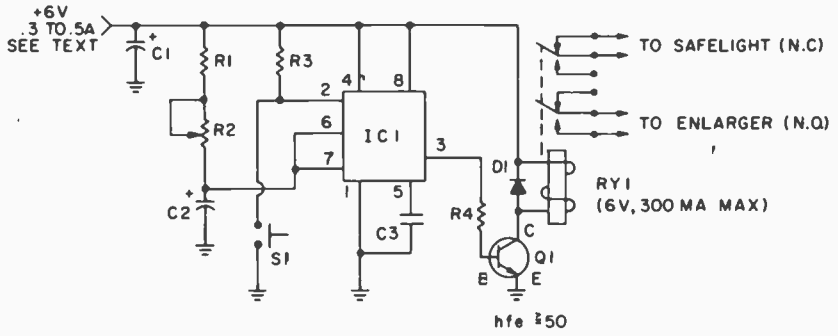
C1—0.1-uF, 3 VDC capacitor
C2—25-uF, 3 VDC capacitor
C3—820-pF, 500V VDC disc capacitor
C4—0.006-uF, 100V VDC disc capacitor
C5—0.0015-uF, 100V VDC disc capacitor
C6—5-uF, 25 VDC capacitor
IC1—Motorola MC1303L
R1—47,000-ohms, ½-watt resistor
R2—100,000-ohms, ½-watt resistor
R3—1,000-ohms, ½-watt resistor
R4—750,000-ohms, ½-watt resistor
R5—51,000-ohms, ½-watt resistor

IC9 Photo Timer

☐ You can spend $50 to $125 for a photo-enlarger timer but chances are you're not going to get more than a fancy version of this easy-to-build circuit. If you use a DPDT relay, as shown, your safelights can be wired to turn on when the enlarger turns off and vice versa.

If R2 is 1-megohm the timer's range is about 1 to 110 seconds. If R2 is 1.5-megohms the timer's range is approximately 1 to 165 seconds. The precise range will be determined primarily by C2's accuracy, so use a reasonably good quality capacitor for C2, but don't get a precision or MIL-spec part; it's not necessary.

If you use a low current relay for RY1, say less than 100-mA at 6-VDC, you can eliminate Q1 and connect the relay directly from IC terminal 3 to ground. If you use a heavy-duty relay, as high as 300-mA at 6-volts, use Q1. The power input should be 6-volts (doesn't have to be regulated) at 300-mA, or 500-mA for a heavy-duty relay. We suggest any popular-brand low cost relay, such as P&B, Magnacraft or Calectro.



PARTS LIST FOR PHOTO TIMER

Resistors ½ watt, 10%, unless otherwise specified.
R1—10,000-ohms
R2—1.0- or 1.5-megohm linear taper potentiometer (see text)
R3—22,000-ohms
R4—560-ohms
Capacitors rated 6-VDC or higher
C1—100-uF electrolytic
C2—100-uF electrolytic (see text)
C3—0.01-uF capacitor
IC1—Integrated circuit timer type 555 (any package)
Q1—NPN transistor, Radio Shack 276-2030 or equiv.
D1—Silicon rectifier, 1N4003, equiv. or higher PIV rating.
RY1—6-VDC relay, see text
S1—N.O. push-button or momentary contact switch.

Potentiometer R2 should be linear taper. After the timer is assembled attach a large pointer knob to R1's shaft, and using an electric clock with a sweep second hand as a reference, calibrate timing control R2.

If the unit is assembled in a metal cabinet use a three-wire linecord to ground the cabinet. If you use an all plastic cabinet with no exposed metal hardware that can be touched you can use a two-wire linecord.

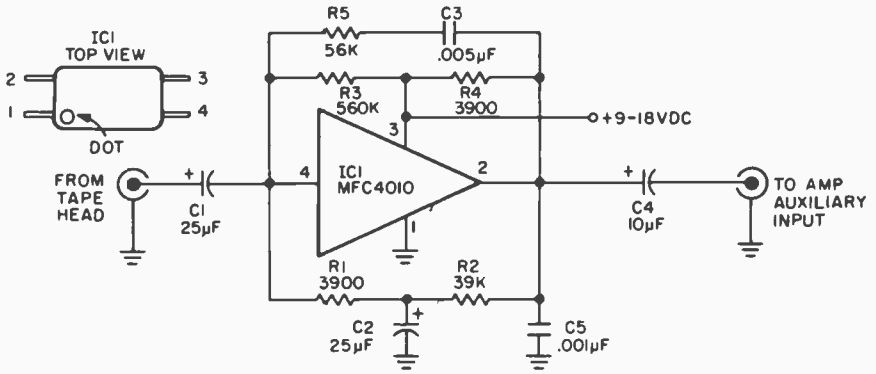
IC10 Bargain Tape Preamplifier

☐ From time to time you'll find bargains at dealers selling tape and cassette deck mechanisms at rock bottom prices—often less than $20! Complete with heads, these decks need only the electronics to get them working. The preamp provides both the amplification and equalization. You can feed its output directly into an amplifier's auxiliary input. Overall frequency response is suitable for cassettes and 3¾ IPS reel-to-reel tapes. Since the actual required equalization is determined partially by the playback head characteristics, it might be necessary to modify or "tailor" the equalization; this is done by small changes in the value of capacitor C3 and resistor R5.

If assembled on a small printed circuit board, the preamp can be tucked under the tape mechanism's base plate. The power supply can be anything from 9 to 18 volts at approximately 3 mA. Transistor type radio batteries will do; if batteries are used they must be bypassed with a 25-uF capacitor. And, be sure you observe proper battery polarity.

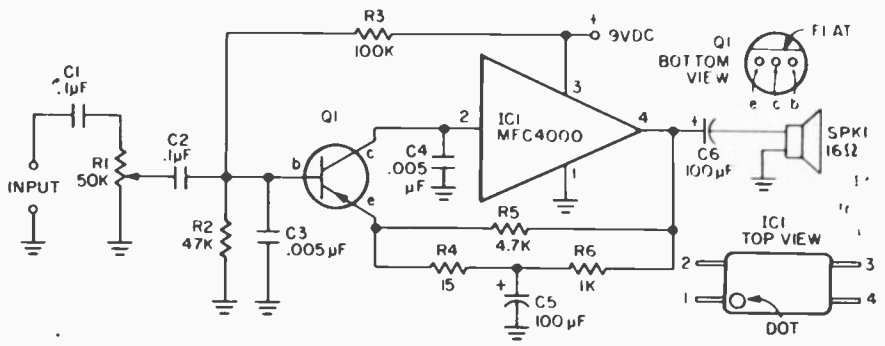
PARTS LIST FOR BARGAIN TAPE PREAMP

C1, C2—25-uF, 6 VDC capacitor
C3—0.005-uF capacitor
C4—10-uF, 20 VDC capacitor
C5—0.001-uF capacitor
IC1—Motorola MFC-4010
R1, R4—3,900 ohms, ½-watt resistor
R2—39,000-ohms, ½-watt resistor
R3—560,000-ohms, ½-watt resistor
R5—56,000-ohms, ½-watt resistor



IC11 Mighty Mite Signal Tracer

☐ Featuring extremely high gain suitable for tracing signals directly from microphones and magnetic pick-ups, our Mighty Mite signal tracer can be made small enough to sit directly on the back of the speaker magnet. Though intended for checking transistor circuits, Mighty Mite 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, Mighty Mite's 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 MIGHTY MITE SIGNAL TRACER

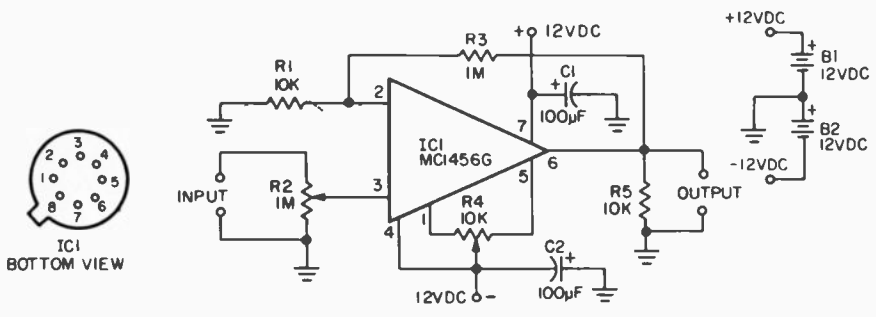
C1—0.1-uF, 600 VDC capacitor (see text)
C2—0.1-uF, 10 VDC capacitor
C3, C4—.005-uF, 10 VDC capacitor
C5—100-uF, 3 VDC capacitor
C6—100-uF, 10 VDC capacitor (250 uF for better low-frequency response with large speakers)
IC1—Motorola MFC-4000
R1—Potentiometer, 50,000-ohms, audio taper resistor
R2—47,000-ohms, ½-watt resistor
R3—100,000-ohms, ½-watt resistor
R4—15-ohms, ½-watt resistor
R5—4,700-ohms, ½-watt resistor
R6—1,000-ohms, ½-watt resistor
Q1—PNP transistor, Radio Shack 276-2021
SPK1—16-ohm speaker (see text)

IC12 100X Instrument Amplifier

☐ When voltages drop too low to be indicated on your scope or VTVM, just connect our 100X Instrument Amplifier ahead of your test gear and you get full-screen or full-scale readings. With an input impedance of 1 megohm, and a flat frequency response from DC to 20 kHz and beyond, the 100X Instrument Amplifier provides a gain of exactly 100 when potentiometer R2's wiper is at the top (full gain).

Connected ahead of a VTVM, the 100X Instrument Amplifier will convert, for example, a 10 mV DC level into 1V. Here's a value that can be read on your VTVM! Similarly, if connected ahead of a scope's vertical input, the amp boosts a signal that will just cause a wiggle on the CRT to almost a full screen trace. The maximum input signal level for undistorted output is 100 mV peak-to-peak. Naturally, higher input signals can be used because of the attenuation provided by sensitivity control R2.

After you've completed the 100X Instrument Amplifier, connect a VTVM across the output, adjust R4 for a zero DC meter reading. From time to time check the DC output; if it has drifted off zero, simply readjust R4. It might happen that changing R2's setting over a wide range might cause the output to drift off zero; if so, simply readjust R4. If you are primarily concerned with AC measurements, the output DC zero drift is unimportant, and a 0.1-uF capacitor can be connected between the 100X and your VTVM or scope.

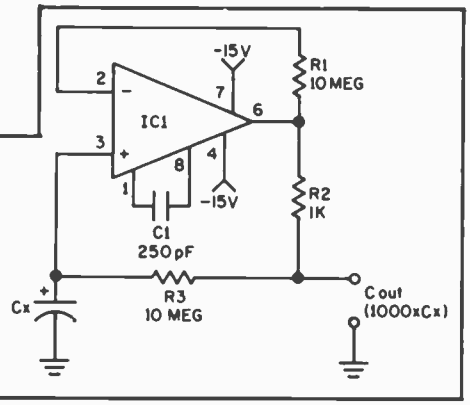


PARTS LIST FOR 100X INSTRUMENT AMPLIFIER

B1, B2—Battery, 12V
C1, C2—100-uF, 15 VDC capacitor
IC1—Motorola MC-1456G
R1—10,000-ohms, ½-watt, 5% resistor
R2—Potentiometer, 1 megohm
R3—1 megohm, ½-watt, 5% resistor
R4—Potentiometer, 10,000-ohms linear taper
R5—10,000-ohms, ½-watt resistor

IC13 C Booster

☐ Suppose you needed a 10,000-*uF* capacitor; do you think it could squeeze on your project's printed circuit board? The answer is yes because it need be no larger than a transistor. By using a capacitance amplifier, the value of any capacitor can be boosted by a factor of 1000X. Capacitor Cx is the value to be boosted; the effective capacity appears at the terminals indicated C. If Cx is 10 *uF* the effective capacity that appears at the output terminals is 1000 x 10 *uF* or 10,000 *uF*. Almost any capacity value can be used for Cx.



PARTS LIST FOR C BOOSTER

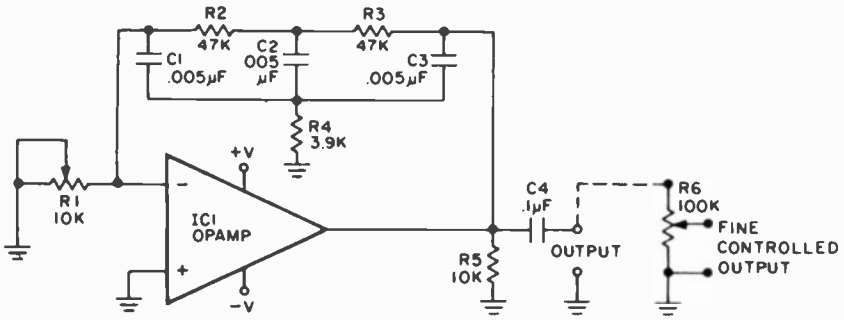
C1—250-pF disc capacitor, 50 VDC or better
IC1—SE537 Integrated Circuit (Signetics)
R1, R3—10-megohm, ½-watt resistor
R2—1000-ohm, ½-watt resistor

IC14 Notch Filter Oscillator

☐ Every experimenter's spare parts box has the necessary components for our Notch Filter 1 kHz Oscillator. It's suitable for testing audio equipment, signal tracing or tape recorder bias adjustments. Integrated circuit IC1 can be just about any operational amplifier sold through "surplus dealers." The 1 kHz "notch filter" from the amplifier output to the inverting or negative (−) input determines the output frequency. Notch Filter Oscillator's non-inverting or positive (+) input is grounded.

The power supply is bi-polar; use any voltage up to ±15 VDC. While resistor R5 is not needed in many instances, its use insures your Notch Filter Oscillator project's success. Potentiometer R1 sets the output level; its maximum value will approach the total power supply voltage. If fine output control is desired, add potentiometer R6.

When your Notch Filter Oscillator is connected to a DC circuit, connect a DC blocking capacitor in series with R6's wiper arm. If the oscillator is to drive circuits of less than 10K ohm impedance, substitute a 1-uF nonpolarized capacitor for C4, rated to the power supply's voltage.



PARTS LIST FOR NOTCH FILTER OSCILLATOR

C1, C2, C3—0.005-uF, 75 VDC capacitor
C4—0.1-uF (see text) capacitor
IC1—741-type operational amplifier
R1—10,000 ohms pot
R2, R3—47,000-ohms, ½-watt resistor
R4—3,900-ohms, ½-watt resistor
R5—10,000-ohms, ½-watt resistor (see text)
R6—Potentiometer, 100,000-ohms, audio taper (see text)

IC15 Electric Butler Intercom

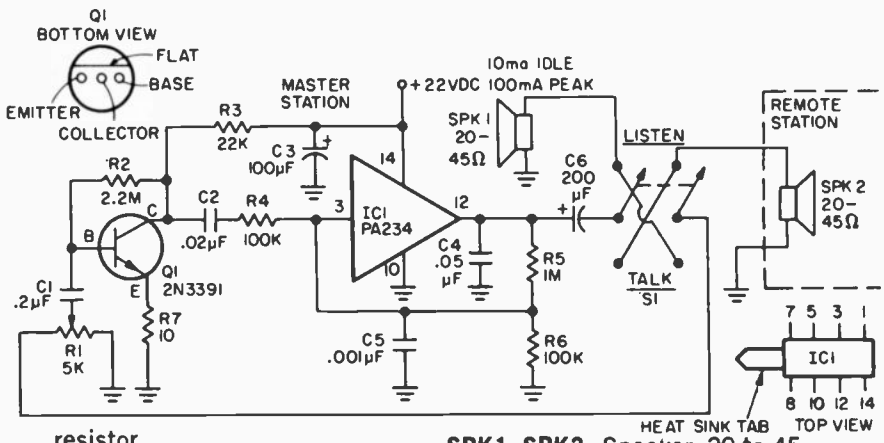
☐ Using a miniature 1 watt IC power amplifier, our Electric Butler provides very high sensitivity and a loud, clean output. Wiring and layout is not critical as long as capacitors C4 and C5 are installed directly at IC1's terminals. Capacitor C6 can be as low as 100 uF if you want to cut costs and are willing to give up a little bass response. While S1 can be a standard DPDT switch, a spring-return type will keep the Master station always monitoring the Remote.

The speakers can be any "intercom type" rated from 20 to 45 ohms. Though miniature 16 ohm speakers can be used, they do not have the power handling capacity of the "intercom" speaker. If there appears to be some high frequency instability, use a shielded wire between S1 and R1; make a single-shield ground at R1.

If an AC power supply is used, it must be rated for at least 100 mA drain. If a battery supply is used, figure the 10 mA idling current; the batteries will be able to deliver the 100 mA maximum output peak current. Solder a 1 inch square tin heat sink to IC1's tab during construction.

PARTS LIST FOR ELECTRIC BUTLER INTERCOM

C1–0.2-uF, 3 VDC capacitor
C2–0.02-uF, 3 VDC capacitor
C3–100-uF, 25 VDC capacitor
C4–0.05-uF, 75 VDC capacitor
C5–0.001-uF, 10 VDC capacitor
C6–200-uF, 25 VDC capacitor (see text)
IC1–General Electric PA-234
Q1–NPN transistor 2N3391 (HEP 726)
R1–Potentiometer, 5,000-ohms, audio taper resistor
R2–2.2 megohms, ½-watt resistor
R3–22,000-ohms, ½-watt resistor
R4, R6–100,000-ohms, ½-watt resistor



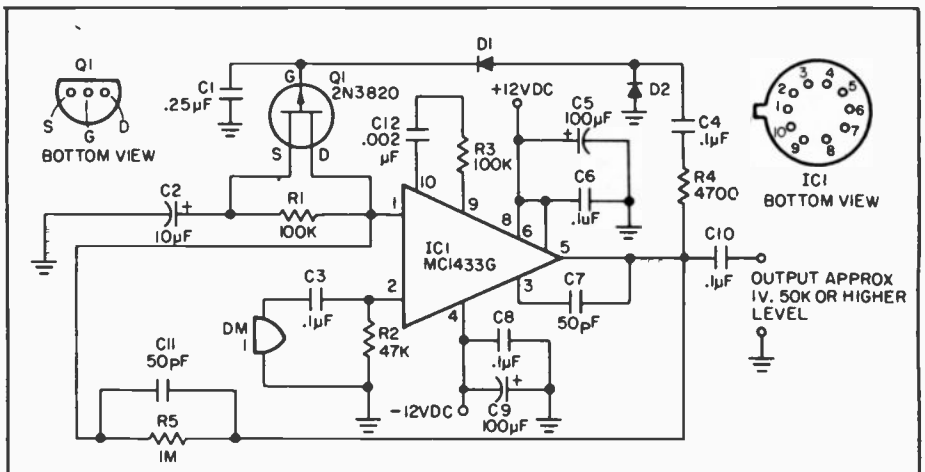
resistor
R5–1 megohm, ½-watt resistor
R7–10-ohms, ½-watt resistor
SPK1, SPK2–Speaker, 20 to 45 ohms, (see text)
S1–Switch, DPDT (see text)

IC16 Ultimate Talk Power

☐ Operating directly from microphone level and providing a nominal 1V output, this compressor delivers 20 dB of compression (essentially distortion-free limiting) and will give ultimate talk-power to P.A. systems and ham or CB transmitters. Fact is, some sideband transmitters might not be able to handle the almost continuous "peak power" output of our compressor!

The only restriction on its use is that the microphone, DM1, must be the dynamic type: any impedance from 50 to 50,000 ohms will work. If DM1 can be permanently connected to the circuit, components R2 and C3 can be eliminated. But they must be used if there is any possibility DM1 will be disconnected. No substitution can be made for transistor Q1.

Capacitors C6 and C8 must be installed directly at the IC terminals for instability suppression. Capacitors C5 and C9 can be installed anywhere that's convenient. A bi-polar 12V supply (well filtered) is required. Power can be provided by batteries (for total hum-free operation) because the current requirement is approximately 15 mA. Any gain controls must come after the output at C10.



PARTS LIST FOR ULTIMATE TALK-POWER

C1–0.25-uF, 10 VDC capacitor
C2–10-uF, 10 VDC capacitor
C3, C4, C6, C8, C10–0.1-uF, 75 VDC capacitor
C5, C9–100-uF, 15 VDC capacitor
C7, C11–50-pF, 75 VDC disc capacitor
C12–0.002-uF, 25 VDC capacitor
IC1–Motorola MC-1433G
R1–100,000-ohms, ½-watt resistor
R2–47,000-ohms, ½-watt resistor
R3–100-ohms, ½-watt resistor
R4–4,700-ohms, ½-watt resistor
R5–1 megohm, ½-watt resistor
DM1–Dynamic microphone (see text)
D1, D2–Germanium diode, 1N60 or equiv.
Q1–FET transistor, type 2N3820 (Texas Instruments)

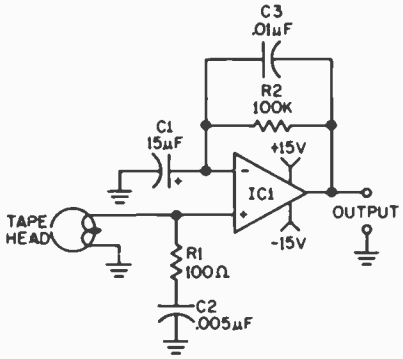
IC17 Tape Head Preamplifier

☐ Is it worth about $20 to have another tape or cassette player? From time to time surplus dealers offer complete tape or cassette mechanisms –everything ready-to-go except for the electronics, and at rock-bottom prices of $10, $15 or $20. All the mechanism needs is this equalized tape head preamplifier. Though the power supply is rated at ±15 VDC, almost optimum results will be obtained with supply voltages as low as ±7 VDC. Two ordinary 9-volt transistor radio batteries will power the preamp for many hours.

The op amp, ICI, is internally compensated and no special wiring practices are needed; the preamp can be built in just about any enclosure, though the connecting wire from the tape head should be shielded. R1 connects to the non-inverting (+) input of the IC, R2 between the output and the inverting (−) input. No pin connections are given because the IC is available in many different pin configurations.

PARTS LIST FOR TAPE HEAD PREAMP

C1—22-uF electrolytic capacitor, 25 VDC or better (Calectro A1-128)
C2—0.005-uF disc capacitor, 25 VDC or better
C3—0.01-uF disc capacitor, 25 VDC or better
IC1—Type 741 op amp
R1—100-ohms, ½-watt resistor
R2—100,000-ohms, ½-watt resistor



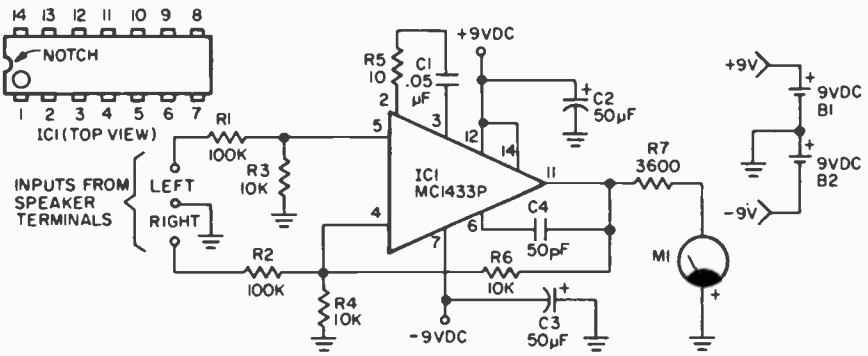
IC18 Stereo Balancer

☐ By comparing the difference between channel outputs when feeding a mono signal, this differential stereo balancer meter allows you to set your stereo amplifier for precise electrical balance. Wiring is not critical; the circuitry can very easily be battery powered using a bi-polar battery connection as shown.

To use, set your stereo amplifier to mono—then adjust the balance control until meter M1 indicates a null (minimum reading). If you cannot obtain a null it indicates there is a phase reversal—which should be corrected—between the signal input and the speaker terminals. This circuit works on the differential principle. When an amplifier is in perfect balance there is no difference in mono output voltage between channels. So our differential amplifier indicates zero difference on the meter.

PARTS LIST FOR STEREO BALANCER

B1, B2—Battery, 9V, type 2U6
C1—0.05-uF, 50 VDC capacitor
C2, C3—47-uF, 50 VDC capacitor
C4—50-pf, 100 VDC capacitor
IC1—Motorola MC-1433P
M1—VU meter (Calectro D1-958)
R1, R2, R6—100,000-ohms, ½-watt resistor
R3, R4—10,000-ohms, ½-watt resistor
R5—10-ohms, ½-watt resistor
R7—3,600 ohms (usually with VU meter) resistor

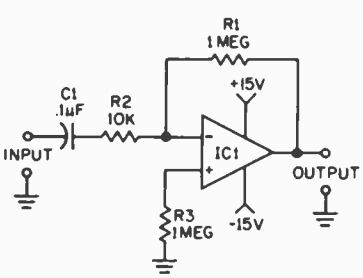


IC19 The Basic Amplifier

☐ This general purpose amplifier features a power gain of 100 (20dB) and can be used as a preamplifier for a microphone, receiver, signal tracer, etc. The IC is internally compensated, providing stable performance with a flat frequency response to about 10 kHz with a gradual roll-off to 20 kHz. The overall gain can be reduced to 10 by increasing the value of R2 to 100,000-ohms. IC1 is available in several different packages; use the one most convenient for your particular component layout. R3 connects to the non-inverting (+) input of the IC, R1 between the output and the inverting (−) input. No pin connections are given because the IC is available in many different configurations.

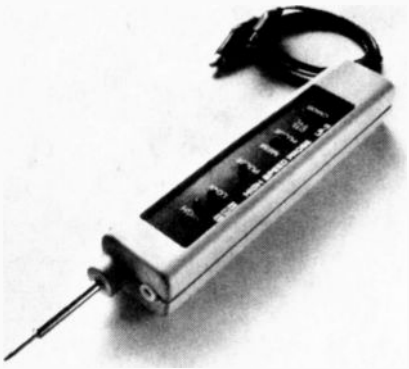
PARTS LIST FOR THE BASIC AMPLIFIER

C1—0.1-uF Mylar capacitor, 25 VDC
IC1—Type 741 operational amplifier
R1, R3—1 megohm, ½-watt resistor
R2—10,000-ohm, ½-watt resistor, (see text)



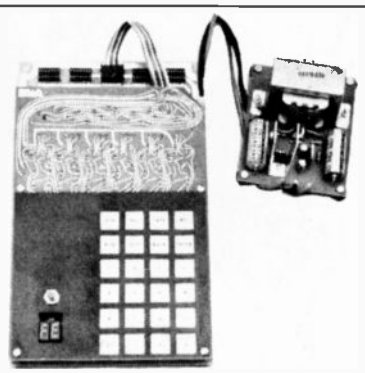
COMPUTER NEW PRODUCTS

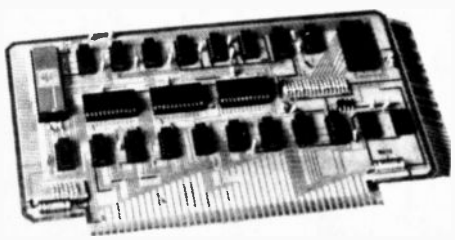
Here in one place the editors of 101 ELECTRONIC PROJECTS present for you the latest in home and hobby computers



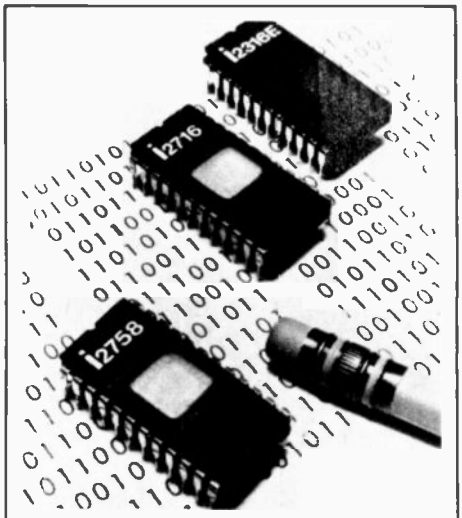
High Speed Logic Probe—Continental Specialties claims to have broken a speed limit with this LP-3 High Speed Logic probe which is capable of detecting pulses as fast as 10 nanoseconds. The pulse detector can read both positive and negative-going leading edges. The pulse stretcher then lengthens the pulse to a tenth of a second. A single pulse causes a single blink of the Pulse LED. A pulse train causes it to flash at a 10 Hz rate. With the Pulse/Memory switch in the memory position, a pulse will latch the LED on indefinitely. The high and low LEDs may also come into play during pulse trains, permitting an easy estimation of the pulse duty cycle. High and low logic states are read independently by separate dual threshold window comparators to permit full logic state analysis. A slide switch selects suitable threshold levels for either TTL/DTL or CMOS/HTL logic families. Since power is derived from the circuit under test, no phantom logic state readings are possible. Input impedance is 550K, and input is protected against 117VAC overloads for up to 15 seconds. Interchangeable power leads and replaceable probe tips and accessories are available. Price of the LP-3 is $69.95. Circle 57 on Reader Service Coupon.

Power Supply/CPU Board—PAiA Electronics' 8700 Computer/Controller, an OEM micro-processor development system, is based on the popular 650X family of processors. Its fully socketed, plated through board provides space for 1K bytes of RAM in 256 byte increments (2112) and 1K bytes of PROM also in 256 byte increments (2112), five 8-bit parallel input ports and one 8-bit parallel output port. Several connectors are for system expansion and the implementation of more complex I/O structures. A unique microdiagnostic feature provides simple system check-out by floating the MPU data buss while forcing the execution of an address-incrementing NOP instruction. The PAiA 8700 is available in kit or assembled form at prices starting at $90. Currently available options include a PS-87 Power Supply priced at $24.95 (shown), and CS-87 Cassette Interface ($22.50) which also provides on-board software and hardware relay drivers for tape motion control. A variey of low-cost (under $40) video display options for the 8700 including 80 x 16 Upper and Upper/Lower case ASCII and 128 and 256 color and B/W graphics displays are scheduled for near-future release. Circle 55 on Reader Service Coupon for more information about this product from PAiA Electronics.

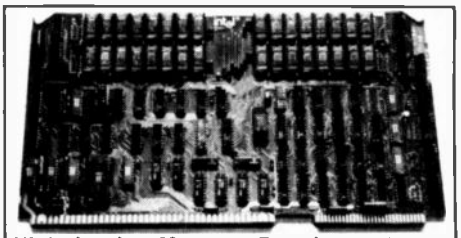




Math Board—Developed by Petrotech Lavalin and available from Woodtron Ltd. in Canada or La Porte Electronics in Texas, this math board reduces the size of RAM required to compute standard math functions and operates with microcomputers such as the Motorola M6800 or Intel 8080. That math board operates as a block of memory occupying 16 address states which are on board selectable. Functions carried out on the math board are trigonometric, logarithmic, e^x, square roots, and many more. In addition, 16 address and eight data line boosters are provided along with two RS 232 receiver channels. These boards are available in kit form, which consists of printed 9¾-in. x 5½-in circuit board, instructions, and a software package of input-output routines for an M6800. Price: $72.80. Circle 50 on Reader Service Coupon for more information about this product from Petrotech Lavalin.



5-Volt, 8K EPROM—Intel's 2758 5-volt, 8-kilobit EPROM (erasable programmable read-only memory) is claimed to provide significant advantages in microcomputer system designs. Operation on a single +5-volt TTL power supply eliminates special MOS supplies from systems based on 5-volt microprocessors, and also minimizes costs in other systems. The 2758 is directly upgradable to 16K masked ROM. There's complete freedom to change system storage capacity in 1K-byte increments with no design changes. Reduced power and cooling costs because the 2758 reduces active power dissipation by more than fifty percent, and a new standby mode can be used to reduce dissipation by more than eighty percent. Programming rates two to 2,000 times faster, depending on the number of bytes stored at a time. Easily programmed in a system; this feature can be used in new designs to save socketing and to automate updates of programs. The 2758 stores 1024 x 8 bits (1K byte), is TTL-compatible in all modes—active operation, standby and programming—and has a maximum access time of 450 nanoseconds. Price: $40. Circle 48 on Reader Service Coupon for more information from Intel about this product.



High-density Memory Boards—Intel has come up with three Multibus high-density memory expansion boards for SBC-80 single board computers. Designated as SBC 032, SBC 048 and SBC 064 RAM Memory Expansion Boards, they respec-

(Continued on page 117)

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CB NEW PRODUCTS

101 Electronic Projects looks at some of the newest transceivers, antennas and accessories for you to use in CB contacts this year!

Voice Activated CB Headset

For use with any two-way communications system, Speak Easy is easily installed in home or vehicle CB rig. With Speak Easy you no longer have to hold and key a microphone to be heard. Simply speak and it will automatically transmit your message. A powerful miniaturized pre-amp delivers your voice to its destination. Dual red/green LEDs tell you when you're on the air. Fully adjustable sensitivity gives you total sound control. Speak Easy comes with two

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miniaturized microphones built in to boost modulation and effectively eliminate background noise. Made with a durable and lightweight aluminum boom mike, Speak Easy is both rugged and comfortable. Suggested retail price is $79.95. For more information, write to Chase Westerr. Product Sales, 11526 Burbank Blvd., Suite 17, North Hollywood, CA 91601.

Silent Vehicle Alarm

The Page Alert 101 Silent Vehicle Alarm alerts you with a pocket pager "beep beep" signal when your mobile CB rig, or even your car, is in the process of being ripped off. The system consists of a small transmitter that sends out an individually coded radio signal when the doors, hood or trunk of your vehicle are opened. This signal is received by a small pocket pager, much like the kind doctors use, conveniently worn on your belt or carried in your pocket or purse. A "crime-in-progress" telephone call can be made to the police after hearing your pocket pager's warning "beep." The

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Page Alert 101's pocket pager can be carried more than ½ mile from the vehicle. No special installation beyond the usual car alarm system is required to install the Page Alert 101 transmitter. The solid-state transmitter is powered by the vehicle's 12-volt battery and the pocket page uses batteries. There are over 60,000 individual tone codes so that there is no chance of another transmitter signalling the wrong receiver. Although compatible with any existing horn or bell audible alarm, used alone the Page Alert 101 is a silent vehicle alarm device. The complete Page Alert 101 (sells for $189.50) along with installation accessories is available from Page Alert Systems, Inc., 23840 Madison Street, Torrance CA 90505.

Absorbtive TVI Filter

The CPI FL-1, according to the manufacturer, attenuates all 27 MHz harmonic frequencies by 90 dB or better, without troublesome tuning for optimum harmonic rejection. The FL-1 has up to 10 watts power dissipation capability, so all CB harmonics will be absorbed rather than reflected back to the transceiver where they could radiate off the coaxial

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cable or from the set. The unit has a power-through rating of 650 watts. In addition, the TVI filter also serves as an antenna-transceiver matchbox. Input and output tuning controls in the CPI FL-1 filter will match a 3:1 antenna SWR down to 1:1 at 50 ohms. Insertion loss is reduced to only 0.3 dB. Priced to sell at $49.95. Further information on the CPI FL-1 TVI filter, and the complete line of the company's high technology, American-made communications gear, is available from Communications Power, Inc., 2407 Charleston Road, Mountain View, CA 94043.

Magnetic Mount Antenna

A new, 40-channel mobile CB antenna system has been announced by Avanti Research & Development, Inc. Featuring a powerful magnetic mount for roof or trunk locations. Model AV-727 permits instant removal for hideaway or car wash. A mylar pad protects the vehicle finish. Other features includes a hermetically sealed coil to maintain antenna im-

CIRCLE 51 ON READER SERVICE COUPON

pedance and eliminate internal surface leakage, a ribbed base to provide a long leakage path, and a 48-in. whip. The system, complete with an 18-ft. coaxial cable, is priced at $32.95. Avanti Research & Development, Inc., 340 Stewart Avenue, Addison, IL 60101.

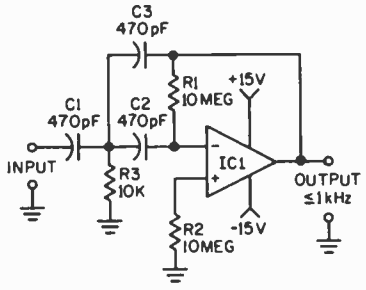
All Stainless Steel Bumper Mount

"Bumper Mate" (Model #HWM-19) is another new addition to the line of CB antennas and accessories from Anixter-Mark. The makers says that this is the first all stainless steel antenna bumper mount. Motorists can not only put an end to rusty bumper mounts, but this mount will probably outlast chromed bumpers. It's fully adjustable and fits practically all bumpers. The perforated strap allows the antenna mount to be placed anywhere on the bumper. The full adjustment allows compensation for the angle of the mounting surface of the bumper. Clamp the mount on any bumper, tighten the bolts and it's ready to go. The Anixter-Mark "Bumper Mate" will accept any antenna with a ⅜-[illegible]24

(Continued on page 114)

IC20 Versatile Hi-Pass Filter

☐ A high pass filter is a handy device to have around. Depending on the corner (turnover) frequency you select it can serve as a hum filter, distortion meter or highly-selective audio equalizer. The values of C1, C2, C3 and R1 provide a corner frequency of 1000 Hz. The IC has internal compensation so special wiring techniques are unnecssary. No pin connections are given because the 741 IC is available in many different pin configurations. Check the manufacturer's specs for the particular IC used. R2 connects to the non-inverting (+) input of the IC, R1 between the output and the inverting (−) input.



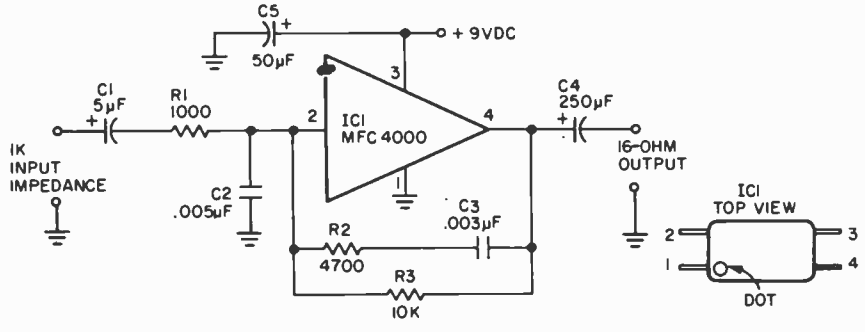
PARTS LIST FOR VERSATILE HI-PASS FILTER

C1, C2, C3—470-pF, disc capacitor, 50 VDC or better
IC1—741-type operational amplifier
R1, R2—10 megohms, ½-watt resistor
R3—10,000-ohms, ½-watt resistor

IC21 Cigar-Size Amplifier

☐ Using an IC no larger than a fly, Cigar-Size Amplifier delivers almost 250 mW into a 16-ohm speaker. A 50 mV input signal coming from a source whose output impedance is 1000 ohms or lower is required for maximum output. The power supply can be a 9 volt type 2U6 battery; the idling current is no higher than 6 mA. Best way to keep things small is to use a printed circuit board assembly or a mini-mount as shown.

Cigar-size amplifier can serve as a general utility amplifier for checking out low-level audio projects, or it can serve as a monitoring amplifier for tape and cassette decks.

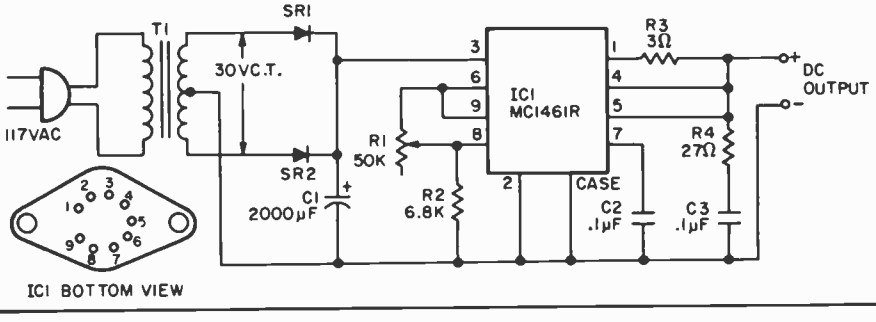


PARTS LIST FOR CIGAR-SIZE AMPLIFIER

C1—5-uF, 10 VDC capacitor
C2—0.005-uF, 10 VDC capacitor
C3—0.003-uF, 10 VDC capacitor
C4—250-uF, 10 VDC capacitor
C5—50-uF, 10 VDC capacitor
IC1—Motorola MFC 4000
R1—1,000-ohms, ½-watt resistor
R2—4,700-ohms, ½-watt resistor
R3—10,000-ohms, ½-watt resistor

IC22 Protect-A-Volt

☐ A simple turn of a knob sets Protect-a-Volt's output voltage anywhere in the 3 to 20-volt range—and with full short circuit protection! Should there be a wiring error in the powered project, this supply automatically



PARTS LIST FOR PROTECT-A-VOLT

C1—2000-uF, 25 VDC capacitor (see text)
C2, C3—0.1-uF, 75 VDC disc or Mylar capacitor
IC1—Motorola MC-1461R
R1—50,000-ohms pot
R2—6,800-ohms, ½-watt resistor
R3—3-ohms, ½-watt resistor
R4—27-ohms, ½-watt resistor
SR1, SR2—Silicon rectifier, 50 PIV, 1A
T1—Power transformer; 117 VAC primary, 30 VC.T.: 200 mA secondary (see text)

shuts down the output voltage until the overload is removed. The maximum output current (short circuit protection) has been established by resistor R3's value to 200 mA. Power transformer T1's rating should not exceed 200 mA as extra current capacity could not be handled by the integrated circuit.

To make this project easy to build, and to sharply reduce total cost, it was necessary to eliminate a fully off, or zero output, setting for Voltage Adjust control R1. The minimum output voltage is 3V. The maximum voltage from T1's secondary must be 30V rms if the secondary is center-tapped; 15V rms if there is no center-tap and a bridge-rectifier is substituted for silicon rectifiers SR1 and SR2. Capacitor C1's voltage rating must be 25 volts minimum. Do not eliminate high-frequency-compensation network components R4/C3.

IC23 Hi-Level 4-Channel Mixer

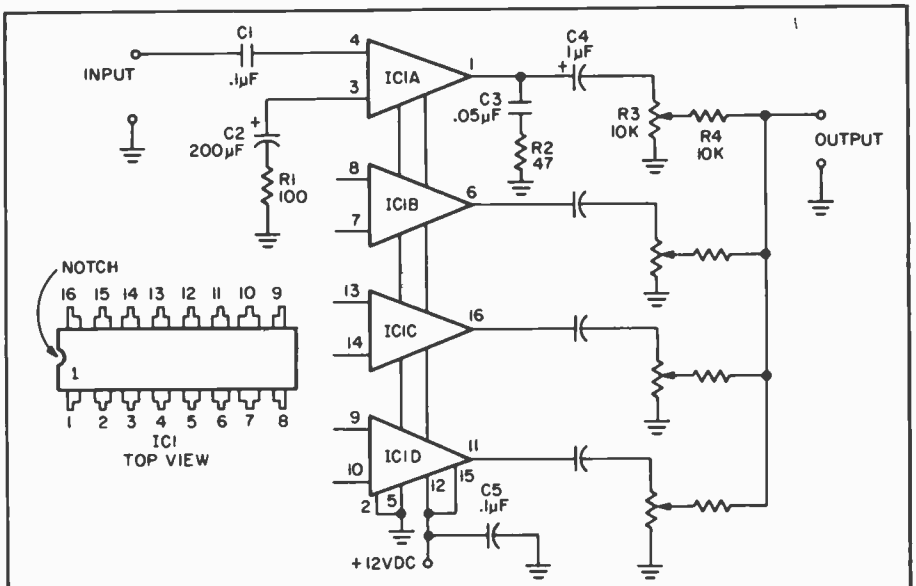
☐ Best signal to noise ratio in a microphone mixer is always obtained if amplification is provided ahead of the loss in the mixer network. You can easily put this idea to work with our mixer—a full-fidelity, professional-grade microphone mixer that contains four independent amplifiers within the integrated circuit.

For simplification, our schematic shows only the connections for one of the four amplifiers; the others are identical to the first.

Note that the power supply is a single-ended 12 VDC (negative grounded); it must be well filtered, or, use a battery supply. The current requirements are approximately 30 mA total. The power supply is internally connected to the amplifiers.

To prevent high frequency oscillation, components C3, R2 and C5 must be installed directly at the IC's terminals.

Any 50 to 50,000 ohm dynamic microphone can be used. However, crystal and ceramic mikes won't work with Pro-Mix; the medium impedance IC's medium input impedance will excessively load down a high impedance mike, resulting in sharp, low-frequency attenuation.

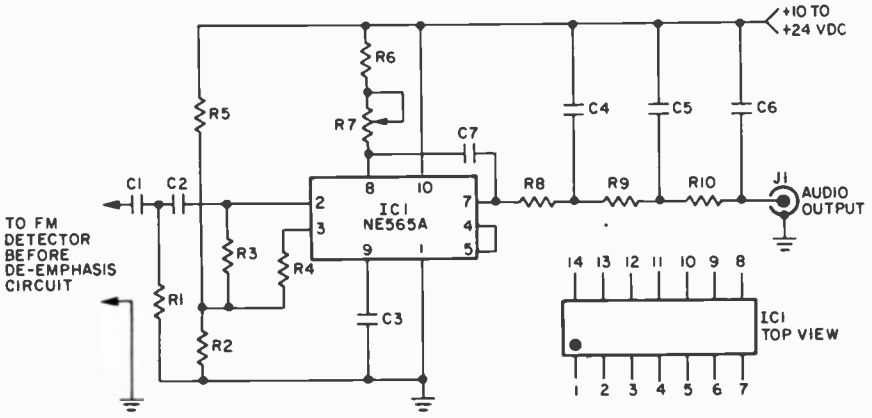


PARTS LIST FOR HI-LEVEL MIXER

C1—0.1-uF, 3 VDC capacitor
C2—200-uF, 3 VDC capacitor
C3—0.05-uF, 75 VDC disc capacitor
C4—1-uF, 15 VDC capacitor
C5—0.1-uF, 15 VDC capacitor
IC1—RCA CA 3052
R1—100-ohms, ½-watt resistor
R2—47-ohms, ½-watt resistor
R3—Potentiometer, 10,000-ohms audio taper
R4—10,000-ohms, ½-watt resistor

IC24 SCA Adaptor

☐ This simple but very effective SCA Adaptor can be assembled on a section of perfboard about 2-in. x 3-in. in size. All components should be firmly soldered to push-in terminals.



PARTS LIST FOR THE SCA ADAPTOR

C1, C2—510-pF, 500 VDC ceramic disc capacitor
C3, C7—0.001-uF, 75 V Mylar capacitor
C4, C6—0.018-uF, 500 VDC ceramic disc or Mylar capacitor
C5—0.047-uF, 75 VDC Mylar capacitor
IC1—Signetics NE565A
J1—Phono jack
R1, R2, R3, R4—4700-ohm, ½-watt resistor
R5—10,000-ohm, ½-watt resistor
R6—1800-ohm, ½-watt resistor
R7—5000-ohm potentiometer
R8, R9, R10—1000-ohm, ½-watt resistor

The input *must* connect to the FM receiver's detector output before the de-emphasis network. The SCA output at J1 can be connected to any relatively high-gain amplifier—the output level is about equal to that of a crystal microphone.

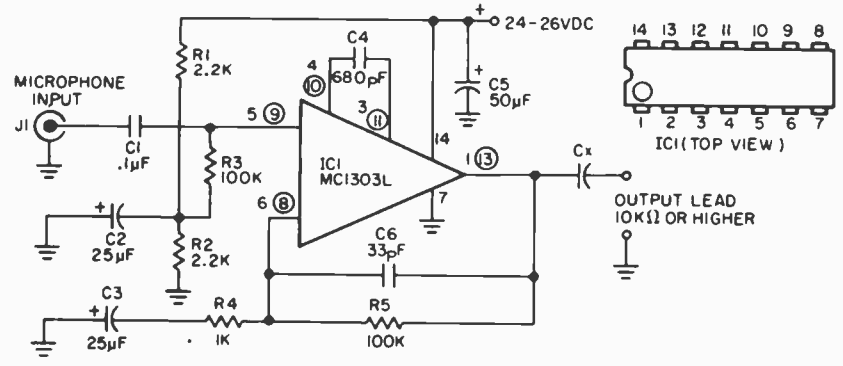
The FM receiver must be tuned to a station you know has SCA programming. Then adjust potentiometer R7 for a clean SCA audio output. Potentiometer R7's adjustment is not critical—the subcarrier is pulled in when R7's adjustment is near the correct setting. A metal cabinet is suggested. If desired, a *pre* de-emphasis output jack can be installed on the FM receiver or tuner so that the normal (after de-emphasis) output can feed the hi-fi system independent of the SCA output.

IC25 Stereo Mike Preamplifier

☐ A dual IC gives hi-fi amplification for a stereo microphone pair. Low distortion and full-fidelity frequency response characterize this mike preamp. With resistors R1 and R2 providing a center-tap for the power supply, the IC can be powered from a standard single-ended power supply, or series connected batteries.

Be very careful to observe the correct polarity for capacitors C2 and C3. In the event the unit motorboats (low frequency oscillation), install a 0.1 uF capacitor from pin 14 to ground.

The connections for one of the two amplifiers is shown circled; the connections for the second amplifier are uncircled. Pins 7 and 14 are common to both amplifiers. Capacitor Cx's value is determined by the load impedance. It should be of such value as to provide the desired overall low frequency response; 0.1 uF is suggested for high impedance output loads (100K and higher), while 10 uF is suggested for low impedance loads.



PARTS LIST FOR STEREO MIKE PREAMP

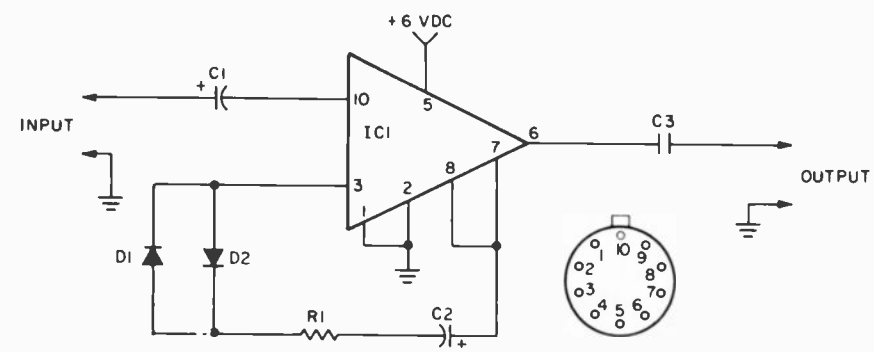
C1—0.1-uF, 100 VDC capacitor
C2, C3—25-uF, 25 VDC capacitor
C4—680-pF disc capacitor
C5—50-uF, 25 to 50 VDC capacitor
C6—33-pF disc capacitor
Cx—See text
IC1—Motorola MC1303L
J1—Microphone jack
R1, R2—2,200-ohms, 5% resistor
R3, R5—100,000-ohms resistor
R4—1,000-ohms resistor

IC26 Comm-Press Log Amplifier

☐ A log amplifier is a device that takes a large change in input signal and converts it to a small change in output. Hook one into a communications system and both low and loud sounds come out at almost the same level giving you a lot more talk power; it sounds just like the hard-sell commercials on TV. The input level should be about 0.1 volt peak for an output voltage of about 1 volt peak.

Since this is a high frequency device, lead dress and good power supply bypassing at the power supply terminals are required. Keep the ground leads short. If a microphone preamplifier is used before the log amplifier, connect a volume control before the log amp's input.

Some experimentation will be needed for optimum P.A. operation. Because of the much higher average voice power, a P.A. system using a log amp compressor might appear to be more sensitive to acoustic feedback (howling). Actually, you will have much more voice output before the howling starts.



PARTS LIST FOR THE COMM-PRESS LOG AMP

C1—1-uF, 6 VDC electrolytic capacitor
C2—10-uF, 6 VDC electrolytic capacitor
C3—0.1-uF, 75 VDC Mylar capacitor
D1, D2—Diode, Silicon, 1N914
IC1—Signetics SE501
R1—510-ohm, ½-watt resistor

IC27 Porta-Groove Amplifier

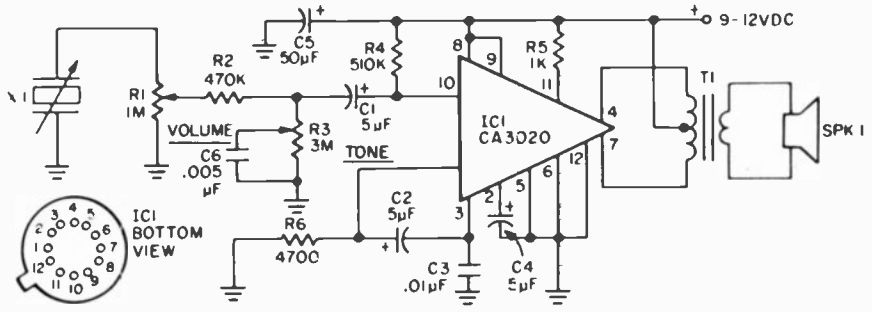
☐ Just add a battery-powered motor to our Porta-Groove Amp, and you've made a portable phonograph of considerably better quality than you can buy. Phono pickup X1 must be the ceramic type—either the usual high impedance or so-called low impedance (actually several thousand ohms) ceramic type can be used.

Transformer T1 should have a primary impedance anywhere from 150 to 300 ohms center-tapped. The secondary should match the speaker impedance. Do not use a sub-miniature T1; for good sound quality T1 must have sufficient "iron," so make certain it can handle approximately 25 mA average current.

A 6-inch speaker will deliver remarkably good sound quality, at least the equal of a good quality table radio. Two 6V lantern batteries or eight D cells easy give Porta-Groove Amp enough oomph. Do not use C or AA cells; they cannot give even reasonable life with the 20 mA idling drain, 140 mA peak power drain.

PARTS LIST FOR PORTA-GROOVE AMP

C1, C2, C4—5-uF, 6 VDC
C3—0.01-uF, 10 VDC
C5—50-uF, 15 VDC
C6—.005-uF, 15 VDC
R1—Potentiometer, 1 megohm audio taper
R2—470,000-ohms, ½-watt resistor
R3—Potentiometer, 3 megohms
R4—510,000-ohms, ½-watt resistor
R5—1,000-ohms, ½-watt resistor
SPK1—Speaker, 3.2, 4 or 6-8 ohms
T1—Output transformer, 150 to 300 ohms center-tapped primary coil to speaker impedance (see text) (Calectro D1-729 or equiv.)
IC1—RCA CA3020 or CA3020A
X1—Ceramic phono pickup (see text—Calectro S2-288 or equiv.)

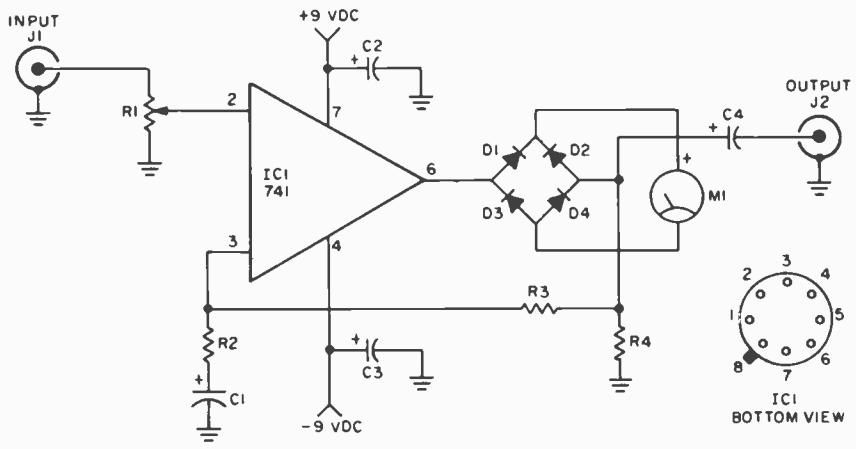


IC28 Record Remote Amplifier

☐ Here's a professional performance record remote amplifier suitable for the hobbyist, amateur recordist or professional broadcast engineer. The input is any microphone with an output impedance up to 50,000 ohms, or for professional use, the input can be at line level. Output is 500-ohms at line level with a bulit-in VU meter indicating output level. When the distance between the remote amplifier and its associated equipment is less than 25 feet the amplifier can be connected to any hi-fi type, high impedance input (10,000-ohms or higher).

For long line or professional applications, connect a 500/500 line matching transformer to output jack J2. Capacitor C4 is 0.1 *u*F for all applications except when used with a line matching transformer. When a transformer is used C4 is 25 *u*F. Better results can be obtained with a line matc' ing transformer if the transformer primary *replaces* R4 (eliminating C4).

M1 is a standard VU meter whose internal rectifier has been removed (open the case and unsolder the rectifier). Total current drain is less than 5 mA and the bi-polar power supply can consist of two transistor radio type 9-volt batteries.



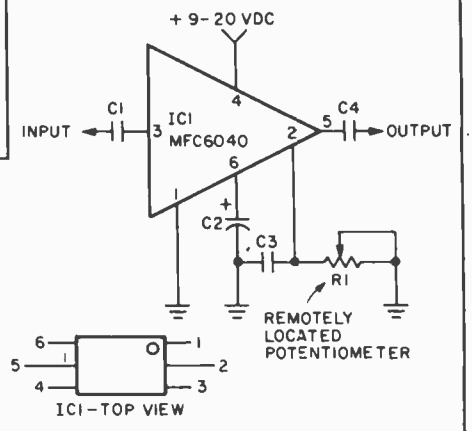
PARTS LIST FOR RECORD REMOTE AMPLIFIER

C1—220-uF, 12 VDC electrolytic capacitor
C2, C3—47-uF, 50 VDC electrolytic capacitor
C4—0.1-uF or 25-uF, 12 VDC capacitor (see text)
D1, D2, D3, D4—1N60
IC1—Type 741 operational amplifier
J1, J2—Shielded jacks
M1—VU meter with internal rectifier removed (Calectro D1-930 or equiv.)
R1—50,000-ohm audio taper potentiometer
R2—100-ohm, ½-watt resistor
R3—15,000-ohm, ½-watt resistor
R4—560-ohm, ½-watt resistor

IC29 Far Out Gain Control

☐ One of the problems of locating a volume control in a remote location is that of hum and noise pickup; as a general rule, the greater the wire length the greater the hum and noise picked up. With an electronic attenuator the entire problem is eliminated, for the volume control wires carry only a DC control voltage which causes an integrated circuit amplifier's gain to vary by as much as 90 dB. Hum and noise picked up in the DC control wires are not impressed on the amplified audio signal.

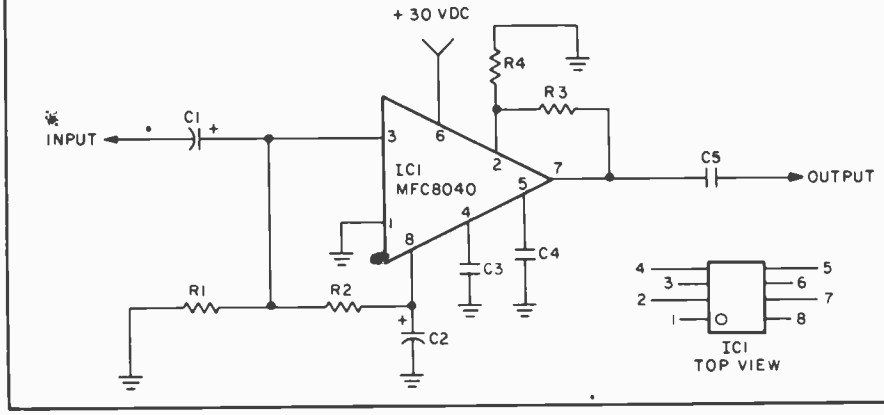
No layout precautions are required and any type of assembly can be used. If desired, the amplifier gain can be voltage controlled by eliminating potentiometer R1 and applying 3.5 to 6 volts DC directly to pin 2. With 3.5 VDC the amplifier works at full gain. The attenuation increases to a maximum of 90 dB as the control voltage is increased to 6 VDC.



PARTS LIST FOR THE FAR OUT GAIN CONTROL

C1–0.47-uF, 25 VDC capacitor
C2–50-uF, 25 VDC capacitor
C3–680-pF, 500 VDC ceramic disc capacitor
C4–0.1-uF, 75 VDC Mylar capacitor
IC1–Motorola MFC 6040
R1–50,000-ohm potentiometer

IC30 No-Noise Mike Preamplifier

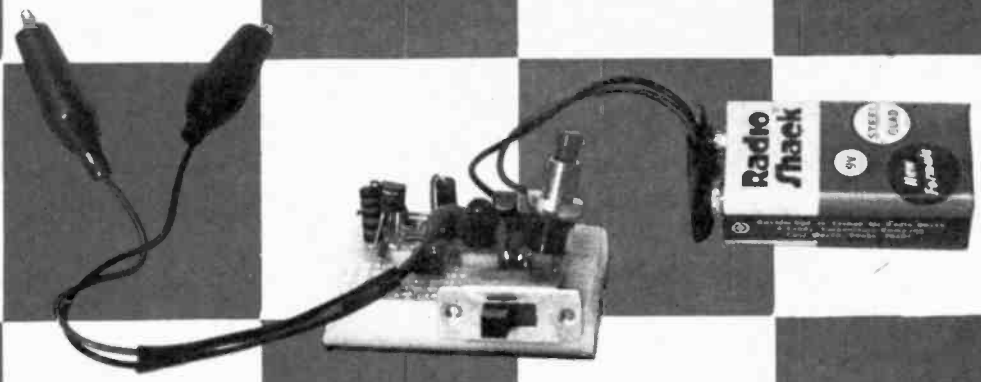


PARTS LIST FOR THE NO-NOISE MIKE PREAMP

C1–2-uF, 12 VDC electrolytic capacitor
C2–100-uF, 12 VDC electrolytic capacitor
C3–0.047-uF Mylar capacitor
C4, C5–0.1-uF Mylar capacitor
IC1–Motorola MFC 8040
R1–75,000-ohm, ½-watt resistor
R2–270,000-ohm, ½-watt resistor
R3–110,000-ohm, ½-watt resistor
R4–100-ohm, ½-watt resistor

☐ Packing a walloping 60 dB gain with a 7 volt output, this mike preamp nevertheless is almost dead quiet. The input impedance is about 75,000-ohms; output impedance about 100-ohms. Actual maximum output voltage depends upon the load resistance, ranging from 7 volts output into a 10,000-ohm load to 4 volts output into a 1000-ohm load. Parts layout is not critical and any type of assembly can be used. The power supply current is approximately 8 mA, with a maximum of 12 mA.

BUILD CHECKERBOARD FOR QUICK TESTING



A handful of parts plugged into solderless breadboard make a tester for crystals, diodes, LEDs and lots more.

by Martin Weinstein

☐ I built a crystal tester several years ago and had an accident. Two of the connections were accidentally shorted together when I soldered the parts together. As a result, I soon discovered that my crystal tester was also good as a diode tester, a LED tester, a continuity tester, an electrolytic tester and more.

Now *that's* what I call a *happy accident!*

The whole circuit was built onto a scrap of printed circuit board and mounted in a small plastic box. I've used it for years, and it's come in handy dozens of times. Recently, while chatting with a couple of ELECTRONICS HOBBYIST editors it occurred to us that some of you might enjoy this handy little gadget. So I rebuilt it one evening on a small, inexpensive solderless breadboard. And now I can pass the secrets of this marvelous little *Checker Board* on to you.

What It Can Do. Checker Board started out as a crystal tester, with the desired action that a good crystal lights the LED and that a bad crystal won't. You can also use it to check out so many other components with just as simple an indication. These are some of the things you can test with your Checker Board: lamps, switches, diodes, LEDs, cables, capacitors, crystals, printed circuit traces, connectors and more. You can even use Checker Board to test itself!

How It Works, Part One. Transistor Q1 and the parts near it, R1, R2, C1, and C2, work together with the crystal you connect into the circuit as a simple crystal oscillator. Without a good crystal, the circuit will not oscillate. When it does oscillate, a signal appears at the emitter of Q1.

Capacitor C3 passes this signal to diodes D1 and D2, which are connected as a rectifier. They convert the signal (which is a high-frequency AC signal, at the frequency of the crystal) to a bumpy DC signal. C4 smoothes out most of the bumps. As result, the signal that leaves Q1 arrives at Q2 as a small DC voltage. Q2 then acts as a switch. When the DC voltage appears at its base, it completes the circuit from the battery and switch, through R3 and the LED, to ground. When this happens, the LED turns on.

With no signal coming out of Q1, no voltage appears at the base of Q2 so it doesn't turn on, and neither does the LED. R3 limits the current that can go through the LED to keep it from burning out and to help give it a very long life. It also lengthens Checker Board's battery's life.

And that's how Checker Board checks crystals.

How It Works, Part Two. Take a good look at R4. It acts as a kind of cheater, connecting the cathode end of the LED to the red clip. So, when there's no crystal in the circuit, R3, R4 and D3 are the only parts of the circuit actually connected to the clips, the switch and the battery. The equivalent circuit is shown nearby. As you can see, whatever you connect to the alligator clips then completes the circuit to light the LED. The purpose of R4, here, is to keep this mode of operation from interfering with Checker Board's performance as a crystal tester, since that's why we built it.

Building Checker Board. Use any construction technique you feel comfortable with. Nothing is very critical, and you can try lots of other values for any given component and still have a Checker Board that works.

The Checker Board you see here was built on a small solderless breadboard from AP Products. It's fully described in the Parts List. You can use any size wire from #20 to #28 to make the connections between terminals, and most components' leads plug right in.

You can help the switches, battery leads and alligator clip leads plug right in, too, if you use AP Headers. They're small contact posts embedded in a plastic strip at precise 1/10-inch intervals, so they can plug right into the breadboard. Just break off the number of posts you need from the rest of the strip, solder your connection to the short end and plug the long end into the breadboard.

I used small U-shaped pieces of bare wire plugged into several holes in a row to form a contact pad area, connected to each clip lead. This makes testing larger components as easy as touching

CHECKERBOARD

their leads to the bare wires.

You can use either a momentary switch, like a pushbutton, or any spst switch, or both for S1. It depends on whether you prefer on-off or push-to-test operation.

If you have trouble relating the schematic to the solderless breadboard, it should clear up quickly once you understand how the solderless breadboard is arranged.

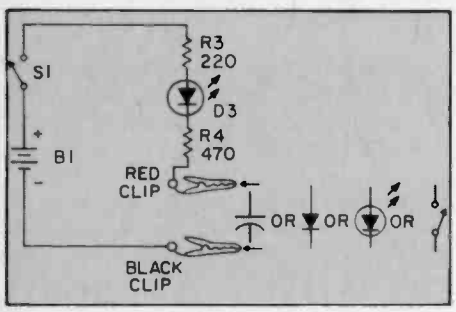
There are 17 rows of five holes each on each side of the center of the breadboard, a total of 34 rows in all. Underneath each row of five holes is a connecting spring clip. The clip holds onto whatever lead you push through the hole. And all the leads you've inserted in any one row (on each side of center, independently) are connected together.

In other words, there are 34 places where you can tie up to 5 leads together, 17 on each side of the center.

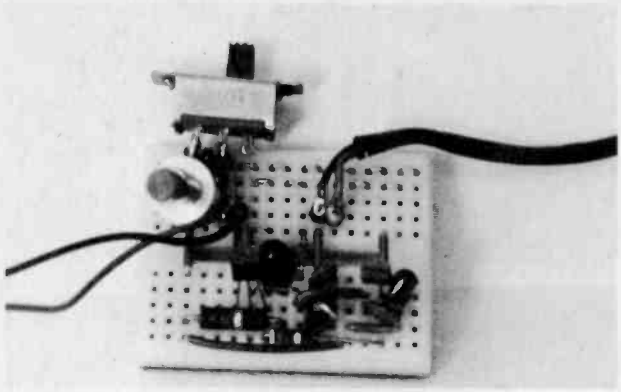
Once you know that, you can custom-design a circuit in just a few minutes, working directly from your idea onto one of these breadboards. Or you can translate a circuit like Checker Board into a solderless breadboard layout very, very quickly indeed. You can solder switches and cable leads to headers, like these from AP products, and plug them right into either solderless breadboards or female headers, the darker strips near the center of the photo. Headers come in rows of 36 contact posts, and either cut or can be broken to length. A single row of male headers, widely available, costs less than a dollar.

Using Checker Board. Follow the instructions below as you test each component. Generally, components can either be clipped-to with the alligator clips, plugged directly into the solder-

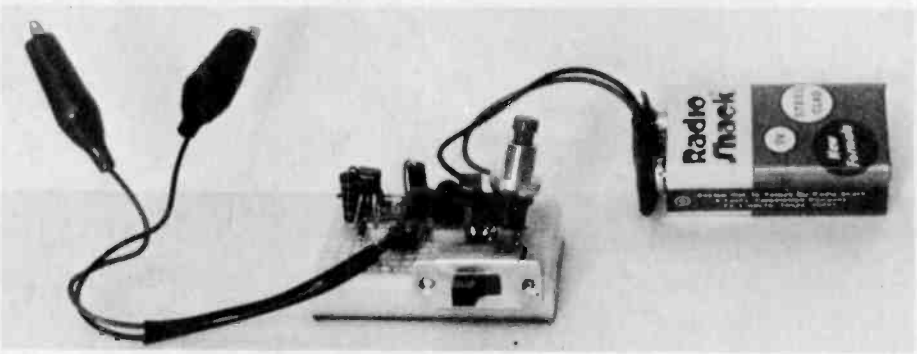
(Continued on page 113)



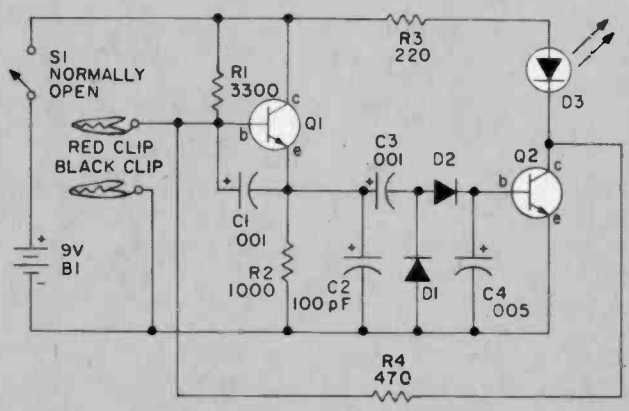
If you use Checkerboard circuit to test capacitors (electrolytics, tantalums, etc.) or diodes, LEDs, or switches, here's the actual working circuit, simplified from the complete Checkerboard circuit, which can check crystals.



Top view of Checkerboard tester assembled on solderless breadboard shows where the parts go if you use this method of assembly.



Prototype Checkerboard was built on AP Products' solderless breadboard for ease of construction and flexibility in layout. Perf board can also be used.



PARTS LIST FOR CHECKER BOARD

C1, 3—.001-uF capacitor
C2—100-pF capacitor
C4—.005-uF capacitor
D1, 2—1N914 or other general-purpose, rapid-response silicon diode
D3—LED (light-emitting diode)

Q1, 2—General-purpose, small-signal NPN transistor, 2N3904 or similar
R1—3300-ohm, ½-watt resistor
R2—1000-ohm, ½-watt resistor
R3—220-ohm, ½-watt resistor
R4—470-ohm, ½-watt resistor

S1—SPST toggle switch, or normally-open pushbutton. Use either, or both in parallel, as desired.
Misc.—Solderless breadboard (AP Products, Inc. distribution strip part number 923273-for AP dealer see end of Parts List); headers (AP Products), alligator clips with pastic covers, 9-V battery connector, 9-VDC transistor radio battery, hookup wire, solder, etc.

For name of dealer nearest you who carries AP Products telephone 800-321-9668 toll free.

The 470 ohm resistor (R4) is included to keep the continuity tester from interfering with the crystal checker. In the crystal tester mode, the crystal being tested plus C1, R1, R2 and Q1 act as a simple oscillator circuit. If the crystal is good a signal will appear at the emitter of Q1 and be rectified by D1 and D2 into a bumpy DC that will turn on Q2. If the crystal is bad nothing will get past Q1 and, therefore, there will be nothing to turn on Q2 and light LED 1.

ADD TONE TO YOUR PHONE

With your own Touch Tone Pad you can key a phone, computer, or transceiver for peanuts.

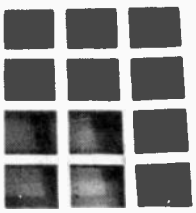
☐ One of the most popular hobbyist items—appealing to hams, experimenters, *phone phreaks* and thousands of other experimenters—is the Touch-Tone Pad or Encoder, that two-tone generating device used on Touch-Tone Telephones. It seems the uses for the Touch-Tone signals are almost endless: hams use them to activate and use autopatches that permit telephone calls from a mobile transceiver to a landline, experimenters use them in conjunction with the Signetics touch-tone decoder ICs for remote control applications, and *phone phreaks* use them to help make "free" (though illegal) long distance calls. Some people use them to access hobby and time shared computers, and others simply connect them to standard dial phones to get additional Touch-Tone service without paying Ma Bell a lifetime's worth of extra charges for a relatively inexpensive extension phone.

In actual fact there is a difference between a Touch-Tone Pad and an Encoder. Though they eventually do the same thing you can be stuck for some rather expensive, unusable hardware if you can't get them straight. The original telephone pad, the one used in Touch-Tone phones, generates a two-tone signal when a key is depressed and is called a Touch-Tone Pad. On the other hand, when a keyboard device resembling the telephone keyboard is used to control an electronic tone generator—usually an integrated circuit purchased as an independent component—the keyboard is also called a Touch-Tone Pad but it is really only a switching matrix; it does not generate any tones. When this keyboard is combined with an electronic circuit that generates the tones—usually at a signal level slightly higher than normal microphone level—the entire device is called a Touch-Tone Encoder.

The encoder is a rather small, somewhat fragile device generally used by radio amateurs for controlling autopatch repeaters. The pad—which is made by Western Electric and other telephone equipment manufacturers—is built like a battleship, produces a relatively high level output that can be used for just about anything, and until recently the only way to get one was to go directly to a telephone equipment dealer and pay list price, or hope one fell off the back of a truck.

But now the telephone-type Touch-Tone Pad has flooded the surplus market and anyone can pick one up for between $8 and somewhat less than $20, depending on condition. For an extra couple of dollars you can also get a beige plastic cabinet pre-punched to fit the pad. About the only problem you'll have is that some of the pads have only numerals, not letters; but this should create no problems since most touch-tone coding, and even telephone numbers, are now predominantly numerals.

Probably the most flexible pad is the Western Electric type shown in the pho-



This is what you can get from the surplus dealers: a Western Electric Touch-Tone pad and plastic housing.

TONE TO PHONE

tographs. This model is available from several surplus dealers.

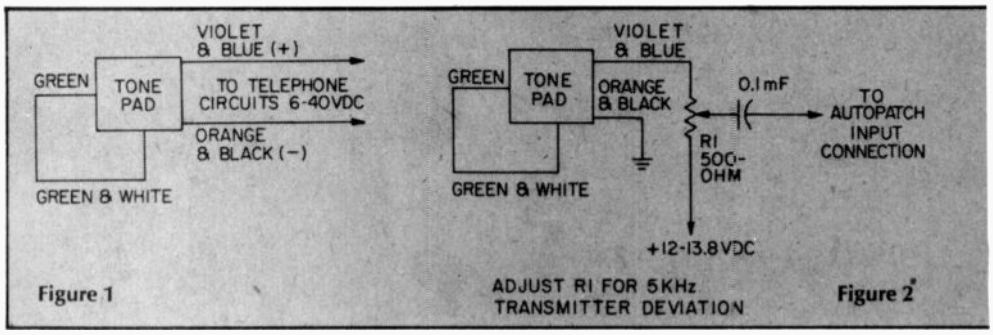
Wiring. The Western Electric pad comes jam packed with attached color coded wires which are generally used for connecting into telephones. For many hobbyist uses most of these wires are simply ignored. There is some variation in color coding between different models of Western Electric pads, but most models are very similar and some general color coding can be used. Also, most reliable suppliers will send connecting instructions and so specify in their ads.

In fact, before undertaking this project, you might want to check your ability to discern colors. It often happens that people who ordinarily would have no trouble seeing colors find it difficult to distinguish between color-coded wires in electronic equipment. A problem in this area could make it impossible to wire the Touch Tone Pad properly. So why not compare your reading of the wires with one or two friends', just to make sure.

The schematics show the hobbyist connections for the Western Electric type 35N1A and 35N3A pads—or dials as they are called by Western Electric—the most common type of pads available. The circuit shown in Fig. 1 can be connected directly across the telephone terminals of a telephone where touch-tone is already provided by the local telephone company. You will hear the tones in the receiver (handset). If you don't hear a tone simply reverse the connections to the line.

A normally open switch which is built into the pad is closed each time a key is pressed. This switch closes the circuit between the pad and the line, simultaneously applying power from the line to the pad (an external power supply isn't needed). If you want the pad connected only when the handset is off the hook connect the pad after the line switch terminals; usually terminals F and C on the phone network (repeat coil or transformer).

Figure 2 shows the connections for using the pad with an FM transceiver for autopatch. Potentiometer R1 sets the level into the modulator and is normally adjusted for 5 kHz deviation. Some phase modulated transceivers require a frequency correcting network when using a touch-tone pad and instructions for a simple resistor-capacitor (R/C) equalizer are generally given in the transceiver's instruction manual.

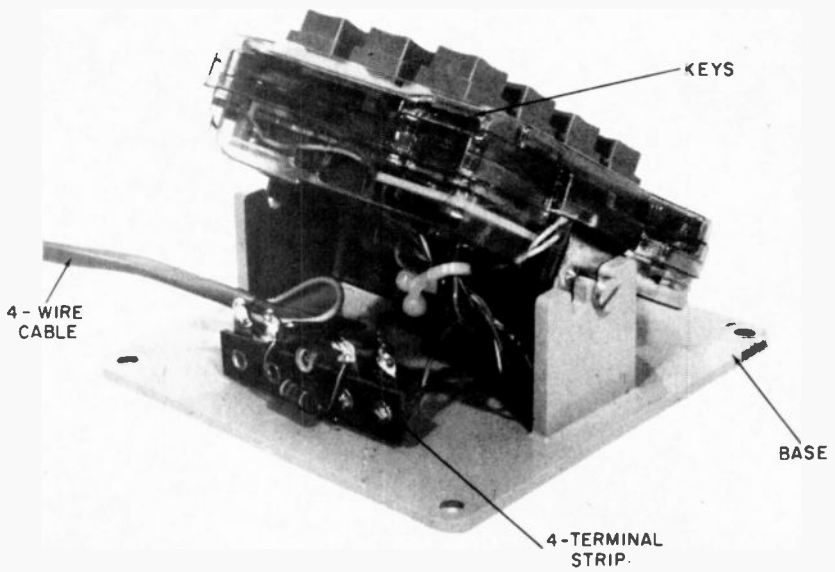


The circuit in Fig. 2 requires the transceiver's PTT (push to talk) be held down when the tones are keyed in. We will show later how to modify a pad so it also provides automatic transmitter keying each time a tone is keyed.

Mounting the pad. The best way to mount and wire a pad is in one of the plastic cases usually available from the same dealer who supplies the pad. As shown in the photographs there's plenty of room inside the cabinet for a terminal strip and associated components. To avoid short circuits clip the unused pad leads short, or tape the lugs on the end of each wire. The pad wires are standard stranded type—not *litz* silk wound—so you can clip off the lugs, strip the insulation and solder just as you would any other stranded hook-up wire.

If you need or want automatic PTT, or control circuit switching each time a pad key is depressed, you can easily modify the pad to provide the circuit control shown in Fig. 4. Note that switch S1 is the normally open switch that is part of the pad and applies the power to the pad as well as connecting the pad's output signal. Switch S2 is the modification and can be wired directly across a PTT switch, or used as control wires for a keying or switching circuit.

First step is to remove the plastic covers of the pad. They snap right off. Remove the front one first, the one over the keys. Then remove the rear cover taking care to snake the wires carefully through the opening in the plastic cover. You wil find the rear of the pad looks like the photograph, with a set of multi-switch terminals at the upper left. If you look carefully at the switch you'll find almost all the sections are normally closed, opening when a pad key is depressed. But two sets of contacts are normally open and close only when a key is depresesd. The bottom set of contacts is S1 and should not be disturbed. Counting down from the top, the second set of contacts is also normally open and usually is the only set of contacts to which no wires are connected. (Note that some pads might



With the pad installed in the cabinet mount there's plenty of room in the back for a terminal strip and some components. This 4-terminal strip installation provides the connections shown in Figs. 1 and 2 through a 4-wire cable. The user simply selects the right set of color-coded wires.

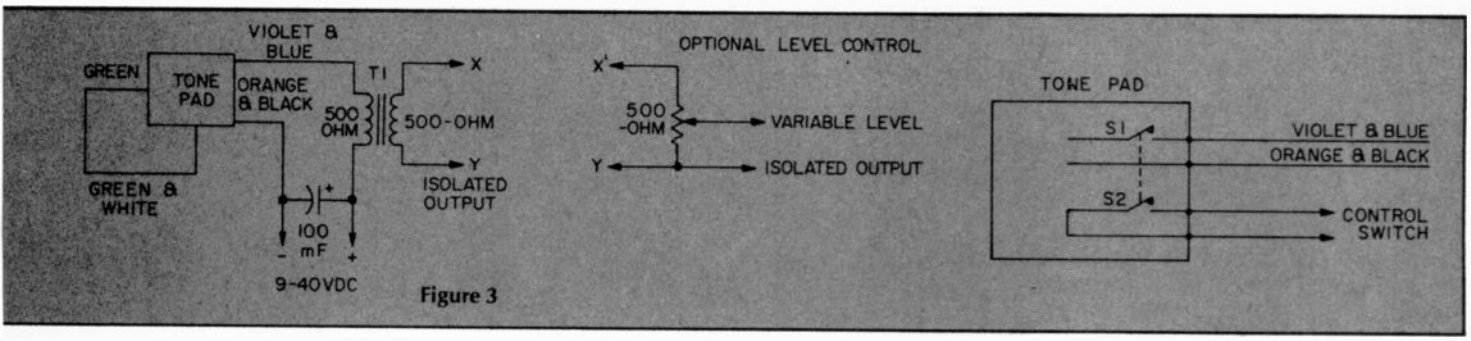


Figure 3

have one wire connected to one of the normally open terminals, and the wire is generally brown. Simply cut the wire off at the terminal and leave it alone.)

Carefully cut off the unused wires from the top set of normally closed contacts and move them to the normally open contacts using a very small soldering iron (about 20 watts) and as little heat as is possible. Use a tiny drop of solder to prevent a solder bridge. If you don't want to cut the wires from the top contacts use #22 stranded wire for the normally open connections.

Carefully slip the plastic cover over the wires, seat it on the pad and then install the front plastic cover. You now have a touch-tone pad with an extra set of normally open switch contacts.

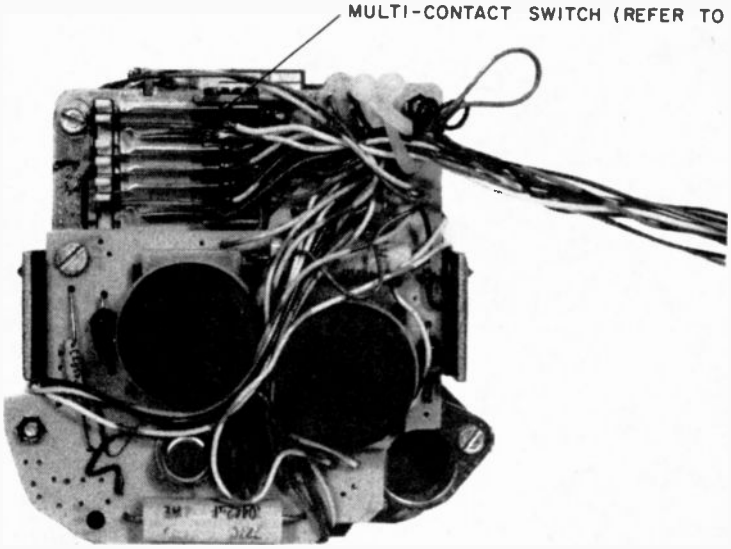
Get Out the Grinder. For some unaccountable reason a few of the plastic touch-tone pad cabinets do not make allowance for pointed projections on the mounting ear located on each side of the pad. Each ear has two projections with a mounting screw in between. The plastic cabinet has been pre-formed to accommodate the screw and one projection; the remaining projection gets in the way and can result in damage to the cabinet when the mounting screw is tightened. For best results use a hand grinder or file and remove the projection towards the bottom when the pad is held upright. When the pad is installed in the cabinets don't tighten the two mounting screws; let the pad *float* on its mount. When the top of the cabinet is secured with the four mounting screws provided, the pad will be rigidly locked in position without damage to the cabinet.

Correct Voltages. The Western Electric touch-tone pad will work with an applied voltage between 6 and 40 VDC at the orange/black and violet/blue terminals. If the voltage is less than 6 volts the oscillator won't "start," or the output signal will be highly distorted. Keep in mind that if you use the circuits shown in Figs. 2 and 3, there is a voltage drop across R1 and T1, and less than the applied voltage arrives at the pad. In Fig. 2 about 3 volts is dropped across R1; you can normally get good operation if the voltage applied to the power supply end of R1 is no less than 9 VDC. Of course, if Fig. 2 is used for an autopatch the normal transceiver power supply of 12 to 13.8 VDC is available and you'll have no problems.

The transformer shown in Fig. 3 has less of a voltage drop than the resistor load of Fig. 2, so the applied voltage can be closer to 6 volts and still insure proper operation of the pad.

The pad has build-in Zener diode voltage regulation so the output voltage is more or less constant over the power supply. The maximum output voltage measured across R1 in Fig. 2 is nominally 0.77 volts RMS when indicated by a standard VOM; 3.5 volts peak-to-peak when measured by an oscilloscope. If you plug these values into a calculator nothing comes out the way you expect because two tones are involved.

(Continued on page 113)



PAD CHASSIS IS WITH PLASTIC GUARD REMOVED

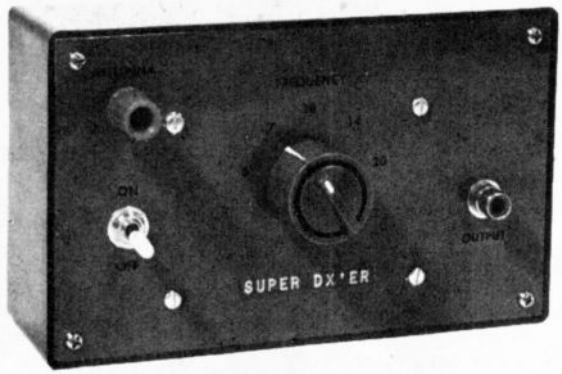
Switch arrangement to secure the control function shown in Fig. 4. Switch S1 is part of the pad wiring and controls both the power and pad connection. The set of contacts labeled S2 is the second down from the top and can be connected as in Fig. 4 to provide an isolated control circuit.

Figure 4. Power switch S1 is part of the pad and is connected in series with the violet-blue (positive power) lead. It automatically closes each time a key is pressed. Switch S2 is connected to S1's operating lever but is not normally used in the pad. You can connect a pair of wires, as shown, to provide a set of isolated control terminals. S2's terminals can be used to operate the PTT switch of a transceiver whenever a key is depressed, or to lift the 500-ohm potentiometer off a microphone circuit with connection shown in Fig. 2 or the optional circuit that is included in Fig. 3.

PARTS LIST

1—0.1-uF capacitor (Radio Shack 272-135 or equiv.)
1—100-uF, 50-VDC electrolytic capacitor (Radio Shack 272-1044 or equiv.)
1—500-ohm adjust potentiometer (Radio Shack 271-226 or equiv.)
1—Isolating transformer, primary 500-600-ohms, secondary 500-1000-ohms (Calectro D1-728 or similar) Calectro-GC Electronics, Rockford, IL 61101.

Touch tone pads can be purchased from: Telephone Equipment Co., P.O. Box 596, Leesburg, FL 32748.



SUPER DXER

Our outboard rig makes QSL waves—adds 20dB minimum gain to any shortwave receiver

CAN YOU REMEMBER the early days of TV—back to the mid- and late-1940s—when the Joneses, who had the only TV in the neighborhood, would strain to clean up a snowy, flickering picture by adjusting a "booster" that sat on the top of their 12-in. phosphor cyclops?

Well, more often than not those outboard boxes, with their 6J6s in push-pull tunable circuits, didn't amount to the proverbial hill-of-beans. Those World War II vintage tubes were not at all well suited to the new-fangled wide-band requirements of TV. But later on as the technology advanced, and more powerful transmitters were built, good, solid pictures became the rule.

Unlike the old TV boosters, today a good booster for short wave receivers—a preselector—can be designed with all the advantages of the latest solid-state devices; and, to boot, it can be simple and very easy to build. It's the easiest way to turn any receiver into an even hotter signal sniffer. You use a booster (a very high gain RF amplifier) between the antenna and the receiver antenna terminals. A good one will also provide sharp image rejection by adding a relatively high-Q circuit to the receiver input. Image signals (which often take the pleasure out of receivers with low frequency single-conversion IF amplifiers by jamming desired signals) vanish as if by magic when passed through a high-Q booster or preselector. In short, a top quality super booster such as the SUPER DXER, will add another dimension of performance to any shortwave receiver.

What It Can Do. The SUPER DXER provides from 20 to 40 dB of signal boost—the exact amount is determined by the particular input characteristics of your receiver. Figuring on 6 dB per S-unit, that's an increase of better than 3 to 6 S-units. In plain terms, the SUPER DXER will bring in stations where all your receiver will pick up running barefoot is its own noise.

The SUPER DXER's input is a diode protected FET (field effect transistor); the protection diodes are built into the FET so that excessively strong input signals, and even static discharges, will not destroy Q1. Since the FET's input impedance is many thousands of megohms, there is virtually no loading of the L1/C1 tuning circuit; its "Q" remains high and provides a very high degree of image-signal attenuation.

The SUPER DXER output circuit is a low impedance emitter follower, and it will match, with a reasonable degree of performance, just about any receiver input impedance. As long as your receiver has two antenna terminals, one "hot" and one ground, you can use the SUPER DXER.

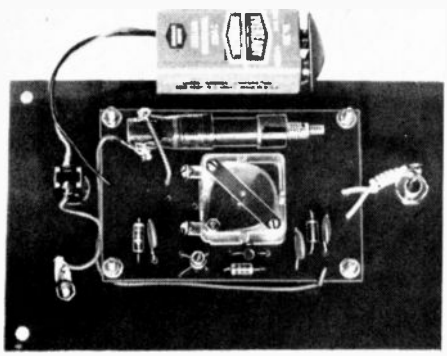
Optimum performance will be obtained if your receiver is equipped with an antenna trimmer. Just as the antenna trimmer peaks the receiver for use with any type of antenna, it also adds something extra when matching the SUPER DXER.

Set Bandpass. The SUPER DXER has a tuning range of slightly more than 3-to-1 between 5 and 21 MHz. That means if the low end is set to 5 MHz, the upper limit will be slightly higher than 15 MHz (3 times 5). If the lower limit is set at 7 MHz, the upper frequency limit will be slightly higher than 21 MHz. Since the slug in tuning coil L1 is adjustable, you can select any operating range between 5 and 21 MHz.

SUPER DXER, though a very high gain device, is absolutely stable if built exactly as shown and described. There will be no spurious oscillations or response. It is possible that changes in the component layout or construction will result in self-oscillation at certain frequencies; hence, make no modifications or substitutions unless you are qualified.

Getting Started. Your first step is to prepare the printed circuit board. Using steel wool and a strong household cleanser such as Ajax or Comet, thoroughly scrub the copper surface of a 2¼-in. x 3¼-in. copper-clad board. Any type will do—epoxy or fiberglass; the type of board is unimportant. Rinse the board under running water and dry thoroughly.

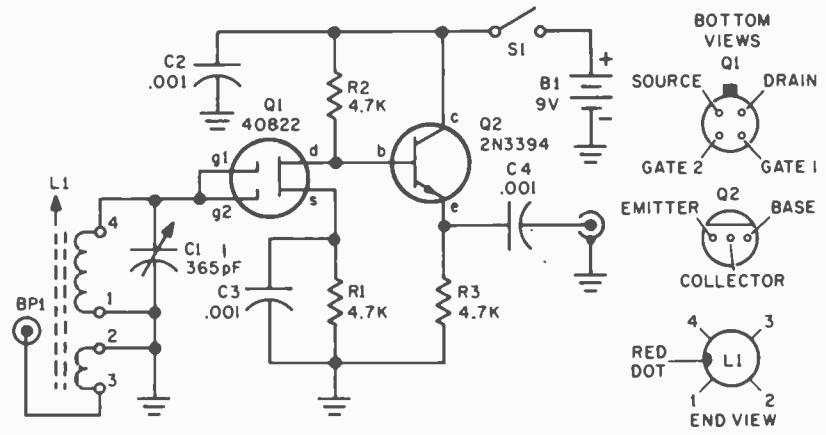
Cover the copper with a piece of carbon paper—carbon side against the



Add an extra 20+ dB gain to your shortwave receiver. Simple kit-of-parts is available. You supply the outer case and knob. Note: Wrap J1 ground wire as shown above.

copper—and place under the full-scale template we have provided. Secure the PC board in position with masking tape. Using a sharp pointed tool such as an ice pick, indent the copper foil at each component mounting hole by pressing the point of the tool through the template and carbon paper. Next, using a ball point pen and firm pressure, trace the foil outlines on the template.

After all foil outlines have been traced, remove the PC board from under the template and, using a resist pen, fill in all the desired copper foil areas with resist. Make certain you place a dot of resist over the indents at each of the corner mounting holes. Pour about one inch of etchant into a small container and float the PC board—copper foil down—on top of the etchant. Every five minutes or so gently rock the container to agitate the etchant. After 15 or twenty minutes check the PC board to see if all the undesired copper has been removed. When every trace of the undesired copper is gone, rinse the board under running water, and then remove the resist with steel wool or a resist "stripper."



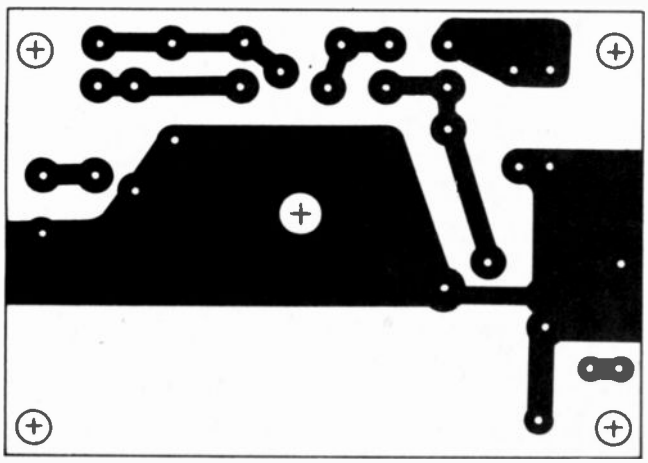
PARTS LIST FOR SUPER DXER

B1—9-volt battery (Eveready 216 or equal) and connector
BP1—insulated binding post
C1—365-pF subminiature tuning capacitor
C2, C3, C4—0.001-uF, 25-VDC or better ceramic disc
J1—RCA-type phono jack
L1—5 to 20-MHz antenna coil, Custom Components SW-520
Q1—MOSFET, RCA 40822
Q2—npn transistor, 2N3394
R1, R2, R3—4700-ohm, ½-watt resistor
S1—spst switch (power on-off)

The Printed circuit board for the Super DXer is available from Electronics Hobby Shop, Box 192, Brooklyn, NY 11235 for only $4.95. US orders add $1.50 for postage and handling: Canadian orders add $3.00. No foreign orders, please. Postal money orders will speed delivery; otherwise allow 6-8 weeks for delivery.

Continue. Drill out all the mounting holes marked by an indent with a #57, 58, or 59 bit—this includes the corner mounting and C1 mounting holes. Then drill the corner mounting holes for a #6 screw, and use a 5/16-in. bit for the C1 mounting hole.

Install tuning capacitor C1 first. Tuning capacitor C1 should be the type provided in the kit of parts. It has a plastic dust cover and a long shaft. Do not use the type supplied with a short shaft to which a tuning dial for the broadcast band can be attached. Remove the mounting nut and ground washer from C1's shaft. Then make certain the shaft's retaining nut is tight. It is usually supplied loose. Discard the ground washer and secure C1 to the PC board with the mounting nut. Then install tuning coil L1. Make note of two things about L1: the terminal end of L1 has a large *red* dot (ignore any other marks); L1 must be positioned so the red dot faces the bottom edge of the PC board—the edge closest to the coil. Also note that the lug connected to the top of the fine-wire primary is adjacent to the bottom of the heavy-wire secondary. When the red dot is facing the edge of the PC board, both these lugs are against the board. Solder the lugs to the matching holes in the PC board. Use the shortest possible length of wire to connect the remaining primary (fine-wire) terminal to the antenna input printed foil. Connect the remaining L1 terminal (heavy wire) to its matching hole with solid, insulated wire—form a right angle bend in the wire so it doesn't touch L1. Now mount the remaining components.



Exact PC board size. Transfer image to copper-clad board using carbon paper. This is the bottom (copper) side of your board. Mount it to the front panel with ¼-in. spacers between board and panel at each mounting screw. Secure the battery to the back of the cabinet with tape.

Orienting Q. Note that Q1 is positioned properly when the small tab on the case faces the nearest edge of the PC board. Also note that the round edge of Q2 faces the nearest edge of the PC board. The flat edge of Q2's case should face C1.

Because the printed copper foil faces the front panel when the assembly is mounted in the case, and is therefore inaccessible for soldering, the connecting wires to front panel components should be installed at this time. Solder 6-in. solid, insulated wires to the antenna, output, and output ground, and +9V foils. Solder the negative (usually black) wire from the battery connector to the ground foil.

The SUPER DXER is mounted in a standard plastic or Bakelite case approximately 6⅜-in. x 3 3/16-in. x 1⅞-

SUPER DXER

in. The front panel must be aluminum. If the cabinet is not supplied with an aluminum panel, obtain an optional or accessory metal panel. Do not use a plastic panel.

Drill a ⅜-in. hole in the center of the front panel. Position the PC assembly over the hole with C1's shaft fully inserted through the hole, and mark the locations for the four PC board mounting screws. Drill the panel and temporarily secure the PC board to the panel. Then locate the positions for power switch S1, antenna input binding post BP1, and output jack J1. Make certain J1 is as close to the PC board output terminals as is possible—within 1½ inches.

Remove the PC board and drill the holes for the panel components. Power switch S1 can be any inexpensive spst type such as a slide switch. Install the panel components and then the PC board. To prevent the copper foil on the underside of the PC board from shorting to the panel, place a ⅜-in. plastic or metal spacer, or a stack of washers, between the PC board and the panel at each mounting screw. Connect the panel components to the appropriate wires extending from the PC board and the SUPER DXER is ready for alignment.

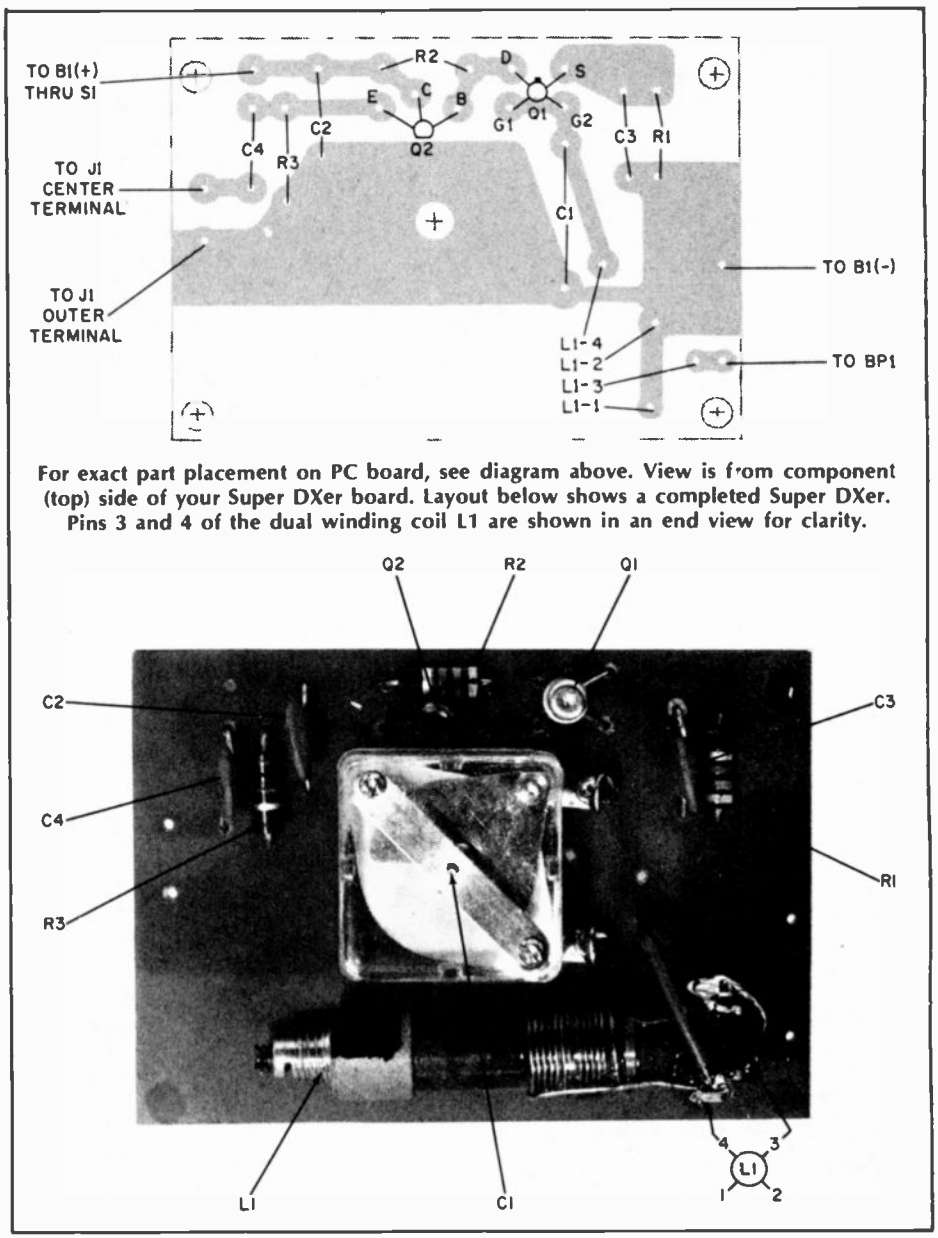
Alignment. Prepare a length of 50 or 52-ohm coaxial cable (such as RG-58) that will reach from the SUPER DXER's output jack to the receiver antenna input terminals. Solder a standard phono plug to one end. Take care that you do not use ordinary shielded cable such as used to interconnect hi-fi equipment; coaxial cable is a must.

Connect the coax between the SUPER DXER and your receiver. Rotate the C1 shaft fully counterclockwise and install a pointer knob so that the pointer extends to the left (9 o'clock position). Connect your antenna to binding post BP1. Then, set L1's slug so that the *bottom* of the screwdriver slot is level with the very *top* of L1. This will provide a frequency range of approximately 5 to 15 MHz. If you back out the slug ¼ inch, the frequency coverage will be from approximately 7 to 21 MHz. You can use any in-between slug adjustment.

Turn on the receiver and booster, and set the receiver tuning to 5 MHz, or whatever frequency you selected for the "bottom end." Adjust C1 for maximum received signal or noise and mark the panel accordingly. Repeat the procedure at approximately 7, 10, 14, and 15 (or 20) HMz. The panel markings are important because the SUPER DXER's tuning is so sharp it must be preset to near the desired frequency or you'll receive nothing—neither signal nor noise. The panel markings complete the adjustments.

Pull 'em In. To prevent self-oscillation, you must keep the antenna wire as far as possible from the coaxial output cable. To receive a signal, set C1 to the approximate desired frequency and then tune in the signal on the receiver. Finally, peak C1's adjustment for maximum signal strength as indicated on your receiver's S-meter, or listen carefully for an increase in speaker volume. Keep in mind that, if the signal is sufficiently strong to begin with, the receiver AVC will "absorb" the SUPER DXER's boost, and the speaker volume will probably remain the same, though the S-meter reading will increase. SUPER DXER's boost will be most apparent on very weak signals, digging out those signals below the receiver's usual threshold sensitivity, making them perfectly readable.

Don't worry about strong signals overloading your SUPER DXER; it is virtually immune to overload even from excessively strong signals. However, the booster's output can be so high as to overload the input of some budget receivers. If this occurs simply reduce the booster's output by detuning C1 just enough to drop the overall signal strength below the receiver's overload value. Happy DXing! ■



For exact part placement on PC board, see diagram above. View is from component (top) side of your Super DXer board. Layout below shows a completed Super DXer. Pins 3 and 4 of the dual winding coil L1 are shown in an end view for clarity.

CHANNEL CHANGER

Soups Up Your Scanner

Add the versatility and excitement of extra frequencies to your Public Service Band monitoring.

by Louis A. Smith II

☐ With today's increasing crime rate, and the increasing need for security, many police departments are expanding the number of frequencies on which they transmit information. In most scanners you can only fit either eight or ten different frequencies, and the task of changing crystals when the ones you have installed are temporarily out of use, is bothersome, especially in a mobile unit!

Of course, instead of changing crystals you could always buy one of the sixteen-channel synthesized units, and pay in excess of $300! Or you could solve the problem of changing crystals by building and installing the "Channel-Changer." It's small and easily installs on either a mobile or base scanner, and requires no external power source. It provides you with capability of changing crystals at the flip of a switch. For this project I used a Realistic Patrolman PRO-14, but the principle can be easily adapted to work with most major crystal-controlled scanning monitors.

What it Does. The Channel-Changer is a low-cost switching device which performs the task of changing crystals in a scanner. It does this by using a 12-position, single pole, rotary switch to change from one crystal to another. This gives a maximum of 12 possible frequencies for one crystal position in the scanner. The only limitation is that all crystals in the Channel-Changer must be in the same frequency band, i.e., *all* frequencies installed in the device must be either in the 30-50 MHz (VHF low), 150-174 MHz (VHF high) or 450-512 MHz (UHF) range. Do not install several crystals from one of these bands and several from another band in the Channel-Changer at the same time, as this may damage the crystal, the scanner, or both. This rule of thumb only applies to the crystals installed in the Channel-Changer itself; the other nine crystal sockets in the scanner may be used with crystals in any frequency band.

Construction. All components are mounted in a metal utility cabinet using the base of the box as the chassis.

First mount S1, the crystal-selector switch, on the front panel of the case. Exact placement isn't critical, but it should be mounted near the center of the panel.

Next comes the crystal holder. For this purpose I utilized a 22-pin edge card connector. The edge card connector is excellent for this purpose because firm contact with the crystals is essential. Before mounting the connector on the chassis, some wiring must be done. Connect the first twelve terminals on one side of the connector together, using #20 gauge wire. After this wiring has been completed, the connector may be mounted in the center of the chassis base, parallel with the front and back panels. It should be mounted on one-inch aluminum spacers, with the side with the terminals connected facing the back panel of the case.

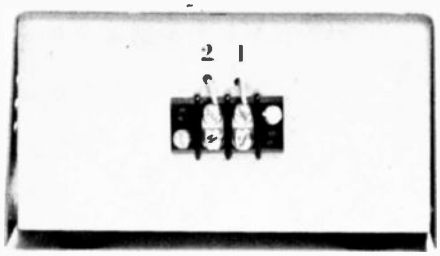
Lastly, mount the 2-terminal barrier strip on the outer side of the back panel, near the center. Drill two ⅛-inch holes in the back panel, one above each terminal.

Now attach some type of indicator knob on the shaft of S1. I used a communication knob. The shaft of S1 will have to be shortened to accommodate such a knob.

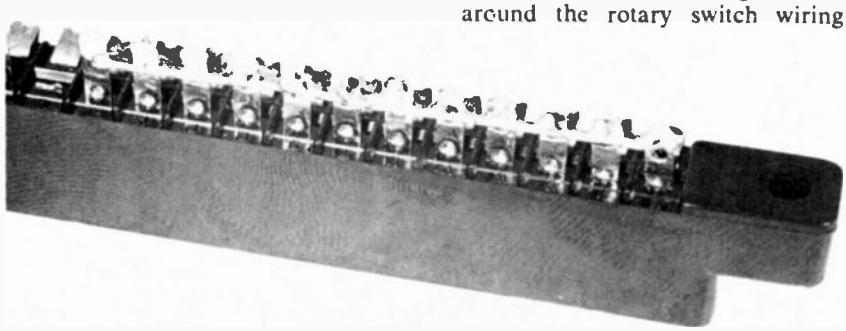
Wiring the Changer. When the components are mounted, it is time to finish the construction by wiring the project.

The first step in wiring is to connect a wire from the common (innermost) terminal on S1 to terminal 1 on the barrier strip.

Next S1 must be wired to the edge card connector (crystal holder). When looking at S1 from a rear view, choose one of the 12 outside terminals which is approximately at the 6 o'clock position. Connect a wire from this terminal on S1 to the first terminal on the edge card connector, (that is, the terminal facing the leftmost of the twelve which were previously wired together.) This will be the connection for crystal socket #1 in Channel-Changer. Continue around the rotary switch wiring the

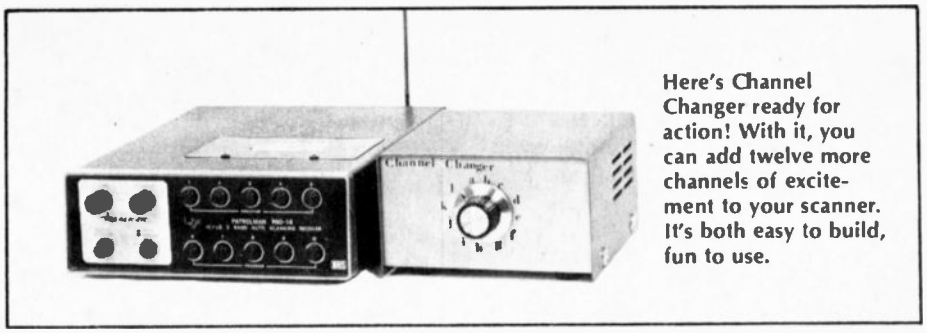


This back view of the Changer shows the barrier terminal strip and its two interconnection points to connect to the scanner.



Wire the first twelve terminals of an edge-card connector together, as shown above. Some of the terminals opposite those wired are bent down for greater clarity.

CHANGER



Here's Channel Changer ready for action! With it, you can add twelve more channels of excitement to your scanner. It's both easy to build, fun to use.

next terminal on S1 to the next terminal on the connector, going from left to right on the connector, and clockwise around S1. Continue wiring in this manner until all twelve positions on S1 have been wired to the corresponding twelve terminals of the crystal holder.

The final connection to be made in wiring is to connect a wire from one of the twelve terminals on the connector which were wired together, to terminal 2 on the barrier strip. Consult the schematic diagram.

Interfacing with the Scanner. After the wiring is finished, install up to twelve crystals in the twelve wired positions in the edge card connector. The position furthest to the left will be position #1, the next, position #2, and so on. Although Channel-Changer has the capability to hold 12 crystals, it may be used to switch any number from 2 through 12. Now the Changer is ready to be attached to the PRO-14.

First, remove the crystal compartment cover, located on top of the scanner. Choose the channel to which you want to connect the device and remove a crystal, if one is already present in the socket. Next, move the "Band Select Switch" for that channel to the specific band in which all the crystals in the Channel-Changer are. If the channel you selected is channel 1 through 5, connect a wire (#20 gauge) from terminal 1 on the barrier strip to the *lower* pin in the socket. If the selected channel is 6 through 10, connect a wire from terminal 1 on the barrier strip to the *upper* pin in the crystal socket. Instead of inserting a plain wire into the crystal socket, it is better to use some type of metallic terminal. The pins on these terminals are .042 inches in diameter, so I recommend pinching them slightly with long-nosed pliers to fit in the crystal sockets which are made to accommodate the pins on a crystal which are approximately .038 inches in diameter. (See schematic diagram for definition of upper and lower pins in the socket.)

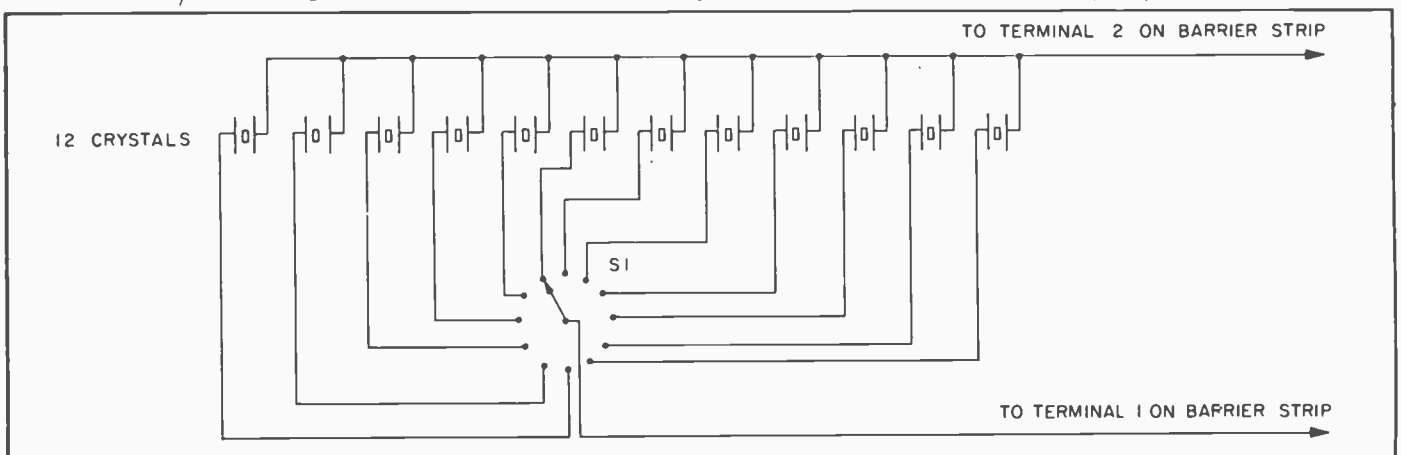
Next connect a wire to terminal 2 on the barrier strip and fasten the other end of this wire to the outside of the crystal compartment cover with electricians tape. Strip about ¼-inch of the plastic covering on this wire off the end which is attached to the compartment cover. These two wires running from terminals 1 & 2 on the barrier strip to the crystal compartment of the PRO-14 can be of any length, but it is best to keep them short to avoid possible interference with the FM broadcast band.

After these connections have been made in the compartment, the cover can be replaced. Be careful not to tighten the cover screws too much as this may cut the wire running from terminal 1 on the barrier strip to the inside of the scanner, and thus short out the connection.

A few final construction hints: It is advisable to label the positions of S1 on the front panel, so that it can be easily seen which crystal is connected to the scanner at any given time. Labeling should be done before replacing the cover of the utility case, while looking at the back of S1 to see which crystal is connected when S1 is in any of its twelve positions. Dry-transfer lettering works well on the surface of the utility case.

Testing it Out. When construction is completed, Channel-Changer is ready to be tested out. Before turning power in the scanner on, check all wiring against the schematic diagram, and correct any errors.

With a National Weather Service crystal, (or any other continuous broadcasting crystal in your area, such as mobile telephone, etc.) installed in the changer, set S1 so that this continuous broadcasting crystal is connected in



This extremely simple circuit can be put together in an evening with a minimum of effort. Wire up the switch and terminals in sequence so that the wiring is neat and orderly, and mark the front panel carefully to align with the switch positions.

PARTS LIST FOR CHANNEL CHANGER

S1—Rotary switch, single-pole, 12-position, shorting

XTAL holder—Edge card connector, made to accommodate 22-pin card

Misc.—aluminum spacers, barrier terminal strip, 2 terminal, communications knob, crystals, see text for options, dry-transfer lettering, hook-up wire, gauge 20, metal utility cabinet, metalic terminals

RADIOTELEPHONE (RCC) FREQUENCIES

These VHF and UHF frequencies are used by mobile telephone systems across the country.

Receive	Transmit	Channel Designator
VHF "High" Band		
152.03	158.49	1
152.06	158.52	3
152.09	158.55	5
152.12	158.58	7
152.15	158.61	9
152.18	158.64	11
152.21	158.67	13
UHF Band		
454.025	459.025	21
454.050	459.050	22
454.075	459.075	23
454.100	459.100	24
454.125	459.125	25
454.150	459.150	26
454.175	459.175	27
454.200	459.200	28
454.225	459.225	29
454.250	459.250	30
454.275	459.275	31
454.300	459.300	32
454.325	459.325	33
454.350	459.350	34

Thanks to Channel Changer, you're going to have a lot of extra frequency requirements in your scanner. The radiotelephone bands can make for some real exciting listening. Here's the lowdown—our compliments.

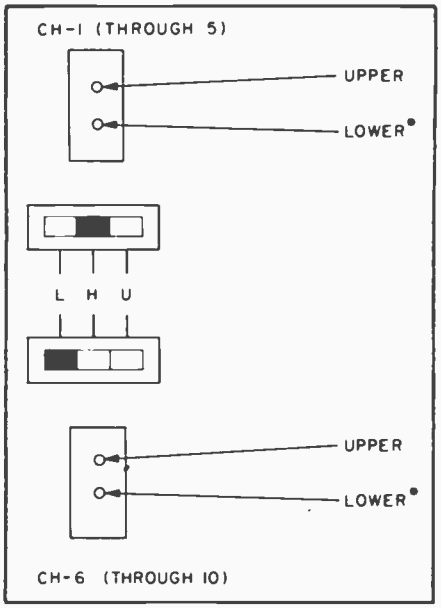
the circuit. Turn the scanner on, and manually stop the scanner on the channel to which the Changer is connected. The scanner should now be receiving the frequency of the continuous broadcasting crystal. If reception is poor, or doesn't exist at all, switch the connections at the terminals on the barrier strip. If this doesn't correct the problem, a bit more of the plastic covering should be removed from the wire which was taped to the crystal compartment cover. Also, make sure that the wire in the crystal socket is securely in place. This should improve reception.

Installing the Changer. Channel-Changer can be easily mounted in either a base or mobile installation. It should be kept in mind that the two leads extending from the terminals of the barrier strip should be kept as short as possible.

To install Channel-Changer on a base installation, it can be set either on top or beside the scanner after the wiring between the Changer and the Scanner has been completed.

If you want to install the Changer in a vehicle, it can easily be bolted under the dash board next to the scanner after all interconnections have been made.

Channel-Changer is very useful for scanner-owners who live in major metropolitan areas, or in areas in which police departments have several frequencies, but who primarily use one for general communications, and hold the others in reserve for special or emergency messages. It is also useful when installed on a mobile unit, for people who commute from one area to another, because the crystals of the police or fire departments of another locality could be installed in the Changer, and switched to only when you drive within receiving range.

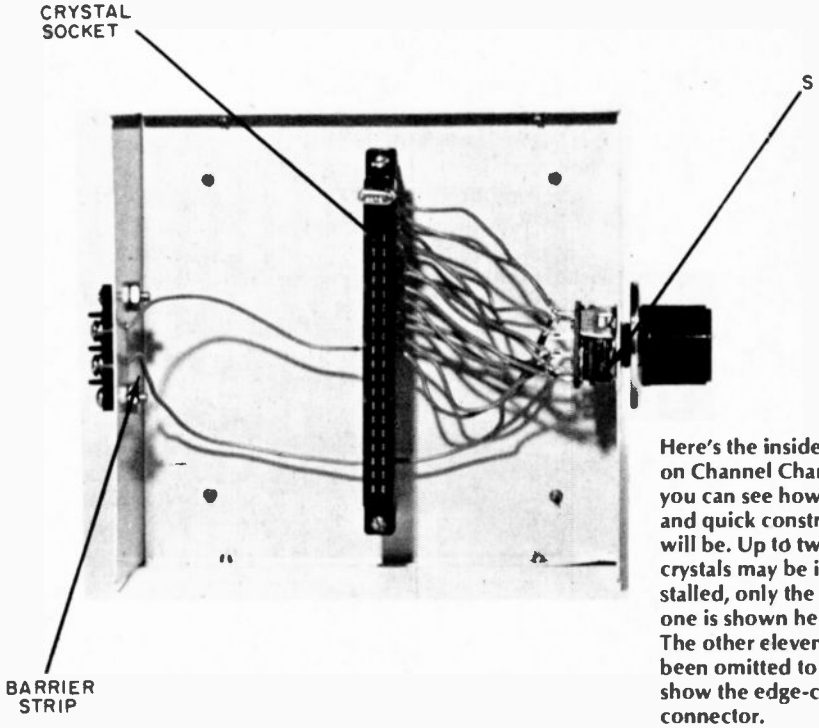


If you're interfacing Channel Changer on your scanner's channels 1 through 5 (inclusive) connect a wire from terminal one on the barrier strip to the lower pin in the socket. If to channels 6 through 10 (inclusive) then the wire goes from the terminal to the upper pin in the socket Make certain you don't do it backwards.

Operation. After the PRO-14 scanner is turned on, set the control knob (S1) on the Changer to the desired crystal position. The scanner will scan 9 crystals installed in the scanner itself plus the one crystal in the desired position of the Changer. The PRO-14 will not scan all twelve crystals in the Changer at the same time, but only the one to which S1 is set. When a transmission is received on the selected crystal in the Changer, the channel indicator light on the PRO-14 will light corresponding to the channel in the scanner to which the Changer is connected.

As an example if the Channel-Changer is connected to channel 3 on the scanner, the indicator light for channel 3 will light when a transmission is received on the crystal selected in the Changer. The Changer can be cut out of the scanning circuit altogether by simply locking out the channel on the scanner to which it is connected.

Now that you've built the Channel-Changer, you've solved your crystal change problem! Happy PSB listening! ■



Here's the inside story on Channel Changer, you can see how easy and quick construction will be. Up to twelve crystals may be installed, only the first one is shown here. The other eleven have been omitted to show the edge-card connector.

FLASHMATE— THE PHOTOGRAPHER'S DREAM

Photoflash problems vanish with this easy-readout solid-state meter.

Frank I. Gilpin

☐ Any photographer, amateur or pro, will tell you the biggest bane of his life is figuring exposures for electronic flash photography. *If* you know the manufacturer's guide number for your flash unit, and *if* that number is close enough to being accurate for your production line unit, and *if* you can remember it from one shooting session to another, and *if* you remember how to use it, and *if* your flash is fully charged, and *if* you use straight, harsh flash instead of bouncing it, and *if*. . . . Well, flash photography is very often *iffy*.

Theoretically, you divide the guide number by the number of feet between the flash and subject, and the answer you get is the f-stop. This has to be figured for every shot, if you move between shots and this guide number is only good for one film type. Again, it gets pretty iffy. There are, to be sure, flash meters on the market, but the least expensive one I know of costs nearly $100, and they are all rather bulky.

The answer to these problems is Flash-Mate. It's smaller than an Instamatic camera, inexpensive to build, reliable and accurate, and easy to build, with readily-available parts. It takes all the IF variables in stride, and gives you the right f-stop for *any* flash at *any* distance and for *any* film type from ASA 10 to ASA 400. Flash-mate can be either of two basic types of meters. One, called an *ambient* light meter, measures the light output of your flash, aimed right at it. The other type, for measuring *reflected* light, is aimed at the subject and reads the light reflected by the subject. Your Flash-Mate can be calibrated for either type, as you choose.

How Circuit Works. The silicon phototransistor used as the light-sensing element in Flash-Mate has a very high resistance to ambient light, therefore the unit will work effectively under a wide range of lighting conditions, even including sunlight. The *sudden* light provided by the electronic flash causes a sudden drop in the phototransistor's resistance. This sudden drop in resistance pulses the trigger circuit of Q2-Q3. This pulse allows Q3 to charge capacitor C2 to a value proportionate to the intensity of the energy-producing light striking Q1. The value of this charge on C2 is then measured by FET Q4, and indicated on the meter. Because of the high input resistance of the FET, C2 does not discharge for several minutes and you have plenty of time to take a reading.

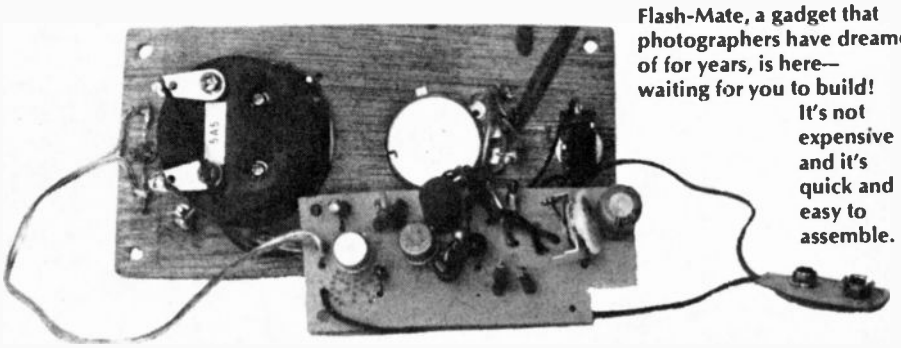
A discharge path for the meter and C2 is provided by R4 and S1. The switch turns the unit off and simultaneously discharges C2, leaving it ready for another reading, in about two seconds.

Sensitivity adjustments for various film types are effected by adjusting R8. A rotary switch could be used to connect a different trimmer resistor to the meter for each ASA number, but that would boost the cost, increase the size of the unit and limit the number of ASA numbers for which Flash-Mate can be calibrated.

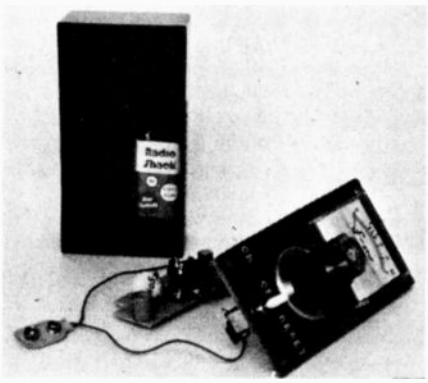
Potentiometer R8 can be calibrated for any ASA value, and as many as you want. You can even add more calibrations later. The only drawback to this compromise is that you must take care to set the pot directly on the reference marks before taking readings for a given ASA. If you exercise care and patience when calibrating the unit, this will present no problems in later use.

The two PNP transistors Q2 and Q3 are audio signal types and almost any high gain experimenter grade units will do. There are, however, few substitutes for Q1. It has a very high resistance to ambient light, has a reaction time on the order of 2.8 microseconds and has a wide range of illumination sensitivity. You can use a HEP-312, or a Clairex CL902, which also have the necessary reaction times and ambient light resistances required to keep the trigger circuit biased off until a bright, sudden light is sensed. The FET, Q4, is a P-channel, small signal unit and there are a number of substitutions possible, such as 2N5461 through 2N5465.

Assembly Options. You have a choice of assembly methods. Your Flash-Mate can be assembled on a perforated board using point-to-point wiring, or on a printed circuit board, for which the foil pattern is shown. Layout is not overly critical and you can vary the arrangement. Q1 is made with a clear epoxy lens which is quite durable, but an extra measure of protection can be provided by covering it

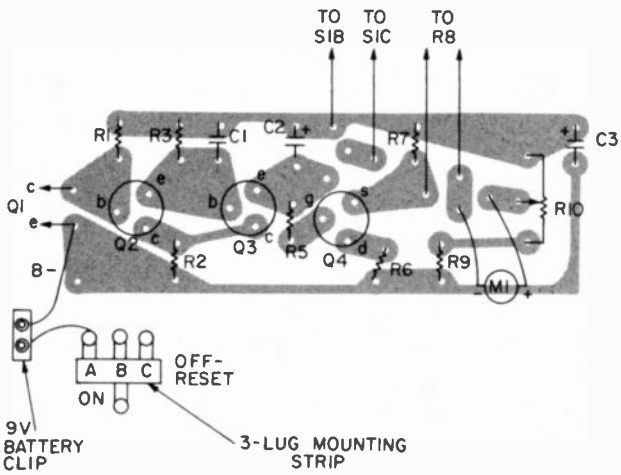


Flash-Mate, a gadget that photographers have dreamed of for years, is here—waiting for you to build! It's not expensive and it's quick and easy to assemble.



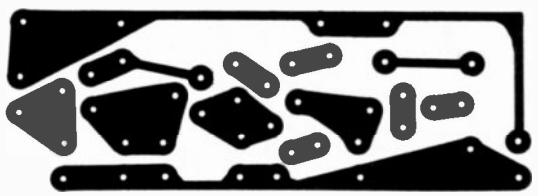
The layout of Flash-Mate's perf (or PC) board is uncritical and the arrangements of the components may vary. The roominess of the box allows for a clean layout

To calibrate Flash-Mate you will need an accurate electronic flash with an f-stop computer disc. Calibration can be done either for ambient light or bounce flash.



Here's the component side of Flash-Mate's PC board. The layout is simple and straightforward, which helps keep assembly time to a minimum. Flash-Mate is a great weekend project; accurate, unique, and goes together easily.

The foil side of Flash-Mate's board is quickly etched, especially if you use this full-size pattern. You could reduce or enlarge this as size and layout are not critical in this circuit.



with a clear pilot light lens or other clear plastic dome. The phototransistor can be mounted in several ways. You can press-fit it through a rubber grommet in the front panel of the cabinet, epoxy it through a hole, or it can be mounted on the chassis board so that it is rigidly suspended behind a hole in the front panel.

After all components are mounted and wired to the chassis board and connected to M1, R8, Q1 and S1 on the front panel, check to make sure all polarities are correct. Remember that when the chassis board is mounted in the cabinet, you have to be able to reach R10 to make adjustments. If the shaft is slotted you can drill a small hole in the cabinet facing the adjustment slot in the trimmer.

Some potentiometers have a knurled plastic wheel for adjustment which can be manually roated regardless of its mounting position.

When you are sure all is in order and you have double checked your wiring, apply power to the unit with S1. Turn R8 fully clockwise for least resistance and adjust R10 until the meter needle rests on zero. After this one internal adjustment, you can close the cabinet, screw down the front panel and prepare for the calibration procedure. You'll need a tape measure, a tripod and a flash unit.

To calibrate Flash-Mate either for ambient readings, or the reflected light reading mode, you will need a reliable electronic flash with an f-stop computer disc. You should also be sure the unit is charged fully, or has fresh batteries.

Ambient Light Reading Calibration. Set the flash computer to ASA 400. Determine the distance-from-subject necessary for an f-stop of f22. For instance, if your computer says a distance of three feet for f11, two and a half feet for f16 and 18 inches for f22, place the meter on a table and the flash mounted on a tripod exactly 18 inches in front of it. Carefully remove the clear plastic meter cover. Turn on the meter and set R8 fully clockwise and after a few seconds to stabilize, fire the flash. The meter needle should travel all the way upscale. Adjust R8 until the needle rests exactly on the uppermost reference mark of the meter scale. Label this spot "f22." Reset the meter with S1 and consult your flash computer once more to determine the distance for f16. Measure off this distance, set the flash at that spot and fire it at the flash meter. The needle should rest at a spot lower than the first. Mark this spot on the meter scale "f16." Take care not to disturb the setting of R8 during this calibration step.

Follow this procedure all the way through the scale to f2, remembering to reset the meter after each reading. When you've finished this step, replace the cover on the meter face and label the panel adjacent to R8's indicator knob "400."

This completes the calibration of the meter scale for all ASA values and the calibration of R8 for ASA 400. Select the next highest ASA on the computer and find the distance for an aperture of f16. Set the flash that distance from the meter and fire it. Adjust R8 until the needle rests exactly on the previously established mark for f16. Now mark the panel adjacent to R8's indicator knob and label it for the ASA number used to determine the distance. The meter is now calibrated for that ASA. Repeat this step for each ASA value desired. I have my meter calibrated for 25, 64, 80, 125 and 400, the five films I use most, but I can easily add more at some later date by using a reliable flash and the above procedure.

Reflected Light Calibration. The best situation is to find any wall which is an 18 percent gray, but any neutral color wall, or off-white bedsheet will do. In this procedure, the wall (or a sheet tacked up on a wall) becomes your "subject." Using the reference flash

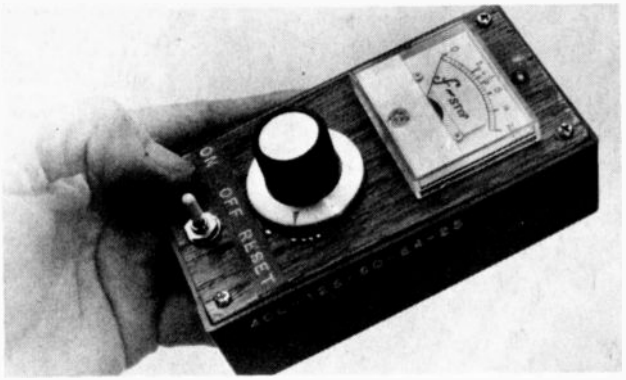
FLASHMATE

unit's computer to determine the first distance for f22 at ASA 400, place the meter and flash this distance from the wall. Both the flash and meter are aimed at the same spot on the wall. Fire the flash from just above and a few inches behind the meter to avoid "blinding" it with a strong sidelight from the flash. Mark the meter face for f22 and continue moving the meter and flash farther from the wall until f2 is calibrated. Repeat for other ASAs as in the previous step.

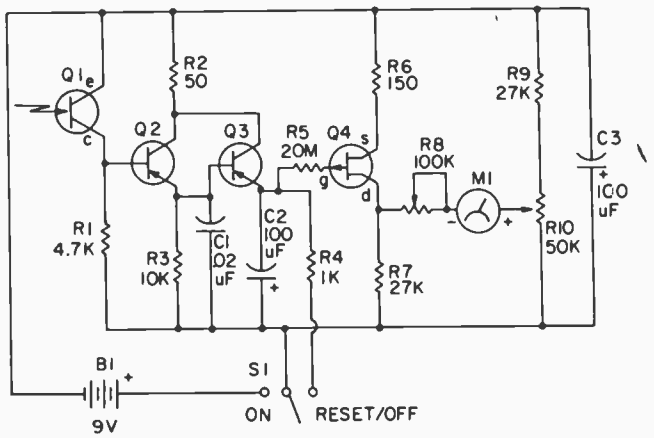
Using Flash-Mate. For the ambient light reading model, the procedure for taking a reading is as follows: Place Flash-Mate at the same location as the subject, facing the flash, and set R8 for the ASA of the film you're using and turn it on. Place the flash where you want it and fire it using the open flash button. Read the f-stop from Flash-Mate and set your camera to that f-stop.

To use Flash-Mate calibrated for reflected light readings, place it facing the subject in the same position as the flash. Fire the flash, take the reading from Flash-Mate and set your lens to that f-stop.

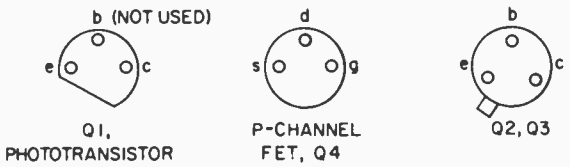
Personally, I prefer the direct, or ambient reading mode of calibration. For me, it offers more versatility. For example, your model need not be present to take a reading in advance. If you were going to shoot portraits using direct flash, bounce flash, or the popular umbrella reflector technique, you need only set up the flash and select where the model will sit or stand for the picture. Place Flash-Mate at that position, take a reading and set your camera lens. When the model arrives, all you need do is focus and shoot with no wasted time and wow, will you appear professional with no fumbling over f-stop computations or camera fiddling. If you plan to shoot from several positions during the session, these spots and their readings can be determined beforehand and noted. A piece of masking tape on the floor with the appropriate f-stop marked on it will remind you of the correct setting for that position. This technique is also handy for those special awards luncheons, handshakes, weddings, graduations, or any other planned events. You can go a little early before the event and take your readings and pick your spots from which to shoot and when that once-in-a-lifetime event occurs, you'll have a perfect exposure of it. ■



Flash-Mate is one useful gadget-bag stuffer. Forget about computing f-stops and concentrate on composing those pictures. The photo-sensitive transistor (above the meter) measures the light, and the meter reads directly in f-stops. The unit can be calibrated to read either ambient light or for bounce flash photography, depending on your own artistic preferences.



Schematic for Flashmate circuitry. Be sure when wiring in the transistors that you carefully observe lead keying, and always avoid allowing them to heat too much.



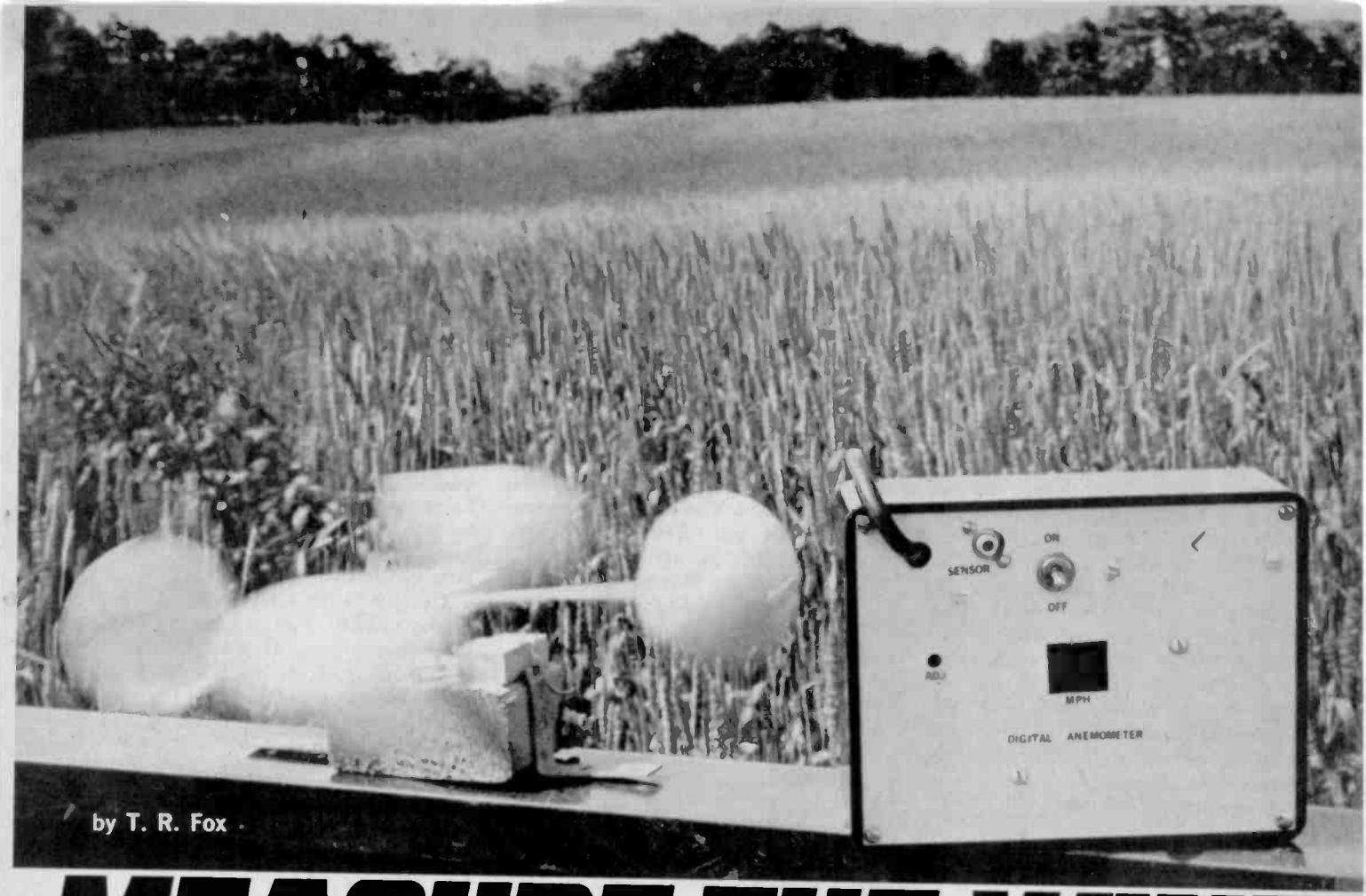
PARTS LIST FOR FLASH MATE

C1—.02-uF capacitor
C2, 3—100-uF, 16-VDC electrolytic capacitor
M1—0-50 microampere DC panel meter
Q1—Photo-sensitive transistor HEP-312 or Clairex CL902
Q2, 3—General-purpose PNP silicon transistor, 2N5139 or HEP-51
Q4—Field-effect transistor, P-channel, 2N-5460 or 2N5461
R1—4700-ohm, ¼-watt resistor
R2—47 or 50-ohm, ¼-watt resistor
R3—10,000-ohm, ¼-watt resistor
R4—1000-ohm, ¼-watt resistor
R5—20-megohm, ¼-watt resistor
R6—150-ohm, ¼-watt resistor
R7, 9—27,000-ohm, ¼-watt resistor
R8—100,000-ohm printed circuit board-mounting potentiometer
R10—50,000-ohm printed circuit board-mounting potentiometer
S1—Single-pole, double-throw switch

Misc.—Printed-circuit board kit cabinet 6¼-in. x 3¾-in. x 2-in. or larger; knob; hookup wire, hardware, solder, etc.

Note: If you use construction such as perf board, axial-lead capacitors will be more convenient to mount.

Flashmate can be built either with the printed circuit board layout presented with the article, or you could just use a perfboard and point-to-point wiring as the layout is not critical. A few final reminders: Once all components are mounted to the chassis, and wired, check to make certain you have not reversed any polarities; reall that you have to reach R10 to make adjustments so don't forget the small hole in the cabinet facing that trimmer's adjustment slot. The phototransistor, Q1, is made with a clear epoxy lens which is fairly durable and should hold up under most circumstances. If, however, you seek a measure of extra ruggedness, cover the phototransistor lens with a clear pilot light lens or any other clear plastic dome. Properly built and cared for your Flashmate will be calculating F-stops for you for years of parties, weddings, or just plain shutterbugging.



by T. R. Fox

MEASURE THE WIND

Easy-to-wire, accurate, anemometer uses ICs and LED-readout.

Increasing energy costs have driven many people to thinking of alternate sources of power, such as solar energy and water power. But the technology for these natural energy sources is still quite expensive and complicated to install. It'll be at least several years before the cost of most natural energy systems comes down enough and the parts are easy enough for most people to install. Wind power for generating electricity, on the other hand, has been available for many years. For several decades farmers and others in rural areas have used windmill generators as standby electricity and in some cases, as their main power supply. Windmills and wind-driven electrical generators can be bought off the shelf by anyone, and require no expertise other than the usual home mechanic skills to set up.

Have you wondered if there's enough wind where you live to drive a windmill electrical generator? Do you know if there's enough wind to fly that big kite you've often thought of constructing? Is there enough wind coming over the hills near your area so you can get into hang-gliding? Or do you live in an area where tornadoes or hurricanes sometimes strike? If so, it could literally be a matter of life-and-death for you to read the windspeed easily, with an accurate, easy-to-install anemometer (windspeed meter). That's what the Digital Windspeed Meter is—an accurate anemometer using the latest digital TTL (transistor-transistor logic) integrated circuits.

Though this project isn't recommended for someone who's never built any solid-state projects before, it should be easy enough for anyone who has built one or two simpler projects such as most of those published in *Electronics Hobbyist*.

In addition, it's the sort of project which will get you started easily in digital logic circuitry, the circuits and components which are the basic building blocks of computers and most other advanced electronics today.

How Anemometers Work. There are two types of electronic anemometers in general use. One type uses air cups or a wind turbine to turn a tiny electric generator whose output is directly connected to a milliammeter. The faster the wind blows, the faster the generator turns and the higher the meter reads. This type of anemometer is simple and reliable but it usually is not accurate.

A more sophisticated type uses air cups to turn a shaft to produce electric pulses. The pulses are integrated by a capacitor and related circuitry to produce a DC voltage whose magnitude is directly proportional to the wind speed. This voltage is aso displayed on a meter. This method is easier to calibrate, and thus is more accurate than the simple generator method. By

DIGITAL WINDSPEED METER

using state-of-the-art digital electronics, improvement can be made upon this method of measuring the wind's speed. Instead of the round-about method of adding up the electric pulses by charging up a capacitor, why not just count them directly? The digital anemometer described here does just that. The result is a more accurate sophisticated instrument that is easier to read and cheaper to build.

How It Works. The theory behind the digital anemometer is simple. See Fig. 1. The wind turns a shaft which has streamlined plastic cups attached to it. On one rod that holds two oppositely directed cups are placed two small magnets. A reed switch is mounted on the stationary base beneath the rotating cups so that it will be operated by the rotating magnets above. Each time the cups make a full revolution, the reed switch opens and closes twice. The pulses generated by this reed switch trigger a one-shot multivibrator (TTL-7412) which cleans up the pulses, eliminating contact-bounce and other error pulses. The cleaned-up pulses are then fed to a TTL NAND gate which is controlled by the 555 one-shot multivibrator. The 555's one-shot output pulse is manually adjustable to let us calibrate the anemometer. Another 555 astable multivibrator provides automatic triggering pulses for the 555 one-shot as well as supplying reset and blanking pulses for the counters and decoders. The resulting controlled and cleaned up pulses (which originated in the reed switch) are counted on two TTL decade counters and displayed on two LED displays.

Construction. The rotating wind sensor is made up of 4 plastic cups, mounted with 3/32-in. or 1/8-in. rods to a slot-car motor or similar cheap and readily available bearing. (The brushes of the motor can be removed if desired.) The egg-shaped containers in which *Leggs* nylons are sold are ideal for the plastic cups which catch the wind.

The rods which support the cups can be steel welding rods or (better) copper or brass. One rod should be one foot long and the other two should be six inches long.

Next, obtain a small cylindrical piece of a solid metal that is easily solderable —brass or copper is best. Drill two holes, using bits the same size as the rods, at right angles to each other through this cylinder of metal as shown in Fig. 2.

Now center the 12-in. rod in the cylinder. Insert the two shorter rods in the remaining two open holes in the cylinder, as shown in Fig. 3. Using acid-flux, solder the rods to the cylinder.

Mount the motor, which is used as the bearing, in a 2-in. long piece of two-by-four. To mount the motor, drill and file a hole in the wood large enough to take the motor. Cover the motor's case with epoxy glue and insert it in the hole as shown in Fig. 4.

Using a bit as close to the diameter of the motor's shaft as possible drill a hole about 1/2-in. deep in the bottom of the cylinder (see Fig. 3) which now has rods soldered to it. Insert the motor shaft into this hole and solder it, using acid-core flux.

(If steel is used, secure with epoxy glue.)

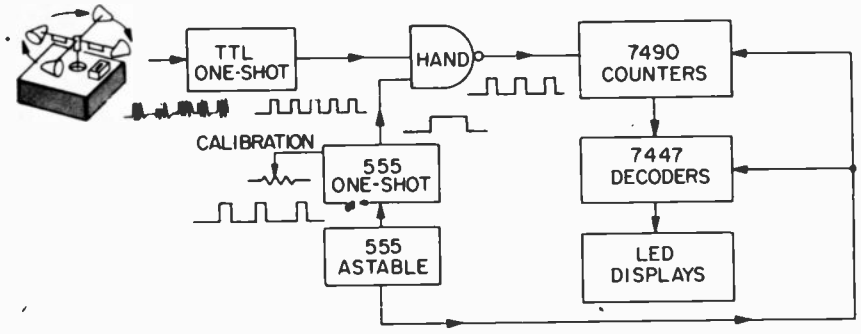
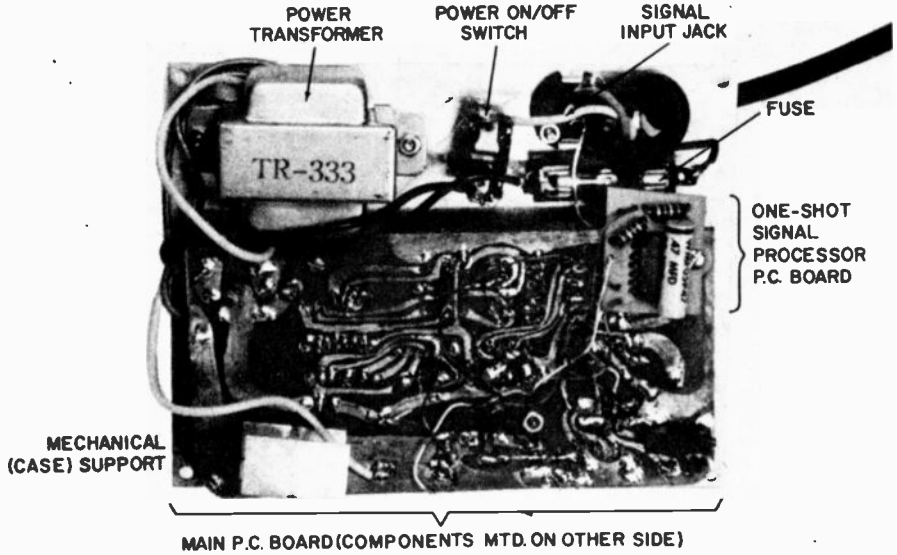


Fig. 1—Block diagram for digital anemometer. As the calibration control is varied it changes the duration of the pulse put out by the 555 one-shot. This acts as a variable window for the pulses coming from the windspeed sensor permitting accurate readout of the LEDs.



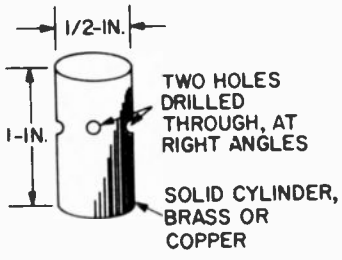


Fig. 2—Centerpiece of windspeed sensor.

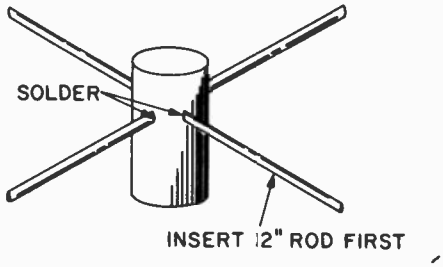


Fig. 3—Assembly of rods and centerpiece to form rotor.

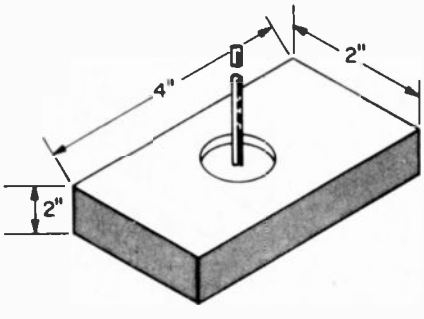


Fig. 4—Wood block mount with bearing.

Now mount the four plastic cups to the rod, taking care to correctly orient the cups. Drill holes in the cups and insert the rods in the holes. Keep the cups in place with epoxy or other good glue.

Next we mount the magnets on the rods. If copper or brass rods are used, great, just solder or glue the magnets to the undersides of two opposite rods, centering them one inch from the pivot. The reed switch is then mounted on the wood base so the magnets pass a quarter of an inch above it.

If the rod is iron or steel, we have a problem because it will distort the magnet's magnetic field. This problem is overcome by using a non-magnetic spacer between the magnet and the rod —¼-in. is enough space. A ¼-in. x 1-in. piece of wood is glued to the rod and then the magnet glued to the wood. Since there is very little weight involved, a good glue will hold the magnet fine. This completes the construction of the wind sensor.

Circuit Assembly.. To build the cir-

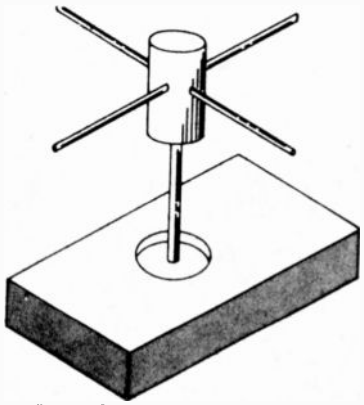


Fig. 5—Rotor in place on bearing.

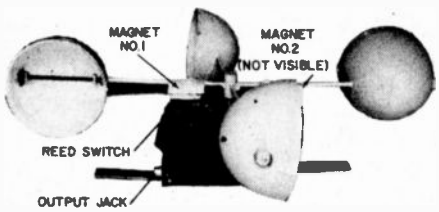


Fig. 6—Completed unit. Adjust height of reed switch so magnets pass about ¼-in. over it or less.

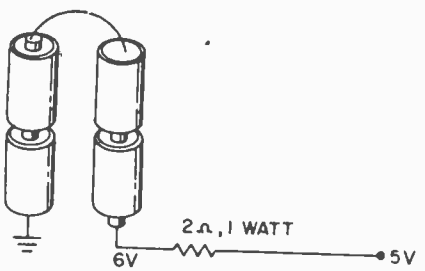
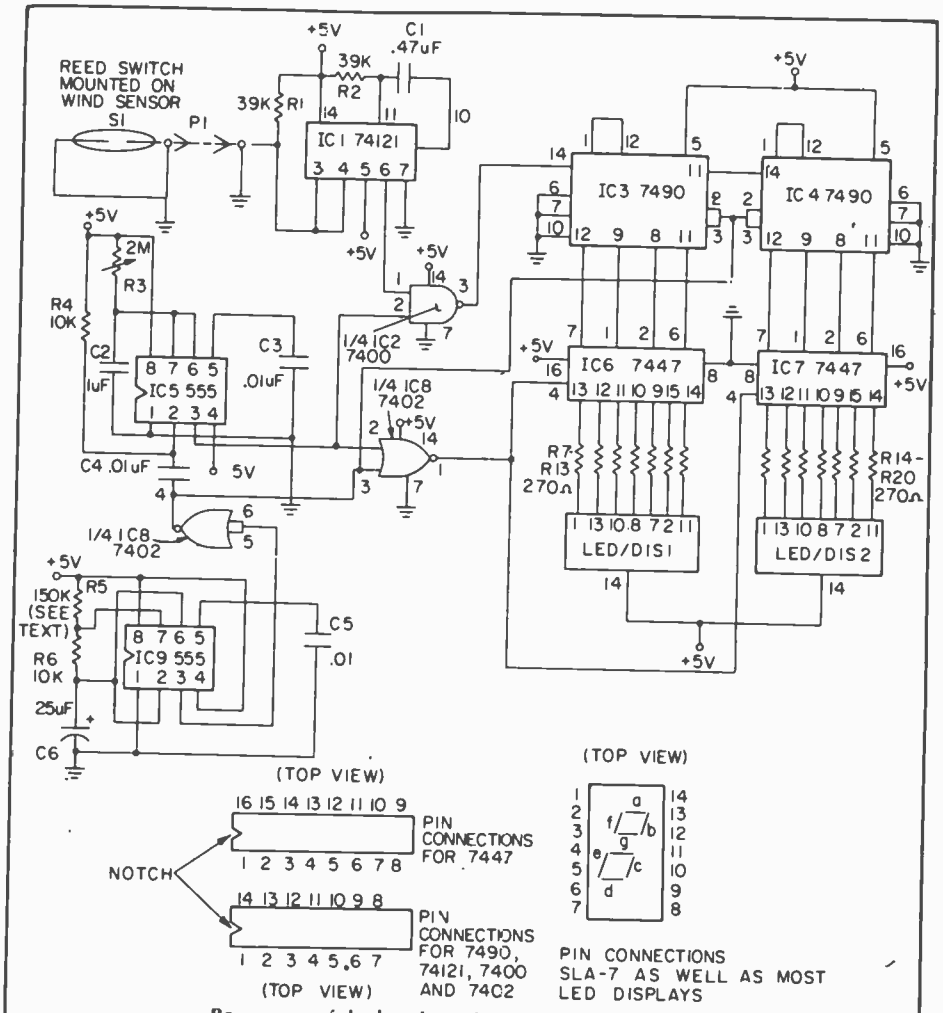


Fig. 7—Temporary battery power supply for use when calibrating the instrument in an automobile.



Be very careful when inserting IC into their respective sockets. Be sure right types are inserted and oriented so that IC half-moon keys align correctly with sockets.

PARTS LIST FOR DIGITAL WINDSPEED METER

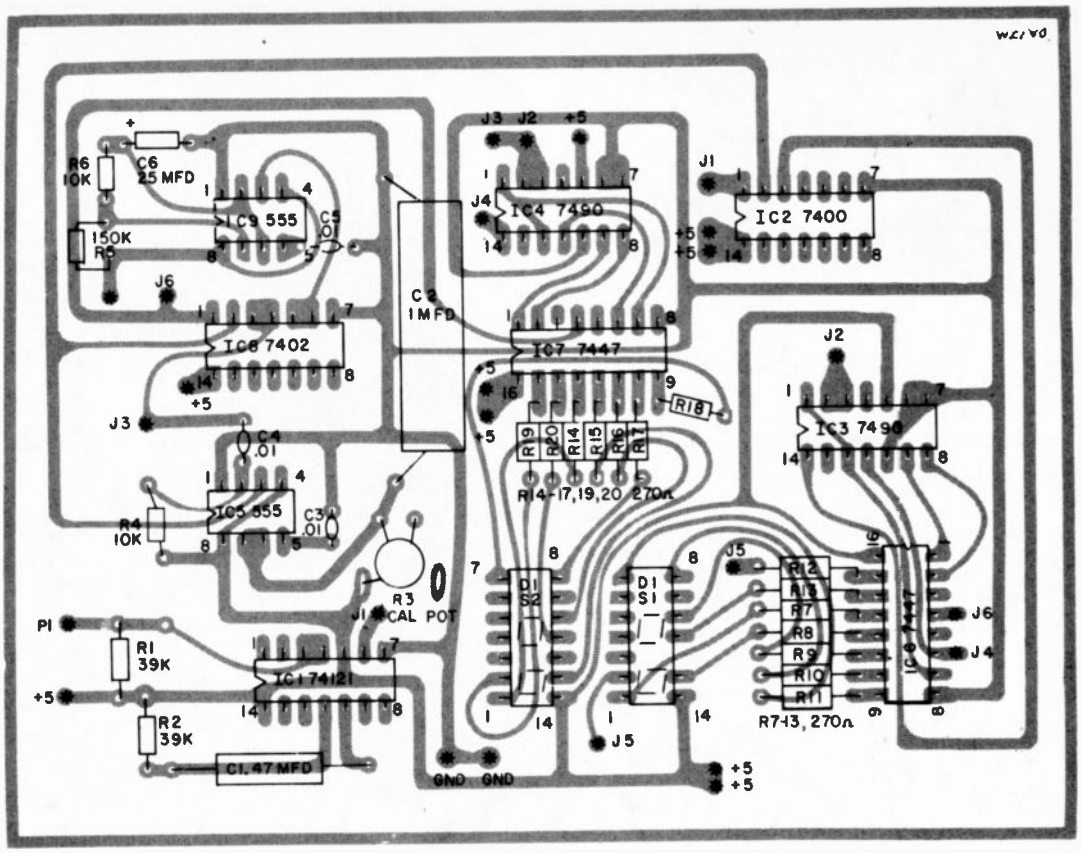
C1—0.47-uF, 50-VDC capacitor
C2—1.0-uF, 50-VDC capacitor
C3, C4, C5—0.01-uF, 50-VDC capacitor
C6—25-uF, 35-VDC or more electrolytic capacitor
LED1, LED2—LED display numerals (Radio Shack 276-053 or equiv.)
IC1—74121 monstable multivibrator integrated circuit, TTL type
IC2—7400 NAND gate integrated circuit, TTL type
IC3, IC4—7490 decade counter integrated circuit, TTL type
IC5, IC9—NE555 integrated circuit
IC6, IC7—7447 BCD-to-Decimal decoder, TTL type
IC8—74C2 NOR gate, TTL type
P1—2-connector jack (& matching plug for cable) RCA-type phono plug recommended
R1, R2—39,000-ohm, ¼-watt resistor
R3—2-megohm printed circuit board-mounting potentiometer (Allied Radio 854-6287 or equiv.)
R4, R6—10,000-ohm, ¼-watt resistor
R5—150,000-ohm, ¼-watt resistor
R7—R20—270-ohm, ¼-watt resistor (14 needed)
S1—Miniature reed switch (Radio Shack 275-033 or equiv.)

Misc.—Four plastic cups such as the containers Leggs stockings come in. Two small magnets such as the "Magic" magnets most hardware stores carry. One 12-in. and two 6-in. pieces of copper or brasss rod, ⅛- or 3/32-in. diameter. One slot car motor or equiv.), for use as bearing. One piece of copper or brass rod about 1-in. long, ½-in. diameter (solid). One 2-in. piece of wood two-by-four. Epoxy glue, solder, mounting brackets (two) for wood block, screws. Ten IC sockets.

POWER SUPPLY

The Digital Windspeed Meter requires a regulated five-volt DC power supply. The easiest way to do this is to hook a 2-ohm resistor in series with a six-volt battery. This is also the safest power.

DIGITAL WINDSPEED METER



The pictorial shows the location of compenents as seen from the bottom (the components are on the far side of the board, from the viewers perspective) with the foil-side up. It is best to secure the ICs by using IC sockets, although you can solder them directly by using a low-wattage soldering iron (25 watts would be good). You might use sockets when mounting the display sockets to allow easy replacement if necessary. Since the location of components isn't critical, this circuit can be assembled on perf board if that's easier.

cuit use any convenient layout on a perf board. The position of the components is not critical. If you haven't worked with ICs before you'll be better off soldering IC sockets in place on the perf board, and connecting the other components to the pins of the IC sockets. If you've had a fair amount of experience and can solder ICs directly into a circuit without overheating the pins (using a pair of long-nose pliers as a heat sink while soldering to each pin), do it that way.

The main job in wiring the anemometer lies in making the printed circuit board. The pattern shown can be made by using the simple resist method. Simply draw the pattern with a felt-tipped resist pen on the foil side of the printed circuit board, place in etching solution for an hour or so and drill the holes marked. The somewhat more sophisticated, yet still easy, non-camera photo method can also be used.

If a small 25-watt soldering iron is used, the *ICs* can be soldered directly to the board, although IC sockets are less risky. Be sure to orient the notch on the *ICs* as shown in the component layout diagram. It is always wise to use IC sockets when mounting display LEDs. Be sure to either bend back or cut off pin 12 on the socket which is used to mount Display No. 1.

Unless double sided PC boards are used, jumpers made up of hookup or bare wire are needed. Place jumpers between the two J1s, J2s, J3s, J4s, J5s and J6s. In addition, interconnect the +5 VDC points on the PC board with jumpers (6 needed).

Connect the two leads from the remote mounted reed switch to points P1 and to one of the two GNDs.

Connect the plus power supply lead to the +5 point at the top of the board. Connect the other supply lead to the other GND point which is also located at the top of the board.

The 5-volt regulated TTL power supply described by Herb Friedman on page 61 of this issue of Electronics Hobbyist is ideal for this project. This power supply is compact enough to easily fit in the same case as the logic unit.

The entire circuit can be mounted in any convenient size bakelite or aluminum case with aluminum panel. For a smart appearance, spray paint the panel with some auto-touch-up white lacquer. Use dry transfer decals for the lettering.

Cut a slot in the panel so the two digit LED display can be readily seen. If desired, the switch to turn on the power can be an inexpensive slide switch but a toggle switch is more reliable and easier to mount. The circuit board and all other components should be mounted to the back of the front panel for ease of accessibility.

If one desires a longer display time, increase R5 from the recommended 150k to 220k or even 270k.

Any type of two-conductor connecting jack can be mounted on the front panel (I used an RCA-type jack) as long as the appropriate plug is used. The two wire cable which connects the rotary wind sensor to the electrical unit must be long enough to reach from the roof to the place in your home where you want to keep the display unit. Any kind of shielded cable, including audio cable or microphone cable is OK. Coax such as RG-59/U is fine, but don't buy it special for this job because it costs much more than other (audio) cable.

Calibration. This anemometer is easily calibrated since there is just one pot to adjust. As an initial test, plug the unit in and connect the wind sensor to the display unit. After a few seconds warmup the unit should show 00 then go momentarily blank. Turn the cups by hand and a number should appear on the display for a second or two and then disappear for a second. Now turn the cups as fast as you can by hand and adjust the calibration pot to read as close as possible to 20. If everything so far works OK, it is time to take the anemometer for a ride. If not, go back to Square One and check your wiring and the seating of the LED display modules.

The anemometer should be calibrated against an accurate automobile's speedometer. Since the anemometer will be away from the regular house supply, you will have to take along a 5-volt

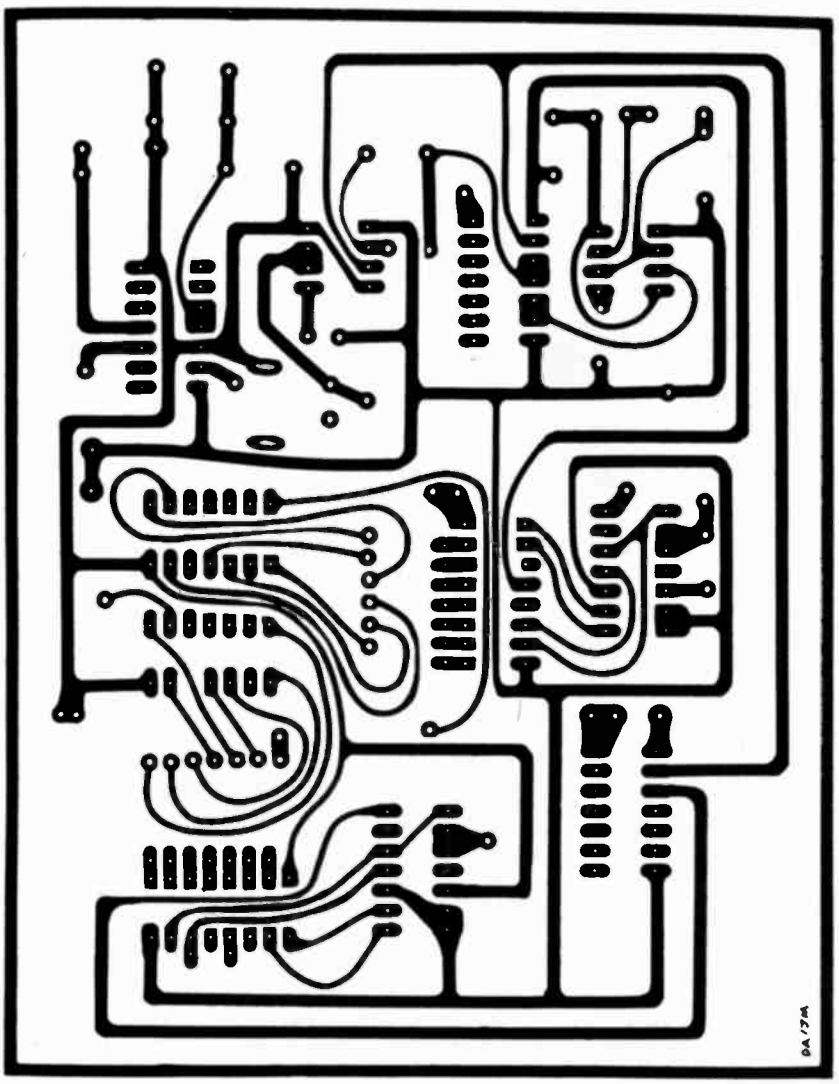
(Continued on page 100)

battery supply. In order to drop the voltage to the required 5 VDC, you must connect a 2 ohm resistor in series with a 6 volt battery.

With someone else driving, take the unit in an auto on a nearly calm day and drive as steadily as possible at a certain definite speed, say 30 mph. Drive up and down a quiet road, with the wind sensor held out the window and adjust the calibration pot so the display will read an average value of 30.

Use. The wind sensor should be mounted on a roof or other location where there are few obstructions. Because of the one-shot ahead of the NAND gate, the anemometer may suddenly go blank, when winds are of hurricane speed. So if the display one minute shows 75 mph and the next minute 00, don't stick your head out the window to see if something happened to the wind sensor on your roof, a tree might just be sailing by.

A simple way of checking your speedometer is to drive down an expressway at 55 and have someone time you betwen two mileposts. Then get your hand calculator out and divide 3600 by the number of seconds it took you to travel the mile. The result is your true speed. ■



The key to building a successful Digital Windspeed Meter is the making of an accurate printed circuit board. As you can see, many of the foil strips are in close proximity to each other. Be sure not to let any of the lines touch where they aren't supposed to; the resulting short circuit would probably damage one of the integrated circuit chips. Probably the best method for this circuit, if you are not equipped to use a photo-etching technique, is to use a resist type felt tipped pen and sketch the patterns on the copper-plated board. The board is then soaked in an acid etching solution for an hour or so. After the pattern is reproduced in copper you should drill all the holes. If you have a small drill-press, use it—a hand-held drill is likely to slip and damage the circuit.

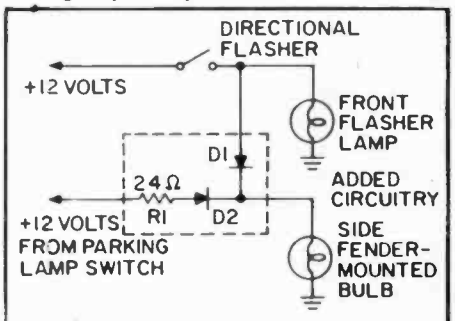
Turn Signals from Side Marker Lights

☐ Side clearance lights are the lamps usually mounted on the front and rear fenders. These lights can be made to provide additional driving safety by adapting them to flash *in unison* with the directional flashers if the auto does not now have rear flashers.

The circuit diagram shows how the present auto or pick-up electric wiring is modified so the side lights will also flash. A 24 ohm resistor is added in series with each side-clearance lamp bulb filament. This reduces the brilliance of the side bulb to about half of what it was originally. An epoxy diode is used to isolate the parking lamp filament from the flashing light circuit.

A separate wire lead is run from the side lamp to the directional flasher lamp on the same side of the auto. The side clearance lamp will then flash in unison with the front directional flasher lamp. A second diode is used to isolate the flasher filament from the parking light circuit so that it will not turn on when the parking light turns on.

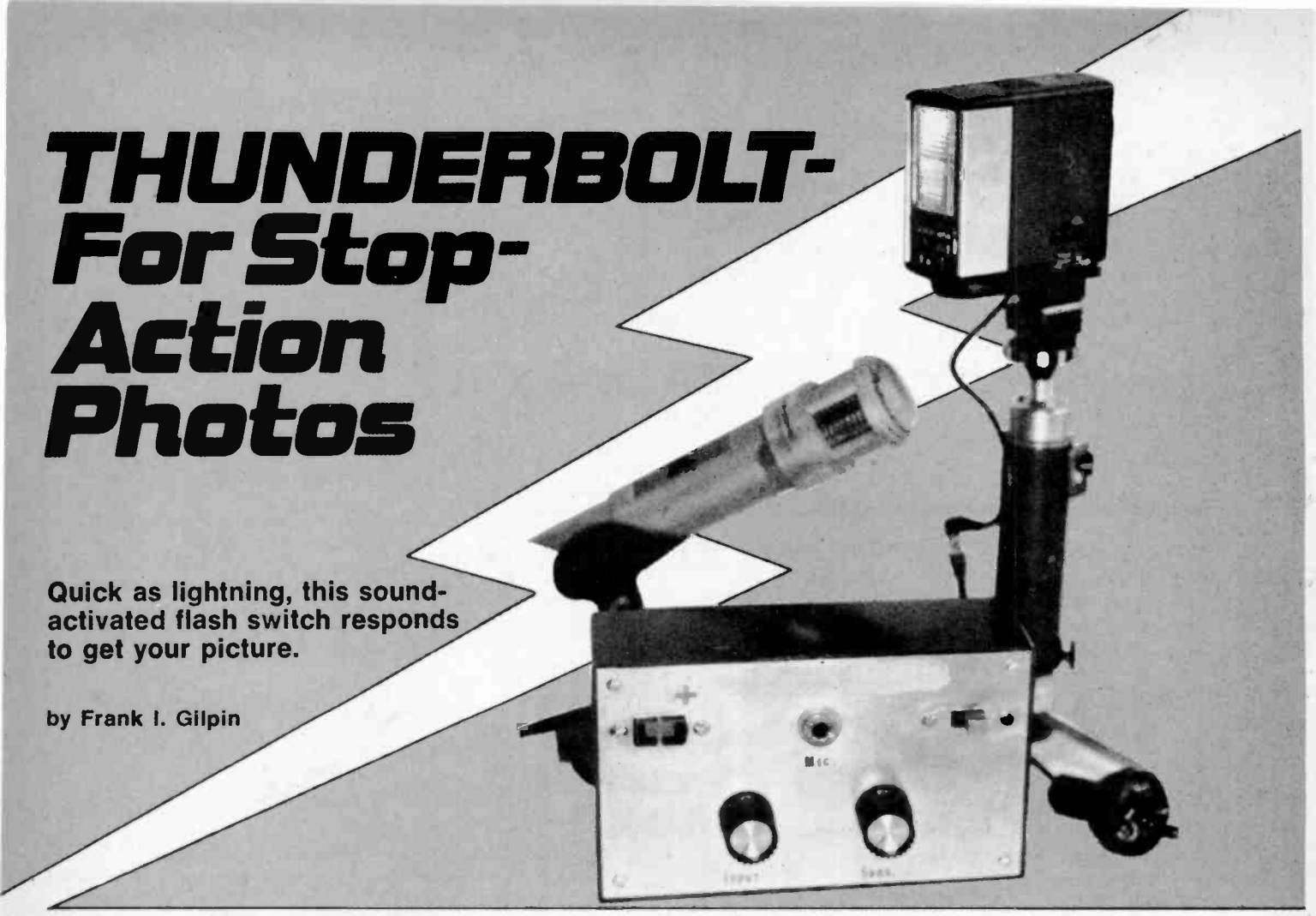
Make good electrical connections by using instant auto electric connectors or soldering with a good soldering iron. Wrap all connections and components with a good amount of black plastic electrical tape so that they will withstand the weather. The side clearance lights will now flash not only with the directional signals but also when the emergency 4-way flasher is turned on. ■



PARTS LIST FOR ADD-ON TURN SIGNALS

D1, D2—Diode 1 amp, 50 PIV or better (Radio Shack 276-1135 or equiv.)
R1—24-ohms, 1-watt resistor (Radio Shack 271-1000 or equiv.)
Misc.—wire, electrical tape.

THUNDERBOLT- For Stop-Action Photos



Quick as lightning, this sound-activated flash switch responds to get your picture.

by Frank I. Gilpin

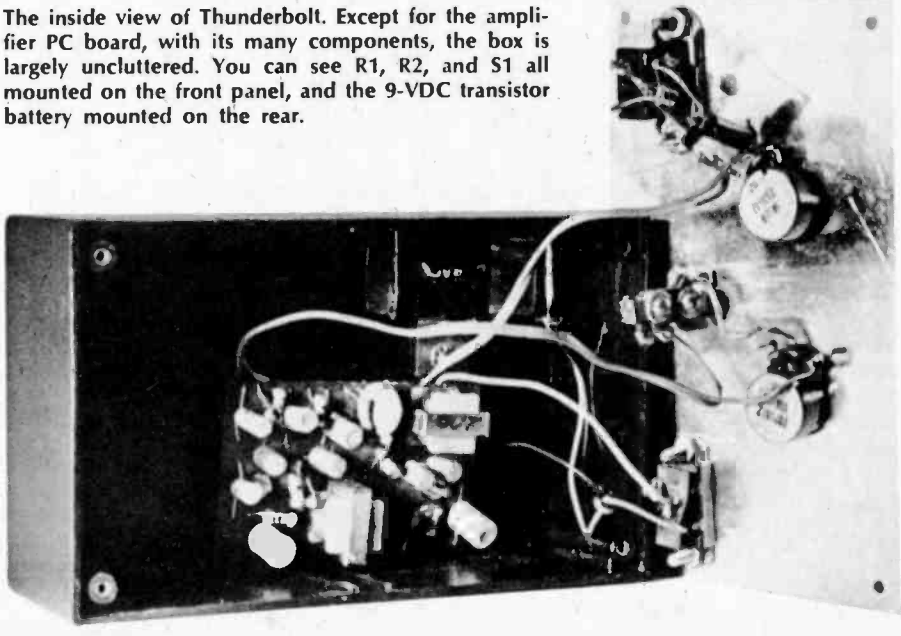
HOW WOULD YOU LIKE TO CAPTURE the sphere-capped minaret of a drop of water at the precise moment it strikes the surface of a pool, or a bursting balloon with the piercing dart still in mid-air? All you need is this easily-constructed, sound-activated, electronic flash—Thunderbolt.

Sound-activated switches have been around a long time. The first one I built 18 years ago weighed 25 pounds and would have cost nearly $100 if I hadn't cannibalized some old radios for the parts and tubes . . . remember tubes? When I built Thunderbolt a few months ago it cost five dollars and weighed in at about eight ounces. What made the difference? Solid-state components, including a silicon-controlled rectifier, make it lighter and cheaper—and it works much better and faster.

How It Works. Sound picked up by a microphone is boosted by an amplifier which feeds the signal in the form of a rectified pulse (via R3 and D1) to the gate and cathode of the SCR. The SCR is internally like three diodes connected (alternately) in series—positive-negative-positive—so it acts like a conventional rectifier in the reverse direction. Thus, the SCR's forward conduction is controlled by operating the "switch," or *gate*. Since the sound we are picking up is a single, sudden sound of short duration, it acts like a pulse, when magnified by the amplifier, and it causes the SCR to conduct. An electronic flash unit connected across its anode and cathode "sees" this conduction as a direct short so it flashes.

In practice, you will find a wide latitude of application techniques possible. You can control the microphone's sensitivity so it will respond only to certain higher level sounds, if the ambient noise level is high. Additionally, you can select the time at which an event is photographed by varying the distance between the event and the mike.

Various Applications. Let's say, for example, the event to be photographed is a coin dropping into water. By placing the mike very close to the container of



The inside view of Thunderbolt. Except for the amplifier PC board, with its many components, the box is largely uncluttered. You can see R1, R2, and S1 all mounted on the front panel, and the 9-VDC transistor battery mounted on the rear.

water, and by turning up Thunderbolt's sensitivity control, you can freeze the coin as it first touches the water. On the next shot, repeat the event, but place the mike farther away from the point of impact. The sound must now travel farther to reach the mike and the flash will go off at a later stage in the splash sequence.

By repeating this process, you can get a series of shots to cover the entire sequence from the coin first touching the water, to the final catapulted droplet falling back into the water. It could be a club flattening a golf ball, a dart bursting a balloon, a hammer shattering a light bulb, or a (patient) athlete diving into a swimming pool. Any event which produces a sound, faint or deafening, can be recorded on film at the decisive moment chosen by you.

The great advantage of Thunderbolt is that it is totally electronic, as opposed to the electromechanical heavyweights of a few years ago. The older devices depended on mechanical relays and electromagnets to close a switch. This mechanical energy transfer added milliseconds to reaction time. Even that is a significant interval when you are planning to break up into sequences such events as bursting firecrackers and shattering lightbulbs. Once the sound gets to Thunderbolt's mike the reaction time approaches the speed of light. That's about as fast as you're going to get—in *this* world.

Putting Thunderbolt together is easy, because the most complicated part—the amplifier—is a module, ready to wire into a circuit with just a few simple connections and a handful of other parts.

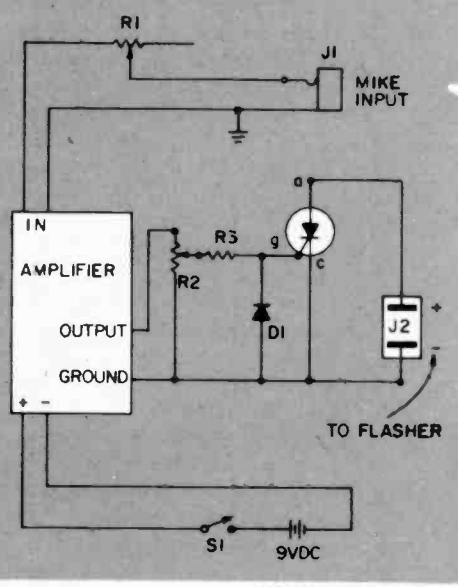
Building It. Begin by selecting an amplifier. Almost any inexpensive module will do as long as it has an output transformer. Note that most modern transistor amps don't have an output transformer. Radio Shack and Lafayette Electronics sell suitable amp modules for less than six dollars apiece. Any amp capable of delivering a couple hundred milliwatts is sufficient. I scavenged the amp for my Thunderbolt from an old, discarded portable tape player. You can find many of these old reel-to-reel relics in second-hand stores for a dollar or two. Goodwill and Salvation Army Thrift Shops are a good hunting ground. All you need do with these old units is carefully trace and identify the input and output leads and the battery supply leads. If you get a unit that's fairly intact, it may even have volume and tone control pots which are of the correct value for your Thunderbolt.

The cabinet I show in the parts list will accommodate almost any transistor amp you select. You could even get ambitious and build a simple transistor amp. Most any old tube amp will also work fine, though it'll be quite bulky.

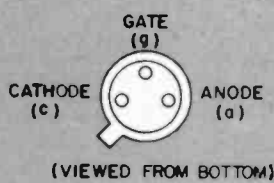
Just which mike jack, you use will depend on the plug on the microphone you use. It may be a standard phone jack, or the miniature type—whatever, as long as it matches your mike plug. When you have all the parts in hand, arrange them on the cabinet's front panel and mark the panel for the mounting holes to be drilled. Parts placement is not critical, but the leads to R1 and R2 should be kept short. If you locate S1 close to the *sensitivity* control, R2, then you can use point-to-point wiring for the SCR, D1 and R3. They are rigid enough to be self-supporting if the leads are kept short; otherwise a tie-point terminal can be used. Follow the schematic and wiring illustrations carefully and you'll have no trouble. You must use shielded (co-ax audio cable) for the input connections from R1 to your amp.

Hookup To Flashgun. After making all the connections, double check your work. Be sure you have connected the SCR's three leads correctly and check the polarity of D1. When you are sure everything is in order, you'll need to make a connector cord for your flash unit. Insert the PC plug of your flash extension cord into the flash unit's sync cord. Both ends of some brands of extension cords look almost alike and you don't want to cut off the wrong end. With one end plugged into your flash unit to make sure, cut off the other end close to the plug. Strip off the insulation and carefully separate the braided

Closeup of the front panel, showing the way SCR1 is mounted directly on S1, and D1 and R3 attached to R2.



Schematic diagram for Thunderbolt. As you see, most of the components are encapsulated in the amplifier, which is described fully in the text. Virtually any amplifier will do, as long as it produces a couple hundred milliwatts. The diagram below shows the connections to SCR1.



PARTS LIST FOR THUNDERBOLT

R1—10,000 ohm potentiometer
R2—5,000 ohm potentiometer
R3—2,200 ohm half-watt resistor
D1—PIV 50 volts Rectifier Diode
J1—To suit your mike. (see text)
J2—AC chassis-mount receptacle
S1—SPST slide switch
SCR—Silicon Control Rectifier (General Electric C5G or equivalent in TO-5 type case.)
Misc.—Wire, solder, two control knobs, chassis box (see text), a PC type extension cord for electronic-flash sync cord, and an AC plug. Total cost for all parts should not exceed $12, excluding chassis.

You'll find Thunderbolt to be one of the most useful photographic accessories. It's easy to build, both at the worktable and on the pocketbook, and is a truly fun project. Before you know it, you'll be happily strobing away roll after roll.

shielding from the inner conductor of the co-ax cord. There is little or no standardization in the photo industry, so you can't be sure that the inner conductor of any given sync cord is connected to a positive voltage when plugged into a flash unit. Some units have a positive ground and some have a negative ground. In order to make sure your Thunderbolt will work with any flash unit, you need a plug which can be reversed for any polarity match. You may have more than one flash unit and they may not be the same, hence the adaptor cord.

Plug one end of your modified cord into Thunderbolt and the other into the flash unit's sync cord. Set the *sensitivity* control, R2, at the center of its rotation and *input* control, R1, fully counter-clockwise. Plug in a microphone and apply power to both the switch unit and the flash unit. The flash may fire once or twice by itself before it settles down. If the flash unit keeps firing as fast as it recycles, reverse the plug in J2 to get the correct polarity match.

With the polarity established, whistle or hum into the mike as you slowly turn R1 clockwise. The flash should go off. From this point, it's a matter of see-sawing controls R1 and R2 back and forth until you get the hang of your mike's sensitivity. The best way to discover what your Thunderbolt can do is to use it in a closely controlled test set-up. This procedure is easier with an assistant, so recruit a friend.

This is one of the things you can do with Thunderbolt. You can use it to capture any sound-producing motion instantaneously, as long as the object to be photographed is within the range of your electronic flash gun.

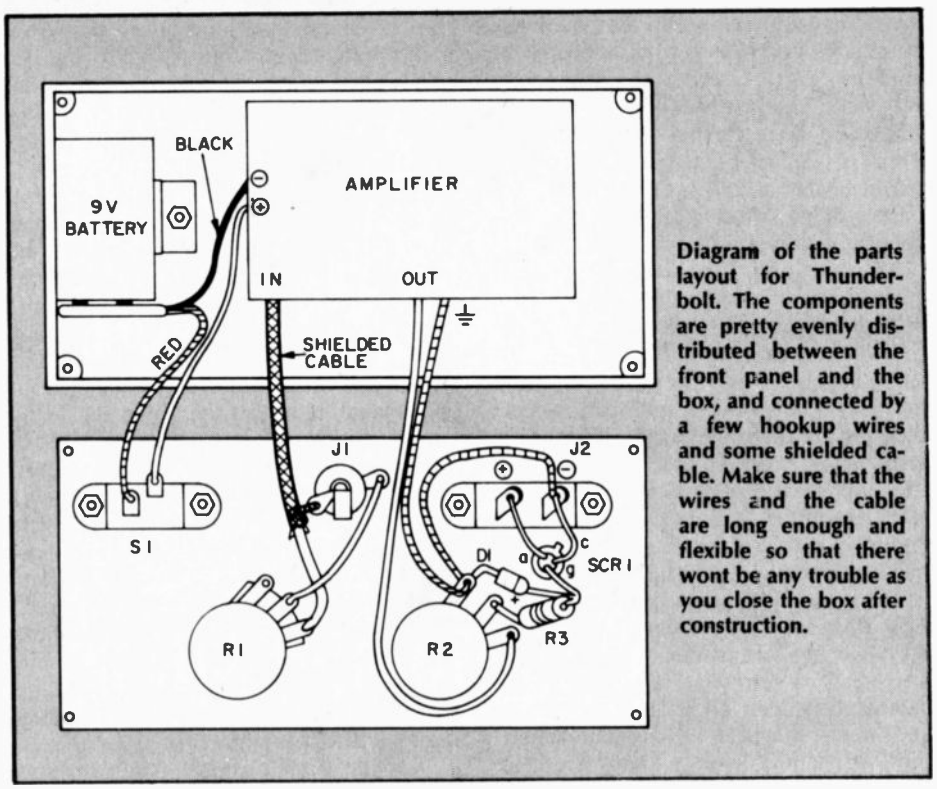


Diagram of the parts layout for Thunderbolt. The components are pretty evenly distributed between the front panel and the box, and connected by a few hookup wires and some shielded cable. Make sure that the wires and the cable are long enough and flexible so that there wont be any trouble as you close the box after construction.

Against a dark background, set up a clear glass, or bowl, of water. Place the mike as near to the bowl as possible without it getting into the picture area. Position the flash on a tripod and aim it at the bowl. The camera, also tripod mounted, should be aimed at the bowl at a 45 degree angle to the flash. Focus on the surface of the water and compute your f-stop as you normally would for a flash shot using the flash's guide number divided by its distance to the subject. (For instance, if the manufacturer's recommended guide number for your flash is 45 when used with ASA 25 film and your flash is placed five feet from the subject, divide 45 by five. Since the answer is nine, choose the f-stop closest which is f-8).

Set the camera's speed control on "B" as you would for a time exposure. Attach a locking type shutter release cable to the camera and position your assistant close to the bowl, but out of the camera's field of view.

Turn off all the lights in the room and open the lens with the shutter release cable, but *do not* remove the lens cap yet. With your assistant poised over the bowl, ready to drop a coin into the water, turn on the flash unit and the switch unit. The flash may go off, triggered by the sound of its own switch, which is why you've left the lens cap on. Wait for the flash to recycle, then snap your fingers. It should go off again. When it recycles, remove the lens cap and give your assistant a visual signal to drop the coin. As the coin hits the water, the flash will go off and you can close the shutter and replace the lens cap.

On the next shot, move the mike a foot or two farther away and repeat the process. On successive shots, move the mike exactly the same distance farther away. You should have a complete sequence after about six to eight shots.

The film should be a very slow film, that is one with a very low ASA number, such as Plus-X by Kodak, which has an ASA of 125. If you have a set-up which requires you to have more room illumination in which to work, use an Othro type film which is insensitive to red light. With this film, you can use a fairly bright red light in the room without affecting the film image while the lens is open.

Once you've done a series such as the water bowl and coin, you will know what Thunderbolt can do for you and how to predetermine its sensitivity to a given sound. When you have all its parameters for operation understood and set up, you can start thinking of things to do with Thunderbolt. Its applications are virtually limitless, since the principle of stopping sound-producing motion is an especially fascinating one. You can use it indoors in ordinary ways, such as the coin and bowl technique, or you could even use it for crime detection, by fixing it at night on a window or door you expect an intruder to come through. Any sound he makes will take his picture. Good luck! ■

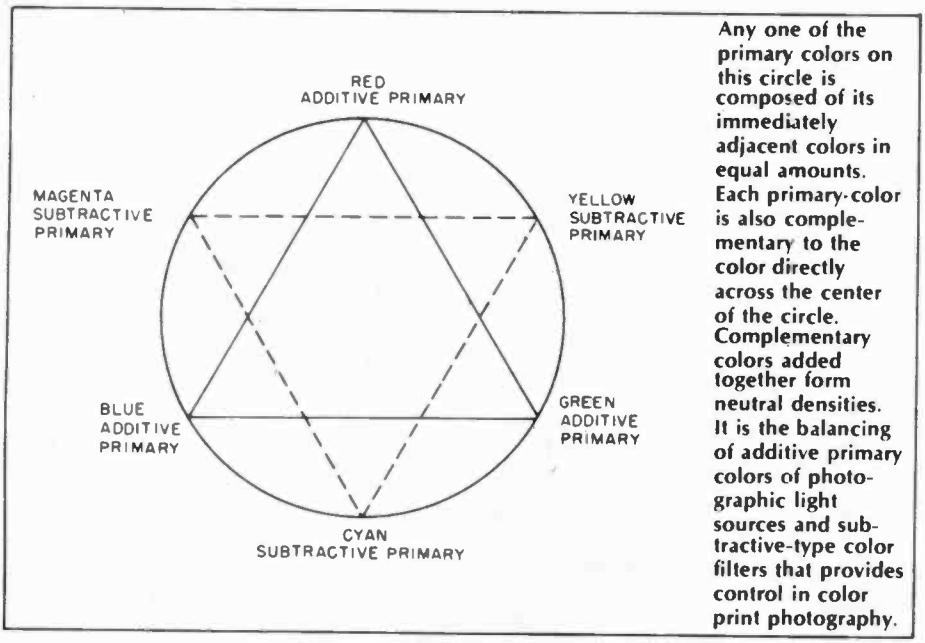
Darkroom Color Analyzer

by Herb Friedman

It's easy to make quality, bright color prints at home with modern color chemistry and this electronic color analyzer!

ONE OF THE SHUTTERBUG'S most satisfying accomplishments is producing his own color prints. For years the time spent on and the cost of making color prints were discouraging, but with modern color chemistry, such as the Beseler system, you can turn out quality color prints *in less time than for black and white* (about 3 minutes), and the prints will be far superior to anything you're likely to get from a color lab.

One thing that takes the drudgery out of color work—besides the chemistry—is a color analyzer, a device that gives you the correct filter pack and exposure time at the very first crack. Most often, the very first print made with the analyzer will be *good*. At most, it will take perhaps 0.10 or 0.20 change of filtration for a *superb* print. This is a lot less expensive and time-consuming than making test print after test print. In fact, it's really the color analyzer that puts the fun into making your own color prints!



Any one of the primary colors on this circle is composed of its immediately adjacent colors in equal amounts. Each primary-color is also complementary to the color directly across the center of the circle. Complementary colors added together form neutral densities. It is the balancing of additive primary colors of photographic light sources and subtractive-type color filters that provides control in color print photography.

Color Analyzers Are Not Cheap. A decent one costs well over $100, and a good one runs well over $200. But if you've got even a half-filled junk box you can make your own color analyzer for just the junk parts and perhaps $10 to $15 worth of new components.

A color analyzer is basically a miniature computer. You make a "perfect" print the hard way—by trial and error—and then calibrate the analyzer to your filter pack and exposure time. As long as you use the same box of paper and similar negatives, all you need to do to make a good color print is focus the negative, adjust the filter pack and exposure so the analyzer reads "zero," and hit the enlarger's timer switch. Even if you switch to a completely different type of negative, the analyzer will put you well inside the ballpark, so your second print is a winner. (And even if

the filtration is off, the exposure will probably be right on the nose.)

Construction. The color analyzer shown was specifically designed for the readers of this magazine—essentially an electronics hobbyist with an interest in photography. All components are readily available in local parts stores or as junk box parts. Several protection devices have been designed into the circuit so accidental shorts won't produce a catastrophe. The printed circuit board template has foils for both incandescent and neon meter lamps, as well as extra terminals so you can use either a socket and plug or hard wiring for the color comparator and exposure sensor. In short, you can make a lot of changes to suit your individual needs.

The template for IC1 uses a half-minidip, Signetics V-type package lead arrangement. However, you can also use an IC with a round (TO-5) configuration. If anything is wrong with the IC you can get the TO-5 out easily. The half-minidip removal might result in destruction of the PC board. We'll explain how to install the TO-5 IC on the PC board later.

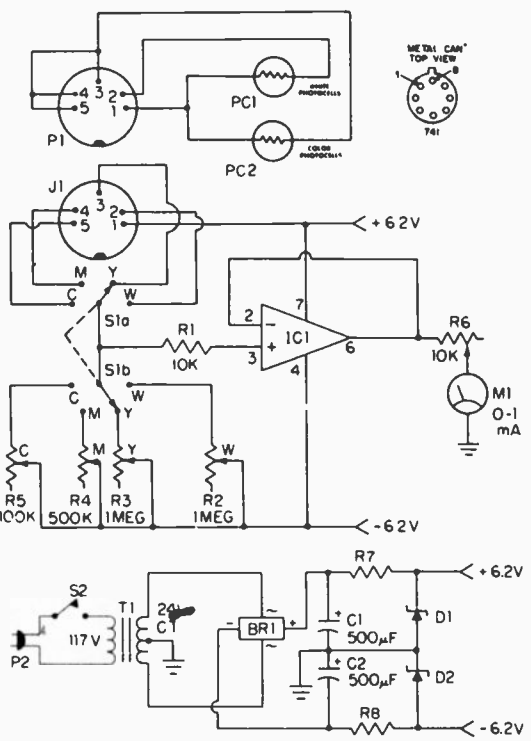
You can either buy or make the printed circuit board (see parts list). Either way, the first step is to prepare the printed circuit board. If you do it yourself, make it any way you like, using free-hand or template resist. Nothing is critical, but be certain there are no copper shorts between the terminals for IC1. Use a #56 bit for all holes. Then use a larger bit for transformer T1's mounting screws (#4 or #6 screws), a ¼-in. bit for resistor R6, and a #30 to 40 bit for the linecord connections (any bit that will allow the linecord wires to pass through the board).

Assemble the power supply and check it out before any other components are installed. Install transformer T1 first. Any 24-volt or 25.2-volt center-tapped transformer that will fit on the board will be fine. Get something small, like 100 milliamperes. A Wescom 81PK-100 is a perfect fit.

Bridge rectifier BR1 is the low cost "surplus" found in many distributors. This type has the positive and negative outputs at opposite ends of a diamond. The AC connections are the remaining opposite ends. Note that BR1 is installed in such a manner that its negative output is farthest from transformer T1 while the positive output is nearest to T1. Make certain your bridge rectifier has the same lead configuration; if it is different, modify the printed circuit template to conform to the rectifier you're using. Get it right the first time.

Finally, install C1 and C2, R7 and R8, and zener diodes D1 and D2. Take care that the capacitors and zener diodes are installed with the polarity correct. If the capacitors have their negative leads marked with an arrow or line, these markings face the *opposite edges* of the PC board (negative to the outside). The zener diodes are installed so that their cathodes (the banded ends) face each other towards the center of the board.

Initial PC Checkout. When the power supply is completed, temporarily connect a linecord. Connect the negative lead of a meter rated 10 volts DC or higher to the foil between T1's mounting screws (that's ground). Connect the meter's positive lead to the junction of R7 and D1, which is in the center of the board; the meter should indicate approximately +6.2 volts DC. Then connect the positive meter lead to the R8 and D2 junction, which is near the edge of the board. You should get approximately −6.2 volts DC. If the voltages



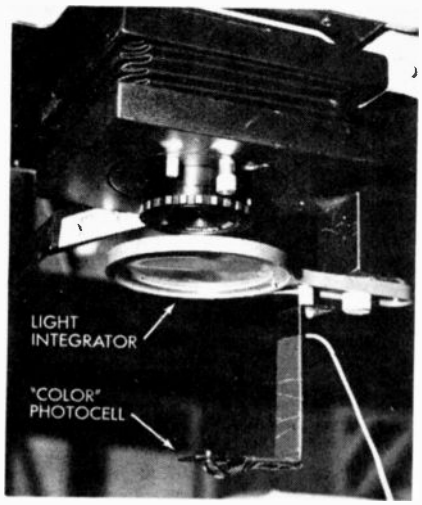
PARTS LIST FOR COLOR ANALYZER

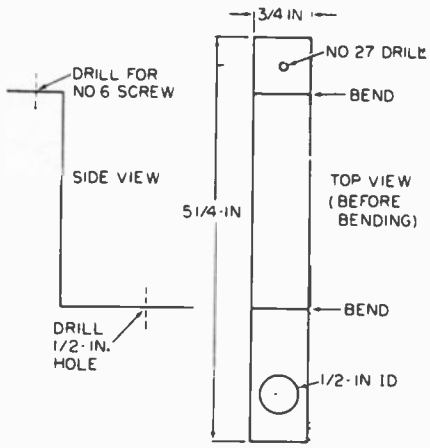
BR1—50-PIV, 0.5-amp or higher silicon bridge rectifier
C1, C2—500-uF, 10-VDC or better electrolytic capacitor
D1, D2—6.2-volt, 1-watt zener diode
IC1—type 741C operational amplifier, see text
J1—5-pin socket, DIN-type (optional, see text)
M1—0 to 1-mA DC meter, see text
P1—5-pin plug, DIN-type (optional, see text)
PC1, PC2—Clairex CL5M5L photocell, **do not substitute**
R1—10,000-ohm, ½-watt resistor
R2, R3—1-megohm potentiometer, see text
R4—500,000-ohm potentiometer, see text
R5—100,000-ohm potentiometer, see text
R6—10,000-ohm trimmer potentiometer (Mallory MTC-14L4 for exact fit on PC board)
R7, R8—820-ohm, ½-watt resistor
R9—100,000-ohm, ½-watt resistor
S1—2-pole, 4-position rotary switch (Allied Electronics 747-2003; adjust stops for 4 positions)
S2—spst switch
T1—117-volt primary, 24 to 26.6-volt secondary transformer, see text for point-to-point wiring (Note: you can also use two less expensive 12-volt transformers with secondary windings connected in series-aiding, if you have the space.)

The printed circuit board for the Color Analyzer is available direct from Electronics Hobby Shop, Box 192, Brooklyn, NY 11235 for only $5.50. US orders add $1.50 for postage and handling; Canadian orders add $3.00. No foreign orders, please. Postal money orders will speed delivery; otherwise allow 6-8 weeks for delivery.

If you cannot obtain the Clairex Type CL5M5L photocell locally, write to Electronics Hobby Shop at the above address, enclosing $3.50 for each photocell. U.S. orders add $1.50 for postage and handling. Canadian order add $3.00. No foreign orders, please. New York State residents add sales tax. Postal money orders speed delivery; otherwise allow 6-8 weeks for delivery.

Misc.—cabinet, pilot lamp for meter, 2-in. or 3-in. size Kodak Wratten filters #70, #98, and #99 (available from photo supply dealers), calibrated knobs, wire, solder, hardware, etc.





The color comparator photocell Z-bracket is installed under a light integrator. If your enlarger has a filter holder under the lens, attach the Z-bracket to the holder.

are far apart in value, or if the polarity is wrong, make certain you find the mistake *before* installing IC1.

Disconnect the linecord and complete the PC assembly. If you use a 24 or 28-volt pilot lamp to illuminate the meter you connect to the holes adjacent to T1's secondary (24-V) leads. If you plan to use a neon illuminator, install a 100,000-ohm resistor (R9) on the PC board and connect the lamp to the holes marked "neon." The lamp must have as little illumination as possible. Incandescent 24 or 28-volt lamps must be the miniature or "grain of wheat" type rated approximately 30 to 60 mA; the lamps come with attached leads. Do not use pilot lamps of the 100 to 500 mA variety. The excessive light will confuse the analyzer.

To install IC1 when it is the metal can TO5 type, fan out the #1 to 4 leads and #5 to 8 leads so they form two straight lines. Note that the lead opposite the tab on a TO5 package is #8. Insert the leads into the board leaving about ¼ inch between the IC and the board. The IC is correctly installed if the tab faces *away* from the transformer towards the nearest edge of the PC board. Solder IC1 and cut off the excess lead length.

The edge of the PC board nearest IC1 has four sets of paired foil terminals. These are provided as mounting terminals if you connect the photocell comparator and sensor without the use of a plug and jack. However, we strongly suggest the use of the specified DIN-type connectors as they allow for easy repairs if the connecting wires break. (The connectors aren't *that* costly).

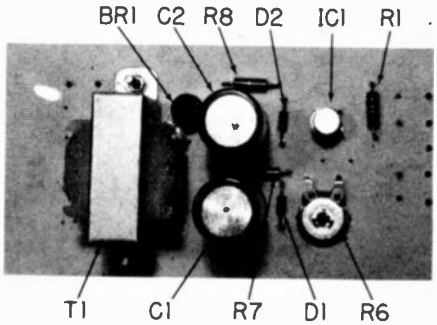
Potentiometers R2 through R5 can be linear or audio taper, though audio taper gives a slightly smoother adjustment; use whatever you have in stock.

The analyzer shown is built in a Bud 7-inch AC-1613 Universal Sloping Cabinet. This is the least critical item and you can substitute whatever cabinet you prefer. Just be certain the cabinet will accommodate the type of meter you use.

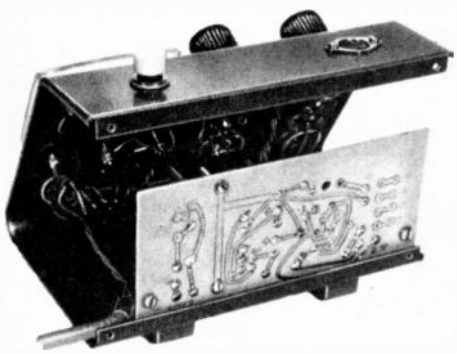
Meter M1 should be O-1 mA with a zero-center scale. But these are expensive, so you can substitute any standard 1-mA meter you want. You will simply calibrate the instrument for zero-center.

If you use a neon pilot lamp mount it directly above the meter and shield the forward brilliance with a piece of black tape; the lamp should radiate straight down onto the meter scale. If you use the meter in the parts list, remove the front cover by pulling it forward. Then remove the meter scale. As shown in the photographs, place a black dot approximately 3/16-inch wide at the center of the scale. If you want, you can also modify the meter for the incandescent lamp. Drill a ¼-inch hole in the lower right of the meter *from the rear.* Position the meter in the cabinet and mark the location of the meter hole on the panel. Remove the meter and drill a ⅜-inch hole in the panel. When the meter is installed you can pass a "grain of wheat" lamp through the panel into the meter. Reassemble the meter and complete assembly.

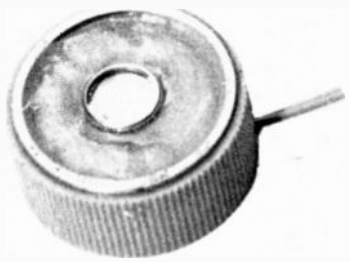
The Comparator. The photocells used for the comparator and exposure sensor, P1 and P2, must be Clairex type CL5M5L. Make no substitutions. From a piece of scrap aluminum ¾ to 1 inch wide, fashion a Z-bracket to the dimensions shown. Drill a ½-inch hole close to the end of the longer Z-leg. Fasten the other end of the Z-leg to your enlarger's under-lens filter holder. If your enlarger does not have a filter

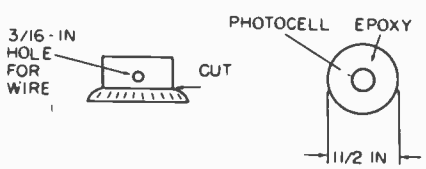


This is the parts location when our PC board is used. To get a free template of the PC board, send a Self-Addressed Stamped Envelope to: Davis Publications, Dept. T, 229 Park Ave. South, New York, NY 10003.



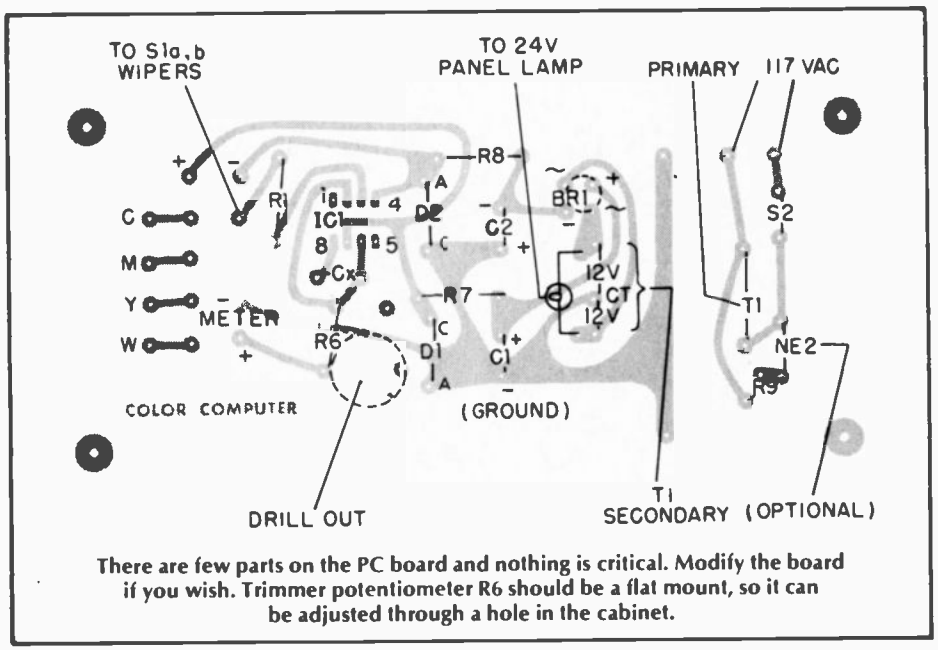
Rear view of author's color analyzer shows vertical mounting of the circuit board.





The exposure sensor photocell is mounted in anything that will keep it in place on the easel. This example was epoxy-cemented into a large control knob after the outside dial section was ground off. In typical operation, the sensor is placed under the lens with the light integrator or filters.

holder, or if it has a permanent swing-away red filter under the lens, mount a Paterson swing-away light integrator (available from local photo shops) under the lens. Fasten the short leg of the Z-bracket to the integrator—which has pre-drilled holes—so that the ½-inch hole is on the optical center of the lens. Then cement photocell P2 in the hole and attach the connecting wires; these can be extra-thin zip cord such as used for short-length speaker connections. (This whole bit reads a lot more complicated than it is. Use the photographs as a guide.)



There are few parts on the PC board and nothing is critical. Modify the board if you wish. Trimmer potentiometer R6 should be a flat mount, so it can be adjusted through a hole in the cabinet.

Photocell P1, which measures the exposure light, can be mounted in anything heavy enough to hold it in place on the easel. The photographs show the photocell epoxy-cemented in an oversize control knob.

When the complete analyzer is assembled, attach oversize calibrated knobs such as the Calectro E2-715 to R2 through R5. The knob calibrations are important so they should run out to the very edge of the knob skirt. If the calibrations don't run to the edge you won't be able to preset the controls with any reasonable degree of accuracy. Place a fine line or other indicator directly above each knob.

Checkout. Connect the photocells to the control unit and apply power. Don't worry if the meter pins at either end of the scale. Set switch S1 to the extreme clockwise position and adjust R2 through R5 until you find the control that changes the meter reading. Mark the switch and the control "C" for cyan. (We suggest you paint the cyan knob insert a blue-green. Also paint the other knobs the appropriate color.) Advance S1 one position clockwise, find the correct knob and label both "M" for magenta. Advance the switch another position clockwise, find the knob and label both "Y" for yellow. The last switch position and knob is labeled "W" for white (white light exposure). Make certain the C, M, and Y controls are reading P2, the color comparator mounted under the enlarger lens.

Set S1 to any position, set all other controls to their mid-position, and turn on bright room lights. If the meter pins out or approaches full scale deflection, adjust trimmer control R6 so the meter pointer just pins (don't be afraid to pin the meter). Depending on the amount of light the meter pointer will pin right (for bright light) and left (for dark or very low light). This is normal and there will be no damage to the circuit or the meter. (Note: If you use a zero-center meter the pointer will barely pin on both sides.)

Close-up of meter face showing a small scale-illumination lamp in lower right corner. This lamp should not be operated at full voltage to avoid fogging the film.

Install the Z-bracket under the lens. If your enlarger uses a filter holder under the lens insert a diffusion screen or glass, or a Beseler Light Integrator or similar ground glass in the filter holder. You are now ready to make color prints.

The first thing you need to make fine quality color prints is a high speed chemistry, such as the two-step Beseler system which can produce a finished print in two minutes. The second item you need is the electronic color analyzer for which we've alreacy given you the plans.

Color Variables. Color materials such as the negative, printing paper, enlarger lamp, and even color correction filters vary in their sensitivity to light colors from batch to batch, roll to roll, and time to time. Even the enlarger's optical system can have a color cast. For this reason it is generally impossible to place a negative in your enlarger, expose the paper, and develop a good—let alone decent—color print.

To avoid upsetting a control setting while groping for the on-off switch in the darkroom, mount switch S2 as far as possible from the controls.

Provides a wealth of worthwhile info for photographers interested in the color print techniques available from Kodak or your photo dealer. Their publication No. E-66.

One way we can correct for these variables is through an *additive* exposure, exposing the paper through blue, green, and red filters for differing lengths of time. Since blue, green, and red create all the colors in additive printing, any correction can be obtained by controlling the precise timing of each exposure. The additive system is a pain in the neck for the hobbyist, for the slightest desired change in the color rendition or saturation (exposure) can involve changes in the exposure through all three filters.

A printing system that's easier to use and more favored by hobbyists is the *subtractive* exposure. A single filter pack made up of two of the filters known as YELLOW, MAGENTA, and CYAN makes all the color corrections at the same time. This filter pack is placed between the enlarger lamp and the negative; virtually all modern enlargers have a drawer in the lamphouse to accommodate a filter pack. A single exposure through the filter pack is all that's required to make a color print. Some of the more expensive enlargers have what is termed a "dichroic head" with variable filters as part of the light system; the exact value of filtration is simply dialed by the user. Again, all the color correction is provided at one time by the dichroic head so only a single exposure is needed.

More Info. A full and complete treatment of both types of color printing is contained in the Kodak publication *Printing Color Negatives;* this book is a required reference for anyone who wants to make quality color prints. The book also gives the most convenient operating procedures for electronic color analyzers.

The subtractive printing procedure is particularly well adapted for use with a color analyzer, is the easiest method for the amateur, and is exceptionally fast-handling, so the illustrations to follow will refer to the subtractive system.

An electronic color analyzer basically consists of a photocell (vacuum tube photomultiplier or photoresistor) positioned under the lens, blue, green, and red filters mechanically positioned over the photocell (or positioned over the cell by hand) and a meter that indicates the amount of light falling on the cell. The meter is connected to the photocell through independent potentiometers as shown in the figure. Color analyzer readings will be accurate for most negatives and lighting situations as long as the same box of printing paper is used. The system needs to be recalibrated only when the printing paper is changed (so purchase boxes of at least 100 sheets to avoid extra work).

The first step is to make a really fine print from a decent negative. You can do it the hard way, one print at a time, or use a Beseler Subtractive Calculator which puts you inside the ball park on the first try. When you have made a print with satisfactory flesh tones and color saturation don't disturb the enlarger or timer controls.

To Continue. . . . Place the color analyzer's probe on the easel or swing it under the lens (if it is mounted on the enlarger). Install a light integrator—which is nothing more than a piece of ground glass or its equal—under the lens, between the lens and the analyzer's probe. The light integrator scrambles the picture into a diffused "white light" which contains all the color elements of your negatives and the filter pack. Place a blue filter (Kodak Wratten No. 98) on top of the light integrator. (Note that most hobbyist analyzers have a selector switch that also mechanically positions the correct filter over the photocell.) Turn on the enlarger and adjust the analyzer's *yellow* control for a convenient reference meter reading. (Usually, center-scale or "null" is used as the reference reading, but any meter reading can be used as a null.)

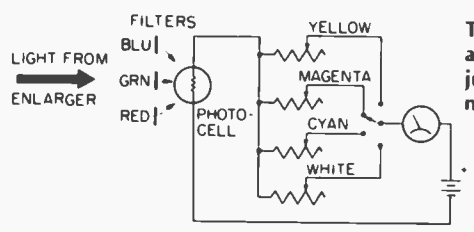
Remove the blue filter, install a green filter (Kodak Wratten No. 99), switch the analyzer to MAGENTA and adjust the *magenta* control for a null meter reading. Remove the green filter, install a red filter (Kodak Wratten No. 70), switch the analyzer to CYAN and adjust the *cyan* control for a null meter reading (the color controls yellow, magenta, and cyan refer to the color of the subtractive filters in the filter pack). Finally, remove all filters from under the lens, switch the analyzer to WHITE and adjust the *white* control (exposure control) for a null meter reading.

(The color analyzer in this project uses a separate photocell for the exposure. If you look at the easel you'll see a shadow cast by the Z-bracket holding the color comparator cell. Position the exposure cell on the easel so it is just off the edge of the shadow. If you prefer, you can place several thicknesses of opaque paper over the color comparator cell and use it for the white measurement, though we suggest you use the separate cell.)

Modern color print chemistry techniques from Beseler include this subtractive color calculator to aid filter selection.

When all the controls are adjusted you have programmed the color characteristics and exposure of your "reference" print into the analyzer, and you should note the control settings and exposure time for future use.

Down to Business. Now assume you want to make a print from another negative. Put the new negative in the enlarger. Then set the degree of enlargement and focus, leaving the lens wide open. Place the analyzer's probe under the lens, install the light integrator and set the analyzer's switch to CYAN. Install the red filter on top of the light integrator and adjust the lens aperture until the meter indicates null. Switch the analyzer to MAGENTA, install the green-reading filter and note the meter reading. If it is not at null, add or remove magenta filters (from the filter pack) until the meter shows a null. Then switch the analyzer to YELLOW, install the blue-reading filter and



The basic color analyzer. Once controls are matched to a "standard" negative, just select filters for a null on the meter for each individual color and white.

modify the yellow filtration in the filter pack until the meter shows a null. Finally, set the analyzer to WHITE, remove all reading filters and adjust the lens aperture for a null indication.

Through the color analyzer you have now established a new filter pack and exposure for the new negative. If the new negative uses similar lighting to the reference negative the print should be perfect. If the lighting was considerably different the print will be good—acceptable to most people, but requiring just a slight filter pack modification for a great print.

Swinging Filters. In the previous example the filter pack would wind up with magenta and yellow filters—which is what is generally needed. Some Kodacolor negatives, however, might require cyan lters plus magenta *or* yellow (but never all three). This information will have been programmed into the color analyzer, so you will have no difficulty if you make a slight modification in procedure. The first meter reading, the one where you adjust the lens's aperture, should be made for the filter you are *not* using in the filter pack. For example, if your basic filter pack has cyan and magenta, switch the analyzer to YELLOW, place the blue-reading filter in position on the light integrator, and close down the lens for a null indication. Then proceed with the other readings. If your reference negative did not require cyan in the filter pack, if it had yellow, magenta, or both, and you find a new negative just can't be pulled in for null meter readings with yellow and magenta filters, it indicates the new negative requires cyan filtration, so start with the assumption that yellow is not required. If you still can't null the meter, it means magenta should *not* be in the filter pack.

Kodak color printing filters. Typical filter designation CP20Y means color filter with a .20 density; the color is yellow.

As we mentioned, a more thorough discussion and procedure for using a color analyzer is found in Kodak's *Printing Color Negatives.*

Most, but not all, commercial color analyzers use photomultiplier tubes which have no light memory, nor are they confused by infrared from the enlarger lamp. These units are, as you would expect, relatively expensive. Low cost models use photoresistors.

More Data. Photoresistors are infrared-sensitive and they have a light memory, both of which can confuse the meter. The infrared is easily handled by installing a heat or infrared filter glass in your enlarger (it should be there to protect the negative anyway). The light memory is handled by using a consistent measurement procedure. The best way is to turn the enlarger off, install the reading filter and the light integrator, turn off the bright room lights, count to five, and then turn the enlarger *on.* Take the meter reading. or adjust the appropriate color control, slide the new reading filter in place before withdrawing the old one, switch the analyzer, and make the new meter reading. Repeat this for the third reading filter. You'll note that this procedure keeps bright white light from falling on the photocell between meter readings. If you want to change filters under room lights, make certain there are about five seconds of darkness between turning the room lights out and turning the enlarger on.

The whole bit might sound somewhat complicated, but after you've run through the procedure once or twice to get the hang of things it shouldn't take you more than a minute or so for a full color analysis of a new negative.

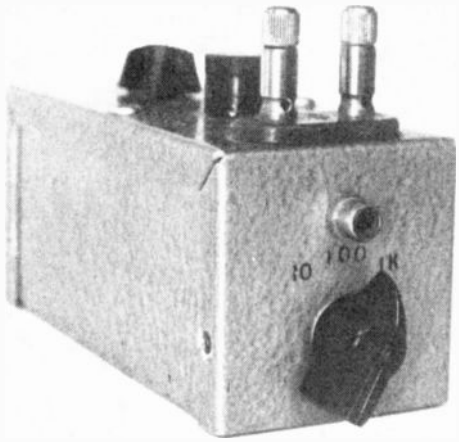
The Kodak Wratten filters needed are available from professional camera shops. For the construction project, color analyzer 2-in. or 3-in. Kodak Wratten filters Nos. 98 (blue), 99 (green), and 70 (red) are recommended. If you have difficulty obtaining these specific filters you can make the following substitutions, through the analyzer's precision will be slightly reduced: 47B (blue), 61 (green), and 92 (red).

The Pro Shop. We could not close without some words on commercially processed color prints such as you might order from a drugstore or camera shop. Commercial color labs have as high (if not higher) a remake rate than the amateur if *quality* color prints are desired. As a general rule, it takes two tries to get a decent color print, so the hobbyist with a color analyzer is way ahead of the game because he can turn out, at worst, two *good* prints for each three first tries. The average is even higher than this as the hobbyist gets skilled in the use of a color analyzer.

Commercial labs come close to a hobbyist's results only when they are equipped with a video analyzer such as the Kodak Video Color Negative Analyzer Model 1-K; and Kodak only claims a 75% + first try acceptance rate for their analyzer. The video analyzer is a 5-in. x 5-in. TV display. The operator views the color negative as a positive color TV image, and adjusts the TV's controls for proper color balance and brightness (saturation). The control settings are translated to the printing equipment's filter adjustments so that the final print is similar to the image displayed on the TV.

The video analyzer is a fast and easy way to get good color prints on the first try, but since video analyzers cost in the thousands, the color analyzer is the best thing going for the hobbyist. ■

Professional equipment used by color labs includes this Kodak Video Color Negative Analyzer. It uses a 5-in. color TV screen to assist an operator in selecting the correct filter.



FRAG your friendly audio generator

By Frederick W. Chesson

IF YOU NEED AN INEXPENSIVE and highly portable audio test set, this Full Range Audio Generator (FRAG) is for you! Our friendly FRAG delivers variable and fixed outputs of sinusoidal waveform from 10 Hz to over 15 kHz and up to five volts peak-to-peak.

The Circuit. There are several circuit networks which can produce a sinusoidal waveform, including the Phase-Shift and the Twin-T. It is the latter which will be examined here, as it proved in application to be the most suitable for the FRAG.

As shown in the Twin-T Oscillator diagram, we have a Low-Pass network of R1, R2, and C1 in parallel with a High-Pass network formed by C2, C3, and R3. The combined network is connected between the inverting input and output of a gain device, such as the familiar 741 integrated circuit op-amp. Typically, R1 = R2, while R3 is one-half to one-tenth of R1, and C1 = C2, and C3 = 2C1.

Since the phase shifts for the two networks are opposite, there exists, in theory, only one frequency where the total phase-shift from input to output will reach 180°, at which point sinusoidal oscillations will occur, provided sufficient gain is available. The approximate frequency will be

$$F = \frac{1}{2 \pi R1 C1}$$

Varying any or all of the network elements will cause the nominal frequency to change, accompanied by a drop in output, until oscillation can no longer be sustained. Over a certain range, varying the resistive elements simultaneously, as by a ganged potentiometer, will yield a useful frequency span, provided the gain can be raised appropriately, but without causing overdriven distortion.

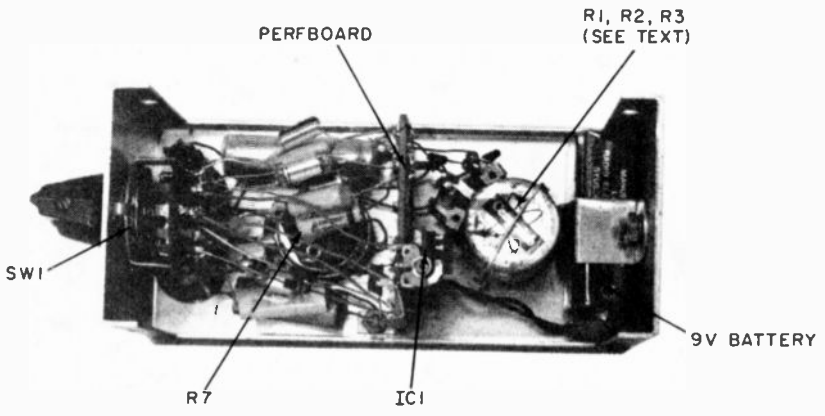
Shunting the Twin-T network with a fixed resistance RF yielded fair results, in experiments conducted to obtain a wide operating range consistent with simplicity. It was then found that addition of a diode back-to-back pair, forming an active feedback element, gave a considerably greater range, as shown. Further experimentation finally showed that even greater improvement could be obtained by connecting the feedback elements between output and the *offset-null* terminal associated with the inverting-input. Three switch positions give ranges of 10-100 Hz, 100-1000 Hz, and 1kHz – 10kHz. A fixed output of about 5 VPP and a variable output of 0-1.0 VPP were added to provide a choice of useful signal levels.

Put It All Together. For convenience in portability, a utility box having a five inch length by two and one-quarter inch height and width was selected (Either Bud CU-2104A or Premier 12P3886 types are suitable).

A photo shows the parts placement of the prototype, with the range-capacitors being strung between the range switch and a perf-board mounting the integrated circuit and other components. Check the drawing to see how these components may be placed on a two inch square section of perf-board having 0.1 inch spaced holes. A pair of No. Six ground lugs are bent at right angles to serve as miniature mounting brackets. There is sufficient room for a 14-pin DIP IC socket for the 741 op-amp, should replaceability be desired. Although a mini-dip 8-pin 741 was used in this circuit, the standard 14-pin unit will do as well, paying attention to the pin connections. The nine-volt transistor battery (Eveready type 222, or equivalent) is secured in place by an S-shaped half-inch wide aluminum bracket.

The only component difficult to find is a three-gang 250K, 250K, 25K potentiometer, used for variable frequency settings. If a ready-made assembly (preferably log-taper) cannot be obtained, use a built-up unit, like Centralab *Fastach* components.

Optional resistors R4, R5, and R6 are included so that the variable frequency dial may be rotated to maxi-



Use the parts layout given for the perfboard and you will have no trouble wiring the capacitors point-to-point as shown here. Be certain that the long leads do not short out against each other by keeping them as straight as possible.

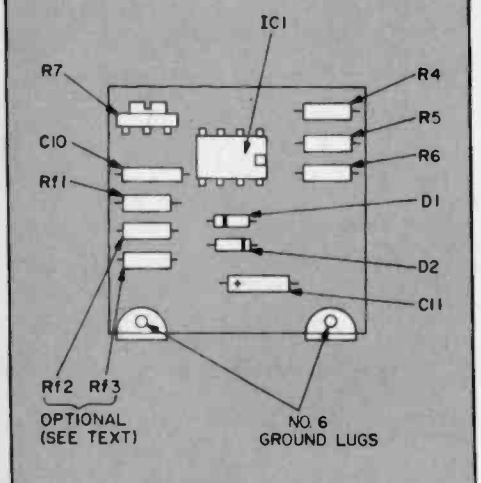
audio generator

mum frequency without having the circuit drop out of oscillation, as it would should R1, R2, and R3 fall too low. Temporarily omit the feedback resistor(s) RF for later adjustment. If a four pole-three position switch (such as Calectro E2-168) is available, then each range may have its own individually selected feedback resistor for maximum efficiency.

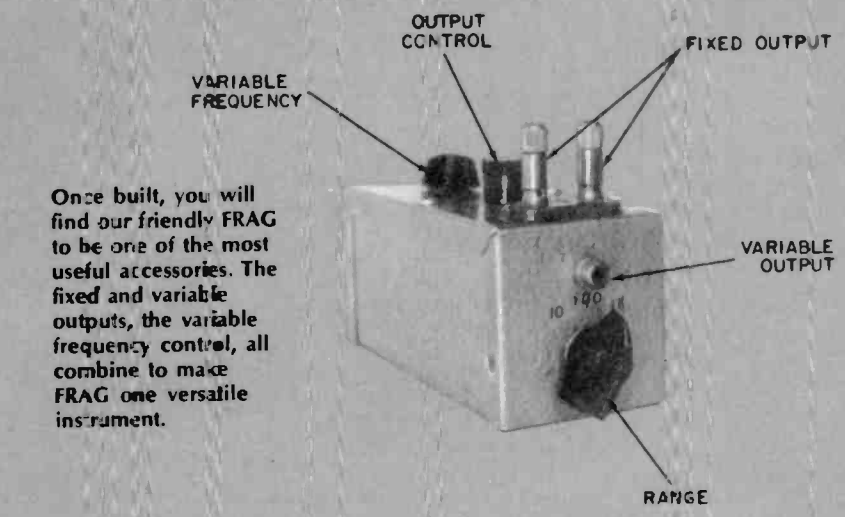
Adjustment and Operation. An oscilloscope is essential for adjustment of the friendly FRAG to determine optimum waveform and amplitude and for rough frequency determinations. A freqeuncy-counter is also useful, although the FRAG is not intended to be a precision audio generator.

Before applying power, set the input bias potentiometer R7 for approximate midrange position and connect a decade resistance box, set at about 33K ohms, in place of RF. Set the Range Switch to its middle (X100) position and the variable frequency control to its mid position. Connect the scope (and frequency counter, if available) to the fixed output terminals.

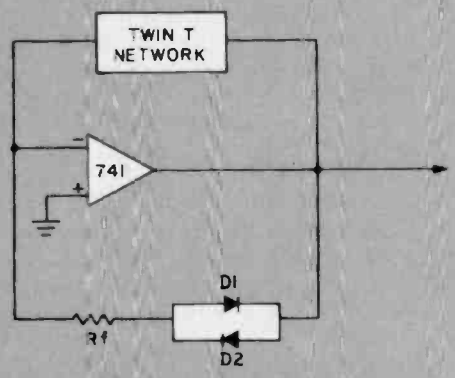
Switch on the power by turning the Output control to mid-position. The scope should display a more or less square wave of about 200 Hz. Adjust the decade box, or individual fixed resistor, for a sinusoidal waveform of maximum amplitude, consistent with low distortion. If the wave is flattened at top or bottom, try adjusting R7 while rechecking RF. Rotate the variable frequency control from one end to the other, rechecking RF and R7



Use this parts layout for your perfboard. Rf2 and Rf3 are optional, as mentioned in the text. Also, use a socket for IC1.

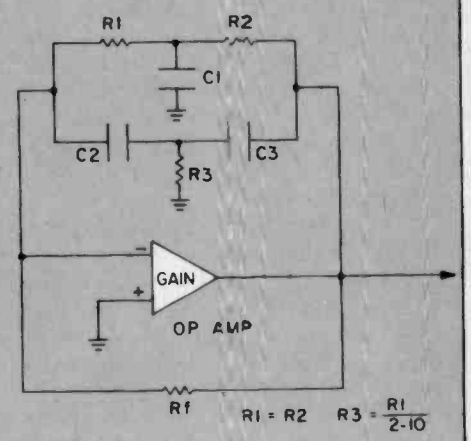


Once built, you will find our friendly FRAG to be one of the most useful accessories. The fixed and variable outputs, the variable frequency control, all combine to make FRAG one versatile instrument.



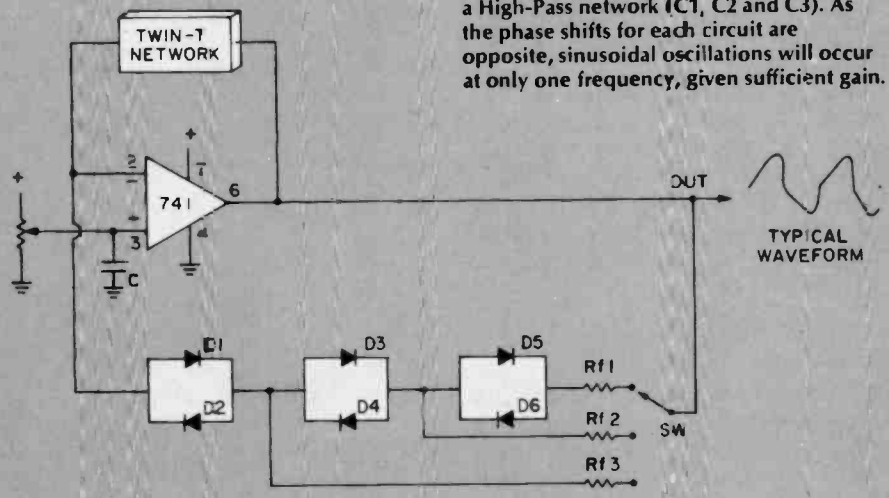
DYNAMIC AMPLITUDE CONTROL
WITH DIODES IN FEEDBACK LOOP

Shuntng a Twin-T network with feedback resistance (Rf) yielded fair results. The addition of a back-to-back diode pair as an active feedback element greatly tended to increase the FRAG's operating range.



BASIC TWIN-T OSCILLATOR

This basic Twin-T circuit uses a Low-Pass network (R1, R2 and R3) in parallel with a High-Pass network (C1, C2 and C3). As the phase shifts for each circuit are opposite, sinusoidal oscillations will occur at only one frequency, given sufficient gain.



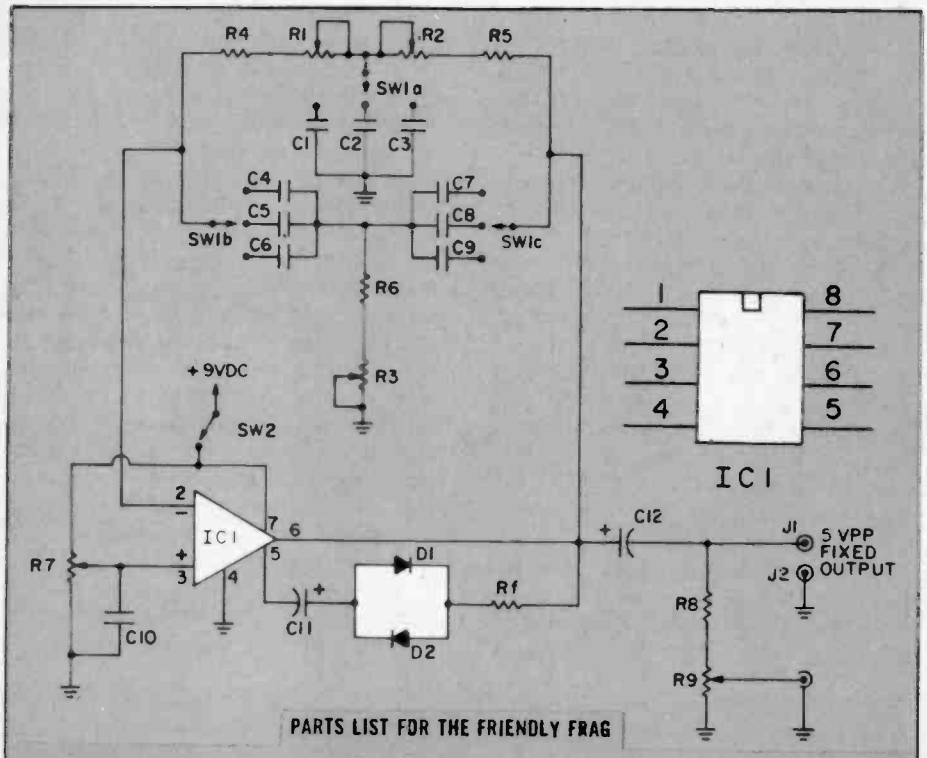
VARIABLE WAVEFORM GENERATION

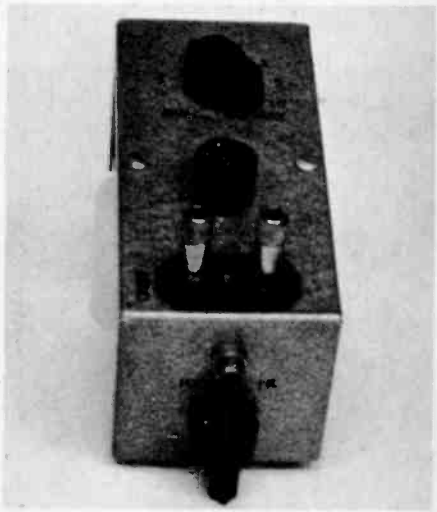
During development of the FRAG, additional diode pairs were added to see if they would further increase the variable frequency range. They did—but at the cost of adding some distortion. This, however, results in some interesting tones—music!

should distortion occur. Amplitude will be less at each end of the dial, and will drop out entirely at the upper end, unless the optional resistors R4, R5 and R6 have been included. A maximum output of 5 VPP should be obtainable at the fixed output terminals and up to 1 VPP at the variable output jack. If separate feedback resistors are used (with a four-pole Range Switch) recheck the other two range positions and select the correct individual resistors and mount them on the perf-board. Otherwise, a single feedback resistor will have to be a compromise for best operation over the entire span of all three ranges.

The variable frequency dial may be calibrated simply on a 1 to 10 basis, which should hold good for the three ranges. If a linear potentiometer is used (all that was available in the Fastach components at time of construction) the dial will necessarily be non-linear, which is why a log-taper pot is more desirable. Also, due to mechanical backlash in the stacked sections, it is best to move well past an over-shot frequency point before reversing to zero back in. The 0-1 VPP shielded jack is best for low-level output applications involving audio amplifiers and other high-input impedance gear. The 5 VPP fixed-output terminals are useful for general purposes, or where it may be desired to construct fixed voltage-divider networks.

Although the battery drain is quite modest, make sure to turn off the test set when not in use.





Looking at FRAG from the front shows the frequency range selector, as well as the output terminals and level controls on top.

Range Switch Positions

X	FREQ.	SW1a	SW1b/c
10	10-100	C1	C4/C7
100	100-1000	C2	C5/C8
1K	1K-10K	C3	C6/C9

Other Applications. During development of the circuitry, additional diode pairs were tried to see how far their "dynamic feedback" operation could extend the variable frequency range. Although two pairs gave some increase, this was at the expense of waveform purity. This distortion, however, can be put to use in the area of electronic music. The last diagram shows how a chain of diodes, with individually selected feedback resistors may be switched in to provide for the generation of interesting synthetic tones . . . another benefit of this original FRAG! ■

PARTS LIST FOR THE FRIENDLY FRAG

IC1—Type 741C
C1—.22uF capacitor
C2—.02uF capacitor (Allied 710R1136 or equiv.)
C3—.002uF capacitor (Allied 710R1093 or equiv.)
C4, C7—.1uF capacitors
C5, C8—.01uF capacitors
C6, C9—.001uF capacitors
C10—.1uF capacitor
C11—10uF electrolytic capacitor
C12—220uF electrolytic capacitor
D1, D2—1N914 silicon diodes
R1, R2, R3—250,000-ohm, 250,000-ohm, 25,000-ohm, ganged potentiometer (Centralab "Fastach")
R4, R5—10,000-ohm, ¼-watt resistor
R6—1,000-ohm, ¼-watt resistor
R7—5,000-ohm trimmer potentiometer
R8—4,700-ohm, ¼-watt resistor
R9—1,000-ohm potentiometer (Allied 854-5800 or equiv.)
SW1—3-position, 3 or 4-pole miniature rotary switch (Calectro E2-168 or equiv.)
SW2—potentiometer switch (mount on back of R9)
Rf—feedback resistors (see text)
J1—Pair of five-way binding posts
J2—RCA type phono jack
Misc.—9-V battery, battery clip, perf board with .1-in. spacing, perf. board terminals, DIP socket, a 5 x 2.25 x 2.25-inch chassis (such as the Bud CU 2104A), wire, solder, etc.

Allied Electronics' address is:
401 East 8th St., Ft. Worth, Texas 76102
Calectro Electronics' address is:
400 S. Wyman St., Rockford, Ill. 61101
Centralab Electronics' address is:
P.O. Box 858, Fort Dodge, Iowa 50501

If you ever need a Full-Range Audio Generator, then call it by its initials, FRAG, and start building a fun and interesting project. Our FRAG uses a neat and unique means of building which can be easily duplicated following instructions in the article. A main perfboard is positioned in the middle of a rectangualr metal box and the many capacitors the circuit calls for are wired point-to-point to the components on the perfboard. It's quick and easy, and results in a very small and compact, professional-looking instrument. If you ever get tired of having FRAG work for a living, a simple and reversible modification, also explained in the text, will turn FRAG into something of a songstress. She is a very friendly FRAG!

CUSTOM SWITCHES ...THAT YOU COULDN'T AFFORD TO BUY.

By Jorma Hyypia

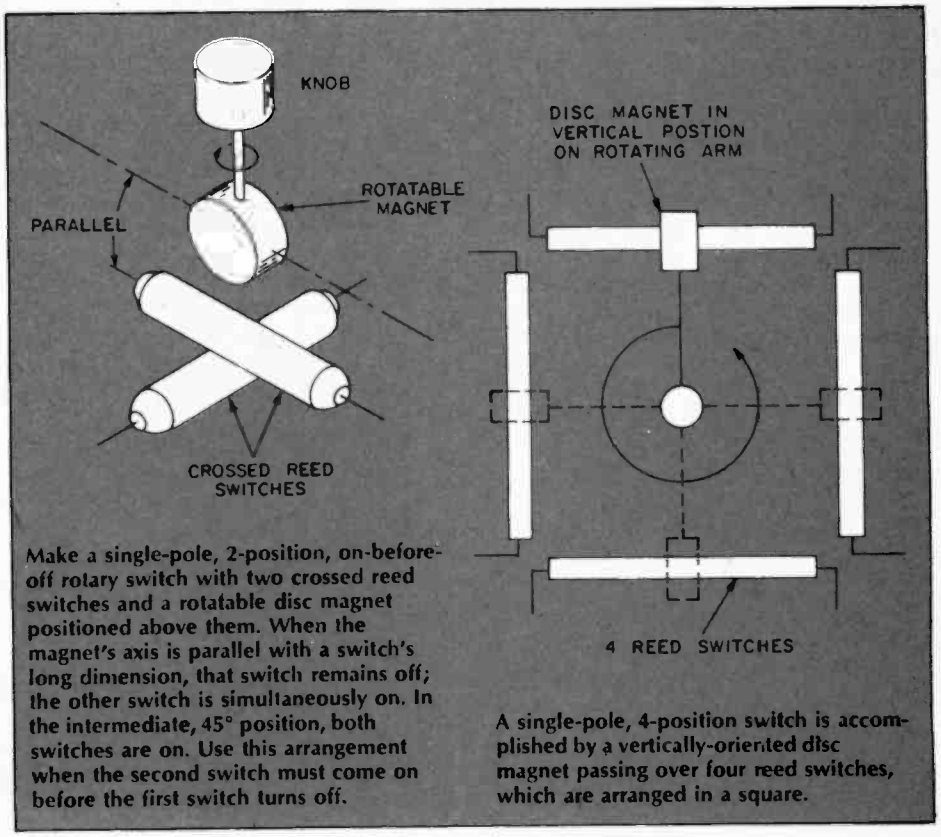
HOW OFTEN HAVE YOU searched fruitlessly for a special switch? Probably dozens of times—if you're at all an active builder. The next time this happens, consider custom-building your own complex switches using inexpensive magnetic reed switches and small ceramic magnets. Such do-it-yourself switches offer several advantages. They are relatively inexpensive, silent, and long lasting, as there are no rubbing contacts and the reed contacts are sealed in glass, away from corrosive atmospheric gases.

You can purchase two sizes of magnetic reed switches and the ceramic magnets from Radio Shack. The larger switch (Cat. No. 275-034; 1¾" overall length) comes in a 4-for-79¢ blister package. The smaller "Micro Mini" switch (275-035; 1⅛" long) comes 10 to a package, for $2.99. The magnets cost 10 cents each, regardless of size. The smallest, ½" diam. disc ("button") magnet is the most useful, but you may need the larger 1⅛" disc or 1" x ¾" rectangular magnets to build really large, complex switches.

The several custom-built switches shown in this article only hint at the virtually limitless design combinations that are possible. Study the drawings to learn how magnet orientation and direction of travel past the reed switches affect switching action.

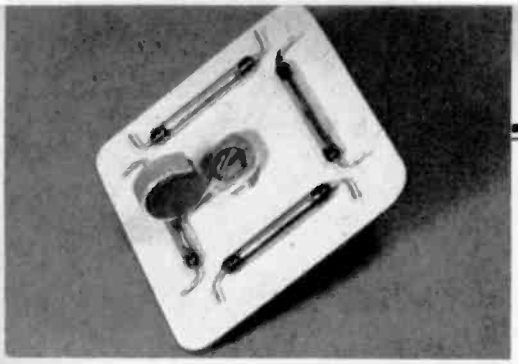
Carpetak Tape, a cloth tape with adhesive on both sides that is used to hold down carpets, is excellent for mounting the reed switches to panels. The switches adhere firmly, yet can be removed without damage. For greater permanence, you may wish to use epoxy cement for mounting once you know exactly where to locate the reed switches. Generally, it is best to locate the magnet and reed switches on the same side of the panel; however, it is also possible to put the switches on one side of a non-magnetic panel and orient the magnet on the other side. The ceramic magnets are of extremely hard material, and you may have poor success if you try to hacksaw them smaller. Try breaking the magnet by clamping in a vise and striking with a chisel; it may not break cleanly across, but grinding on an emery wheel may be practical. When possible, just use the magnets as they are. Mount them in aluminum holders as shown here, or glue to support arms with epoxy adhesive.

The following brief descriptions of various switch types should help clarify the principles of building switches:

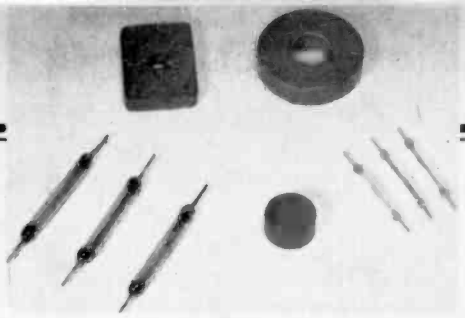


Make a single-pole, 2-position, on-before-off rotary switch with two crossed reed switches and a rotatable disc magnet positioned above them. When the magnet's axis is parallel with a switch's long dimension, that switch remains off; the other switch is simultaneously on. In the intermediate, 45° position, both switches are on. Use this arrangement when the second switch must come on before the first switch turns off.

A single-pole, 4-position switch is accomplished by a vertically-oriented disc magnet passing over four reed switches, which are arranged in a square.



A rotary switch with a 1/2" diam. ceramic magnet mounted vertically turns the switches on individually. The magnet arm is turned by a knob on the other side of the panel, or can be turned continuously with a small motor drive for constant scanning applications.



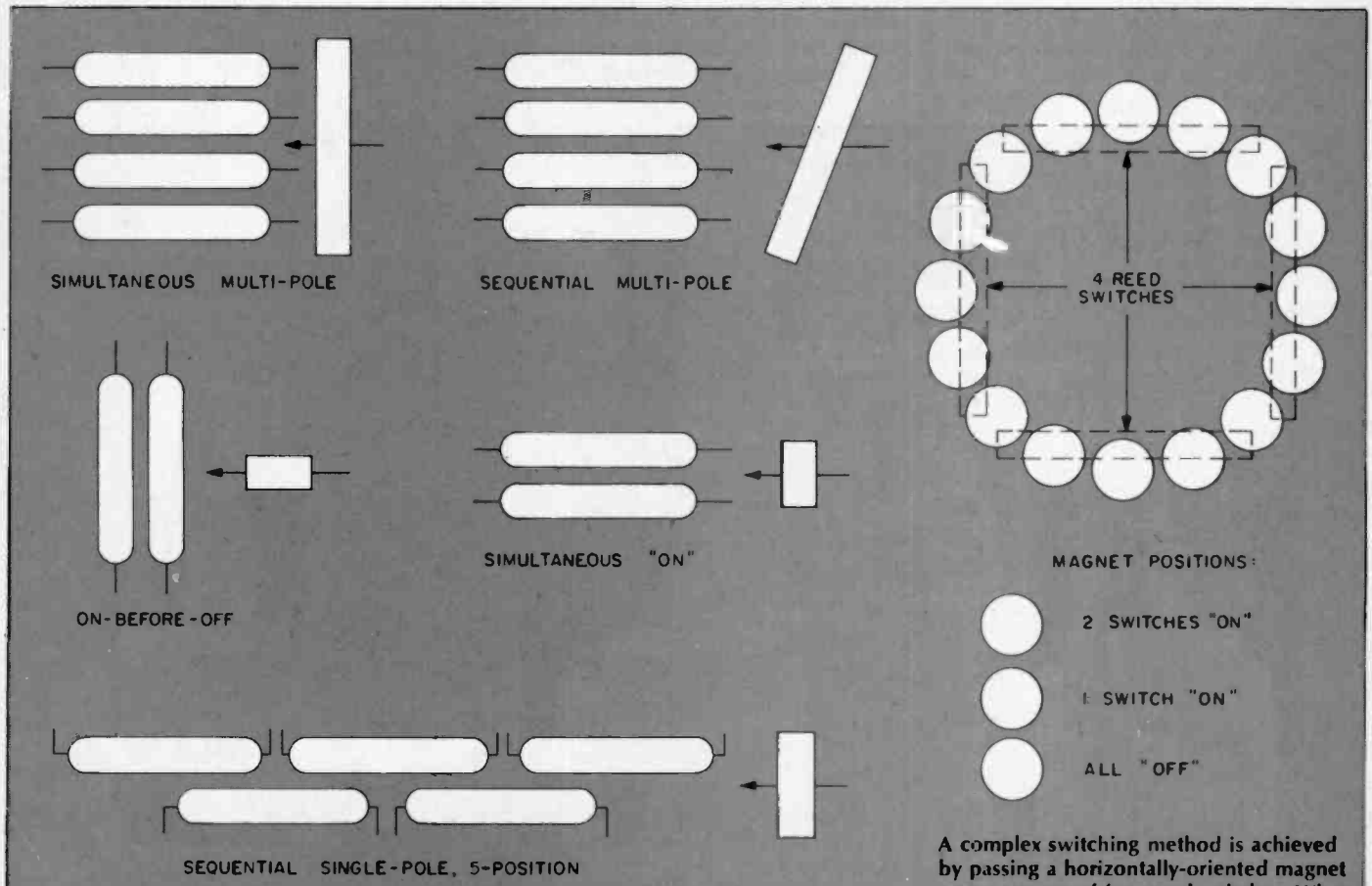
Magnetic reed switches, available from Radio Shack, come in two convenient sizes; the overall lengths, including leads, are 1 1/8" and 1 3/4". Both are rated at 0.56 amperes at 125 volts. The small, 1/2" diam. disc magnet is handiest, but the 1" diam. disc and 1" x 3/4" rectangular magnets may be desirable for building complex, multi-pole switches.

Single-throw, multi-pole. These can be constructed simply by mounting reed switches in parallel, and passing the *edge* of a vertically-mounted magnet over them to trip all switches simultaneously. If you need a sequential switching action, just angle the magnet about 30 degrees so that the parallel reed switches are tripped in 1, 2, 3, 4 order. If the magnet movement continues in the same direction, the switches will go off in the same 1, 2, 3, 4 sequence, on the other hand, if magnet movement is reversed when all switches are on, the switches will go off in the reverse 4, 3, 2, 1 order.

Multi-position, single-pole. Arrange the reed switches one after the other, like cars of a train. You can keep the switch smaller by using two lines of staggered switches, as shown. As the vertically-oriented disc or rectangular magnet passes over the switches, each "on" switch goes off before the next switch comes on.

A photograph shows a sliding switch of this general type, but one made to function as a double-pole, single-pole, double-pole sequencer. A simple locking device consisting of a lock washer under the knob on the other side of the panel permits locking the movement at any desired position. Note the "guide" strip near the slot; a square nut that holds the magnet support arm on the knob shaft bears against this guide to keep the magnet properly aligned over the reed switches.

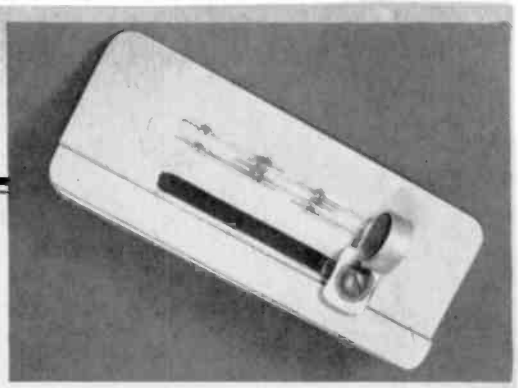
Rotary switches. These are easier to build than slide switches, and there are many ways to achieve special switching characteristics. Note that when the edge (diameter axis) of a disc magnet is aligned with the long axis of a reed switch there is no switching action.



Here are various magnet and reed switch orientations all of which achieve different switching actions. Position the magnets and reed switches exactly as shown, and as further discussed in the text, for best results.

A complex switching method is achieved by passing a horizontally-oriented magnet over a square of four reed switches. When the magnet is in a "corner" two adjacent switches are on; in other positions only one switch is on.

CUSTOM SWITCHES



The ceramic magnet of this sliding switch passes over five 1 1/8" size reed switches to provide double-pole, single-pole sequencing. Separate diagram shows a simple mechanism which permits locking the magnet "on" or any "off" position.

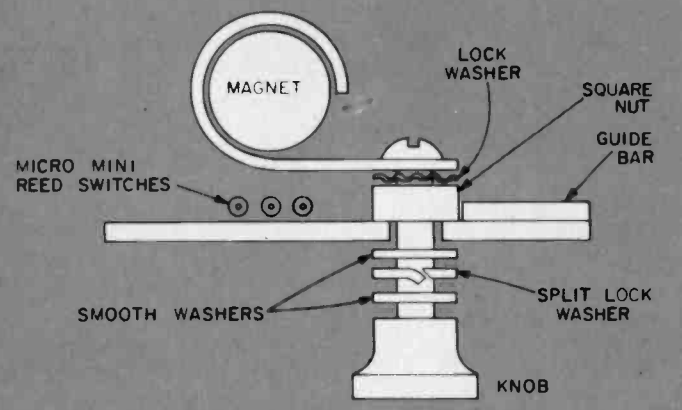
Thus if you mount several reed switches next to each other, and rotate the magnet directly over the center of the switches, you obtain more or less simultaneous on-off action.

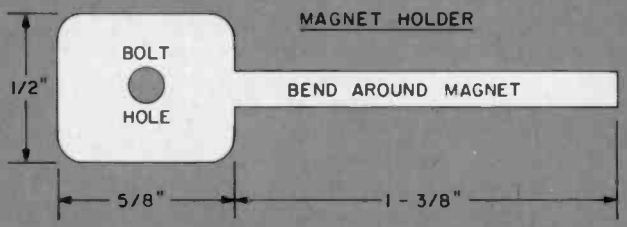
If two switches are crossed a vertically-mounted rotating magnet will turn one switch on and the other off when the magnet axis is parallel to the long axis of one reed switch. In the intermediate position, both switches are on; thus you can have on-before-off action with a very simple physical arrangement. To make a double-pole version, cross four reed switches in pairs.

A 4-pole, 4-position rotary switch can be made by arranging four reed switches in a "square" and adding a vertically-oriented disc magnet so that it can be swung in a circle over the centers of the reed switches. This provides an off-before-on switching action, each "on" switch first going off before the next one comes on.

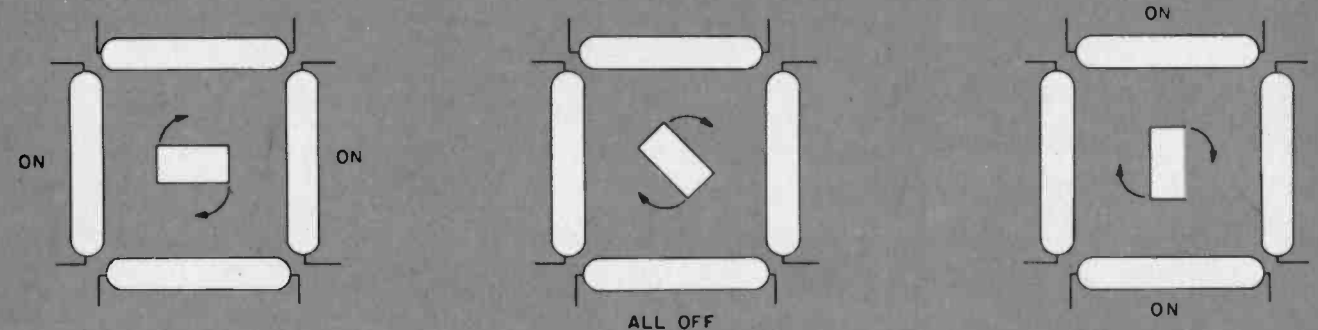
Some strangely useful things begin to happen if you mount the disc magnet horizontally instead of vertically. As the magnet passes over a corner of the square of reed switches so that it is partly over the ends of two adjacent switches, both switches go on. Rotate the magnet a little further, so that it is over just one switch and that switch stays on while the other goes off. Curiously, when the *horizontally* mounted magnet is over the center of a switch, that switch goes off. This is exactly the opposite of the on-action caused by a vertically-mounted magnet. Consequently, this type of rotary switch provides sequential double-pole and single-pole action, with four fully off positions.

Multi-pole Rotary. Such switches can be constructed by stacking additional reed switches atop the first four that make up a basic square. Mount the rotatable magnet inside the "box" formed from the stacked reed switches. When the long dimension of the magnet is perpendicular to stacks on opposite sides of the box, all of those switches will go on; other stacks at 90° to these will remain off because the magnet axis is parallel to them. By using one of the larger rectangular magnets, you can easily stack at least a half dozen switches on a side, for a total of 24 switches; 12 would be on at any one time, 12 off. When the magnet is in the intermediate, 45° position, all switches are off.





Here is a sliding switch designed to function as a double-pole, single-pole, double-pole sequencer. A locking device of a lock washer under the knob on the other side of the panel permits locking the movement at any desired position. The support arm is positioned to keep the magnet aligned properly.



By positioning a rotatable magnet in the center of a square of four reed switches you have a double-pole rotary switch. By stacking magnets on top of the basic four, and using a larger magnet, as many as twelve on-positions are possible at each active orientation.

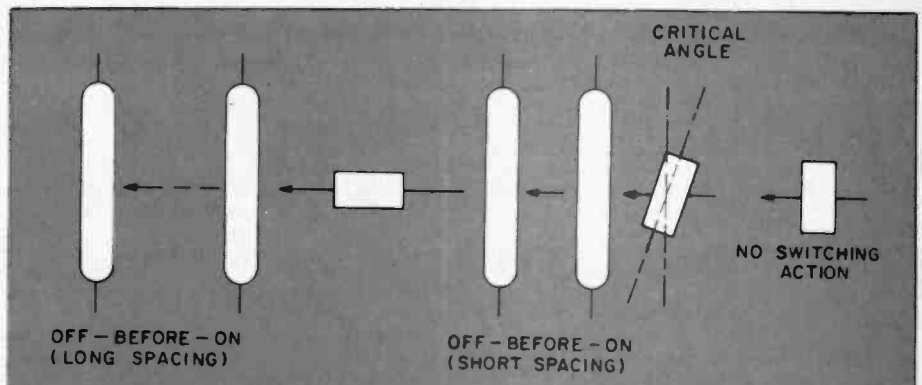
Linear Off-Before-On. Mount parallel switches far enough apart so that, as a vertically positioned magnet approaches the switches from one side, the first switch will go on and off before the next switch is affected. Here's a handy trick that enables you to pull the parallel reed switches much closer together to form a more compact switch: Position a small disc magnet over the center of the first switch so that its long axis (diameter) is parallel to the long axis of the switch. If you have been paying attention, you already know that in this position the magnet has no effect on the switch. Now slowly rotate the switch away from this parallel orientation until you hear the switch click on. Mount the magnet in its sliding holder so that it passes over the center of the reed switch in this slightly angled position. This deliberately weakened magnetic action permits location of the next switch much closer to the first—as close as about ⅜"—and still obtain off-before-on switching.

There's no problem, of course, if you want on-before-off action because then you can mount the reed switches as close to each other as you like. A magnet approaching from the side will turn the first on, then the second, before turning the first off. Bear in mind that if the magnet approaches the pair of switches from the end directions, you obtain approximately simultaneous double-pole switching.

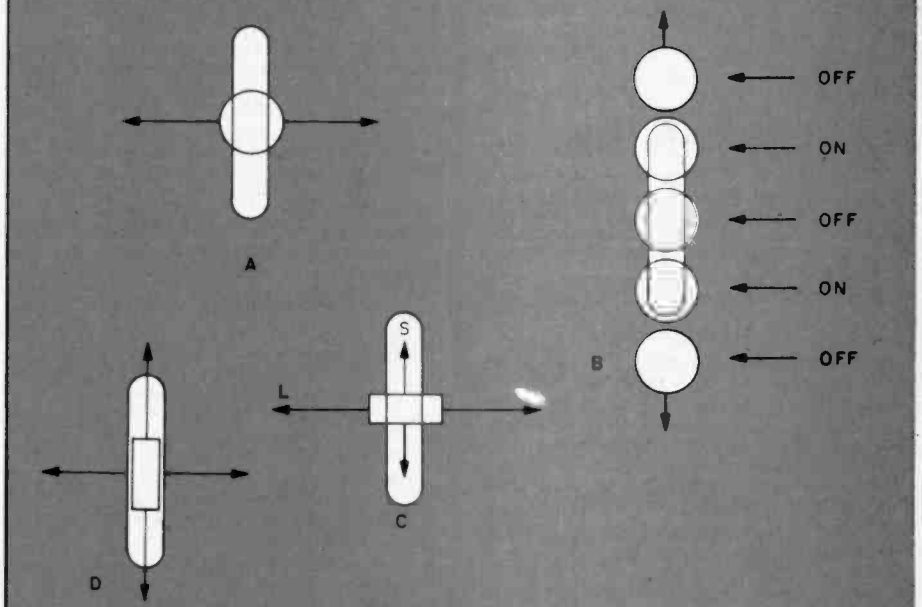
If you have but one reed switch, and the vertically-oriented magnet approaches from one side of the reed switch, it has a longer "reach" and switching action occurs while it is relatively far from the center of the switch. This relative sensitivity, relating to direction of magnet travel, could be an important factor in some switch-design problems.

Special Designs. As you play around with your reed switches and magnets you will undoubtedly discover many variations on the ideas given here. For example, suppose you wanted a sliding multi-pole switch that always switches the reed switches on in the same sequence. As the magnet travels over the parallel reeds, the switches come on in 1, 2, 3, 4 order. But as you slide the magnet back to its original starting position, the reeds would go on in reverse 4, 3, 2, 1 sequence—which is what you do *not* want. So what's the answer? Simply mount the magnet on a holder that permits it to be turned 90° at the end of each sweep. This way the magnet can be in its "active" orientation going one way, and in its "dead" orientation going the other way. Thus it is possible to return the magnet to the starting position, for subsequent normal switching order, without affecting the switches on the return sweep.

I have not tested these ideas, but it seems likely that you could construct such truly off-beat switches as, for example, a level-indicating switch by suspending the magnet on a short pendulum so that it will swing close to either of two parallel magnets to electrically signal tilting. And it may be feasible to create a vibration-detector in much the same manner, but mounting the magnet on the end of a flat or coil spring so that vibrations will swing it in-and-out of the switching range. ■



Spacing of adjacent reed switches is important if the first switch must go off before the next turns on. When the magnet is in its strongest orientation (left), the reed switches must be far apart. If the magnet is positioned at an angle slightly removed from where it does not switch, the two reed switches can be closer together and retain the on-before-off action.



Orientation and direction of movement of a disc magnet influence switching action. No switching occurs as a horizontal magnet moves across the reed switch as at upper left. If the magnet passes along the length of the reed (upper right), switching to "on" occurs when the magnet is near either end of the reed, but not when it is directly over the contact points in the center of the reed. Switching occurs if the magnet is vertically oriented as at lower left, but over a shorter range if the magnet moves along the "S" path than along the "L" path. If the magnet is turned 90° (lower right), no switching occurs when it is moved along either of the indicated paths.

LITERATURE LIBRARY

301. Get the '78 *Eico* Catalog and see their do-it-yourself kits and factory assembled electronic equipment. Specialties are test equipment, burglar/fire alarms, hobbyist and auto electronics.

302. *International crystal* has illustrated folders containing product information on radio communications kits for experimenters (PC boards; crystals; transistor RF mixers & amplifiers; etc.).

303. *Regency* has a new low cost/high performance UHF/FM repeater. Also in the low price is their 10-channel monitoradio scanner that offers 5-band performance.

304. *Dynascan's* new *B & K* catalog features test equipment for industrial labs, schools, and TV servicing.

306. Get *Antenna Specialists'* catalog of latest mobile antennas, test equipment, wattmeters, accessories.

308. Compact is the word for *Xcelite's* 9 different sets of midget screwdrivers and nutdrivers with "piggyback" handle to increase length and torque. A handy show case serves as a bench stand also.

310. *Turner* has two catalogs on their CB microphones and antennas. They give individual specifications on both lines. Construction details help in your choice.

311. *Midland Communications'* line of base, mobile and hand-held CB equipment, marine transceivers, scanning monitors, plus a sampling of accessories are covered in a colorful 18-page brochure.

312. *The EDI (Electronic Distributors, Inc.)* catalog is updated 5 times a year. It has an index of manufacturers literally from A to X (ADC to Xcelite). Whether you want to spend 29 cents for a pilot-light socket or $699.95 for a stereo AM/FM receiver, you'll find it here.

313. Get all the facts on *Progressive Edu-Kits* Home Radio Course. Build 20 radios and electronic circuits; parts, tools, and instructions included.

316. Get the *Hustler* brochure illustrating their complete line of CB and monitor radio antennas.

318. *GC Electronics* offers an "Electronic Chemical Handbook" for engineers and technicians. It is a "problem solver" with detailed descriptions, uses and applications of 160 chemicals compiled for electronic production and packaging. They are used for all types of electronic equipment.

320. *Edmund Scientific's* new catalog contains over 4500 products that embrace many sciences and fields.

321. *Cornell Electronics'* "Imperial Thrift Tag Sale" Catalog features TV and radio tubes. You can also find almost anything in electronics.

322. *Radio Shack's 1978* catalog colorfully illustrates their complete range of kit and wired products for electronics enthusiasts—CB, ham, SWL, hi-fi, experimenter kits, batteries, tools, tubes, wire, cable, etc.

323. Get *Lafayette Radio's* "new look" 1978 catalog with 260 pages of complete electronics equipment. It has larger pictures and easy-to-read type. Over 18,000 items cover hi-fi, CB, ham rigs, accessories, test equipment and tools.

327. *Avanti's* new brochure compares the quality difference between an Avanti Racer 27 base loaded mobile antenna and a typical imported base loaded antenna.

328. A new free catalog is available from *McGee Radio.* It contains electronic product bargains.

329. Semiconductor Supermart is a new 1978 catalog listing project builders' parts, popular CB gear, and test equipment. It features semiconductors—all from *Circuit Specialists.*

330. There are nearly 400 electronics kits in *Heath's* new catalog. Virtually every do-it-yourself interest is included—TV, radios, stereo and 4-channel, hi-fi, hobby computers, etc.

331. *E. F. Johnson* offers their CB 2-way radio catalog to help you when you make the American vacation scene. A selection guide to the features of the various messenger models will aid you as you go through the book.

332. If you want courses in assembling your own TV kits, *National Schools* has 10 from which to choose. There is a plan for GIs.

333. Get the new free catalog from *Howard W. Sams.* It describes 100's of books for hobbyists and technicians—books on projects, basic electronics and related subjects.

334. *Sprague Products* has L.E.D. readouts for those who want to build electronic clocks, calculators, etc. Parts lists and helpful schematics are included.

335. The latest edition of the *TAB BOOKS* catalog describes over 450 books on CB, electronics, broadcasting, do-it-yourself, hobby, radio, TV, hi-fi, and CB and TV servicing.

338. "Break Break," a booklet which came into existence at the request of hundreds of CBers, contains real life stories of incidents taking place on America's highways and byways. Compiled by the *Shakespeare Company,* it is available on a first come, first serve basis.

342. *Royce Electronics* has a new 1978 full line product catalog. The 40-page, full-color catalog contains their entire new line of 40-channel AM and SSB CB transceivers, hand-helds, marine communications equipment, and antennas and accessories.

344. For a packetful of material, send for SBE's material on UHF and VHF scanners, CB mobile transceivers, walkie-talkies, slow-scan TV systems, marine-radios, two-way radios, and accessories.

345. For CBers from *Hy-Gain Electronics Corp.* there is a 50-page, 4-color catalog (base, mobile and marine transceivers, antennas, and accessories). Colorful literature illustrating two models of monitor-scanners is also available.

350. Send for the free *NRI/McGraw Hill* 100-page color catalog detailing over 15 electronics courses. Courses cover TV-audio servicing, industrial and digital computer electronics, CB communications servicing, among others G.I. Bill approved, courses are sold by mail.

353. *MFJ* offers a free catalog of amateur radio equipment—CW and SSB audio filters, electronic components, etc. Other lit. is free.

354. A government FCC License can help you qualify for a career in electronics. Send for information from *Cleveland Institute of Electronics.*

355. New for CBers from *Anixter-Mark* is a colorful 4-page brochure detailing their line of base station and mobile antennas, including 6 models of the famous Mark Heliwhip.

356. *Continental Specialties* has a new catalog featuring breadboard and test equipment for the professional and hobbyist. Descriptions, pictures and specifications aid your making a choice.

359. *Electronics Book Club* has literature on how to get up to 3 electronics books (retailing at $58.70) for only 99 cents each . . . plus a sample Club News package.

361. "Solving CB Noise Problems" is published by *Gold Line* and tells you how to reduce the noise and get a clearer signal. In discussion and diagram you can find out about the kinds of noise, their sources, and the remedies.

362. *B&F Enterprises'* Truckload Sale catalog offers 10% off all merchandise: (military or industrial surplus) speaker kits, TV games, computer terminals, tools, TV components, lenses, and more.

363. Send for *computer enterprises'* catalog of microcomputer systems for personal, business, educational and industrial users. They claim the greatest bargains in microcomputer equipment, systems, parts and supplies.

364. If you're a component buyer or specifier, you'll want this catalog of surplus bargains: industrial, military, and commercial electronic parts, all from *Allied Action.*

365. *Electronic Supermarket* has a new catalog of almost everything in the field—transformers, semiconductors, tv parts, stereos, speakers, P.C. boards, phones, wire and cable, tools, motors.

366. Send for *Poly-Packs'* new catalog featuring hundreds of bargains: new Barrel Pack kits, hobby computer peripheral parts, fiber optics, solar energy chips, digital clocks, and more.

367. *Optoelectronics'* new catalog features their new Frequency Counter, a 6-digit clock calendar kit, mobile LED clock, biorhythm clock, digit conversion kit, and many others.

368. *Cherry Electrical Products* has a handbook describing their new "PRO" keyboard for personal computer, hobbyist and OEM users. Included are instructions on how to customize it on-the-spot, schematics, charts, and diagrams.

369. *Motorola Training Institute* offers a brochure on two new home-study courses: Four lessons cover semiconductors, designed for all technicians servicing electronic equipment; the 34-lesson professional FM two-way radio course is for those planning to service land-mobile equipment.

370. The 1978 catalog from *Computer Warehouse* has data on 10 different microcomputers, with used peripherals, and available for immediate delivery. Over 1,500 products are covered, new and used, from over 170 different vendors

371. Your computer system needn't cost a fortune. *Southwest Technical Products* offers their 6800 computer complete at $395 with features that cost you extra with many other systems. Peripheral bargains are included here.

372. See how you can save with *Olson's* "Erector Kit" Computer System; also their factory wired version which includes a 2-volume Bell & Howell instruction course. Send for information.

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Please arrange to have the literature whose numbers I have circled below sent to me as soon as possible. I am enclosing 50¢ for each group of 5 to cover handling. (No stamps, please.) Allow 4-6 weeks for delivery.

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Checkerboard

(Continued from page 78)

less breadboard, or placed in contact with the bare wire groups You can test as you go by using a slide, toggle or rocker switch at S1, or push-to-test with a momentary switch.

Checking Diodes. A properly operating diode will conduct in one direction only, and will not conduct when the leads are reversed. So you can check a diode with just two passes on Checker Board. If it lights the LED no matter which way it's connected, your diode has an internal short. If it won't light the LED no matter which way it's connected, it's opened up. If it lights the LED only when connected, then you can identify the anode end (the triangular arrowhead on schematic representations) as being connected to the red alligator clip (at the junction of R1, C1 and the base of Q1). The cathode (bar) end is then connected to the black alligator clip (ground).

Checking LEDs. You can follow the instructions for checking diodes to check LED's, but that's the hard way. The LED you test will light up, too, assuming it's good, when you test it on Checker Board. Make sure you get the polarity right. You can also trace 7-segment and multiple-digit LED displays to see which pin does what.

Checking Electrolytics. The thing that most often goes wrong with electrolytic capacitors is that they short out. And that's the easiest thing to spot with Checker Board. Connect the + lead to the red alligator clip and the – lead to the black, or plug the electrolytic right into the solderless breadboard. This test will be more fun with the momentary switch. Push it and watch the LED. You should see a bright flash that decays into darkness. The bigger the electrolytic, the longer the flash lasts. A shorted electrolytic won't go out—an open one won't flash.

Checking Crystals. Connect the two crystal leads to the alligator clips. If the LED lights brightly, the crystal is good. If it lights dimly, the crystal is good but will not work in all kinds of oscillator circuits. If the LED does not light at all, it probably means the crystal is bad. But it *may* mean that the crystal is one of the few, obscure types that cannot make Q1 oscillate in the Checker Board circuit. Most crystals, if good, will light the LED brightly.

Checking Switches. With Checker Board connected to any pair of switch contacts, the LED will light whenever there is continuity between the contacts. When there is no continuity, it will not light. With this information, a sheet of paper and a pencil, you can methodically analyze when continuity occurs with each change of setting of an unknown switch. This can tell you what kind of a switch it is. And, of course, when you know what kind of a switch you have, Checker Board can tell you whether or not it's working properly.

Checking Continuity. A closed circuit will light the LED, an open circuit won't. (We're speaking of DC continuity here). With this in mind, you can check cables, connectors, printed circuit paths, relays, light bulbs and many other devices. As long as the testing-path resistance doesn't get too high (just how high is too high depends on your particular LED and what shape your battery is in), anything that needs to maintain continuity in order to work (or discontinuity, in case you're looking for shorts) can be checked on the Checker Board.

Checking Out Checker Board. Yes, Checker Board even checks itself out. Just clip the two alligator clips together. If everything is working, the LED will light.

Light up! ■

Add Tone to Your Phone

(Continued from page 81)

The meter indicates RMS in terms of the average voltage of a sine waveform so the reading is slightly off because there are two sine waves. The 'scope sees the vector addition of the two tones, and when the tones are in phase the peak value is greater than the peak value of the individual tones. So, to avoid blowing any associated transistor equipment just remember that the maximum pad output is nominally 3.5 volts peak to peak regardless of what your VOM or VTVM indicates.

No Adjustments. Unlike some of the electronic touch-tone encoders the Western Electric telephone dialer pads require no adjustment, nor do they drift. Just install one and it works. ■

Ask Hank, He Knows

(Continued from page 13)

Time Stands Still

I recently picked up some capacitors in sealed, foil lined envelopes. The envelopes are dated August 1, 1955. They are fixed mica capacitors. Are the capacitors still good? How long can one keep capacitors before they vary from their specified value? Is there a special way to keep capacitors "fresh" longer?

—R. F., East Hills, NY

You could say that mica capacitors were the first "solid-state" components. The mica used to separate the capacitor plates are flaky rocks formed millions of years ago. The phenolic moulded case is durable, will last many years. Don't worry about a mica capacitor going bad after years of no use or continuous use. In all my years of servicing friends' radios, phonos, etc., I came across only one bad mica capacitor—that's good performance.

Ring of Fire

My power vacuum machine for the shop is not working properly. I looked at the motor and a ring of fire eminates from the point where the brushes touch the commentator and the fire circles the commentator as the motor turns. What's wrong?

—R. W., Ludlow, MA

I assume you have good brushes in the machine, and if new ones were inserted, they were broken in properly. If the "fire" still exists, then phase the brushes. This is done by loosening a few screws so that the frame holding the brushes can be rotated about the commutator a few degrees. Do this while the motor is running and adjust for minimum fire or glow. Tighten screws.

Foreign Types

I have several foreign-made receivers and tape machines that need solid-state parts. When I go to order them by mail, I have to order from several suppliers. Is there one place I can go to?

—D. N., Wichita, KN

Write to Fugi-Svea Enterprise, P.O. Box 40325, Cincinnati, Ohio 40325 and tell them Hank sent you. They have a very good product line and should be able to handle 100% of your needs. They require a minimum order of ten dollars.

Welcome to the Hobby

Hank I'm a beginner and only received one issue up to now on my three-year subscription. I'd like to get into BCB DX-ing and would like to know what kind of antenna I should use.

—M. A., Norwalk, CA

If you are getting started in BCB DX-ing, I suggest two things immediately. First, start logging all the stations you can receive with whatever you have available. Listen in the early evening, late at night and early morning, especially just before, during and after sunrise and sunset. Gain listening experience. Second, start reading everything you can find that covers the subject. As for your antenna, for a start use what you have. If you must, run a long-wire antenna. Any size is good (25 feet is super for a beginner).

It's Basic

What do you mean by GOSUB in computer language?

—B. D., Fargo, ND

Typically, a Basic computer program may read 110 GOSUB 340. This means, at this point in the program, it is addressed to go to a sub-routine beginning at line 340. When the sub-routine is completed, the program will return to line 111, or whatever line number appears immediately after line 110. Since there are so many repetitions operations, the GOSUB instruction saves valuable memory. ■

CB New Products

(Continued from page 71)

thread. The "Bumper Mate" is also available with 18 ft. of Mil Spec type RG-58A/U coaxial cable and a genuine soldered PL-259 connector (Model #HWM-19C). Sells for $19.50. For further information, write to Anixter-Mark, 5439 West Fargo, Skokie, IL 60076.

Communications Desk

The Telco communications console, known as the Comm-Sol Model CS-50, is the answer to the space problem for all communications enthusiasts. It provides the user with an area for all of his communications equipment, and at the ıe time, serves as an attractive piece

CIRCLE 67 ON READER SERVICE COUPON

of furniture that blends with your home's decor. Completely conceals all the equipment when not in use and prevents unauthorized use. Comm-Sol's modular concept and construction allows additional units to be arranged attractively to provide all the work, storage and functional space you desire. Easy to assemble and install, no specal tools needed, and can be assembled with only a dime. All holes are predrilled and specially reinforced with metal in all areas of stress. Finished in rich walnut veneer. Sells for $139 95 For additional information, write to Telco Products Corporation, 44 Seacliff Ave., Glen Cove, NY 11542.

Burn-Out Proof DC Power Supply

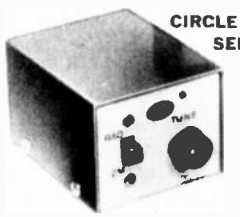
A new DC power supply designed for CB service application, designated Model 244 Mobil/Comm Power Supply, offers features of value to CB service technicians. The fully-adjustable voltage range of 10.5 to 14.5 VDC is accurately metered on large 2½ inch meter with the calibrated standard 13.8 volt setting clearly indicated. Full adjustability and 0.5% regulation permits duplication of actual storage-battery operating conditions such as low-voltage and over-voltage operation. Continuous-duty three ampere output is protected against short circuits by fold-back current limiting. Even dead shorts will do no damage. An additional advantage of fold-back current limiting is that during high current-load conditions that may exist in malfunctioning transceivers, the power supply

CIRCLE 71 ON READER SERVICE COUPON

will not shut off, but, automatically reduce the current output to a relatively safe level. When the meter switch is in the AMPS position the output current is indicated with 3% accuracy. After the short circuit is removed the unit returns to normal operation, no fuse to replace, no circuit breakers to reset. The Hickok Model 244 Mobil/Comm Power Supply is available now at Hickok distributors for $125.00. For further information write to Hickok Electrical Instrument Company, 10514 Dupont Avenue, Cleveland, OH 44108.

Fools the Crooks

The Barker & Williamson model AT-200 antenna matcher mates 2-meter amateur mobile transceivers to automobile AM/FM receiver antennas. The Model AT-200 is intended to provide the theft-foiling benefits of disguised and hideaway antennas at lower cost and to eliminate the nuisance of constantly putting up and taking down a second antenna. The AT-200 consists of a tuneable matching network, an output indicator, and a selector switch in a compact case, with two coaxial cables for connections to the entertainment radio and the 2-meter rig. The front panel contains a tuning knob, a two-position (AM/FM or 2-meter) selector switch, and an output indicator



CIRCLE 66 ON READER SERVICE COUPON

light. The unit is supplied with a mounting bracket and installation instructions. Power capacity is 100 watts. To use the Model AT-200 with a 2-meter transceiver, place the selector switch in the 2-meter position, key the transmitter, and adjust the tuning knob for maximum brightness of the LED tuning indicator. With most vehicle antennas, the VSWR can be adjusted to 1.2:1 or lower. With the selector switch in the AM/FM position, the antenna is fed to the entertainment radio. The Model AT-200 antenna matcher is available through Barker & Williamson distributors and dealers. Introductory price is $22.50. Barker & Williamson also manufactures the Model AT-140 antenna matcher for the 27-MHz Citizens Band service. This unit performs the same functions as the Model AT-200, but in the 11-meter CB band. For additional information, write to Barker & Williamson, Inc., 10 Canal Street, Bristol, PA 19007. ■

New Products

(Continued from page 12)

magnification to allow for less critical focusing. The new Robins "Stylee" Cartridge Maintenance Kit, catalog No. 41-039 carries a suggested list of $10.00. For further information, write to Robins Industries Corp., 75 Austin Blvd., Commack, NY 11725.

Aircraft Clock/Timer

If you're into flying, you may want to assemble a low-cost, five-function aircraft clock/timer kit by Heath. The 01-1154 has two digital LED displays that show various timing functions. The upper display shows GMT/ZULU time. The lower display shows any one of four time functions selected by the pilot; local time; 24-hour timer for total trip time; and a preset alarm time for fuel management or check point notification. The displays dim automatically for night flying. The 01-1154 mounts in a standard 3⅛-in. instrument panel cutout. It is

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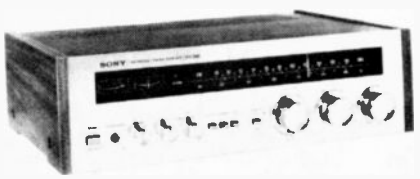
FAA/PMA approved and meets all DO-160 requirements. Mail-order priced at $149.95. For further information, write for a free copy of the latest Heathkit catalog: Heath Company, Benton Harbor, MI 49022.

AM/FM Stereo Receiver

Sony's new STR-2800 receiver features 20 watts per channel, minimum RMS at 8 ohms from 20 Hz to 20 kHz with no more than .5% total harmonic distortion. Intermodulation distortion is also .5%. The amplifier is direct coupled for high stability, wide frequency response, and low distortion. The tuner affords clear FM reception: 50 dB of quieting is reached with only 50 uV of input in stereo; ultimate signal-to-noise is a very quiet 68 dB. Selectivity is 50 dB, cap-



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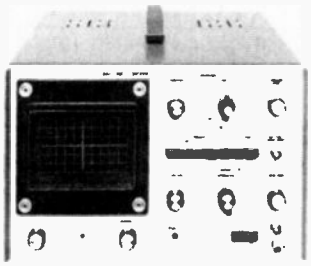
ture ratio 1.5 dB, and separation 35 dB (at 1 kHz). Price is $240.00. For more information, write to Sony Corporation of America, 9 West 57th St. New York, NY 10019.

Triggered Sweep 5-in Oscilloscope

The EICO Model 480 Oscilloscope offers DC to 10 MHz bandwidth, AC and DC Coupling, 11 position calibrated attenuator, 10mV/cm sensitivity, and push-button operation. For the service shop, electronics lab or production facility, you'll find more than sufficient vertical deflection sensitivity, horizontal sweep



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speeds and bandwidth response for testing color or black-and-white TV receivers and any other electronic equipment. All circuits are on four P/C boards for ease in servicing. Controls are human engineered and are grouped functionally. They are color-coded for quick identification and easy use. The custom-molded bezel is ideal for camera mounting. A built-in TV sync separator makes troubleshooting on solid state TV receivers a snap. Frame of line triggering is selected automatically by the scope in conjunction with sweep speed setting. Problems are quickly located and identified, thanks to the calibrated time base. A fully-regulated power supply provides stable voltages regardless of line and load fluctuations, and a calibration voltage of 0.2 volts peak-to-peak square wave is available for probe (the EICO Model LCD-10X), a high-impedance probe that minimizes circuit load during test. Suggested user net is $425.00. For further information, write to Mark Ehren, EICO Electronic Instrument Co., Inc., 283 Malta Street, Brooklyn, NY 11207.

Crimp It Terminals

Quality Terminals, a national distributor of electro-connective parts, offers a useful selection of 240 of the most-used, insulated, color-coded, crimpable, solderless terminals, together with a combination wire stripper/crimping tool and a heavy-duty, 25-drawer steel parts cabinet. All for $24.95 plus $3.00 shipping

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and handling. Tool and terminals are first quality and American made. Selection of terminals consists of 9 sizes of ring type, 8 sizes of fork tongue, 3 sizes of butt splices and male and female quick disconnect in various sizes. For further information, contact Quality Terminals, 368 Hillside Avenue, Needham, MA 02192.

Preamp/Amplifier

Dynaco/Dynakit has introduced a new moderately-priced integrated preamp/amplifier, the SCA-50, which offers a number of features. The unit is available assembled or in kit form. As a kit, it is extremely easy to assemble, requiring only simple tools and a few evenings work. Most circuitry is factory-wired on printed circuit boards, and pre-tested. It

CIRCLE 73 ON READER SERVICE COUPON

is rated at 25 watts continuous average power output per channel. Both the tone control and preamplifier circuits use low voltage regulated power supplies so that AC line fluctuations will have no effect on audio performance. In the amplifier section, the output circuit is full complementary symmetry and the bias supply thermally tracks the output transistors. This cuts down on notch distortion—that type of distortion which many believe is the source of transistor sound. The SCA-50 has a price of $249.00 for the factory-assembled unit and $149.00 for the kit. Detailed information is available from Dynaco/Dynakit, Box 88, Cole Road, Blackwood, NJ 08012.

Blackjack Progam

RCA lets you play Blackjack with its Studio II home TV programmer. The programmer is a combination video game and educational device which can be used with any size black-and-white or color TV set. It has five games built into the console and employs plug-in solid state cartridges for additional add-on games. The built-in games are: Freeway, Addition, Bowling, Patterns and Doodles. The new plug-in cartridge offers Blackjack. In Blackjack the action and excitement of Las Vegas casinos are programmed onto the home TV screen.

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Players are staked with 200 dollars and can bet up to 10 dollars per hand. In trying to beat the computer, who is the dealer, players are offered the chance to "hit" (request another card), "stick" (stay with the cards they have) or "double down" (double their bet but get just one more card). Optional retail price of RCA's Studio II is $149.95. The add-on Blackjack cartridge is optionally priced at $19.95. For further information, write to Joe Searfoss, RCA Distributor and Special Products Division, Deptford, NJ 08096. ■

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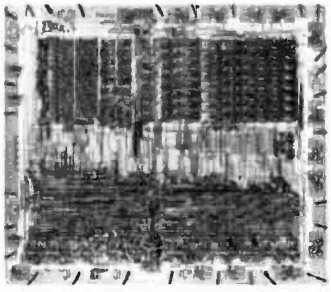
Computer New Products

(Continued from page 68)

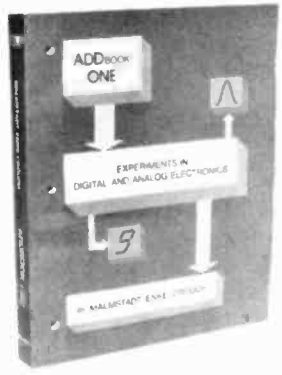
tively store 32K, 48K and 64K bytes of data as the model code numbers imply. In addition to high-density storage, the boards feature flexible organization, battery backup and memory protect capability, transparent refresh and reduced power requirements. Storage can be dedicated to one computer or shared by several computers. The memory boards interface directly with the bus and contain read and write data buffers. Each board is organized as blocks of 16K bytes (16,384 8-bit words). Block addressing is jumper-selectable. To facilitate battery backup, each board contains an auxiliary power bus and memory protect control that prevents read or write accesses during system power-down sequences. Typical power consumption is 15 watts in normal operation, less than 7 watts on backup battery power. Maximum access time is 450 nanoseconds. Maximum cycle times: 600 ns, read; 600 ns/1140 ns for write cycles; 585 ns for refresh cycles. Prices: SBC 032, $1,650; SBC 048, $2,300; SBC 064, $2,950. Circle 65 on Reader Service Coupon for more information about this project from Intel Corp.

Programmable Communications Interface—Signetics says this first programmable communications interface (PCI) features a MOS/LSI circuit that combines the functions of a Universal Synchronous/Asynchronous Receiver / Transmitter (USART) with those of a baud rate generator in a single 28-pin, dual-line package. Model 2651 PCI is claimed to provide extremely cost-effective solutions to many data communications problems in intelligent terminals, communications controllers, data concentrators, front-end processors. Capabilities include modem



control, support of IBM's BISYNC protocol, asynchronous echo mode, and local and remote self-testing. The chip is fully TTL compatible, operates from a single +5V supply, and does not require a system clock. It's compatible with most 8-bit microprocessors, including the 2650, 8080, Z80 and 6800. The PCI is programmed to handle characters from 5- to 8-bits in length. The internal baud rate generator provides 16 different program-selectable baud rates for the transmit and receive clocks; these range from 50 to 19:2K bits per second. Price: $17.15. Circle 19 on Reader Service Coupon.

Digital/Analog Electronics Course—ADDbook ONE, a single-volume guide to a designed program of experiments in digital and analog electronics is available from E&L Instruments at a price of $17. The 400-page workbook is a tutorial and experiment manual based on E&L's ADD 8000, a modular electronics laboratory in a bench-top case. The experiments were



written expressly for persons wanting to gain a working knowledge of electronics without formal classroom study; such persons may be practicing engineers or scientists, technicians, college students or serious hobbyists. Ten experimental units cover subjects completely relevant to the latest digital and analog instruments and measurement techniques. The ADD 8000 contains all needed signal sources, displays, power supplies and breadboards. Circle 54 on Reader Service Coupon for further information. ■

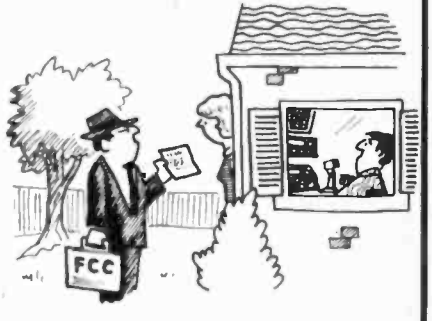
Your Horoscope

By Jack Schmidt

LIBRA—Frustrations may occur as plans fail to jell. Don't hesitate to stop for tonight and to start over again the following day.

GEMINI—Personal activities of a highly social nature may be interrupted by mechanical failure.

SCORPIO—Long awaited communications may fail to materialize as planned. Patience should be your watchword.



LEO—Governmental regulations may interfere with hobby activities with subsequent increases in cost.

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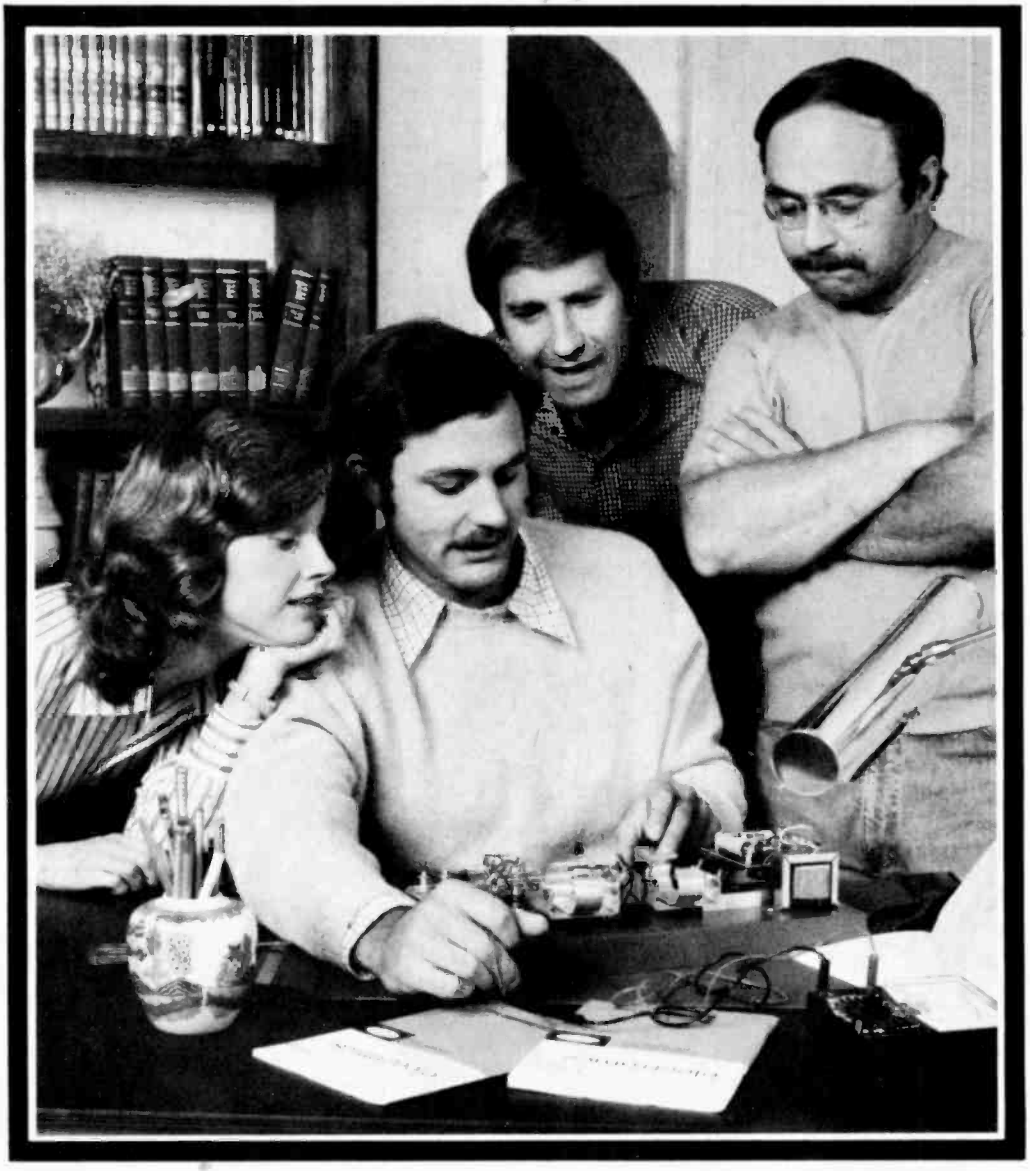

Learning new skills isn't something you just breeze through. Especially in electronics. You've got to really want success if you're going to build your skills properly.

Herb knew that right from the start. But he also knew what rewards he could earn if he took some time and did it right. He knew that, in today's world, people who really know electronics find a lot of other people . . . even whole industries . . . looking for their help.

How about you? How much do you want that thrilling feeling of success . . . of being in demand? Enough to work for it?

Why it pays to build skills and know-how.

One of the things that got Herb interested in electronics is that electronics seems to be something just about everybody needs. Almost everywhere you look these days — in a business office . . . a manufacturing plant . . . a department store . . . a doctor's office . . . a college . . . even your own home you'll find all kinds of electronic devices.

That spelled "opportunity" to Herb. Plus he liked the idea of having a set of skills that might lead to jobs in places as different as a TV station . . . a hospital . . . an airport . . . a petroleum refinery.

But what Herb liked most about electronics is that it's just plain interesting. Even though it takes time and effort to learn, the subject is so fascinating it almost doesn't seem like "studying" at all!

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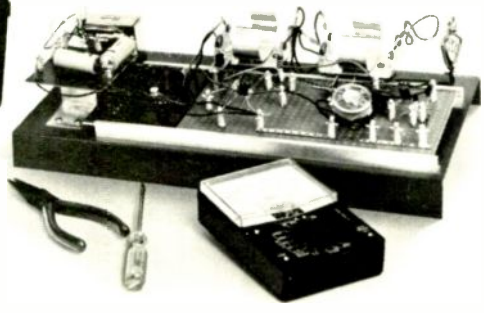

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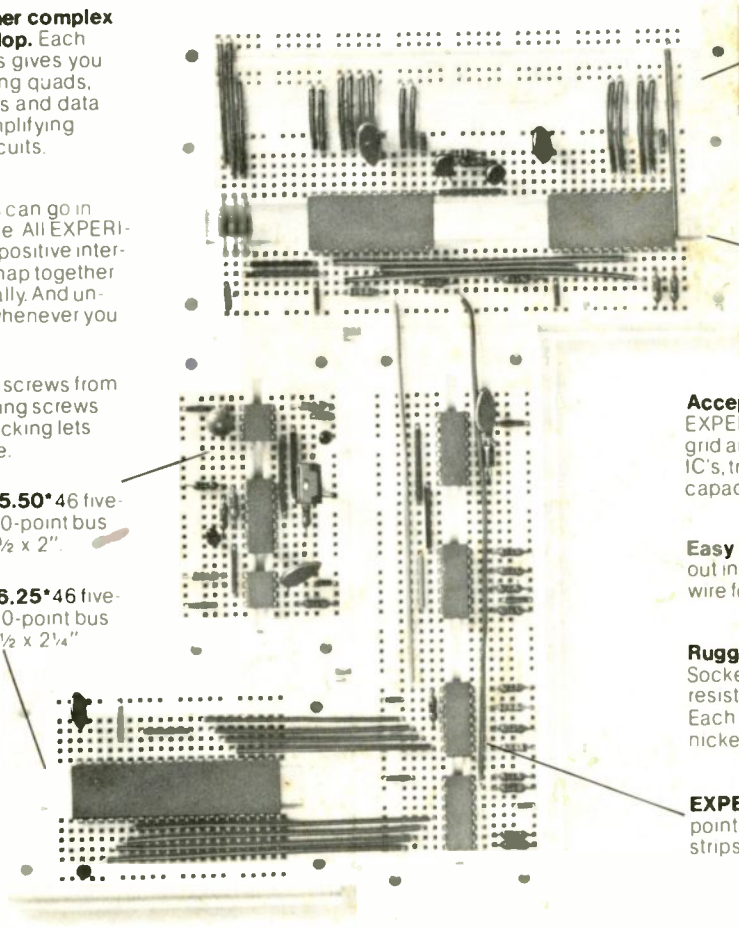

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