PROJECTS

ELECTRONICS HOBBYIST

SPRING-SUMMER 1979 $1.75 02396

by the EDITORS of ELEMENTARY ELECTRONICS

OLYMPIC GOLD MEDAL PROJECTS

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VERY-LOW-FREQUENCY BROADCAST RECEIVER

PLUS:

HELICAL ANTENNA FOR APARTMENT HOUSE DX • SCA FM ADAPTER
DARKROOM COLOR ANALYZER • CB BATTERY CHARGER
NEW LIFE FOR CAR RADIOS • COMPUTERIZED TIC-TAC-TOE
AND MUCH, MUCH MORE!

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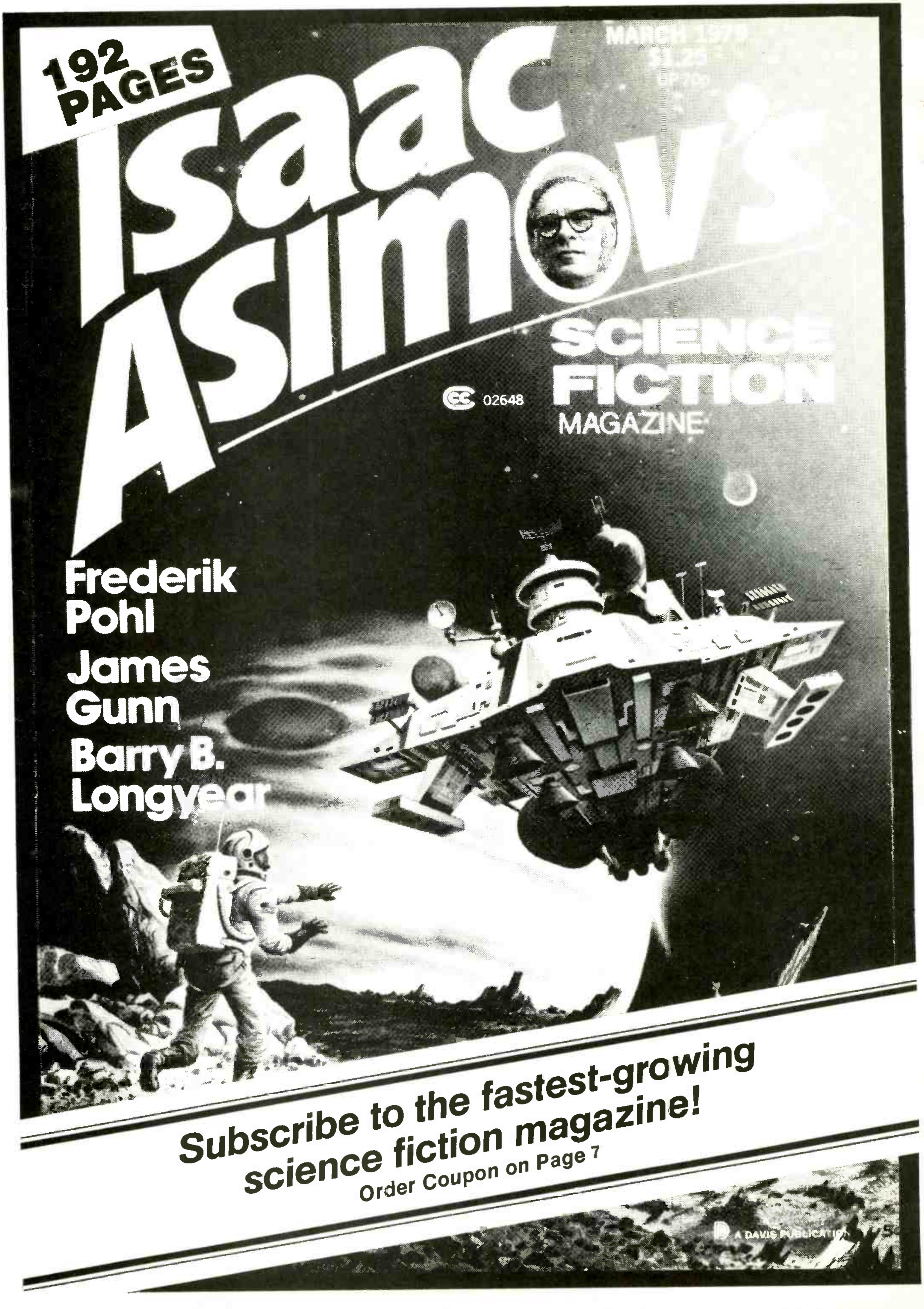
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ELECTRONICS HOBBYIST

SPRING—SUMMER 1979

PROJECTS

New Products

Toe-Controlled "Wah"

RolandCorp US' new Boss TW-1 touch "wah" unit incorporates an envelope follower circuit to generate controlled voltage which activates a sophisticated "wah" filter. The control voltage follows the dynamics and attack characteristics

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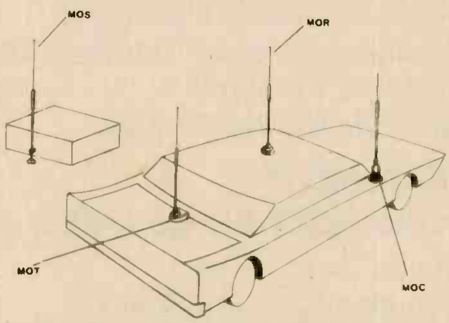
of the incoming note or notes. The louder the input, the greater the "wah" filter sweep. Sweep parameters can also be varied by the unit's sensitivity control. Filtering is adjusted by the peak control. The unit's drive control determines whether the "wah" goes up, or down. Since the triggering mode is electrical, rapid "wah" effects are instantly available. The Boss TW-1 sells for $109.50. Get the facts direct from RolandCorp US, 2401 Saybrook Avenue, Los Angeles, CA 90040, and rock on!

Antennas for Monitors

A full line of Hustler indoor and mobile VHF/UHF monitor antennas has been introduced by New-Tronics. Hustler monitors are designed for optimum re-



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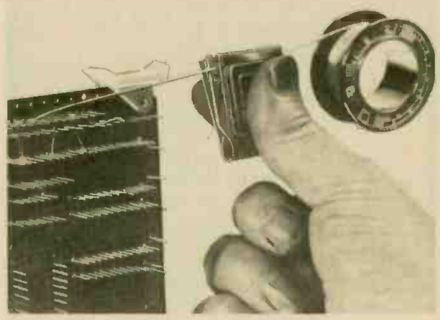
ception on the most-listened-to-bands: 37 to 50 MHz (VHF), 150 to 174 MHz (VHF), and 450 to 512 MHz (UHF). Hustler monitor antennas never need trimming or adjusting, eliminating resetting of the antenna length every time a different band is scanned. The New-Tronics monitor line includes the 33-inch Model MOS ($9.95) indoor receiver-mounted antenna. It plugs directly into a receiver or scanner and has its own adjustable base for maximum stability. The 33¾-inch mobile Model MOR ($19.95) installs on a flat horizontal surface, like a roof or deck lid. It comes complete with 12-feet of RG-58 coax and connectors. The Model MOT (24.95) is a 34½-inch trunk lip mount antenna designed for no-holes mounting. It is supplied with 17 feet of RG-58 and connectors. Finally, the Model MOC ($19.95) is a universal-mount mobile antenna 34¼-inches long. It's easily mounted on a flat vertical or horizontal fender surface, with an adjustable 180° swivel to keep the antenna vertical. The MOC includes 5-feet of Hustler's RG-58 and connectors. For further information on Hustler antenna products, including amateur, professional, or CB, write to New-Tronics Corporation, 15800 Commerce Park Drive, Brookpark, OH 44142.

For Wire Wrappers

The fantastic new CAS-130 "Clip and Strip" tool cuts and strips 30 AWG wire nick-free, hides in the palm of your hand, and costs only $1.98. Just insert wire into the jaws of the CAS-130, squeeze tool to cut off excess wire, and pull wire through precision stripping



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blade. Result is precise, uniform, 1-inch strip-off length ready for wire-wrapping. One-piece cutting mechanism and precision blade insure dependability and ease of operation. The $1.98 tool is in stock at your local electronics store, or available directly from O.K. Machine and Tool Corporation, 3455 Conner Street, Bronx, NY 10475.

6800-Based Microcomputer

A new dual-floppy microcomputer, featuring SS-50 BUS compatibility, and a new controller design, has been introduced by Smoke Signal Broadcasting as

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the "Chieftain" microcomputer. It packs a powerful 6800 microprocessor with 32K of static RAM. Standard features also include two serial I/O ports, two mini-floppies, and the compatible DOS-68 disk operating system. The new microcomputer allows up to 60K of usable memory by adding two more slots. Disk storage can also be increased to four mini-floppies or four 8-in. floppies. Price for the "Chieftain" microcomputer is $2,595. For information, contact Smoke Signal Broadcasting, 6304 Yucca Street, Hollywood, CA 90028.

Mate in Two

Here comes CompuChess, a humanized computer. In addition to playing 6 levels of chess, CompuChess features selectable games: The Game of Knights, chess

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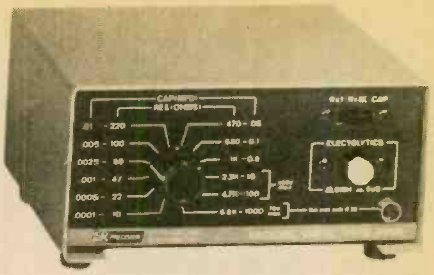
with an Amazon Queen, or SURVIVAL, with 1500 middle-game problems for the chess enthusiast. From beginner to expert, everyone will learn and have fun with The Second Edition of CompuChess. Programmed moves include: castling, en-passant automatic or selectable Pawn promotion, move randomizing, and mate-in-two capability. The keyboard and display are strongly user-oriented for adding, deleting, or finding pieces easily. Available with or without labled magnetic chess set, it includes extra knights. Find it at most department stores for $224.95, or write CompuChess, Box 65, Largo, FL 33540 for all the details.

Substitution Box

The new B&K-Precision Surge-Protected Substitution Box, Model 2910, is designed to eliminate shock hazards, accidental discharges, and the trouble-shooting headaches of the temporary healing of a defective electrolytic (during substitution circuit testing). The Surge Protector's circuit limits initial surge by automatically putting a resistor in series with the substitute capacitor. After substitution, the switch is returned to the discharge position for safe RC discharge of the substitute capacitor. An overload indicator lamp warns against substitution of a low voltage capacitor when applied voltage is over 75 VDC. Compact, lightweight and portable, the 2910 features 36 substitution components for most common resistor and capacitor values. It includes 24 carbon resistors, ranging from 10-ohms to 6.8-megohms (±10%). Nine disc and tubular capacitors range in value from 0.0001 to 0.01-uF at 500 VDC and from 0.05 to 0.50-uF at 600 VDC, for electrolytic substitutions. 10 and 100-uF at 450 VDC, and 100-uF at 75 VDC values are also provided. Capacitance substitutions



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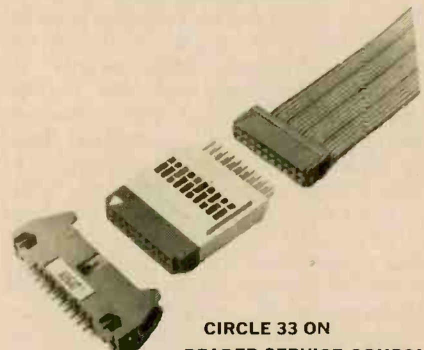
are accurate to within ±10%. The Model 2910 is priced at $50.00, and is available for immediate delivery from local distributors. For further information, contact National Adevrtising Manager, B&K-Precision, 6460 W. Cortland Avenue, Chicago, IL 60635.

Ribbon Switch

The Intra-Switch, made by the Interconnection Products Division of Augat Inc., provides for line-by-line diagnostic testing or quality assurance for flat ribbon cables. Positioned between the female plug on the end of a flat ribbon cable and a male plug on a header assembly or an Intra-Connector, the device has individual sliding switches that open and close each connection between its male and female sides. The individual sliding switch controls, recessed to prevent accidental switching, are pushed open and closed by a pen point or probe. When used with the Intra-Connector, each line in the ribbon cable connected to the Intra-Switch can be checked under load

New Products

or no load conditions. The Intra Switch is available in 20 ($6.10), 26 ($7.00), 34 ($8.20), 40 ($9.15), and 50-pin



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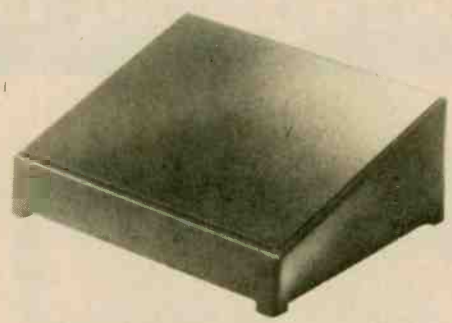
($10.95) models. Get all the facts direct from Augat Inc., 33 Perry Avenue, P.O. Box 779, Attleboro, MA 02703.

Design Mate Cases

Continental Specialties offers two alternatives to the usual options of buying a metal box or making your own. CSC's Design Mate Cases are lightweight, durable, attractive, and offer the large sloping front panels often required by today's miniaturized electronics. Two models are available. The Model DMC-1 measures 7.5-inches wide by 6.75-inches deep at the base, and slopes from 1.5-



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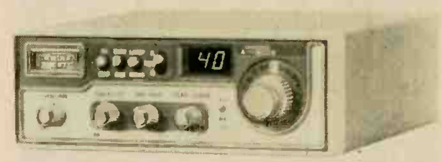
inches to 3.25-inches high. It weighs 12 ounces and sells for $6.95. The Model DMC-2 measures 6.0-inches wide by 5.64-inches deep at the base, and slopes from 1.5-inches to 3-inches high. It weighs in at 10 ounces and sells for $5.95. Both Design Mate Cases are made of a single piece of high impact insulated plastic, and include a metal bottom and mounting screws. Feet are molded into the four bottom corners. These cases are available in blue, and they will accept both paint and screening inks. For additional information, contact Continental Specialties Corp., 70 Fulton Terrace, New Haven, CT 06509.

Full Feature AM CB

Dual receive circuits with scanning capabilities make the Land Command LCM-8, by SBE, a good choice for CB'ers who utilize their mobile transceivers extensively on long trips. A three position switch allows, in the "A" position, the receiver to lock into the channel displayed on a LED readout, or, in the "B" position, allows the receiver to lock onto the channel dialed up on the rotary dial skirt. With the "A-B" switch in the "scan" position, the receiver now scans both channels with one channel on a priority override basis. Dual channel scan means casual listening on one channel, such as channel 19, with a priority override of any other channel, such as channel 9, the emergency channel, if that channel should become active. A scanning sensitivity control allows for one channel to be set with the squelch extremely sensitive, such as channel 9, and the other channel to be set with less sensitivity, such as chan-



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nel 19. It sells for $229.95. And there's lots more to the LCM-8. get more information by writing to SBE, 220 Airport Blvd., Watsonville, CA 95076.

Indoor/Outdoor Digital Thermometer

Edmund Scientific is offering a new Indoor/Outdoor Digital Thermometer. Easy to install, and featuring a four-way control, it can monitor two environments in Fahrenheit or Celsius. The difference between inside and outside temperatures can be obtained simply by switching on the computer. Featuring lab-standard accuracy and micro-computer data processor circuitry, it will read temperatures ranging from −31° to +122°F. Hundreds of readings can be obtained from the standard 9-volt battery that is included with this solid-state unit. Temperature changes are shown quickly in large, clear numbers. A practical thermometer, it is recommended for the home, office, camper, mobile or motor home, farm, ranch, greenhouse, incubator and freezer, or just about anywhere when temperature changes must

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be watched. The new Indoor/Outdoor Digital Thermometer is priced at $94.95 postpaid and can be ordered by mail (stock no. 61,176) from Edmund Scientific Co., 7782 Edscorp Bldg., Barrington, NJ 08007. Add $1.00 for handling. An Edmund catalog describing over 4,000 products can be obtained free by writing to the same address.

On the Air

Telco Products has a new base station preamp, and back-lighted ON-THE-AIR sign, known as the Base Booster Model 10-4. The Base Booster provides an ad-

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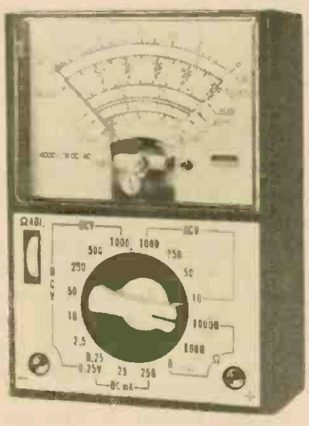
justable gain control which boosts weak signals up to plus 25 dB. It attenuates strong locals to minus 4 dB. With an unique RF sniffer circuit, the Base Booster will sense when the transceiver is keyed, effectively switching the preamp off during the transmit mode, and lighting the On-the Air sign. This feature allows the preamplifier to be connected directly into the coax line without modification of the existing system. Selectable AM/SSB switch. Operates on 12 VDC or 117 VAC. Complete with separate 117 VAC plug-in power supply. Sells for $64.95. For additional information write to Telco Products Corporation, 44 Seacliff Avenue, Glen Cove, NY 11542.

Budget Multimeter

EICO's new multimeter, Model 4A4, is a 4000 ohms/volt general-purpose instrument with 17 ranges. The meter mea-



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sures up to 1000 volts DC and AC, up to 250 mA DC, and up to 2 megohms resistance. The 4A4 features a recessed selector switch and an easy-to-read 3-in. meter with mirror-back scale. The movement is diode-protected. Suggested price of the new Model 4A4 is only $17.95, assembled and complete with batteries. For further details, contact EICO Electronic Instrument Co., Inc., 108 New South Road, Hicksville, NY 11801.

Tri-Band Monitor Antenna

A new tri-band base monitor antenna, utilizing the patented Astro Plane design, has been announced by Avanti Research & Development Co. This new design features exceptional gain across the entire tri-band HF-VHF-UHF spectrum from 25 MHz to 512 MHz, including the new "T" band. Gain figures on the three frequency ranges are: 4.4 dBi on HF, 2.1 dBi on VHF, and 3.3 dBi on UHF. Avanti engineers developed this compact, lightweight, new design to provide easy installation, and improve durability and wind resistance. DC ground construction was incorporated to minimize static

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interference. The antenna sells for $29.95. Get the complete antenna catalog from Avanti Antennas, 340 Stewart Avenue, Addison, IL 60101.

Fast Counter

The Radio Shack Micronta Digital Frequency Counter can be used in making accurate frequency measurements in audio, RF, video, ultrasonic, and digital applications. Operation is completely automatic. Simply turn on the power switch, connect the input leads to a signal source, or install the mini-rod antenna, and take a reading. The counter has an easily readable 0.6-inch six-digit LED display with lead zero blanking.

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Frequency resolution is 100 Hz throughout the 100 Hz to 45 MHz range, and it is protected against input overvoltage. The Micronta Digital Counter, complete with carry pouch, mini-rod antenna, and test leads, is priced at $99.95. Available from Radio Shack stores and dealers in all 50 states and Canada.

New Fit for Smaller Cars

Detroit has squeezed the rear deck in their new, smaller car models, so AFS has developed dual cone (Model 2031) and coaxial (Model 2032) 4-in. x 10-in. KLASSIC bulk pack speakers to fit where 6-in. x 9-in. speakers used to go. The new speaker size also fits nicely into the

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rear posts in most models of station wagons, under the dashboard up front in many cars, trucks and recreational vechicles, or anywhere in a boat or airplane. The specs for the Model 2032 are:

New Products

4-in. x 10-in. coaxial design, 10 oz. ceramic magnet, 1-in. voice coil, 25 watts RMS, 55 Hz to 18,000 Hz, 8 ohms; and sells for $24.60. The specs for the Model 2031 are: 4-in. x 10-in. dual cone design, 10 oz. ceramic magnet, 1-in. voice coil, 25 watts RMS, 55 Hz to 16,000 Hz, 8 ohms; and sells for $17.50. For further information on the 2032 and 2031, write Acoustic Fiber Sound Systems, Inc., P.O. Box 50829, Indianapolis, In 46250 or call (317) 842-0620.

All New Antenna Line

Antenna Specialists has just released its Scorpion line—a whole new breed of CB antennas combining bold, contemporary styling with the latest in antenna technology. A new solid-state circuit replacing the loading coil delivers consistent per-

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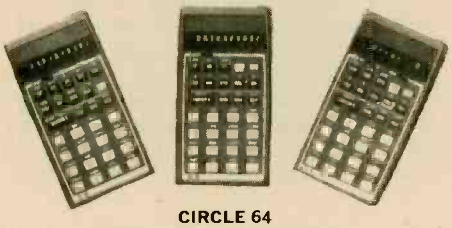
formance over all 40 CB channels. The new Scorpion line is built for durability, and has an unique lever-action quick release system for protection from vandalism or car washes. The Scorpion antenna line now includes the four most popular mounts; roof mount, trunk lid mount, hatchback mount and magnetic mount. All four units come with 17 feet (24 feet on magnetic mount) of type 58/U coaxial cable with a permanently attached PL-259 type connector. They are priced at $29.50 to $34.50. For information, contact The Antenna Specialists Co., 12435 Euclid Avenue, Cleveland, OH 44106.

Scientific Calculators

A family of three, new, hand-held scientific calculators featuring a new display size, error messages, custom literature and a new packaging design was introduced by the Hewlett-Packard Company. The HP031E, priced at $60.00 is an advanced scientific calculator for the professional to use as a basic tool. In addition to the standard arithmetic, logarithmic and trigonometric functions, the HP-31E also has fixed and scientific display modes, and rectangular/polar, degree/radian, inch/millimeter, Farenheit/Centigrade and Pound-mass/kilogram conversion keys. The HP-31E also has the HP RPN logic system with four addressable storage registers. The HP-32E, priced at $80.00, incorporates all of the features and functions of the HP-31E with an engineering display mode and the first use of hyperbolic functions and their inverses in an HP hand-held calcu-



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ON READER SERVICE COUPON

lator. It also features a U.S. Gallons/Liters key, a decimal degree and hour/hours, minutes, seconds key, and the most advanced collection of statistical functions ever offered on an HP calculator—including linear regression, correlation coefficient, x and y estimates, normal and inverse normal distribution and factorial. The HP-32E also features 15 addressable storage registers. The HP-33E, priced at $100.00, has all of the features of the HP-32E, except hyperbolics, metrics and certain statistical functions, and offers 49 lines of fully merged keystroke memory. Of particular interest is the calculator's capacity for three levels of subroutines. Get all the facts direct from Inquiries Manager, Hewlett-Packard Company, 1507 Page Mill Road, Palo Alto, CA 94304.

CB Pistol Mike

new concept in two-way mobile radio microphones combines an electret-capacitor element with a compact pistol-grip case that tucks neatly into the palm. The JMR Mobile Ear Microphone, model 40, is specially engineered to be held at the steering wheel while transmitting, allowing you to talk, switch, and use both hands for driving simultaneously. The built-in Velcro pad lets you mount the unit anywhere. Just attach the mating Velcro pad to steering post, dash, or any other handy surface. The tiny electret-capacitor microphone picks up your voice anywhere within arm's reach with exceptional fidelity. There's no need to

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hold the microphone up to your mouth when transmitting. The specially designed frequency response plus the clear, distortion-free reproduction of the electret-capacitor microphone combine to create an on-the-air sound that punches through noise and interference. Variable microphone gain lets you adjust the level for optimum modulation under varying conditions. Sells for $44.95. Get the facts from JMR Systems Corporation, 168 Lawrence Road, Salem, NH 03079.

Auto Biamplified AM/FM/ Cassette Unit

An in-dash AM/FM cassette player with biamplification, said to bring to the car and van the same quality music reproduction associated with fine home audio equipment, has been introduced by Sanyo. The unit, model FT 1490A, carries the Sanyo "Audio Spec" label, and is spec'd with a super-sensitive FM tuner; wide frequency response; Dolby noise reduction for tape and FM; a loudness contour control; tape transport with virtually negligible wow and flutter. Biamplification provides separate amplifiers for bass and treble frequencies, a system professional sound engineers

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have favored for years in some of the most costly home stereo systems, and in discotheques and concert halls, to produce maximum sound power and minimum distortion. The FT 1490A has a total output of 28 watts RMS, 12 watts per channel on woofer amp and 2 watts per channel tweeter amp. The FM tuner, Sanyo's finest, features dual gate MOSFET front end and PLL MPX decoder, producing a sensitivity of 1 microvolt. Frequency response is 30-16 kHz. Installation in most domestic autos and some imports is greatly simplified with Sanyo's "E-Z Install" system which includes mounting accessories and instructions. Suggested retail price is $199.95. Get more facts by writing to Sanyo Electric Inc., Consumer Electronics Division, 1200 West Artesia Blvd., Compton, CA 90220.

50-Channel Scanner

There's a new 50-channel scanning monitor receiver around with microcomputer control. Named the "Bearcat 250", the radio receives five public service bands. With its microcomputer control it can search a band of frequencies for the active, or "hot," channels and automatically store them in its memory. The operator can then retrieve all the active channels found by simply pushing a "recall" button. If desired, those frequencies can then be programed into the radio's scan memory. Up to 50 preprogrammed channels can be scanned. No crystals are needed. The operator simply uses the radio's keyboard to enter the frequency plus any special instructions for each channel. The Bearcat 250 can count the number of times a call is made on each scanned channel. When this information is recalled from the memory it gives the operator a clear picture of which channels are most active. The radio also has an accurate

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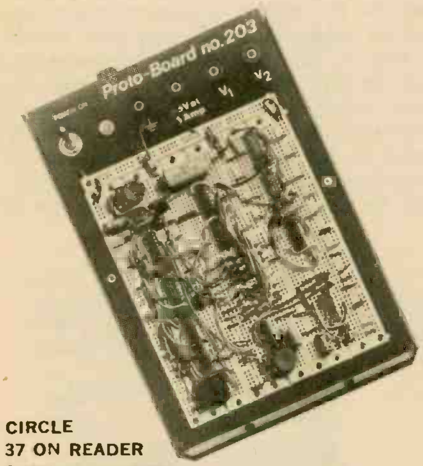
digital clock function which can display hours, minutes and seconds. The radio covers low and high band VHF, the two-meter "ham" band from 146 to 148 MHz, and all UHF frequencies from 420 to 512 MHz (which includes the new "T" band assignments). Suggested retail price of the new Bearcat 250 is $399.95. Complete details are available from Bearcat dealers or by writing to the Electra Company, 300 E. County Line Road, South, Cumberland, IN 46229.

Powered Breadboard

TTL logic system designers are finding an attractive design shortcut available to them, thanks to the Continental Specialties Model PB-203 Proto-Board, a high capacity solderless breadboard that includes a built-in 1%-regulated 5 VDC power supply. The advantage to a TTL hobby designer is the ability to design directly in hardware, assuring proper circuit operation, before hand wiring. This helps prevent the confusion in translating from gate schematics to actual IC packages, often providing valuable insight into ways of simplifying PC layouts. The breadboard area on the Proto-Board 203 includes enough tie points to support 24 14-pin DIP ICs. Four binding posts provide power and signal connections on and off the board. The built-in power supply is 1% regulated at 5 ±.25 Volts, rated at 1 A, and boasts a low 10 millivolts combined ripple and noise at 0.5 A out. And it's short-proof. The 5½-pound package measures 9¾-in. long, just over 6½-in. wide and 3¼-in. tall. CSC's low suggested resale price for the PB-203 is just $80.00 (per unit). Further information is available from CSC deal-



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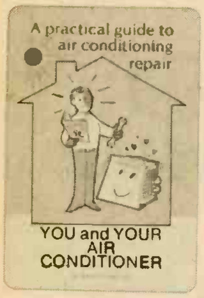
(Continued on page 117)

BOOKMARK
BY BOOKWORM

Keeping Cool. It is amazing how an electromechanical-fluid system can seem so complex to us. So much so, that we cannot analyze what is wrong with it when it fails. *You and Your Air Conditioner* by Louis J. Mangro, Jr., is a practical guide to air conditioning repair. The layman will find easy-to-follow, step-by-step explanations of what must be done and how to do it. This service manual is for the use of the average air conditioner owner who would like to save money by avoiding expensive service calls .The author tells the reader how to troubleshoot and then shows how to replace defective parts and perform other maintenance on both central and window-



Repairing your air conditioner the easy way.

Soft cover
54 pages
$5.00

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unit air conditioners. Photographs and schematic drawings make it possible for the less experienced do-it-yourselfers to work safely and confidently from the directions in this manual. Published by Dorrance & Company, 35 Cricket Terrace, Ardmore, PA 19003.

Build a TV Projection System. Edmund Scientific is offering a new booklet: *How to Design Your Own TV Projection System*. Written by Al Nagler, an optical designer, it explains how a do-it-yourselfer, using Edmund's Super TV Projection Lens, can have big screen television with his own home table-top system for as little as $390. Edmund estimates that a contemporary cabinet system can be constructed for about $458.00—a tremendous savings when compared with complete systems

Big screen TV for a little price.

Soft cover
14 pages
$1.95

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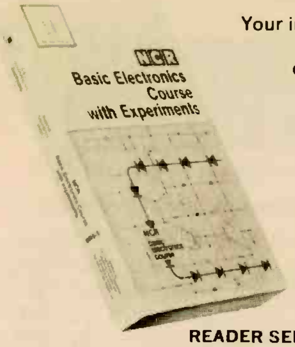
selling today for $1500 to $4000. Contents of this simplified booklet include: Building a Projection TV System, Cabinet Construction Ideas, Setting Up the System, Specifications and Cost Estimates. Nagler points out that maximum brightness, contrast and sharpness should be achievable at the highest brightness control setting, and that regardless of the TV used, one should have excellent reception to fully enjoy the giant picture. Prices approximated above include all the materials, but not the price of the TV set. The simplified booklet which has been designed to save money and to give the family an interesting weekend project can be obtained by mail (Stock No. 9565) by writing to Edmund Scientific Co., The Edscorp Bldg., Barrington, NJ 08007. An Edmund catalog, cover-priced at $1.00, can be obtained free, by writing to the above address.

Get Started. Now you can study basic electronic principles at home and use what you learn in simple experiments. *NCR Basic Electronics Course with Experiments*, offered by E&L Instruments, teaches basic electronic circuit principles in a home study text written for technicians and hobbyists. Prepared by the technical education department of the National Cash



Your introduction into electronic experimentation

Soft cover
440 pages
$9.50

CIRCLE 47 ON READER SERVICE COUPON

Register Co., Inc., this textbook combines explanations, experiments, and self-assessment tests. Assuming no previous experience, the text begins with a discussion of how electrons flow in conductors, and shows the novice how to read schematic diagrams and component identification codes. Three chapters containing numerous experiments investigate Ohm's Law and DC circuit analysis. Proceeding to capacitors and RC time constants, the book discusses differentiator and integrator waveforms, filters, and RC coupling. The text explains transformers and inductive coupling, and concludes with chapters on diodes and transistors that include clamp and logic circuits, zener regulators, rectifiers, and transistor amplifiers. Published by E&L Instruments, Inc., 61 First Ave., Derby, CT 06418.

Semiconductor Reference. The 1978 edition of the Archer Semiconductor Reference and Application Handbook is a compilation of data on Radio Shack's complete line of Archer-brand semiconductors. It contains a cross-reference listing for replacement of more than 46,000 transistors, diodes and other interchangeable devices. The cross-reference/replacement listings are totally computer cross-referenced for greater accuracy and are based on careful analysis of the important parameters of the listed devices. Application information, including actual circuit

Soft cover
144 pages
$1.95

CIRCLE 32 ON READER SERVICE COUPON

diagrams, is given for most of the listed IC's schematics for all clock chips and modules, and detailed information is provided on the 8080A CPU chip. Also has information on the Archer line of display and opto-electronic devices. Available exclusively from Radio Shack stores and dealers. ■

"That one tells our speed, direction, water depth and how many payments to the finance company I have left."

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
ELECTRONICS HOBBYIST
380 Lexington Avenue
New York, NY 10017

Dirty Head

My car's cassette deck has dirty heads. Don't tell me to get there with a Q-tip. I can't. Give me something easier to do.

—*A. F., Tampa, FL*

Pick up a cassette recorder head cleaner, cassette-type, such as the Bib cassette cleaner. It's a cassette cartridge with special head-cleaner tape inside. Slip it in the deck and play the unit. The tape runs for about 2 minutes as it cleans the head. And I never say Q-tips, it's cottonswabs!

"Old" Timer

Hank, I'd like to build a crystal radio from scratch. Can you give me the address of an antique parts supplier?

—D. L., Bronx, NY

For a source of new "antique" parts, I suggest you write to Modern Radio Labs, P.O. Box 1477, Garden Grove, CA 92642.

Listen Here

I want to build a parabolic mike to pick up bird sounds. Ordinary mikes aren't too good because the background noise is always high, even in the woods. You have no idea how many crickets there are, and other birds. My problem is, where do I get a parabolic reflector?

—J. N., Merrick, NY

ETCO Electronics, No. Country Shopping Center, Plattsburgh, NY 12901, sells a 22-inch diameter dish for $19.95. Get details on the phone—516/561-8700.

Make a PC

I need a simple, fool-proof system that I can purchase in one package so that I can make the printed circuit boards I design. Where do I go?

—A. N., Walnut Creek, CA

Write to Vector Electronics Co., 12460 Gladstone Ave., Sylmar, CA 91342 and ask about their 32Y-1 starter kit. It sold for $11.50 last year.

Like a Boxer

I am a shortwave and amateur radio fan and own some Hallicrafters equipment. I have been told that the Hallicrafters Company is still in business and also that it's not. Would you set me and some other people straight?

—J. P., St. Clair, MI

The old Hallicrafters Company, as we knew it, is no more. It has changed hands, or managements, or whatever several times. The last I heard, Hallicrafters was located somewhere between Ft. Worth and Dallas. Wait it out, and they may come back. I hope so.

OK Hum

I'm having trouble with my turntable ground. Everytime I put my hand by the cartridge, a buzzing comes over my speakers. But when I touch the ground terminal on my receiver, and then put my hand by the cartridge, the buzzing stops. What can I do to stop this?

—T. F., Edison, NJ

First, check the continuity of the phono cables from cartridge to cable ends. Don't pass any multimeter current through the cartridge. If all is OK, visually inspect for defective or incorrect cartridge hook-up. Next, reverse the plug to the phono and see if this helps. Finally, connect a ground lead from the receiver to the turntable metal frame. By the way, some inexpensive cartridges have no shielding, and hum will occur as a normal event.

Lots of Ohms

I'm collecting the parts for the "Spider Web Receiver" and can't find the 3.3 Megohm resistor, R2, called for in the parts list. My local parts store doesn't carry it. What do I do?

—G. T., Fostoria, OH

In the days of vacuum tube circuits, resistors up to 10 Megohms in value were easy to get. Not so any more. The highest value I found was at a Lafayette store it was 2.2 Megohms. So, solder a 2.2 Megohm resistor in series with a 1.0 Megohm resistor for 3.2 Megohms. That's close enough. If necessary, three 1.2 or 1.0 Megohm resistors in series are enough.

Lucky and Illegal

Recently, I bought a Radio Shack AM transmitter. It works on 9V and has an antenna length of 10-feet. I have stepped up the voltage to 12 volts without any problem. Also, I'm thinking about lengthening my antenna. Would this be legal?

—M.D., Greenville, S.C.

Stepping up the voltage without any knowledge of the circuit involved is foolish, and dangerous to the circuit parts. Also, I do not know what type of AM transmitter it is, but I'm sure you are violating FCC Type Acceptance by switching batteries. Likewise with the antenna, except for ham rigs. Know what you are doing before you do it!

Not a Stickup

My radio is not a vintage type, but it is over 15 years old. The electrolytic capacitor has 5 leads. I tried to replace it, and no one carries it. One storekeeper tried to sell me four electrolytics. What a crook!

—J. J., Holmdel, NJ

The unit you are talking about has four electrolytics in it, all of different values and two working voltages. These replacement types are difficult to find nowadays. The storekeeper was selling you the four electrolytics separately. That may be the only way to go. I don't think he's a crook!

Can't Leave a Friend at Home

My question is, I have a television which I would like to take to Europe. As you well know, in most places they use 220 volts 150 cycles. I would like to know what changes I would have to make.

—L. D., Sarasota, FL

I don't know much about European TV, but I do know that they use different resoultion standards than in the U.S. I believe that the lines per frame of picture differ from ours, even differ from country to country. Also, the picture transmission is the negative of ours. Your best bet is to leave the TV at home and go see Europe live, and in color.

Lend a Hand

Our readers ask for help, and only you can do it. Please contact anyone below who you can help. They thank you and I thank you!

Δ Preamp for Viking Model 87 open reel tape deck, needs schematic diagram. Without preamp, the deck is useless; Charles D. Jennison, 48 Cocheco Street, Dover, NH 03820.

Δ RCA Communications Receiver, Model AR-77, needs circuit diagram; James D. MacDonald, R.R. #1, West Bay Road, N.S., Canada B0E 3L0.

Δ Heathkit 0-6 oscilloscope needs complete manual. Will pay for copy; contact Jim Hartland, 6951 Glenn Dr., Parma, OH 44134.

Δ PhilcoModel 37-610 BCB and SW receiver, needs schematic diagram and service manual; Walt Carter, Box 268, Bellethase, LA 70037.

Δ Friden Comptometer, Model SW8, urgently needs schematic diagram; Todd W. Carter, 2671 Green Tree Ct., Jenison, MI 49428.

Δ Northern Electric Co., Ltd., Canada Model 832A, vintage 1930-31. Tubes are 6J5, 6K7, 6H6, 6F6, 6A8, 6K5, 5Y4 (6U5), needs schematic diagram; James D. MacDonald, RR #1, West Bay Road, N.S., Canada BOE 3LO.

Δ Round Hill AA-300 amplifier, needs diagram and/or specifications sheet; Jim Douglas, Chief Engineer, WCLU, Box 1320, Cincinnati, OH 45202.

Δ National N46 shortwave receiver, needs circuit diagram; Robert Ross, 4 Meadowland Drive, Brampton, Ont., Canada L6W 2R4.

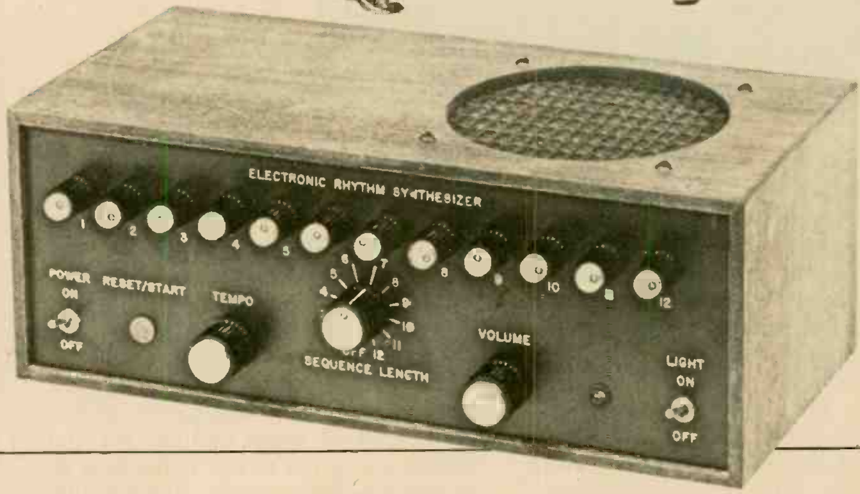
Δ Monarch Model Ham-1 amateur receiver, specs needed on this one; John Parrish, Jr., 2710 Wadhams, St. Clair, MI 48079.

Δ Motorola AM Radio, Mark III made in Canada for Dodge Dart (no other identification), needs schematic diagram; Allan MacDonald, 244 Spencer St., Naugatuck, CT 06770. ■

Rhythm & Blues Box

ELECTRONICS HOBBYIST
SPRING—SUMMER 1979

Boogie to the sound of this electronic drummer



by Randall Kirschman

RHYTHM IS THE TIME-PATTERN of sounds that enables us to distinguish a march from a mazurka, and it is one of music's basic ingredients. It could also earn a stack of votes from both beginner and veteran musician alike as one of the most troublesome. But help can be close at hand if you build the rhythm synthesizer described here.

Use our Rhythm and Blues Box (R&B Box), while practicing on an instrument, to analyze or demonstrate rhythms, or even for learning dances. It can also be connected to a percussion generator to provide simple accompaniments, or it can serve as a programmable controller for musical synthesizers. Whatever your particular involvement with rhythm, you'll find the R&B Box a valuable companion.

A metronome is the traditional aid for timing in music, but it falls short in the rhythm department because the clicks it produces are all identical. In music, rhythm comes about when each beat does *not* receive identical emphasis. With the R&B Box you can overcome metronomic monotony by giving each click in a sequence a different emphasis to produce musical rhythms.

A notable feature of this rhythm synthesizer is that it is not limited to standard or preset rhythms, but can be set up to generate thousands of rhythms of all kinds. Furthermore, each rhythm is precise to the microsecond.

Let's find out how the Rhythm and Blues Box accomplishes its feat by taking a tour of the circuit. Even at second glance the circuit may seem formidable, but it can be understood by tackling it a section at a time. Each section is a basic building block which you may meet in other circuits also—the multivibrator, shift register, flip-flop, latch, analog switch, and multiplexer.

Good Vibes! We'll begin our tour with IC2, a 555 timer, and its associated components. These form an astable (free-running) multivibrator that generates a continuous train of pulses to drive the rest of the circuitry. The tempo of the rhythm is controlled by *Tempo* control R3.

The pulses from IC2 (pin 3) go to IC3A. IC3A and IC3B, both NOR gates, are connected as a monostable (one-shot) multivibrator, which puts out a pulse each time it is triggered by a pulse from IC2. This pulse is then fed to NOR gates IC3C and IC3D to improve its shape and to generate both an inverted (negative-going) pulse (from pin 3 of IC3C) and a positive-going pulse (from pin 4 of IC3D). As we'll see, these pulses serve as *clocking* (or simply *clock*) pulses for the flip-flops in the synthesizer. They occur at the same rate as the tempo pulses from IC2, but are narrower.

Shift Into High. The next section on our itinerary is a *shift register*. Basically, a shift register is a string of flip-flops connected in cascade. The output of each flip-flop is connected to the input of the next and all are clocked by the same clock pulse. Thus, at each clock pulse, the *high* or *low* bit held in each flip-flop is shifted to the next flip-flop (except at the ends). This mode of operation of the shift register, where the bits play follow-the-leader, is called the *serial* mode. Some shift registers, like the one in the Rhythm Synthesizer, can also operate in the *parallel* mode. In this mode the inputs of the flip-flops are disconnected from the outputs so that all the flip-flops can be *loaded* simultaneously from outside during a single clock pulse.

In the R&B Box, IC's 5, 6, and 7, each a four-bit shift register, are cascaded to form a 12-bit shift register.

Blues Box

The Rhythm and Blues Box can be used as a simple metronome for piano practice. Just as easily, the rhythm shown on the score can be dialed in directly, so you can keep your feet on the pedals, your mind on dynamics.

As described later, to start a rhythmic pattern the shift register is loaded in the parallel mode with a *high* in stage 1 and *lows* in the remaining 11 stages. The shift register is then put into the serial mode and clocked by the positive clock pulses from pin 4 of IC3D, which shift the single *high* from stage to stage (left-to-right in the circuit diagram). Thus the output of each stage goes *high* in sequence. This continues until the *high* reaches the stage selected by the *Sequence Length* switch, S3. S3 then feeds the *high* to the input of a *D-type* flip-flop (pin 9 of IC4).

A D-type flip-flop has the characteristic that the logic level (*high* or *low*) present at its input before it is clocked will be assumed by its output after it is clocked. However, note that the clock input (pin 11 of IC4) of the D flip-flop is fed the inverted clock pulse from pin 3 of IC3C. So when the shift register is being clocked by the rising edge of the positive clock pulse, and the *high* is fed to the D flip-flop input, the D flip-flop sees the falling edge of the inverted clock pulse and just sits there with its output still *low*. A few milliseconds later, at the end of the clock pulse, the D flip-flop is clocked and then the *high* is transferred to its output (pin 13 of IC4), which connects to the load enable input of the shift register (pin 7 of IC5, 6, and 7). This puts the shift register into the parallel mode. Nothing happens until the next clock pulse, at the beginning of which the shift register is loaded with a *high* in stage 1 and *lows* in the other stages, and at the end of which the output of the D flip-flop goes low, putting the shift register back into the serial mode. The situation is now the same as it was when we began our analysis, and the whole sequence repeats.

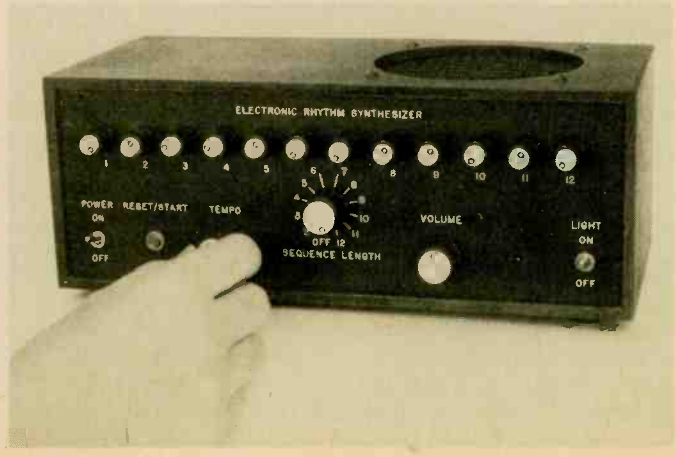
Here we have been assuming that S3 is set to a number (2—12), causing the shift register to keep reloading automatically as described, so that the sequence repeats indefinitely. However, if *Sequence Length* is set to *off*, the *high* in the shift register is shifted through all 12 stages and out the end without being fed to the D flip-flop, so the shift register is not automatically re-loaded. Thus the sequence only occurs once, after which the R&B Box quiets down. To start the action again, it must be loaded manually.

The shift register is loaded manually by means of the *Reset/Start* pushbutton, switch S2, and the other half of IC4. This half of IC4 is also a D-type flip-flop but is used here as a *set-reset* flip-flop or *bistable latch* to eliminate the effects of switch bounce from S2. Pushing S2 makes pin 6 of IC4 *high*, *setting* the latch. This in turn sets the other flip-flop (via pin 1 to pin 8) in IC4, which puts a *high* on the load enable input of the shift register (pin 7 of IC5, 6, and 7), putting it into the parallel mode. At the same time, the latch makes pin 4 of IC2 *low*, stopping the tempo pulse to keep the synthesizer silent.

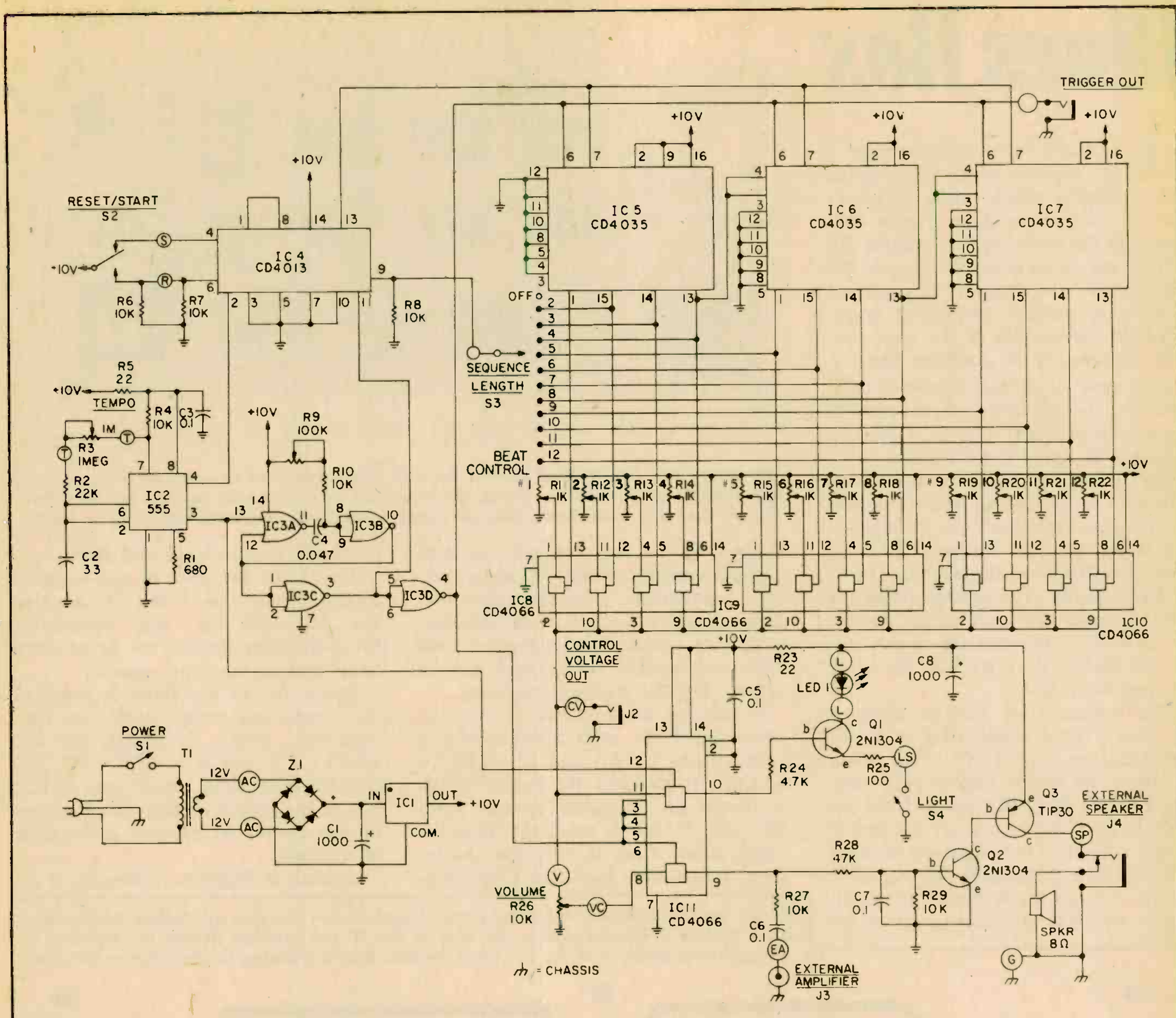
Releasing S2 makes pin 4 of IC4 *high*, which *resets* the latch, and IC2 and IC3 start producing pulses. The initial pulse first clocks the shift register, loading it, and then clocks the D flip-flop so its output goes *low*, putting the shift register into the serial mode. After that the *high* in the shift register is clocked from stage to stage as described previously.

Move To Multiplexing. Let's move on to the next section of the circuit to see why the *high* is being shifted around. The output of each stage of the shift register is fed to the control input of an *analog switch* (in IC8, 9, and 10). An analog switch is a solid state version of a relay; when the control input is *high* the two signal lines are connected together with a low resistance; when it is *low* they are disconnected. An analog switch differs from a logic gate in that a logic gate deals only in *highs* and *lows*, whereas an analog switch passes any voltage level (within limits), and passes it in either direction.

At the beginning of a rhythmic sequence, the *high* in stage 1 of the shift register turns on the first analog switch (pins 1 and 2 of IC8 are connected), while the remaining switches are off. At this time the common output line of the analog switches (pins 2, 10, 3, and 9 of each of the chips—IC8, 9, and 10) is connected only to the wiper of beat control #1 (R11), and assumes the voltage level set by R11. At the next



Just by properly setting the controls, you can program our Rhythm and Blues Box for any kind of beat you wish. Any sequence of one to twelve beats, with any of them emphasized, is readily obtainable. The Tempo control sets overall speed.



PARTS LIST FOR RHYTHM AND BLUES BOX

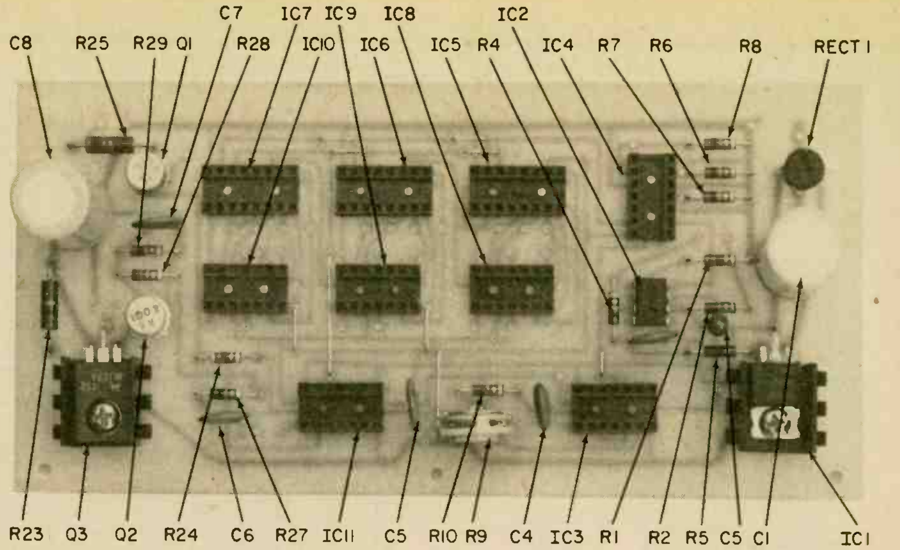
C1, C8—1000-uF, 25-VDC electrolytic capacitor with radial leads (Sprague QV1-185, or equiv.)
C2—3.3-uF, 16-VDC tantalum capacitor
C3, C5, C6, C7—0.1-uF, 16-VDC disc ceramic capacitor
C4—.047-uF, 16-VDC disc ceramic capacitor
IC1—Positive 10-volt regulator in TO-220 package (National LM340T-10, UA7810 or equiv. See note.)
IC2—555 timer
IC3—CD4001 CMOS quad NOR gate
IC4—CD4013 dual D-type flip flop
IC5, IC6, IC7—CD4035 CMOS 4-stage shift register
IC8, IC9, IC10, IC11—CD4066 (preferred) or CD4016 CMOS quad bilateral switch
J1, J2—miniature phone jack, or to suit
J3—phono jack
J4—miniature phone jack with NC switch (Switchcraft 42AP2 or equiv.)
LED1—Jumbo red LED, 70-mA (Radio Shack 276-041 or equiv.)
Q1, Q2—General-purpose NPN germanium transistor (2N1304 or equiv.)
Q3—PNP silicon power transistor in TO-220 package (TIP30 or equiv.)
R1—680-ohm, ¼-watt resistor
R2—22,000-ohm, ¼-watt resistor
R3—1-megohm, linear-taper potentiometer
R4, R6, R7, R8, R10, R27, R29—10,000-ohm, ¼-watt resistor
R5—22-ohm, ¼-watt resistor
R9—100,000-ohm PC-mount trimpot
R11-R22—1,000-ohm miniature linear-taper potentiometer (Mallory MLC13L or equiv.)
R23—22-ohm, ½-watt resistor
R24—4,700-ohm, ¼-watt resistor
R25—100-ohm, ½-watt resistor
R26—10,000-ohm, linear-taper potentiometer
R28—47,000-ohm, ¼-watt resistor (see text)
S1, S4—SPST miniature toggle switch
S2—SPDT, break before make, miniature push-button switch (Switchcraft 953 or 963 or equiv.) or two NO SPST pushbutton switches
S3—single pole, 12-position, non-shorting rotary switch (Calectro E2-161, modified as explained in text, or equiv.)
SPKR—8-ohm speaker, size to suit (author used 4-in. diam.)
T1—12-VAC, 150-mA or greater power transformer (Triad F-113X or equiv.)
Z1—Full-wave bridge rectifier, 50-PIV, 200-mA or greater (Radio Shack 276-1151 or equiv.)
Misc:—Cabinet, knobs, line cord, IC sockets (3 16-pin, 6 14-pin), heat sinks, PC board, solder, wire, hardware, etc.

Note—IC1, TH7 LM340T-10 IS AVAILABLE FOR $1.25 FROM DIGI-KEY, P.O. BOX 677, THIEF RIVER FALLS, MN 56801.

Blues Box

clock pulse, the *high* shifts to stage 2 of the shift register, which turns on the second analog switch, while all others are off. The output line is now connected to the wiper of beat control #2 (R12), and so on down the line. As the shift register goes through its sequence, a series of voltage levels that correspond to the settings of the beat controls appears on the common line.

This type of circuit, where a common line is connected to a series of inputs (or outputs) one at a time in sequence is called a *multiplexer*.



The neat, clean, professional look of the R&B Box is not hard to come by if you follow our printed circuit template. If you fabricate your own PC board, be sure to make sure that all the leads from the IC pins are properly insulated from each other on the board.

On To The Output. The last stop on our tour is the output section, where the voltage levels from the multiplexer are converted into loudness levels of audible clicks and into brightnss levels of LED flashes. The voltage levels are gated through two more analog switches (in IC11), one for the clicks, one for the flashes. We'll see how the clicks are produced first.

The sequence of voltage levels is fed into a signal input of one of the switches (pin 8 of IC11). This switch is turned on briefly during each voltage level by the clock pulses from pin 4 of IC3D. Coming out of the switch (pin 9 of IC11) is a sequence of short pulses whose amplitudes are the same as the voltage levels from the multiplexer, which in turn correspond to the settings of the beat controls. An amplifier consisting of Q2, Q3, and associated components, gives the pulses sufficient current to drive the speaker, producing a click. The loudness of each click corresponds to its beat control setting, thereby creating emphasis.

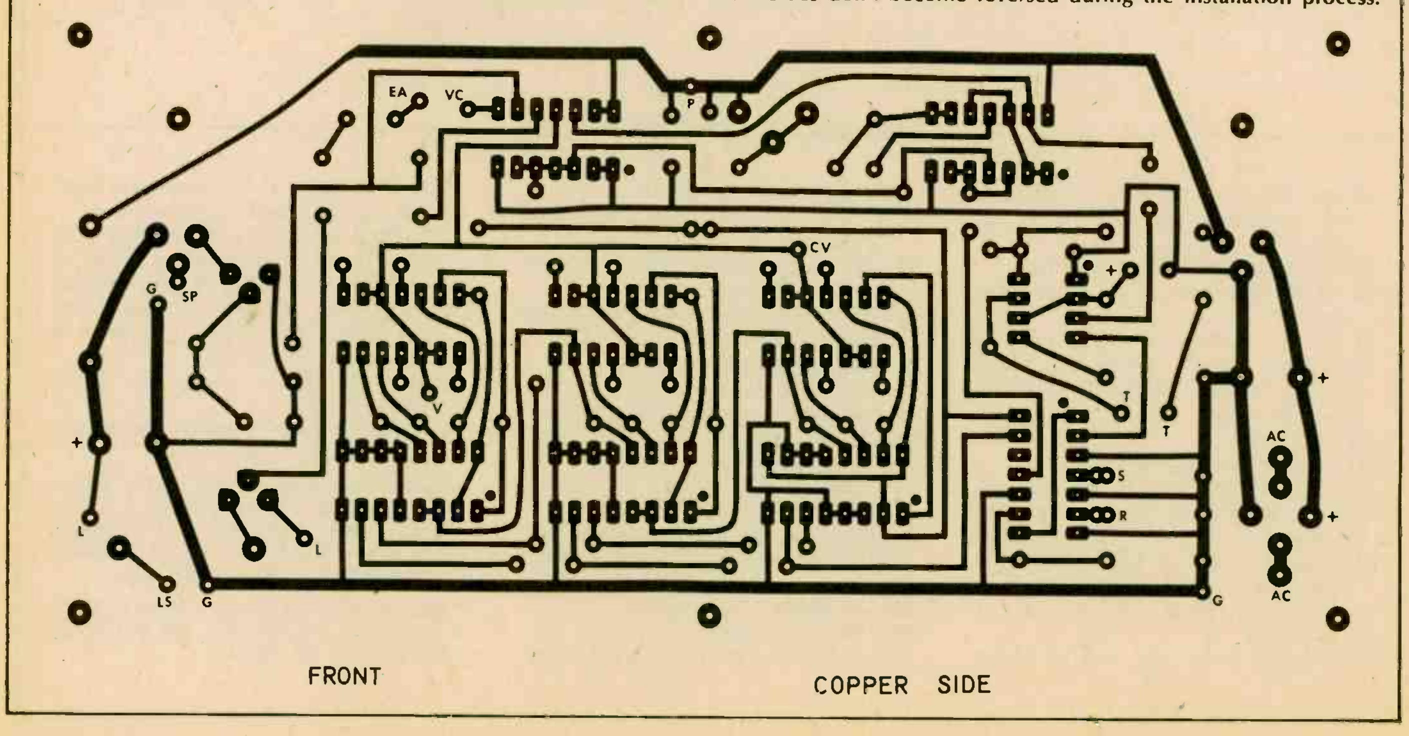
A similar arrangement is used to drive the LED, with another analog switch (pins 10, 11, and 12 of IC11) and Q1. In this case the analog switch is turned on by pulses directly from IC2 (pin 3), which are longer than the clock pulses from IC3. If the shorter clock pulses were used, the LED flashes would be too brief and dim.

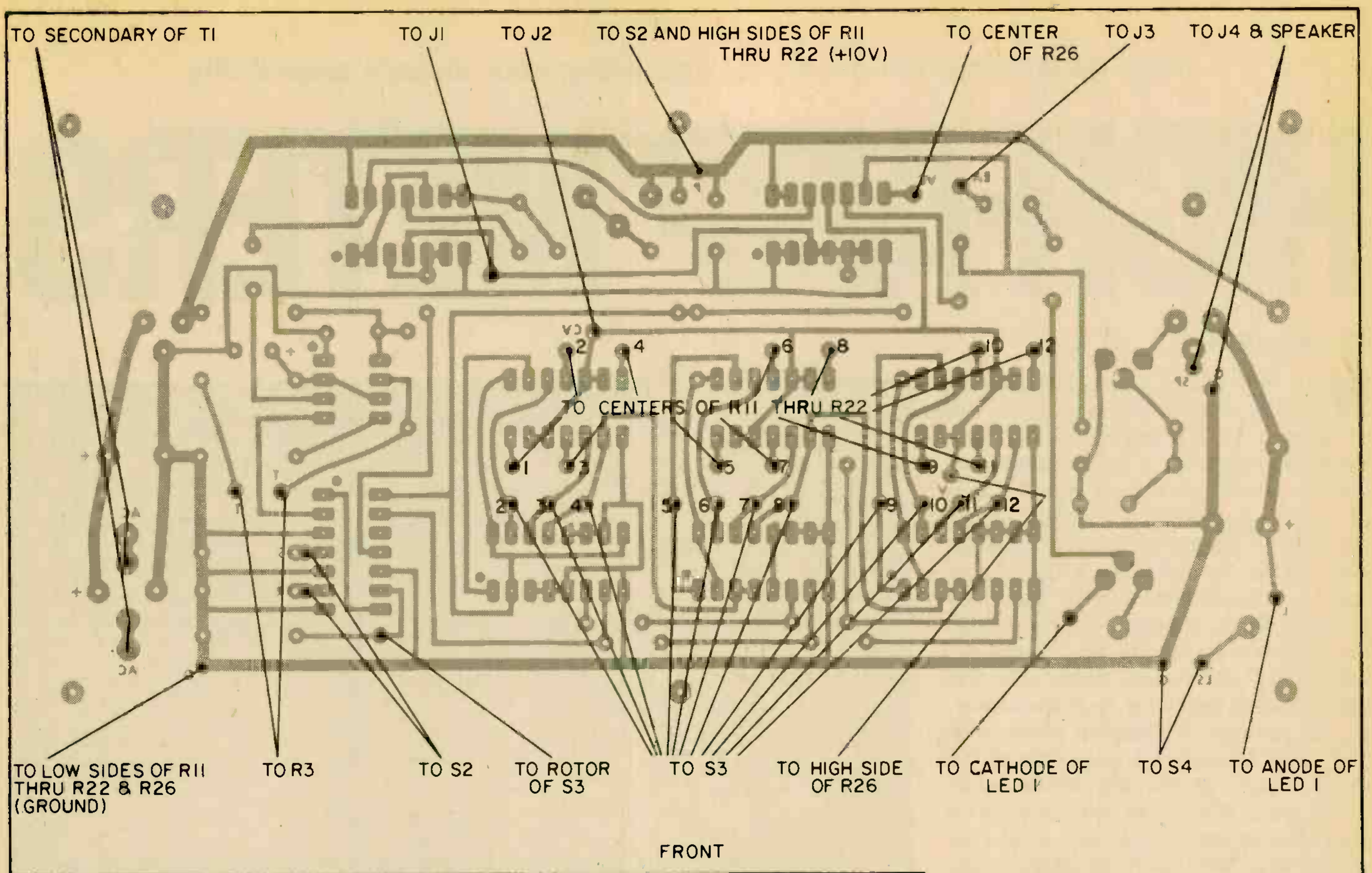
Pins from the two unused switches in IC11 (pins 1 to 5 and 13) are tied (as indicated in the schematic) to convenient points to keep them from picking up stray signals.

Power for all the above is provided by a regulated power supply of conventional design, consisting of T1, RECT1, C1, and IC1. R5-C3, C5, and R23-C8 isolate the power lines to IC2 and to the output section from the rest of the circuit to prevent undesirable interactions.

Getting It Together. Although it in-

Here's the template for the printed circuit board, shown foil side up. Follow this exactly for a perfect finished product. The dots in the IC pin sections denote pin number 1 orientation to insure that the ICs don't become reversed during the installation process.





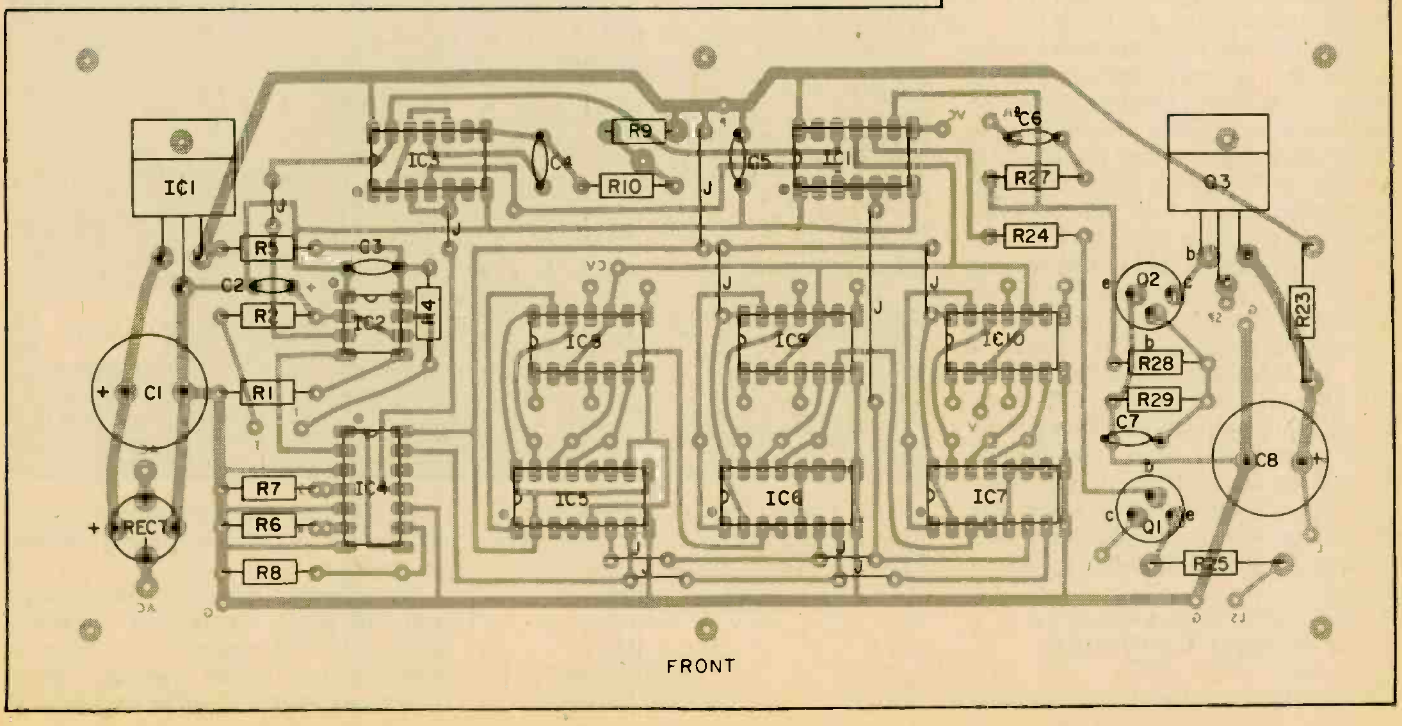
volves a fair amount of wiring, there is nothing particularly difficult about assembling the Rhythm & Blues Box. Follow the directions given here and the diagrams and photos and you shouldn't have any trouble. If this is one of your first projects, enlist the help of someone experienced in electronic construction.

When assembling the rhythm synthesizer, keep in mind that CMOS IC's (IC3 through IC11) can be damaged by static electricity or other excessive voltages, so handle them appropriately. Leave them in their packages until the final steps of construction.

Although the R&B Box could be hand wired, a printed circuit (PC) board will make the job easier and the

(Continued on page 115)

The upper diagram indicates the placement of wires for the components which are not mounted on the PC board, such as the front panel controls. The diagram below shows the placement of components on the PC board. This view of the board is from the top, or unetched surface as you would see it.



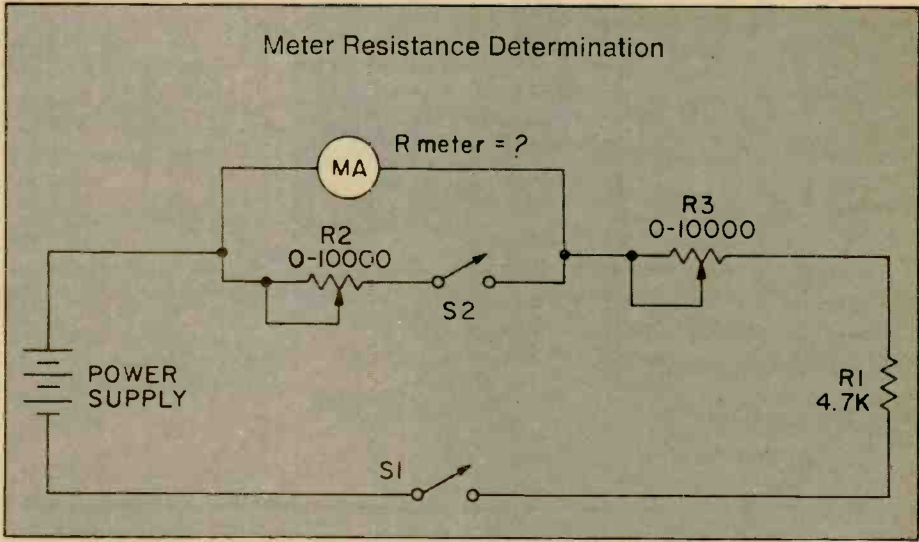
Keep up with current events by expanding your meter's amp-ability

HIGH-AMP METERS

by Jeff Jones

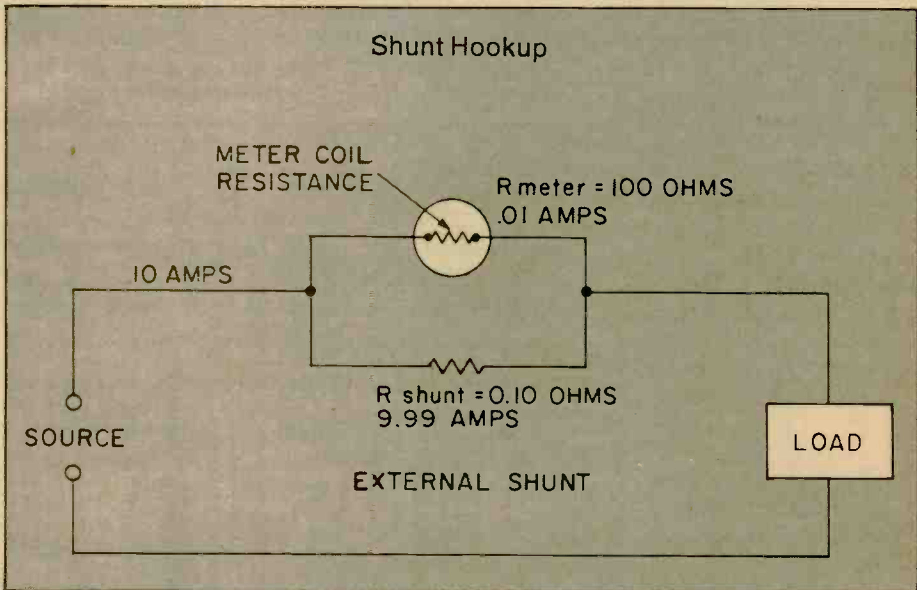
WITH THE RISING COST of test equipment it is advantageous to be able to perform several operations with one meter. For instance a DC milliammeter can be converted to read higher values of current by adding a shunt to bypass the bulk of the current around the delicate meter. By following a few simple steps a milliammeter can be converted to read 10 to 20 amps or more. The first step is to determine the internal resistance of the meter. From this you can calculate the shunt resistance needed and the type of material to be used.

To find the internal resistance of the meter, construct the test circuit illustrated here. The 4700 ohm resistor is used to limit current and serves no other purpose. Start with the power supply set to zero volts, leaving S2 open and S1 closed. Slowly increase the current flow by varying R3 until the meter needle moves to full-scale deflection. Without touching the setting of R3, close S2 and adjust R2 until the meter reads half of full scale. According to Ohm's Law the resistance of the meter and of R2 are now equal. Open switch S2 and measure the resistance across R2. This value will be equal to the internal resistance of the meter.



To determine the internal resistance of a meter construct a circuit like the one illustrated above. If you don't have the parts in your junk box then check an electronics surplus outlet.

A shunt resistor bypasses the bulk of the current around the meter while allowing a regulated amount to pass through the meter's coil and give an accurate reading. A shunt can be a resistor or a measured length of wire. Make sure it will handle the current.



Shunt. Precise shunt resistance is important for accurate current readings and must be chosen carefully. With the shunt connected across the meter, most of the current is diverted past the meter. This is the theory behind a small meter being able to read high currents. The shunt can be a wire, steel or copper bar, or almost any material that will offer the proper resistance. To determine the needed shunt resistance we will consider an example. If we want a 0 to 10 milliammeter to be able to read full-scale for a current of 10 amps. Therefore 10 mA will flow through the meter when 9.990 Amps are diverted through the shunt. If the meter resistance was 100 ohms, using Ohm's Law the voltage across this parallel circuit is found by using the following equation:

$$E = (\text{Current}) \times (\text{Resistance})$$
$$= (0.01 \text{ amps}) \times (100 \text{ ohms})$$
$$= 1 \text{ volt}$$

Using the calculated voltage and solving Ohm's Law for resistance the proper shunt can be found. This derivation is shown below:

$$\text{Resistance} = \frac{\text{Voltage}}{\text{Current}} = \frac{1 \text{ Volt}}{9.990 \text{ Amps}} = .1001 \text{ Ohms}$$

In this case the milliammeter would be capable of giving a readout directly in amperes.

By following these few simple steps you will greatly expand the versatility of your test equipment. It will increase your ability to handle a greater variety of test and trouble shooting situations. ■

Everybody's making money selling microcomputers. Somebody's going to make money servicing them.

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You don't need prior training in electronics or computers to take this exciting new course. NRI starts you with the basics, gives you a firm foundation to build on. And your personal counselor is always available, ready to help whenever you have questions.

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DISCO KING

Drum up a storm with this percussive project!

DISCO MUSIC ENJOYS a phenomenal popularity, as evidenced by many of today's most popular records and movies. This popularity is due, in part, to the uniquely identifiable Disco percussion pattern which is basically identical in all songs. *Disco King* is a low cost rhythm unit which produces the standard Disco pattern plus three variations (selected by moving the "Pattern Select" jumper wire). The King also doubles as a base drum synthesizer which is triggered by means of a standard footswitch.

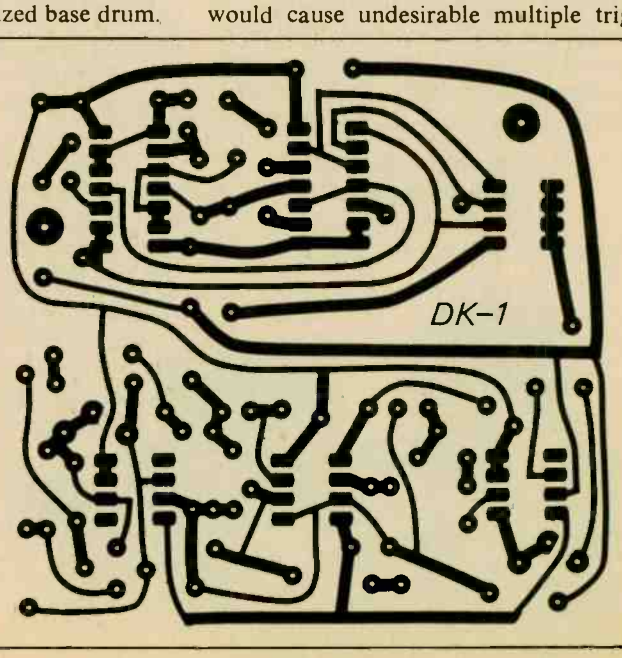
Disco King is simple to construct, uses readily available CMOS and analog active devices and is powered by two 9 volt batteries, Construction cost for the basic unit should be less than $20.00 (see parts list for kit availability).

How It Drums. As indicated in the schematic diagram, CMOS NAND gates IC1A and IC1B form a gated oscillator which serves as the clock for the unit. The clock output frequency (set with *Tempo* control R2) is divided by two in D Flip Flop IC2B and again by two in D Flip Flop IC2A. Either the clock output, the Q output of IC2A or B or the Q output of IC2A can be used as the cymbal trigger signal.

Transistor Q1 generates a continuous white noise signal which is A.C.-coupled through C9, amplified in IC3A and provided to IC4, a transconductance Operational Amplifier. The trigger signal selected is A.C. coupled through (and differentiated by) C7 and used to Amplitude Modulate the white noise signal in IC4. In this way, a repeating pattern of cymbal sounds is generated. Initially, R20 is adjusted to set the decay portion of the differentiated trigger pulses to create the characteristic amplitude envelope of a high hat cymbal. A portion of the IC4 output signal is tapped off *Cymbal Level* control R16 and provided to IC3B, where it is further amplified and summed with the synthesized base drum.

The Q output of IC2A is differentiated by C4 and R5 to produce a narrow trigger pulse. D1 eliminates the negative portion of the differentiated pulse. The Q output signal is also inverted in IC1C which drives LED 1 to indicate the start of the pattern (in musical terms, the start of the *bar*). In lieu of the Q output, a switch may be connected to J1. When depressed, the switch will manually generate a trigger pulse. In this manual mode, C3 and R4 eliminate switch bounce which would cause undesirable multiple trig-

The beat goes on . . . and on . . . and on . . . when you build our Disco King. It's really simple to put together, as it uses readily available CMOS and analog integrated circuit devices. The full-size printed circuit template is shown here, and it is easily duplicated by using one of the popular kits on the market today. For all of you would-be DJs, the Disco King is an excellent device for running mixes!



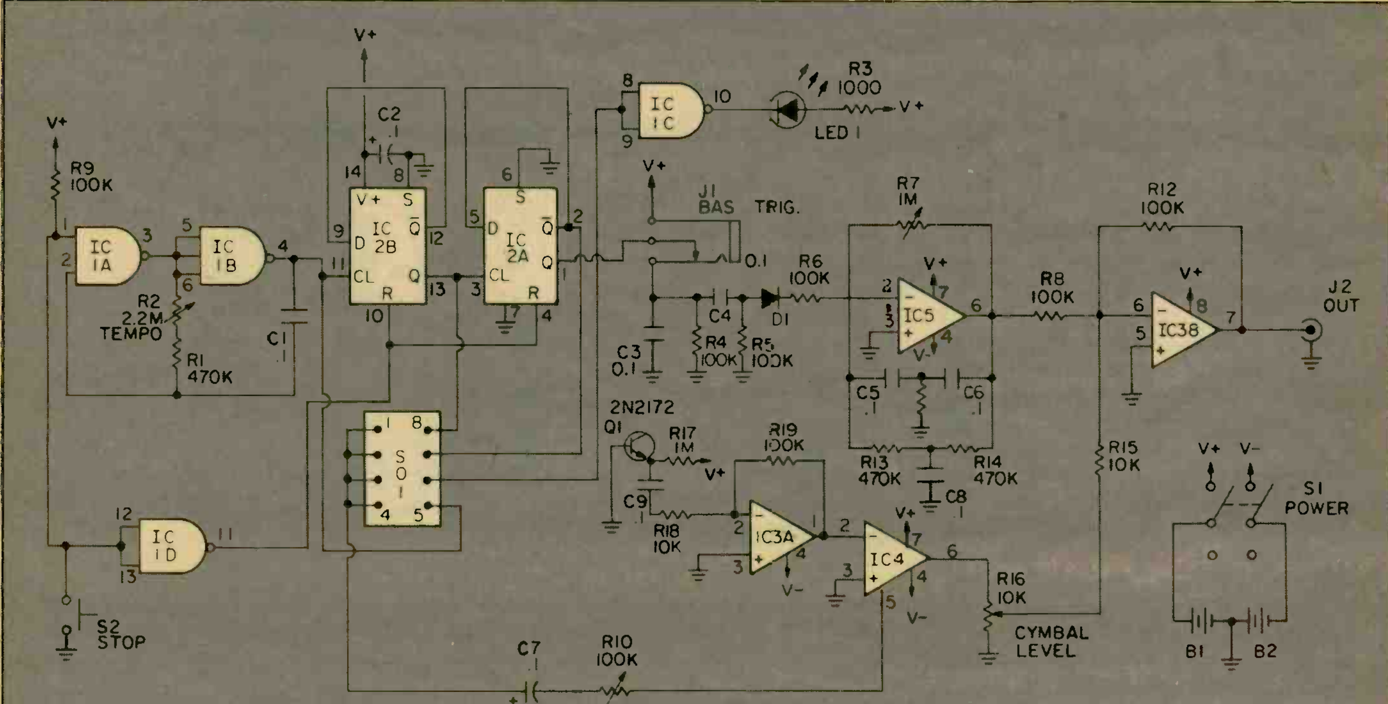
gering. In either the manual or automatic mode, the resultant pulse triggers the base drum generator.

C5, C6, C8, R11, R13 and R14 form a Twin-T notch filter tuned to the base drum frequency and make up one of two feedback loops for Op Amp IC5. If this were the only feedback loop, IC5 would simply oscillate at the notch frequency. Feedback loop R7, however, provides sufficient negative feedback to suppress continuous oscillation. The positive going trigger pulse momentarily overcomes the feedback through R7 and generates a damped sine wave output. The setting of R7 determines the amount of feedback and, accordingly, how long the oscillation lasts before it decays to zero. The synthesized base drum output of IC5 is summed with the cymbal signal in IC3B.

With S2 open, operation is as described above. Closing S2 (*stop*) grounds the input to pin 1 of IC1A, stopping the clock and resetting both Flip Flops with the high output of inverter IC1D. When S2 is released, the clock restarts and the sequence restarts at the beginning of the bar with the base drum sound. Power (±9 volts) is supplied by two 9 volt batteries.

Construction. Although not absolutely necessary, a PC Board is recommended as the means of construction. A PC pattern and components placement guide are provided. Observe standard precautions when handling and soldering CMOS ICs 1 and 2. Sockets may be used if desired. The CA3080 IC in the TO-5 can is available in two different lead configurations. The "S" configuration has the leads preformed in an 8 pin DIP (Dual Inline Package) pattern, where the "plain" configuration does not. If necessary, form the leads in an 8 pin DIP pattern prior to insertion. After all components are installed, perform final wiring.

Any suitable case may be used to house the project (although a case is not actually necessary). The case may be marked as shown in the photo using transfer lettering or other similar marking methods. A suitable holder for the two 9 volt batteries can be formed from a 1" by 3" strip of aluminum. Drill a 3/16" hole in the center of the strip and form it into a stubby "U" shape, the two shorter sides being 3/8" each. Drill a 3/16" hole in the bottom of the case and pass a #6-32 x 1" machine screw through the hole, between the two batteries and on through the



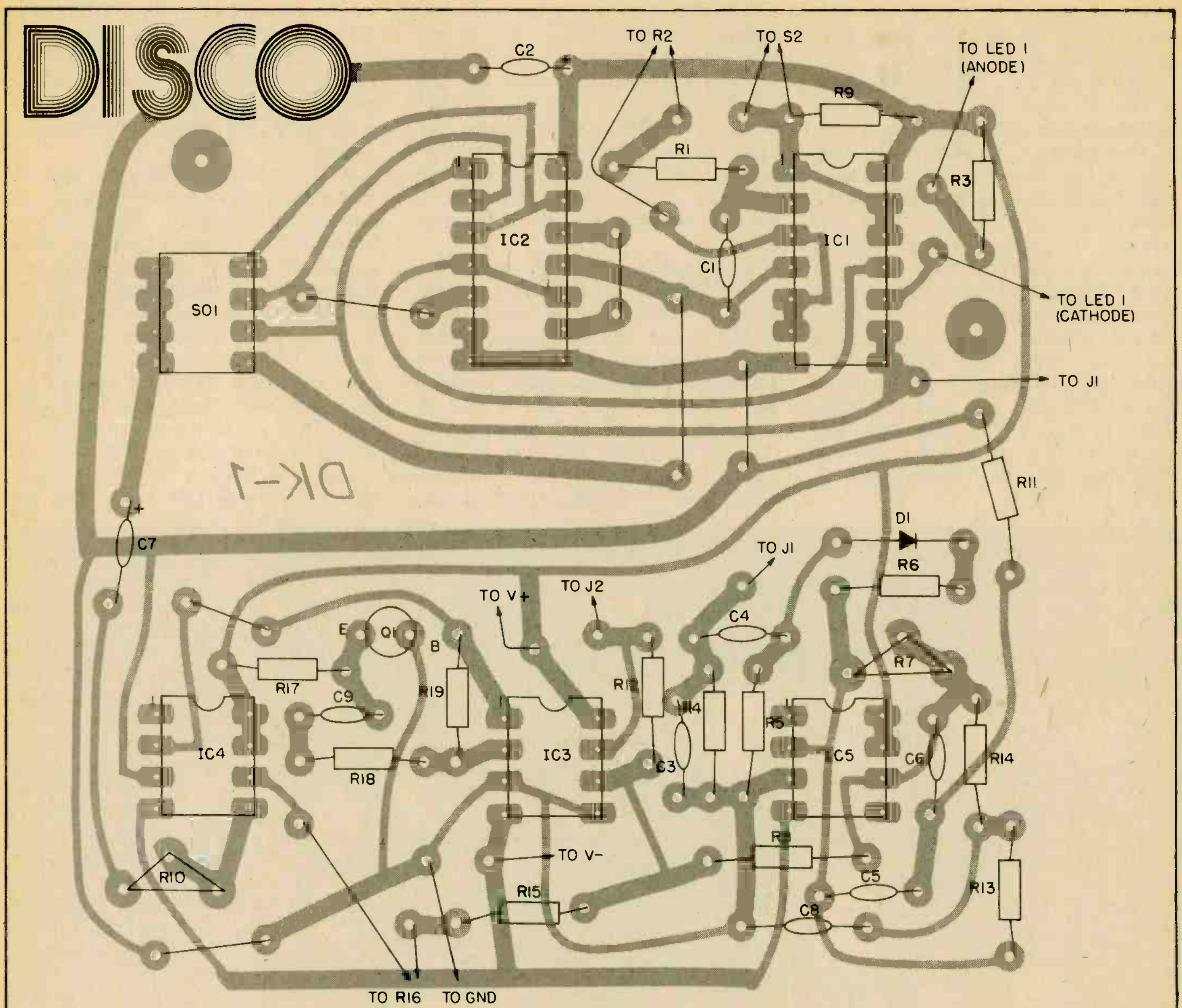
PARTS LIST FOR DISCO KING

B1, B2—9-volt battery
C1, C3, C4, C5, C6, C8, C9—.1-uF capacitor, disk ceramic, 25VDC
C2, C7—1.0-uF electrolytic capacitor (radial leads), 10VDC
D1—1N4148 or 1N914 diode
IC1—4011 Quad 2-input CMOS NAND Gate
IC2—4013 Dual CMOS D Flip Flop
IC3—Dual 8-pin Op Amp (5558, LM1458 or similar)
IC4—Transconductance Op Amp (CA3080 or CA3080S or similar)
IC5—741 Op Amp (8-pin DIP)
J1—Phono jack, closed circuit, ¼-inch
J2—Phono jack, open circuit, ¼-inch
LED 1—Light Emitting Diode, type NSL5053, TIL32 or similar
Q1—2N2712 transistor
R1, R13, R14—470,000-ohm resistor, ¼-watt
R2—2.2 Megohm linear taper potentiometer, ½-watt
R3—470-ohm resistor, ¼-watt
R4, R5, R6, R8, R9, R12, R19—100,000-ohm resistor, ¼-watt
R7—1 Megohm trim potentiometer, ¼-watt
R10—100,000-ohm trim potenticmeter, ¼-watt
R11—4700-ohm resistor, ¼-watt
R15, R18—10,000-ohm resistor, ¼-watt
R16—10,000-ohm linear taper potentiometer, ½-watt
R17—1 Megohm resistor, ¼-watt
SO-1—8-pin DIP socket
S1—DPST slide switch
S2—Momentary pushbutton switch, N/O (normally open)
Misc.—Suitable enclosure, aluminum strip, knobs, wire, solder, hardware, etc.

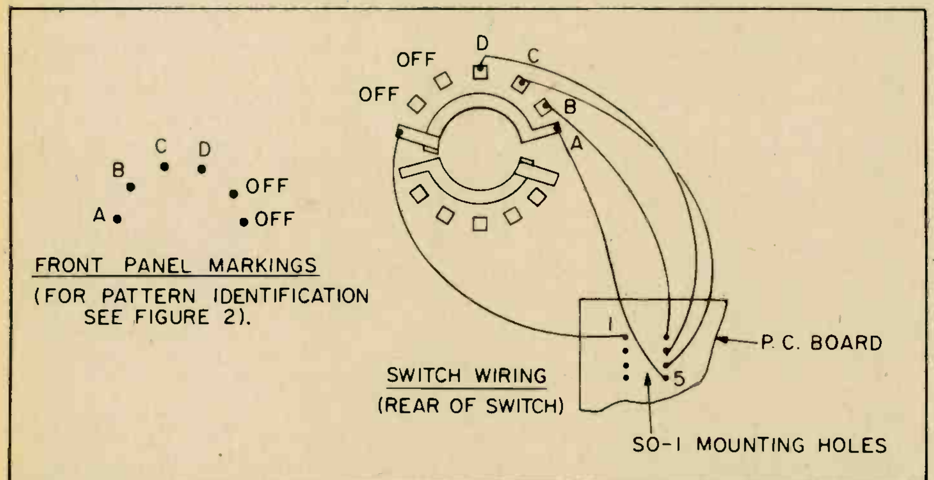
Note: The following are available from BNB Kits, RD #1, Box 241H, Tennent Road, Englishtown, N.J. 07726; Parts Kit (DK-1) consisting of all electronic parts, controls, switches, jacks, wire and etched and drilled P.C. Board at $18.95. Etched and drilled P.C. Board alone (DK-1PC) at $5.95. Prices include handling and U.S. Postage. Canadian residents please add $1. U.S. Funds only. Please allow 3 to 6 weeks for delivery.

Note: Blank case as shown in photo available from Continental Specialties Corporation, 44 Kendall Street, P.O. Box 1942, New Haven, CT 06509 (DMC-2). Write for current price.

DISCO



The overlay, shown above, provides you with the placement of all on-board components, as well as the wiring connections for the switches and jacks. Take care to observe correct polarity for diode D1. This view of the board is foil side down, with the parts on top.



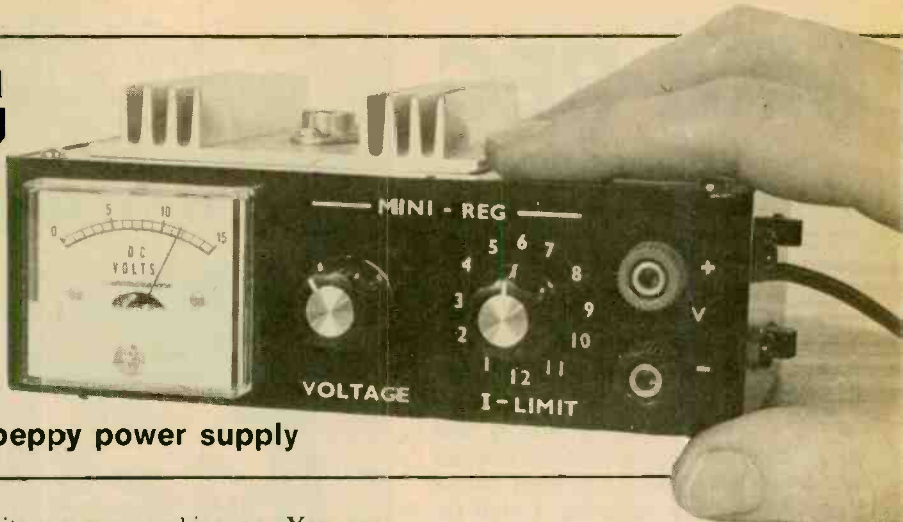
Here's an easy modification to our Disco King! Our own unit uses jumper wires in the SO-1 socket to change the beat but if you'd like a rotary switch could be installed.

hole in the holder. Secure the holder with a #6-32 nut.

Initial Adjustment and Checkout. Set Trim Potentiometers R7 and R10 and controls R2(*Tempo*) and R16 (*Cymbal Level*) to mid position. Connect the output of the unit to a music amplifier or hi-fi. When power is applied, you will hear a repeating base drum sound. Adjust R7 for a non-boomy, short duration "thud" sound. Form a jumper from a short length of #20 or #22 solid wire and insert it into pins 4 and 5 of socket SO-1. Set R2 for medium speed and adjust R10 for a short duration cymbal sound. This completes the adjustments required. To insure the unit is performing properly, check the following. Note

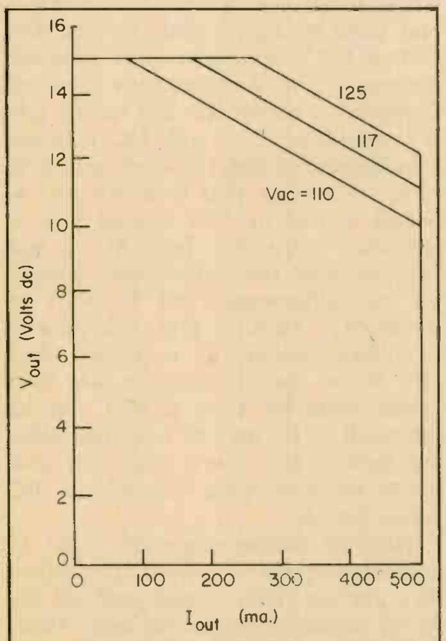
(Continued on page 120)

MINI-REG
the regulated IC Power Supply



Keep your projects cool, calm and under control with this peppy power supply

HERE'S A LOW-COST precision regulated DC power supply which is sure to be a welcome addition to any workbench—provided some family member doesn't appropriate the power supply for use as a universal AC adaptor! Compactly assembled in an eye-catching low profile, the Mini-Reg is continuously adjustable from 3.4 volts to 15 volts DC and delivers up to 500 milliamperes, enough for just about any job. Using the HEP C6049R precision monolithic IC regulator, the Mini-Reg effects 0.01% regulation with line voltage variations, 0.05% regulation for load variations, and its output impedance is a mere 35 milliohms. Short-circuit proofed, the Mini-Reg also features adjustable current limiting which greatly reduces the chances of damaging valuable components in the circuits you are working on. You can also use the Mini-Reg as a constant-current source and recharge nicad batteries.



This chart shows the operating range of the Mini-Reg at various line voltages. The full 15 VDC is only available at lower currents, but few IC projects ever require that much voltage or current supply.

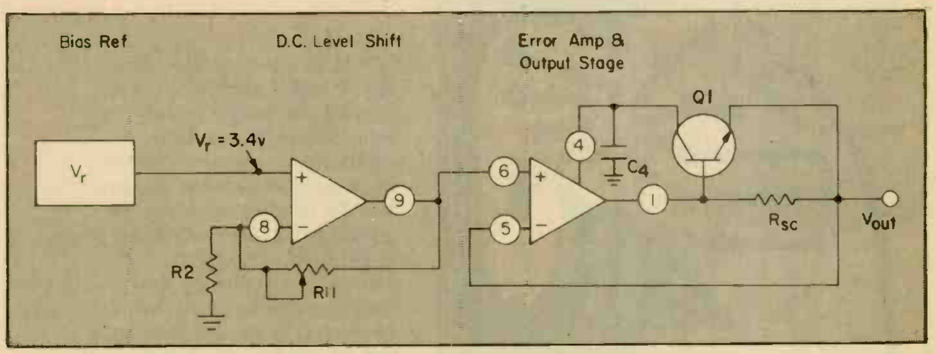
Circuit Operation. The HEP C6049R is actually a DC regulator within a regulator which accounts for its high performance. As shown in the block diagram, a very stable reference voltage (Vr) is applied to the non-inverting or voltage follower input of an op-amp which serves as the first regulator and DC level shift amplifier. The output voltage of this stage can be varied from 3.4 volts to 15 volts by varying pot R11. This voltage is applied to the non-inverting input of the second op-amp which is capable of supplying up to 5000 milliamperes current to the load. This stage has unity voltage gain wherein V-out follows the input voltage to this stage. This double regulator arrangement fully isolates the DC level shift amplifier and results in very close regulation. Capacitor C4 provides frequency compensation and precludes possible circuit oscillation.

External components consisting of transistor Q1 and selectable resistor Rsc provide constant-current limiting should the supply be short-circuited. When the load current passing through Rsc becomes sufficiently high, the base of Q1 becomes forward biased causing Q1 to conduct. When Q1 conducts, the voltage regulator delivers an essentially constant current to the load at a level depending on the value of Rsc. In the schematic diagram, resistor R3 places a minimum load on the regulator. Switch S3 selects the desired current limit. Jacks J1 and J2 permit insertion of a milliammeter to read load current but without impairing regulation. Diode D2 provides meter protection and diode D1 provides reverse voltage protection.

Construction. Assemble the Mini-Reg in an aluminum case or in a plastic case with aluminum cover plate. Select a case which will accommodate the particular meter and transformer you plan to use. Plan the layout allowing room for the PC board assembly when the cover plate is secured.

Begin by laying out and drilling mounting holes for IC1 in the heatsink. Drill a 7/16-inch-diameter hole in the heatsink to pass the lead wires of IC1. File off drill burrs and ridges, so that IC1 mates perfectly on the heatsink. Drill matching holes in the cover plate. For ventilation, drill a number of holes in the cover plate and on the bottom of the case.

Make the PC board using the circuit pattern shown, taking care to locate



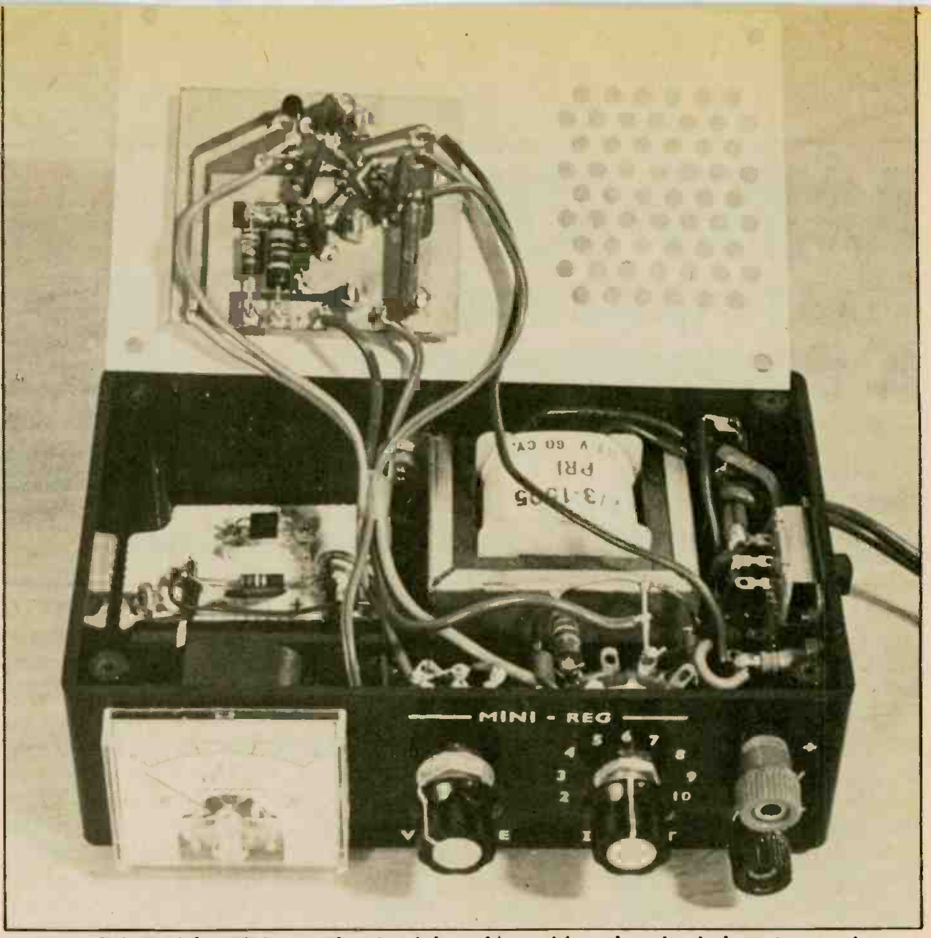
This is a simplified block diagram of the C6049R regulator chip—the heart of the Mini-Reg power supply. Thanks to such ICs construction projects are easy to build.

MINI-REG

pads for IC1 just right. Push IC1 into the drilled board and mark and drill the mounting holes. For easier mating, countersink the lead holes for IC1 on the insulation side of the board by twirling a small drill bit.

Install and solder the jumper on the insulation side of the board and install and solder T42-1 micro-clips (Vector) on the copper side at all resistor and board take-off terminals. Clip a small heatsink (Radio Shack 276-001) on the leads of Q1 when soldering. Install remaining circuit board components excepting trim resistor R5. Using 6-32 machine screws, bolt IC1 and the heatsink to the cover plate. Place a lock washer and two 6-32 nuts on each mounting bolt. *Omit the mica washer between IC1 and the heatsink* and apply a bit of silicone heatsink grease between IC1 and the heatsink. Coil a ¼- by 1½-inch strip of fishpaper insulation and slip it down into the hole in the cover plate around the IC lead wires. Push the PC board assembly down on the mounting screws and mate with the protruding IC leads and secure. If you can't install the assembly, look for bent pins or reversed installation of IC1.

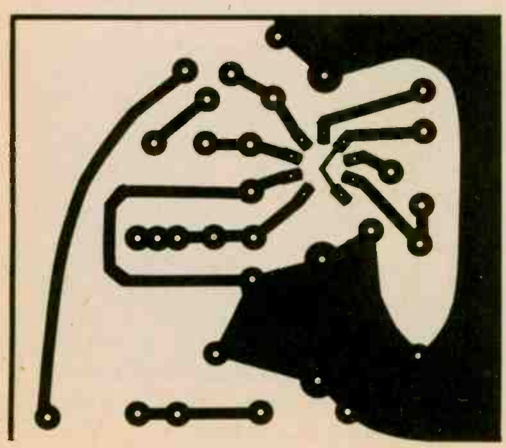
Install switches S1 and S2 along with jacks J1 and J2 on the left side of the case. Install diode D2 and capacitor C7 on switches S2. Secure two solder lugs on each binding post and install diode D1 and capacitor C6 on the binding posts. Pass the AC line cord through the left side of the case and knot the cord for strain relief. Install resistors R6 thru R10 on switch S1. Depending on the base-emitter characteristics of Q1, the specified values of current limit resistors R6 through R10 may differ somewhat in your power supply. This is why trim resistor R5 was included to properly trim the 500 mA current



Internal view of the Mini-Reg. The circuit board is positioned so that it doesn't come in contact with the meter and transformer. The case is perforated for ventilation. You can see the tiny, square HEP 176 rectifier on the small circuit board in the bottom of the case.

limit. For this reason, you may defer installation of resistors R6 thru R9 but *do* install resistor R10.

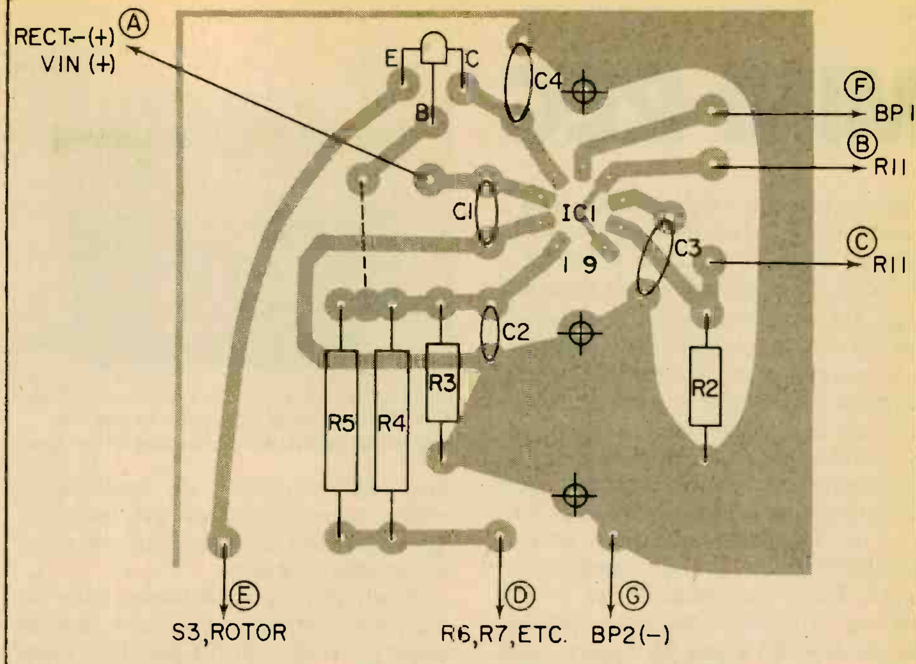
Place RECT-1, R1, C5, and C8 on a small piece of perfboard and situate this sub-assembly behind the meter. Connect meter M1 directly to binding posts BP1 and BP2. Use #20 stranded wire for connections to the PC board. Connect a wire from board pin G to BP2. Run a wire from board pin E to the rotor lug of S3. Connect a wire from board pin D to resistors on S3. Run a wire from board pin F directly to BP1. Run a pair of wires from pot R11 to board pins B and C. Connect a wire from *V-in minus* directly to BP2. Do not make the connection from *V-in plus* to board pin A at this time. You may omit the double-fused plug and provide but one fuse in the primary side of transformer T1. Carefully check all wiring and solder connections.



This is an exact-scale printed circuit board pattern showing the foil side of the board. This side contrary to normal, is, where the components are to be mounted. Only the jumper and the IC chip are mounted on the other side. Be careful to keep the foil-side component bodies off the metal surface to avoid shorts. Be especially careful with resistors R4 and R5 and capacitor C3.

Checking It Out. We intentionally deferred installation of several components and some wiring, so that you can perform a few simple tests which preclude damage to circuit components. Connect a voltmeter across R1 and verify that V-in plus is nineteen volts DC. Connect a milliammeter and 100-ohm resistor in series from V-in plus to board pin A. Set S3 to pick up R10 and set R11 to minimum resistance. Turn S1 on and observe about five milliamperes current on the milliammeter and 3.4 volts on meter M1. Advance R11 and observe a voltage increase up to fifteen volts DC. If the output voltage is less than fifteen volts, the value of R11 may be too small or R2 may be too large. Having verified the above, you may now install the wire from V-in plus to PC board pin A.

Plug the milliammeter into jacks J1 and J2 and open S2 (Meter In). Adjust R11 for ten volts output and set S3 to ten milliamperes current limit. Then, connect a 500-ohm ½-watt resistor across the output terminals. If current limiting action is taking place, the milliammeter should indicate roughly ten milliamperes and the output voltage



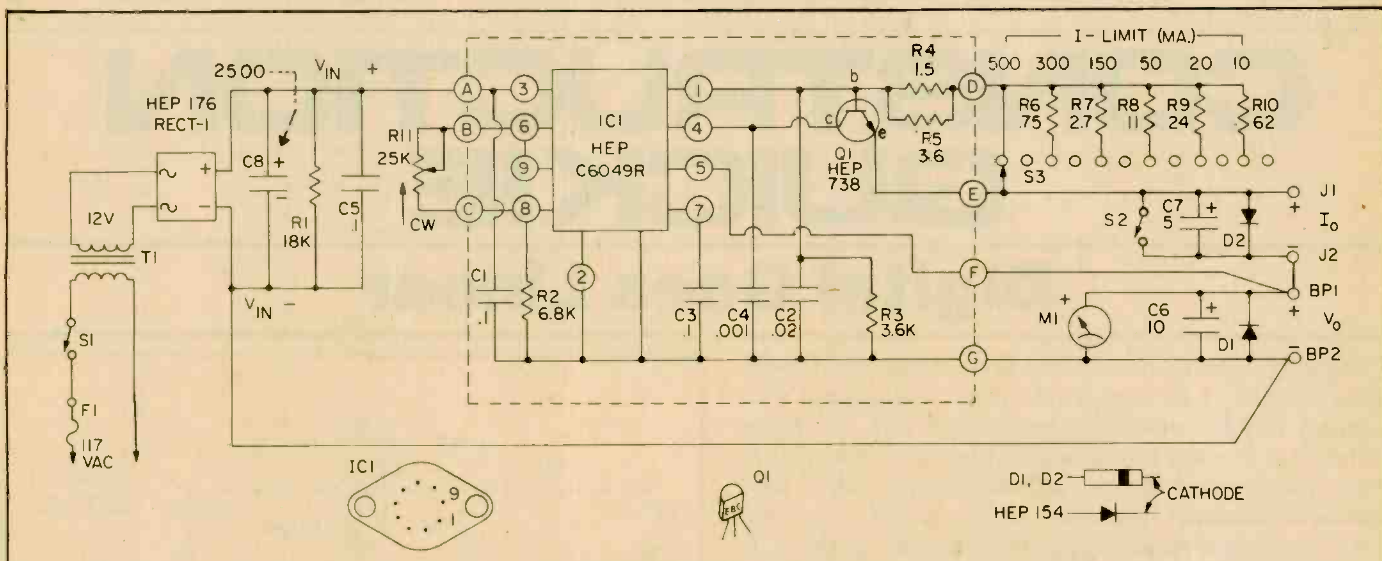
The parts should be placed according to this diagram. Note the location of the three drill holes for securing the IC and the board to the chassis. Locate the IC mounting holes very carefully so that everything mates snugly. This will help keep the chip cool.

should drop to about five volts. If much higher values are observed, current limiting is not taking place. Look for a defective or improperly installed Q1. If your current limit is, say, seven milliamperes, you can bring it up to ten by using a smaller value for R10 or by connecting a suitably larger value resistor across R10.

Only after you have verified current limiting action at low current, set S3 to pick up R4 (500 ma setting) and set the VOM accordingly. You will need either a 50-ohm 10-watt rheostat or adjustable power resistor to gradually load the supply. Or, you can use a number of small-valued power resistors. Set the rheostat to maximum resistance and connect it across the output terminals. Gradually reduce load resistance while observing output voltage and current. Current limiting should occur at below 500 ma. To increase the limit to 500 milliamperes, select and install a suitable resistor for R5. Proceed similarly to size or trim resistors R6 thru R10. You can easily include other current limits in the spare positions on S3 to match the charging currents of your nicad batteries. Do not exceed 500 milliamperes or IC1 will be damaged.

Application. The operating range of the Mini-Reg for several line voltages is shown. The supply "drop-out" shown in the upper right hand corner of this chart is due to an insufficient difference between V-in plus and V-out which in turn depends on transformer T1 voltage. When you are not using a meter at jacks J1 and J2, close S2.

The adjustable current limiting feature of the Mini-Reg greatly reduces the chances of damaging circuit components of the circuit powered by the supply.



PARTS LIST FOR MINI-REG

BP1, BP2—binding posts, red, black
C1, C3, C5—0.1-uF 25-VDC capacitor, ceramic
C2—0.02-uF 25-VDC capacitor, ceramic
C4—0.001-uF 25-VDC capacitor, ceramic
C6—10-uF 25-VDC electrolytic capacitor
C7—5-uF 25-VDC electrolytic capacitor
C8—2500-uF 25-VDC electrolytic capacitor
D1, D2—1-Amp 50 PIV silicon rectifier diode, HEP 154
F1—½-Amp fuse
IC1—HEP C6049R voltage regulator
J1, J2—insulated phone tip jacks, red, black
M1—0-15 VDC miniature DC voltmeter
Q1—HEP 738 transistor
R1—18,000-ohm, ½-watt resistor
R2—6800-ohm, ½-watt resistor
R3—3600-ohm, ½-watt resistor
R4—1.5-ohm, 2-watt wire-wound resistor, IRC type BWH
R5—3.6-ohm, ½-watt resistor
R6—0.75-ohm, 2-watt wire-wound resistor, IRC type BWH
R7—2.7-ohm, 2-watt wire-wound resistor, IRC type BWH
R8—11-ohm, 1-watt resistor
R9—24-ohm, 1-watt resistor
R10—62-ohm, 1-watt resistor
R11—25,000-ohm linear taper potentiometer
RECT-1—HEP 176 1-amp, 200-PIV bridge rectifier.
S1, S2—SPST slide switch
S3—1-pole, 12-position switch, non-shorting (Mallory 32112J or equiv.)
T1—12-volt, 1.2-ampere filament transformer

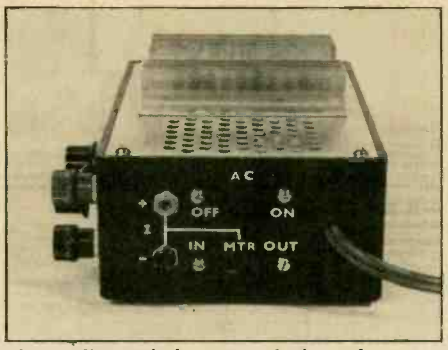
Misc.—Plastic case with aluminum top, 6¼ x 3¾ x 2 inches; heat sink, 3 x 3½ inches, (Allied Electronics 957-2840 or equiv.); T42-1 micro-clips (Vector); AC line cord; fused cord plug or fuseholder; perforated board; copper clad board; rubber feet (4); hardware, etc.

MINI-REG

Suppose you are experimenting with a transistorized circuit drawing five milliamperes at five volts. You would then set S2 to ten milliamperes. At these settings, the maximum power the supply can deliver is but a mere fifty milliwatts.

If you plug a transistor in backwards, the most it can draw is fifty milliwatts, probably much less; hence, the device will survive the error. However, certain semiconductors can be damaged with but microwatts of power. Nevertheless, you are far better off using current limiting supplies. If your experimental circuit draws 400 milliamperes at five volts, set S3 to 500 milliamperes limiting the power to 2.5 watts. This power level is more than enough to zap many devices if you make an error. If you have another five volt supply, split the circuit supply lines and protect those devices you cannot spare with the Mini-Reg.

Almost any circuit operating off three volts can safely operate at 3.4 volts. The output voltage can be further reduced by connecting a low-voltage zener diode in series with the plus lead to the load and monitoring the load voltage with a voltmeter. In this case, load voltage regulation now depends on zener diode characteristics.



The AC line switch, current jacks and current meter switch are on the end of the case.

When recharging batteries with the Mini-Reg, connect a silicon rectifier diode in series with the plus lead going to the battery. This eliminates "backleak" when the supply is turned off with battery yet connected. Observe battery polarity when making connections. Circuits using op-amps usually require a dual or split supply. To provide a dual six-volt supply, set the output voltage to fifteen volts, set S3 to 100 milliamperes, and connect two six-volt zener diodes in series across the output terminals. Then, connect a 100 uF 25V electrolytic capacitor across each zener diode.

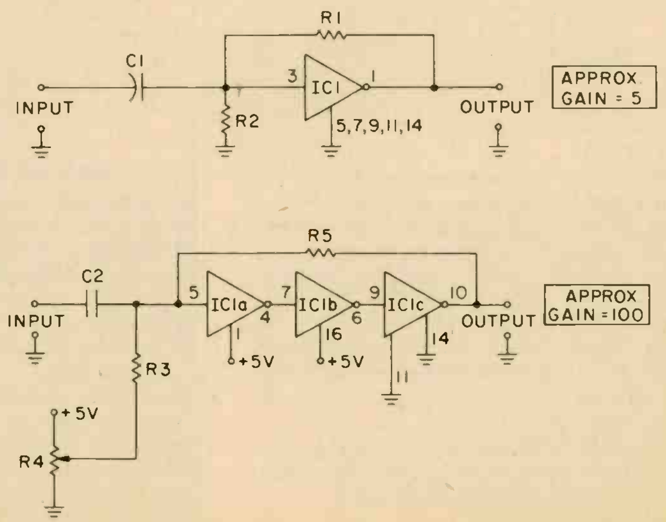
The Mini-Reg handily checks and sorts zener diodes of fifteen volts or less. Set R11 for fifteen volts output and set S3 to ten milliamperes. Connect the diode across the output terminals with plus lead wire to BP1. Observe zener diode voltage on M1. Advance S3 to high currents but do not exceed rated current of the diode. The better the quality of the diode, the less increase in voltage observed on M1.

When you operate radio or audio equipment from the Mini-Reg, set S3 to a current level which supplies peak currents on audio peaks. Otherwise, you will notice audio distortion on audio peaks. With some radio and audio equipment, operations off an AC adaptor or the Mini-Reg may introduce an AC hum. Reversing the AC plug usually remedies the problem. If not, connect a ground wire to either the plus or minus terminal of the Mini-Reg, whichever proves most effective. In addition to its use as a universal AC adaptor, the Mini-Reg serves as an excellent power supply when servicing battery operated transistorized equipment. You'll wonder how you ever solved your power supply problems before you discovered Mini-Reg! ■

CONSTRUCTION QUICKIE

Digital Goes Linear

☐ Digitally-oriented ICs are best at their intended On-Off tasks, but can be persuaded into linear operation if care is taken. CMOS lends itself better than TTL for linear operation, but good by-passing and layout is essential to avoid pickup and exotic self-oscillations. The 4009 CMOS hex-inverter sections can be biased as shown below. A typical single stage yields a gain of about 5. The triple combination can give a gain of 100 with care. These circuits could be useful where a high-impedance input circuit does not quite have sufficient amplitude to operate the digital gate. ■



PARTS LIST FOR DIGITAL GOES LINEAR

C1, C2—0.1-uF ceramic capacitor, 15 VDC
IC1—4009 hex buffer
R1, R2, R3—1,000,000-ohm, ½-watt resistor
R4—500,000-ohm linear-taper potentiometer
R5—5,000,000 to 10,000,000-ohm, ½-watt resistor

COUNT CAPACITA

Bring Your Junk Box Capacitors Back From The Dead!

by Walter Sikonowiz

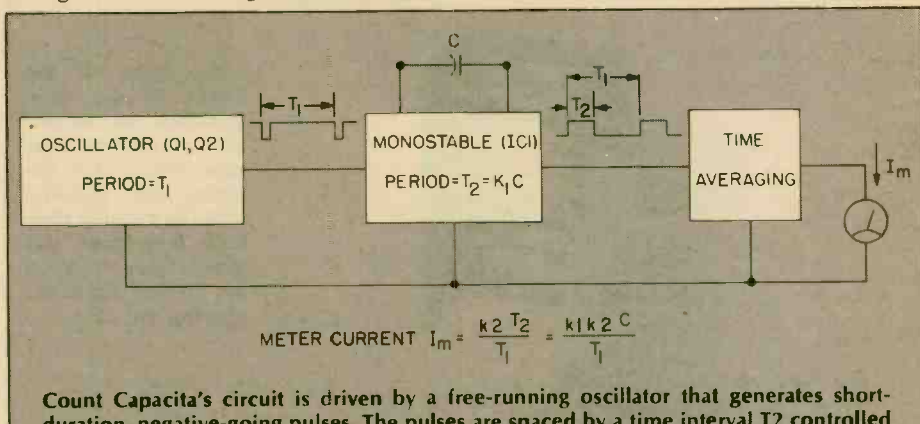
MAYBE YOUR JUNK BOX looks like a haunted mansion? Full of mystery and intrigue? Do you sometimes wonder just what values all those surplus or unlabeled capacitors really are? All the VOMs, frequency meters, power meters, FETVOMs and tachometers in the world aren't going to help you here. What you need is a visit from the Count—*Count Capacita*—our own toothsome capacitance meter.

You can use this capacitance meter to separate good capacitors from bad ones in your junk box. In addition, if you ever have to repair a television or radio, Count Capacita will quickly put the bite on a defective capacitor, thus saving you the expense of a repair bill in the process. Last, but certainly not least, the Count will enable you to purchase surplus capacitors, and this is where you can really save money.

Surplus capacitors are sold at discount rates, usually by mail-order dealers and for several reasons. First, suppose an audio manufacturer decides to completely phase-out his old capacitively coupled amps in favor of direct-coupled designs. His inventory of new and perfectly good capacitors is now useless to him, so he disposes of the lot on the surplus market. Second, sometimes a capacitor manufacturer wants to get rid of old, mislabelled or out-of-tolerance units; he can do this on the surplus market. You can take advantage of the savings—often more than 75%—if you know the Count. With our meter, you can spot the mislabelled or out-of-tolerance units, identify unmarked devices, and eliminate the occasional defective unit. If you do much experimenting, your savings may soon pay for your capacitance meter.

Transylvanian Circuitry. Let's begin discussion of this particular circuit with the block diagram. The circuit is driven by a free-running oscillator that generates short-duration, negative-going pulses. These pulses are spaced by a time interval T_2. Now, T_2 is controlled by the capacitor under test. Specifically, T_2 is equal to k_1C, where k_1 is just a constant of proportionality. At the monostable's output, there is a rectangular waveform that is high for a time T_2, and low for a time equal to $(1_1\text{-}T_2)$. This waveform is then time-averaged to yield a meter current equal to $(k_2T_2)/T_1$, where k_2 is another constant of proportionality. Since T_2 is equal to k_1C, it follows that meter current Im must also equal $(k_1k_2C)/T_1$. Therefore, there is a direct relationship between meter deflection and capacitance; by choosing the right values for k_1, k_2 and T_1, you get a capacitance readout.

The Count's various constants have been chosen to allow a useful measurement range that spans from less than 100 picofarads to 5000 nanofarads (5 microfarads). In case you are unfamiliar with the above nomenclature, one microfarad is one-millionth of a farad, the standard unit



Count Capacita's circuit is driven by a free-running oscillator that generates short-duration, negative-going pulses. The pulses are spaced by a time interval T2 controlled by the capacitor being tested. The waveform is averaged to yield a meter current that changes with varying capacitance moving the meter's pointer to the value.

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of capacitance. It takes a thousand picofarads to equal one nanofarad, and a thousand nanofarads to equal one microfarad. The scales on this meter measure capacitance in terms of picofarads and nanofarads; with the above information, you should be able to easily convert between units when necessary.

Let's now consider the schematic diagram. Assume that switch S2 is in its *battery* position and that S3 is pressed down. Battery current will flow into meter M1 through resistor R2, and M1's deflection will indicate whether or not the batteries are good. Fresh batteries will provide a meter indication of about "45"; batteries should be changed when the indication drops below "33", or thereabouts. Now, flip S2 mentally back to its *capacitance* position, and let's proceed with the rest of the circuit.

Battery current flows through resistor R1 to yield a regulated 6.2-volt supply potential across zener diode D1. Capacitors C1 and C2 bypass the supply and stabilize the circuit. The free-running oscillator is composed of unijunction transistor Q1 plus associated components. Timing capacitor C5 is charged through R13 and R14, or R15 and R16, depending on the setting of *range* switch S1. When the voltage on C5 reaches a specific level, Q1's emitter breaks down to a low impedance, thus discharging C5 through resistor R11. When the capacitor has been discharged to a sufficiently low level, Q1 ceases to conduct, and C5 once again begins to charge. This charging and discharging of C5 proceeds alternately, causing a voltage spike to appear across R11 each itme C5 discharges. Transistor Q2 inverts and amplifies the pulse, which is applied to the inputs (pins 2 and 4) of monostable IC1.

The monostable's period is determined by the capacitor under test in conjunction with a resistor—either R5, R6, R7 or R8—selected by *range* switch S1. In operation, the capacitor being tested first gets connected across a pair of binding posts, and then S3 is pressed to take a reading. You will note that these binding posts are polarized, with BP1 being positive and BP2 (which connects to ground) being negative. This is an important consideration with polarized capacitors such as aluminum and tantalum electrolytics; the capacitor's positive terminal must connect to BP1. Reverse connection is harmful to such capacitors, so be careful. The standard non-polarized capacitors—mica, paper, mylar, polystyrene, ceramic and glass—may be connected across the binding posts in either direction.

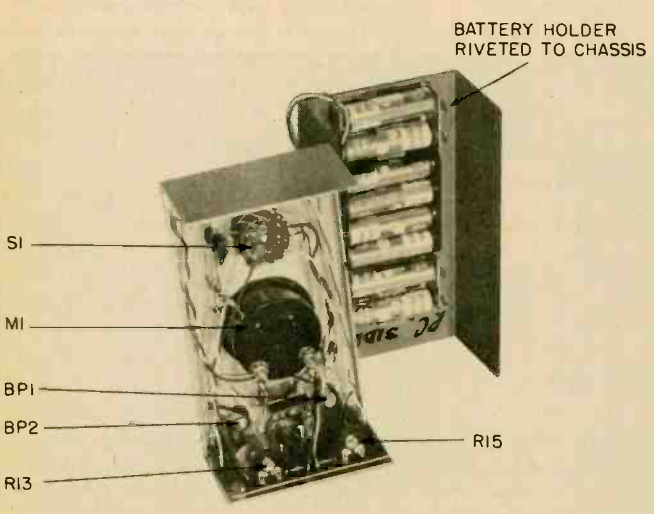
Diode D2 functions to provide a quick discharge of the capacitor under test when S3 is released. Monostable IC1's output, pin 3, drives meter M1 through R3. Averaging of the pulses is accomplished by capacitor C3 across M1 Finally, diode D3 ensures that no current is emitted from IC1's output when it drops low (to about a tenth of a volt).

Since this is not a temperamental circuit, though the Count *is* a bit batty) you should have few problems with its construction. One point that you should bear in mind, however, is that the binding posts must connect to the rest of the circuitry via short and direct wires spaced at least an inch apart. This minimizes stray capacitance between the binding posts and maintains good accuracy on the lowest range (pf. X 10).

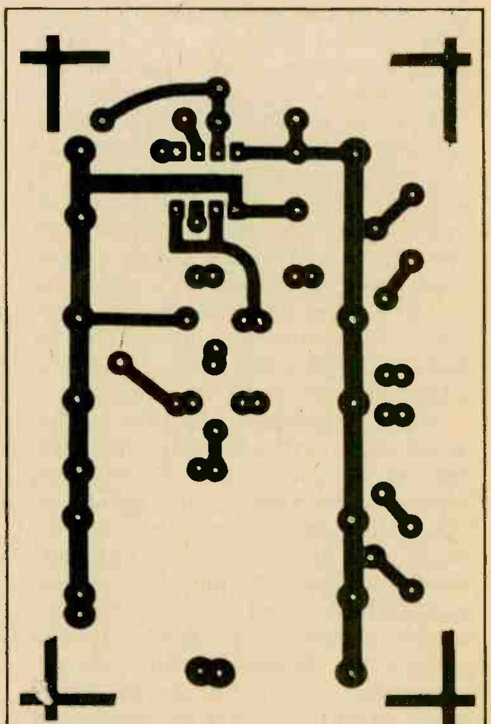
As specified in the parts list, resistors R2 and R3 must have 5% tolerances. Likewise, the tolerances of R5, R6, R7 and R8 must be at least 5 percent. If you desire, 1% precision resistors could be used for R5 through R8. This will improve accuracy somewhat on the four lowest ranges, but it will also be more expensive. You won't be needing hair-splitting precision, so 5%-tolerance resistors should be quite adequate here.

Although it might seem more difficult at first, printed-circuit construction is far and away the most convenient method of assembly. For your convenience, a PC foil pattern is provided elsewhere in this article, and it may be used in conjunction with a printed-circuit kit from any of the electronics retailers. An equally effective construction method involves the use of perfboard. Either technique is capable of turning out a small, neat circuit board.

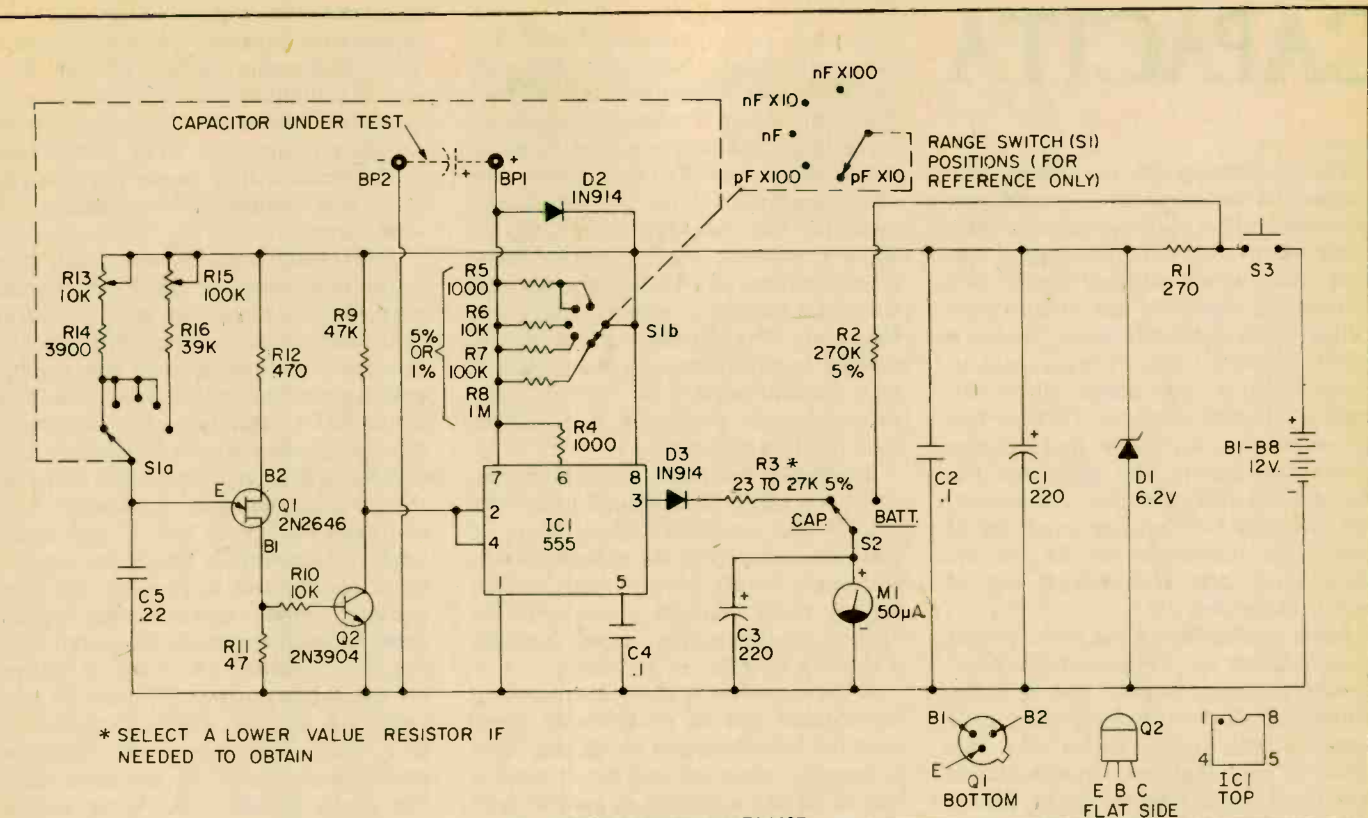
When wiring the circuit, be careful to install all polarized devices in the correct orientation. This applies to all the semiconductors, meter M1, the batteries, and electrolytic capacitors C1 and C3. Basing diagrams for all the semiconductors may be found elsewhere in the article. Lead identification



Construction of the Count is far from gruesome. Just be certain to minimize stray capacitance effects between the binding posts by keeping their leads both short and direct. Leave room on the battery leads for opening the case.



Here's your PC board template to bring the Count home to roost. Use either photo-etch materials or just use a resist marking pen.



COUNT CAPACITA PARTS LIST

B1-B8—1.5 VDC AA-cells, connected in series
BP1, BP2—binding posts
C1, C3—220-uF, 16-volt electrolytic capacitor
C2, C4—.1-uF ceramic capacitor
C5—.22-uF, 10% tolerance, mylar capacitor
D1—1N753A Zener diode, ½-watt at 6.2-volt
D2, D3—1N914 diode
IC1—555 timer
M1—0-50 microamp meter (Radio Shack 22-051 or equiv.—see text)
Q1—2N2646 unijunction transistor
Q2—2N3904 NPN transitor

ALL RESISTORS ARE 10% TOLERANCE, ½-WATT UNLESS NOTED.

R1—270-ohm resistor
R2—270,000-ohm resistor, 5% tolerance
R3—27,000-ohm resistor, 5% tolerance
R4—1000-ohm resistor
R5—1000-ohm resistor, 5% tolerance or 1% if desired
R6—10,000-ohm resistor, 5% tolerance or 1% if desired
R7—100,000-ohm resistor, 5% tolerance or 1% if desired
R8—1-Megohm resistor, 5% tolerance or 1% if desired
R9—47,000-ohm resistor
R10—10,000-ohm resistor
R11—47-ohm resistor
R12—470-ohm resistor
R13—10,000-ohm trimmer potentiometer
R14—3900-ohm resistor
R15—100,000-ohm trimmer potentiometer
R16—39,000-ohm resistor
S1—rotary switch, 5-position, double-pole
S2—SPDT toggle switch
S3—SPST pushbutton switch

Misc.—battery holders; knobs; cabinet (LMB #C-R 632, from Circuit Specialists, Box 3047, Scottsdale, Arizona 85257); wire; press-on lettering; etc.

for transistor Q1 applies *specifically* to a 2N2646. If you use a Radio Shack RS2029 for Q1, note that it uses a different lead orientation, which is clearly illustrated on the package in which it is sold. Though their lead orientations are different, these two transistors are electrically equivalent and interchangeable.

Although it is not absolutely necessary, the use of a socket is advisable for IC1, especially if you haven't had much experience soldering integrated circuits. The socket, as well as most of the other components in the parts list, is available at Radio Shack. Two of the components, S1 and the case, may be purchased by mail from Circuit Specialists (see the parts list for their address). Circuit Specialists carry a tremendous assortment of electronic devices, and they cater to the experimenter by not imposing a large handling charge on small orders. You can obtain their catalog by writing to the address in the parts list.

Under the Lid. During construction, do not substitute for meter M1 unless the device you intend to use has a full-scale sensitivity of 50 microamps and an internal resistance of about 1500 ohms. As usual, you should make all connections with a 25-watt iron and resin-core solder. When wiring S1, make sure that the rotor of S1b engages R8 in the fully CCW position, and R5 in the CW position. Also, S1a's rotor must contact R16 when fully clockwise, and R14 in all other positions. You may then label S1 according to the diagrams provided here, with the lowest range in the extreme CCW position. Finally, be certain to label BP1 with a "+" and BP2 with a "-".

When construction is complete, there are two calibration adjustments that must be made. In order to make these adjustments, you will need two accurate reference capacitors. The first, which will be used to calibrate the highest range, should have a value between 2 and 5 microfarads—the higher the better. Commonly available capacitors in this range are generally mylar or electrolytic. The mylar is your best choice; pick a unit with the tightest tolerance you can find. In this capacitance range, that means about ±10% —sometimes better. If you must go with an electrolytic, choose a tantalum device and avoid the aluminum electrolytics, which tend to be leaky and have poor tolerances. Common tolerances for tantalums run about ±20%, so you can see why the mylar is the better

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choice.

For calibration of the lower four ranges you will need another reference capacitor; since calibration can take place on any of the four ranges, you have some leeway in your choice of a calibration capacitor for these lower ranges. One especially good choice is a 5000 picofarad polystyrene capacitor, available from just about all of the large electronics retailers. This particular capacitor is cheap but precise (±5% tolerance). The steps that follow will use this capacitor, but remember that you can use any capacitor as long as it is accurate and its nominal capacitance falls at the high end of one of the scales.

Begin calibration of the lower ranges by connecting the 5000 picofarad polystyrene capacitor to BP1 and BP2. Set trimmer R13 to the midpoint of its range of adjustment. Make sure that S2 is in its *capacitance* position, and that *range* switch S1 is set to PF. X 100. Press S3 and adjust trimmer R13 for a full-scale indication of "50" on M1. This completes calibration of all four lower ranges.

Calibration of the top range is similar to the above. Hook up your capacitor, and set R15 to its midpoint. Make sure that S2 is set to *capacitance*, and that S1 is fully clockwise. Press S3 and adjust trimmer R15 until your meter indication corresponds to your capacitor's marking. This finishes the calibration.

Use of Count Capacita is fairly obvious; nevertheless, here are a few odds and ends that you might find helpful: The maximum voltage appearing across any capacitor under test is about 4.2 volts, which is well below the rated working voltage of almost any capacitor that you are likely to encounter. Because battery current drain is intermittent and moderate, the cells will last a long time—possibly for years. However, it might be a good idea to replace batteries once a year, even if they indicate more than "33", in order to prevent the possibility of a battery leak inside your meter.

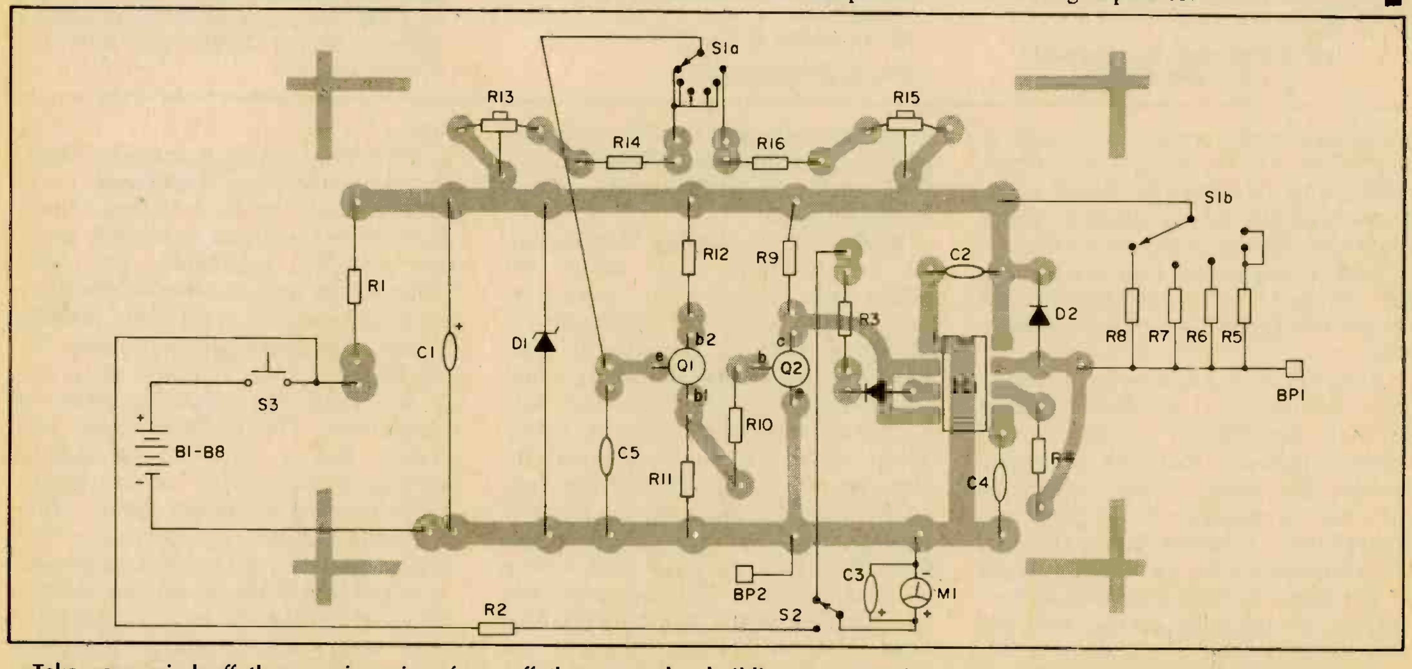
Whenever you make a measurement, start on a range high enough to accommodate the capacitor being tested. If you have no idea of the capacitor's approximate value, always start on the highest range. Should a capacitor be opened up internally, it will provide a reading of zero on all scales.

If the capacitor is leaky, its measured capacitance will be considerably larger than the value stamped on its case. This is because capacitor leakage is equivalent to having a resistor in parallel with the capacitor. This leakage resistance siphons off capacitor current, so the capacitor takes longer to charge, and monostable IC1's output stays high for a longer time. The result is an erroneously high capacitance reading. By the same token, you can expect an internally shorted capacitor to pin the meter's needle on all scales, since a short is, in effect, just a case of complete leakage.

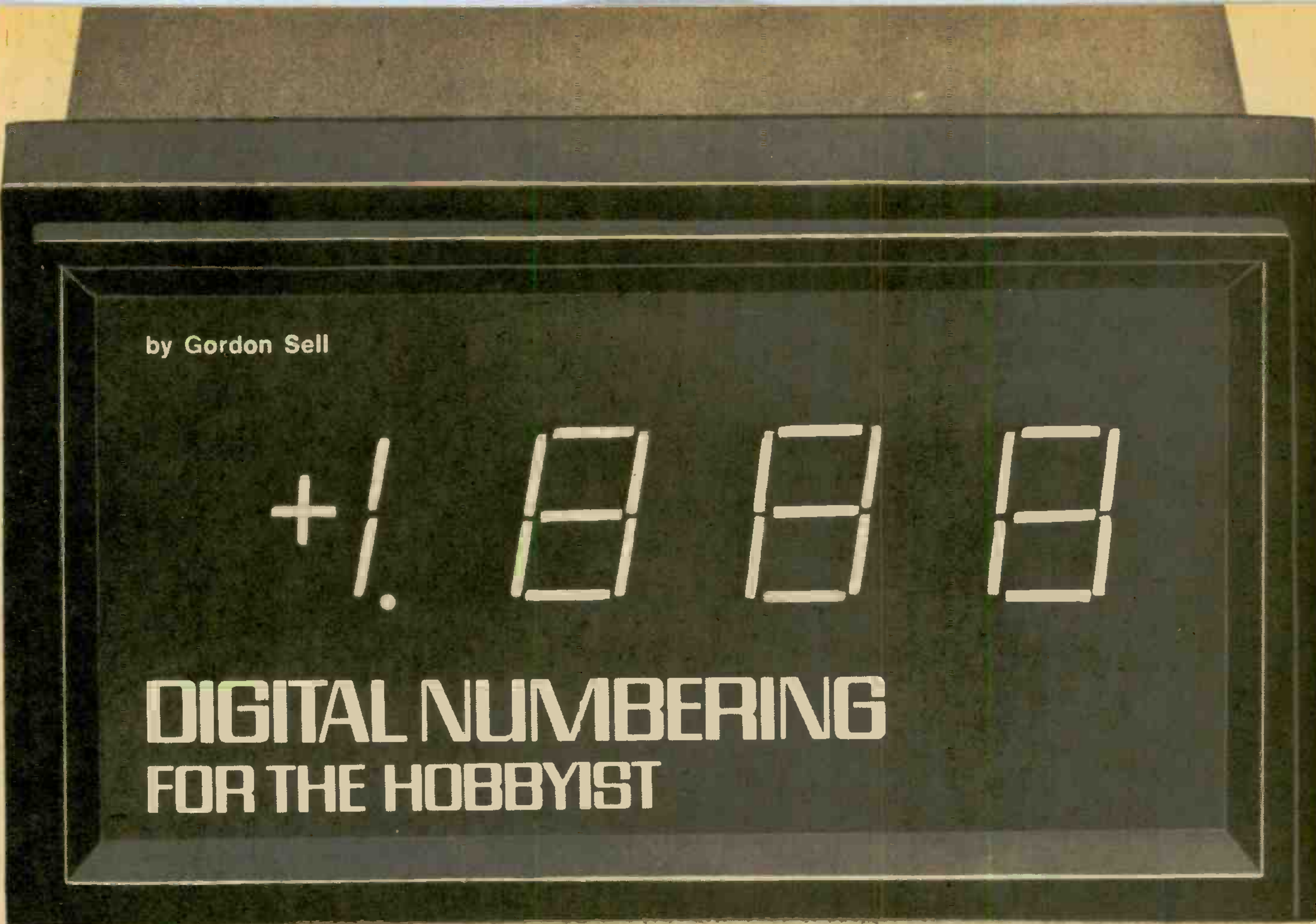
Now, let's return to an important topic that was introduced earlier; stray capacitance between the binding posts. The construction details already presented should help to keep strays at a minimum; however, you can never completely eliminate stray capacitance or the errors it may cause. Fortunately, it is very simple to compensate for such errors.

After your meter is calibrated, turn to the most sensitive range: Picofarads x 10. This is where the effects of stray capacitance will show up. Without any external capacitor between the binding posts, press the pushbutton and note meter M1's indication. On the prototype, a reading of 30 picofarads was obtained. This represents the value of the stray capacitance in parallel with any capacitor under test. It also represents the amount by which any capacitance reading will be in error. To compensate, simply subtract the residual capacitance from any given meter reading. For example, a reading of 480 pf. on the prototype meter would be corrected to 450 pf. (480 pf. minus 30 pf.). Such corrections are significant and necessary only on the most sensitive scale. Finally, since stray capacitance can obviously affect accuracy on the most sensitive scale, it is preferrable that you *not* calibrate there, but on one of the higher scales, as outlined previously.

So, on the next dark night, why not sit yourself down and, to the strains of some Transylvanian music, acquaint yourself with the inner workings of our Count Capacita? You have nothing to lose but your fear—fear of choosing the wrong capacitor! ■



Take your mind off those eerie noises from off the moors by building our sanguine Count. Here's where the components lie. The Count will bring back to life all of those once-useless, unmarked capacitors once doomed to a junkbox graveyard!



by Gordon Sell

DIGITAL NUMBERING
FOR THE HOBBYIST

Make your projects count by teaching them to talk back digitally.

DIGITAL NUMBERS — they are everywhere! The entire electronics world has been caught-up in the digital revolution — watches, radios, TVs, VOMs, frequency counters — the list is almost endless. But, have your construction projects been a part of the revolution or are you still back in the hobbyist stone age of meters and light bulbs? Do your projects look like 20th Century state-of-the-art or do they look more like a turn-of-the-century patent application for an ultimate mousetrap?

If you think it is time to go digital but feel that the technology is beyond your grasp you are not alone. There is a mumbo jumbo that has grown up around digital electronics that makes people think they have to learn all about computers before they can do any kind of digital project. If you have ever made the mistake of asking a "computer know-it-all" how digital number displays work, you are sure to have received a two-hour lecture on binary numbers, Boolean algebra and assorted flip flops, and come away knowing less than when you started.

Learn Backwards. All this hassle is unnecessary, however, if you learn digital electronics *backwards!!* Start with the familiar end result, a decimal number display, and work backwards into the circuitry that makes it possible.

Digital displays come in a number of different forms but all the circuits discussed here will use a common cathode, seven-segment LED (Light Emitting Diode) numeric display. These are cheap, easily obtainable and the circuitry can be adapted to other types—especially the liquid crystal type displays. The best way to learn about numeric displays is to put one together so you can physically see how it works and how the various components interact with each other.

To simplify construction of the demonstration circuit accompanying this article a Continental Specialties Corporation PB-203 solderless breadboard was used. It allowed almost infinite experimentation with various circuit arrangements — experimentation that would have otherwise consumed a prohibitive amount of time. All parts mentioned in the parts list and article are easily obtainable through mail-order houses (see the HOBBY MART in the back of this issue) or from most electronics parts distributors. The parts in the article are referred to by their common name since many parts with different numbers can perform the same tasks. The parts used in the demonstration circuit are identified by their generic part number—most parts distributors will have a cross-reference from this number to the manufacturer's part number, or to a standard replacement.

Translating. As you can see in the diagram of the seven-segment display, any digit from zero to nine can be represented by a certain combination of lit LED segments. Each of these segments is an individual LED with its cathode tied to a common ground; hence the name common cathode (some have common anodes). Each segment can now be activated by a switch between the anode and a power source. Switching on segments a, c, d, f and g, for example will cause the digit five to be lit. (As a practical consideration be sure to use a current limiting resistor—110 ohms in the circuit shown.)

We can now represent any digit by various combinations of "on" or "off" of the seven switches. There is a potential for 49 different character displays with this set-up—well beyond the needs of a numeric display.

So, by using a common integrated circuit chip we can reduce the number of switches to four. The internal circuitry of the BCD to seven-segment decoder (the name will make more sense later), as the chip is called, takes the

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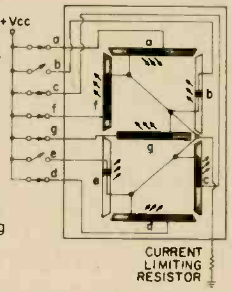
combinations of the four "ons" and "offs" and applies power to the appropriate LED segments. This representation of a digit by four combinations of "on" and "off" is called Binary Coded Decimal or BCD for short. A binary number uses only zero and one rather than zero through nine. The one can be represented electronically by a high level voltage and the zero by a low level voltage. The following chart shows decimal numbers, their BCD equivalent and the segments that are lit on a numeric display:

Decimal	Binary	Segments
0	0000	abcdef
1	0001	bc
2	0010	abdeg
3	0011	abcdg
4	0100	bcfg
5	0101	acdfg
6	0110	cdefg
7	0111	abc
8	1000	abcdefg
9	1001	abcfg



We now have a circuit that can translate "computerese" BCD numbering into the decimal numbers we have used all our lives.

Learning to Count. Now we need to teach our circuit to count from zero to nine. We can do this by adding an integrated circuit chip called a decade counter. This integrated circuit has one input line and four outputs. The outputs, as you have probably guessed, are connected to the four input lines of the BCD to seven-segment decoder. The outputs are all at zero until a single pulse appears on the input line. Then one of the outputs changes to a "one" so that the BCD to Seven-Segment decoder receives the number 0001 and lights segments b and c. On the second pulse the decade counter sends out the number 0010 and a 2 lights up on the display. This continues until the decade counter gets to nine; it then recycles to zero.

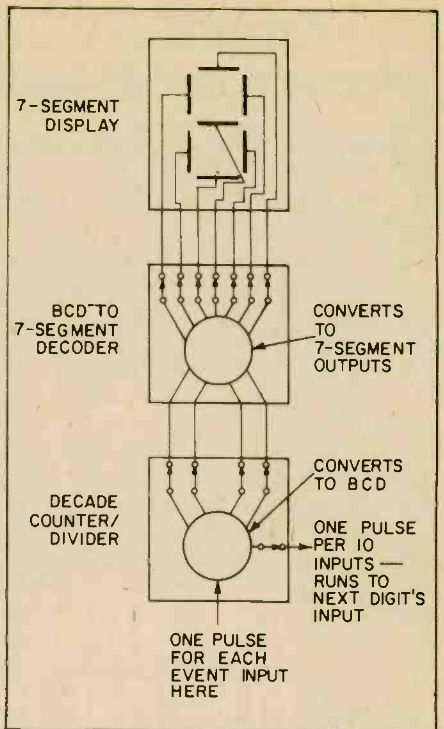
You should congratulate yourself—you now have a practical event counter that will total (up to nine) the number of pulses generated by the occurrence of some event. A switch on a refrigerator door that will turn on once each time the door is opened might allow you to record how many times it has been opened. Unfortunately there is a phenomenon of mechanical switches called contact bounce, where one switch-closing can trigger 3 or 4 pulses. This can be eliminated by adding a one-shot multivibrator, or similar circuit, to clean up the unwanted pulses. For the demonstration circuit the event pulses were obtained from a free-running multivibrator signal generator for simplicity and freedom from unwanted pulses.

Extra Digits. Now it is time to add a few more digits. After all, how many useful things can be measured by a single digit. To do this we must add a second set of the three components already mentioned: a numeric display, a BCD to Seven-Segment Decoder and a Decade Counter. Everything is wired the same way except that the input for the second decade counter is attached to the "carry out" pin of the first counter. This pin gives off an output pulse each time the counter resets from nine to zero. So, after the first display gets to nine and then resets the second display counts one so that the display reads ten. When the decade counter resets a second time the display clicks to 20. An almost infinite number of digits could be added that would count once each time the preceeding stage reset to zero.

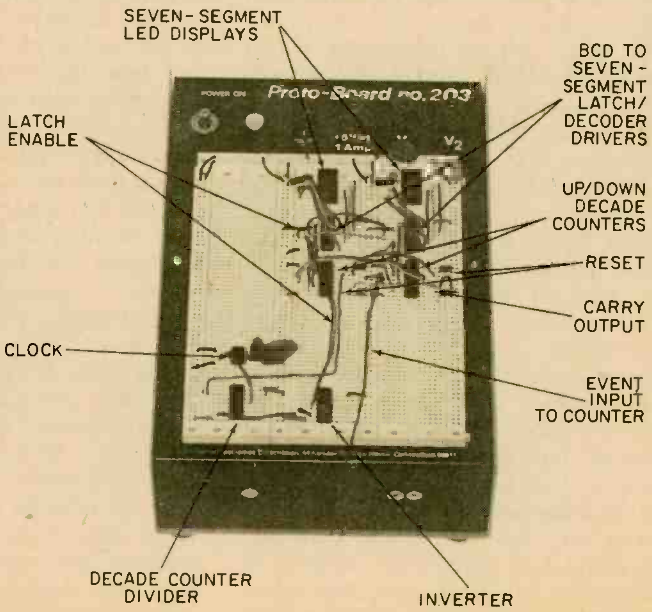
A counter such as this could be used for any sort of tallying operation where you have to keep a record of how many events have taken place. Most digital applications, however, involve rate operations — cycles-per-second, miles-per-hour, gallons-per-day or even dollars-per-week.

Rate Measurements. For the above counter to be converted to measure the number of events per unit of time a few additions have to be made. The first of these is called a clock. A clock gives you the seconds of miles-per-second or the hour of inches-per-hour. It sets the interval over which the number of events is counted. This is achieved by adding a simple freerunning multivibrator. In the case of the circuit shown it puts out five volts with momentary negative going pulses at regular intervals. Once calibrated to the proper rate this multivibrator remains at a constant frequency.

The clock has two main jobs: It must



This block diagram shows how the sequence of pulses at the input are first translated to BCD and then to seven-segment coding.



This photo shows the layout used in the demonstration model. The event input was from a 555-based code practice oscillator. Even better would be an AF/RF Signal generator with a variable square wave output jack.

reset the entire counter circuit to zero at the appropriate time and it must freeze the display at the appropriate part of the counting cycle so that it is a readable and meaningful number rather than a blur of speeding digits.

This last task requires a device known as a latch. A latch is a circuit that freezes on whatever BCD number is in its register when a high voltage is applied to the "latch enable" pin. If your circuit is counting from zero to 1000 every 10 seconds and you put a high voltage on the "latch enable" pin at 6 seconds the display will hold at 600. If it is grounded at seven seconds the display will resume the count at 700. So the count doesn't stop—it is only the display that freezes. In the circuit shown on these pages the latch is incorporated in the BCD to Seven-segment decoder IC chip.

By carefully coordinating the counter "reset-to-zero" pulse and the latch pulse so that the latch freezes the count display a moment before the counter resets, we have a event per unit time display.

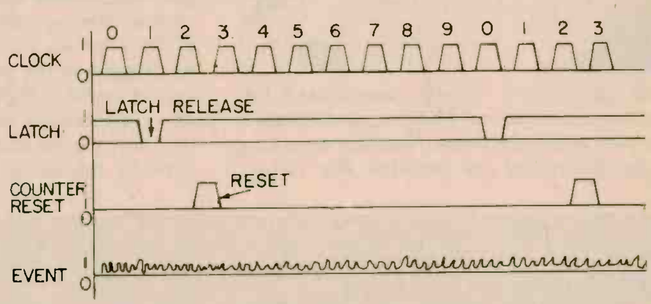
Synchronizing. To get this proper synchronization of clock, latch and reset, a Johnson counter or decade counter/divider is used. In this chip there are 10 output pins that go high (puts out a 5-volt pulse) in a repeating sequence. So for every 10 input pulses each pin goes high once, one after the other. If we control the latch with the pin that goes high on the first input pulse to the counter and then reset with the pin that goes high on the third input pulse we can control the display so that it will latch and reset at the proper time. The pin that goes high on the second pulse isn't used because of pulse overlapping.

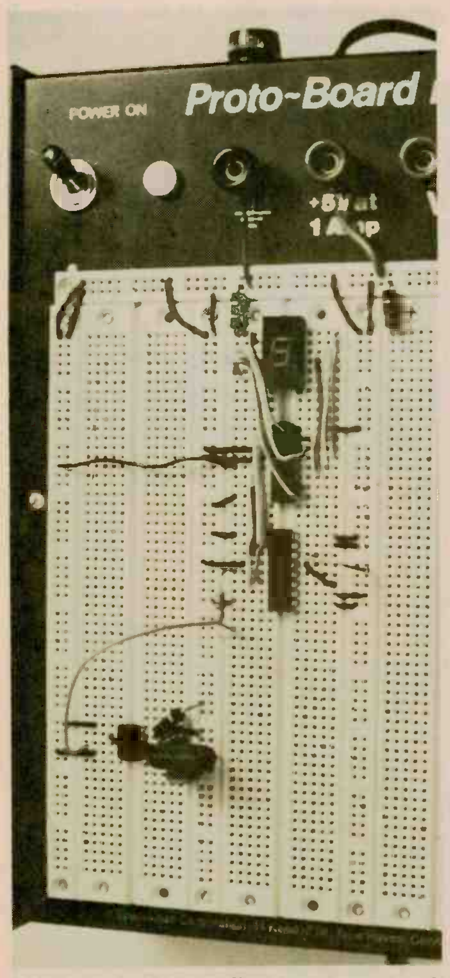
One slight problem with the output to the latch is that it needs to be inverted. This is accomplished by sending the pulse by way of an inverter. You can use a common inverter. An inverter is a device that produces a high output with a low input and a low output from a high input.

Putting It All to Work. You have now finished your basic rate measuring device. Now it's up to you to incorporate all of this into your pet project. All you have tc do is convert your project's output into series' of pulses of high and low voltage—high being about five volts and low about zero volts. A high-frequency of pulses will give a high numeric readout and a low frequency of pulses a low readout.

If your project gives a variable voltage readout you can buy a chip called a analog to digital converter—this puts out a higher frequency of pulses in

The clock sets the timing of the latch and reset. In this circuit the latch holds the count eight clock pulses after the clock has reset so that the number on the display is only proportional to the number of events per cycle rather than a total of the events.





This is a simple one digit event counter. It will count from zero to nine, recycle to zero and start the count again. The resistor added between the clock on the lower left and the decade counter is to lower the level of the input voltage peaks. 220 ohms is fine.

The CSC Proto-Board made experimentation a snap. Connections could be swapped around without muss or fuss. Hang on to the data sheets that come with IC chips, they are an invaluable reference source. Some, like the Radio Shack/Archer ones shown here, have lots of ideas for future experimentation and circuit design modifications.

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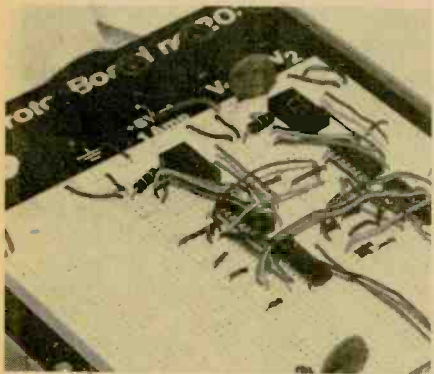
proportion to an increase in voltage.

The chips used in this article were referred to by their general name rather than number since the attached schematic is only an example of a typical digital numbering circuit. There are hundreds of other combinations of similar integrated circuit chips. After you have worked with these circuits for a while you will begin to understand the system better and will find yourself designing more and more complex circuits.

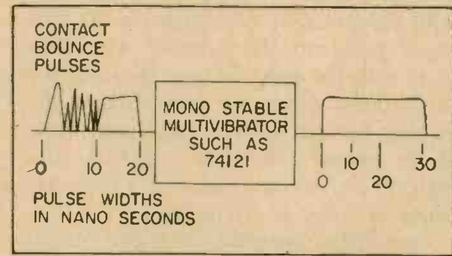
If you want to extend the number of digits much beyond two or three this technique starts to get very expensive and you should consider multiplexing the circuitry, but that is another article altogether. To describe it as simply as possible, multiplexing is the running of many displays off a single BCD to seven-segment decoder. Power goes to the display digit only when that digit is being decoded. Multiple digits are decoded in sequence so rapidly that they appear to be all lit at once.

More Help. Two books which were extremely helpful in putting this circuit together are: *CMOS Databook* by Bill Hunter and published by TAB Books/No. 984, $6.95; and Radio Shack's *Archer Semiconductor Reference Handbook* (276-4002) $1.95.

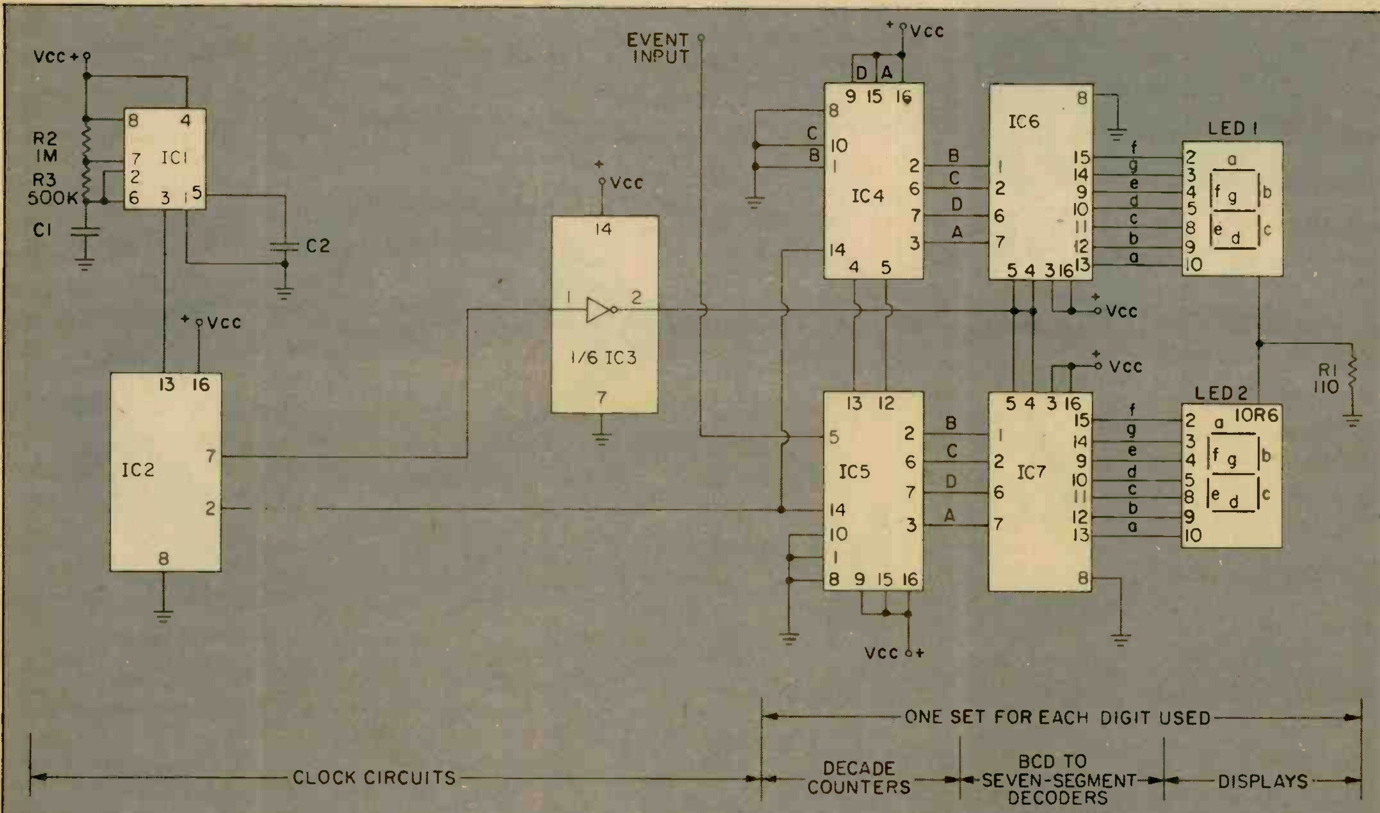
You can learn a lot from these and other books, but nothing takes the place of actually putting one of these circuits together. It is only by trial and error that you learn how to use these basic digital building blocks—learn how to get all the parts ticking over in the proper sequence and humming along to the beat of the clock, the way a good orchestra plays to the rhythm of the conductors batton. ■



The connections appear complicated but once you understand the principles involved they all will make sense. Note the despiking capacitor added to stabilize the circuit.



If the output of a mechanical switch were put straight into a counter, each one of the contact-bounce pulses would trigger a cycle of the counter. The monostable multivibrator triggers as the pulse first goes high. The output remains high for a time longer than any continuation of bounce pulses so the unit only counts once. The pulse widths are typically measured in nanoseconds.



PARTS IN DIGITAL DEMONSTRATION CIRCUIT

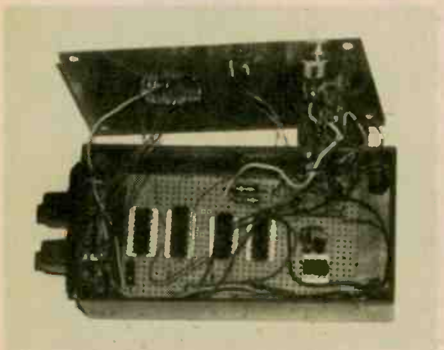
C1—0.1-μF capacitor
C2—.01-μF capacitor
IC1—555 timer
IC2—4017 Decade Counter/Divider
IC3—7404 Hex Inverter
IC4, IC5—74192 Up/Down Decade Counter
IC6, IC7—4511 BCD to Seven-Segment Latch/Decoder/Driver
LED1, LED2—Common Cathode Seven-Segment LED display
R1—110-ohm, ½-watt resistor
R2—1-megohm, ¼-watt resistor
R3—500,000-ohm, ¼-watt resistor
Misc.—CSC PB-203 Solderless Breadboard, jumper wires, and a variable frequency, 5-volt peak-to-peak, square wave signal generator or equivalent free running multivibrator.

10 SECONDS..... AND COUNTING!

Send your model rocket to the stars with our launch computer

FOR YEARS, THOUSANDS of people have been building and launching small scale model rockets that propel themselves with miniature solid-core propellent engines. But no matter how much time, money, and effort a person put into his (or her) rocket, the launch has always been pretty much the same; a switch, a battery, and perhaps a light bulb to check continuity.

A Breakthrough! Thanks to lower Integrated Circuit (IC) prices, a hand-held, computer-like launch controller is new practical even for a "model rocketeer" on a budget. The Rocket Computer consists of a display that—when ordered—counts down from 9 to 0 and then, thanks to a SCR (Silicon Controlled Rectifier), fires current through an igniter to start the propellent engine. Two LED's tell you if power is on and also give continuity verification. It's simple to operate with only three switches. The whole project can be assembled, even at retail prices, for only \$5 or \$20, less case.

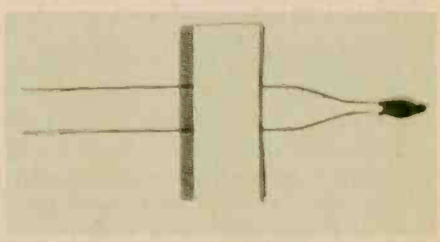


You can use perfboard construction to build your controller, as shown here. Parts layout is not critical, nor are any dimensions.

Construction. The circuit is quite stable, so any method of construction can be used. IC sockets should be used to protect the "chips" from soldering heat, and facilitate easy replacement—if necessary.

I built my Rocket Computer on perfboard, with IC sockets, and a wire-wrapping tool was used to wire it up. But, soldering the project with point-to-point wiring is just as easy and effective. Take care not to make any solder "bridges" between socket pins, as they are usually spaced pretty close together. The LED display pins must correspond with IC 3's output pins. Most manufacturers of these displays give sufficient data to make this an easy task; simply match the A-G lines together. A 15-ohm resistor on the common anode lead should be rated at least at a half watt. (The common anode lead is easily identified on the LED display data also.) In the parts list, I recommend a Radio Shack RS-1020 SCR, but any SCR that can handle 2 amps or more of current with a low gate voltage can be used. Use spring clip terminals like I did to make igniter hook-up quick and easy. I mounted my terminals for the igniter on top of the case. Then, I mounted the power input jacks on the side. Once again, use spring clip or screw type connectors here. It is an excellent idea to use jacks for the power input and igniter output that do *not* look similiar. This will avoid mistakes and possible damage. Finally, be sure to note polarity when wiring the input power jacks.

Testing and Blastoff! Give the circuit a complete bench test before taking it out to your "launch pad". Use only a 6 volt lantern-type battery on this circuit. Only a small or large lantern battery can insure that there will be plenty of current available to drive both the circuitry and igniter. Test the circuit first *without* using an igniter hooked up. Attach your battery to the proper jacks. Now, turn switch S1



This igniter wire fits into the back of a model rocket engine. Once fired by our rocket computer it burns with the intensity of a match. This sets off the engine.

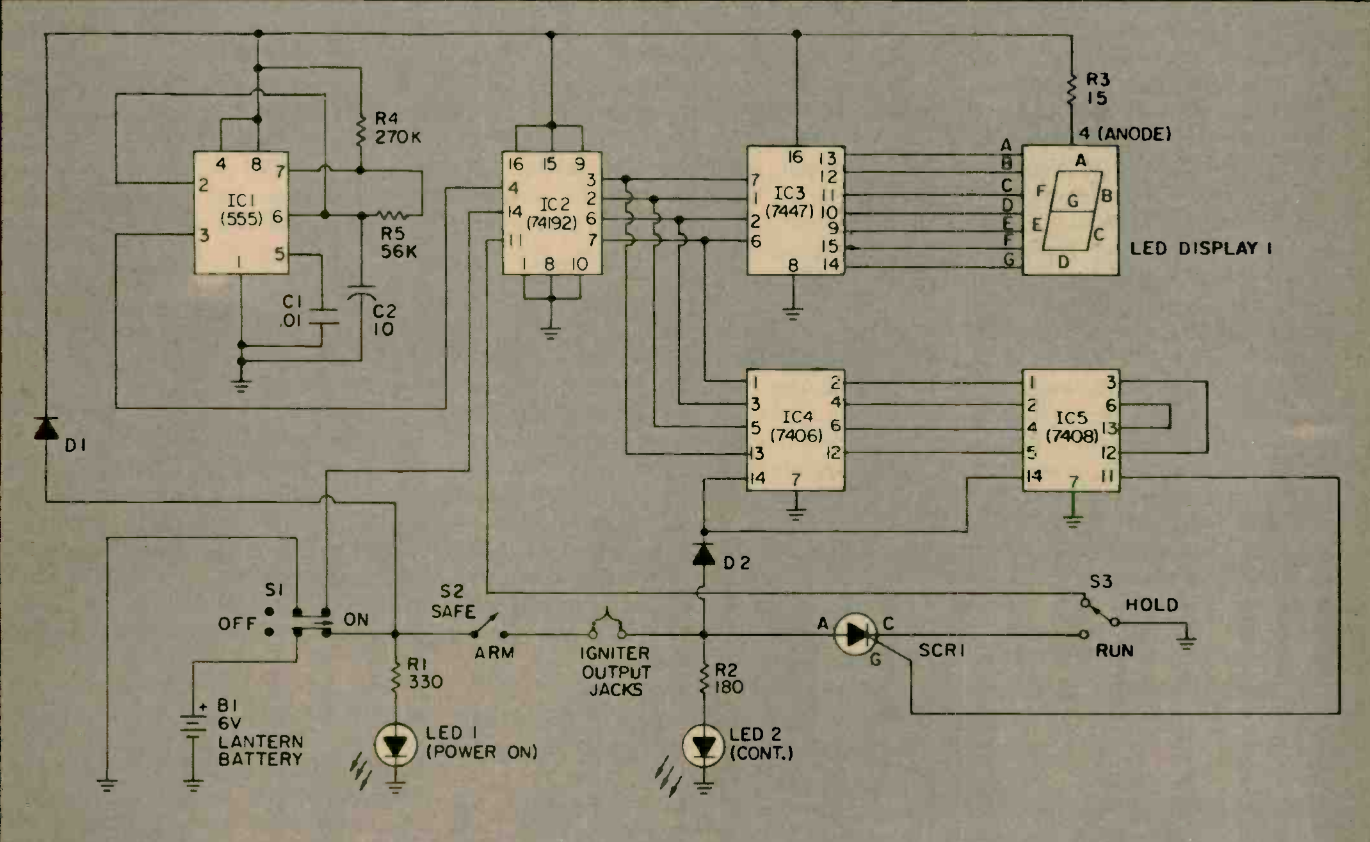
(*off/on*) to the *on* position. LED 1 should light, and the display should show a 9. If the display did not light, or if it didn't show a 9, then recheck the wiring from IC3, and correct the problem. Turn S2 (*safety/arm*) up to *arm*. LED 2 will not light yet because no igniter is in. Now, take a low current igniter (Estes #2301) and hook it up to the igniter output jacks. LED 2 should now glow, proving continuiny. (Polarity is not observed on an igniter.)

Now see if the unit can fire an igniter (not in an engine yet!!!) on your bench. Move the igniter away from anything inflammable as the igniter usually burns for a second at about the intensity of a match. Throw switch S3 (*hold/run*) to *run*. The display should count slowly down, and—get ready—at zero, the igniter should fire.

At all times, when using this unit, start your launching procedure with all switches in their "off", "safety", "HOLD" positions respectively. After the launch *always* pull S2 and S3 down to their safety and hold positions. Failure to do so can result in premature liftoff of the next rocket. Remember, safety in rocketry always comes first!

In the Firing Room. The heart of this circuit is the 74192 IC counter. This amazing little chip takes the clock pluses generated by the 555 timer IC and counts them in binary code. The 7447 IC receives the binary numbers and changes them into a form we can shows us the numbers as they are understand—decimal. The LED display counted. IC 7406 and IC 7408 "watch" the count and when they sense a zero, they send a pulse to the SCR, triggering it into conduction and thus firing the igniter. ■

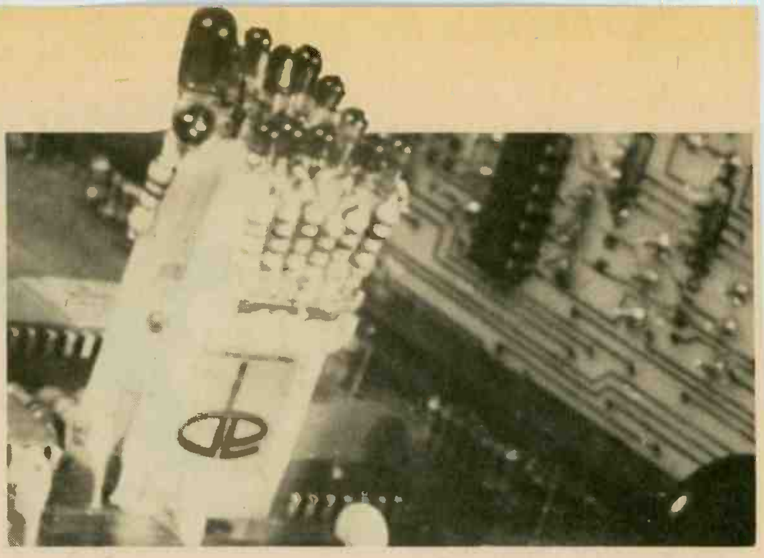
The model rockets our controller will let you launch are fun kits in themselves. Most have a parachute for a colorful "re-entry" and you can get everything from nearly exact scale models of the V2 and Saturn V, to some far-out spaceships of the future.



PARTS LIST FOR THE ROCKET COMPUTER

B1—6-volt lantern battery, Mallory F918 or equivalent
C1—0.01-uF ceramic disc capacitor, 15 VDC
C2—10-uF electrolytic capacitor, 15 VDC
D1, D2—1N4148 diode
IC1—555 timer, 8-pin IC
IC2—74192 binary counter, 16-pin IC
IC3—7447 BCD-to-decimal decoder, 16-pin IC
IC4—7406 hex inverter, 14-pin IC
IC5—7408 AND gate, 14-pin IC
LED1—large red LED
LED2—large green LED
LED Display—7-segment, common-anode LED display
R1—330-ohm, ½-watt resistor
R2—180-ohm, ½-watt resistor
R3—15-ohm, ½-watt resistor
R4—270,000-ohm, ½-watt resistor
R5—56,000-ohm, ½-watt resistor
S1—DPDT slide switch
S2—SPST toggle switch
S3—SPDT toggle switch
SCR1—Silicon controlled rectifier, 50-volt/2-amp or better
Misc:—Input and output jacks, IC sockets, wire, solder, suitable enclosure, igniter (Estes #2301), etc.

Chip-clip



IC testing got you flipping? Don't give up, try Clip-Chipping!

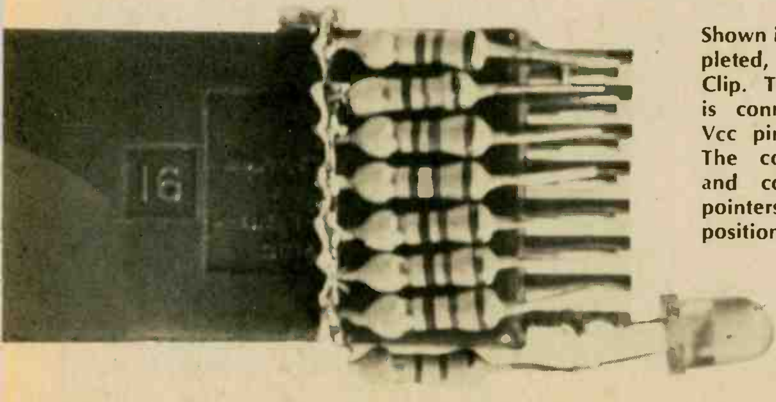
by James Gupton

☐ The dual-inline-package (DIP) integrated circuit (IC) is not a really new electronics device; it's been around for more than ten years. While it was the microprocessor and mini-computer revolution that focused attention on this device, even those of us not involved in computers use ICs. For example, tape decks, radios, and television receivers now use them. Unfortunately, ICs are not infallible, and do on occasion breakdown. Due to the compact size of the IC, working space between devices is scant, to say the least. The need for an IC tester becomes apparent when one tries to follow a schematic diagram, manhandle two snake-like probes, and keep one eye on a meter and the other on an IC pin at the same time. That's where our deluxe *Chip-Clip* becomes a necessity.

Most frequently, repairmen come across digital ICs. In digital logic circuits there are only two input and output values (called states), low or high, corresponding to off or on. Most digital logic ICs use a voltage of +5 volts DC for the high state and 0 volts for the low state. We use the low or high voltage to turn off or on a light emitting diode (LED) and let a number of LEDs tell us what the present state is at every IC pin simultaneously. Chip-Clip will close on the small, tightly spaced IC pins without shorting adjacent pins. Equally important, it can be attached to an IC when there is only a quarter of an inch of space between circuit components.

To further illustrate the utility of our Chip-Clip, lets take a look at two types of logic ICs. We have illustrated a 7420, quad input, positive, NAND gate. It actually contains two separate four-input NAND gates, one on each side of the DIP. In either circuit, the output voltage will be high if a low voltage appears on any of the four input pins. When all four input voltages are high, the output voltage goes low. Therefore, to find out why the output is high on either or both NAND outputs, there are eight close-quarter voltage measurements that you must make. Imagine how difficult it would be to keep your meter probe in the right spot without wandering and shorting between pins! We have also diagrammed the 7404 hex inverter logic IC. Here we have not two logic devices but six independent inverting circuits. In operation, if a high voltage appears on the input pin, the output drops to a low voltage. Should the input go low, the output goes high. By taking advantage of the high and low voltage states, we can observe the on or off condition of the LEDs and see the status of all six inverters simultaneously. Here, too, the Clip-Chip will prove an invaluable aid.

Building the Chip-Clip. The foundation of the Chip Clip is the standard 14 pin or 16 pin IC test clip available at any Radio Shack store or from any number of electronic mail order firms. To the IC test clip we add subminiature LEDs and a current limiting resistor between each logic test-clip pin and the IC ground pin. As mentioned previously, when low voltage is present on the IC pin, the LED does not light. When +5 volts appears on the logic input pin, the LED turns on. In addition, Chip-Clip has a different color LED on the Vcc connection (pin 14 or 16) to confirm the presence of Vcc voltage. The contrasting LED color prevents confusing Vcc indication with a logic indication.



Shown is a nearly completed, 16-pin Chip-Clip. The green LED is connected to the Vcc pin, number 16. The contrasting size and color serve as pointers to the correct positioning.

The assembly drawing illustrates the necessary connections for the 14 pin Chip-Clip. If you are building a 16 pin unit, two additional LEDs and resistors are needed for the two extra test points. The IC ground changes to pin 8 and Vcc input changes to pin 16. The additional LEDs are connected to pins 7 and 15. No other changes are necessary.

The ground pin is connected to a common ground wire loop. It consists of two rectangular loops fashioned from 20 gauge solid wire. One of these loops is placed around each edge of the test clip one-half inch down from the top of the plastic. Four 0.028 holes are drilled to anchor the ground bus to the test clip. Since there is one ground bus loop on each half of the test clip, they must be connected together with a short piece of #20 flexible stranded wire to allow free movement of the test clip's sections and enable the test clip to clamp onto the IC DIP pins.

On the 14 pin test clips, six 150 ohm, quarter watt resistors are soldered to the ground bus loop on each side of the test clip and are positioned vertically. The body of the resistors should not stand above the top of Chip-Clip's frame and the resistor leads should be trimmed to the level of the metering pins. The resistor for the Vcc pin is positioned at the same level as the rest of the resistors but instead of being positioned on the side of the test clip, it is placed at the end of the clip next to the Vcc pin.

Finishing Touches Installing the LEDs is only a matter of soldering the cathode LED lead to a resistor and the anode lead to one of the test clip's metering pins. The cathode lead can be identified by its knotch or flat side. Remember, no LED goes to the test clip's pin 7 on a 14 pin Chip-Clip, or pin 8 on a 16 pin one. All oher test clip metering pins have a LED and resistor attached. It should be noted that the specified LEDs have a forward voltage rating of 1.6 volts d.c. and a maximum current rating of 20 mA. For voltages greater than 5 volts at Vcc, a new value of current limiting resistance must be used. (See accompanying box.)

Determining Limiting Resistance

The simplest way to determine the value of current limiting resistance for any value Vcc is by the formula:

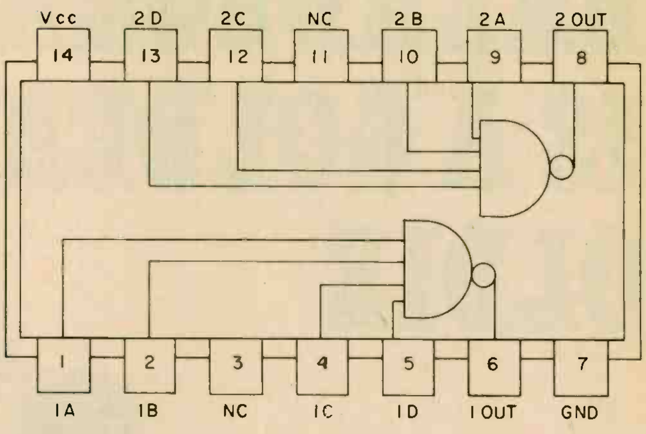
$$R = \frac{Vcc - 1.6}{.020}$$

Vcc = voltage greater than + 5 volts.
1.6 = forward voltage of LED
.020 = maximum LED current
R = the new resistance

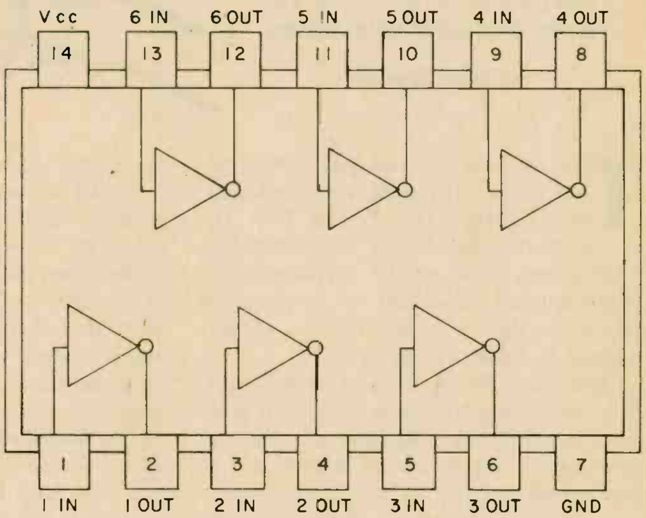
While almost any size LED can be used, the subminiature LED is recommended because of the limited space across the side of the IC test clip. In the author's model, a green emitting LED, jumbo size, was used to indicate the presence of Vcc voltages. The contrasting color prevents mistaking the lit LED as a logic function and serves as a pointer to the correct positioning of the test clip on the IC under test since the Vcc indicator is on pin 14 or 16.

Final Checkout. There are two things to be sure of. Be certain that the LEDs polarities are observed. Also, identify pins 1 and 14 on the 14 pin test clip or 1 and 16 on the 16 pin test clip and always be sure that these numbers always point towards the IC identifying notch, dot, or indenture on the top of the IC case. Final note, while these logic status test clips have been designed only for logic type ICs, it may be possible to employ them for other 14 or 16 pin ICs providing your schematic diagram confirms pins 7 or 8 as ground and pins 14 or 16 as Vcc. If in doubt, *don't use the Chip-Clip.* ■

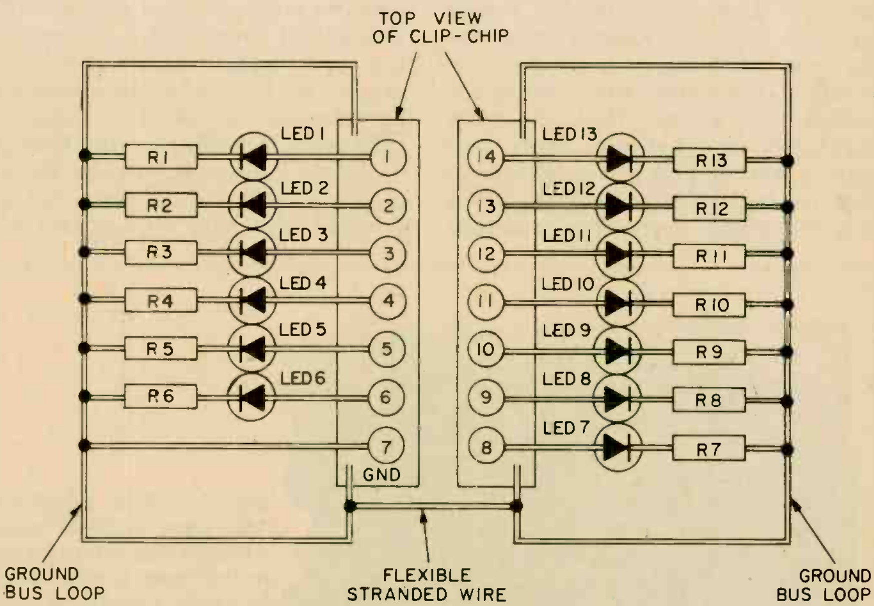
7420 NAND GATE



7404 HEX INVERTER

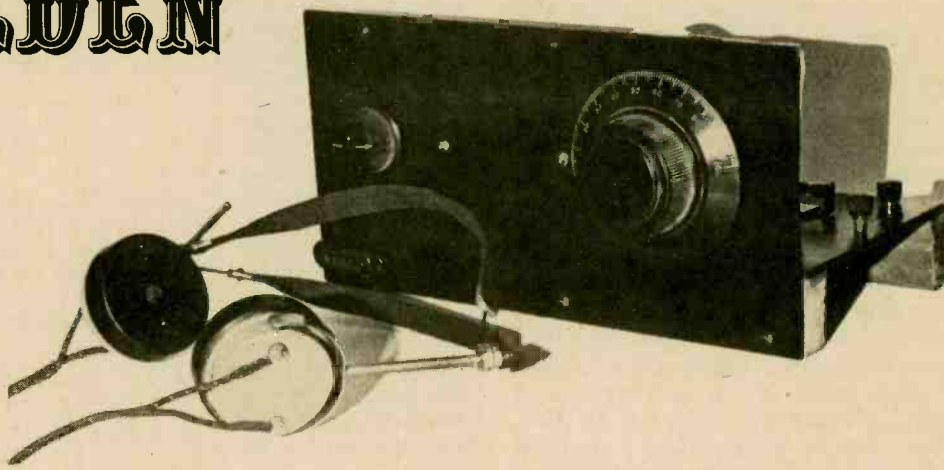


A NAND unit's output is low only if all inputs are high. If any inputs are low, the output must be high. The 7420 is actually two separate NAND logic units housed in the same package and powered from the same source. An inverter's function is to convert a high signal into a low signal, or vice-versa. The 7404 Hex inverter contains six independent units. Like the 7420, the only interfaces are common packages and Vcc inputs.



Composite wiring-component placement drawing for 14 pin Chip-Clip. The LEDs are shown connected to the test clip's metering pins. They are attached to the current limiting resistors which are in turn all fastened to the ground bus loops. The ground bus loops must be firmly anchored to the test clip. Flexible wire connects both loops electrically making them into a common ground wire loop which is wired to pin 7.

BREADBOARD/AMer IS A GOLDEN OLDIE



One-tube authentic depression-days receiver pulls in plenty of stations.

by Newt Smelser

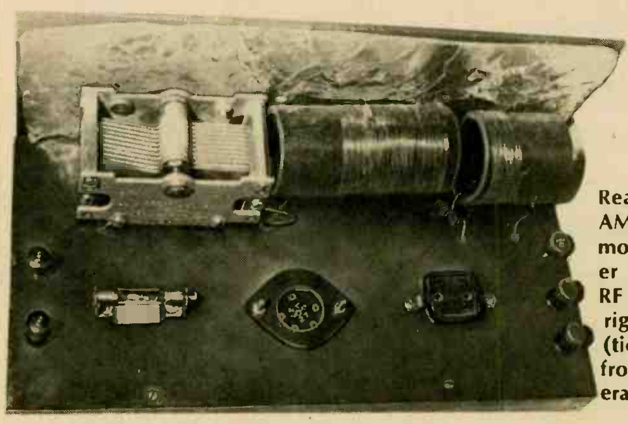
THE GOLDEN AGE OF RADIO was an era plagued by a depression which was followed by World War II. Nevertheless, during those troubled times there was plenty of wonderful entertainment available if one could afford to buy a radio, or was clever enough to *make* a receiver.

The Main Parts. Junked radios had little cash value in those days so it was no trick to beg, borrow, or buy a power transformer out of a used set, a few capacitors (we called 'em condensers) and a "powerful" "Electric Current" No. 27 detector tube. We wound our own coils and winding them was the most intriguing part of the construction. Earphones were usually the hardest part to get. Often it meant mowing a multitude of yards, and moving lots of junk for neighbors to earn the big dollar or so that phones cost. Nonethless many of us managed to get the parts and we also managed to make a radio capable of giving us entertainment far greater than anything going on "downtown." Yes, Amos and Andy, Lum and Abner, T. Texas Tyler, Sam Morris, Captain Midnight, Tom Mix, Jack Armstrong, Joe Louis fights, and Roosevelt's fireside chats—they were all great for us, and we will never hear their like again.

You Can Build One Too. If, like many of us, you're hooked on old-time radio, you can tune in AM stations from all over with the Breadboard/AMer. It's a one-tube broadcast-band receiver which uses an old circuit called the regenerative (or simply "regen") which was popular for some time before the superhetrodyne circuit which is universally used today. The superhet was developed by Edwin Armstrong, who by the way originated this circuit, and also later invented FM radio. It's exactly what boys made during the 30s depression. I rigged this one up a few nights ago, and got stations all over the dial. It is able to drive an old-time high impedance speaker with powerful WWL, New Orleans. For a one-tube set, that is some accomplishment. There are two ways to get into this antique radio project. You can substitute modern parts for those hard to find, or you can make some of the parts and buy the antique parts wherever you can find them.

Looking for Collectors, Parts, or Clubs? If you're interested in receiving a list of newsletters, books and other places you can learn about antique radio collectors and clubs, which is a good place to start looking for old sets and parts, send a stamped addressed envelope to "Antique Fact Sheet, ELEMENTARY ELECTRONICS magazine, 229 Park Ave. South, New York, NY 10003, and we will send it to you free of any charge. The Fact Sheet also includes a list of Public Radio and Wireless Museums.

Occasionally at a Goodwill store you will find a 1930s radio for a few bucks that you could afford to buy to get the transformer and No. 27 tube from. And Salvation Army stores often have old radios in the basement that are beyond fixing, and can be had for nearly nothing. Be sure what you buy has a No. 27 tube. It may be labeled 227 or 327, but those are the same tube. While you are at it, be sure to get a socket to match, because you can't cram this oldie into an octal, loctal, miniature, or compactron socket. It must be an old-style, 5-pin socket. For the young, and also

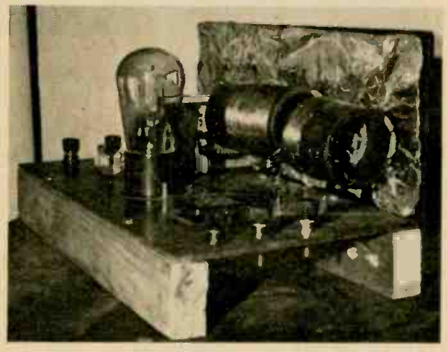


Rear view of the Breadboard AMer shows grid-leak resistor mounted atop capacitor (lower left) next to tube socket, RF bypass capacitor at lower right. Note that right-hand (tickler) coil is rotated from front panel to adjust regeneration (squeal).

oldsters who have forgotten, I have drawn a diagram of how to determine pin numbers on a five pin tube.

If you can't find a 27 tube but happen onto a 37 you can use it off the 110-volt AC line by connecting a 40-watt light bulb in series with it.

The grid leak resistor and capacitor, R1 and C2, may be found on junked old-time radios, or you can use modern counterparts and hide them under the chassis to preserve the antique flavor. Or you can fabricate them. The drawing shows the details. For the grid-leak resistor hide a one-megohm, small-wattage resistor inside a short piece of a clear plastic drinking straw, with black paper surrounding the resistor. Solder the leads to cut pieces of light sheet metal to form ends. The capacitor can be made from four pieces of thin sheet metal, such as tin can metal, two with long projections to bend upward to support the grid leak resistor, and two with shorter projections for the connecting screws. They are separated with pieces



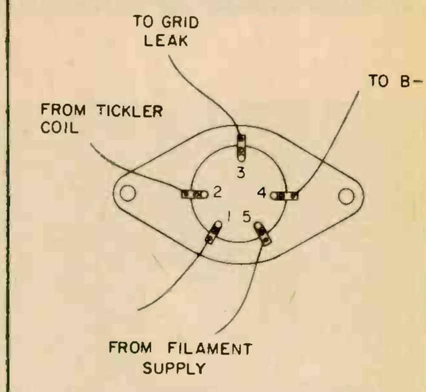
Breadboard AMer with 27 tube in place has tinfoil on rear of front panel to reduce capacitance effect of hand when you tune.

of milk carton material or waxed paper. Screws connect the metal plates of the capacitor to the circuit below the chassis, and the uprights connect the resistor in parallel with the capacitor. Nuts below the chassis connect to wires that lead to pin three of the tube socket on one end and to variable capacitor C1 on the other end. If you decide to use modern components, a one megohm resistor is OK but anything up to four meghohms can be used. A 270 to 470 picofarad (pF) capacitor is fine for C2. Bypass capacitor C3 may also be homemade, like C2. Just add two more plates on the left and two more on the right with appropriate plastic insulation between. You can purchase a 600 pF capacitor for C3 if you prefer. 600 pF is the same as .0006 uF (microfarads).

Making the Coils. The coils are not purchasable items. Use 2-in.-diameter plastic cold water pipe, cutting one 2-in. long for tickler coil L3, and the other piece 3½-in. long for L2 and L1. This plastic pipe can be sawed with a hand saw or hacksaw, and holes in it are easy to make with an icepick or drill. L1 and L2 are close wound, using #20 enameled wire. Smaller wire such as 24 or even 30 may be used with only slight loss of volume. Antenna coil L1 is wound so as to face toward the variable capacitor, with 20 turns, then a tap for ground, and then without a space begin L2 and wind 60 turns. The high end of L2 must be toward the tickler coil, and should end ¼-in. from that end of the plastic. It is imperative that L2 and L3 be close together. L3, the tickler coil, is 25 turns of the same kind of wire on the 2-in. form.

To make the tickler adjustable use a bolt of sufficient length, ¼-in. in diameter so a standard knob will fit on it. Nuts at A and B lock the coil form and hold it secure. Flat washers at C and E, with a short piece of door spring D between them, hold the coil form rigidly in place as it is turned. Washer F allows slippage against the front panel. Nut G secures the whole assembly. It takes considerable adjusting to get it just right.

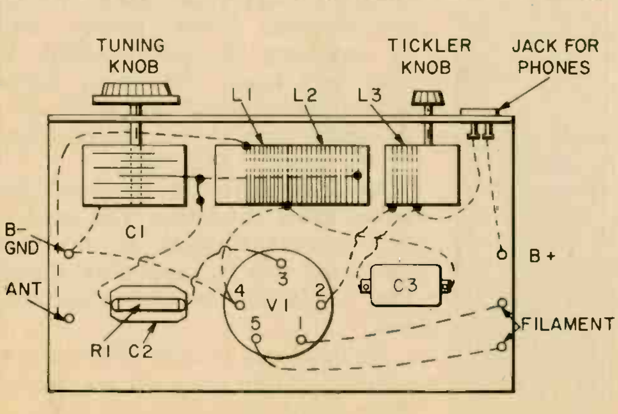
Now mount the longer coil form with L1, L2 on it to be the same distance behind the front panel, and as close to L3 as posssible without touching L3, when L3 is rotated. Bolts, spacers, etc.



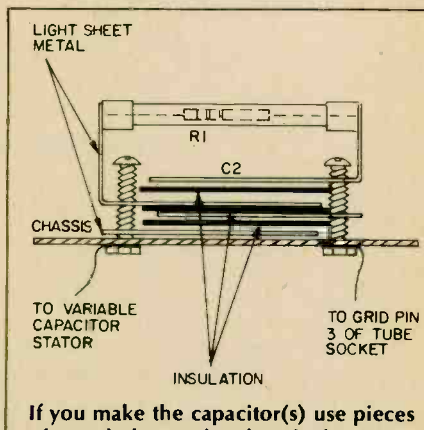
Here are connections for the 27 tube. Examine the tube and you'll see the "plate" is actually a piece of wire mesh.

attach L1 and L2 to the front panel.

Build the Panel and Chassis. Bakelite would be the ideal material for the panels as it was the standard radio building material in the old days. But it's hard to find. A fair substitute is double-tempered Masonite. And even plywood will do. Paint it black to look good. My Breadboard/AMer was built on masonite panels, but you can use almost anything, certainly including a bread board. Dab black enamel with a cloth on the panels, and while it is tacky hold it high over a gas flame, *carefully* so as not to set the house afire. This instant drying will give you a dull, Bakelite-like finish, similar to what we boys used to make the radios with. Shiny bakelite can be faked with enamel, sprayed, then and allowed to dry overnight. The front and chassis panels of my Breadboard/AMer 6-in by 12-in., but this is not critical. The wooden bottom supports are 1-inchers. None of the wiring is critical, except that the tickler and L2 coils must be close together physically. A sheet of aluminum foil directly behind the front panel will prevent tuning

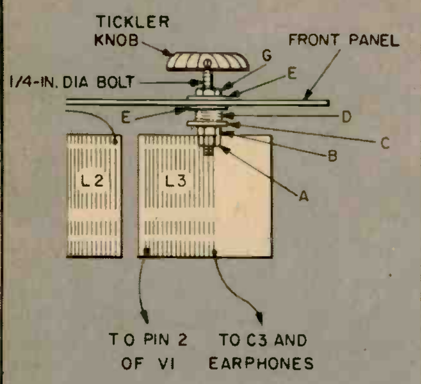


This drawing shows the best arrangement of parts for short connections. Dotted lines indicate the connecting wires underneath the wood chassis.



If you make the capacitor(s) use pieces of metal about 2/3 of an inch square, with insulating material slightly larger.

BREADBOARD



Drawing above shows detail of tickler coil knob and shaft assembly. Follow directions in text for parts A to G.

changes when you touch the knobs. Make sure the coil wires do not rub against this shield.

If you are not fortunate enough to find an old 0-100 dial use a more modern pointer type and paint on a scale. Tuning capacitor C1 need not be an oldtimer. Your standard miniature variable will work as well, it just doesn't look quite right. Many a junked 1930 to 1940 radio has a large variable capacitor in it. Use the larger section of two-section superhet types. It will be the correct, 365 pF size.

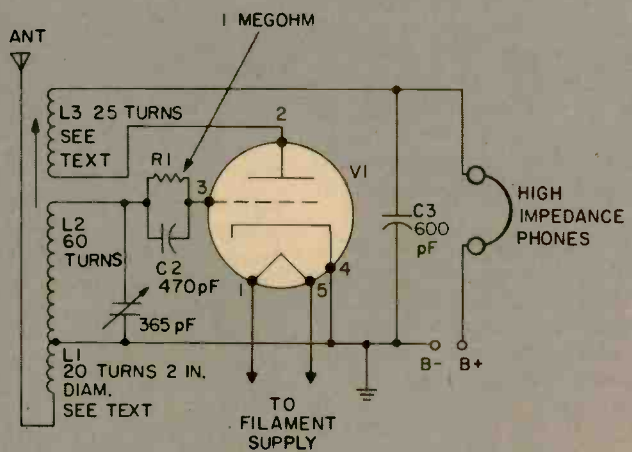
Your Breadboard/AMer can be connected to power supply, antenna, etc. with five-way binding posts, fahnestock clips, or just plain wire. You could operate this set with batteries, using 22½ volts for the B supply and 3 volts for the heaters with a series resistor of about 0.3 ohms in the heater circuit, but since a 27 tube draws 1.75 amps the A battery would soon give up. It's best to find a junked radio of the proper vintage, very early electric, and use its power supply. As an alternate you could construct the power circuit shown. If you wish to use a more modern tube in the set you can construct it with a 6SF5 instead of the 27. Use an octal socket. Pins 7 and 8 are heaters, 3 is the grid, 5 the plate, and 2 is the cathode. A higher plate voltage can be used with this modern tube, and you'd need a modern heater transformer supplying 6.3 volts at 0.3 amps for the 6SF5.

With a 27 tube set the value of R3 can be determined by experimentation. I use a value high enough that 22 to 25 volts of DC are at the plate of the tube. I put the switch only on the power supply and not at the radio, but you can adapt it several ways.

Tuning In Stations. This regenerative radio requires a bit of patience in operation. A good outdoor antenna is essential, up to 100 foot for good DX reception. Unless you use batteries to power it, no ground is needed as the set grounds through the household power supply. Try the plug in the wall both ways for best reception. As you advance the tickler adjustment the Breadboard/AMer will howl in your ear. Learn to get it just shy of the squeal and you will be amazed at its performance. If you don't get much volume or squeals when the tickler is lined up parallel with the tuning coils, you have the leads on the tickler reversed. The side next to the L2 winding must go to the plate of the tube, and the side out to the right must go to the earphones and bypass capacitor. This makes for greatest squeal. Then back off with adjustment of the tickler knob on the front panel until the squeal just disappears. Lower settings will lower the volume to very loud stations. As with any electrical device, practice safety by unpluging the power supply any time you touch live parts. Cutting some turns off of L2 will allow you to get short wave if you prefer, instead of the regular AM band.

Headphones To Use. We have not yet talked about earphones. You must use high impedance phones, not the 8-ohm ones used with hi-fi sets. 2000 ohms is fine, but 4000-ohm phones are better yet.

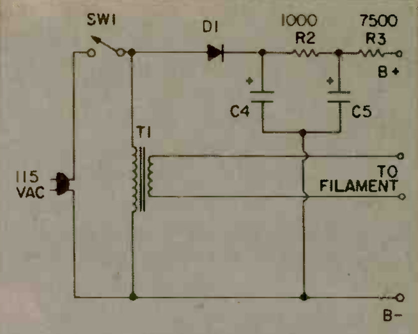
So there you have it. With some ingenuity, and an old parts bin you can make a real Depression Era radio. ■



PARTS LIST FOR BREADBOARD/AMer RECEIVER

C1—365-pF variable tuning capacitor
C2—470 to 500-pF capacitor
C3—500 to 600-pF capacitor
R1—1 to 4-megohm, ½ or ¼-watt resistor
V1—Type 27 triode radio tube (see text for sources)
Misc.—Coil forms—2 in. plastic water pipe; 5-pin tube socket (antique type); high-impedance phones (2,000 to 4,000-ohms); 5 to 6 feet of #20 enameled wire (#20 preferred, but #22 or #24 acceptable); five binding posts or clips for connecting power, antenna, phones; panels (two); 1 in. wood strips for base; nails or wood screws, solder, paint, wire, etc.

Relive the Golden Days of Radio and of MW DXing by building this golden oldie reciever. You can make it look super-authentic following the painting hints given in the text!



PARTS LIST FOR POWER SUPPLY

C4, C5—40-uF, 150 or more VDC electrolytic capacitor
R2—1000-ohm, 2-watt resistor
R3—7500-ohm, 2-watt resistor
T1—115 VAC primary, 2.5 VAC, 3-ampere secondary. (an old radio is a good source)

Power up your Breadboarder with this power supply. You will find this and the receiver to be one fun project.

TELEPHONE TRIGGER

Keep the home fires burning when youre far, far away

by Anthony Caristi

HOW WOULD YOU LIKE to be able to energize any electrical device in your home, from anywhere in the country, and do it without paying for a phone call? You can do it, and it's perfectly legal. The remote control described in this article is a simple digital circuit which responds to the sound of the telephone bell. There is no need to make any hard wire connections to the telephone line, and it is this feature which permits you to build and use this device without any permission from Ma Bell. You can't even be charged any tariff for using it.

The remote control circuit is protected against accidental operation through normal telephone calls by means of an automatic reset feature which cancels out the effects of any telephone calls made by others. This is accomplished by incorporating a time delay circuit which allows the circuit to receive a valid code for a period of ninety seconds. When the ninety second period is completed, the circuit resets itself and waits for the next telephone call.

The proper code to activate the circuit consists of 2 rings of the telephone, a 25 to 40 second delay, and 2 more rings. If, and only if this code is received before the 90 second delay is terminated will the device be activated. Any other combination of rings will not operate the circuit. Since it is very unlikely that anyone would ring your telephone with such a sequence, accidental operation is virtually eliminated. Included in the circuit is a group of LED indicators which monitor the control pulses and indicate the status of the circuit at all times.

How It Works. The best way to understand circuit operation is to refer to the illustration of several pertinent waveshapes in the circuit, and to the schematic. A crystal or ceramic microphone is used as the sensing element which detects the sound of the telephone bell. The output of the microphone is fed to the negative input of a comparator, IC 1. The positive input of the comparator is set to a positive DC voltage by means of a potentiometer which acts as a sensitivity control. This forces the output of IC 1 to +5 volts. During periods of silence there is insufficient output from the microphone to exceed the voltage setting of the sensitivity control, and the output of the comparator remains at 5 volts. When the telephone rings, the increase in sound energy causes the output of the microphone to exceed the setting of the sensitivity control. The output of the comparator oscillates between zero and 5 volts as the bell continues to ring. This is shown in the illustration as waveform A.

The output of IC 1 is fed to the trigger input terminals of IC 2 and IC

TRIGGER

3, pin 2. Each of these IC's is a 555 timer connected to operate as a monostable or one shot multivibrator. IC 2 produces an output pulse of about 3 seconds duration, and IC 3 produces an output pulse of about 90 seconds duration. These output pulses are illustrated as waveforms B and C.

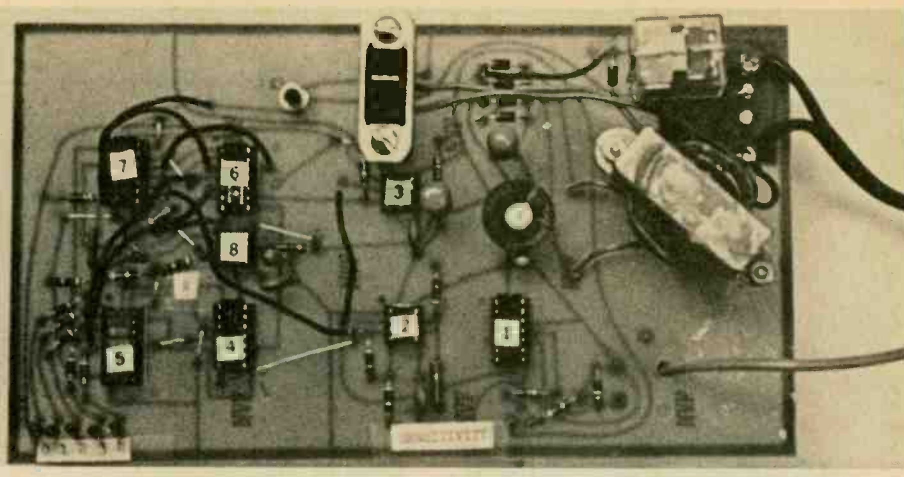
The purpose of IC 2 is to convert the rapidly oscillating output of IC1 to a rectangular pulse of known duration, about 3 seconds. Note that the pulse time of IC 2 is greater than that of one ring, but stops before the start of the next ring. IC 2 provides an accurate waveform which can be counted by IC 4.

The output of IC 2 is inverted by IC 7D, which in turn drives LED "R." This provides a visual indication of the circuit response to the sound of the telephone.

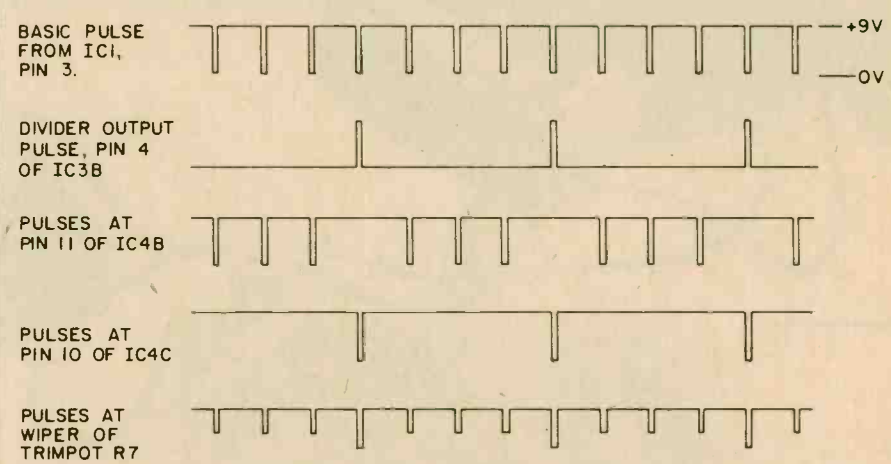
IC 3 is used as the control of the binary counter IC 4. When the circuit is in a standby condition the output of IC 3 is at a logic level of zero. This is fed to IC 4 reset terminals 2 and 3 through NAND gate IC 6C and forces IC 4 to be set to a count of zero. When the first telephone ring is received, the output of IC 3 goes to a logic one state, thus allowing IC 4 to count for a period of 90 seconds.

The output of IC 2 feeds the clock input, pin 14, of IC 4 which clocks on the trailing or falling edge of the pulses. IC 5 is a 4 bit decoder which provides a zero logic level at any one of its output terminals as determined by the binary information fed from IC 4 to its input terminals. The output of IC 5 is used to drive a set of LED's and also to control a 25 second timer, IC 8.

This is a 555 timer chip which operates as a one shot multivibrator in a similar manner as IC 2 and IC 3, except that its period of operation is 25 seconds. The purpose of IC 8 is to provide a 25 second time interval, starting after the second ring, which will cause the circuit to reset itself should a third ring be received before IC 8 resets itself. IC 8 is also retriggered after the fourth ring to prevent the appliance from being turned on if a fifth telephone ring is received. When IC 4 reaches a count of 2, the 25 second time is activated. This is shown in the figure as waveform D. If IC 4 receives a third clock pulse from IC 2 during this interval, it is reset to zero through inverter IC 7A and NAND gates IC 6D and IC 6C. Once IC 8 returns to its normal state after the period of 25 seconds, IC 4 is ready to receive additional clock pulses without being reset to zero.



Here's a close-up of a prototype board for Telephone Trigger. The placement of the major components is the same, though your editors eliminated the jumper wires in the final version. However, this should give you a fairly accurate idea of how the final version will appear. Keep in mind that there will be slight differences from this.



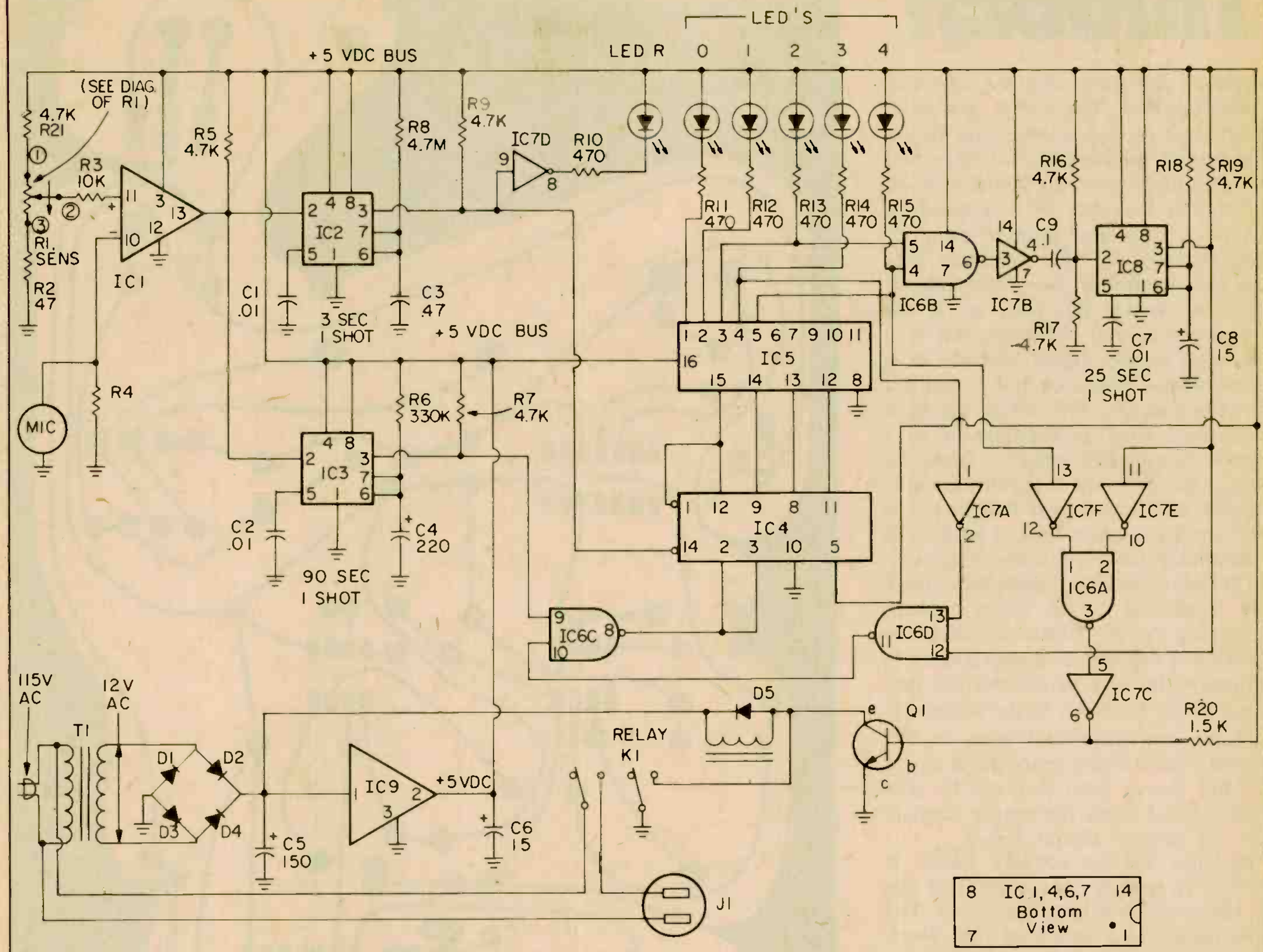
Here's the best way to understand the operation of a circuit such as Telephone Trigger, by studying these waveshapes in conjunction with the schematic and the lucid explanation presented in the text. Read the explanation over a few times, referring to the diagram and schematic as you do. Soon you'll be a logic-circuit, solid-state "maven."

When IC 4 reaches a count of 4, the 25 second timer is reactivated as shown in waveform D. The output of IC 5, pin 5, is prevented from reaching Q1 base until the 25 second period is over. Should IC 4 receive any more input pulses Q1 would not be activated at the end of the 25 second period, since the counter would then be at a count of 5 or more.

The outputs of IC 5 are shown in figure one as waveforms E. When IC 5 is fed a binary number from 0 to 9, the corresponding output terminal assumes a logic level of zero. All other output terminals remain at a logic level of one. By connecting LED's to outputs 0, 1, 2, 3, and 4, (pins 1, 2, 3, 4, and 5) the status of binary counter IC 5 is visually indicated.

The coil of a 12 volt relay is connected in the collector circuit of Q1 so that it is activated whenever Q1 conducts current in response to the zero logic level of IC 5, pin 5. Since the output of IC 5 is not permanent, one section of the relay contacts is connected to the coil circuit so that the relay latches and remains activated even though IC 4 is reset to zero at the end of the 90 second pulse time of IC 3. The other set of contacts of the relay is used as a single pole switch.

Power to operate the circuit is obtained through a 12 volt transformer feeding a full wave bridge rectifier. The output of the rectifier is fed to IC 9 which is a fixed 5 volt regulator. The entire circuit, with the exception of the relay is returned to the unregulated



The schematic diagram for Trigger, the automatic telephone relay tripping circuit. As you see, there are plenty of components in the circuit, so exercise a reasonable amount of care as you assemble them and build this exciting project.

PARTS LIST FOR TELEPHONE TRIGGER

C1, C2, C7—0.01-uF, 15-VDC mylar capacitor
C3—0.47-uF, 15-VDC mylar capacitor
C4—220-uF, 10-VDC tantalum electrolytic capacitor
C5—150-uF, 15-VDC electrolytic capacitor
C6, C8—15-uF, 15-VDC tantalum electrolytic capacitor
C9—0.1-uF, 15-VDC mylar capacitor

D1-D5—1N2069 silicon diode
IC1—LM339 quad comparator
IC2, IC3, IC8—555 timer
IC4—SN7493N binary counter
IC5—SN7442N BCD-to-decimal decoder
IC6—SN7400N quad NAND gate
IC7—SN7404N hex inverter
IC9—LM309H voltage regulator
K1—SPDT relay w/12-VDC coil
LED0-4, LED R—general purpose LED
MIC—crystal microphone element
Q1—2N3904 NPN general purpose transistor
R1—5,000-ohm, linear tape potentiometer, PC type
R2—47-ohm, ½-watt resistor
R3—10,000-ohm, ½-watt resistor
R4—100,000-ohm, ½-watt resistor
R5, R6, R9, R16, R17, R19, R21—4,700-ohm, ½-watt resistor
R6—330,000-ohm, ½-watt resistor
R8—4,700,000-ohm, ½-watt resistor
R10, R15—470-ohm, ½-watt resistor
R18—1,000,000-ohm, ½-watt resistor
R20—1500-ohm, ½-watt resistor
T1—115-to-12-VAC transformer @ 300 mA.

Misc.—Line cord, AC socket, IC and transistor sockets, Hardware, Wire and Solder. (Allied Electronics' address is: 401 East 8th St., Ft. Worth, Texas 76102)

TRIGGER

output of the bridge rectifier, 12 volts.

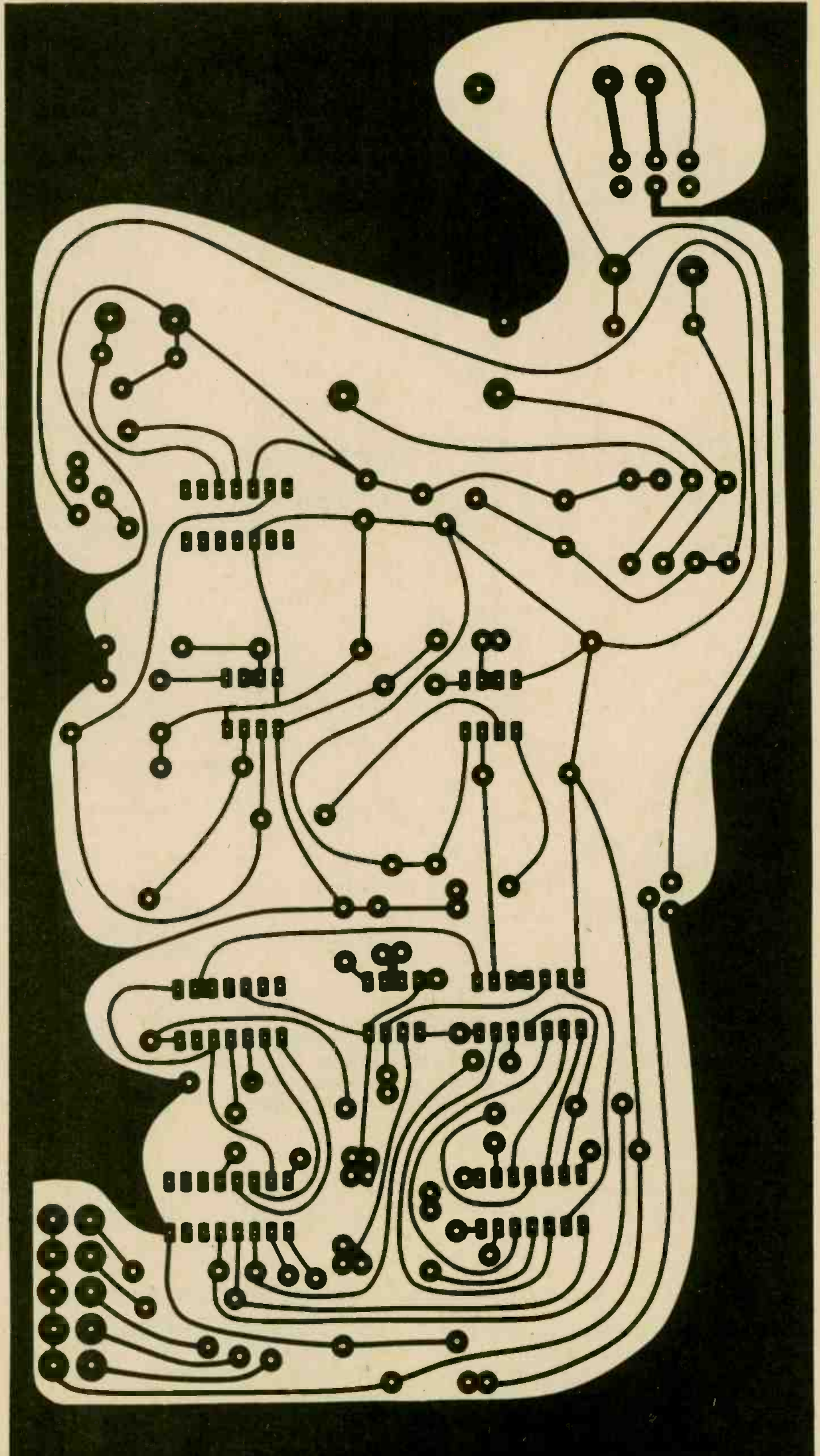
Construction. The entire circuit is constructed on a printed circuit board. The crystal microphone cartridge was mounted directly on the board with adhesive, but also may be connected by means of a shielded wire to some remote location by the telephone bell. The foil pattern of the printed circuit board is shown full size, as is the component layout. Although this is a relatively simple digital circuit, it is recommended that sockets be used for the IC's and Q1. The initial checkout of the circuit will be simplified if IC 3 can be temporarily removed from the circuit. In the event that the unit ever requires service you will find that it is well worth the added cost of sockets. It is extremely difficult to remove a multipin IC which has been soldered directly into a printed circuit board without destroying the IC. When mounting the electrolytic capacitors, diodes and LED indicators, be sure to observe the correct polarity as shown in the schematic.

Mount and solder all parts to the printed circuit board as shown in figure 3. After this is done you will be able to locate and insert the proper jumpers into the printed circuit board.

Be sure to use a relay which is capable of carrying the current of the appliance which is to be turned on. The parts list shows a choice of two relays. Part number 275-206 has a current rating of 10 amperes. You will have to use the higher current relay if you plan to operate a high current appliance such as an air conditioner or coffeemaker. If the remote control is to be used to operate a heating system, relay contacts can be connected into the thermostat circuit. Such a connection permits the use of the lighter duty relay. The relay coil driver transistor, Q1, can safely carry up to 150 milliamperes to drive the relay coil.

A receptacle for plug-in appliances is mounted on the circuit board and is wired directly to the line cord and relay as shown in the schematic. Be sure to use a line cord and wire which will safely carry the desired current. For 10 ampere operation use at least a #16 gauge wire.

Testing And Adjusting. Checks are made with only the built-in LED indicators and a DC voltmeter. The first check is on the timing of IC 2. It will be helpful if you temporarily remove IC 3 from the circuit to prevent it from



Here's an exact-size PC board layout to make your own Telephone Trigger. If this is your first time etching out a complex board, avail yourself of some of the excellent layout aids which are available at many large electronic supply houses. You might also investigate some of the photographic kits used to make boards by copying images such as this right off the magazine page, a definite help to those of us who have trouble drawing a straight line with a ruler. One thing, you will find that in a project such as this one doing your own PC board is an additional part of the enjoyment.

resetting the counter while you perform the first part of the check.

Apply power to the unit and measure the voltage at pin 1 and pin 2 of IC 9. The voltage at pin 1 should be about 12 volts and the voltage at pin 2 should be 5± 0.25 volts, measured with respect to ground. Set the sensitivity control about ¾ maximum clockwise. Gently tap the microphone while watching LED R. It should light when the microphone is tapped, and remain lit for about 3 seconds. Each time the microphone is tapped LED R should light for at least 2 seconds and not more than 4 seconds. It is important that the timing of IC 2 falls into this range so that it will be able to sense each telephone ring separately. You may change the value of R 8, if necessary, to bring the timing of IC 2 within the range of 2 to 4 seconds.

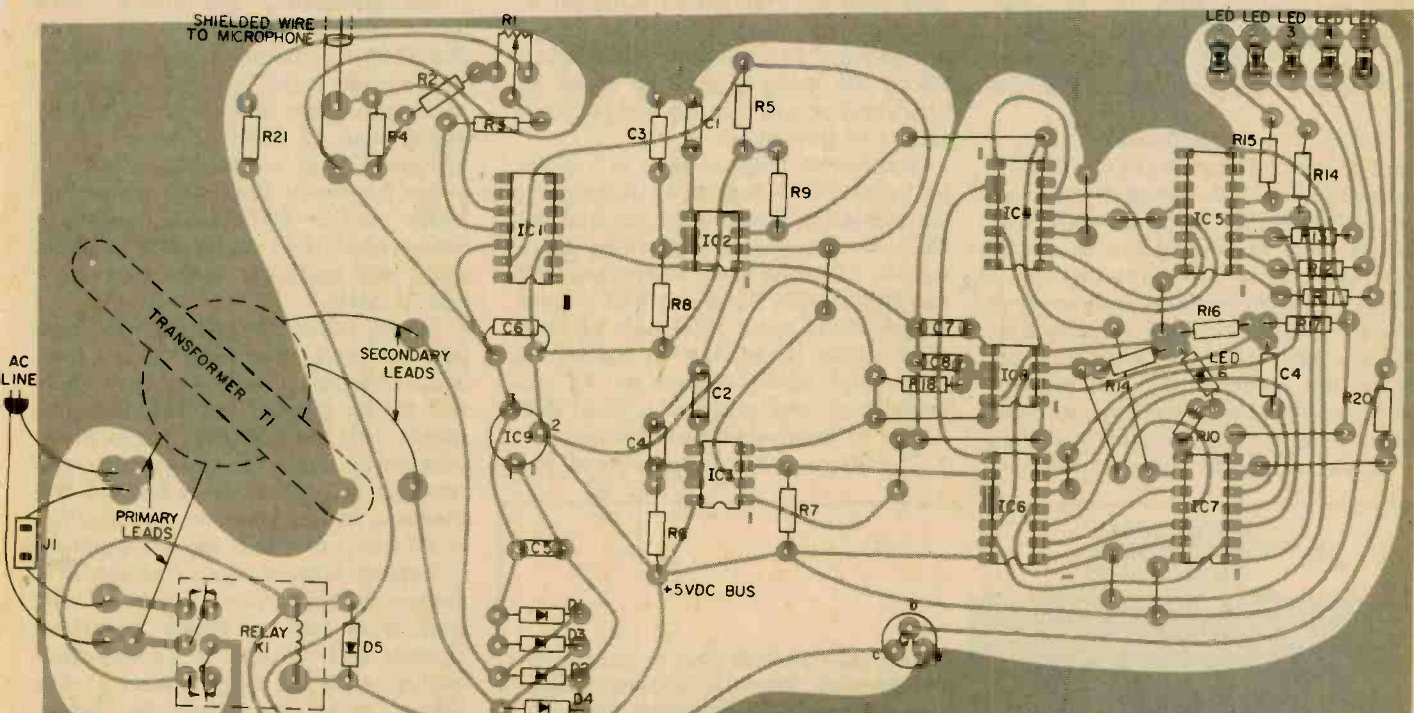
To check the operation of IC 4 and IC 5 momentarily short pin 9 of IC 6 to ground to clear the counter and set it to zero. LED 0 should be lit. Gently tap the microphone and wait for LED R to be extinguished. When this occurs, LED 1 should light, indicating that the counter has advanced one count. Connect a voltmeter to pin 3 of IC 8. Tap the microphone while watching the voltmeter. At the end of the 3 seconds the counter should advance to a count of 2, and the voltage at pin 3 of IC 8 should rise from zero to about 5 volts. This voltage should hold for at least 25 and not more than 30 seconds. You may adjust R 18 to bring the timing of IC 8 into this range, if necessary.

You may check the operation of the reset circuitry by tapping the microphone three times to simulate three telephone rings without the required 25 second delay. When this is done the counter should not advance to a count of 3, but should reset to zero after a count of 2.

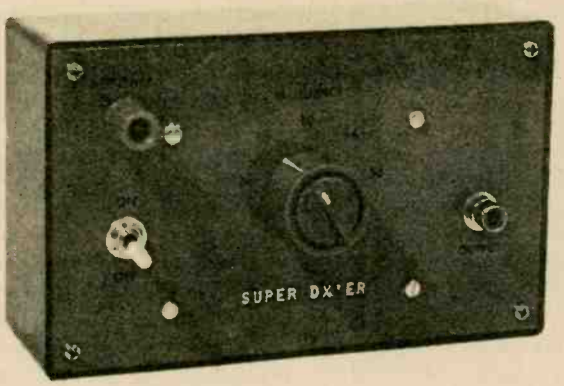
Replace IC 3 in its socket. Check the timing of IC 3 by connecting a voltmeter to pin 3. The voltage should be zero before the circuit is triggered by tapping the microphone, and should rise to about 5 volts and hold for at least 80 and not more than 95 seconds. You may adjust R6, if necessary, to bring the timing into this range. The operation of IC 3 may be visually checked by advancing the counter to a count of 1 and watching the LED indicators. After IC 3 completes its 90 second time, the counter should be reset to zero.

The final adjustment is the sensitivity control. If possible have a friend call you up and let the telephone ring for about a minute. Locate the remote control microphone as close to the telephone bell as possible. Set the sensitivity control the maximum counterclockwise (least sensitivity) position. Slowly turn the sensitivity control while watching LED R, and leave it set to the least sensitive position which gives a reliable detection of the sound. It is best to avoid excessive sensitivity so that the circuit does not respond to random noises in the house.

The remote control is now ready to be placed in operation by connecting the appliance to the receptacle on the circuit board and turning its power switch on. Once the hookup is made the appliance will automatically be turned on when you call your own telephone number with the the proper code. The 25 second delay time between the 2nd and 3rd rings is not critical, but should not be less than 25 seconds and not more than 40 seconds. The circuit will operate properly if you happen to get a partial ring when you call, but if there is any doubt that the phone has rung it is best to hang up, wait 2 minutes, and try again. Also, since it is possible that you may call during a time that the circuit is in an activated state due to any calls made by others, it would be good practice to ring the code two times, spaced several minutes apart. ■



Following this full-size component layout will help to make construction of your Telephone Trigger as simple as dialing a phone. Make certain to observe the polarity of diodes and LEDs; the LEDs will have a notch on the negative lead to help you distinguish which is which. Some of the foil runs are close together so, if this is one of your first projects, or even if you're a seasoned construction veteran, check after building for any solder bridges. If you find one repair it carefully with a sharp knife blade.



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 receiever has two antenna terminals, one "hot" and one ground, you can use the SUPER DXER.

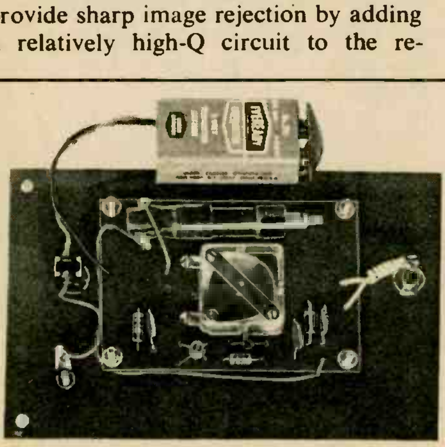
Optimum performance will be obtained if your receiver is equipped with an antenna trimmer. Just as the antenna trimmer peaks the receiver for use with any type of antenna, it also adds something extra when matching the SUPER DXER.

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."

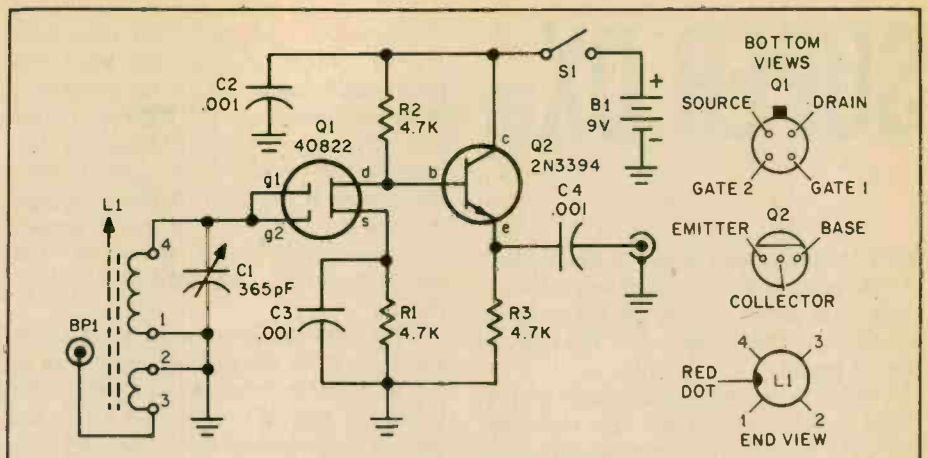
Continue. Drill out all the mounting holes marked by an indent with a #57, 58, or 59 bit—this includes the corner mounting and C1 mounting holes. Then drill the corner mounting holes for a #6 screw, and use a 5/16-in. bit for the C1 mounting hole.

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.

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.

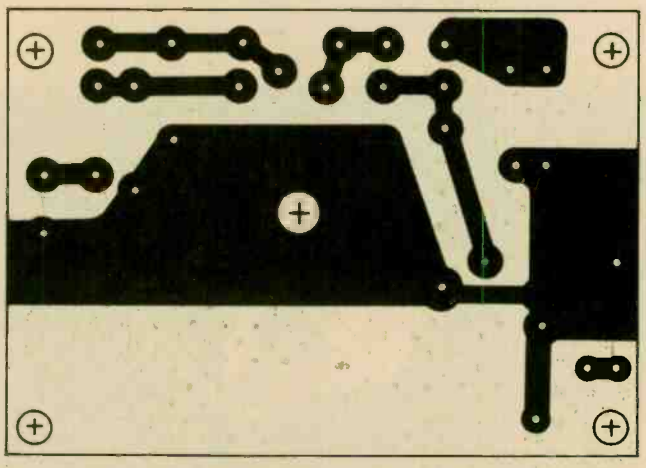
The SUPER DXER is mounted in a standard plastic or Bakelite case approximately 6⅜-in. x 3 3/16 -in. x 1⅞-



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 $5.10. US orders add $2.00 for postage and handling: Canadian orders add $3.50. No foreign orders, please. Postal money orders will speed delivery; otherwise allow 6-8 weeks for delivery.



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.

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.

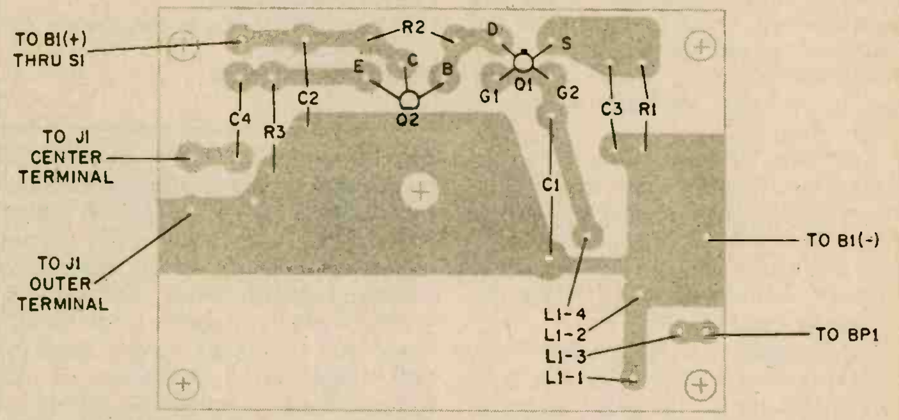
Alignment. Prepare a length of 50 or 52-ohm coaxial cable (such as RG-58) that will reach from the SUPER DXER's output jack to the receiver antenna input terminals. Solder a standard phono plug to one end. Take care that you do not use ordinary shielded cable such as used to interconnect hi-fi equipment;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

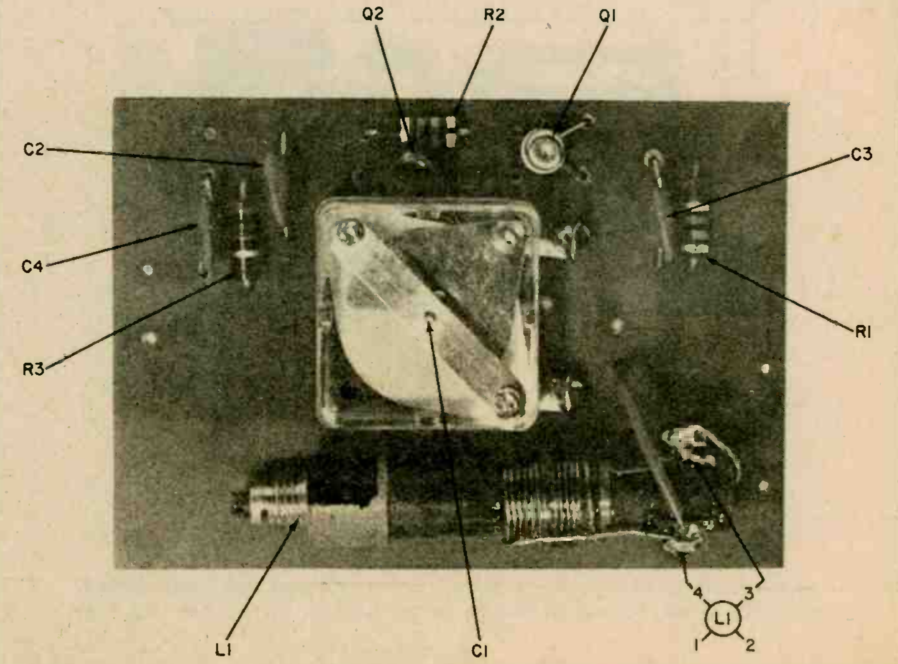
Turn on the receiver and booster, and set the receiver tuning to 5 MHz, or whatever frequency you selected for the "bottom end." Adjust C1 for maximum received signal or noise and mark the panel accordingly. Repeat the procedure at approximately 7, 10, 14, and 15 (or 20) HMz. The panel markings are important 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.



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CB BATTERY CHARGER SAVES SSS

Low-cost project charges inexpensive nickel-cadmium cells to keep you on the air for pennies an hour.

by Herb Friedman W2ZLF

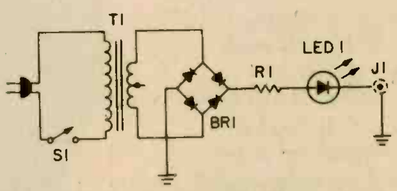
☐ If you're a typical user of one of those high-power hand-held CB walkie talkies rated between 3- and 5-watts input, you know that batteries don't come cheap. And if the cost of the batteries doesn't get you, their leakage will. Leave the power switch on overnight by accident and it's a good bet by next morning the hand-held set will be dripping battery *gook*.

But there is a way to beat the problems of high battery upkeep and leakage, and also to insure maximum RF output at the same time. The answer? Switch to nickel-cadmium (NiCad) penlight batteries (AA size). Are they expensive? Not any more. A NiCad should cost about the price of two alkaline batteries, or even less, and the NiCad can be recharged hundreds, possibly a thousand times. If you use a hand-held transceiver you'll break even on the second or third recharge.

Hold on, don't go running to the parts catalog to look up the price of NiCads, you probably can't afford them at catalog prices. What you need is a surplus dealer. You see, today everyone is in a hurry and most people can't wait the usual overnight period to recharge NiCads—they demand a *fast*-charge battery. So hundreds of thousands of the overnight (or *trickle* charge) NiCads were dumped on the surplus market, and you can buy them for as little as a buck a piece, no higher than $1.50. And you get a tremendous advantage with the trickle-charge NiCads: they hold their charge much longer than the fast-charge type. Charge 'em up, stash the transceiver in the closet, or the trunk of your car, and a week or two later they will deliver almost full power. Fast charge NiCads can't hold a charge that long.

You Can Refrigerate 'Em. Speaking of car trunks, if you leave a hand-held CB set in the trunk and the temperature plunges down near freezing ordinary penlight batteries aren't going to deliver much operating time. But NiCads will still be going like gangbusters in cold weather long after standard batteries are too pooped to pop.

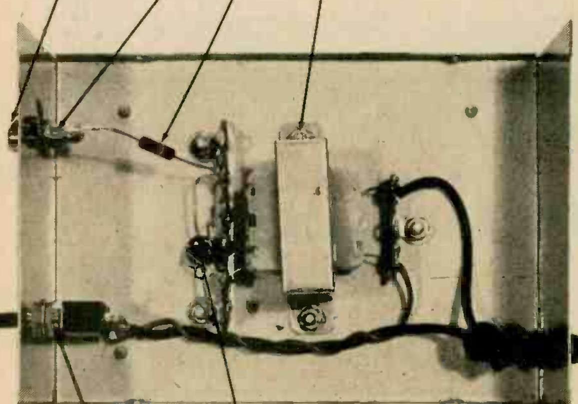
Can your hand-held use NiCads? Simply look inside to tell. If your hand-held uses penlight (AA) size batteries there is probably room for twelve cells though only ten are used; a filler takes up the space of two cells. Since the standard battery delivers voltage of 1.5,



This simple circuit will allow you to take advantage of recharging your batteries and saving a bundle of cash. Using surplus parts also keeps costs low.

PARTS LIST FOR CB-BATTERY CHARGER

- R1—220-ohm, ½-watt resistor
- T1—24-28-VAC power transformer rated 100 mA.
- BR1—Bridge rectifier, 50 PIV, 100 mA.
- LED1—50 mA.
- J1—Phono jack
- PL1—Phono plug (see J1, above)
- PL2—Plug to match transceiver power input receptacle
- S1—Switch, SPST
- Misc.—Cabinet, terminal strips, wire, solder, etc.

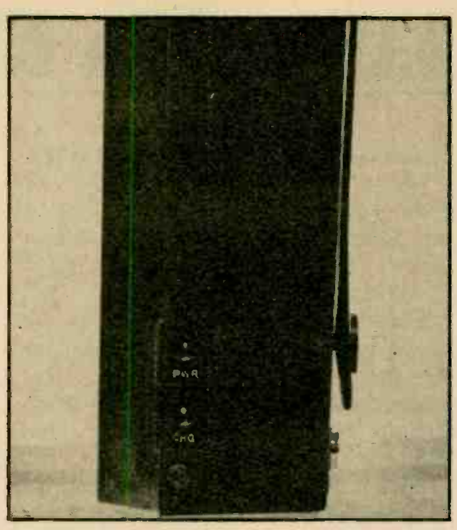


Inside view of author's prototype charger. Parts layout is uncritical. Using terminal strip lugs as shown makes things secure. Bridge rectifier can be made up from four junk box diodes.

ten batteries equals a fresh power pack of 15 VDC. But NiCads only deliver 1.2 volts, so twelve batteries are required to produce 15 VDC. The two "extra" NiCads fit in place of the filler. So in order to use NiCads your set must provide room for twelve, rather than ten cells. There must also be a jack on the side of the transceiver to which a charger can be connected. If you have both these conditions (space for twelve cells, and a charger jack) you can use NiCads. The only exception to this rule is a few models which cannot accept NiCads because some NiCads are very slightly longer than a standard penlight AA battery, or the CB set manufacturer did not allow for the extra size even though he provided a charger connection. Make certain your hand-held set will accept NiCads before you buy them.

Really Low-Cost. Finally, you need a NiCad charger, and that's where you can spend real money, but really! One of the top instrument companies charges $30 for a NiCad charger you can build for less than $8. They get this exorbitant price because they manufacture one of the very few chargers that can handle all twelve batteries at the same time. Most chargers handle only four to eight cells at a time, taking two to three days to recharge a complete set of NiCads. If you can recharge all twelve cells at once you plug it in in the evening, and you're ready to go the following morning.

The diagram shows a simple but effective charger circuit that will handle up to twelve cells simultaneously. It needs no regulation or control because it trickle-charges *any* type of NiCad. You can even leave it plugged in continuously without fear of damage to the cells, thereby insuring the NiCads are always in a state of full charge. The charging current is 40 to 50mA regardless of the number of cells (in case some become defective), or their state



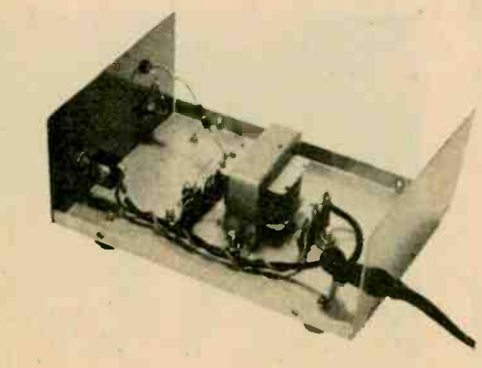
Side view of author's CB transceiver shows two inputs, one for charging internally-contained Nicad batteries.

of discharge. From full-discharged to fully-charged the charging current is always a safe 40 to 50mA.

Use These Parts. Excepting the cabinet, if you select surplus components the whole thing will cost less than $8. If you buy all new, you'll run up unnecessary expense, which have no effect bearing on the performance.

Transformer T1 is 24-to-28 VDC at no less than 100 mA. It doesn't have to be more than 100 mA. Don't waste your money on a high current filament transformer. If you use a 28-volt transformer increase R1's value to 270 ohms. BR1 is a 50 PIV bridge rectifier rated 100 mA or better. Use the least expensive type you can get. If you have four discrete silicon diodes lying about simply connect them as the bridge circuit.

LED 1 serves as both a pilot light and *Charge* indicator. If the LED doesn't light the batteries aren't being charged. The LED also serves as a fuse. If the rectifier and R1 short out the NiCads will attempt to discharge through the diodes and the



Completed charger chassis shows neat layout of parts. Note knot in AC power cord just to the left (inside) of the rubber pass-through grommet in the chassis. Knot prevents power cord from pulling through grommet accidentally.

high discharge current could cause considerable damage. But the LED will burn up almost instantly, thereby opening the circuit to the batteries.

The LED is the only critical component, in the sense you must be certain it is rated for a *maximum* of at least 50 mA. We suggest a diffused LED be used as its light can be seen from the sides. These are usually not too hard to obtain.

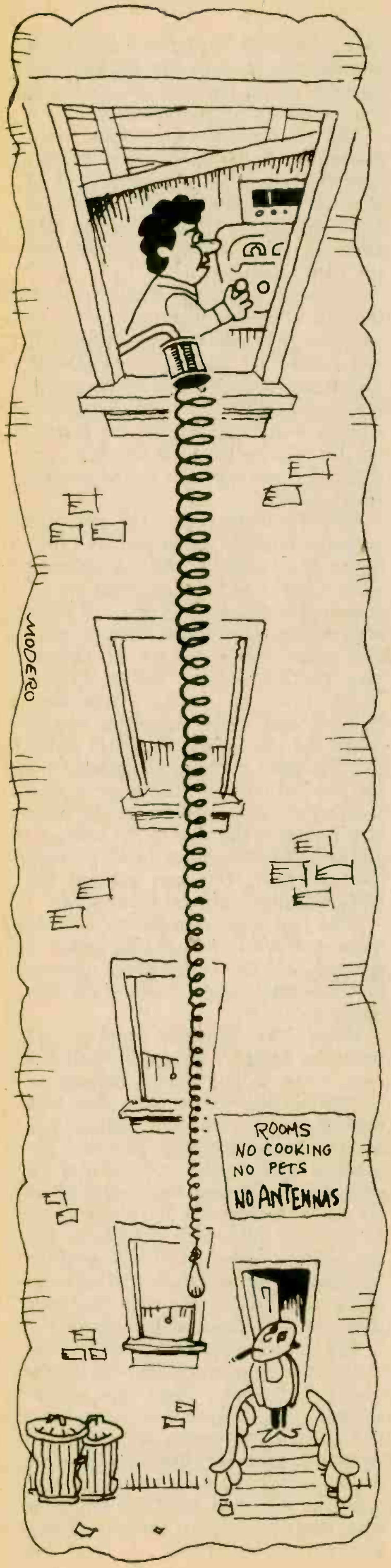
To mount the LED simply push it through a hole in the front panel of whatever you use for the cabinet. If you connect R1 between the LED and a terminal strip as shown in the photographs the LED will be held in position without need for glue or a lamp mounting kit. The cabinet can be plastic or metal; the one shown is a store-bought metal cabinet.

How To Connect It. The charger's output is through phono jack J1 rather than a direct cable. In this way different patch cords can be connected to accommodate the several styles of plugs required for transceivers charging jacks. Just make certain you get the charger plug polarity correct. Before PL2 is wired, insert it in the transceiver's charging jack and measure the voltage across the jack noting the plug's polarity. Normally the shield is ground (–) and the tip (center conductor) is positive, but it can sometimes be the other way round. Make certain the charger's positive output connects to PL2's positive terminal. You can damage the NiCads badly if you get it reversed.

Note that most transceivers are disconnected when the charger plug is inserted, so don't expect to operate the transceiver while charging the batteries.

Using The Charger. Resistor R1 limits the charger's output to 40-50 mA even if the output jack is shorted, so the charger can be used with hand-held transceivers that use ten, rather than the usual twelve NiCad batteries. Regardless of the number of batteries the charging current remains a safe 40 to 50 mA. Normally 14 to 16 hours will be required for a full charge, so this can be done overnight. If you want the batteries maintained fully charged and ready for use at any time you can keep them on continuous-trickle charge.

The only caution is not to try and charge two or more hand-helds at the same time. Don't make up a "Y" adaptor that connects two or more hand-held battery packs in parallel because one pack will discharge into the other, and if there is a weak cell in one pack the other pack will discharge with excessive output current. Charge only one set at a time. ■



DX with BOINGER

IF YOU'RE an apartment-dwelling DXer, you've no doubt had your share of the age-old antenna hassle. Sad to say, few landlords sympathize with a shortwave listener's need for a good skyhook.

For those of you whose nerves are just about shot from the continual carping about your antenna (". . . that confounded wire of yours was crudding-up Kung Fu last night!"), the "Boinger" will bring fast relief.

What's The Boinger. Simply put, it's an inconspicuous *canned* antenna that'll sit on your windowsill, drawing about as much attention as yesterday's newspaper. Fact is, people just don't notice this little marvel. That's the beauty of it! But at the push of a button, this DX-dangler literally springs into action for you, as it accordions out to a fully-expanded shortwave longwire antenna. "Boinger" will be music to your ears. That's the sound made by the key to this antenna, a super-long spring. And as it unravels, it'll also unravel your aerial problems. And when you're ready to call it quits for an evening, just a few turns of the crank retracts the Boinger back into the hardly-noticeable case, ready for another day. It's been suggested we call this unit the "Candestine" (clandestine can antenna), since it does incorporate a bit of the old cloak-and-dagger. Call it what you may, it works in even the most impossible antenna conditions.

How It Works. Our Boinger is essentially an end-fed helically-wound longwire. The only big difference between it and the longwire most SWLs use is that it is vertically-oriented.

How do you find helically-wound wire? Believe it or not, the first place to check is in Junior's toy-box! Or, head for the local five-and-ten and ask for "the spring that walks down stairs by itself." Right—a "Slinky!"

Since the coil is vertical, gravity will help pull it down for you. Rigging it to a fishing reel will take care of pulling it back up again. You don't have to be 20 stories up to take advantage of this antenna since the helical winding allows you to pack tremendous wire length into a short distance.

How To Build It. You'll need the following items, all of which shouldn't run more than $6 to $10:

Slinky. Actually it's a highly stretchable coil which folds down to only a few inches, but can stretch clear across the street.

Tin can to house the spring, about four-inches in diameter by five-inches deep. A salted peanut tin is perfect.

Some odds and ends from your fishing gear—a handful of lead weights, and a fishing reel with heavy-duty line. Now don't panic, the cheapest reel available will do. We've seen, and *used* in our own Boinger, a plastic reel that goes

If you decide to solder the leadin wire to Slinky, use an X-rated iron—something that really gets hot. Slinky can draw away lots of heat before the solder flows.

Canning Slinky after it is fixed to a wood insulating block. Here author is checking clearance of block and Slinky from can's inside.

Here's how you can lick the no-antenna-on-the-roof edict landlords use to torture SWLers—by Ralph W. Perry

for about $3.

½-in. conduit pipe cut to the length you need. Aluminum electrical conduit is easy to bend, and you'll need a screw-end adaptor to secure it to the can. If you use iron pipe, it can be threaded at the can end, but it's hard to bend. However, elbow pieces are available. Look at ½-in. copper tubing. It's easy to work with and can be soldered to the tin can.

Miscellaneous hardware: clamps, screws, and a piece of ½-inch-thick wood to fit in the can.

Construction. Solder an insulated leadin wire to the top end of the Slinky coil—or secure it with a machine screw. Any way you do it is okay so long as it's mechanically secure. Be sure not to let the antenna leadin wire contact the can or the conduit.

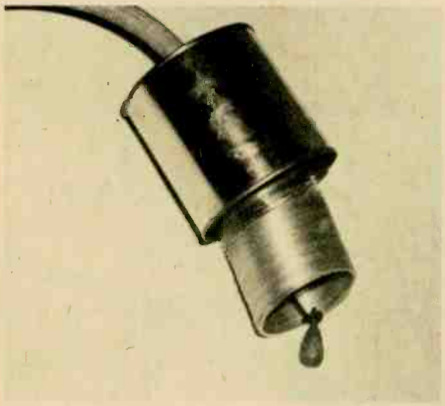
The conduit pipe serves double-duty in the Boinger. It is both the support for the unit and the feeder channel for the fishing line that controls the antenna's ups-and-downs. Bend the pipe into a flattened-out Z, with the center strut at right angles to the ends. Then, lay the pipe down flat and bend one end so it points straight up.

Put the wood-coil assembly into the can, and drill a hole through both, big enough for the pipe to fit through. Slip the end of the pipe (the end you made the last bend in) through the hole in the top of the can and through the wood, clamping both below and above with epoxy glue or threaded pipe and nut so it is solidly joined. Slip the wire through a hole in the can top, and tape it along the length of the pipe. It's a good idea to liberally apply putty or silicone sealer to the can top to seal the cracks—the Boinger will withstand some pretty rough weather.

Now, thread the fishing line into the far end of the pipe and pull it through the coil. Make a cross-hatch with two wires across the *bottom* loop of the Slinky (opposite end from the solder), and tie the fishing line, along with a few weights, here.

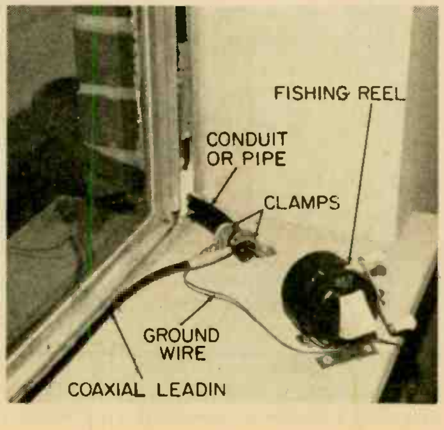
Mount the fishing reel on your inside window sill, and bolt the pipe to the outside wall. Depending upon the type of window, you may have to cut a small piece of glass out of the corner to feed the pipe through. We found that closing the window on the pipe and then trimming a wooden "stopper" to size for the crack is one good way.

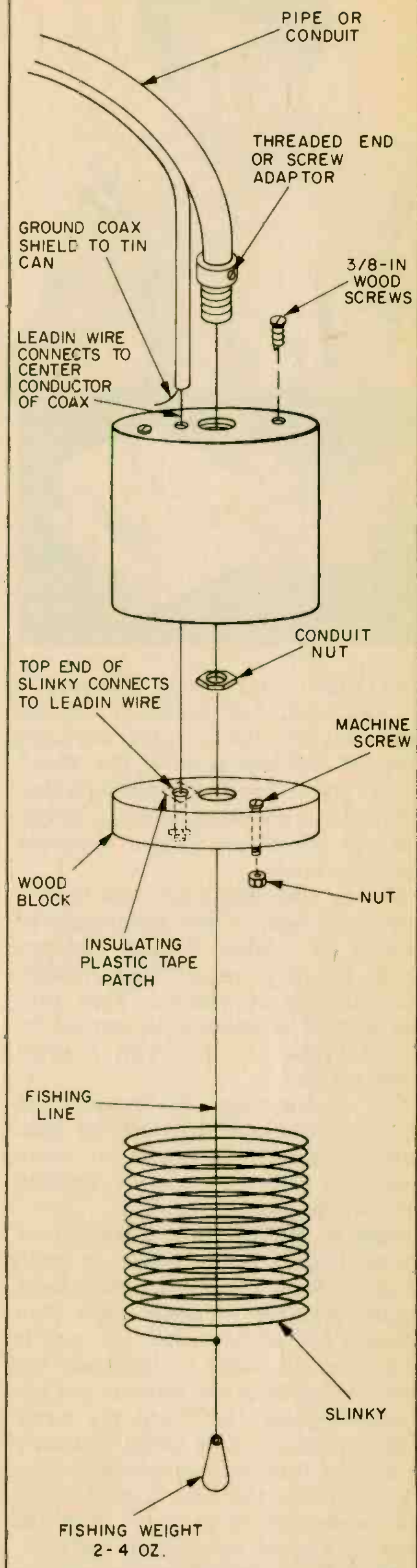
Attach the leadin wire to your receiver and let out some line on the reel. *Boing!* Gravity and the weights will stretch out your mini-antenna as far as you need. When you're finished, the coil will reel up and fit neatly in the can. Paint it a dull black, draw as little attention as possible when you install it and, believe it or not, you'll be surprised when nobody notices all the trouble you've gone to! ■



Boinger is finished and ready for installation. Outside world look out! A coat of black paint will keep down reflections and neighbor's questions. Keep in mind the SWLer's code, "Out of sight, out of mind!"

The finished setup may look a bit weird to the SWL's XYL, but that is the price she must pay to keep the OM at home evenings. Heavy wire running left and down is a shielded coax cable used as the leadin, and thinner wire running left is ground lead.





We blew up Boinger so you could put it together. Electrical connection of Slinky to antenna leadin wire should be insulated from tin can and pipe or conduit.

the MOVING COIL

Build our accurate model of a moving coil meter ar

LEARNING ELECTRONIC THEORY is dull, dull, dull. Right? Not necessarily. In some cases you can learn a lot and still have a lot of fun. How? Leave your theory textbook behind and build a current-measuring gadget that will allow you to see electronic theory in action.

Moving coil meters are used universally in all types of test instruments to measure DC current because they are highly sensitive, rugged and reliable, and relatively inexpensive. They may also be used to measure AC current by first rectifying the AC with a small meter rectifier.

Our project uses the moving coil principle in a simplified form of indicating meter. You can learn more about this form of meter by building our easy-to-construct project.

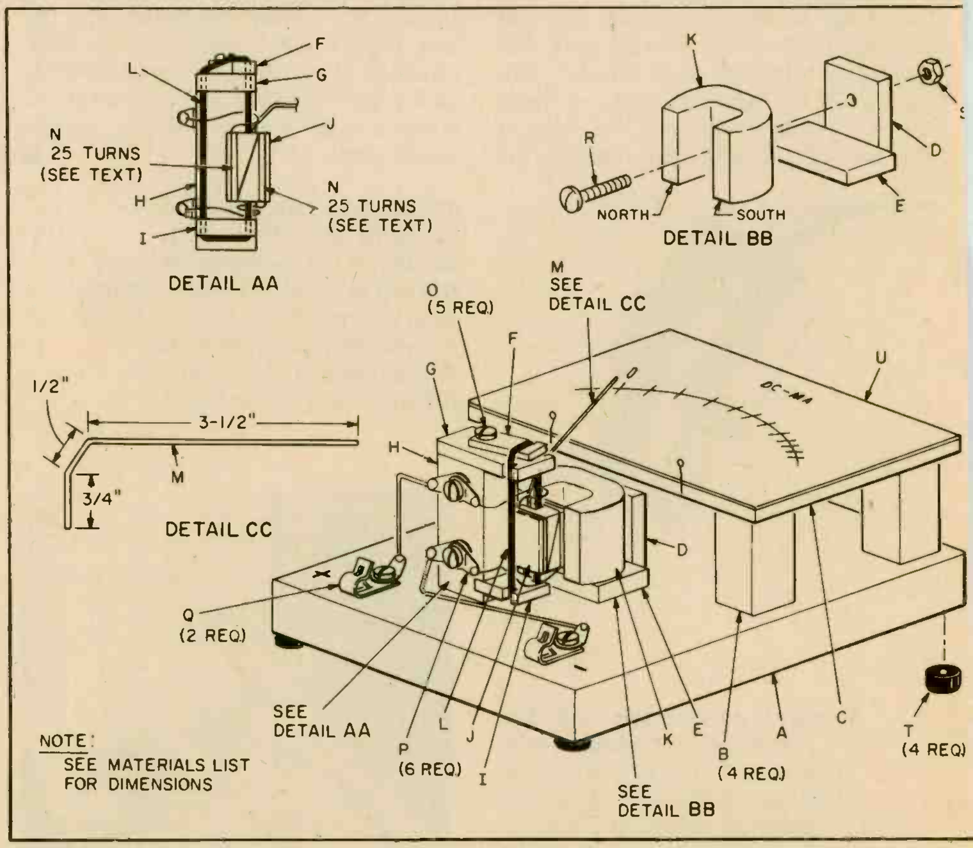
How It Works. The operation of the moving coil type of meter is based on the attraction between a permanent magnet and the magnetic field of a movable coil of fine wire. The coil is pivoted in the center of the space between the poles of the magnet, and has a return spring (to return the meter pointer to zero). This spring is usually of a spiral form in commercial meters, but our meter unit uses a rubberband coil suspension in place of both the pivot and spiral zero return spring.

When DC current flows through the coil, it produces a magnetic field that is attracted to the permanent magnet's magnetic field. This attraction imposes a turning force on the coil, that rotates the coil and moves the attached pointer over the meter scale. The amount of turning force is dependent on the amount of DC current flowing through the coil. The more DC current, the more the coil rotates. The meter is calibrated in DC current indications.

Construction. As can be observed from our photos and drawing, our model of a moving coil meter has been made in a very simplified form to facilitate construction. It's a taut-band moving coil instrument by virtue of the rubber band suspension of the moving coil assembly. We used wood for the various supporting structures because it's easier to work with and most everyone has the few hand tools required.

Size is relatively unimportant. However, we suggest you follow the dimensions and construction details given in the drawing and Parts List. In this way you should have no difficulty in making the meter and you won't have to fiddle with changing the number of turns of wire for the moving coil to compensate for a change in physical size.

You should cut out all of the various pieces of wood and sand them smooth before actually starting to assemble the meter. Mount rubber feet on the bottom four corners of the base (A) and then glue the 4 supports (B) to base (A), as shown in the pictorial drawing. Next cement the scale plat-



In this explicit exploded view, you can see in detail the more varied steps of the Moving Coil Meter assembly. To find the name of each part, refer to the Parts List.

METER

ırn exactly how they work—by Charles Green, W6FFQ

block H as shown in drawing.

The form block J for the moving coil is made from balsa wood, which is lighter in weight than any other wood and therefore contributes to the sensitivity of the instrument. Cut a notch in the center of J as shown in our drawing. The rubber band (L) is cemented in this notch. We used a rubber band approximately 6¾ x ⅜ x 1/16 inch. The coil is made in two sections by winding 25 turns of #38 enameled magnet wire on one half of J and by repeating this winding process in the same direction on the other half of J. Put a touch of cement to the ends of each coil to hold the wire in place and have 6-inch lengths of the start and finish of the 2-section coil for future connection to it. Mount the coil assembly by stretching the rubber band over pieces G and I, centering it vertically within the height of the pole pieces of the magnet.

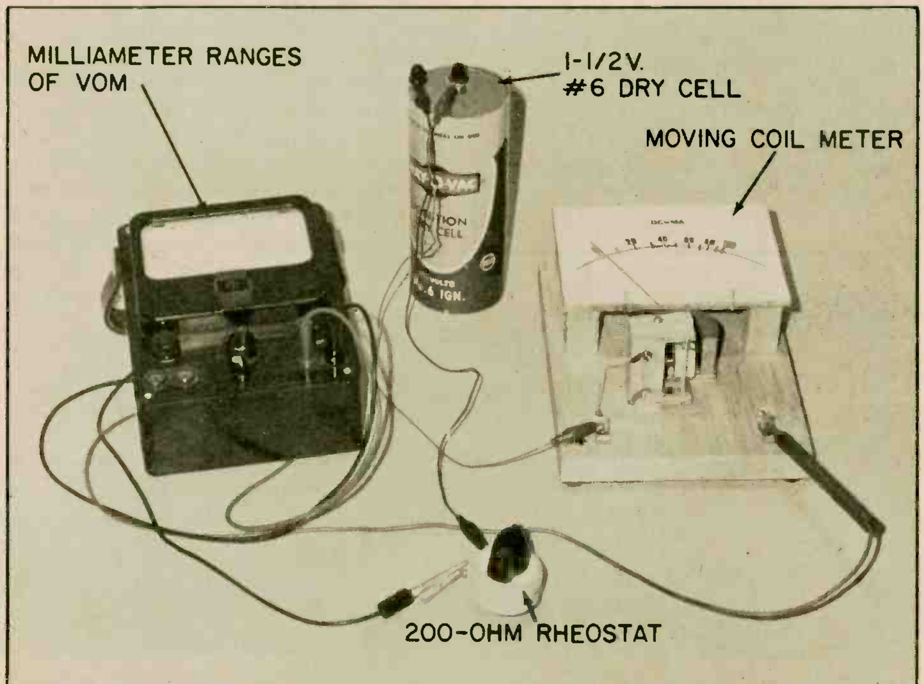
form (C) to these supports. We used our electric glue gun, but epoxy cement, Elmer's glue. Pliobond, or similar adhesives can be used with equal success.

Now you're ready to cement the magnet and moving coil assembly supports to base (A). Pieces D, E, G, and I are made from ¼-inch plywood. First step is to cement D and E in their respective locations and fasten the magnet in place. The magnet used in our unit has a mounting hole. If the magnet you use isn't drilled at the bottom center of the *U* to allow a bolt to go through it to hold the magnet in place, it too can be cemented to D and E.

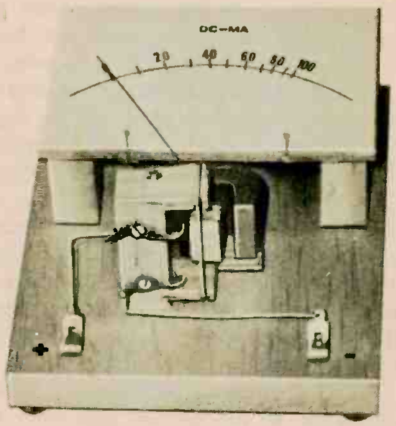
At this point the main support block (H) should be readied for cementing. But first you must notch it out so that piece I can be properly fastened to it. Hold H on the base (A) near piece E and mark H so that the top of the notch will be even with the top of E. The notch should be about ¼-inch deep. The best way to determine its depth is to hold piece G in position at the top of H and place piece I so that its notched end is even with the notched end of G. Mark the depth of the notch in block H based on the position of the end of piece I that will be inserted in the notch where its end is matched with piece G as mentioned above. Be sure that the notch in block H is cut square so that the surface of piece I will be square with the surface of block H where I is cemented in place. The notches in the free ends of I and G are required only to hold the rubber band in position. Cement block H in position, and also piece G to

Now for a Pointer. Straighten out a 4¾-inch length of #18 gauge bare copper wire and then form it as shown in the drawing. The pointer is cemented into the notch in block J so that it rests near the O end (left side) of the scale platform. Piece F is used to make final O rest position adjustments after a scale has been cemented in position.

Fasten two double solder lugs to block H; these are intermediary connecting points for the two wires from the coil. Form a helix like a hairspring with each of these leads so that they will wind up as the coil assembly moves clockwise. Solder the end of the wire from the top helix to the top lugs and the bottom helix to the bottom lugs. Mount two Fahnestock clips or binding posts along the front edge of the meter baseboard and connect them to the solder lugs on H, using #18 solid base wire. Since meter polarity is determined

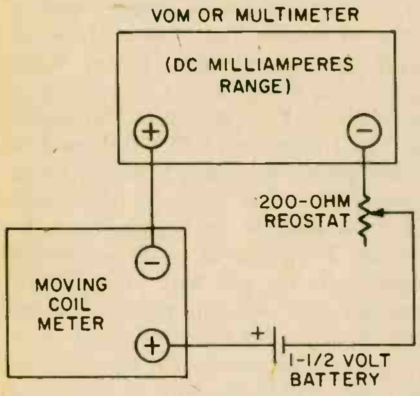


A volt-ohmmeter is very helpful in calibrating the Moving Coil Meter project. If you don't have a VOM handy, try a 0-100 mA milliameter in the same circuit.

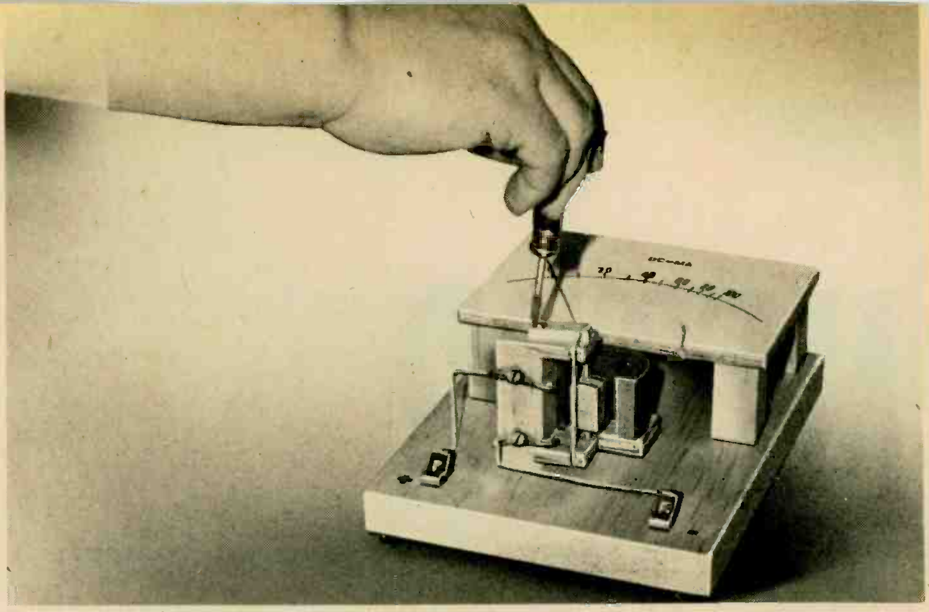


Here's how your finished MCM will look. Its innards are very similar to a bought meter.

MOVING COIL METER



Any 0-100 mA or higher milliameter will test your MCM just as well as a VOM or multimeter, provided its accuracy is fairly good.



To zero the pointer of your Moving Coil Meter project, all you need to do is loosen the screw as shown, and move the wooden block, thus repositioning the coil assembly.

by magnet polarity and the direction of current flow, established by how the coil is wound, the correct polarity markings of the meter should be determined when you calibrate the instrument.

Calibration. In order to calibrate this instrument, you'll need a potentiometer having roughly 20 ohms resistance, a 1½-volt battery and a DC milliammeter, preferably a multi-range one available as part of a VOM.

Now you are ready for the calibration scale that's mounted on the platform C made during the framework construction. The scale is drawn on a piece of heavy white paper (U) which will be cemented to the platform after the calibration marks have been drawn. (Rub-on numerals, such as Datak, make a neat scale.) Temporarily fasten this white paper (U) to platform C, draw an arc as shown in the photo and place a mark on the left-hand side for a zero reference point.

Connect a 1½-volt battery, a 200-ohm potentiometer (used as a rheostat) a multimeter set on DC milliamp ranges (or a milliammeter), and the moving coil meter you have just built, as shown in the calibration diagram.

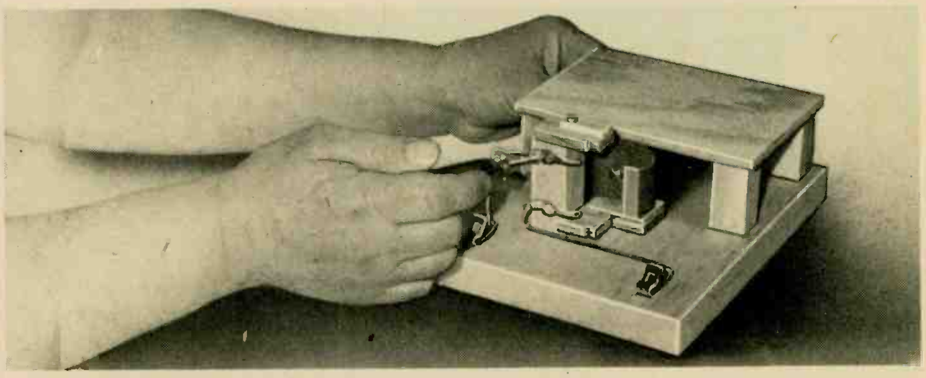
Set the potentiometer for maximum resistance and at the start use the highest milliamp range of the multimeter. If the pointer on your moving coil meter deflects to the left, below the established O point, reverse connections to it and then mark the binding posts + and —. Use the connection diagram to determine their polarity markings after connecting the meter so that the pointer moves to the right.

Slowly turn potentiometer to reduce resistance in the circuit and note the readings of the multimeter milliamp range selected. Mark your moving coil meter with the same readings shown on the milliammeter. We divided the 0-100 scale into 10 mA divisions. In the manufacture of DC moving coil meters spring tensions, spacing and coil weight are carefully controlled so that these meters are linear. For this reason commercial milliammeters have uniform spacing between divisions. Our moving coil meter doesn't have such uniformity because of the variations in the rubber band used for suspension and tension, and because it's difficult to maintain accuracy of positioning the various pieces and to be assured of the strength of magnetic field developed by the magnet. Once you have established the calibration points they can be considered accurate.

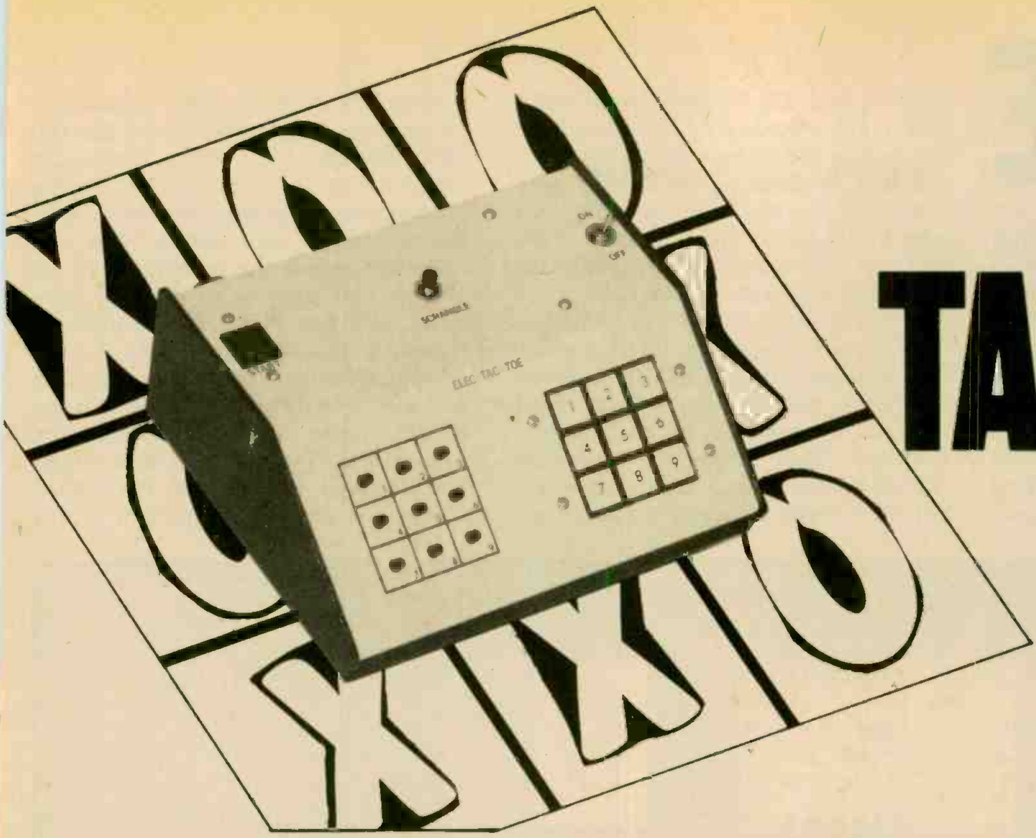
Now that you have marked the scale in pencil you can remove it from the platform and apply the permanent markings. Permanently fasten the scale in position and stand back to admire your work. If you used reasonable care in following the instructions, you'll have good reason to be proud of your handiwork. ■

PARTS LIST FOR MOVING COIL METER

A—6 x 7 x ¾-inch white pine
B—¾-inch square x 1½-inch white pine (4 required)
C—4 x 5 x ¼-inch plywood
D—1¼ x 1 x ¼-inch plywood (see text)
E—1¾ x 1 x ⅜-inch plywood
F—⅜ x 1 x 3/16-inch white pine with end notch
G—¾ x 1½ x ¼-inch plywood with end notches
H—¾-inch square x 2-inch white pine (see text)
I—¾ x ⅞ x ¼-inch plywood with end notches
J—½-inch square x ¾-inch balsa wood with slot
K—Alnico magnet
L—Rubberband (see text)
M—Meter pointer (#18 copper wire—see text)
N—50 turns #38 enameled magnet wire (see text)
O—Five #4 x ½-inch wood or sheet metal screws
P—Solder lugs (6 required)
Q—Fahnestock clips (2 required)
R, S—8-32 x 1 or 1¼-inch machine screw and nut
T—4 rubber bumpers
U—4 x 5½-inch heavy white paper for meter scale
Misc.—Hookup wire, 200-ohm rheostat, 1½-V. battery, VOM or DC milliameter



Assembling this moving coil meter is an excellent project for anyone who is handy with tools—and it teaches you how instrument (panel) meters work to measure voltage, as well as current in most electronic circuits.



ELEC TAC TOE

Tic-Tac-Toe goes space age with this IC circuit

by Walter Sikonowiz

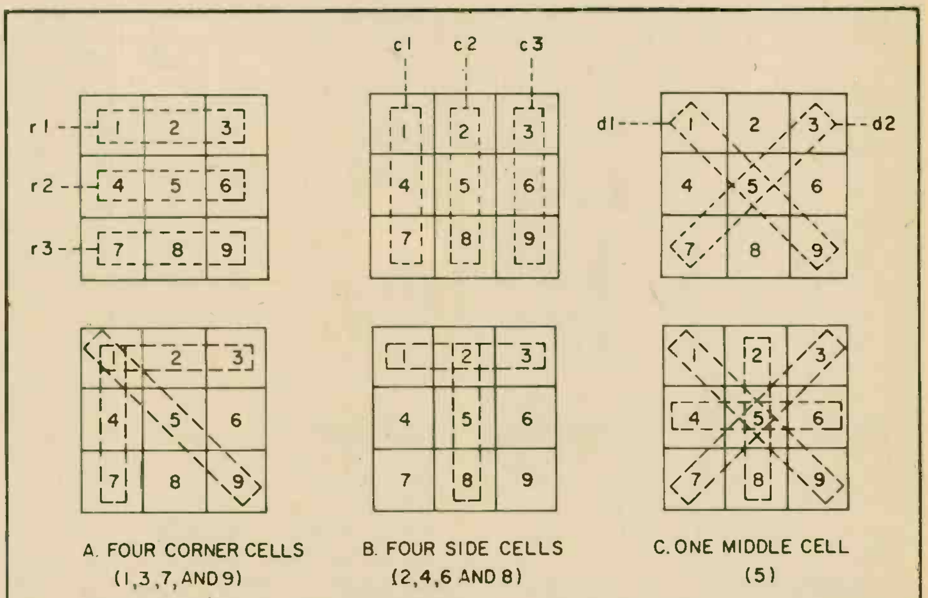
ELECTRONIC GAMES SEEM TO pop up again and again as construction projects, presumably because a game is not only fun to construct, but fun to use. But how many of the games you've seen (or built) are really worth the time and money put into their construction? Sure, electronic dice or roulette wheels are fascinating for the moment, but it's doubtful that anyone clever enough to build such a game could remain intrigued with it for very long. Then consider the other extreme; a cassette-programmed, microprocessor-based TV game. These devices are certainly more entertaining than a simple construction project, yet there are the undeniable disadvantages of high cost and the inability to play without a television receiver.

As a solution to the whole dilemma there is *Elec-Tac-Toe*, a game that is simple to construct, yet always fascinating because it is a game of deductive logic. The rules of play are so simple that even a child can catch on after a few minutes of instruction, but winning will require razor-sharp wits. If you're up to the challenge, read on.

As the name suggests, Elec-Tac-Toe is derived from Tic-Tac-Toe; both use the same 9-cell grid as a playing field. The similarity, however, ends there. In Elec-Tac-Toe there are nine LEDs, arranged so that each one occupies a single cell of the grid. In addition, there is a separate grid of nine pushbutton switches. The internal electronics randomly select three cells out of the grid, and if the pushbutton corresponding to a selected cell is pressed, the LED in that cell will light up. If a pushbutton corresponding to a cell not selected by the electronics is pressed, that cell's LED remains unlit. Two players compete, and the first person to correctly deduce which three cells out of the nine have been selected is the winner.

It is important to note that the three cells selected by the internal circuitry will form one of the scoring sets of traditional Tic-Tac-Toe. The sets are pictorially detailed, and you can see that these are the familiar three row-sets (r1, r2, and r3), three column-sets (c1, c2, and C3), and two diagonal-sets (d1 and d2). A simple-minded way of finding out which set has been selected by the internal circuitry would be to press each of the nine pushbuttons in succession and note which three LEDs lit up. However, we can be more clever than that.

Let's begin by noting that the cells

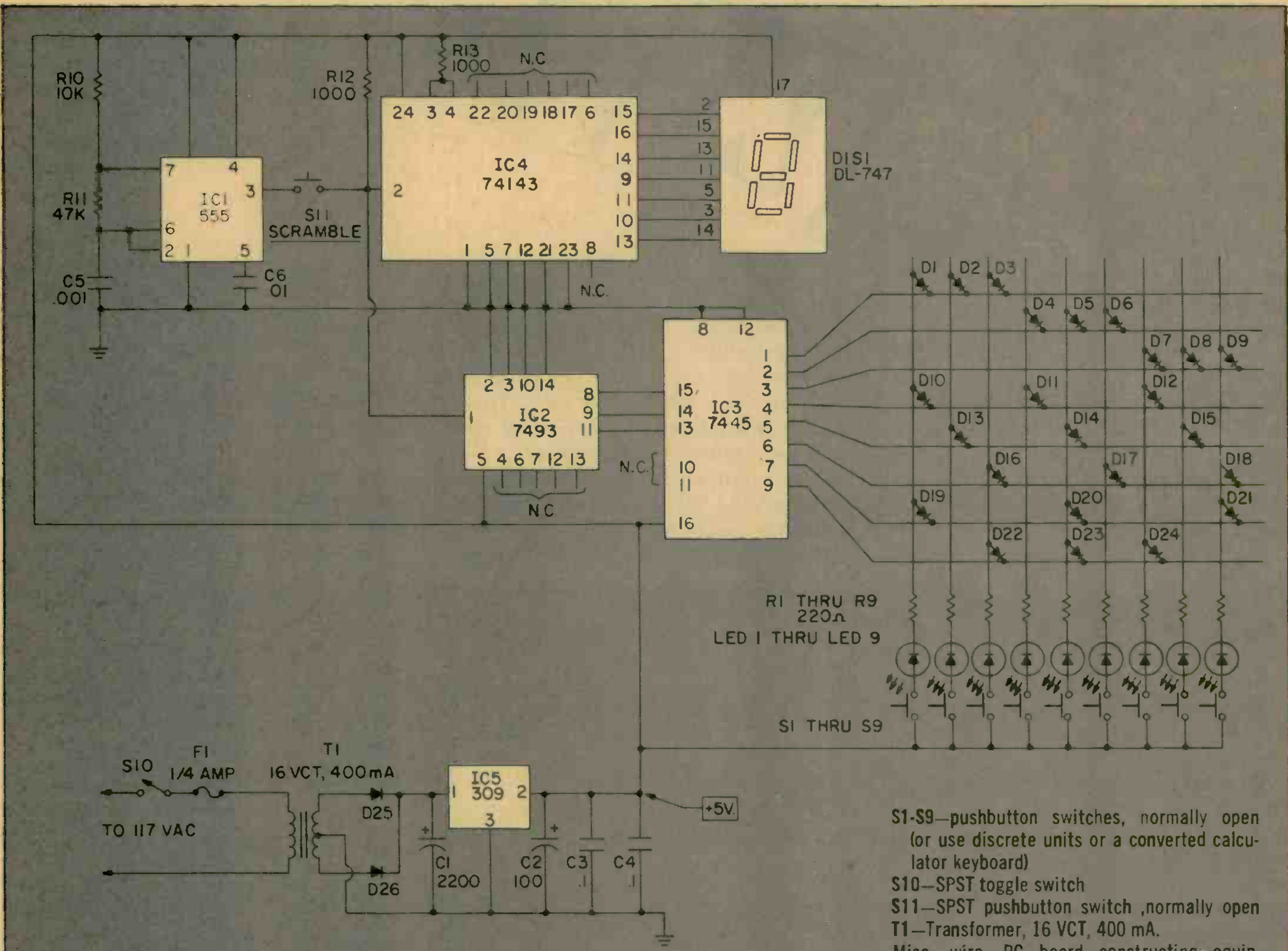


Along the top are pictured Elec-Tac-Toe's rows, columns and diagonals. The fun begins when the two players try to outguess each other as to which three LEDs will light, as secretly selected by the game. As you can see on the bottom pictorial; if LED 1 is lit Row 1, Column 1 or Diagonal 1 may be the scorer. Deductive reasoning will win here!

TAC TOE

of the grid may be divided up into three classes, as shown. There are four corner-cells (1, 3, 7, and 9), four side-cells (2, 4, 6, and 8), and one middle-cell (5). Furthermore cells of a particular class each belong to a characteristic number of scoring sets. For example, each corner-cell belongs to one row-set, one column-set, and one diagonal-set. Each side-cell belongs to one row-set and to one column-set. And the lone middle-cell belongs to the two diagonal-sets (d1 and d2), to one row-set (r2), and to one column-set (c2). Classifying the cells in the above way is a tremendous help to deducing the correct solution. You can try for yourself to see why this is so—and the examples at the end of this article will explain the reasoning in detail.

A rough outline of a game of Elec-Tac-Toe may be helpful at this point. To begin with, the SCRAMBLE button is pressed, thus causing a new set of cells to be selected by the internal circuitry. This scrambling operation simultaneously causes a random number (0 through 9) to be generated on a display. One player then commences by pressing the pushbutton of the cell (#1 through #9) whose number is called out on the display. If the display shows zero, the player may begin with the cell of his own choice. Next, the opponent presses the pushbutton of his choice. This pressing of buttons alternates until one player has enough information to correctly identify the unknown, electronically selected set. The first player to deduce the solution is the winner. Later on, we'll consider the rules of Elec-Tac-Toe more thoroughly, and examine examples of the logical elimination that is so important in this



S1-S9—pushbutton switches, normally open (or use discrete units or a converted calculator keyboard)
S10—SPST toggle switch
S11—SPST pushbutton switch ,normally open
T1—Transformer, 16 VCT, 400 mA.
Misc.—wire, PC board constructing equipment, cabinet, etc.
Note—Insta-Fab #MBK 2-7-6 cabinet is available from Circuit Specialists, Box 3047, Scottsdale, AZ, 85257 for $7.91 plus postage.
Transformer T1 is a Signal #241-4-16 available from Signal Transformer Co., 500 Bayview Ave., Inwood, N.Y. 11696 for $4.85 plus postage.
ICs are available from James Electronics, 1024 Howard Ave., San Carlos, Calif. 94070 —write for current prices.

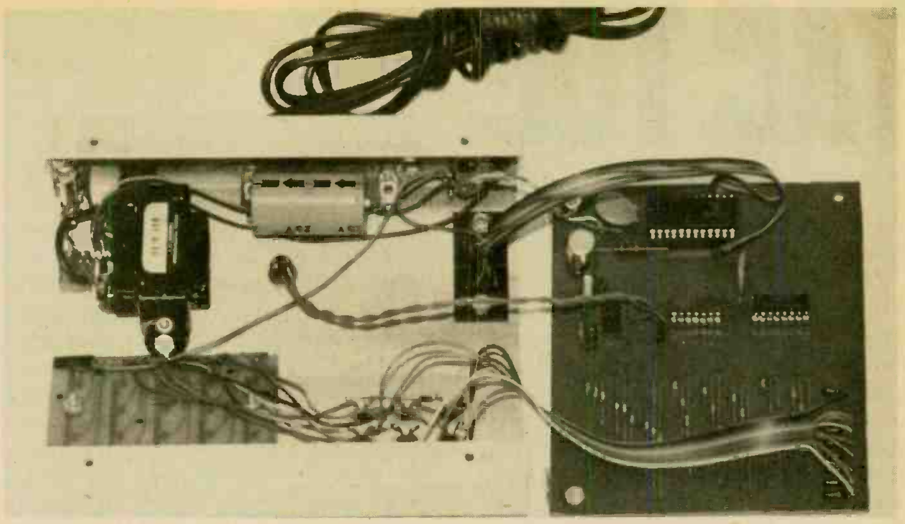
PARTS LIST FOR ELEC-TAC-TOE

C1—2200-uF electrolytic capacitor, 25-volt
C2—100-uF electrolytic capacitor, 16-volt
C3, C4—.1-uF capacitor
C5—.001-uF capcitor, mylar
C6—.01-uF capacitor
D1-D24—1N914 diode
D25, D26—1N4003 diode
DIS1—Litronix DL-747 7-segment display
F1—¼-amp. fuse
IC1—555 timer
IC2—7493 counter
IC3—7445 decoder
IC4—74143 counter and decoder
IC5—LM309K 5-volt regulator
LED1—LED9—light emitting diode
ALL RESISTORS ½-WATT, 10% TOLERANCE
R1-R9—220-ohm resistor
R10—10,000-ohm resistor
R11—47,000-ohm resistor
R12, R13—1000-ohm resistor

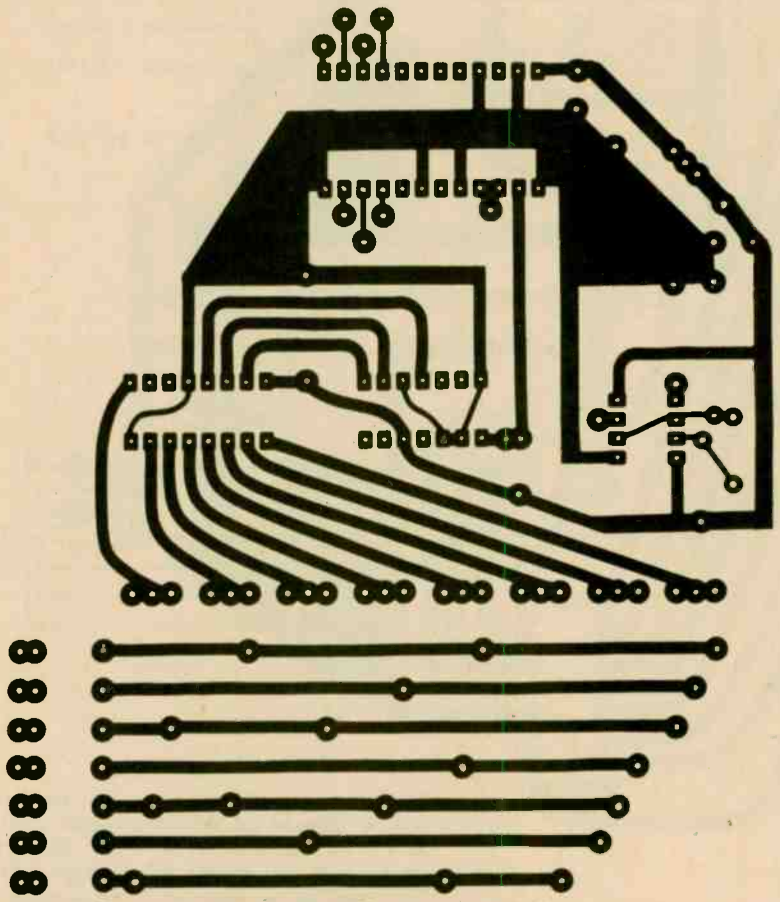
game. First let's consider the electronic circuit and its construction.

In the schematic you will see IC1, a 555 timer, hooked up as an astable multivibrator. At its output (pin 3) there is available a 14-kHz square wave. Momentarily pressing SCRAMBLE switch S11 causes the square wave to be applied simultaneously to two counters: IC2 and IC4. We will be interested in the resting state of each counter after S11 is released, and because the clocking signal is so rapid, and examine examples of the process of the resting states cannot be predicted by the person manipulating S11; therefore, the outputs of both counters at rest are random. Since the two counters have different count lengths (eight for IC2 vs. ten for IC4), they can both be randomized by the same clock signal without getting locked together.

Consider IC4 first. Inside this IC we have a decade counter plus a seven-segment decoder. The outputs of this IC are constant-current sinks that connect directly to the display, DIS1, without any intervening resistors. On the display we can read a random number (between 0 and 9), which denotes the cell at which play must begin in a game. This feature prevents players from starting at a particular cell and then working through the cells in a fixed pattern all the time. Such a procedure would make finding the solution somewhat easier because a fixed set of decisions would be made every time. Hence, fewer slip-ups would occur. IC4's inclusion means that players need to remember more facts, so more mistakes are made, and the game becomes more of a challenge. Furthermore, the fact that players alternate at choosing cells adds a little bit more confusion to the game.



Note the wires that go from the Elec-Tac-Toe keyboard to the PC board. Our unit made use of ribbon cable. You'll find that ribbon cable can be almost indispensable once you get used to it—no more messy wire tangles or having to use troublesome cable ties.



As you can see, Elec-Tac-Toe uses a very neat PC board arrangement and the diodes are well-placed for easy construction. This is a full-size template so you can copy it exactly to make your own board. Use any of the many popular PC boards kits.

Let's proceed to IC2 next. This IC is a 3-stage binary counter, at whose outputs (pins 8, 9, and 11) we may find the binary representation of any number from 0 to 7. The outputs drive decoder IC3, which converts each one of the eight unique input states into a specific output signal. These output signals are such that only one of IC3's eight outputs conducts current to ground in response to any given binary input. Suppose, for instance, that it is pin 1 of IC3 that happens to be capable of conducting. We then have three potential paths by which current might flow from the positive supply to ground: S1-LED1-R1-D1, S2-LED2-R2-D2, and S3-LED3-R3-D3. Thus, the set selected by the circuit consists of the three cells in which LED1, LED2, and LED3 reside. Pressing S1, S2, or S3 results in the lighting of LED1, LED2, or LED3, while pressing any other switch will not cause any LED to light. Similar results occur if any one of the seven other outputs of IC3 happens to be the one capable of conduction.

Power for the circuit comes from transformer T1, whose output is full-wave rectified by D25 and D26, then smoothed by electrolytic capacitor C1. Voltage regulator IC5 provides a regu-

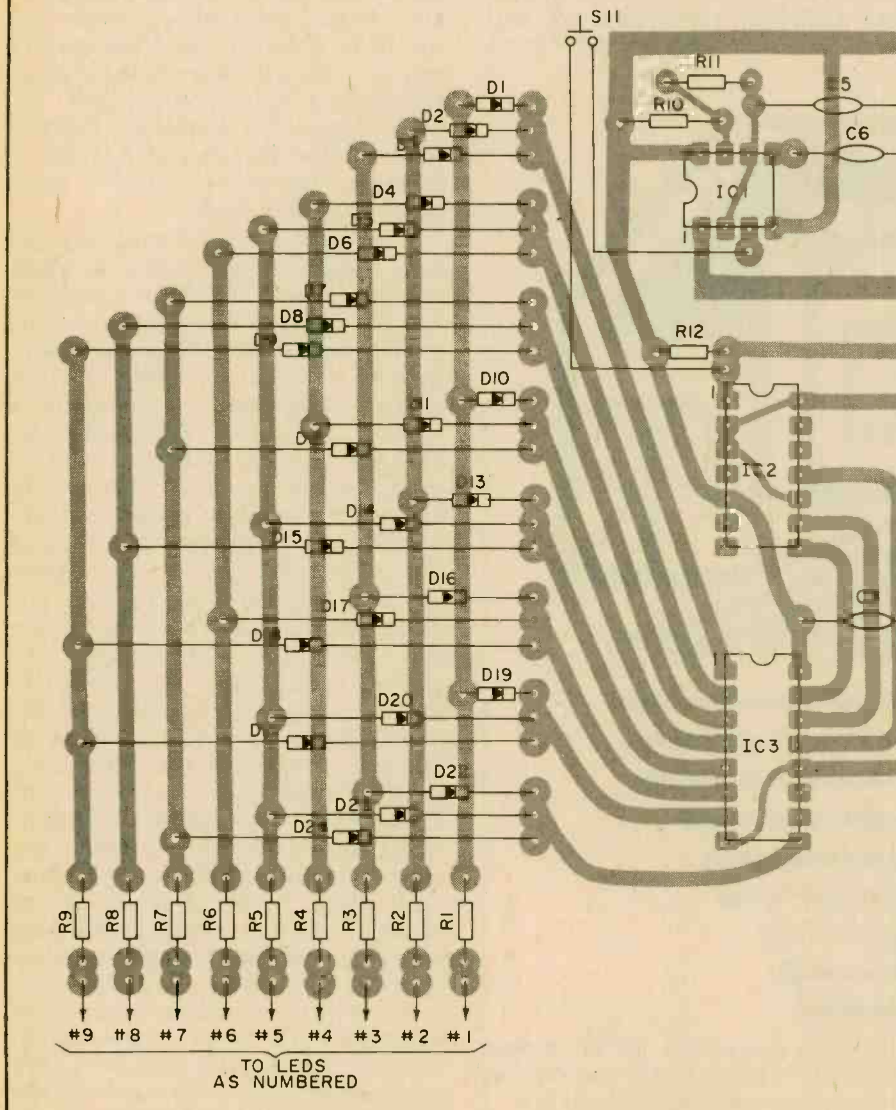
TAC TOE

lated 5-volt potential between its output (pin 2) and ground. Capacitors C2, C3, and C4 bypass the supply and stabilize the circuit.

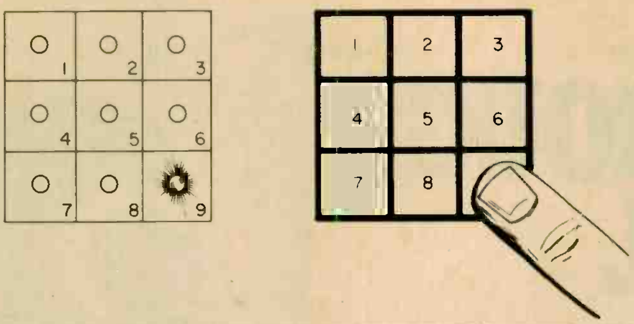
There is an optional part to the schematic; see Figure 5. When players become experienced, they may find a solution nearly simultaneously. Because it is difficult to tell who shouted first when sounds are closely spaced, you may wish to build a priority latch. The latch's output consists of two LEDs, one for each contestant. The player who presses his pushbutton first causes his LED to light, and at the same time prevents the opponent's LED from lighting at a later time. Only one IC is necessary to build the latch: a 7474 dual D-type flip-flop. Pressing S11 sends the square wave from IC1 to the CLEAR inputs of the two flip-flops. The first time that this square wave goes low, it sends both Q outputs high; consequently, neither LED is lit. When S11 is relased, R12 holds the CLEAR inputs high, and they no longer have any effect on their respective flip-flops. If the priority latch's S1 is the first switch to be pressed, the latch's IC1a gets clocked and its Q output drops low because its D input is connected to a high potential at the instant of clocking. Naturally, when the Q output drops low, LED1 goes on. Now, suppose at some later time the latch's S2 gets pushed, thus clocking the latch's IC1b. Because the latch's IC1b's D input connects to the latch's IC1a's Q output, which has already gone low, the latch's IC1b's Q output remains high after clocking, and LED2 cannot light. If latch S2 had been the first switch pressed, the situation would simply have been reversed. Pressing Elec-Tac-Toe's S11 again will reset the priority latch.

Since Elec-Tac-Toe's circuit is simple and stable, you can use any construction method you like. As always, however, a printed circuit will yield the neatest and most professional-looking results. The PC layout accompanying this article may be copied using any of the commercially available etched-circuit kits.

When building the circuit, you will find it wise to use sockets for all the ICs (except IC5). In this way, if an IC should prove to be defective, it can be easily replaced. IC5, the voltage regulator, needs to be heat-sinked. This is conveniently done by simply mounting it against your game's cabinet, provided that you've used a metal (preferably aluminum) cabinet. If this is not the case, you will need to bolt IC5 to a separate heat-sink. All in all, it is much easier to use an aluminum cabinet to



When you assemble Elec-Tac-Toe, be certain to observe all device polarities such as C1, C2 and all the IC chips. Be very careful with the diodes, D1 through D24. They must all be arranged in the same direction. With so many it could be easy to make a mistake, so keep a watchful eye on that part of the assembly. You can use about any front-panel layout. The switches may be discrete, or a calculator keyboard.



Clues as to which LEDs are lit are simple to obtain. Just push the switch that controls the LED in question. If it lights, you're a step closer.

begin with. A thin layer of silicone grease between IC5's mounting flange and the aluminum cabinet will improve the heat flow from the IC.

Transformer T1 is a 16-volt, center-tapped, 400 mA. unit. It may be ordered directly from the Signal Transformer Co. for $4.85. Be sure to specify the model number (241-4-16), and include sufficient money for postage. Signal's address can be found in the parts list.

While assembling the circuit, double-check all device polarities. This applies to all the semiconductors as well as capacitors C1 and C2. Be especially careful with diodes D1 through D24; they should all point in the same direction.

Solder connections must be made with resin-core solder and a low-heat iron (25 watts or less). Too large an iron may char the circuit board and damage the components.

Finally, any suitable front-panel layout can be used. You may, however, wish to copy the prototype's front panel. That particular arrangement proved to be not only functional, but eye-catching as well. As noted in the parts list, switches S1 through S9 may be discrete pushbuttons or a converted calculator keyboard. The LEDs must be mounted in the proper cells of the grid; put LED1 into cell 1, LED2 into cell 2, and so on. This wraps up construction, so let's return to our discussion of the game itself.

The complete rules of Elec-Tac-Toe are as follows: 1) Press SCRAMBLE at the start of each new game. 2) Decide which player goes first; in subsequent games players alternate at taking the first turn. 3) The player going first presses the pushbutton called out on DIS1. Zero denotes a free choice of the first button to be pressed. 4) The other player presses the button of his choice. Players now alternate at pressing buttons until someone has figured out the selected set. 5) The first person to declare knowledge of the solution tests his answer by pressing three pushbuttons simultaneously. If three LEDs light, he wins. 6) If he is wrong, the opponent gets one guess, which he tests as above. If he too is wrong, the game ends in a draw.

As noted previously, the priority latch can be used instead of shouting to determine who first finds a solution. From the rules you can see that this game posesses elements of chance and competition, which together make deduction more difficult. You should also note that a good visual memory is an absolute necessity for winning. In order to get some idea of the thinking necessary in Elec-Tac-Toe, consider the sample games which follow. Each game is a sequence of plays, with no indication who made a particular play or who eventually won.

GAME 1

Cell 2 lights/Set is r1 or c2.
Cell 1 won't light/Set is c2.

GAME 2

Cell 1 won't light/Eliminate r1, c1, and d1.
Cell 5 lights/Set is r2, c2, or d2.
Cell 3 won't light/Set is r2 or c2.
Cell 2 won't light/Set is r2.

GAME 3

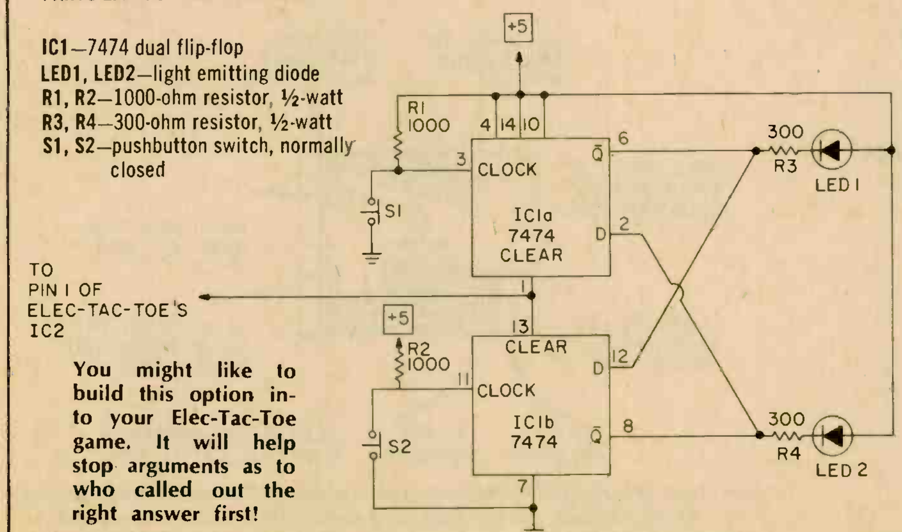
Cell 2 won't light/Eliminate r1 and c2.
Cell 8 won't light/Eliminate r3.
Cell 1 won't light/Eliminate c1 and d1.
Cell 9 won't light/Eliminate c3. Set is r2 or d2.
Cell 5/lights/No new information.
Cell 3 won't light/Set is r2.

Note that in Game 3 the fifth step (testing cell 5) was useless. The players should have known beforehand that Cell 5 would light because it belongs to both r2 and d2, and one of those sets of LEDs had to be the one that would light. But it's easy to criticize when everything is on paper; in play you will often find it difficult to keep track of data. In fact, you may find yourself pushing buttons that have already been pushed. Clearly, a solution that becomes evident after only a few steps is easier to spot than one requiring more steps because there is less to remember (or forget).

In general, is there anything that can be said about the amount of information necessary to reach a decision? Well, each press of a button yields one bit of information to each player; all solutions require two or more bits. The maximum possible number of bits necessary for logical players (with perfect memory) reasoning with information from randomly chosen cells is six. If the cells are chosen in an intelligent sequence, the solution can always be reached with four or fewer bits of information (again assuming the players are logical and have perfect recall). Can you spot how this would be done? Real games are likely to be longer than the ideal. ■

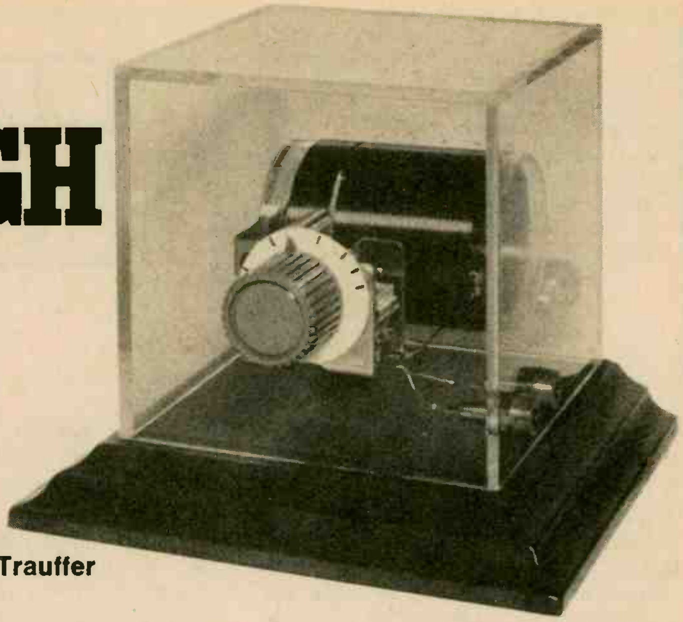
PARTS LIST FOR PRIORITY LATCH OPTION

IC1—7474 dual flip-flop
LED1, LED2—light emitting diode
R1, R2—1000-ohm resistor, ½-watt
R3, R4—300-ohm resistor, ½-watt
S1, S2—pushbutton switch, normally closed



You might like to build this option into your Elec-Tac-Toe game. It will help stop arguments as to who called out the right answer first!

Build the SEE-THROUGH CRYSTAL RADIO RECEIVER



by Art Trauffer

☐ Have you ever wanted to recreate those old days of listening to AM radio on a crystal set and headphones? No tubes, no batteries, no hum, no nothing but pure clean sound drifting out of the ether into your headset? If you have the yen to get a crystal set which has the advantage of using a crystal diode instead of the old unreliable cats-whisker and galena crystal, this radio is the one for you to build. In addition to being about as good a power-supplyless AM receiver as you can make, it's also a pleasure to look at.

It closely resembles the beautiful glass-enclosed radio receivers that were custom-built by manufacturers for display in radio exhibitions in the 1920's. Manufacturers of radio receiver kits mounted and wired their kits in glass cabinets so the visitors could see the "works" from all angles instead of lifting the lid to look inside. Those glass cabinet radios are now rare collectors items.

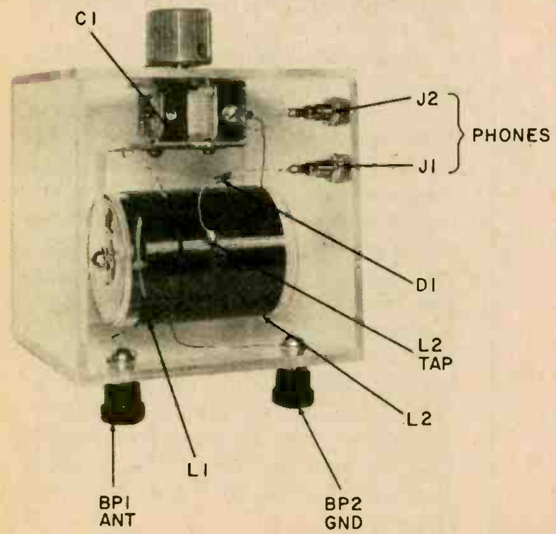
This crystal radio also saves you the work and expense of making a wood cabinet, and it is low-loss for radio frequencies because the cabinet and coil form are made of styrene plastic which is a good dielectric material. The cabinet is simply a clear plastic 4-in. square photo display cube, and the coil form is a clear plastic pill container about 2-in. in diameter.

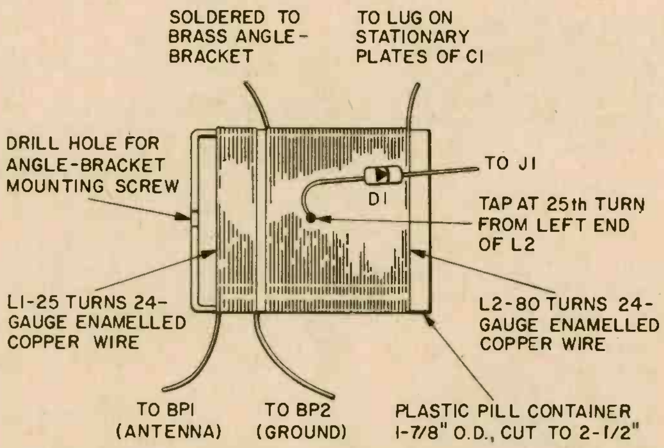
Circuit Description. The simple schematic diagram shows a time-tested hookup which is still widely used, but it's improved here by connecting one side of the crystal diode to a tap on the secondary, L2. This greatly increases the receiver's selectivity and helps you separate the powerful local stations.

Making the Coil. To make coils L1 and L2 the four ends of the coils are anchored in small holes drilled through the wall of the plastic container and spotted with Duco cement. You can also make small holes by pushing a hot sewing needle through the plastic. To make the tap on the coil, simply twist a small loop in the coil and spot it with Duco cement. Scrape the enamel insulation off the loop, and solder to it.

Build Your Own or Ours. The plastic cube makes a very attractive enclosure, as you can see in the photographs. However, the parts layout isn't at all critical, and you can breadboard this radio any way you want, so long as it's wired correctly. If you want to have a beautiful-looking radio you can show off you'll follow the model I made which is shown in the photographs.

Mounting The Parts. The photograph shows how the parts mount inside the plastic box. The coil form is mounted to the rear of variable capacitor C1 by means of a brass angle-bracket. Use lockwashers wherever needed to hold the screws, binding posts, and phone tip jacks securely to the plastic material.



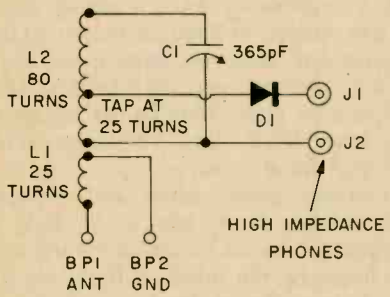


Apart from getting hold of the parts, construction of the See-Through Crystal Set should take you less than two hours in all. You can use any kind of box you want, but the lucite box shown will make it into a real showpiece.

Vhen assembling and wiring this re-eiver be careful not to scratch the lastic, and keep the soldering iron well way from the plastic. If you use rosin ore solder, protect the plastic by cov-ring it with pieces of paper taped in lace to keep the rosin from splattering n the plastic.

The completed crystal radio is nounted on a fancy walnut base pur-chased from a woodworking shop. The plastic box is secured to the wood base by spotting the four corners of the bot-om of the box with Duco cement. The dial for the pointer knob is simply a small disc of white double-weight pa-per held to the plastic box with a spot of Duco cement. Make pencil marks at the places where your local stations come in.

Use of a pair of sensitive high-im-pedance magnetic or crystal earphones, a good connection to a cold water pipe, and a long outdoor antenna (for best results, put up a long single-wire, ran-dom-length antenna.) With a simple crystal set it becomes particularly im-portant that the antenna-ground sys-tem be the best possible. Remember, unlike its bigger cousin, the super-heterodyne, the crystal set does not have rf amplifiers and other circuitry to help it pull in all those signals floating around out there in the ether. ■



PARTS LIST FOR CRYSTAL RADIO

BP1, 2—Binding posts for antenna and ground connections; may be any convenient type

C1—365-pF variable tuning capacitor, single-gang.

D1—Small-signal, general purpose diode, similar to 1N34.

J1, 2—Jacks for headphones (dependent on phone(s) selected.

Misc.—Headphone(s), high impedance. May be crystal or magnetic, or small earphone as supplied with transistor radios and portable tape machines; plastic photo display cube, approx. 4-in. each dimension; plastic pill container, 1 7/8-in. diameter, for use as coil form; 1/4-lb. 24-gauge enamelled copper magnet wire (Radio Shack 278-004 or equiv.); brass mounting strip, assorted screws, nuts and lockwashers.

Talk Power Booster

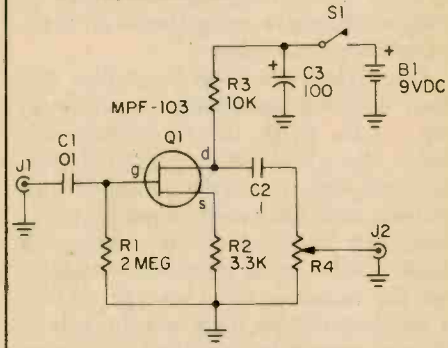
☐ If your CB or Ham rig is a little shy on talk power, this 10 dB talk power booster will give your signal that extra edge through the QRM. The input impedance is high enough to handle anything from a low impedance dynamic mike to a crystal or ceramic model. You can run the booster into just about any rig; chances are it will work. Since it's so easy and inexpensive to try out a breadboard model, don't bother worrying about the input impedance of your rig; it's faster to give it a try.

Potentiometer R4 serves as the volume control into your rig; it is adjusted for optimum modulation, as indicated on a modulation meter or other reliable device.

Jacks J1 and J2 match your existing microphone and transmitter connectors. Battery B1 can be the type used for small transistor radios as the current drain is but a few milliamperes. Capacitor C3 must be used regardless of what you use for a power supply. A metal cabinet is suggested to keep hum and RF out of the microphone system. ■

PARTS LIST FOR TALK POWER BOOSTER

B1—9-volt battery (Type 2U6 or equiv.)
C1—0.01-uF capacitor
C2—0.1-uF Mylar capacitor
C3—100-uF, 10 VDC capacitor
J1, J2—Jacks to match existing microphone equipment
Q1—FET, Motorola, MFP-103 (Radio Shack 276-2028)
R1—2-megohms, ½-watt resistor
R2—3300-ohms, ½-watt resistor
R3—10,000-ohms, ½-watt resistor
R4—50k or 100k audio-taper potentiometer.
S1—Spst switch



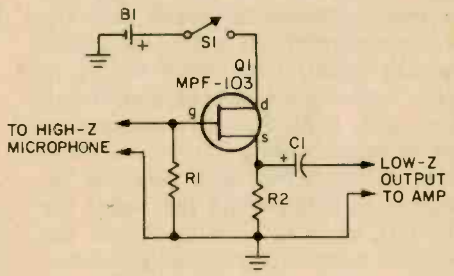
Hi-to-Lo Z Mike Amp

☐ Try to run a high impedance mike line for more than 25 feet and you're sure to get high frequency losses and hum pickup. But this simple junk-box project mounted in a small metal enclosure on the mike stand will convert the mike's output to a low impedance that can run for hundreds of feet without hum pickup or losses.

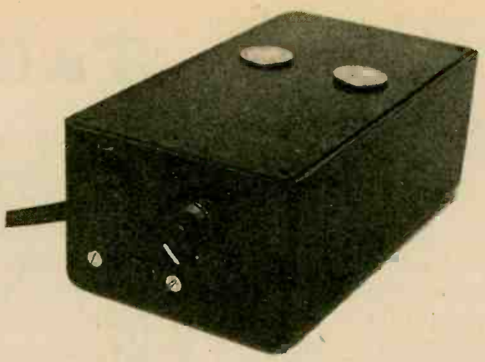
The output can be run into any microphone input-rated from 150-ohms up to high impedance. The circuit serves only to convert high to low impedance; it provides no amplification. A metal enclosure must be used. The Field Effect Transistor, Q1, can be just about any surplus N-channel type. ■

PARTS LIST FOR HI-TO-LO Z MIKE AMP

B1—1.5-volt AA battery
C1—10-uF, 12 VDC electrolytic capacitor
Q1—Field effect transistor, Motorola MPF-103 (Radio Shack 276-2028)
R1—2-megohm, ½-watt resistor
R2—150-ohm, ½-watt resistor
S1—Spst switch



BUILD TOUCH 'N' DIM CONTROLLER



Two ICs and a handful of components let you turn lights on and off with a flick of the finger.

TOUCH CONTROL SWITCHES have fascinated experimenters for many years, but the circuits usually seen haven't been practical for household use. Typical problems include, excuse the expression, touchy adjustments or lack of power-handling capability, as well as expensive components or overcomplicated circuitry.

Our Touch 'N Dim controller has been designed specifically for controlling a table lamp. It uses modern ICs and a Diac/Triac phase control to provide relayless, Touch-On Touch-Off operation, and full-range dimming capability for loads up to 200 watts. We constructed it as an outboard accessory, but the circuit is small enough so that it could readily be built into the hollow body of a suitable lamp, making a most effective conversation piece.

How It Works. Some circuits use body capacitance to detune an oscillator and thus achieve control. This can be very sensitive, but it is much easier for our purpose to sense the 60 Hz noise that one's body is always picking up and use that as the control signal. Referring to the schematic, IC1A is connected as a standard amplifier with a gain of about 50. Noise voltage on the touchplate (a penny or dime) is amplified, rectified by D1 and filtered by C2 to provide a small voltage change across R4. This becomes a change in current through R5 and the inverting input of IC1B. IC1B is a signal comparator; if the current into the inverting input is greater than the reference current into pin 1, the output switches quickly from about 4-VDC to nearly zero. This rapid changeover will cause IC2, a flip-flop, to change state and extinguish lamp I1. I1 normally holds photocell PC1 at a very low resistance, thus bypassing the signal for Diac Q1 to ground. With I1 off, the photocell is essentially out of the circuit and the dimmer represented by Q1, Q2 and associated parts will operate normally. To turn the load off, IC2 is reset by activating the *Off* amplifier channel consisting of IC1C and IC1D.

Construction. The touchplates will be required later to check out the amplifier circuits, so it's best to make them now. I found it best to use coins as shown in the photos since, even though they are small, their size has great influence on circuit sensitivity. Cut the heads off a pair of 6-32 x ½-in. screws using a bolt cutter or hacksaw and save the shanks. File the cut edges flat and tin with a heavy, hot soldering iron. Prepare two dimes by cleaning the head side of one and the tail of the other with steel wool. Tin a small area in the center of each prepared side and sweat the screw shanks to the dimes. Be careful to get the shanks as nearly perpendicular to the coins as possible. When the touchplates have cooled down, add a nut and solder lug to each and put them aside.

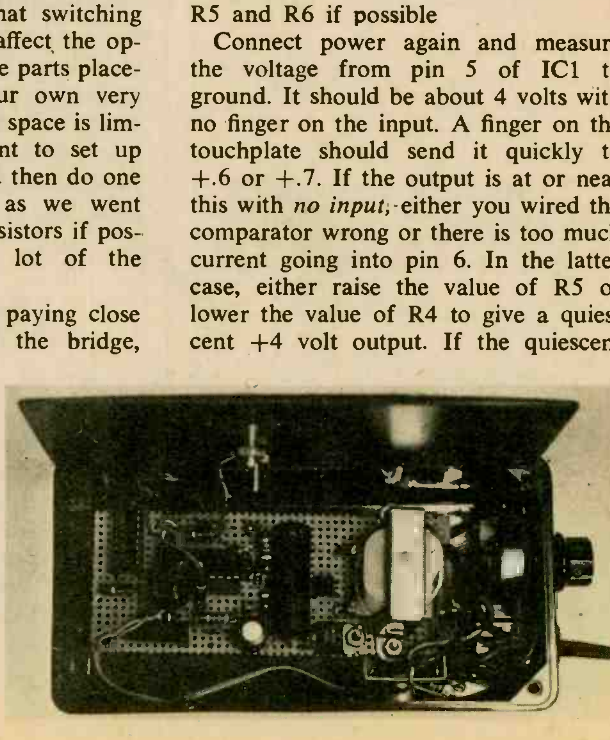
The bulk of the circuitry is assembled on a piece of perfboard about 4¼-in. by 2-in. The layout is critical in only one respect: Don't put any of the dimmer components except PC1 near the ICs. The reason is that switching noise from the Triac can affect the operation of the logic. Use the parts placement shown, or plan your own very carefully beforehand, since space is limited. I found it convenient to set up the power supply first and then do one stage at a time, testing as we went along. Also, get ¼-watt resistors if possible—it will alleviate a lot of the crowding.

Wire the power supply, paying close attention to polarities of the bridge, capacitor, and regulator. Apply line voltage temporarily to the transformer and check for a reading of about +5 volts from pin 3 of the regulator to ground. Once you have supply voltage, wire the sockets for the ICs into the supply lines. Remember to leave a note for yourself as to which way the ICs are to be inserted.

Now hook up the first amplifier stage and stop when you have wired in R4. Connect one touchplate to the input with a short length of wire. Install IC1, hook a VOM across R4, and again temporarily apply power.

Check the Voltages. The quiescent voltage across R4 should be about +.25 volts and should go to about +3.5 volts when you touch the plate. If there is no reaction or the readings are drastically off, you probably have a wiring error. If the output voltage is more or less correct and does rise, even if not quite to 3.5, proceed; you may need to trim R4 slightly later. Wire in the comparator stage IC1B. Use 5% resistors for R5 and R6 if possible

Connect power again and measure the voltage from pin 5 of IC1 to ground. It should be about 4 volts with no finger on the input. A finger on the touchplate should send it quickly to +.6 or +.7. If the output is at or near this with *no input*, either you wired the comparator wrong or there is too much current going into pin 6. In the latter case, either raise the value of R5 or lower the value of R4 to give a quiescent +4 volt output. If the quiescent



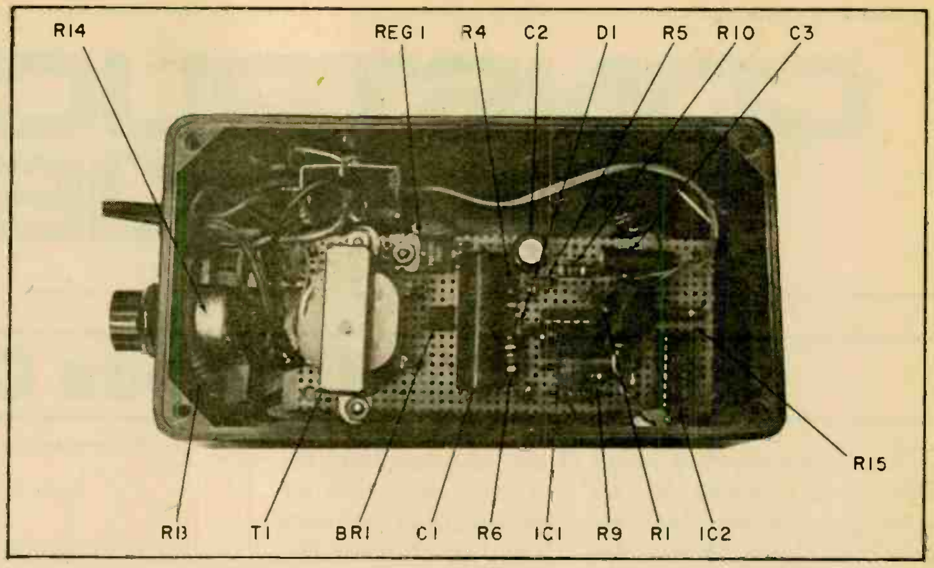
Touch 'N Dim prototype with cover removed shows parts mounted on perf board. Rheostat control at right adjust brightness of lamp. Note the ICs are mounted in holders, not directly soldered.

TOUCH 'N' DIM

output is about +4 volts but won't go down, R5 should be lowered until a touch on the input sends pin 5 to +.6 to .7 volts. When both stages are working together correctly, wire and test IC1C and IC1D similarly. Now make the final connections to the socket for IC2 and install both the chip and I1. With power applied, I1 should go on and off in response to a touch on the proper plate. If this much is happening, you are pretty well home free.

Putting It In the Case. Prepare the case by locating and making mounting holes for the line cord, potentiometer R14 and receptacle SO1. Mount these two parts. The mounting arrangement you select for Triac Q2 depends on the

(Continued on page 117)

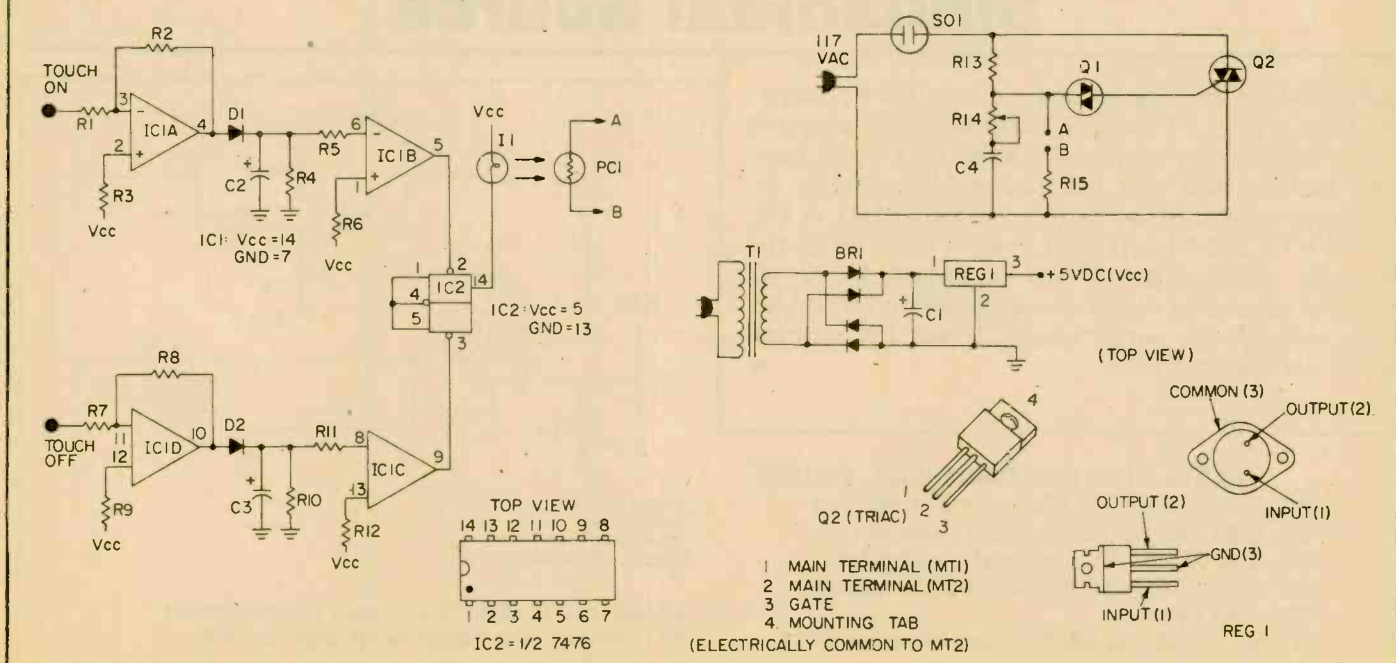


Parts layout on perf board shows all components are on the one board, with exception of brightness adjust control rheostat, R14. Any convenient layout may be used, depending on size of parts used in the project.

PARTS LIST FOR TOUCH 'N DIM CONTROLLER

BR1—Bridge rectifier module, 50-PIV, 1-A
C1—200-uF, 25-VDC electrolytic capacitor
C2, C3—20-uF, 15-VDC electrolytic capacitor
C4—.22-uF, 250-VDC capacitor
D1, D2—1N914 or similar, silicon diode
I1—6-volt, 25-mA, miniature lamp
IC1—LM3900 quad IC amplifier
IC2—7476 IC Flip-Flop
PC1—Cadmium sulfide photocell
Q1—Diac switch
Q2—Triac switch, 200-volt, 3-A or more
REG1—5-VDC volt regulator
R1, 7—100,000-ohm, ½-watt resistor
R2, 8—4.7-megohm- ½-watt resistor
R3, 9—10-megohm, ½-watt resistor
R4, 10—3900-ohm, ½-watt resistor
R5, 11—560,000-ohm, ½ watt (5 percent preferred, not essential) resistor
R6, 12—1 megohm, ½-watt (5 percent preferred, not essential) resistor
R13—6800-ohm, 1-watt resistor, or use two 15,000-ohm, ½-watt resistors in parallel
R14—100,000-ohm potentiometer
R15—1000-ohm, ½-watt resistor
T1—Power transformer, 117-VAC to 12-V secondary, 300 mA or more
SO1—AC socket, chassis mounting
Misc.—Perfboard, flea clips for mounting parts to board, mounting screws, IC sockets, chassis box 3-in. x 6-in. x 2 in. or more, preferably non-metallic, solder, etc.

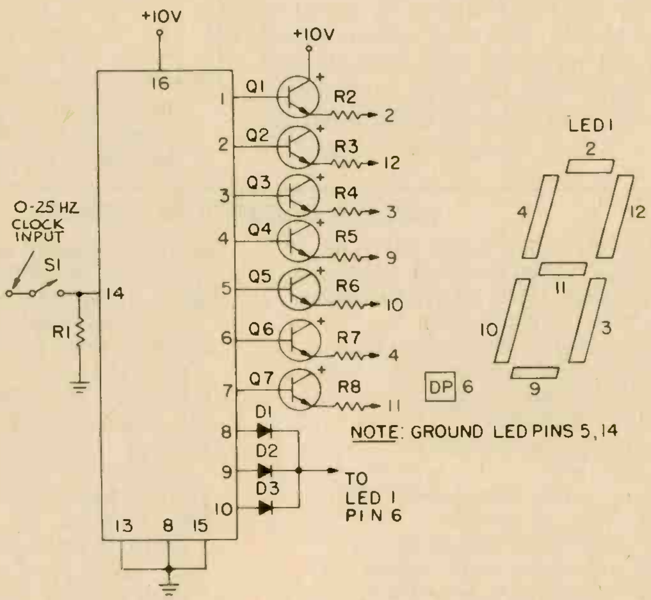
Make the switch—to a Touch 'N' Dim controller, and to a futuristic means of control to lighting up your life. Our little Touch 'N' Dim circuit was designed with the express purpose of controlling a table lamp but it can be adapted to other uses as well, up to controlling 200 watts of power. Some circuits use body capacitance to detune an oscillator, but Touch 'N' Dim will sense the 60 Hz noise the body is always picking up and use that as the control signal. The construction of this switch is unique and quite interesting as well. The touchplates are fashioned from dimes rather than more expensive, and less eye-catching means.



CONSTRUCTION QUICKIES

Common Cathode Casino

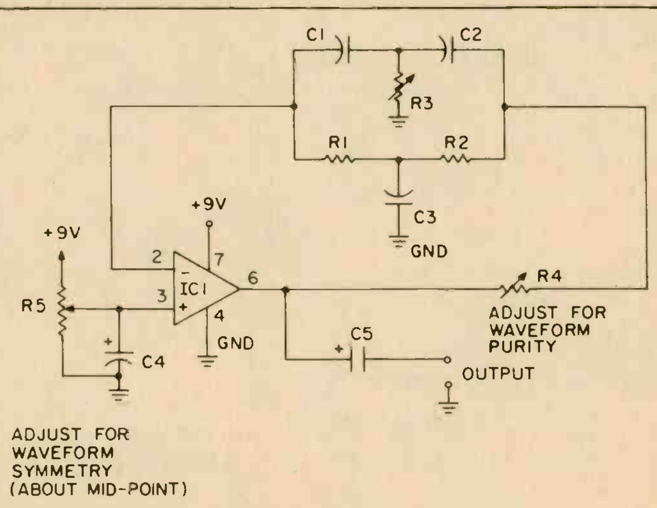
☐ The counter-display circuit of the "Quicker Than the Eye" project can be adapted to a game of chance for up to seven players, with a built-in provision to insure that "The House Never Loses." Note that all seven display segments, like the previous circuitry, have only one connection. Three outputs (pins 8, 9, 10) now go to the decimal point, via isolating diodes D1, D2, and D3. This gives "The House" a 3 out of 10 chance to take all bets. The clock should be set to provide a rapidly flickering display when the push-button switch is depressed. When the player holds down the switch for a few seconds and releases it, one of the segments, or the decimal point will remain lighted . . . and the odds are on the Point!



PARTS LIST FOR COMMON CATHODE CASINO
D1, D2, D3—1N4148 diode
IC1—4017 CMOS decade counter
LED1—DL-750, 7-segment display
Q1 through Q7—2N4401
R1 through R8—1,000-ohm, ½-watt resistor
S1—SPST momentary-contact switch

Sinusoidal Source

☐ The 741 op amp has become a classic for IC designers. Here it is as a Parallel-T audio oscillator, operated from a single power supply, which can be a 9 volt transistor battery. Note that the frequency-determining resistors and capacitors are fixed in the ratio of C1 = C2, C3 = 2 × C1 and R1 = R2, R3 = R1 × 0.1. To vary the frequency, all three pots should be ganged, but a fair degree of adjustment can be accomplished by varying R3 alone, although the output amplitude will fall on each side of the optimum value. ■



PARTS LIST FOR SINUSOIDAL SOURCE
C1, C2—0.022-uF, 10 VDC ceramic capacitor
C3—0.047-uF, 10 VDC ceramic capacitor
C4—100-uF, 15 VDC electrolytic capacitor
C5—10 to 20-uF, 15 VDC electrolytic capacitor
IC1—741 op amp
R1, R2—47,000 to 56,000-ohm, ½-watt resistor
R3, R5—5,000-ohm, linear-taper potentiometer
R4—100,000-ohm linear taper potentiometer

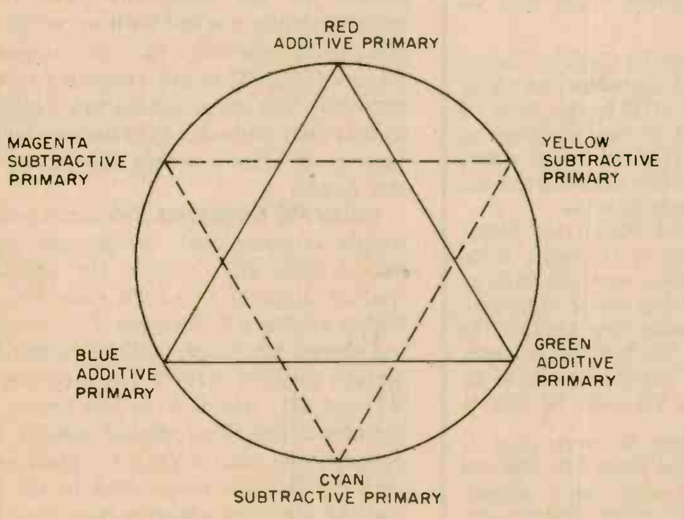
Darkroom Color Analyzer

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.

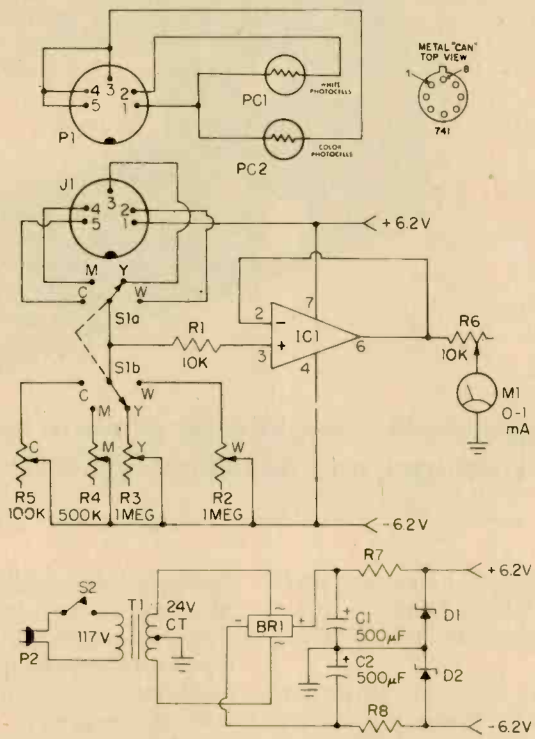
You can either buy or make the printed circuit board (see parts list). Either way, the first step is to prepare the printed circuit board. If you do it yourself, make it any way you like, using free-hand or template resist. Nothing is critical, but be certain there are no copper shorts between the terminals 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 1/4-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



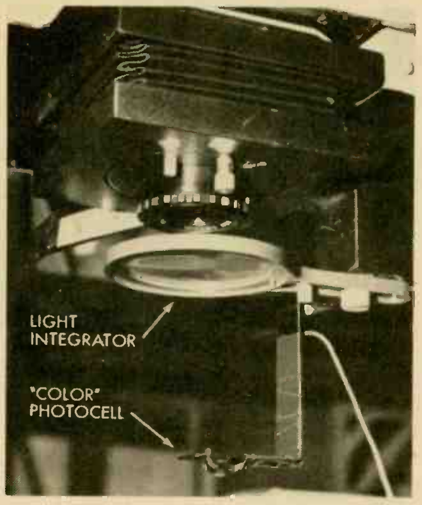
PARTS LIST FOR COLOR ANALYZER

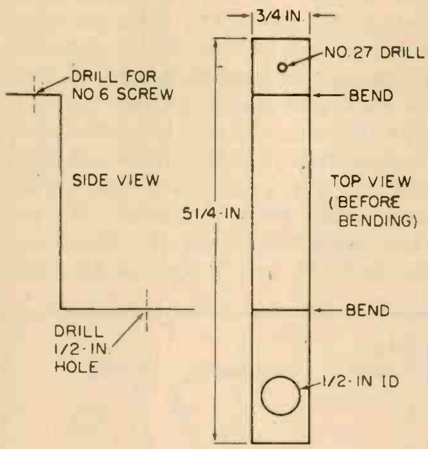
- BR1—50-PIV, 0.5-amp or higher silicon bridge rectifier
- C1, C2—500-uF, 10-VDC or better electrolytic capacitor
- D1, D2—6.2-volt, 1-watt zener diode
- IC1—type 741C operational amplifier, see text
- J1—5-pin socket, DIN-type (optional, see text)
- M1—0 to 1-mA DC meter, see text
- P1—5-pin plug, DIN-type (optional, see text)
- PC1, PC2—Clairex CL5M5L photocell, do not substitute
- R1—10,000-ohm, 1/2-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, 1/2-watt resistor
- R9—100,000-ohm, 1/2-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 $5.60. US orders add $2.00 for postage and handling; Canadian orders add $3.50. 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 $4.00 for each photocell. U.S. orders add $2.00 for postage and handling. Canadian order add $3.50. 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).

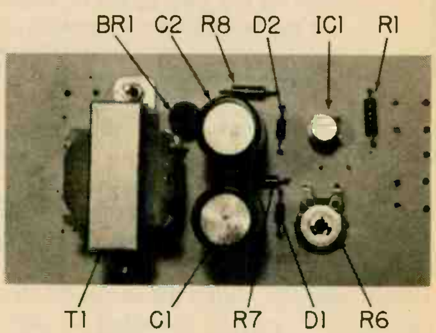
Potentiometers R2 through R5 can be linear or audio taper, though audio taper gives a slightly smoother adjustment; use whatever you have in stock.

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.

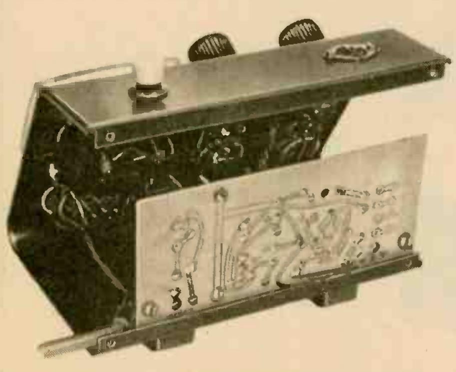
Meter M1 should be 0-1 mA with a zero-center scale. But these are expensive, so you can substitute any standard 1-mA meter you want. You will simply calibrate the instrument for zero-center.

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.

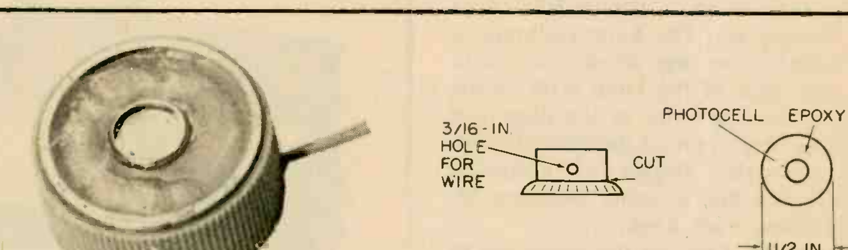
The Comparator. The photocells used for the comparator and exposure sensor, P1 and P2, must be Clairex type CL5M5L. Make no substitutions. From a piece of scrap aluminum ¾ to 1 inch wide, fashion a Z-bracket to the dimensions shown. Drill a ½-inch hole close to the end of the longer Z-leg. Fasten the 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.



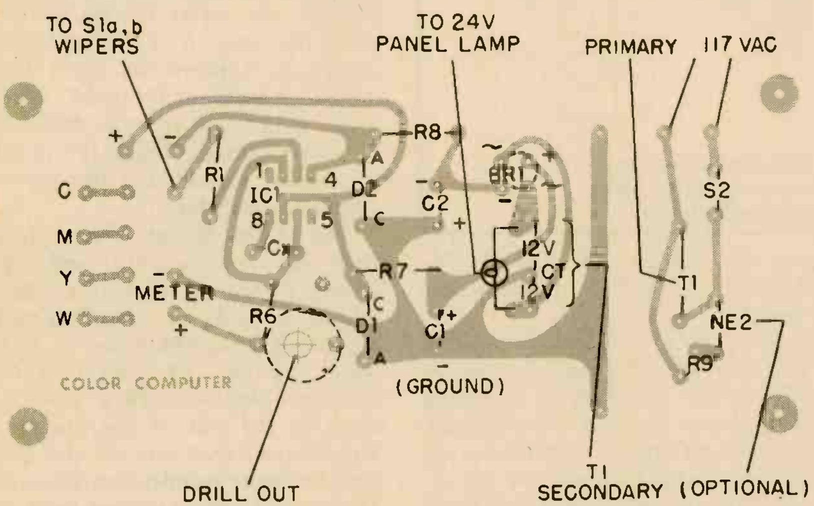
Rear view of author's color analyzer shows vertical mounting of the circuit board.



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.

COLOR ANALYZER

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



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.

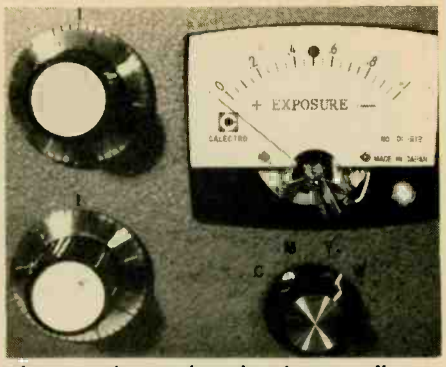
in the hole and attach the connecting wires; these can be extra-thin zip cord such as used for short-length speaker connections. (This whole bit reads a lot more complicated than it is. Use the photographs as a guide.)

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



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.

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.)

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 already 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.

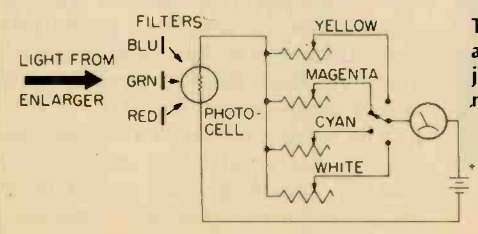
The subtractive printing procedure is particularly well adapted for use with a color analyzer, is the easiest method for the amateur, and is exceptionally fast-handling, so the illustrations to follow will refer to the subtractive system.

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.

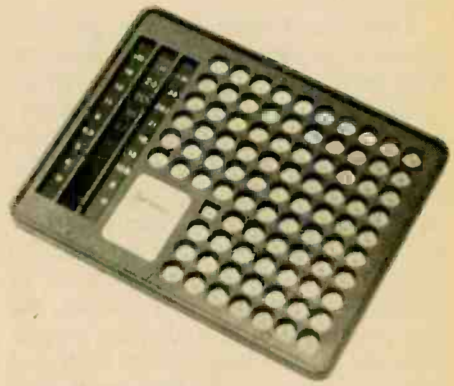
To Continue. . . . Place the color analyzer's probe on the easel or swing it under the lens (if it is mounted on the enlarger). Install a light integrator—which is nothing more than a piece of ground glass or its equal—under the lens, between the lens and the analyzer's probe. The light integrator scrambles 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 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.

(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.)



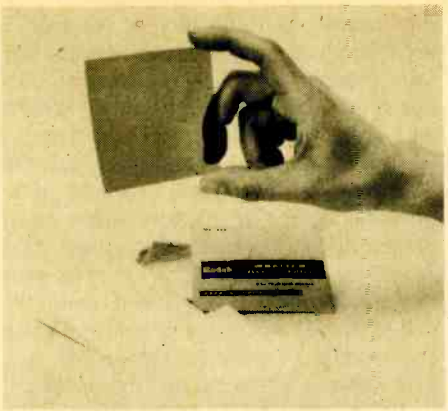
Modern color print chemistry techniques from Beseler include this subtractive color calculator to aid filter selection.

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 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



Kodak color printing filters. Typical filter designation CP20Y means color filter with a .20 density; the color is yellow.

required. If you still can't null the meter, it means magenta should *not* be in the filter pack.

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.*

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.

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. ■

SUB-BASEMENT RADIO

EXPERIMENTER'S DELUXE FET/IC VLF RECEIVER

JUST AS MANY of the "cliff dwellers" in modern multi-story apartment buildings have little-known basements and sub-basements, the radio spectrum has a "basement" LF (low frequency) band and a mysterious "sub-basement" VLF (very low frequency) band, little known to many electronics hobbyists and experimenters. The LF band goes from 300 kHz down to 30 kHz, and the VLF band from 30 kHz down to 3 kHz.

The lower portion of the LF band, from about 60 kHz to the upper portion of the VLF band (about 18 kHz), is used by the National Bureau of Standards to transmit coded, standard-frequency signals (similar to WWV). Special receivers are used for proper reception of these signals, which automatically adjust electronic laboratory generators to coincide with the standard frequencies. The U.S. Navy has found that the VLF band signals will penetrate into salt water and has established giant high powered transmitting stations that communicate with submerged submarines anywhere in the world.

Other nations maintain transmitting stations in the LF/VLF region for scientific and navigational purposes. These stations are subject to changes in frequency, power, and time of broadcast since there is still considerable experimentation. The stations usually transmit their call signs in CW at periodic intervals for identification.

Receivers for the LF/VLF "basement" transmissions are usually quite complex, but you can sample the activity in this portion of the rf spectrum with our simplified receiver project which covers the most popular portion of the bands from 20 to 50 kHz. This frequency coverage can be changed by using different values of inductances than specified in our plans. Plans are also included for a VLF-style loop antenna to be used with the receiver instead of the usual outdoor dipole antenna used in the higher frequencies. Inasmuch as VLF wavelengths are many miles long, a half wave antenna dipole is impractical at these frequencies.

The receiver uses two ICs and three FETs in a simplified regen detector circuit with a two-stage rf amplifier. Good audio volume is provided for earphone reception, and the receiver is housed in a compact metal utility box. Perf board style construction is used for ease in building the receiver.

The Circuit. Very low frequency signals picked up by the loop antenna are fed through coax cable to the input of IC1, the rf amplifier stage. The amplified signals are fed through C3 to the coil L1 and the second rf amplifier stage, IC2. L1 and the input capacity of IC2 act as a broadly tuned circuit for VLF signals: R2 controls the rf amplification.

Capacitor C6 couples the amplified rf signals to the oscillating detector stage of FET Q1. These signals are tuned by L2 and the S1 switch-selected capacitors of C8 to C18. Variable capacitor C7A/B acts as a fine tuning control for the VLF signals, and R5 controls the oscillation point and, therefore, the sensitivity of the detector stage.

The detected audio signals are fed through the low pass filter R7/C20 and coupling capacitor C21, to the audio gain control R8 and audio amplifier stage Q2. The amplified audio signals are coupled via the L3/C23 peak filter to the second audio amplifier stage of FET Q3. The peak filter is tuned to approximately 800 Hz to provide better receiver selectivity of the

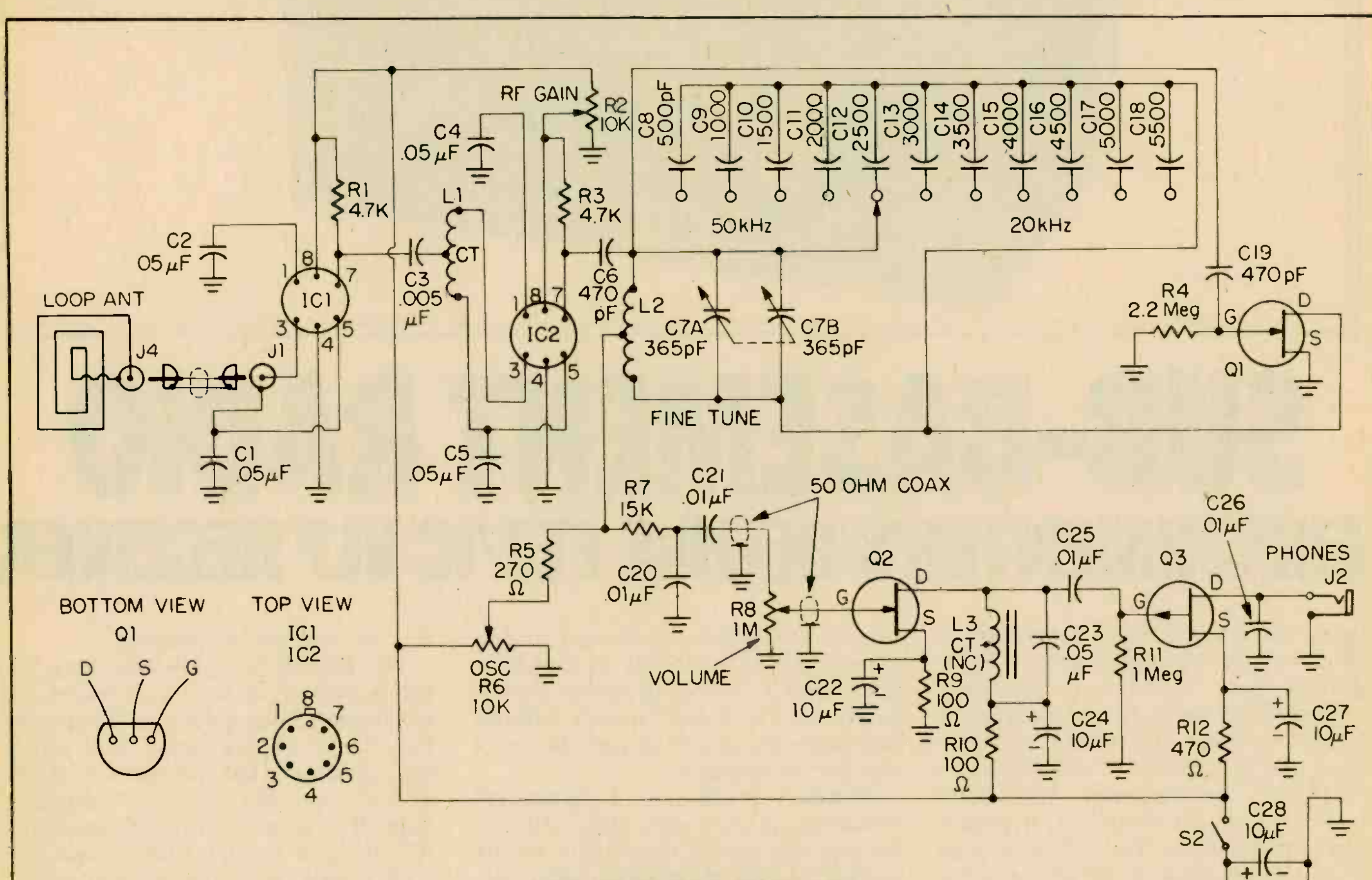
SUB-BASEMENT RADIO

VLF signals. The amplified signals are fed from the drain circuit of Q3 to J2 and can drive high impedance earphones (2000-ohm type).

Field effect transistors Q2 and Q3 form the audio amplifier stages. Q3 is a P-channel FET and therefore requires a relatively negative potential on its "drain" terminal. This is accomplished by grounding the drain through the earphone and returning the "source" to the positive power supply terminal.

Construction. Coils L1 and L2 are made from miniature transistor audio transformers by removing the laminated iron core. We used 10,000-ohm to 2,000-ohm center-tapped transformers for the coils in our receiver. The connections are made to the 2,000-ohm center-tapped winding only; the leads to the 10,000-ohm winding should be cut off close to the coil form. Coil L3 is a 1,000-ohm CT to 8-ohm miniature output transformer and is used *with* its iron core intact. The 1,000-ohm winding is used (no connection is made to the center tap), and the 8-ohm and center tap leads should be cut off close to the coil form.

The receiver operation is at low rf frequencies, but the wiring of the receiver should still be carefully done. For best results, follow our component layout as shown in the photos. Your best way to start construction is to cut a 4¼ x 7⅞-in. section of perf board and install it approximately halfway up the LMB-146 aluminum box. We used two 4¼-in. lengths of sheet aluminum



PARTS LIST FOR SUB-BASEMENT RADIO

C1, C2, C4, C5, C23—0.05-uF capacitor, 12-VDC or better
C3—0.05-uF capacitor, 12-VDC or better
C6, C19—470-pF capacitor
C7A/B—dual-gang 365-pF variable capacitor (TRW 273 or equiv.)
Note—A dual-gang 365-pF variable capacitor may be difficult to obtain. You can go the same route as pioneer radio builders by using two single-gang 365-pF variable capacitors and operate them in tandem (turn each knob the same amount).
All capacitors 15-VDC or better
C8—500-pF (see text for all capacitors, C8 to C18)
C9—1000-pF
C10—1500-pF
C11—2000-pF
C12—2500-pF
C13—3000-pF
C14—3500-pF
C15—4000-pF
C16—4500-pF
C17—5000-pF
C18—5500-pF
C20, C21, C25, C26—0.01-uF capacitor
C22, C24, C27, C28—10-uF electrolytic capacitor, 16-VDC
IC1, IC2—703-type integrated circuit
J1, J3—insulated phono jack, RCA type (see text)
J2—two-conductor phone jack
L1, L2—inductors made from small 10k to 2k audio driver transformers
L3—inductor made from small 1k to 8-ohm audio output transformer (see text)
Q1—N-channel FET, HEP-802 (Motorola)
Q2—N-channel FET HEP-F0015
Q3—P-channel FET HEP-F1035
R1, R3—4700-ohm, ½-watt resistor
R2, R6—10,000-ohm potentiometer, linear taper
R4—2.2 meg, ½-watt resistor
R5—270-ohm, ½-watt resistor
R7—15,000-ohm, ½-watt resistor
R8—1 meg potentiometer, audio taper
R9, R10—100-ohm, ½-watt resistor
R11—1 meg, ½-watt resistor
R12—4700-ohm, ½-watt resistor
S1—single pole, 11 position rotary switch (Calectro E2-161 or equiv.)

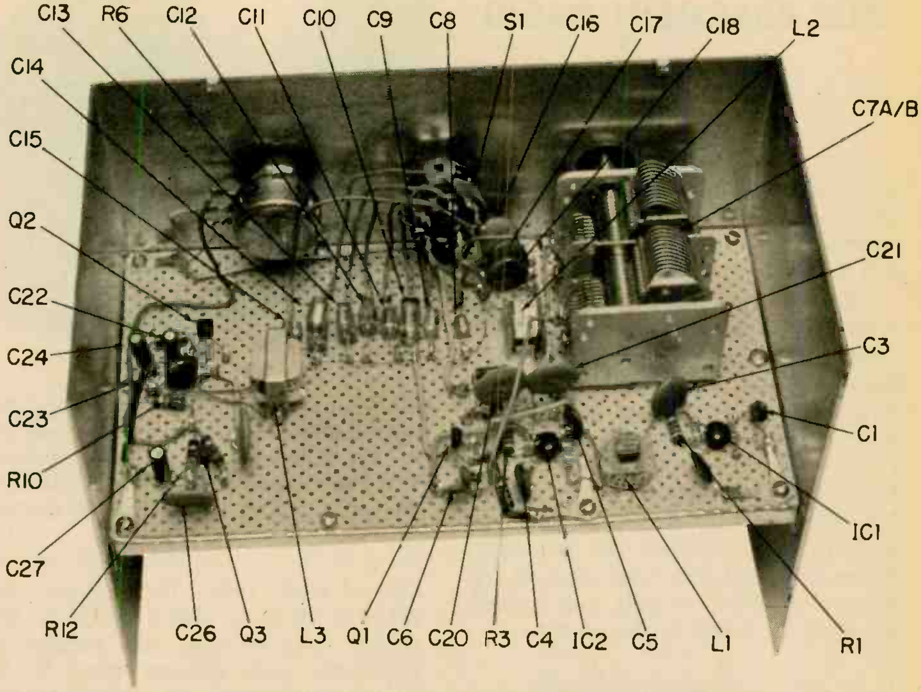
Note: values for bias resistors R9 and R12 may be changed for optimum performance.

Misc.—aluminum cabinet 8-in. x 6-in. x 4½-in. (Author used LMB 146), perf board, push-in clips, 50-ohm coaxial cable, knobs, hook-up wire, No. 28 enameled wire, plastic tape, solder, etc.

bent into brackets with sides approximately ¼ x ½-in. (½-in. side mounted to the box wall, and the ¼-in. side mounted to the perf board). Additional lengths of ¼-in. wide sheet metal stiffeners were added to the side of the perf board to increase the rigidity of the board. This may not be necessary in your unit.

More Mechanics. Locate C7A/B on the front panel as shown in the photos, and then cut a ½-in. or larger hole for the shaft. This will allow the frame of C7A/B to be mounted to the perf board and allow the shaft to protrude through the front panel without touching the metal panel. Note that the shaft *must be* insulated from the panel, or it will short the B+ at the detector circuit. If necessary, you can use an insulated coupling for the shaft. Make sure that you use a plastic tuning knob to minimize the possibility of short circuits.

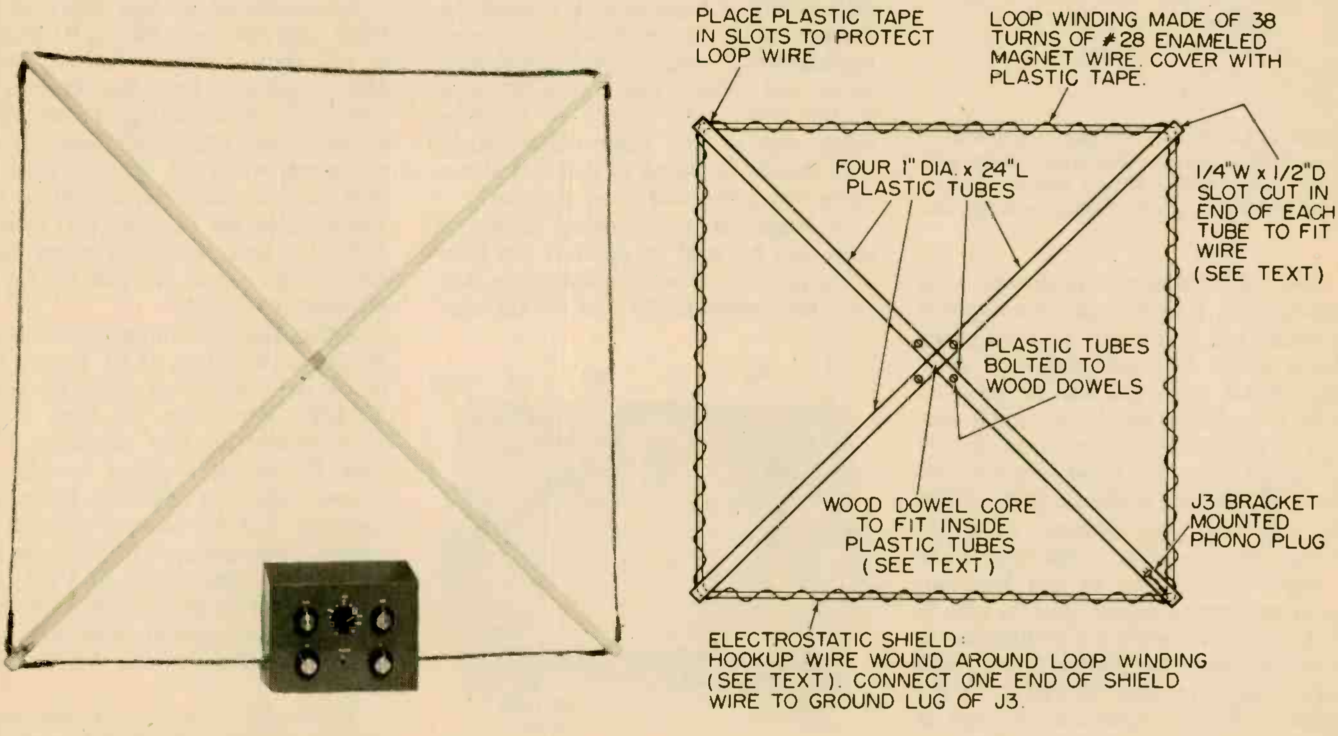
Locate and install the remainder of the front and side panel controls and components as shown in the photos. Make sure that you install serrated washers between the control bushings and the inside of the panels to prevent accidental disturbance of the position of the controls. Also, use insulating washers for J1 to keep the jack body from electrical contact with the box panel and electrical ground.



These are the major parts locations for the perf board. Note dual-gang cap C7A/B.

Most of the components on the perf board are connected to push-in clips. Keep the component leads as short as possible and group them around their particular IC or FET as shown in the photos. Wire the components as indicated in the schematic drawing and position the leads as shown in the board photo.

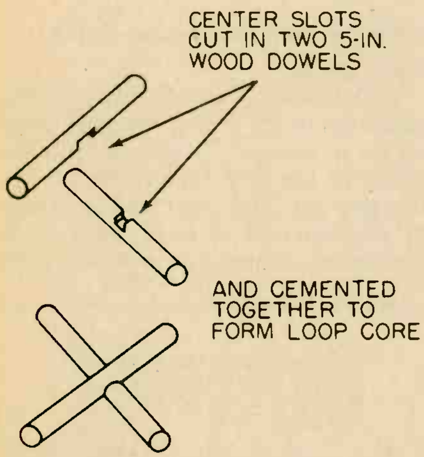
Coil forms L1 and L2 can be either cemented to the top of the perf board, or (as in our unit) held with an application of hot plastic glue from an electric glue gun. Use short lengths of coax or shielded wire to connect R8 to the perf board components as shown in the



Reinforced PVC tubes available from building supply outlets are lighter and easier to work with than dowel sticks when building an open air antenna support frame. The RCA-type phono connector makes a convenient way to use standard audio cable.

photo. Connect ground lugs at the board corners and on the C7A/B mounting screws for the necessary electrical circuit connections.

Capacitors C8 to C18 should have as accurate a capacity value as possible (select them on a capacitor bridge if possible), and they can be either ceramic or polystyrene types. Mount them with short leads around S1 and connect them with straight direct leads to the S1 lugs. If necessary, you can parallel capacitors to make up the required capacity values. Connect the remainder of the front and side panel controls and jacks to the board circuits, and position the leads as shown in the photos.



Dowel sticks for this assembly are available from lumber yards, hardware store and hobby shops. Notch with a wood chisel or a keyhole saw or whittle with a pocket knife.

The Loop Antenna. As shown in the drawing, the loop antenna is composed of four 1-in. diameter x 24-in. long plastic tubes. We used polyvinyl chloride (PVC) tubes that can be obtained from a building supply store. Or any type of plastic tube can be used as well. The plastic tubes are fitted over a wood-dowel center core as shown in the drawing, and the loop antenna wires are wound over the slots in the tube ends.

Begin construction of the loop antenna by cutting center slots in two 5-in. long wood dowels (of a diameter to fit snugly into the plastic tubes), and cement them together as shown in the drawing. Wood screws can be used in place of cement, or hot glue from an electric glue gun can be used as we did in our model.

Cut the plastic tubes to size and then

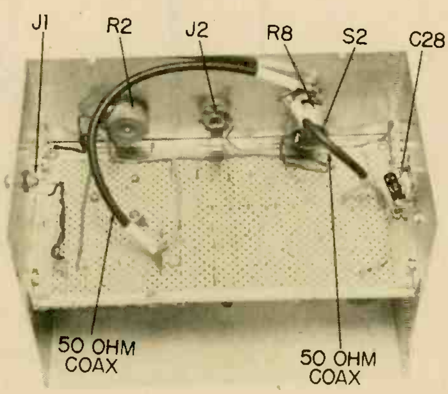
The front panel control knob "osc" sets the regenerative feedback point of the detector FET Q1 (it sets the audible "plop" point!). That "tune" knob is actually a fine-tune of the bandswitch-like "kHz" (course) control.

cut a ¼-in. x ½-in. deep slot on one end of each tube. Then mount the tubes to the wood dowel core with the slotted ends outward and parallel to allow the loop antenna wires to be wound around the ends as shown in the drawing.

Place plastic tape in the tube slots to prevent the wire from being abraded, and wind the loop with 38 turns of #28 enameled magnet wire, and cover the wires with a layer of plastic tape. Connect the loop leads to a phono jack (J4) mounted on the end of one of the plastic tubes.

To minimize noise pickup, wind an electrostatic shield composed of a spiral winding of hookup wire around the antenna loop. Leave about 1-in. spacing between the electrostatic shield wire turns, and connect one end of the wire to the "low" side (shell) of J4. The other end of the electrostatic shield wire should be taped so that it will not cause any accidental short circuits.

A length of good quality phono or coax can be used to connect the loop antenna to the receiver. Make sure that the "low" sides of P4 and J1 are con-



Experimenters should use a short length of 50-ohm coaxial cable for vol. control R8 connections (mini-type RG-174U or RG-58 U).

nected together (the outside shells of the jacks).

Range and Panel Markings. We used rub-on decals for the panel markings for our receiver model, but neatly drawn pen and ink markings on white tape can be used as well.

The receiver does not require any calibration for exploratory operation on the VLF band, and you can designate the approximate frequency of the S1 kHz switch as follows: 20 kHz (C18=5500 pF), 25 kHz (C15=4000 pF), 30 kHz (C13=3000 pF), 35 kHz (C10=1500 pF), 40 kHz (C9=1000 pF), 45 kHz (C8=500 pF).

For more accurate calibration with the transformers you used for L1 and L2, connect an audio oscillator to J1 through an isolating audio transformer.

Testing and Operation. The loop antenna can be suspended with a length of cord from one of the plastic tubes for easy rotation and operation indoors. Or the loop can be placed on a wooden chair for temporary operation. Note, however, that the loop should be away from AC appliances for best performance.

Set all controls to the extreme counter-clockwise position, and connect the receiver to a 12 volt DC power supply or battery. Connect the loop antenna to J1 with either coax or a length of good quality phono cable, and plug in a set of high impedance earphones at J2.

Adjust the *audio gain* (R8), *rf gain* (R2) and *fine tune* (C7A/B) controls to mid-range. Adjust the *osc* control (R5) clockwise until the detector circuit (Q1) is oscillating. There will be a "click" or "plopping" sound in your earphones when the detector stage first falls into an oscillating condition. Keep adjusting the *osc* control (R5) near this point for best sensitivity when tuning for signals. Adjust R8 and R2 for best reception of signals.

Adjust the *fine tuning* control (C7A/B) for each setting of S1 as you listen in on the VLF band from 20 kHz to 50 kHz. Reposition the loop antenna as necessary for best reception of signals. Practice is required to obtain the proper "feel" for operating the receiver controls. You can also try different loop antenna assemblies with different turns of wire for best results in VLF reception over different portions of the band. You can experiment with the tuning range by changing the values of L1 and L2.

Remember, this is an experimenter's project exploring the little-known, little-tuned very low frequencies. It's a good first-step project into VLF; why not "kick in" right now! ■

THE JUNK BOX SPECIAL

Power your projects, spend pennies for parts.

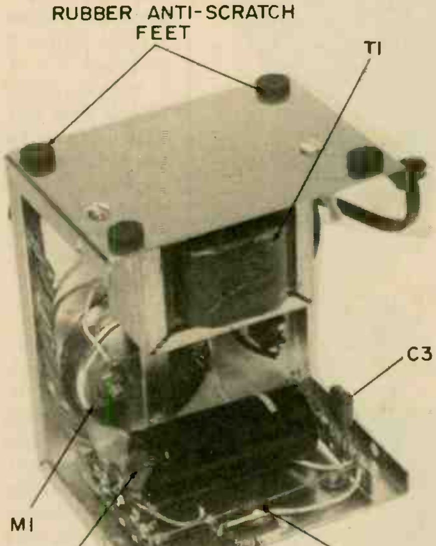
by Herb Friedman

Between 555 timers, TTL, CMOS, opamps and run of the mill transistor projects, the average experimenter is often faced with the need for a regulated power supply with a range of about 5 to 15 volts—just to try out a breadboard project. If you've priced any regulated supplies lately you know they don't come cheap. Maybe, just maybe, you might get one for $30 or $35.

With a little careful shopping, a reasonably stocked junk box and one or two "brand new" components you can throw together a regulated supply costing less than $10 that will handle most of your experimenter power supply requirements. One of these Junk Box Specials is shown in the photographs and schematic. The range of this model is 5 to 15 volts DC at currents up to 1 ampere. One of the common, 3-terminal regulators which are now flooding the surplus market provides everything in the way of regulation. Depending on the source, the regulator will cost you from $1 to $2.50; the higher prices often include an insulated mounting kit (worth about 25-cents).

5 to 15 volts from one 3-terminal regulator? Correct. If regulator IC1's collector terminal is connected to a voltage divider across the output—R1 and R2—the output voltage will be that at the junction plus the volage rating of the regulator, which in this instance is 5 volts. So, when potentiometer R2 is adjusted so its wiper is grounded the power supply's output is that of the regulator, 5 volts—perfect for TTL projects. As R2 is advanced, increasing the resistance from IC1's collector to ground, the voltage output increases.

Getting the parts. There are plenty of parts around to build this supply for under $10. If you go out and round up "all new" components the cost is likely to go well over $30, so forget about new parts. Power transformer T1 can be 18 volts at 1 ampere (or rated at higher current, though the supply's maximum output is 1 ampere), or 36 volts center-tapped at 1 ampere or more. Both the 18 volt and 36 volt transformers are glutting the surplus market. If you get an 18 volt transformer use the bridge rectifier shown in the schematic. If you get a 36 volt C.T. transformer use the full-wave rectifier shown below the schematic. The diode rectifiers SR1 through SR4, are type 1N4001, 1N4002, 1N4003, or 1N4004, which are also glutting the surplus market. Just to show you the savings possible, at the time this article is being prepared you can buy fifteen surplus 1N4001s for $1. Just one single "general replacement" for the 1N4001 from a national supplier is selling for over 40-cents. Get the idea how to save costs on this project?



To prevent scratching your workbench apply rubber anti-scratch feet or bumpers on the bottom of the cabinet. They are available in most hardware and houseware stores.

Capacitor C1 can be anything from 2000 to 4000 uF at 25 volts or higher. Look for an outfit selling surplus computer capacitors. If worse comes to worse you can get the value specified in the parts list in a Radio Shack store.

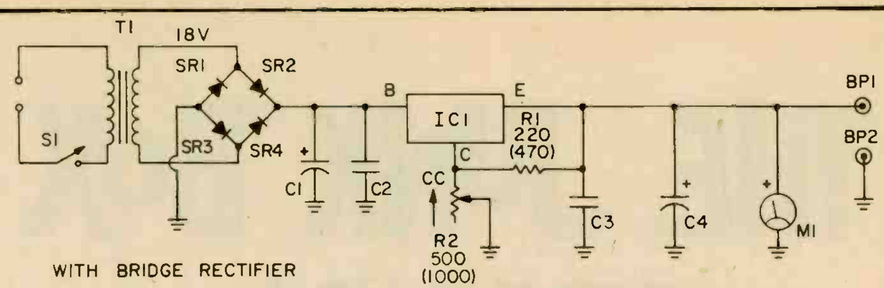
The 3-terminal, 5 volt regulator is another item easily found on the surplus market. With an adequate heat sink—such as the cabinet itself—the device can safely deliver 1 ampere. The unit shown in the photographs is a Motorola MC7805 (though you can substitute any similar type) obtained for $2.50 from Circuit Specialists. We have seen similar devices from other manufacturers selling for $1. The terminals B, C and E are indicated directly on the device or on the terminals—where they join the case. The collector (C) lead is connected to the IC's metal tab, and is normally grounded. Note that in this project, however, the collector terminal, and therefore the tab, is not grounded. You must use an insulated mounting kit consisting of a mica insulator and a shoulder washer. Place the insulator between the IC's body and the cabinet, or the tab and cabinet, and slip the shoulder washer into the opening (hole) in the body or tab. Pass the mounting screw from outside the cabinet through the mica washer, through the IC, and

JUNK BOX

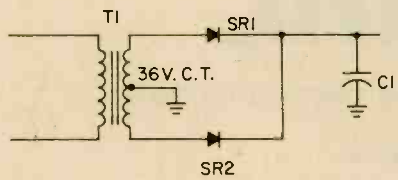
through the shoulder washer. Secure with a ¼-inch (or smaller, not larger) nut hand-tightened against the shoulder washer. Before going any further check with an ohmmeter to be certain the collector terminal is insulated from the cabinet.

Connecting wires are soldered directly to IC1's terminal leads; use a heat sink such as an alligator clip on each terminal if you have a large (greater than 40 watts) iron. Since the layout is not important, we suggest the arrangement shown, with IC1 positioned between two mounting strips so R1 can span across the strips and be soldered to IC1's collector terminal.

Finally, we come to the meter, a device that has become slightly more expensive than a barrel of Arabian oil. Any meter that can indicate at least the range of 0 to 15 VDC is adequate. The EMICO 0-30 VDC meter shown in the photographs was selling in one local store for $7.95, while we bought ours almost down the block as "surplus" for $2.99. A good source for surplus meters is Fair Radio Sales. You might not end up with a meter case that looks suitable for NASA, but the output voltage doesn't care two hoots whether the meter is a modern $25 dollar model or a surplus-special for a buck ninety-nine.



WITH BRIDGE RECTIFIER



ALTERNATE FULL-WAVE RECTIFIER

Virtually any DC voltmeter that can display the range of 0 to 15 volts can be used. The surplus market is loaded with less-than-$5 meters that are suitable if you don't mind a little extra scale coverage.

PARTS LIST FOR JUNK BOX SPECIAL

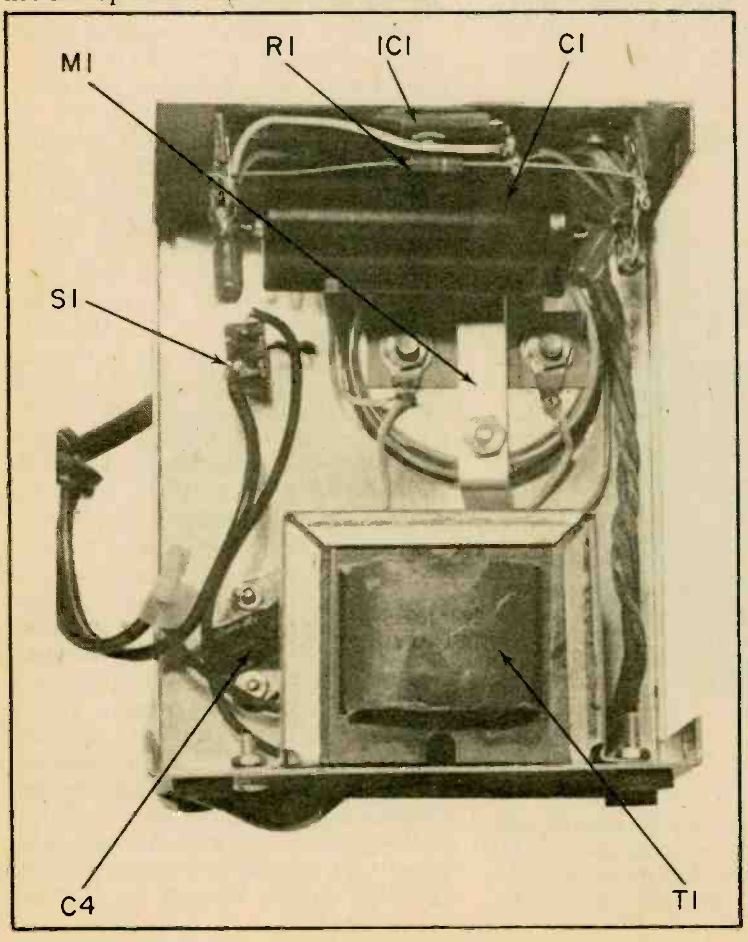
R1—220 or 470-ohms, ½ watt, 10% (see text)
R2—Potentiometer, 500 or 1000-ohms (see text)
C1—3300-uF, 35 VDC (see text) (Radio Shack 272-1021 or equivalent)
C2, C3—0.1 uF Mylar
C4—25-uF, 25 VDC or higher
M1—DC voltmeter (see text)
IC1—Motorola MC7805, 5 volt 3-terminal regulator (see text)
T1—Power transformer, secondary 1 ampere at 18 volts or 36 volts C.T. (see text)
SR1, SR2, SR3, SR4—Silicon rectifiers (see text)
S1—SPST switch
BP1, BP2—5-way binding posts
Misc.—Cabinet, terminals strips, etc.

Power switch S1 can be a separate SPST as shown in our project, or it can be part of R2. But keep in mind that a separate S1 allows you to turn the supply on and off without affecting voltage control R2's adjustment.

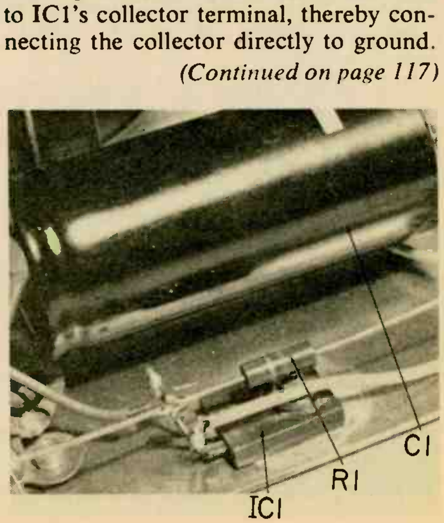
Finally, we come to R1 and R2. You will note that the schematic shows two values for each. One value for each resistor is in brackets (parenthesis). You can use either set of values as long as they are matched. If R2 is 500 ohms R1 is 220 ohms; if R2 is 1000 ohms R1 is 470 ohms. The reason we show both sets of values is because 500 and 1000 ohm potentiometers appear on the surplus market from time to time, but usually not together. This way, you can use whatever is available at low cost.

CHECKOUT. Set potentiometer R2 so the wiper shorts to the end connected to IC1's collector terminal, thereby connecting the collector directly to ground.

(Continued on page 117)

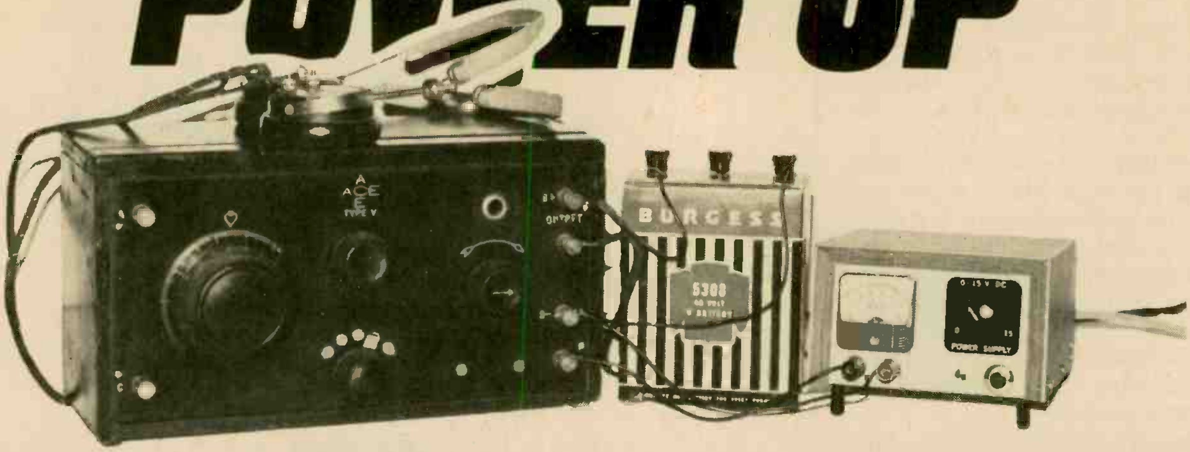


If you've had experience with assembly in tight quarters, you can shoehorn the power supply into a standard 3 x 4 x 5-inch Minibox. If your soldering iron is so big it burns adjacent wires when you make a connection, use a larger size cabinet.



In order to handle a full ampere, the IC regulator must be heat sinked to the cabinet. Make certain the collector and its attached sink tab (the back of the package) is insulated from the cabinet. Use silicon grease to insure heat transfer from the IC to the cabinet.

POWER UP

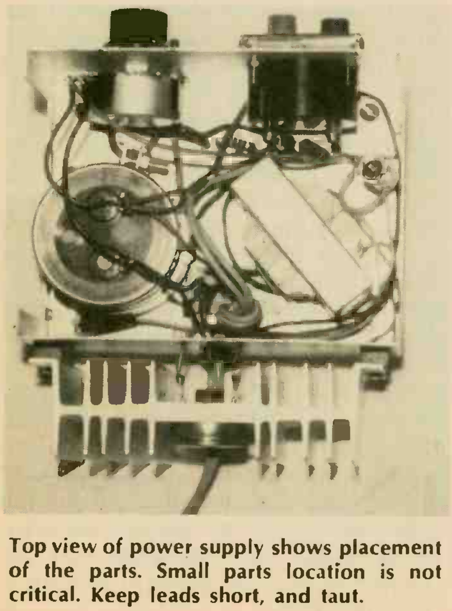


FOR ANTIQUE RADIOS

Collectors can power the filaments of old radios with this simple supply as well as supplying all the power for modern equipment.

by Jim Fred

☐ One of the most important things the serious antique radio collector needs if he wants to make those old radios work, is a power supply for heating the filaments of those ancient tubes. This is a low-voltage, variable output DC power supply. If you have an old enough tube manual you will find that various antique tube filaments need voltages of 1.1 to 5, as well as 14 volts DC at currents ranging from .06 to as high as 0.3 amperes. In addition to using it for operating the filaments of antique radios you can operate transistorized car radios when testing or repair them on the bench, and even charge many kinds of batteries, provided you don't try to draw much more than about 1.5 amperes of current from this supply. You might even use it for electroplating the nickel-plated binding posts, knobs, hex nuts, washers and lever-type switch handles which most antique radios built before 1928 have (such as Aeriola Jr. and Sr., and the Radiola III and IIIA).



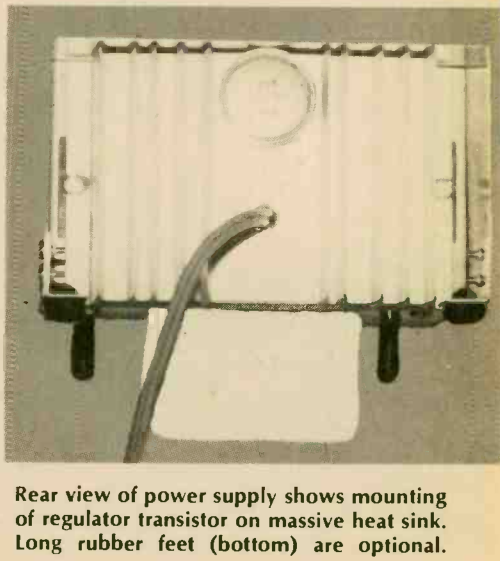
Top view of power supply shows placement of the parts. Small parts location is not critical. Keep leads short, and taut.

Now I love old tube radios, and I hate the new transistor sets, but transistors and diodes do have their proper place, and one of those is in power supplies such as this one.

This unit can supply from zero to 13 volts DC, at currents up to 1.5 amperes. This will handle the filament requirements of most sets with up to five tubes. For instance a one-tube Crosley Pup requires 3.3 volts at .063 amperes, while a six-tube set may require 5 volts at 1.5 amperes. Most pre-1928 battery sets fall within these limits.

How It Works. The transformer steps the line voltage down to 12.6 volts, which is changed into pulsating DC by the bridge rectifier. The switch is used to turn the power on and off while the pilot light indicates that the power is on. The capacitor smoothes out the pulsations and helps prevent hum in the radio whose filaments are being lighted. The potentiometer varies the voltage applied to the base of the power transistor. Varying the base voltage changes the operating characteristics of the transistor and causes the output voltage to vary.

How To Build It. This project is an ideal one for the beginning collector. There are no etched circuit boards to make, nor any critical wiring. You can make the supply as simple or as fancy as you like. If you will look at the photographs you can see that I made the cabinet from scratch, rescaled the meter, and made the dial plate. You too can add these distinctive touches to make a one-of-a-kind power supply. I do this because I enjoy designing and building from scratch and also because I don't like the garden-variety gray ham-



Rear view of power supply shows mounting of regulator transistor on massive heat sink. Long rubber feet (bottom) are optional.

POWER UP

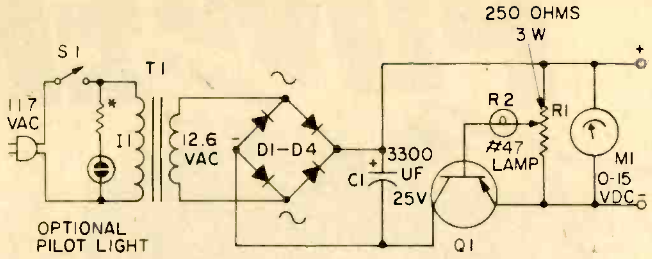
mertone boxes you can buy. For those of you that don't want to spend the time I have called out easily-obtained commercial parts and sources in the parts list.

Construction. The photographs show where the parts are placed inside the cabinet. Arrange the parts you are using in the approximate positions shown and mark the mounting holes. The holes in the bottom of the box are 5/32 inch in diameter to clear 6/32 machine screws. All components are mounted with ⅜-in. long by 6/32 pan head screws and hex nuts.

The panel is similarly marked by laying the parts down and marking their location. The potentiometer specified needs a ⅜-in. hole; the switch and pilot light holes will depend on the parts you use. On the back of the box are the holes for the transistor leads, the line cord grommet, and the heat sink mounting blocks.

Final Assembly and Wiring. Mount all the components in the bottom of the box, and place the insulating blocks on the back of the box. Be sure the mounting screws are short enough that they do not go all the way through the blocks and short the heat sink to the aluminum box. The collector lead of the transistor connects directly to the body of the transistor and is in turn fastened to the heat sink. Use a lock-type solder lug to mount the transistor to the heat sink.

Mount the front panel components



* RESISTOR IS INSIDE NEON PILOT LIGHT ASSEMBLY

Diagram shows easy-to-build circuit that supplies 0 to 13 VDC, at currents up to 1.5 amperes, to power antique radio filaments, operate modern transistor radios and a variety of electrical and electronic equipment in the home and shop.

PARTS LIST FOR ANTIQUE RADIO POWER SUPPLY

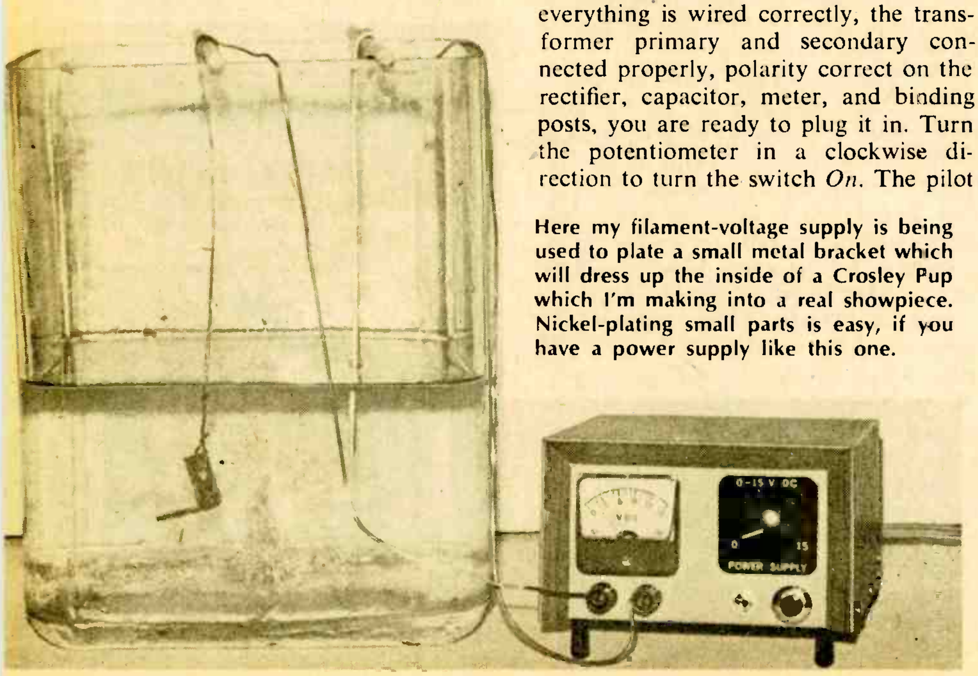
C1—Electrolytic capacitor, 3300 uF or more, 25 or more volts.
D1-4—Bridge rectifier, 2-A, 50 or more volts.
I1—indicator neon lamp assembly, including limiting resistor, for 117 VAC.
M1—Panel meter, 0-15 volts DC.
Q1—Power transistor, PNP, 3-amperes or more collector current.
R1—Potentiometer, wire wound, 250-ohm, 3 or more watts.
R2—No. 47 incandescent pilot lamp used as variable resistor, 150 mA, 6.3 V, bayonet base.
S1—AC power line switch, SPST.
T1—Power transformer, 117 VAC to 12.6 V, 1.2 A or more.
Misc.—Transistor heat sink, binding posts, cabinet, aluminum approx. 5-in. x 3-in. x 6-in., socket for #47 lamp, knob, heat sink insulators, dial plate, line cord.

with the proper hardware. After mounting the meter lay a soft cloth on the bench so the plastic meter face will not be damaged. Insert the rubber grommet, run the line cord through it and the clearance hole. Now you are ready to wire all the parts together. Follow the schematic drawing carefully and you will have no trouble.

Testing It Out after you are sure everything is wired correctly, the transformer primary and secondary connected properly, polarity correct on the rectifier, capacitor, meter, and binding posts, you are ready to plug it in. Turn the potentiometer in a clockwise direction to turn the switch *On*. The pilot light should light. If there is no smoke turn the knob clockwise and the meter should begin to indicate. With no load the meter pointer may go off scale. You will exceed 15 volts output only if you have no load on the power supply. The meter reading should be quite linear with the rotation of the voltage control.

Caution. Because the collector of many power transistors is connected to the outside case of the transistor, you must take care to isolate the negative output (emitter, in this circuit) of the power supply from the case. That's because the heat sink, being tied to the outside of the aluminum case, is not at quite the same (negative) potential as the negative output terminal. Another way of handling this problem is to do what I did—mount the heat sink on insulators before securing it to the aluminum cabinet. Then the negative output terminal can be tied to the case, as in most DC supplies.

You now have a power supply to be proud of, and you have a useful addition to your electronic workshop. In addition to operating antique battery radios, you can operate transistorized auto radios and even charge many kinds of batteries. Just remember you are limited to just two amperes of current with this unit. ■



Here my filament-voltage supply is being used to plate a small metal bracket which will dress up the inside of a Crosley Pup which I'm making into a real showpiece. Nickel-plating small parts is easy, if you have a power supply like this one.

SUPER SCA SOOTHER

Get fancy restaurant music for down-home kitchen prices with your own FM tuner.

by Herb Friedman

YOU CAN LISTEN TO SCA BROADCASTS at far greater distances with this SCA (Subsidiary Communications Authorization) adapter for your FM receiver or tuner than with previous designs, even those costing many times more. The secret lies in a new integrated circuit now available at very low prices which decodes the ultrasonic frequency the SCA signal is on. This IC is a PLL (Phase-Locked Loop) which acts as the detector of the 67 kHz SCA carrier wave which the subsidiary signals are transmitted on.

Although most people are unaware of it, many FM stations transmit not just the two signals of a stereo program, but one, two, or even three other programs, usually music, which cannot be heard by the owners of normal FM tuners or receivers. These programs can be heard only if you have a special SCA receiver, or if you have an SCA adapter, similar to the one described in this article.

Our SCA Super-Soother is so-called because the most common use for SCA is to transmit Muzak-like background music into stores and factories. It uses two ICs which cost $6.00 (total, including postage) plus a handful of resistors and capacitors. Because of the advanced design made possible by the PLL IC, Super-Soother can grab SCA signals which ordinary SCA adapters would lose completely, or at best receive with lots of hash and/or distortion—and who needs that with soothing background music, music to lull you by . . . or whatever?

Using a two IC circuit in an amplifier / (PLL)-detector configuration Super-Soother will actually permit you to DX your FM-SCA programs. No longer will your SCA listening be restricted to local FM stations. You can now monitor *fringe reception* FM stations with SCA programming.

But before going further let's take a look at what SCA is all about. When a *Subsidiary Communications Authorization* is granted to an FM station by the FCC the station is permitted to transmit up to *three more programs* in addition to its regular program (called the main channel program) by a special method of modulation. A standard FM radio—either mono or stereo—cannot detect the SCA programs. The regular listening audience hears only the main channel programming. In fact, there is no way a listener with a standard FM radio can tell the station is transmitting an SCA program(s). Only listeners with FM radios equipped with an SCA adaptor can hear the SCA program.

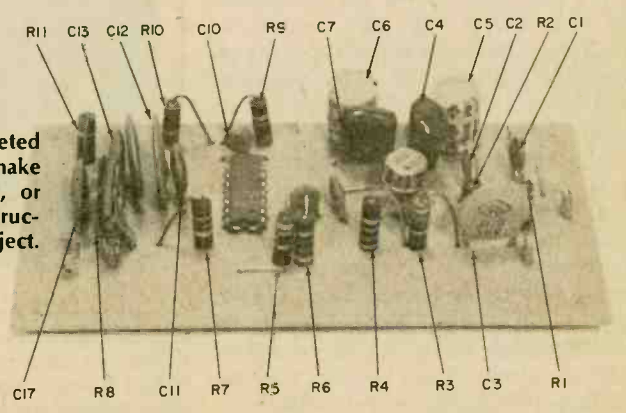
If you would like to tune in to these "phantom broadcasts" you can do so with Super-Soother SCA Adapter. It's super because its extra-high sensitivity permits reception of SCA programs that other low cost SCA adaptors can't detect.

What You Can Hear. For many years SCA has been used to transmit educational programs and weather reports to specialized audiences; it has been used for reading to the blind, and even for broadcasting some school tests. The most common use of SCA, however, is the transmission of background music—the type heard in restaurants and shopping centers—and ethnic music. For example, in the New York City area there are FM stations with SCA programs of the music of China, Greece, Ireland, and many others.

Best of all, this pleasant, interesting music is rarely, if ever, interrupted by an endless barrage of commercials or the patter of an announcer in love with his or her own voice.

How It Works. SCA programming is transmitted by a 67 kHz FM subcarrier (or sometimes 65 kHz impressed on the main FM carrier). When a station broadcasting SCA is received

Here's the way the completed board looks. You can make your own circuit board, or order it. Perf board construction won't do in this project.



SOOTHER

by a standard FM radio or tuner the SCA subcarrier is simply wiped out in the radio's detector and the listener has no idea it exists.

To receive SCA the regular FM detector output must be fed into a 67 kHz detector before the 67 kHz subcarrier is eliminated by the standard FM detector's de-emphasis network.

Until recently it took a lot of expensive hardware to receive SCA programs: a very sensitive receiver and a rock-steady detector. (A good receiver is needed because the SCA subcarrier is usually only 10% of the total FM signal.) Though many low-cost SCA adaptors have been available in projects, or in wired form, most had a tendency to burp, gargle or distort on weak SCA levels.

While the radio astronomy crowd had a great weak-signal detector known as the *phase-locked loop* or PLL, it was also true that the astronomical-use PLL was astronomical in price. Thanks to modern solid-state techniques, however, the Signetics Corp. has come up with a PLL specifically intended for SCA detection that's priced well under $5.

Available in both the standard 8-pin round and the 14-pin DIP IC packages the Signetics SE/NE565 requires virtually no external hardware for SCA detection. Most important, since the PLL automatically locks onto the incoming SCA subcarrier frequency the SE/NE565 will demodulate subcarriers of either 67 or 65 kHz without need for individual adjustment.

Combination Gets Results. Unfortunately, the phase-locked SCA detector requires at least 80 mV input from the FM detector for good reception, and this usually means that only one or two very strong, or local SCA stations can be received. To make our Super-Soother the best there is we have combined the PLL with a high gain operational amplifier. The result is the Super-Soother which can receive SCA programs even using a cheapie FM radio and an indoor (rabbit-ears) antenna.

Another plus feature of Super-Soother is that no large filter coils are needed to suppress the main channel program. Even SCA programs on stereo stations are received cleanly, with no trace of *stereo hash*. And because large coils aren't need the entire adaptor can be assembled on a 2¼-in. x 4¼-in. printed circuit board which you can purchase, or make, as you wish.

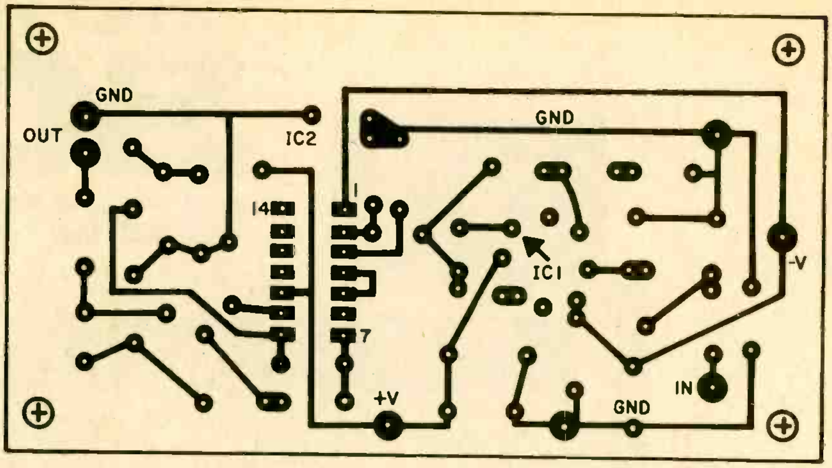
Because the gain of the adaptor is unusually high it must be assembled on the circuit board exactly as described to insure stability. You can't build this project on perfboard.

How The Circuit Works. The signal from your FM tuner's detector, before de-emphasis, is applied to operational amplifier IC1 through a high-pass filter consisting of C2, R1 and R2. The filter's effective frequency is 60 kHz, which removes just about all of the main-channel information. The frequency response of the amplifier is tailored by the feedback loop through R3 and C3 to further suppress main-channel information.

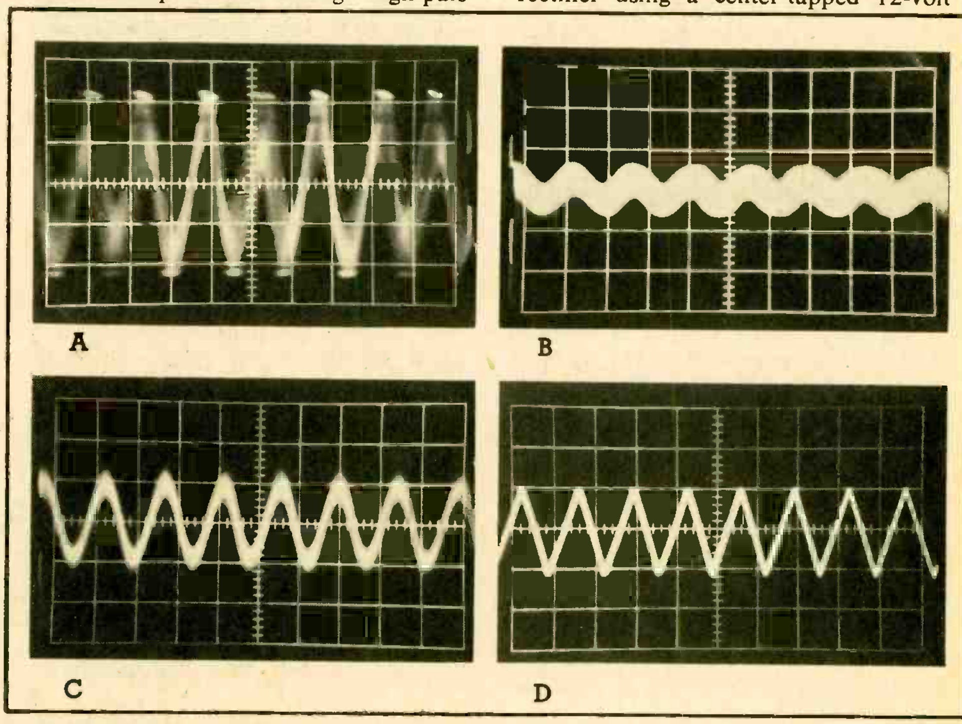
IC1's output is fed through high-pass filter C9 and R5 to IC2, the PLL detector. IC2's output is passed through a low-pass filter consisting of C12, C13, C14, R9, R10 and R11 which provides SCA de-emphasis and noise suppression. The output level at C15 is about 50 to 100 mV depending on the particular signal, and can then be fed to your hi-fi amplifier.

Since SCA audio response is limited to a maximum of 7 kHz just about any amplifier can be used.

Note that Super-Soother requires a bipolar power supply in the range of ±6 to ±9 VDC. The supply can be either batteries or a power-line bridge rectifier using a center-tapped 12-volt



Exact-size printed circuit board layout is shown here. Transfer the image to copper clad board using carbon paper. This is the bottom (copper) side.



Oscilloscope patterns will pinpoint any possible difficulty. You can use a general purpose scope since the signals are under 100 kHz. With "triggered" scopes, set the time base to u sec/cm. Photos B and C are input and output of IC1, the 67 kHz amplifier. If signal is clipped as in A, main channel program may break through—see text for curves. Normal IC2 pin 9 waveform is shown in the waveform of D. Vertical sensitivity B, 20mmV/cm; C, IV/cm.

filament transformer as shown on the schematic. Since the SCA adaptor requires only about 10 mA of current any small power transformer can be used.

Assembly. If you cannot make your own circuit board, you can purchase a drilled and plated board. See the parts list for information.

If you make your own board use a #56 bit to drill the holes for the push-in connecting terminals and trimmer potentiometer R8. Drill the corner mounting holes to clear a #4 screw. Drill the component holes with a #58, #59, or #60 bit.

Install IC1 and IC2 before any other components. Note that the IC1 lead opposite the case tab is #8. Insert the leads—beginning with #8 and push IC1 within ¼ to ⅜-inch of the board. Solder the leads and cut off the excess.

If this is your first IC project it would be wise to use IC sockets.

Hold the board so you are looking at the top, with IC1 to your left. Hold IC2 so the notch is away from you and insert IC2's leads into the matching holes. *Doublecheck the notch before soldering.*

Install trimmer potentiometer R8 and solder. Then install the three wire jumpers, and finally, the remaining components, taking extreme care the polarity of capacitors C5 and C6 is correct. Note that C5 has the positive lead connected to ground.

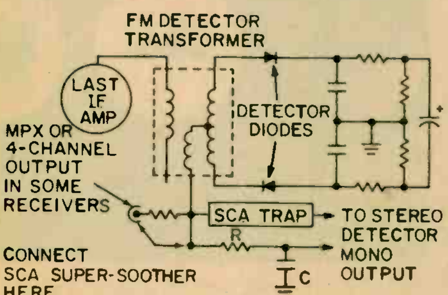
While capacitors C12 and C14 are indicated as 0.02 uF they aren't the easiest to obtain in miniature size. You can substitute two parallel-wired 0.01 uF capacitors.

The three oscillosope traces show what you can expect to get if you are tuned to an SCA station. Photo B is the input, IC1 pin 2; note the presence of a 67 kHz carrier. Photo C is IC1 pin 6; note the very strong 67 kHz carrier. Photo D is IC2 pin 9, the phase lock detector's voltage controlled oscillator triangular wave output.

If you don't get photo B, the trouble is the connection between the tuner and the adaptor. If you get photo B but not photo C, the trouble is in the IC1 circuit. If you get photo C but not photo D, the trouble is in IC2.

If you don't get photos C and D, there is most likely a major fault in the assembly; we have specifically designed the adaptor so one defective IC cannot disable another IC.

Setup And Checkout. Either a bipolar battery power source or an AC supply can be used. Since there is no difference (in this case) in performance between a ±6 and ±9 VDC supply use whatever you have available. For long-term battery life Burgess Z4 6-volt batteries are suggested. However regular (or long-life) 9-V transistor batteries will work fine. *(See page 118)*



The Super-Soother (or any other SCA adaptor) is connected after the FM detector, but before the deemphasis network, as here.

PARTS LIST FOR SUPER-SOOTHER

C1, 9—470-pF capacitor
C2—47 or 50-pF capacitor
C3—.005-uF capacitor
C4, 7—.1-uF capacitor
C5, 6—100-uF, 16-VDC or better electrolytic capacitor
C8—7 or 10-pF capacitor
C10, 11—.001-uF capacitor
C12, 14—.02-uF capacitor
C13, 17—.05-uF capacitor
IC1—op amp integrated circuit Signetics NE 531T (available from supplier listed below)
IC2—phase-locked-loop SCA detector integrated circuit Signetics NE 565A (available from supplier listed below)
R1, 5, 6—4700-ohm, ½-watt resistor
R2, 4—47,000-ohm, ½-watt resistor
R3—470-ohm, ½-watt resistor
R7—1800-ohm, ½-watt resistor
R8—5000-ohm potentiometer, circuit-board mounting
R9, 10, 11—1000-ohm, ½-watt resistor
S1—SPST switch
Misc.—Cabinet 6-in. x 4-in. x 2⅜-in. or larger, two batteries 9-VDC or 6-VDC unless power supply is used, battery connecting clips, phone jacks, wire, solder, etc.

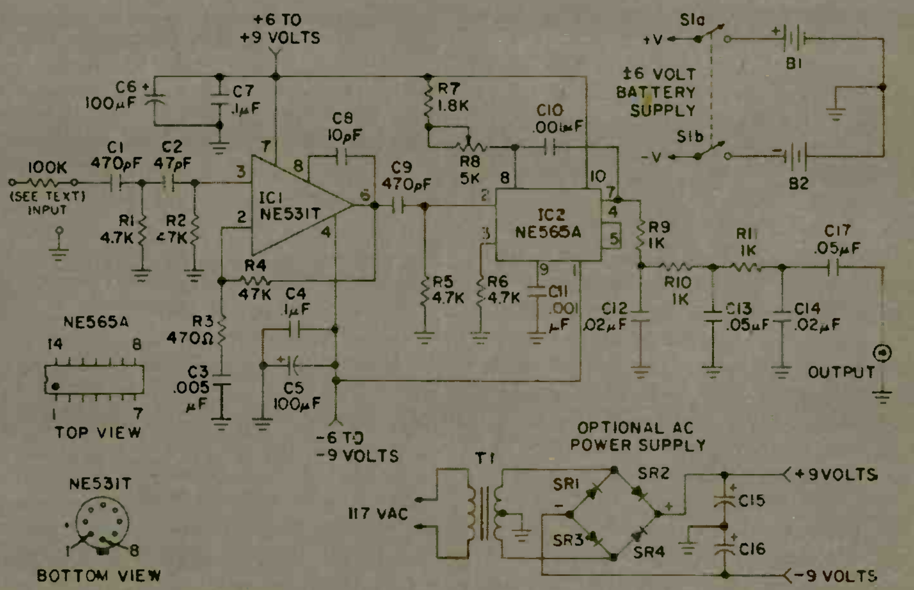
An etched, drilled, printed circuit board for the Super-Soother SCA Adapter is available from Electronic Hobby Shop, Box 192, Brooklyn, NY 11235 for $7.00. US orders add $2.00 for postage and handling: Canadian orders add $3.50. No foreign orders, please. Postal money orders will speed delivery: otherwise allow 6-8 weeks for delivery. NY state residents must add sales tax.

The two ICs for this project are available from Circuit Specialists Co., Box 3047, Scottsdale, Ariz. 85257 for $6.00 which includes shipping and postage.

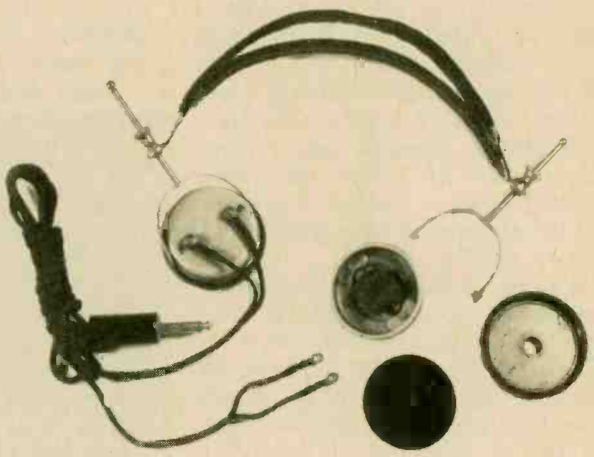
PARTS LIST FOR POWER SUPPLY FOR SUPER-SOOTHER

C15, 16—2000 or 2200-uF, 20 VDC or better electrolytic capacitors
SR1-4—Bridge rectifier, or separate diode rectifiers—anything over about 15 mA will do
T1—Small 12.6-VAC filament transformer

Blasting, raucous commercials can ruin an otherwise blissful evening of enjoying the FM broadcast band. Let Super-Soother calm the savage commercial. With this new adapter you'll be able to pick up even the weaker SCA (Subsidiary Communications Authorization) stations. These SCA stations transmit background music to such clients as stores and restaurants and, with a little ingenuity, right into your own living room as well. This particular adapter features extra-high sensitivity to receive, soothingly clear, SCA broadcast that many other adapters can't detect. Forget about commercials—get fast, fast, fast relief with Super Soother.



LOW-COST FILTER IMPROVES CODE RECEPTION



A few snips of aluminum and an old reed make headphones into high quality filter.

Amateur radio operators and short wave listeners often find CW (continuous-wave code) reception difficult, if not impossible, when several radiotelegraph stations are transmitting on, or near, the same frequency. Such interference can be eliminated, or at least greatly reduced, by a narrow band electronic filter circuit that can be installed in the radio receiver or transceiver. However, this extra equipment can cost up to $150.

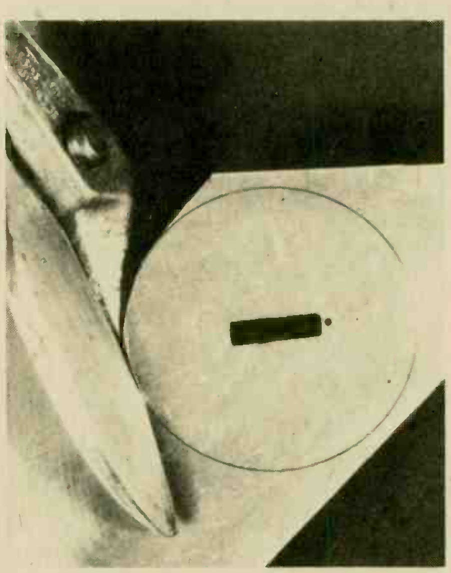
What You Need. A mechanical filter that will do the job can be built for $15, or less. In fact, should you already own a pair of earphones—the old-fashioned kind with metal diaphragms—and have access to a music store that will sell a used steel reed removed from an accordion (the writer was given his at no cost by such a store) you can build this effective filter for practically nothing.

A low-frequency reed should be used. A 440-Hertz (A) reed will work well. In fact, anything from about 300 to 1000 Hertz will be ok.

Should you have access to a steel (not brass) reed from an old harmonica, that could be used, too.

The removed reed is installed in one earphone of the headset so that it vibrates only when an incoming CW signal sets up a beat note at the reed's resonant frequency. All other interfering signals will automatically be eliminated since they will be of a different beat frequency, and the reed will not respond (audibly) to them.

To Get More Volume. Should you wish to have both earphones of the headset operate in this manner, the *matching* reed of the same length (they come in pairs in the instrument) must be installed in the second earphone.



A thin piece of aluminum is cut to same size disc as the original iron diaphragm of the 'phones. Rectangular center opening is for the iron frequency-resonant instrument reed. Small hole at right of rectangle is for rivet (or nut and bolt) to secure reed.

Here's how it's done: Use a pair of tin snips to cut from a thin sheet of aluminum (about 1/32-inch thick) a disc that will replace the earphone diaphragm. At the center of the aluminum diaphragm make an elongated hole that will permit the reed to vibrate freely (see picture) when it is riveted fast at one end of the opening.

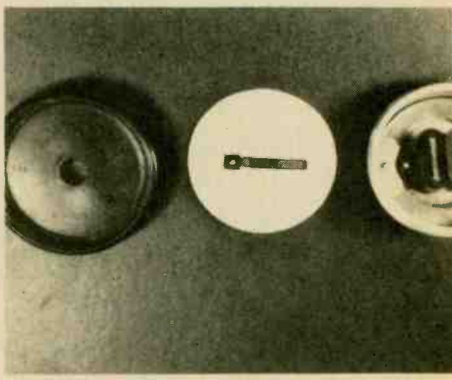
In installing the reed it is important that the little strip of steel extend into its opening for the *same* vibrating distance that it did when it was in the musical instrument.

The operation is simple. The aluminum diaphragm, being non-ferrous metal, will not be influenced by the magnets in the earphone. Only the reed will vibrate, instead. In use, only the desired CW signal will be heard loudly as the receiver or transceiver is tuned. The resulting silence can be uncanny!

PARTS LIST FOR CW FILTER

Communications-type headphones, 1000-ohms or more. (Not stereo headphones, which are all wrong for this project).
Steel reed(s) from accordion or harmonica.
One (or two) small rivets of the same size as were used to hold the reed in place in the instrument.

Use These Tools. You'll need a pair of tin snips or metal cutting shears. An electric (or hand) drill, with bits the right size for drilling out the rivet(s) which secure the reed(s) in the instrument will be needed, and you'll find a small square-edge (or triangular) file good for dressing the opening in the aluminum disc. ■



Original hard rubber cap (left), original magnet and coil assembly (right) and new aluminum diaphragm (center) with steel reed in place.

Las Vegas LED

Always win on the red with electronic roulette

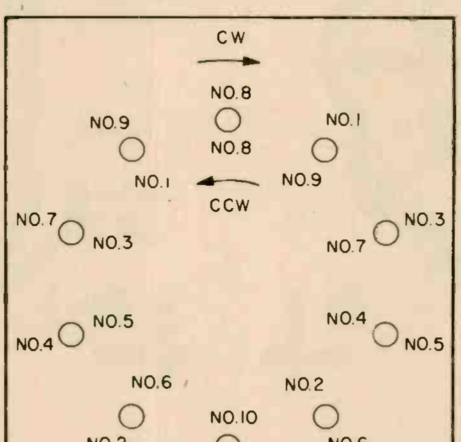
by Walter Sikonwiz

PEOPLE HAVE ALWAYS BEEN fascinated by games of chance, as diversions and obsessions. Inveterate gambler or not, chances are you'll really like *Las Vegas LED*, our version of that old favorite, Roulette. Here's more good news—you won't have to drop a bundle to cash in on the fun.

Las Vegas LED's spinning wheel of fate is a revolving dot of light, provided by a ring of ten LEDs. A glance at the photographs will show you that play is governed by three controls: *Accelerate, brake,* and *decay*. You start by pressing the *accelerate* button, which causes a red dot of light to revolve at an ever-increasing rate until a terminal velocity is reached. If you release *accelerate*, the spinning light will gradually coast to a standstill. The rate of deceleration is determined by the *decay* control. Pressing *brake* while the light is coasting causes a more rapid, but not instantaneous, halt to the spinning.

At least two games are possible, with this control format. Using a little imagination, you can probably devise more. The first possibility is similar to standard Roulette. A player presses *accelerate*, then releases it, and hopes that the number he has predicted beforehand will be the one at which the light ultimately comes to rest. Alternatively, the player starts the light into motion; then, upon the release of *accelerate*, he tries to stop the light on a number designated by his opponent, using only one pulse of the *brake* switch for this purpose. This second variation is quite a frustrating game; particularly so if various decay times are used. Decay times from about 1.5 to 15 seconds can be selected via the *decay* potentiometer.

How It Works. Before discussing construction, let's delve into the theory behind our Roulette game. We start with a very simple voltage-controlled oscillator. We then devise some means for converting the oscillation of our VCO into the apparent revolution of a spot of light (this might seem hard, but we'll see how simple it is later); the velocity of the light will be directly proportional to the VCO's frequency. The VCO's frequency, however, is proportional to the control voltage applied to it. We can produce acceleration of the revolving light if we cause the VCO's control voltage to gradually rise while the *accelerate* button is depressed. Conversely, deceleration of the light is synonymous with a gradual reduction in control voltage. How do we produce a control voltage that behaves in such a manner? We can charge and discharge a capacitor through resistors, and use the voltage across the capacitor as our control voltage.



Mount the LEDs in one of the two orders shown here, which one depending on whether you wish your wheel to "rotate" clock-wise (cw) or counter-clockwise (ccw).

Take a look at the schematic diagram. The voltage across capacitor C3 is our control voltage, and you can see how pressing S2, the *accelerate* button, charges the capacitor through R13. Once S2 is released, charge accumulated on C3 drains away through R13, R11, and *decay* control R12. Setting R12 to its maximum resistance produces the slowest rate of capacitor discharge; hence, as we'll see later, the revolving light will take a maximum amount of time to come to rest.

Brake switch S3 also discharges C3, this time through R14. Since the resistance of R14 is set to a relatively small value, the rate of discharge is quite rapid, and produces a quick cut in the speed of the light. It is the voltage on C3 that is to be our control voltage. Transistor Q11, functioning here as an emitter follower, reads C3's voltage; and because the emitter follower configuration is used, Q11 will not significantly contribute to the discharge of capacitor C3. At Q11's emitter we now have a voltage proportional to that on C3, which is used to drive our VCO.

Unijunction transistor Q13, along with R16, R17, R18, R19, and C4, comprise a relaxation oscillator, the frequency of which is proportional to the input voltage present on the left-hand end of R16. We don't have the nice, linear, voltage-to-frequency conversion of fancier VCOs, but what we have serves our purpose well enough. The output signal of our VCO appears across R19, and is a series of short-duration spikes with an amplitude of a volt or two. Such a signal won't be acceptable to the circuitry that follows, so we first feed it to transistor Q12, set up so that only a small input signal saturates it fully. The resultant output signal, available at Q12's collector, is a well-defined series of negative-going pulses, approximately 9 volts in amplitude.

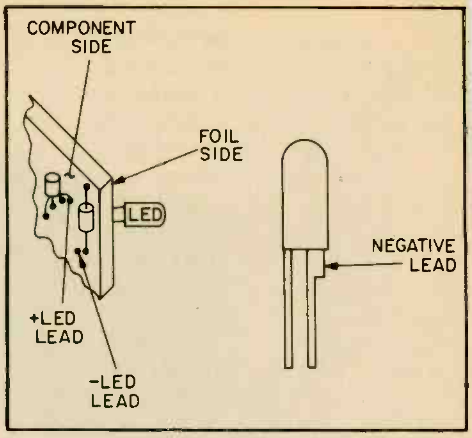
Now we convert the variable-frequency pulses from Q12 into the apparent revolution of a dot of light by using an integrated circuit known as a decade counter. One essential characteristic of such an IC is that it has ten outputs, and at any given instant of time, nine of these outputs will be at a low potential, while the tenth will be high. The second important feature of the decade counter is that whenever its input, (pin #14 in this case), senses a specific change in potential (high-to-low in this case), the lone high signal advances serially along the outputs. Specifically, successive input pulses to IC1 will cause the high signal to advance from output #1 all the way to output #10, and then back to output #1 again. You might logically assume output #1 to be available at pin #1, and so on; however, this is not the case. We won't discuss the actual location of the individual outputs, because this information is available on the data sheet that accompanies this IC.

From the schematic, we see how Q12's output feeds IC1's input, pin 14. The outputs of IC1 (pins 1 through 7, plus pins 9, 10, and 11) connect to ten LEDs through buffer transistors Q1 through Q10. These buffers are emitter followers; they're necessary because the IC alone cannot supply sufficient current to illuminate an LED. Whenever a particular output is high, its associated driver transistor will supply current to a LED, and light it.

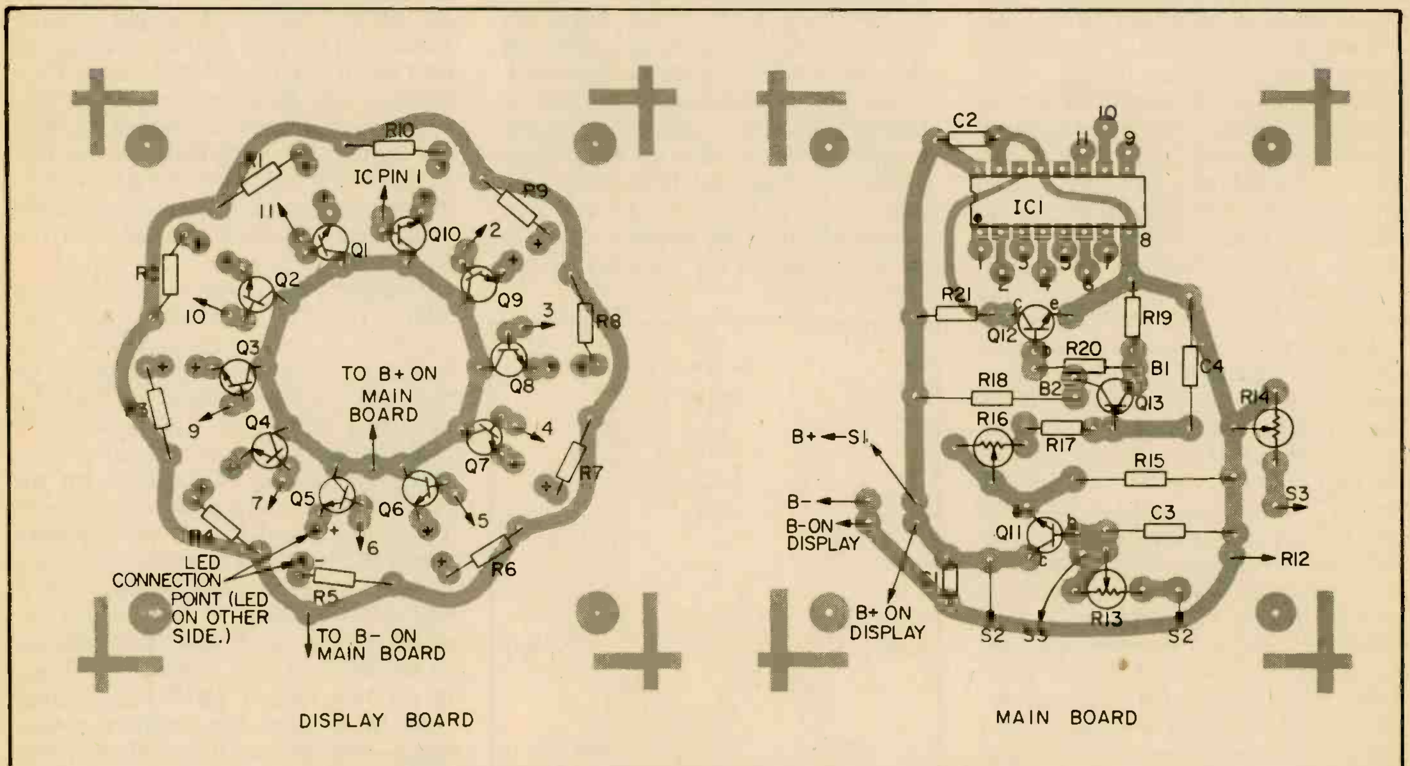
We arrange these LED's in a circle so that as we progress in a clockwise direction, starting at the LED associated with output #1, we encounter, *in proper consecutive order*, those LEDs associated with output #2 through output #10. When we feed an input signal to our IC, we see the LEDs fire sequentially so that a spot of light appears to be revolving in a counterclockwise direction. One full revolution of the light requires ten input pulses, and the rate of revolution is in direct proportion to the input frequency.

Let's review what we have: 1) the frequency of our VCO is controlled by the gradual charge and discharge of a capacitor; 2) the variable-frequency signal from the VCO feeds a decade counter, which drives ten LEDs; and 3) proper LED arrangement results in the apparent revolution of a single dot of light, with a velocity proportional to the frequency of the VCO. That's all there is to it.

Wiring. Since nothing about the circuit is critical, you may build it any way you wish. Perfboard construction is good. Alternatively, you might want to copy the PC layouts provided; the choice is up to you. A good place to begin construction is by drilling your cabinet to accept the ten LEDs. With a compass, lay out a small circle on a sheet of paper. If you intend copying the PC layout provided, the circle's radius should be exactly .9 inch. With a protractor centered at the circle's center, divide the circle into arcs at 36-degree intervals. Trim away any excess paper, leaving just the circle and a small border around it. Position the circle conveniently on your cabinet, and tape it down. With a fine, sharp awl make



LEDs are to be wired to the foil side, with their leads left long enough that their heads poke through the front cabinet (see text). Observe polarity; the negative leads of the LEDs are notched, as shown, and should be connected as both the pictorials and the schematic indicate.



The component sides of the main and display boards are shown in this pictorial view. Make certain that the main board's IC pins are all interconnected properly to the solder-points on the display board, as labeled. Connect, for example, IC pin 1 to Q10. Don't forget about R11 which is not shown and is wired point-to-point between R12 and S2.

slight indentations in the cabinet at the points where the circle is subdivided into arcs. Remove the circle, and at each indentation drill holes through which the LEDs can protrude.

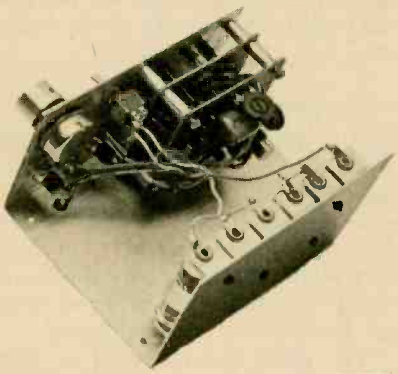
The drawing given shows the order of mounting of LEDs for both clockwise and counterclockwise revolution. The PC layout supplied for the display board provides counterclockwise revolution of the light.

The majority of the components mount on two circuit boards—either the main board or the display board. Even if you decide not to use a PC board, the PC layout provided for the display board may be helpful to you. Note that the arrangement is particularly simple, even though a good many parts are involved, because a radially symmetric pattern is employed instead of the usual rectilinear layout.

When installing components on the display board, follow the dimensional details in the accompanying drawings. Note that Q1 through Q10, and R1 through R10 mount on the component side of the board. LED1 through LED10 mount on the opposite foil side, with leads of such a length that the tops of the LEDs extend beyond the spacers and through the cabinet's panel. The semiconductors that mount on the display board are not especially fragile, but as is the case with all solid-state devices, excess heat can be damaging. Solder all connections quickly, using a 25-watt iron and fine, rosin-core solder. Twelve wires will run between the display board and the main board; ground, +, and the ten counter output leads.

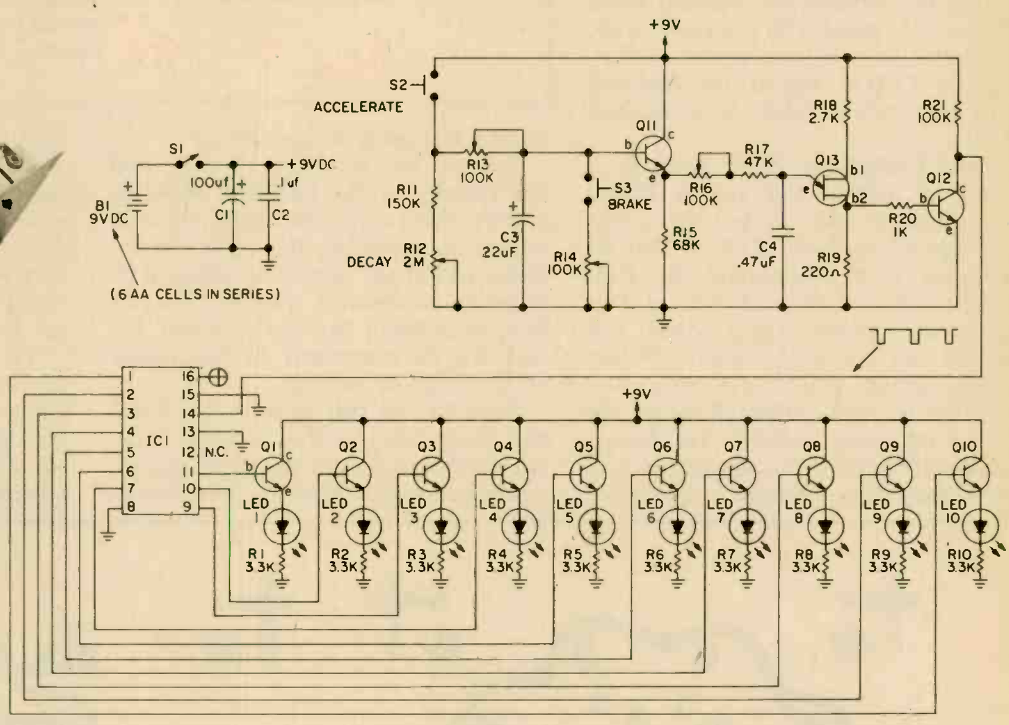
The main board contains the rest of the components. Note that if the PC patterns supplied are copied, the main board may be stacked right behind the display board. This makes for a very dense packing arrangement, but if you have ample space, the boards may be mounted in any manner you like. R11 does not appear on either circuit board; instead, it is wired point-to-point between R12 and S2. Be sure to use a 16-pin socket for IC1. This IC is a CMOS unit, and should be inserted into its socket only after all soldering is finished. If, in checking out your unit, you should find an error that requires re-wiring, remove IC1 before applying a soldering iron to the board.

In assembling the circuit, pay atten-



Inside view of Vegas LED showing stacking of PC boards.

Completed Vegas shown fully assembled, and installed in case.



PARTS LIST FOR LAS VEGAS LED

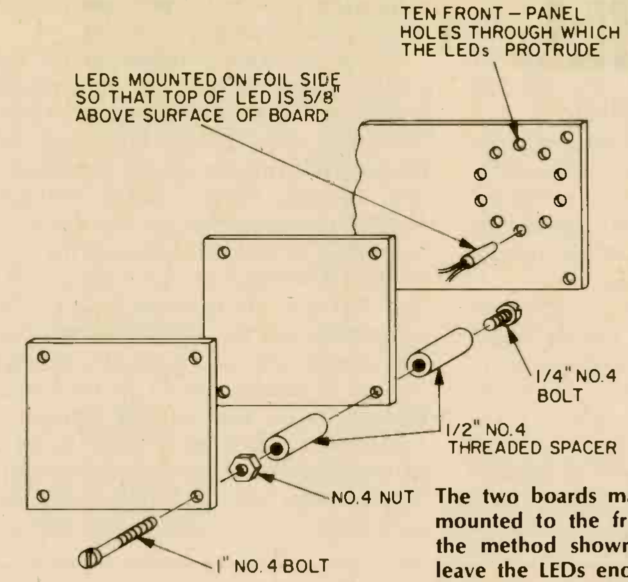
B1—Six AA (penlight cells) 1.5 VDC
C1—100-uF, 16-VDC capacitor
C2—.1-uF capacitor
C3—22-uF, 16-VDC tantalum capacitor
C4—.47-uF, capacitor
IC1—Decade Counter/Divider CD4017
LED1-LED10—Light Emitting Diodes
Q1-Q12—2N3904 transistors
Q13—Unijunction transistor
R1-R10—3300-ohm resistor
R11—150,000-ohm resistor
R12—2-Megohm potentiometer
R13, R14, R16—100,000-ohm trimmer
R15—68,000-ohm resistor
R17—47,000-ohm resistor
R18—2700-ohm resistor
R19—220-ohm resistor
R20—1000-ohm resistor
R21—100,000-ohm resistor
S1—SPST toggle switch
S2, S3—SPST pushbutton switches, normally open
Misc.—Battery clips, IC socket, aluminum spacers, wire, solder, hardware, etc.

You might not be able to afford a trip to Vegas; but Las Vegas LED will bring the glittering, gambling glamor of that city right into your own home town. When you assemble the circuit, just pay strict attention to the orientation of C3 and C1. It also pays to doublecheck the positions of all ICs and transistors; you'd be surprised how often a simple positioning error can lead to hours of fruitless trouble-shooting. The boards may be mounted in any way you like within the cabinet, but remember to leave room for the batteries to fit into later on. Finally, make absolutely sure you have positioned the LEDs properly depending on whether you want clockwise or counter-clockwise rotation of your "wheel." Follow the diagram on the first page very exactly. Once it's all together just get your bet down and start Las Vegas LED spinning around.

Las Vegas LED

tion to the orientation of C3 and C1. Likewise, make sure the transistors and IC are correctly positioned. The LEDs must also be properly oriented. The leads of all these devices are identified on the packages in which they are sold. Because of the circuit's low power consumption, six 1.5-volt penlite cells in series will power it for a long, long time. A single 9-volt transistor battery could also be used.

Because this is not a finicky circuit, the operating controls and circuit boards can be mounted in any convenient way inside your cabinet, but be certain to allow sufficient room to accommodate the batteries. When you've completed cutting and drilling the cabinet, finish off the front panel with press-on decals. As shown in the photographs, LED1 through LED10 should be identified with numerals applied in a random order.



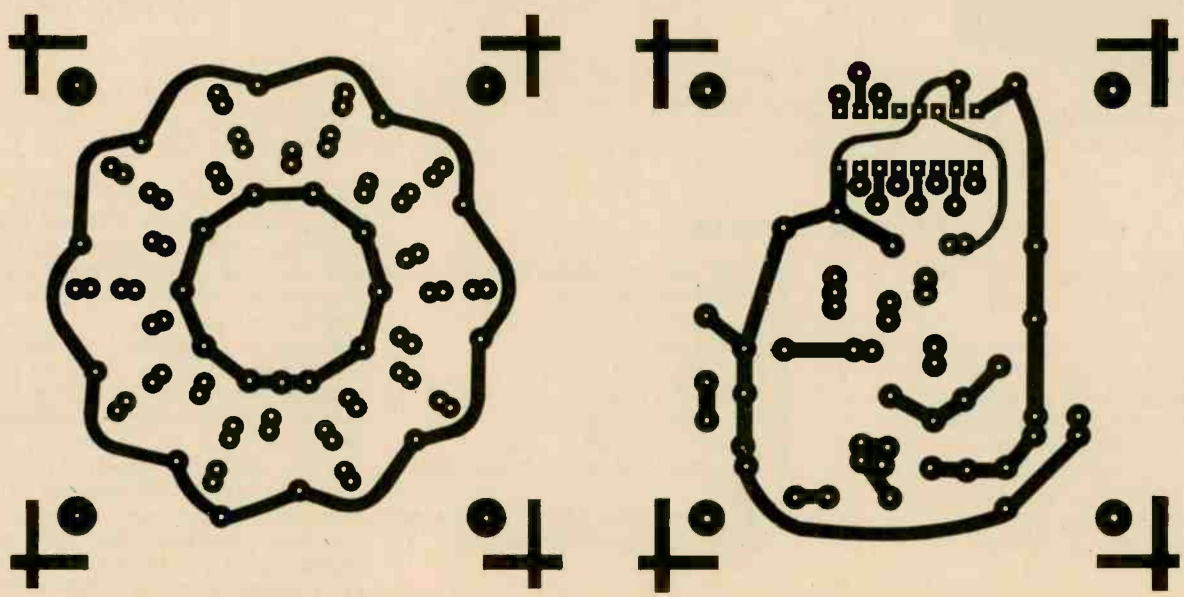
The two boards may be easily and neatly mounted to the front panel by following the method shown here. Make sure you leave the LEDs enough lead, and that you mount them to the foil side of the display board.

Final Calibration. After assembly is complete, only a few simple adjustments are necessary to put the circuit into operation. Turn R12 so that its resistance is at a minimum. Set R13, R14, and R16 to the midpoints of their ranges of rotation. Apply power, and depress the *accelerate* button. Within several seconds you should see a spinning dot of light. Adjust R16 for the desired maximum velocity. Too high a maximum speed blurs the image and spoils the effect, whereas a slow-poke display is equally undesirable.

Release the *accelerate* button, and the velocity of the light will diminish rapidly. Press *accelerate* again, and then release it, repeating the cycle several times, and at the same time adjust R13 to get an acceleration response that you like. In general, the best position for R13 will be somewhere in the middle of its range of rotation.

Turn R12 so that its resistance (and the decay time) is a maximum. Press the *accelerate* button until the display reaches maximum velocity, then release it, and press *brake*. Note the rate at which the display is slowed down. Adjust R14 while alternately pressing *accelerate* and *brake* until you obtain a rate of deceleration that you like. A very rapid braking action is undesirable; the brake should diminish the velocity, not halt motion instantaneously.

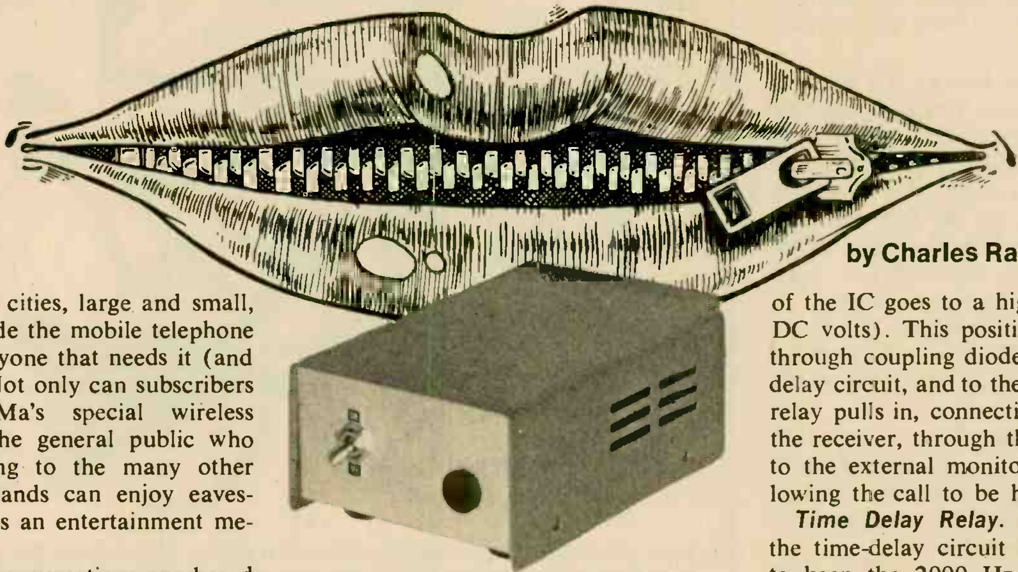
The game may be used as already described in the opening paragraphs. However, just as dice can be found as constituent parts of many other games, so too can Las Vegas LED be adapted to games of your design. ■



Las Vegas LED uses two compact PC boards to keep its "wheel" spinning. The display board, on the left, takes advantage of a repetitious circuit to achieve a neat, clean symmetry of design. The main board, on the right, is also simple to etch and wire. Use these two full-size patterns as templates for your own Las Vegas LED.

MA BELL'S MOBILE-TEL LIP-ZIPPER

Easi-build silencer lets you listen in on land-mobile phone talk with any regular communications set.



by Charles Rakes

☐ In almost all cities, large and small, Ma Bell has made the mobile telephone available to everyone that needs it (and can afford it). Not only can subscribers benefit from Ma's special wireless phone service—the general public who are now listening to the many other public service bands can enjoy eavesdropping on it as an entertainment medium.

Many of the conversations overheard on Ma Bell's mobile phone frequencies would make a person blush, even in these loose and liberal times, because most users don't have the foggiest idea that their phone conversations can be overheard, and on an ordinary multiband receiver. For the majority of us, who no longer have the advantage of the old party-line telephone system it's a great way to once again catch up on the latest gossip with the no-holds-barred *MBMT Lip-Zipper*. That is, *Ma Bell's Mobile Telephone*, Lip-Zipper.

Who Needs Lip-Zipper? You Do! Now hold it just a second. Why can't you just tune in on the public service band and sit back and enjoy listening to the gossip? Well, you can. This part of the operation is just that simple, but the problem is what happens when no one is using the mobile phone radio channel. Good old Ma Bell places an *idle tone* of 2000 Hz on the channel during this *non-busy period*, and holds it there until the system becomes busy again. This audio tone is transmitted so that the subscriber's receiver can tell when the radio channel is open for use. This is all well and good for the complex mobile telephone system, but it is darn annoying to sit and listen to a continuous 2000 Hz tone while impatiently waiting for the next juicy call to come in. (Ed Note: Maybe that's why Ma chose that frequency. It could just as easily have been one above the limits of the audio range.)

We Lick the Problem. Our handy-dandy MBMT Lip-Zipper shuts Ma's mouth during the tone period. During this time our Lip-Zipper disconnects the speaker from the receiver, giving us peace and quiet, and when the channel is put back in use the audio is routed to the speaker so we don't miss anything.

How Lip-Zipper Zips. The heart of the Zipper is a 567 phase-locked loop (PLL) IC tone decoder tuned to respond to the 2000 Hz idle-tone frequency. The output of the 567 IC (pin 8) is direct coupled to a time-delay relay driver transistor, Q1. When a 2000 Hz tone signal is present at the input of the PLL (pin 3), the DC output (pin 8) of the IC is low—near zero volts. During this time no DC bias is present at the base of Q1, and the relay is not operated. The relay remains in this condition as long as the tone is present at the input of the IC.

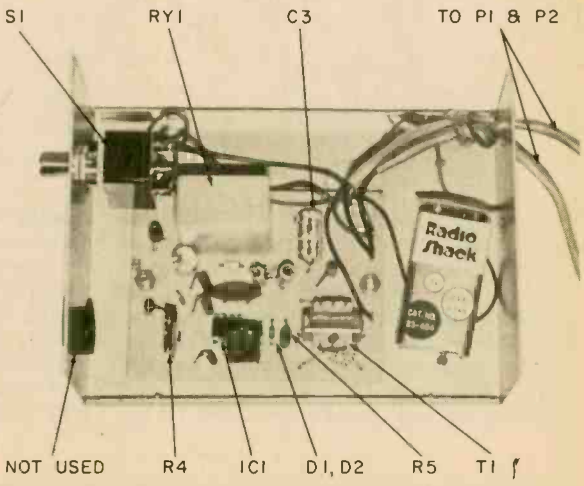
At the instant the channel goes into use the tone is removed and the output of the IC goes to a high state (positive DC volts). This positive voltage is fed through coupling diode D3 to the time-delay circuit, and to the base of Q1. The relay pulls in, connecting the output of the receiver, through the relay contacts, to the external monitoring speaker, allowing the call to be heard.

Time Delay Relay. The function of the time-delay circuit (C6 and R6) is to keep the 2000 Hz audio-frequency components that are present in normal speech from causing the relay to chatter. Without this delay circuit the relay would cut in and out, badly interrupting normal voice conversations.

The input of the Zipper is matched to the receiver's audio output by transformer T1. The audio signal level at the secondary of T1, is limited by diodes D1 & D2 to maintain a near constant level at the input of the PLL.

A DPDT toggle switch is included to allow the receiver's audio to pass directly to the monitor speaker when the Zipper is turned off, and it places Zipper's mouth-shutting circuit into operation when the switch is in the *On* position.

Putting Zipper Together. Construction of Lip-Zipper is simple and straightforward. It can be built either on perfboard or on a printed-circuit



Interior view of completed Lip-Zipper showing major parts locations. Consult parts layout for location of small components.

LIP-ZIPPER

board. The choice is yours because the layout isn't at all critical, and the circuit will perform in almost any physical configuration.

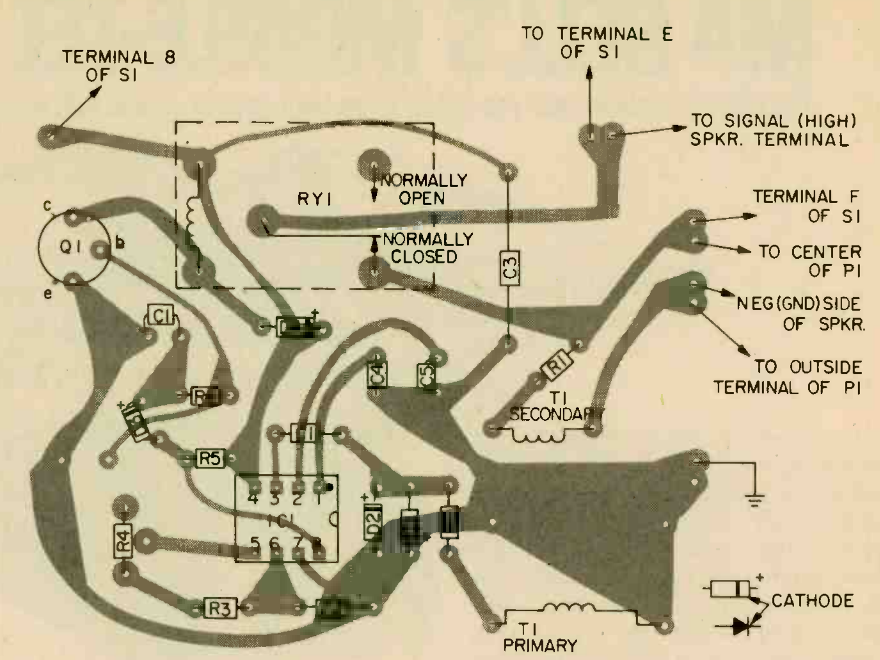
To Use a Circuit Board. If a printed-circuit board is used, you can copy my layout and cut your construction time to the minimum. Take great care when soldering the semiconductors in place, and use a socket for the PLL IC. Zipper can be housed in a metal cabinet 4-in. wide x 2⅜-in. high x 5⅜-in. deep without crowding, as shown here.

The printed-circuit board should be mounted so that trim pot R4 may be adjusted either through the front or the side of the cabinet.

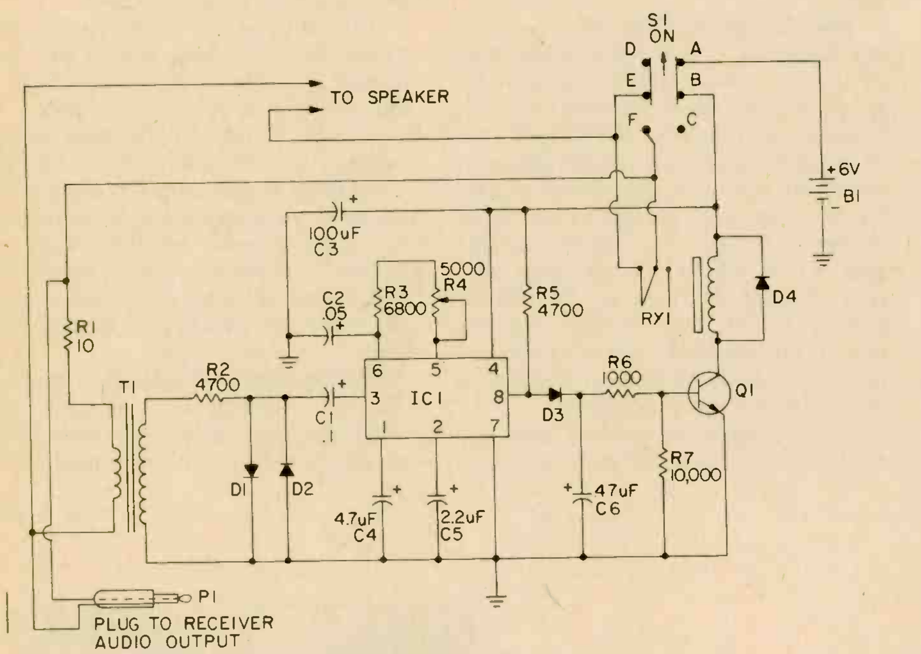
Using Lip-Zipper. Plug P1 into the monitor receiver's audio-output jack, and connect P2 to an external speaker. For added enjoyment try using a good-quality enclosed speaker.

With the toggle switch in the *Off* position the audio should be coming

(Continued on page 120)



Parts placement on printed circuit board is shown above. Note the polarity of the four diodes. The striped end is the cathode. Parts may also be mounted on perf board, if desired (viewed from foil side).

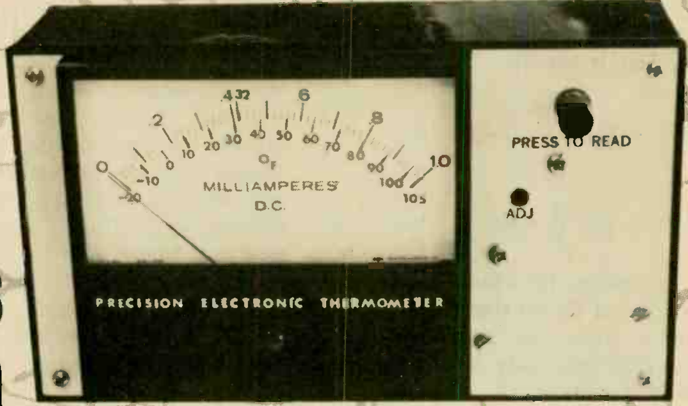


The Lip Zipper's circuit will kill that unwanted 2,000 Hz audio tone that Ma Bell puts on its mobile telephone carrier when the frequencies are not in use. The 567 phase-locked loop (PLL) IC chip is the base of the system. This will respond to the 2000 Hz idle tone and drive a relay that will shut off the speaker. To keep the relay from turning off and on every time 2000 Hz appears in normal speech there is a time-delay circuit added to the output of the IC (pin 8). This time-delay circuit, made up of resistor R6 (1000 ohms and capacitor C6 (47uF), will keep the relay from chattering during a normal conversation. The time-constant need not be very large since no voice tone would remain on 2000 Hz for more than a fraction of a second.

PARTS LIST FOR LIP ZIPPER

B1—Four AA (penlight) cells 1.5 VDC
C1—.1 uF, 100-VDC capacitor
C2—.05-uF, 200-VDC capacitor
C3—100-uF, 16-VDC capacitor
C4—4.7-uF, 16-VDC capacitor
C5—2.2-uF, 16-VDC capacitor
C6—47-uF, 16-VDC capacitor
D1, 2, 3—1N914 signal diode, silicon only, not germanium
D4—1A (or more), 25-V silicon diode, 1N4000 series
IC1—Phase-locked loop (PLL) integrated circuit (Radio Shack 276-1721 or equiv.)
Q1—NPN medium power amplifier/switching transistor, silicon, 2N2924 or similar
R1—10-ohm, ½-watt resistor
R2, 5—4700-ohm, ½-watt resistor
R3—6800-ohm, ½-watt resistor
R4—5000-ohm, printed circuit board mounting potentiometer
R6—1000-ohm, ½-watt resistor
R7—10,000-ohm, ½-watt resistor
RY1—6 VDC relay, coil 300-ohms or higher (not lower)
S1—DPDT toggle switch
T1—1000-ohm to 8- or 16-ohm audio output transformer

Misc.—Cabinet, IC socket, battery holder, plug to match receiver output (and speaker, if required) wire, solder, etc.
Printed circuit board for this project, with holes drilled, ready for installation of components may be ordered for $3.75 postpaid from Krystal Kits, Box 445, Bentonville, Arkansas 72712.



Make This Precision Electronic Thermometer Your PET

New sensor and IC chip let you measure temperature accurately, anywhere—even under water.

IF YOU'VE ALWAYS WANTED a really precise electronic thermometer so you can measure the temperature outdoors at a distance, or to continuously perature outdoors at a distance, or to continuously monitor the cold in your refrigerator or ice compartment, or check the temperature down deep in the water for fishing up the big ones, or for medical or other uses where the need for continuous temperature readings in a distant, inaccessible, or uncomfortable situation makes an electronic thermometer desirable, the *Precision Electronic Thermometer* —PET, is for you.

If the cost, or the supposed complexity has scared you off—or if you've heard it's difficult to calibrate an electronic thermometer, take heart, PET is for you. Most electronic thermometers have calibration directions which instruct one to fiddle with 2 or even 3 adjustments while alternately sticking the thermometer's probe in ice water and lukewarm water. Even after minutes or hours of fussin' and cussin' and water everywhere, the accuracy of the thermometer often leaves much to be desired. But not so with PET.

The trouble with most electronic thermometers is the most important component—the sensor. Most temperature sensors have a temperature-versus-output curve that would make Raquel Welch envious. Also, few inexpensive sensors include the necessary identical twin. This causes even more problems.

Now, however, National Semiconductor has brought out a relatively inexpensive temperature transducer, the LX5700, which makes electronic thermometers fun to build and calibrate again. The LX5700 has a temperature-versus-output curve as flat as a pancake. Its non-linearity is less than ½ of one percent, compared to over one percent for *good*-quality mercury thermometers. Its only real deviation from perfection is an easily-corrected offset error of about ±4 degrees Celsius. This means you can build PET, a simple highly-accurate electronic thermometer with this transducer, yet have only one simple adjustment.

The heart of the LX5700 transducer is the sensor, which is made of two identical transistors fabricated on the same silicon chip but operating at different current densities. The 10-millivolt-per-degree Kelvin output of the sensor is proportional to the difference in emitter-to-base voltages, which is linearly related to temperature. This sensor was impossible to construct before integrated circuit techniques were perfected since it depends upon making two identical transistors right next to each other on the same chip.

In addition to its temperature linearity this transducer has two other features which make it a really neat device for people who love simplicity. First, it has its own built-in voltage regulator (See Figure 1, showing the zener diode in the block diagram) which makes it great for accurate, battery-operated thermometers. Second, the transducer also includes in its tiny case that marvelous device, the op-amp. By adding two resistors you can take that 10 mV-per-°Kelvin output of the sensor and amplify it to any practical output.

(Note that 1 mV is one-thousandth of a volt. °K is degrees Kelvin, which is the absolute temperature in the metric system. Kelvin degrees are the measure of temperature universally used by physicists. All you have to do to get the absolute—Kelvin—temperature in any system is to put a plus sign on its

Make PET

absolute zero and add it to the regular (Celsius) temperature. That is, degrees Kelvin = degrees Celsius + 273°. As an example, the room temperature of 25°C (77°F) is actually 298°K. Other equivalents:

$$Tc = (40 + Tf)\ \frac{5}{9} - 40 \text{ and}$$

$$Tf = (40 + Tc)\ \frac{9}{5} - 40$$

where, of course, Tf stands for degrees Fahrenheit and Tc for degrees Celsius.)

Figure 2 shows an electronic thermometer that uses only 4 components (including a voltmeter). Assuming the transducer in Figure 2 is at the room temperature of 298°K (25°C–77°F), if you connect an accurate voltmeter to the output of the transducer, you will get a voltage reading of 2.98 volts (±.04 volts). The problem with such a thermometer, however, is the same problem some people find with life in general—a lack of *meaning*. For instance, wouldn't it sound funny to hear a DJ say on the radio, ". . . so folks another bitter cold night tonight with a low near 260° Kelvin . . ." Another problem arises if a standard 0-5 VDC meter is used as a thermometer's readout, for even if the thermometer is taken from Niagara Falls to Miami in January, the needle's movement will

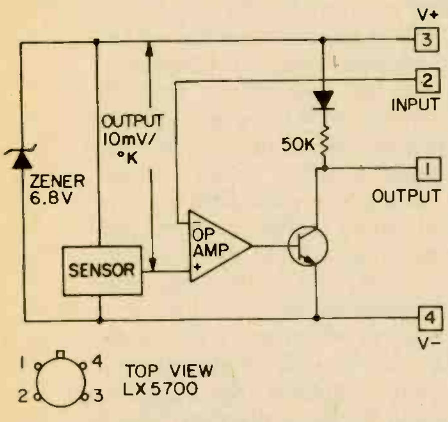


Fig. 1—Block diagram shows what's inside the LX5700 temperature-sensing transducer by National Semiconductor. Heart of device is the sensor itself, which produces output of 10 millivolts per degree Kelvin (see text). Op amp and transistor raise output, and voltage divider (external to transducer) determines meter deflection due to output at terminals 1 and 4.

hardly be visible. If cost were no problem, a digital voltmeter could solve this problem but the issue of "meaning" would remain.

In order to make a simple, useful thermometer with "meaning" we must add a few more resistors and a capacitor. Although our prototype PET measures temperatures between −20° and +105°F, I also explain how to make thermometers with ranges of 0-100°F and −50°C-+50°C. The only variation between the three thermometers are three resistors. If you plan to use your thermometer to measure the outside air temperature, the range you choose depends on where you live. If you live on the East, West or Gulf Coasts the 0-100°F range would do nicely. If you live in the northern great plains, desert southwest or similar areas or you are into metric, the −50°C to +50°C range is for you. For most of the rest of the country the −20°F to

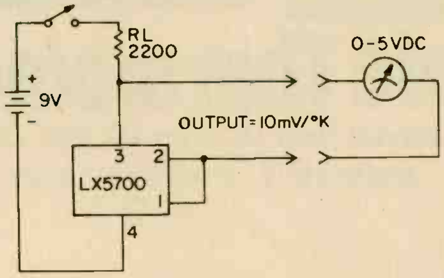


Fig. 2—Basic electronic thermometer circuit shows voltage divider is in the PET case, sensor and op amp contained in LX5700 transducer package and readout meter.

+105°F range is ideal. See the Tables for the resistors required for each temperature range.

Circuit Operation. Although the full schematic diagram is fairly simple it isn't much help in understanding exactly how the circuit works. To help clarify the matter, I have simplified that schematic in Fig. 3. R1, R2 and R3, are the same resistors shown in the full schematic.

From basic operational amplifier theory we know the following: The differential input voltage is zero, so **V1** = **V2**. It can also be shown that

$$Vo = \frac{R2 + R3}{R3} \times V2.$$

From basic electricity,

$$Im = \frac{V1 - Vo}{R2} + \frac{6.8 - Vo}{R1}$$

To simplify the equation further, to understand the circuit, we can say that

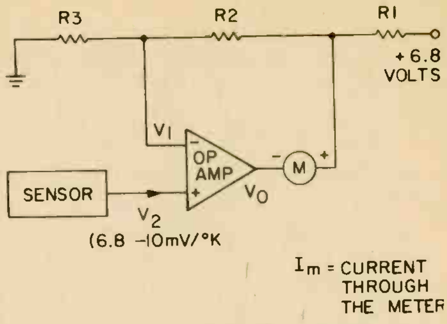


Fig. 3—Simplified schematic of PET precision electronic thermometer shows basic thermometer circuit adapted to LX5700 sensor.

Im is approximately equal to

$$\frac{6.8 - Vo}{R1}.$$

We can do this since we know that R2 is much greater than R1. Since **Vo** = KV2, where K is a constant and **V2** = 6.8 −10 mV/°K, we see that the higher the temperature the smaller will be **Vo**. Thus, the current through the meter, **Im**, increases as the temperature increases.

The exact values of R1, R2 and R3 are chosen so that at the minimum temperature we want to measure, **Im** = 0, and at the maximum temperature we want to get a full scale deflection of our meter. (In the thermometer described in this article, **Imax** = 1 mA).

In the actual circuit, R7 and the transducer's own zener diode form a

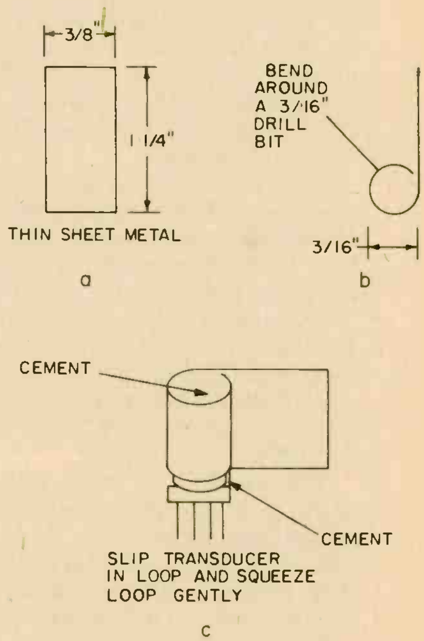


Fig. 4—How to construct a simple heat sink for the LX5700 temperature-sensing transducer. No heat sink is required if PET will be used in water or to measure only cold situations (below 32 degrees F, or zero C.).

voltage regulating system. R6 is an external load resistor for the transducer's output transistor. R8 and C1 increase the circuit's stability, and R4 and R5 form the calibration circuit.

Putting It Together. Although the circuit can easily be constructed with perf board techniques, a printed circuit board foil layout and component guide is given for your convenience. See Fig. 6. If a printed circuit board is used, R5 should be of the printed circuit type.

By far, the easiest way to make simple printed circuit boards is to draw directly on the copper clad board with a felt tip resist pen. These pens put a layer of acid-resistant ink on the copper and keep it from being dissolved where you marked the board.

The only critical components in addition to the transducer are resistors R1, R2 and R3. For precision readings these three resistors should be the one-percent tolerance kind. However you can use the five percent resistors shown in the tables, although some adjustment of R1 may be required. See the section on Testing and Adjusting. The exact values of these three resistors depends upon the temperature range you want the thermometer to measure. The Tables give the values. Notice that extra room is available on the foil layout of the printed circuit board for R1, R2 and R3 so that two resistors could be tied together in series, if necessary.

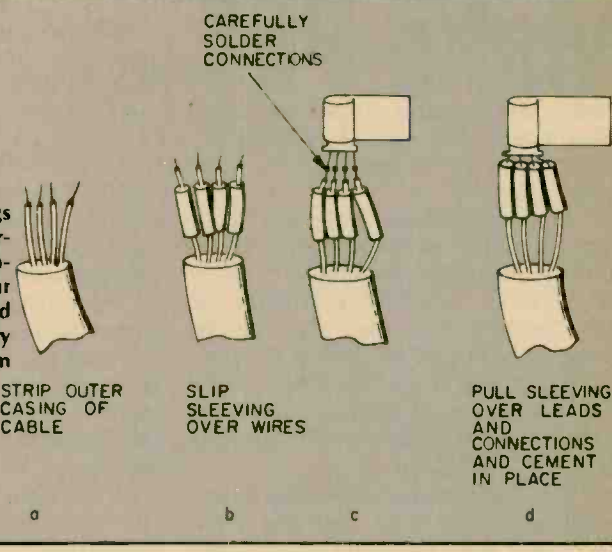
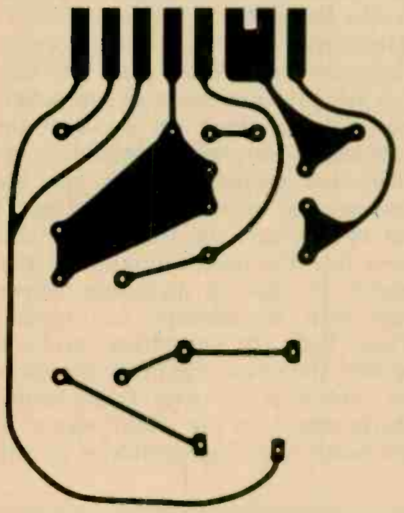


Fig. 5—Step-by-step drawings show how to connect a four-conductor cable to the temperature-sensing unit. Four separate wires may be used with pieces of tape every foot or so to keep them bundled together.



Printed circuit board pattern shown above is same size as the actual foil for the components board of PET. Foil side shown.

Although tiny, the power used by the transducer does raise its temperature slightly. If the transducer is to be operated in still air, a small heat sink should be used. Most other applications such as medicine, fishing, etc. do not require a heat sink. If small errors (up to about two degrees) can be tolerated, or if you take your temperature readings quickly, you don't even need a heat sink for measuring still air temperature. If you won't need the heat sink, disregard Figure 4 and the next two paragraphs here.

The heat sink can be constructed from a ⅜″ × 1¼″ piece of aluminum or copper sheet metal as shown in Figures 4(a) and 4(b).

Place the transducer in the loop made out of the sheet metal and give the loop a very gentle squeeze. See Figure 4c. Using a good epoxy, cement the transducer permanently to the heat sink.

As shown in Figure 5, strip the outer casing of the four-conductor cable and slip plastic tubing or sleeving over the leads. This sleeving will be used shortly to insulate the connections and bare leads of the transducer.

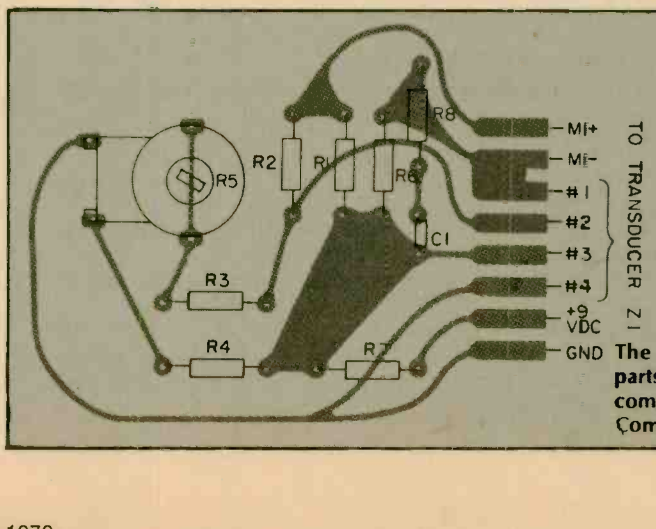
Using a 25-watt or smaller soldering iron, solder the leads of the transducer to the end of the four-conductor cable you have prepared. Be sure to use a small alligator clip or long-nose pliers as a temporary heat sink between the soldering iron and the transducer. After soldering the leads, pull the sleeving over the connections and bare leads and cement the sleeving in place.

Next, spray all the exposed wires and connections with several coats of a clear sealant such as Spra-Clear by Plasti-Kote, or GC Insul-Volt. These are available at almost any electronics supply store. Let the assembly dry between coats. It takes a little time but it is well worth while.

After the unit is completely dry, immerse it in the sealant. I have also found that Plasti-Dip, a product used to coat tool handles works well. Let the assembly dry overnight and re-coat if desired.

To avoid accidentally leaving the thermometer on for long periods of time and depleting the battery, the power switch should be the momentary-contact pushbutton type.

If you decided to build the thermometer that measures temperatures between 0 and 100°F, you've just won the bench warmer prize—you won't have to touch the meter's dial at all! Just let 0 mA stand for 0°F, .10 mA for 10°F, .20 mA for 20°F, .30 mA for 30°F, .32 mA for 32°F etc. If you chose the −50 to + 50 Celsius (Centi-



The drawing above shows parts placement on the components board of PET. Component side shown.

Make PET

grade) thermometer, your job isn't much harder. Just add the temperature markings shown in the chart to your meter's dial.

If you are building the same thermometer as the one which I built, which measures temperatures between −20°F and +105°F, you have a decision to make on how you mark the dial on the meter. The easy way out is to mark it according to Table II, which labels every tenth of a milliamp with a temperature reading. Each division stands for 12.5°F.

If you find a thermometer that reads according to Table II confusing, you can instead label the meter's dial every 5 or 10°F. As shown in photo, my prototype was labeled every 10°F. However, to have the thermometer show every 5°F you must place a label at .04 milliamperes intervals (or .08 mA every 10°F). While this can be easily done on some of the larger and better quality meters, most meters will require careful work and constant checking with drafting dividers (an instrument similar to a compass).

To label the temperatures on the meter dials, carefully remove the plastic or glass panel that protects the meter's movement and needle. This panel can often be pulled off with your fingers, but some meters have machine screws holding it in place.

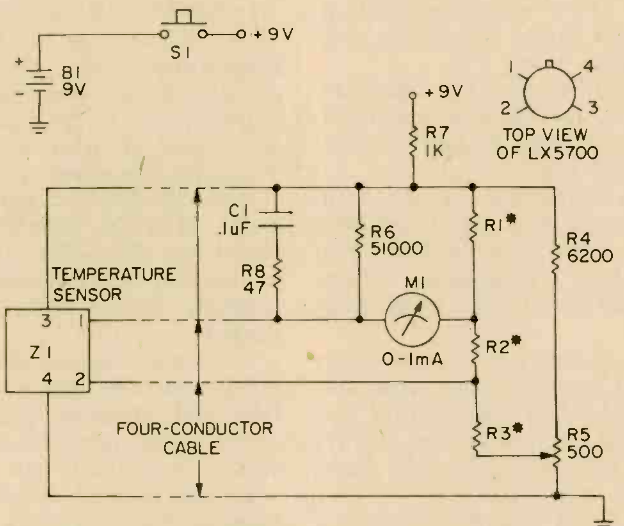
Unless you are an artist or are just naturally great at lettering, use commercial dry transfer lettering. It's worth that extra little effort to do a nice job in building electronic projects, especially this thermometer, which you will use every day, for many years.

Testing and Adjusting. Connect the four-conductor cable to the thermometer. With the potentiometer, R5, set to its mid-point, depress the power switch. The needle should move upscale to the vicinity of the transducer's temperature. If the transducer is in still air, and has no heat sink, the needle will continue to slowly move upscale 1 to 2°F more.

Before attempting the following calibration, make sure all bare wires in the transducer probe assembly are completely insulated with one of the waterproofing materials.

Fill a small plastic pail half full of small ice cubes, bits of ice, or, if available, clean, compacted snow. Pour enough cold water into the pail to fill it approximately two-thirds full.

Place the transducer probe assembly into the icy concoction in the plastic pail. Wait several minutes. Press the power switch and adjust the pot, R5, so the thermometer shows 32°F (0°C). That's about all there is to the calibration, easy huh? What's that! You didn't use the precision resistors recommended, and you have an *accurate* thermometer (surgical) available! Well then, you should test your new thermometer at another temperature. To do this obtain luke warm water from your tap. The temperature of the water should be near the maximum temperature your thermometer can measure. Place both the transducer probe assembly from your electronic thermometer and your accurate (store-bought) thermometer in the warm water. Stir the water every few seconds or so. After



*REFER TO TABLE FOR VALUES.

R1, 2, and 3 values depend on the thermometer scale you use, Celsius or Farenheit, from −20 to +105, or from 0 to 100 degrees. Consult Table at the right of this box for resistances. Four-conductor cable may be made from two lamp-cord wires taped together every foot or so. Or you can use two audio or speaker cables.

PARTS LIST FOR PET PRECISION THERMOMETER

C1—0.1-uF 25 VDC capacitor, ceramic
M1—0 to 1-mA panel meter
R1, R2, R3—see text and the Tables—depends on temperature range you choose.
R4—6200-ohm resistor, 5% tolerance (Allied Electronics 824-1489 or equiv.)
R5—500-ohm, printed-circuit board mounting potentiometer
R6—51,000-ohm, ¼-watt resistor
R7—1000-ohm, ¼-watt resistor
R8—47-ohm, ¼-watt resistor
S1—SPST, momentary-contact pushbutton switch
Z1—temperature sensing transducer, National Semiconductor LX500 or equiv. (Available from address below)
Misc.—9-volt transistor radio battery, 4-conductor cable, cabinet, wire, solder, etc.
Allied Electronics' address is 401 East 8th St., Ft. Worth, TX 96102.
Temperature transducer Z1 is available from TR Electronics, Box 604, R.R. 4, Newaygo, MI 49337 for $5.50 postpaid. Send check or money order.

For Farenheit Thermometer −20 to +105 degrees

	1% (ohms)	5% (ohms)
R1	1100	1100
R2	23.7K	24K
R3	43.2K + 470	43K + 680

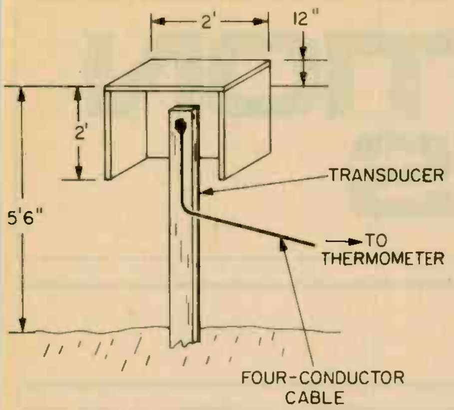
For Farenheit Thermometer 0 to 100 degrees

1% (ohms)	5% (ohms)
900	910
25K	24K + 1100
42K	43K

For Celcius Thermometer −50 to +50 degrees

	1% (ohms)	5% (ohms)
R1	1.5K	1.5K
R2	21.5K	22K
R3	46K	43K + 2.7K

Note that the plus sign between resistance means the two resistors should be placed in series.



If PET's temperature sensor will be outdoors where sun may shine on it a simple cover should be built for it. Dimensions are approximate. If not thus sheltered the readings might be off a degree or two.

about five minutes take readings from both thermometers. If the readings differ by 2°F (1°C) or more, you can increase the thermometer's accuracy by slightly changing the value of R1. If the thermometer reads low, place a 100K resistor in parallel with R1. If it reads high, add a 10- or 15-ohm resistor in series with R1. Or you can replace fixed resistor R1 with a 500-ohm potentiometer in series with an 820- or 680-ohm resistor. However, you should do this approach *only* if a laboratory-grade thermometer is available for use as your standard.

Using PET. The real advantage of an electronic thermometer over the common garden variety is that it is the only kind of thermometer which can accurately measure temperature at a distance. The Viking landers on Mars use electronic thermometers in their miniature weather stations to keep constant track of Mars' air temperature at two surface locations in the planet's northern hemisphere. Although our PET thermometer described here isn't designed to measure temperatures from quite that far away, it does have many uses right here on good old terra firma.

Because of its accuracy and quick response, it can be used as a fast responding medical thermometer if the probe is placed under one's arm. Underarm temperature averages around 97.5°F (36.4°C) in healthy people—about 1°F lower than oral temperatures. PET can also be used as a super-accurate fishing thermometer to get the big ones, or in your car to measure the outside air temperature. When used in an automobile, it is most accurate when the car is moving. The only modification necessary to run PET directly off a car or boat's 12 VDC electrical system is that the resistor R7 must be increased to 3300 ohms. Because of its low power consumption, no power switch is necessary when a storage battery is used for power.

One of the most popular uses for electronic thermometers is the measurement of the outside air temperature from the comfort of one's home. However, even with such an accurate electronic thermometer as described here, this isn't as easy as it first may appear. Although just about everybody knows you must keep the thermometer out of sight of that 11,000°F Ball of Fire in the sky to measure the true air temperature, few realize that a clear night sky has an effective temperature that would make a penguin shiver. Even on a clear, July night the effective temperature of the sky is around −100°F!

A thermometer without a shelter, placed in the shade of the north side of a building, may read correctly during the day or on a dark and foggy night, but on a crystal-clear night it will read several degrees colder than the true air temperature. Moisture or frost will also lower a thermometer's temperature below that of the air on account of cooling by vaporization. Like it or not, you need some sort of thermometer shelter if you are to accurately measure the outside air temperature. The National Weather Service uses quite a sophisticated shelter, but for most purposes the shelter shown on this page is sufficient, especially if located in the shady area on the north side of a building. This shelter can be constructed out of an old apple box or built from scrap lumber. The transducer probe assembly should be mounted near the top of the inside of the enclosure and approximately 5 feet from the ground. All dimensions shown in the drawing are approximate and are given only as a guide. The shelter should be painted, inside and out, with a white or, better yet, aluminum exterior paint. Notice the enclosure has no bottom. This is to provide good air circulation for the transducer.

For Celcius Thermometer −50 to +50 degrees

mA	Degrees
0.0	−50
.10	−40
.20	−30
.30	−20
.40	−10
.50	0
.60	+10
.70	20
.80	30
.90	40
1.00	50

For Celcius Thermometer −20 to +105 degrees

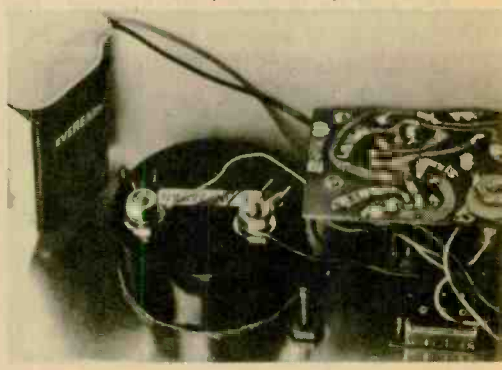
mA	Degrees
0.0	−20
.10	−7.5
.20	+5
.30	17.5
.40	30
.416	32
.50	42.5
.60	55
.70	67.5
.80	80
.90	92.5
1.00	105

For Farenheit Thermometer −20 to +105 degrees

mA	Degrees
0.0	−20
.04	−15
.08	−10
.12	−5
.16	0
.20	+5
.24	10
.28	15
.32	20
.36	25
.40	30
.416	32
.44	35
.48	40
.52	45
.56	50
.60	55
.64	60
.68	65
.72	70
.76	75
.80	80
.84	85
.88	90
.92	95
.96	100
1.00	105

The Components Board. In this project the parts layout is entirely uncritical so the parts may be mounted on a printed circuit board, using the board pattern shown, or a similarly-sized piece of perf board, with flea clips inserted into holes at roughly the

(Continued on page 118)

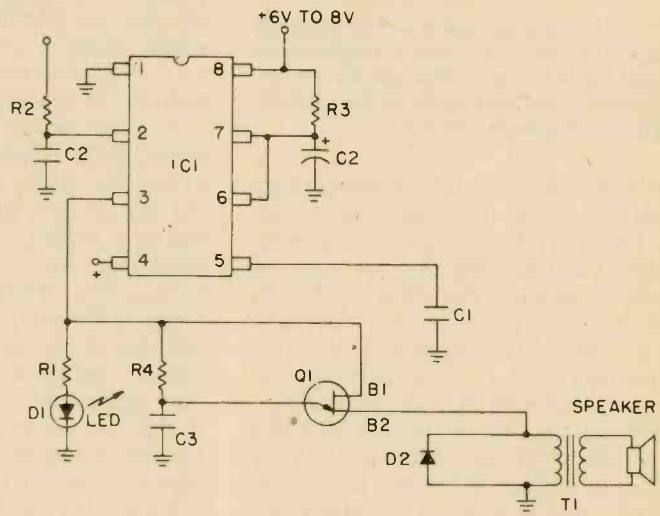


Inside view of PET shows simple construction using printed circuit board. Parts placement is non-critical and perf-board construction may be used if preferred.

CONSTRUCTION QUICKIES

Hands Off!

☐ This circuit finds the 555 timer as a watchdog ready to cry out if an inquisitive finger comes too close. The trigger input is terminated with a one megohm resistor, attached to a coin or some other small metallic object. Hand capacity is sufficient to initiate the timer for about five seconds. The output is fed not only to a warning LED, but to a unijunction type oscillator, whose tiny two-inch speaker can make itself heard throughout the room.

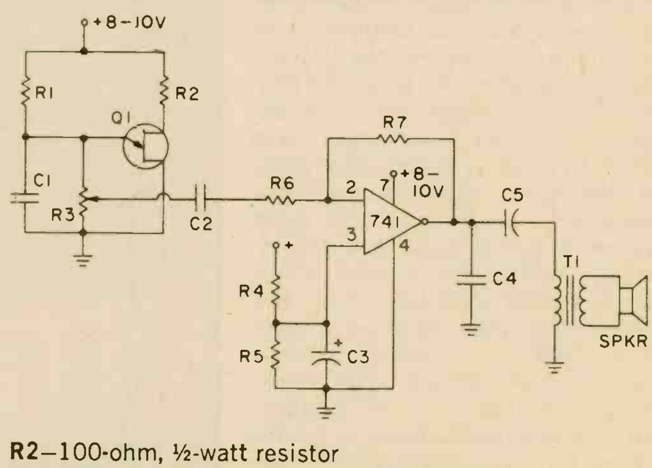


PARTS LIST FOR HANDS OFF

C1—0.1-uF ceramic capacitor, 15 VDC
C2—0.01-uF ceramic capacitor, 15 VDC
C3—0.1-uF ceramic capacitor, 15 VDC
D1—small LED
D2—1N4148 diode
IC1—555 timer
Q1—2N2646
R1—470-ohm, ½-watt resistor
R2—1,000,000-ohm, ½-watt resistor
R3—220,000-ohm, ½-watt resistor
R4—15,000-ohm, ½-watt resistor
SPKR—8-ohm PM type speaker
T1—audio output transformer 500-ohm primary/8-ohm secondary

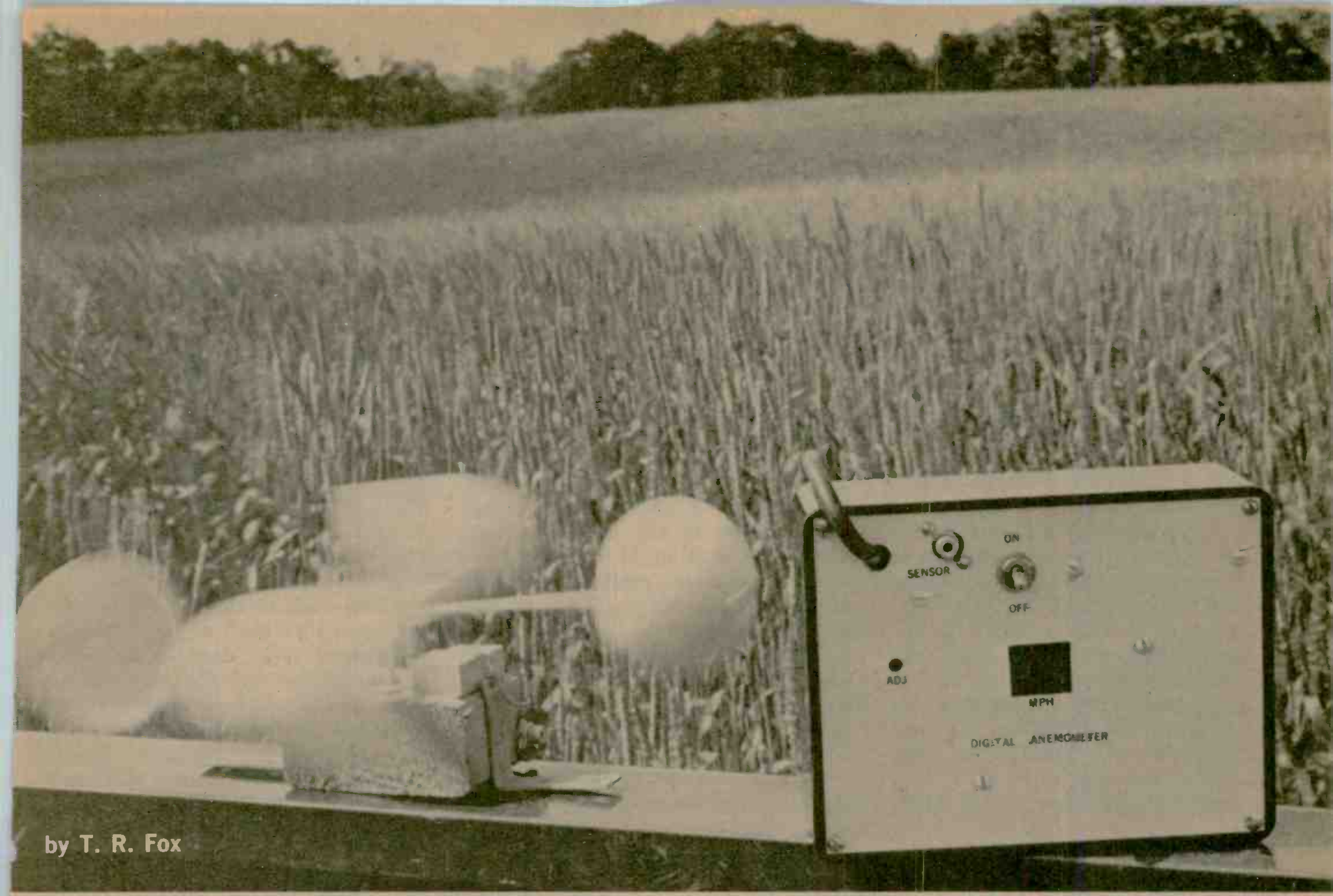
Sawtooth Sounds

☐ The Micro-Mini-PA described earlier can put the sound of the unijunction transistor oscillator in the air and demonstrate its operation via the charge and discharge of its timing capacitor. The tone, about 300 Hz with the components shown below is roughly musical and can be shaped with filtering. The waveform of the inverting op amp is the reverse of the charge on the capacitor before the unijunction fires. This is the same as when a *charged* capacitor is discharged through a resistance to a certain level, whereupon it is recharged through negligible resistance to full potential. ■



PARTS LIST FOR SAW-TOOTH SOUNDS

C1—0.47-uF ceramic capacitor, 15 VDC
C2—0.1-uF ceramic capacitor, 15 VDC
C3—6 to 8-uF electrolytic capacitor, 25 VDC
C4—0.01-uF ceramic capacitor, 15 VDC
C5—50-uF electrolytic capacitor, 25 VDC
IC1—741 op amp
Q1—2N2646 unijunction transistor
R1, R4, R5—4,700-ohm, ½-watt resistor
R2—100-ohm, ½-watt resistor
R3—50,000-ohm linear-taper potentiometer
R6—10,000-ohm, ½-watt resistor
R7—100,000-ohm, ½-watt resistor
T1—audio oututransformer 500-ohm primary/8-ohm secondary



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.)

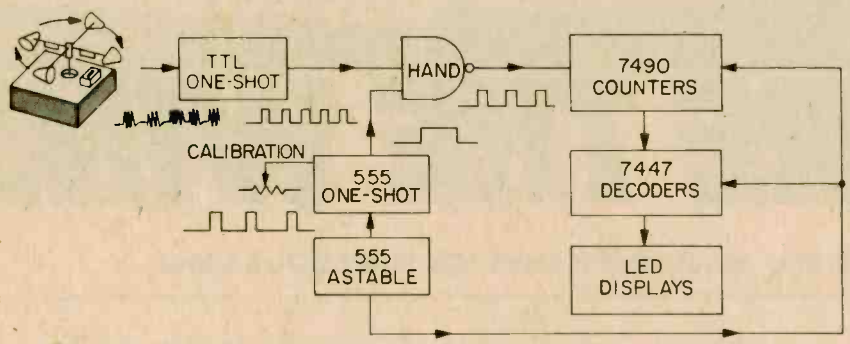


Fig. 1—Block diagram for digital anemometer. As the calibration control is varied it changes the duration of the pulse put out by the 555 one-shot. This acts as a variable window for the pulses coming from the windspeed sensor permitting accurate readout of the LEDs.

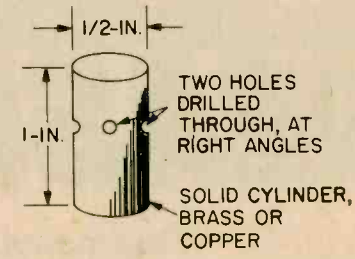


Fig. 2—Centerpiece of windspeed sensor.

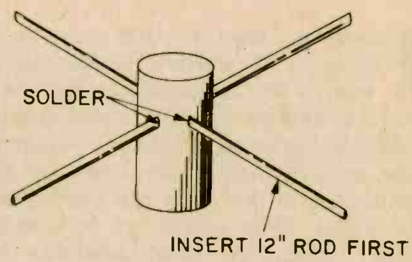
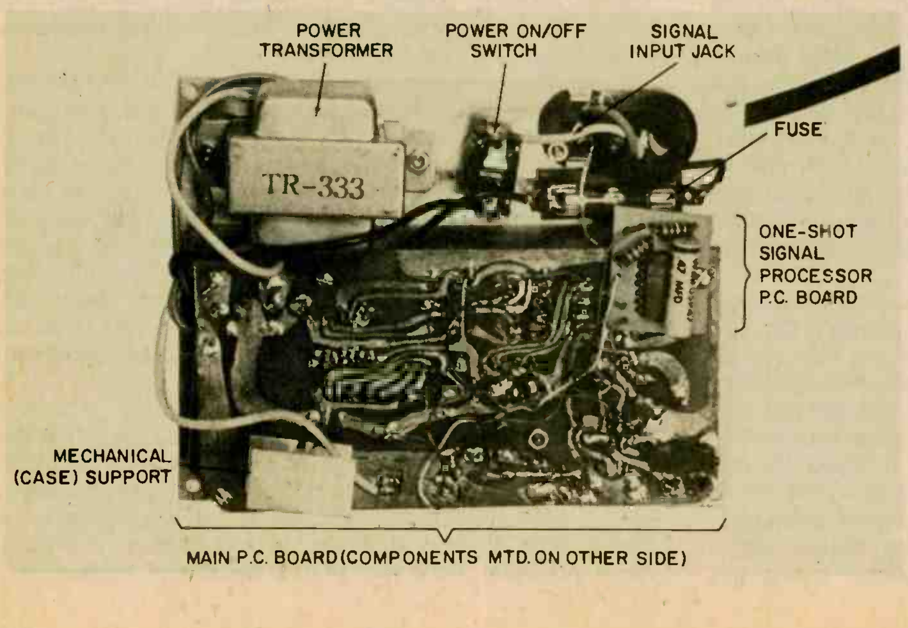


Fig. 3—Assembly of rods and centerpiece to form rotor.



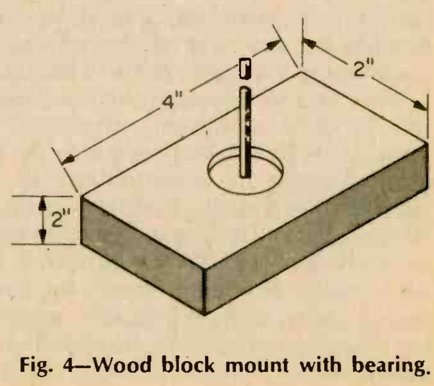


Fig. 4—Wood block mount with bearing.

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-

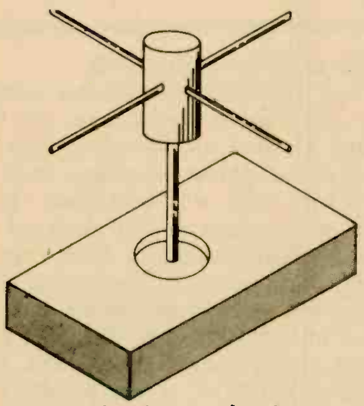


Fig. 5—Rotor in place on bearing.

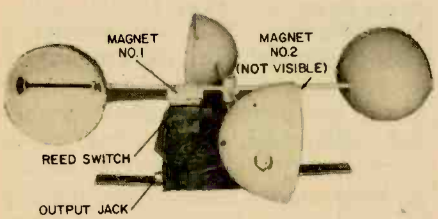


Fig. 6—Completed unit. Adjust height of reed switch so magnets pass about ¼-in. over it or less.

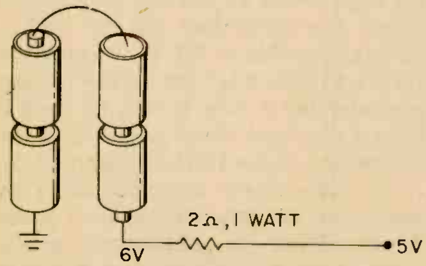
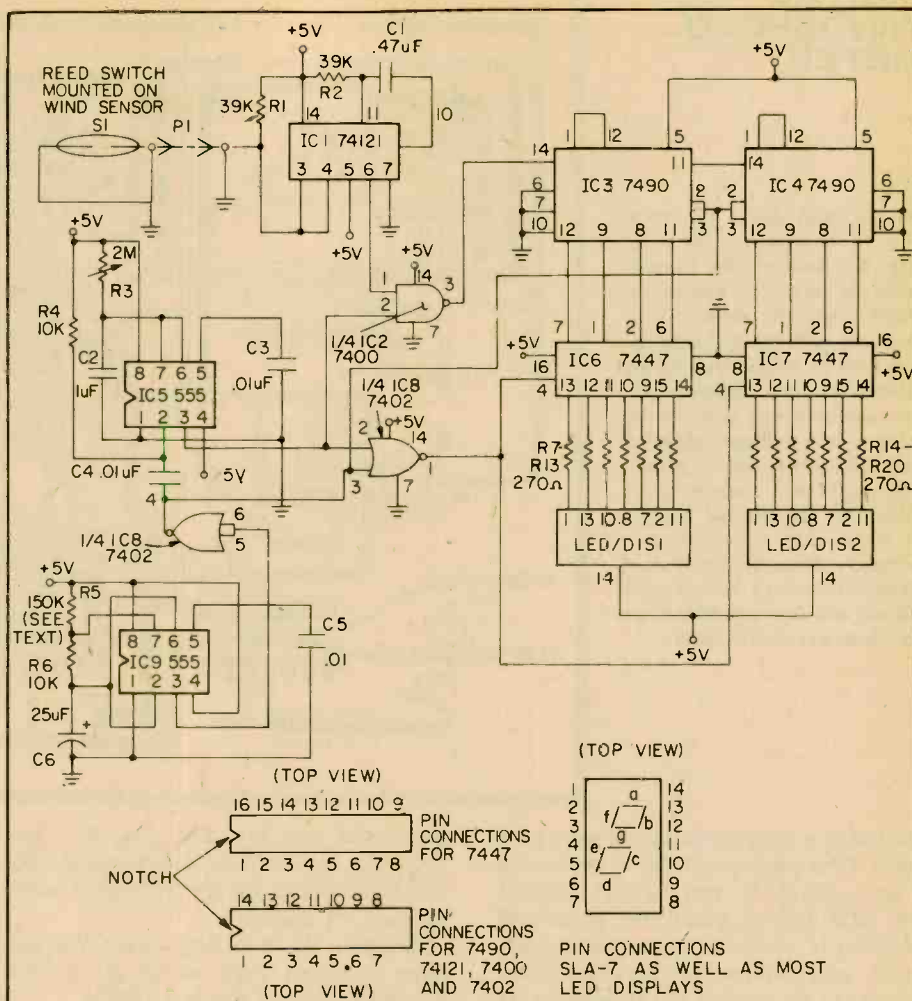


Fig. 7—Temporary battery power supply for use when calibrating the instrument in an automobile.



Be very careful when inserting ICs 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—7402 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.)

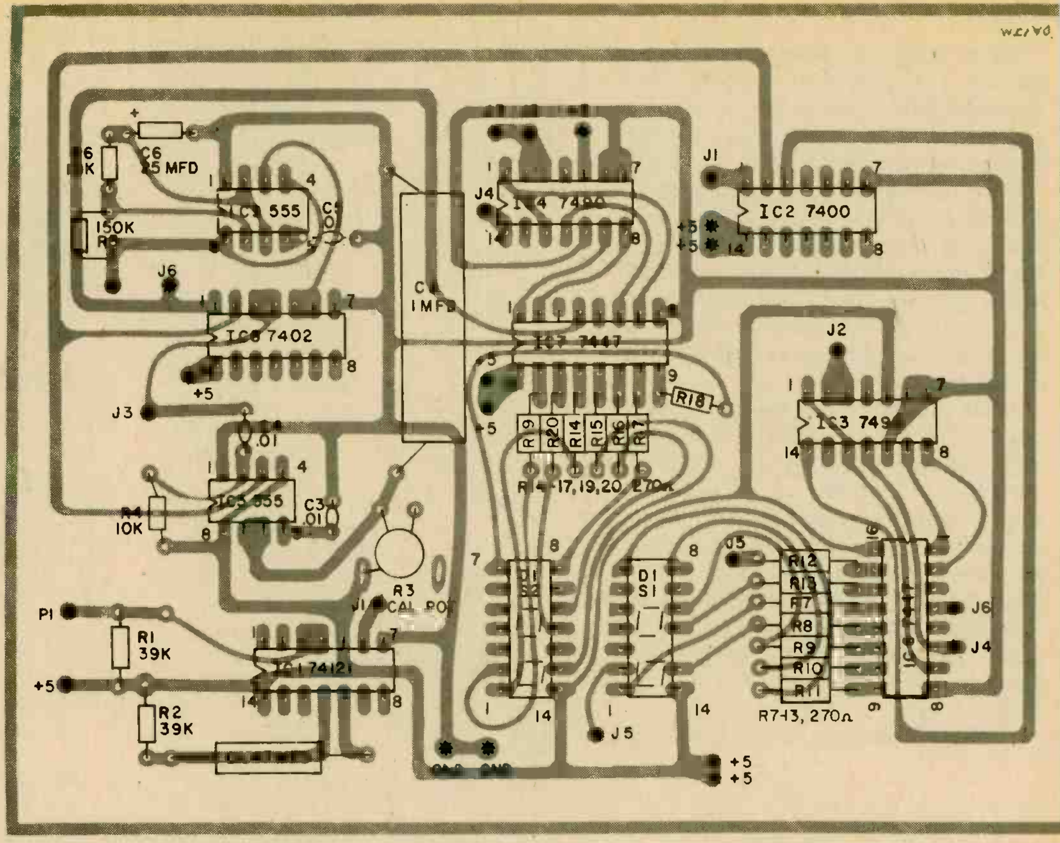
Misc.—Four plastic cups such as the containers Leggs stockings come in. Two small magnets such as the "Magic" magnets most hardware stores carry. One 12-in. and two 6-in. pieces of copper or brasss rod, ⅛- or 3/32-in. diameter. One slot car motor or equiv.), for use as bearing. One piece of copper or 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.

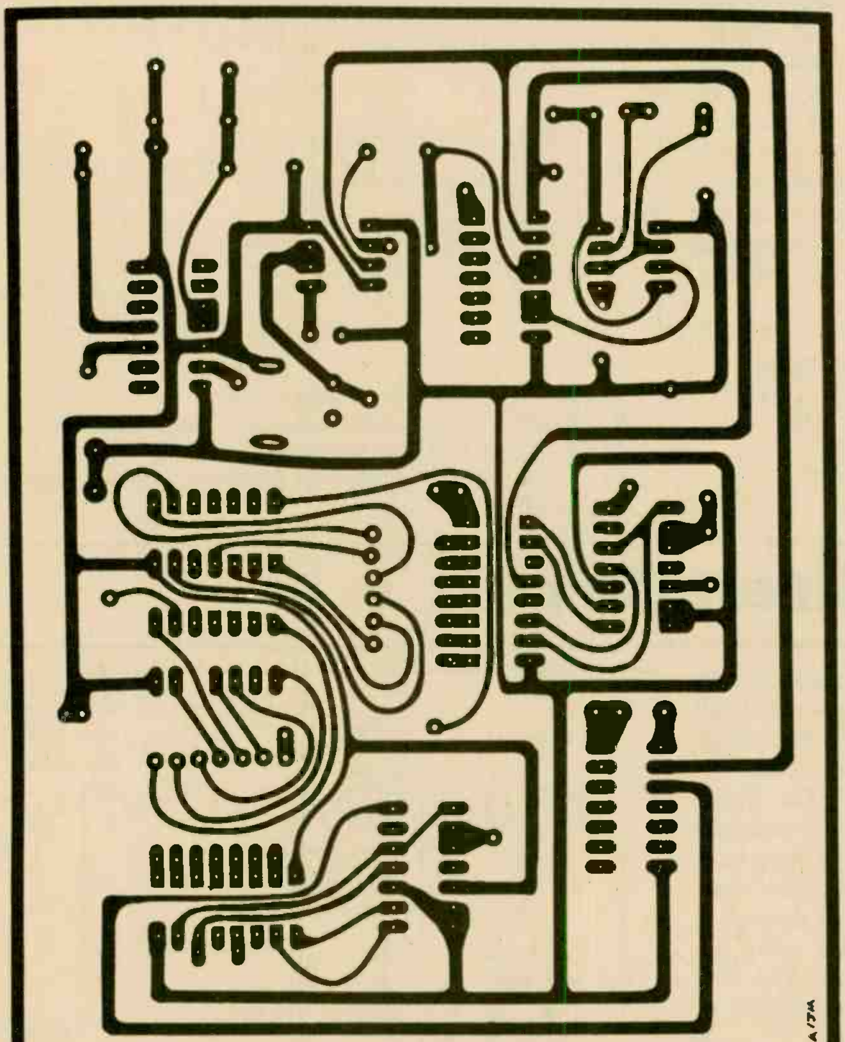
Calibration. This anemometer is easily calibrated since there is just one pot to adjust. As an initial test, plug the unit in and connect the wind sensor to the display unit. After a few seconds warmup the unit should show 00 then go momentarily blank. Turn the cups by hand and a number should appear 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 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.

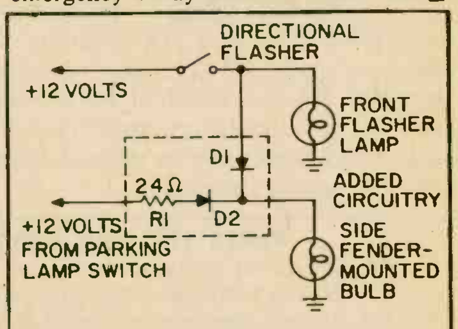
Turn Signals from Side Marker Lights

☐ 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.)

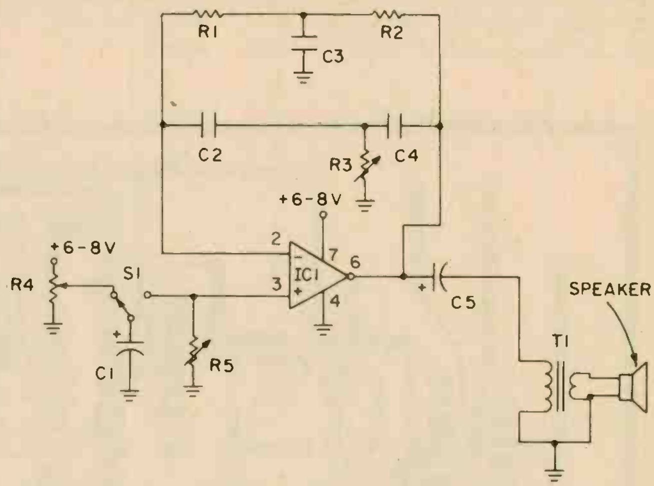
R1—24-ohms, 1-watt resistor (Radio Shack 271-1000 or equiv.)

Misc.—wire, electrical tape.

CONSTRUCTION QUICKIES

The Whistler

☐ At the push of a button, this circuit lets forth with an attention-getting whistle, which can be tailored to meet a variety of formats. The circuitry is built around a Twin-T oscillator, which is triggered into action by a varying positive potential placed on the non-inverting op amp input. Resistors R1, R2, and R3, together with capacitors C1, C2, and C3, determine the fundamental pitch, with R3 providing a useful variation. When S1 is pushed, the potential stored in C4 is placed on the non-inverting input, causing the oscillator to function. The duration is determined by R5. The format of the whistle is modified by the setting of R4. At full potential, the effect is a sharply rising tone, followed by a more gradual decline. At about half setting, the effect is more bell-like.

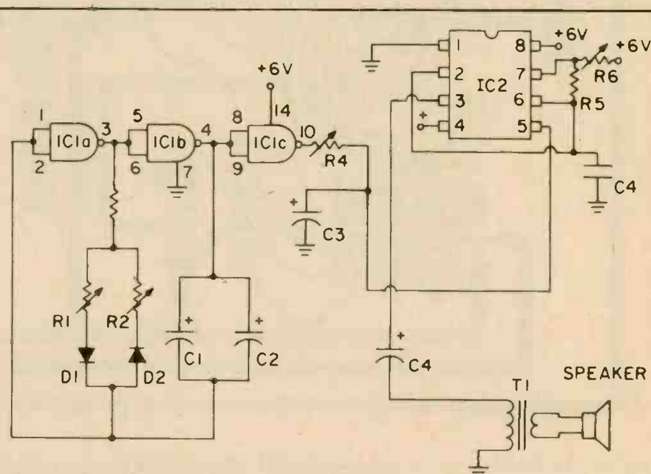


PARTS LIST FOR THE WHISTLER

C1—100 to 200-uF electrolytic capacitor, 15 VDC
C2, C4—0.001-uF ceramic capacitor, 1 VDC
C3—0.002-uF ceramic capacitor, 15 VDC
C5—100-uF electrolytic capacitor, 15 VDC
IC1—741 op amp
R1, R2—100,000-ohm, ½-watt resistor
R3, R4, R5—10,000-ohm linear-taper potentiometer
SPKR—8-ohm PM type speaker
T1—audio output transformer 500-ohm primary/8-ohm secondary

Siren Circuit

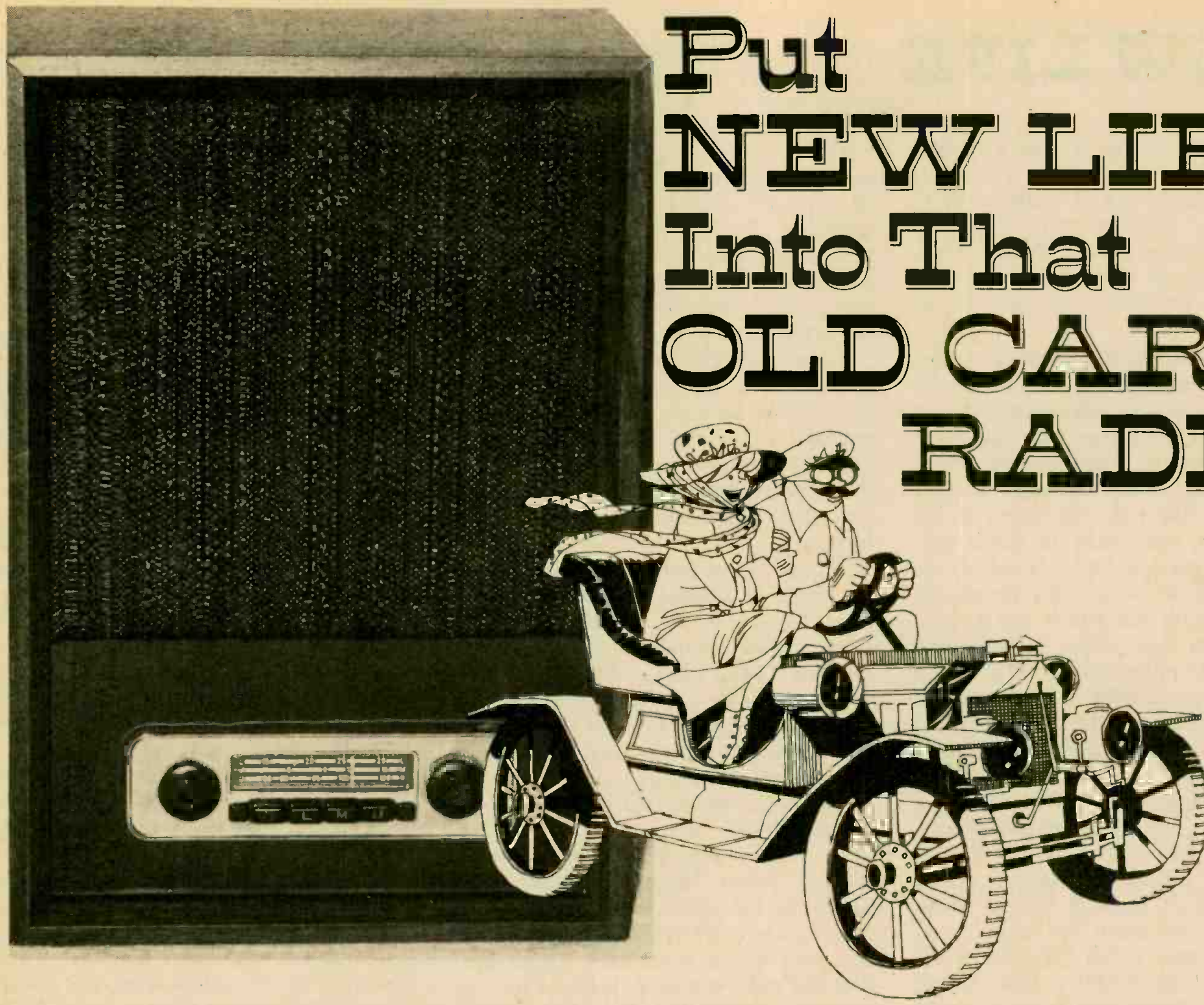
☐ When switched on, this little screamer sounds like its official counterpart, with authentic-sounding rise and fall in pitch. Since the siren-sound is subjective to a large extent, plenty of variable components have been included in order to obtain the "perfect pitch." The circuit consists of a 555-type timer in astable mode, modulated by a varying DC, which is developed from a long-term multi-vibrator or clock. The high-low action of the clock causes capacitor C3 to charge and discharge through a resistance R4, the potential on the capacitor being applied to the "modulation input" (pin 5) of the 555. The long-period clock may be derived from another 555, or from the circuit shown. ■



PARTS LIST FOR SIREN CIRCUIT

C1, C2—4.7-uF tantalum capacitor, 25 VDC
C3—500 to 1,000-uF electrolytic capacitor, 25 VDC
C4—100-uF electrolytic capacitor, 25 VDC
C5—0.1-uF ceramic capacitor, 15 VDC
IC1—4011A quad NAND gate
IC2—555 timer
R1—500,000-ohm, ½-watt resistor
R2—500,000-ohm linear-taper potentiometer
R3—47,000-ohm, ½-watt resistor
R4—10,000-ohm linear-taper potentiometer
R5—4,700-ohm, ½-watt resistor
R6—25,000-ohm linear-taper potentiometer
SPKR—8-ohm PM type speaker
T1—audio output transformer 500-ohm primary/8-ohm secondary

Put NEW LIFE Into That OLD CAR RADIO



With a loudspeaker and a simple power supply your old car radio will become a high-quality home receiver. Good for DXing, too.

☐ For years now Americans have bought 10 million or so new cars every year, and most of those cars have radios in them when new. As a result millions of used cars are sold by their original owners each year. Now the price a car dealer will pay, or allow you on a used car is a combination of the so-called "book" value, which he gets from a little blue book, and of the bargaining. He doesn't care whether your used car has a radio or not, and many people, knowing this, take out the car radio before trading in the old bus on a new one. The result is that there are hundreds of thousands of used car radios lying around in garages, attics and cellar storehouses, waiting to be thrown out some year in the annual spring cleaning.

Most of these radios are perfectly good, but won't be used because it's usually too much trouble to install them in a car other than the one they were originally set up for.

But there's no reason such sets can't be put to work as house radios, especially since they will almost always work better than most table model radios, and even most console sets you can buy today. Their tone is as good or better than most home sets—obviously we're not comparing them with high fidelity component sets, which cost many times more than regular table or console radios. Their selectivity and sensitivity is also better than that of most home sets because they have an RF (radio frequency) amplifier stage ahead of the converter stage, and most home sets don't bother with an RF amplifier stage which car sets need.

Going for AM DX? DX fans can have a ball with converted car radios. The sensitivity and selectivity of most car sets, when combined with a good outside antenna can get you AM stations from all over the country. Here in California I've been able to get stations like KOMA, Oklahoma City, WLS Chicago, and many others regularly, at night. For more on AM DXing see ELEMENTARY ELECTRONICS Sept./Oct. 1976 "The Secrets of Split-Frequency DX." White's Radio Log, regularly published in our sister publication, COMMUNICATIONS WORLD, is an excellent source of info on the super DXing you can do on AM radio.

Car Radios Are Better. The typical car radio was built to perform in one of the toughest environments—your car. The set has to work with a ridiculously small antenna, and yet get distant stations. It also must have enough volume to overcome road noise and tone quality to offset the shortcomings of the small, poorly baffled speakers found in most cars. And to top it off, the car radio must perform well over a wide temperature range.

Conversion is easy and inexpensive.

NEW LIFE

All you have to do is add a power supply, antenna, and a good speaker to a car set and you are in business! So if you have an old car radio, or know where you can get one, don't pass it up. You won't know how good radio can be until you convert a car set to home use.

First Get Your Radio. What car radios are best for conversion? Just about any old car radio can be converted to home use, provided it's a *transistor set*. Tube sets will be too old, and more important to us, they use much too much current (to heat up the tube filaments) to be practical for conversion to home use.

You can use an AM-only set, or an FM/AM set. If it's a really recent car radio it may be one which has a four- or eight-track tape player built in, and with a stereo radio section. If it has a tape player you'll have to use a heavier power supply than if it's just a radio receiver, but that's the only other restrictions (besides no tube sets).

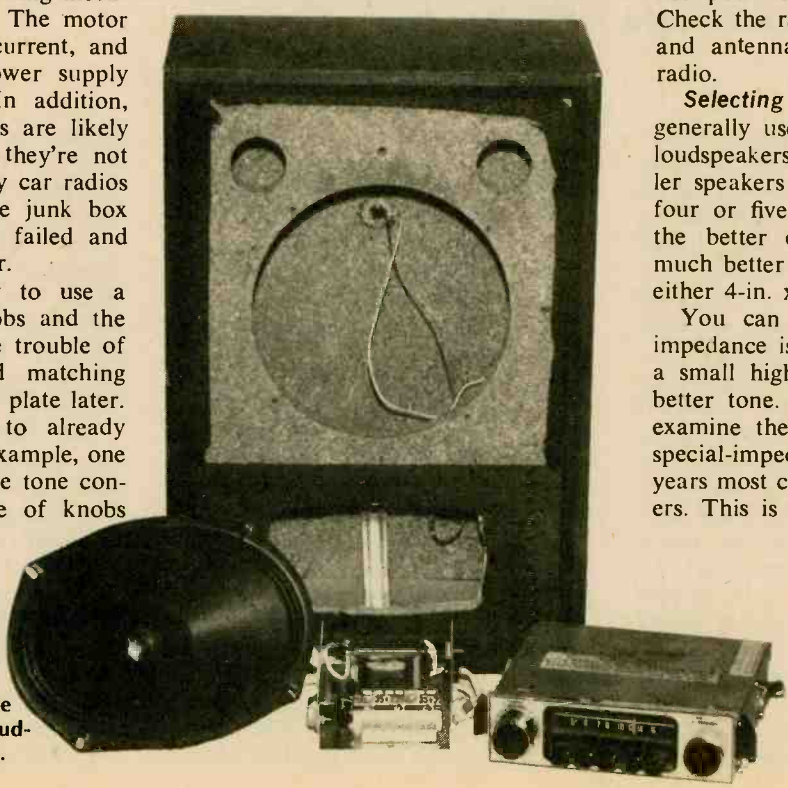
Of course the car radio should be a 12-volt unit. 6-volt car radios haven't been made for quite a while, though it's possible you might happen across one. And don't convert one of those fancy car radios which has "signal seeking" (sometimes called "Wonder Bar," because you just touch a little bar to activate it). These sets have a motor inside the set to drive the tuning mechanism and the tuning dial. The motor draws several amperes of current, and would require a heavy power supply costing much too much. In addition, these automatic-tuning units are likely to get out of whack, and they're not easy to repair. In fact many car radios have been consigned to the junk box just because the auto tune failed and it was too expensive to repair.

And another thing. Try to use a radio which has all its knobs and the dial plate. It'll save you the trouble of scrounging around to find matching knobs and a dial escutcheon plate later. However, if you happen to already have a good car radio—for example, one with separate bass and treble tone controls, don't let the absence of knobs hold you back. They *are* available at some specialized stores. And you *can* make up a new escutcheon plate from a piece of scrap aluminum.

Check It Out First. Before you convert the car radio to home operation, be sure it's working OK, or is worth repairing. To do this make up an antenna as shown in the diagram, and connect it and a speaker (just about any speaker will do) and a power supply to the radio as shown.

Hook up a 12-volt battery or battery eliminator to the radio, being careful to hook the positive (red) side, usually marked +, to the "hot" lead of the radio. The negative (ground, or common) nearly always goes to the case of the radio. Check the markings first to be sure.

Adjust the antenna trimmer capacitor to get maximum sensitivity. This is done by setting the tuning dial to a weak station around the high end of the dial (1400 kHz is ideal) and adjusting trimmer C2 for maximum volume. The setting of C2 will be different when you connect the final antenna to the set, later. Measure the current drawn by the radio. Most solid state sets draw ½ amp or less—if it draws much more than this we suggest you use a commercial power supply such as those made for CB radios and tape players. Almost any store-bought power supply will work fine in most cases. Make sure that the radio works properly. Clean it off and wipe the dial glass clean. Spray the volume/tone controls with a good control cleaner, and remove the dial lamp. This will save power and allow the power supply to run cooler.



Car radios may be converted for home use using any convenient enclosure, a simple power supply, and a better loudspeaker, as shown at the right.

Making the Conversion. Start by building the power supply shown unless you buy one. If you use the commercial power pack mentioned, skip this section. I built my supply on a 4-in. x 3½-in. piece of U-shaped aluminum. The components, with the exception of transformer T1 are all mounted on the sides of the "U", which are about 1½-in. high. You can build yours in the same way, or mount the parts in a commercial chassis instead. Or you can mount the power supply on the top or back of the radio. But just be sure if you do this that you can install the radio in a cabinet. Install the components and wire them up, being careful of the connections of IC1, a voltage regulator. The case is ground so you don't have to isolate the case from the chassis. When you complete the component wiring, add leads at least three feet long so that the power supply may be easily attached to the radio.

You have an option at this point as to how you connect the AC power switch. You may use a separate unit as I did with the second radio shown, or open up the set and use the existing switch. If you choose this method, be sure to carefully remove the existing wires and solder them together. Then connect the AC wires from the power supply. Connect up the ground and 12-volt positive wires to complete the job. Check the radio out again with speaker and antenna. If all's well, install the radio.

Selecting a Loudspeaker. You can generally use any of a wide variety of loudspeakers with a car radio. The smaller speakers supplied with car sets are four or five inches in diameter, while the better ones, which usually have much better tone, are oval-shaped units either 4-in. x 6-in., or 6-in. x 9-in.

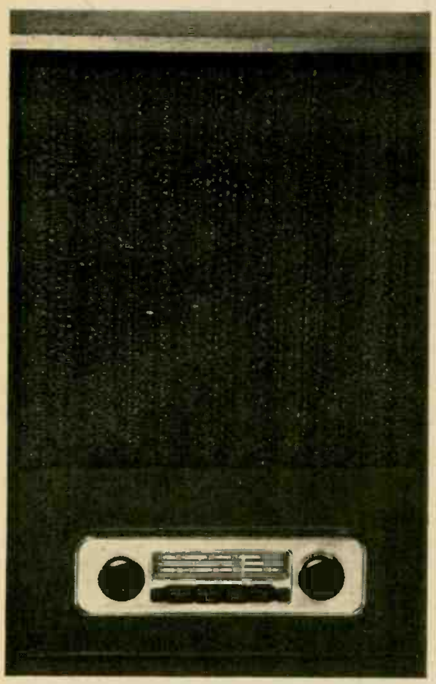
You can use one of these, if the impedance is correct, or you can go to a small high fidelity speaker for even better tone. First you should carefully examine the radio to see if it uses a special-impedance speaker. For many years most car sets used 3.2-ohm speakers. This is the nominal value if there is no special indication. Many of today's sets use higher impedances, however, such as 10, 20, or even 40 ohms. If the set you're converting is so marked, you can use any one of the multi-impedance speakers listed in the Parts List. If it's not specially marked, use any speaker of 3.2, 4, or 8 ohms. Choose the largest speaker, with the heaviest magnet (and costing the most, generally) for the best tone.

Installation. This is where you get to exercise your creative talents. There are many different places you can mount your converted car radio. You can go my route and install it in a speaker cabinet. This worked great because reject cabinets were available from a local speaker company for $1.00 each. I installed both radios in reject cabinets. I bought speakers to match the cut-outs (8 inches in both cases). Then I added grille cloth to cover the speaker area and installed it. If you do this you will find the going very easy as most of the work has been done for you by the cabinet manufacturer.

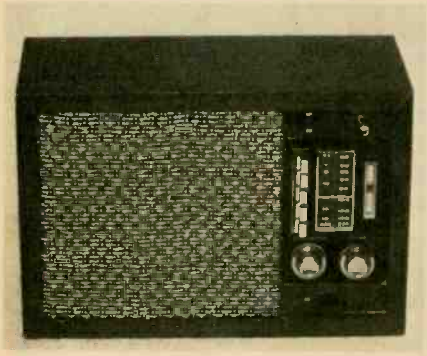
Some other places you can put your radio are in a room divider or end table. Or how about the wall in your kitchen? What about under a shelf in a cabinet? The choice is up to you. If you have room for the radio only, you can locate the speaker somewhere else.

Operation. After you have installed the radio, power supply, and speaker, connect the antenna. Place C2 in a convenient spot where you can get at it. Then turn on the radio and tune in a weak station around 1400 KHz on the dial. Adjust C2 for maximum volume. The antenna lead may be stapled around the back of the cabinet. If you've converted an AM/FM set you might wind several turns of the antenna around the AC cord for better reception. The lead may also have to be carefully positioned for best results on FM. This was necessary for the two radios that are seen here. That's all there's to it! Sit back and enjoy your new radio. You'll be amazed at the performance; it will far outstrip the radio receivers you buy in the drugstores, and the AM sections of all but the best stereo sets, too!

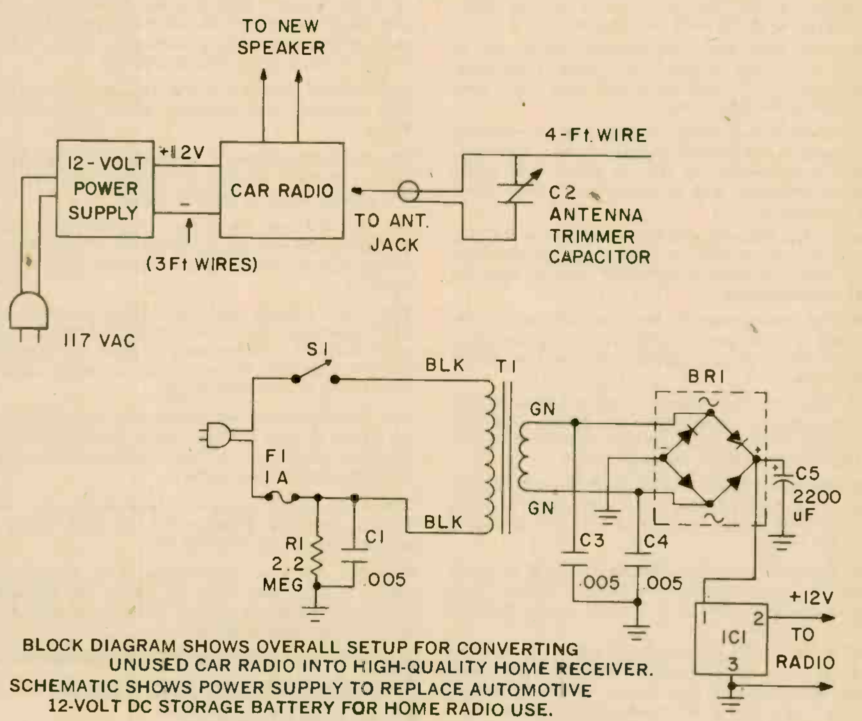
If You Don't Have A Car Radio. If you don't have one, a good place to get car radios is from junk yards and used car dealers. Better yet, check out flea markets, garage sales, and other similar places. You'll generally be able to bargain and get a set for a lower price from the former sources. You shouldn't have to pay over $10.00 for a set. You might get a radio that needs repairs and cut the price even farther. I bought several broken radios for fifty cents each, fixed them, converted them and gave them away as gifts! ■



Another loudspeaker cabinet (cost: $1.00!) houses this converted car radio. Sounds great!



Out of a VW and into a reject speaker cabinet goes this car radio. AM, FM, and short-wave.



BLOCK DIAGRAM SHOWS OVERALL SETUP FOR CONVERTING UNUSED CAR RADIO INTO HIGH-QUALITY HOME RECEIVER. SCHEMATIC SHOWS POWER SUPPLY TO REPLACE AUTOMOTIVE 12-VOLT DC STORAGE BATTERY FOR HOME RADIO USE.

CONVERSION PARTS LIST FOR CAR RADIO

BR1—6-ampere, 50-volts AC or better bridge rectifier.
C1, 3, 4—0.005-uF, 600-volts or better capacitor.
C2—365-500-pF (maximum) trimmer capacitor.
C5—2200-uF, 35-VDC or better electrolytic capacitor.
F1—1-ampere fuse.
IC1—Voltage regulator chip.
R1—2.200,000-ohm ½-watt resistor.
S1—SPST switch.
T1—Power transformer, 117 VAC primary, 12.6-volt, 1.2-amp.
Loudspeakers—Oval car speakers, 4-in. x 6-in. or 6-in. x 9-in. multi-impedance units, 10, 20, 40 ohms, if required—see text.
Misc.—Fuse holder, AC line cord and plug, car radio antenna plug obtainable at radio parts suppliers).

LITERATURE LIBRARY

322. *Radio Shack's* 1979 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. *Lafayette Radio's* 1979 catalog offers almost everything in hi-fi, CB, ham and many electronic parts. A product index will help you find anything from auto equipment accessories to wire wrapping tools.

381. *Fordham Radio's* handy catalog covers test instruments, tools, parts, home and car audio products, scanners and lots more. Get your free copy today!

385. Amateur Radio buffs and beginners will want the latest *Ham Radio Communications Bookstore* catalog. It's packed with items you should be reading today!

373. 48-page "Electronic Things and Ideas Book" from ETCO has the gadgets and goodies not found in stores and elsewhere.

382. Buys by the dozens in *Long's Electronics* super "Ham Radio Buyer's Guide." Good reading if you're in the market for a complete station or spare fuses.

383. If you're a radio communicator, either ham, SWL, scanner buff or CBer, you'll want a copy of *Harrison Radio's* "Communications Catalog 1979." Just what the shack book shelf needs.

372. Just what the experimenter needs can be found in *Olson's* bargain flyer—parts, assemblies, semiconductors, components, and more. Even more interesting are the prices.

379. There's everything in the area of musical synthesizers for drums, strings, other instruments and full orchestras, as well as audio gear, video display modules, and a computer in *PAIA Electronics'* catalog.

380. If your projects call for transistors and FETS, linear and digital ICs, or special solid-state parts, then look into *Adva Electronics'* mini-catalog for rock bottom prices.

384. *The B&K-Precision* test instruments are described in a new compact catalog all experimenters should have! Start stepping up your test bench capabilities.

301. Get into the swing of microcomputer and microprocessor technology with *CREI's* new Program 680. New 56 page catalog describes all programs of electronics advancement.

302. Big catalogs are coming back. *Burstein-Applebee* will send you theirs. It's a parts bonanza every experimenter would want to see. Latest catalog is over 200 pages.

303. *Graymark's* catalog reveals a host of products and kits every experimenter would like to have. Unusual binary clock is a winner. A *must* catalog for the beginner.

305. A new 4-page directional beam CB antenna brochure is available from *Shakespeare*. Gives complete specs and polarization radiation patterns for their new fiberglass directional antennas.

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.

374. *Radatron's* Catalog 1006 lists many projects from a self-contained portable lab station for an electricity-electronics course to many texts, lab manuals, and applied activities.

306. *Antenna Specialists* has a new 32-page CB and monitor antenna catalog, a new amateur antenna catalog, and a complete accessory catalog.

307. *Atlas* calls their 210X and 215X the perfect amateur mobile rigs. Their 6-page, full-color detailed spec sheet tells all. Yours for the asking.

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.

308. Your guide to equipment for radio communication is an informative product booklet offered by *R. L. Drake Co.* Hams and SWLers alike should scan this 20-page shopper's guide.

310. New and used personal computer machines, and peripherals you never dreamed existed, or were available are in the *Newman Computer Exchange* catalog. Get yours today.

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. *E.D.I. (Electronic Distributors, Inc.)* carries everything from semi-conductors to transformer/relays to video cameras. In prices ranging from 19¢ to $500, products appear from over 125 electronic parts manufacturers. The catalog is updated 3 times a year.

313. Get all the facts on *Progressive Edu-Kits* Home Radio Course. Build 20 radios and electronic circuits; parts, tools, and instructions included.

314. Cover the Ham bands from 80 to 10-meters with one classy rig—*Swan Electronics'* 100-W 100 MX mobile transceiver. Get the details direct from *Swan*.

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.

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. If you are into audio, ham radio, project building, telephones, CB or any electronics hobby you'll want *McGee's* latest catalog of parts and gadgets. Hard to find parts fill each page, so get a copy of the catalog from *McGee* today!

329. *Semiconductor Supermart* is a new 1979 catalog listing project builders' parts, popular CB gear, and test equipment. It features semiconductors—all from *Circuit Specialists*.

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.

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.

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.

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. Now you can get the "Break-through Book" with its 105 innovations in breadboarding and testing. *Continental Specialties*. The break-through is twofold—products and price!

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.

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.

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. How about a hybrid 13-watt audio module for $8.88? Or ultrasonic transducer for $1.49? You find these and other exotic parts and products aplenty in *Poly Paks* flyer. Get your copy now!

375. *Compucolor Corp.* has a personal computer system with an 8-color integral display, a typewriter-like keyboard, and a mass storage device. Programs are ideal for checkbook and income tax figuring.

377. We can't enumerate all the products in *John Meshna, Jr.'s* catalog of surplus electronic parts: power supplies; computer keyboards; kits for alarms, clocks, speakers; and more.

378. *Delta Electronics* is a complete parts source for electronics experimenters. Discrete parts, modules, boards, subassemblies and complete gadgets. Get *Delta's* 120-page catalog today.

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RHYTHM & BLUES

(Continued from page 15)

finished product neater. An actual-size PC etching guide is provided. Most of the components of the synthesizer mount on the PC board, as shown in the parts placement diagram. Note that ten jumper wires are required (identified by J). These are all inserted from the component side of the board and may be bare wire. Use sockets for the nine CMOS IC's; using a socket for IC2 is optional. Heat sinks are recommended for IC1 and Q3, either commercial or homemade.

The optimum value for R28 depends on the transistors used for Q2 and Q3. Therefore, at this time, temporarily install a 100,000-ohm potentiometer wired in series with a 10,000-ohm fixed resistor, in its place. Set the potentiometer at midrange for starters. This will allow for tailoring the pulse to the speaker.

After assembling the PC board, check carefully for solder bridges, bad connections, etc. The PC board may be mounted to the chassis or cabinet by means of six sets of screws and spacers at the location indicated near its edges.

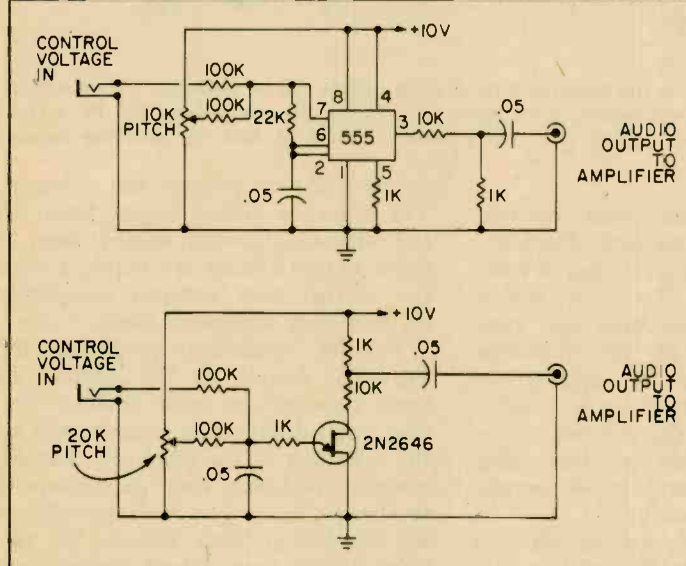
Arrangement of the components off the PC board is not critical. The author's arrangement is shown in the photos. Some of the connections from the PC board to these components are indicated by circles on the schematic diagram. Letters within these circles also appear on the etching guide.

If you use the switch specified in the parts list for S3, you will need to make a simple modification to it. The specified switch has a rotation stop which allows only eleven positions to be indexed. Bend the stop out of the way to allow all twelve positions to be indexed. Note that in the newly-created position the switch rotor does not contact any of the stationary treminals; this position is used as the *off* position. When wiring S3 and the beat controls, take care to connect the wires in the correct order. Please note that switch S3 is wired only to stages 2 through 12 of the shift register. The chassis, panel, and cabinet were custom made for the author's unit, but standard commercial items could be used. The author's cabinet measures 4-in. high by 10½-in. wide by 5-in. deep.

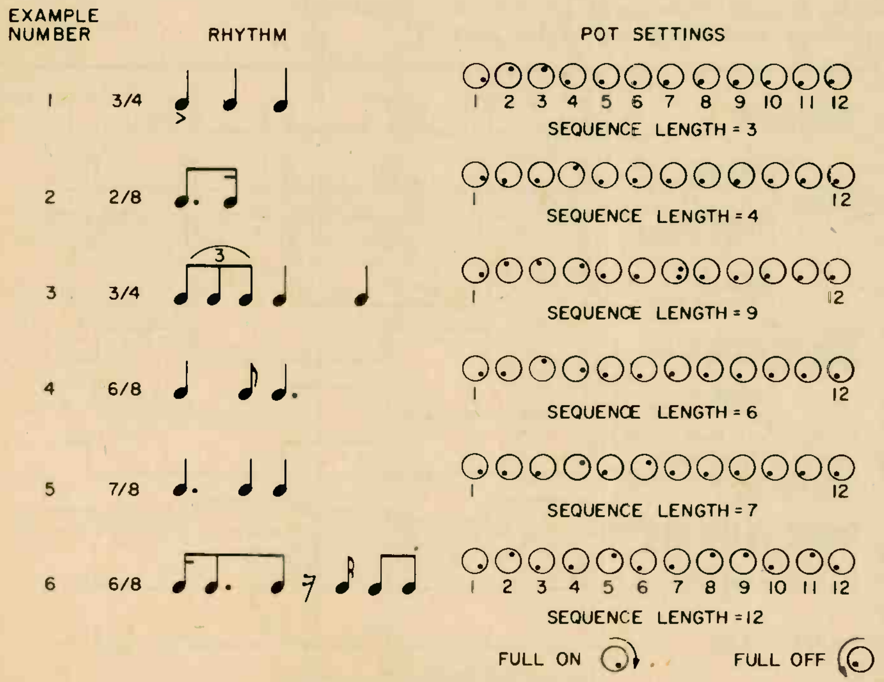
Tuning Up. After you have completed the wiring and assembly, but *before* you insert the CMOS IC's, check out the power supply. Plug the unit in, switch it on, and measure the voltage between the point labeled P and either one of the points labeled G on the PC board. It should be 10 volts (plus or minus 0.1 volt) with P positive. If not, check the power supply (S1, T1, Z1, C1, and IC1) for wiring errors or faulty parts. When the power supply checks out, unplug the R&B Box and insert the IC's, observing their orientations.

To continue the checkout, set the beat controls (R11-R22) fully clockwise; *Tempo* (R3) about ¾ of the way clockwise; *Sequence Length* (S3) to 12; *Volume* full on, and *Light* to *on*. Turn the power on, and push and release *Reset/Start* (S2). Immediately after it is released, a continuous series of clicks should be heard. The synthesizer may start without pushing S2. The clicks should all be equally loud, occurring at evenly-spaced intervals, and the LED should flash for each click that you hear.

Sour Notes? If your R&B Box doesn't behave as it should, first recheck the PC board and all the wiring. Make sure that the ICs are correctly installed and oriented properly. Next, determine that the clock (IC2 and IC3) is working. Check for a series of 10-volt pulses at the *External Amplifier* jack, which indicates that the shift register (IC5, 6, and 7) and analog switches (IC8, 9, and 10) are work-



To use your R&B Box as a melody generator, construct one of these voltage controlled oscillator circuits, and connect it to jack J2 and to an audio amplifier.



Here are some examples of time signatures and their corresponding setups on the control panel. Remember that not only is tempo controlled, but also emphasis. There aren't many musical notations that the Rhythm and Blues Box can't handle.

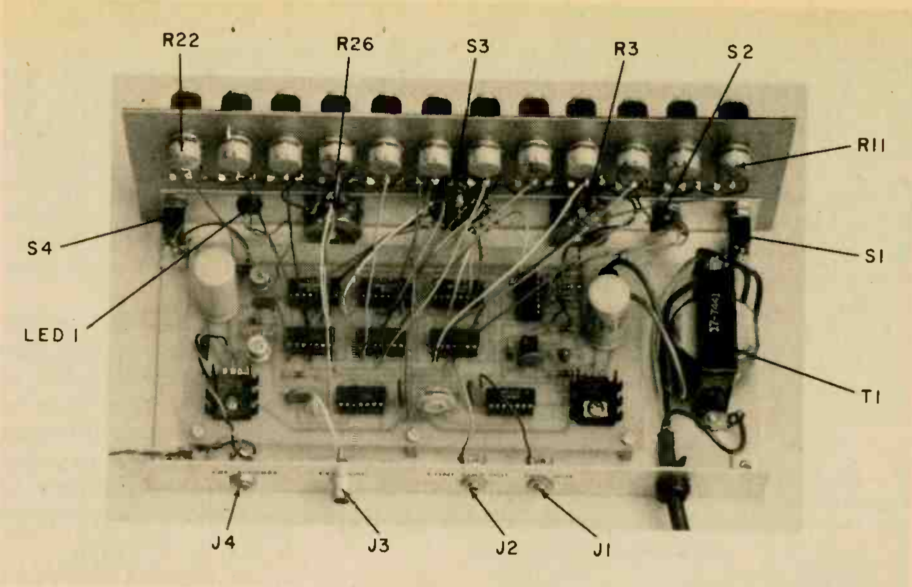
ing. If either the sound or light operates, but not the other, check the appropriate output circuitry. If one of the clicks is weak or absent, look for a problem in the corresponding stage. The troublesome stage can be identified by varying each numbered pot in turn.

Assuming everything is OK, the next step is to determine the optimum value for R28. Verify that all controls are set as specified earlier; be sure that *Volume* is at maximum. If you can get an oscilloscope, connect it across the speaker terminals to observe the pulses; if not, make the adjustment by ear. First, set the potentiometer (temporary R28) to maximum resistance. Turn the synthesizer on, and start it pulsing. Now, slowly decrease the resistance, which should cause the amplitude of the pulses to increase up to a point of saturation, that is when the amplitude no longer increases with decreased resistance on the potentiometer. Back the potentiometer off a bit from this point, unplug the unit, remove IC11, and measure the resistance of the potentiometer and fixed resistor, and replace them with a fixed resistor of the same value, or the closest standard value which you can get.

Reinsert IC11, start the R&B Box again, and continue the checkout by turning all the beat controls, except number one, down to about ⅓. This should result in one loud click (corresponding to beat control number one), followed by eleven softer ones (corresponding to numbers 2 through 12). The intensity of the LED's corresponding flashes should follow the same pattern. Holding the *Reset/Start* button in should stop the clicks. Releasing it should immediately start the sequence of clicks again, beginning with #1, the loudest. Now set *Sequence Length* to 11; a repeating sequence of one loud click followed by ten softer ones should be heard. Similarly check *Sequence Length* settings of 10, 9, 8, etc. When changing the *Sequence Length* setting the pulse may be "lost" from the shift register with the result that the clicks are no longer produced. This is normal, and if it happens, simply push and release *Reset/Start* to restore operation. With *Sequence Length* at *off*, a sequence of twelve clicks should be produced (the first one should be loudest) each time *Reset/Start* is pushed and released.

Check that the loudness of each of the twelve clicks in the sequence can be varied from zero to maximum

Finally, adjust trimmer potentiometer R9 to give the desired sound quality to the clicks.

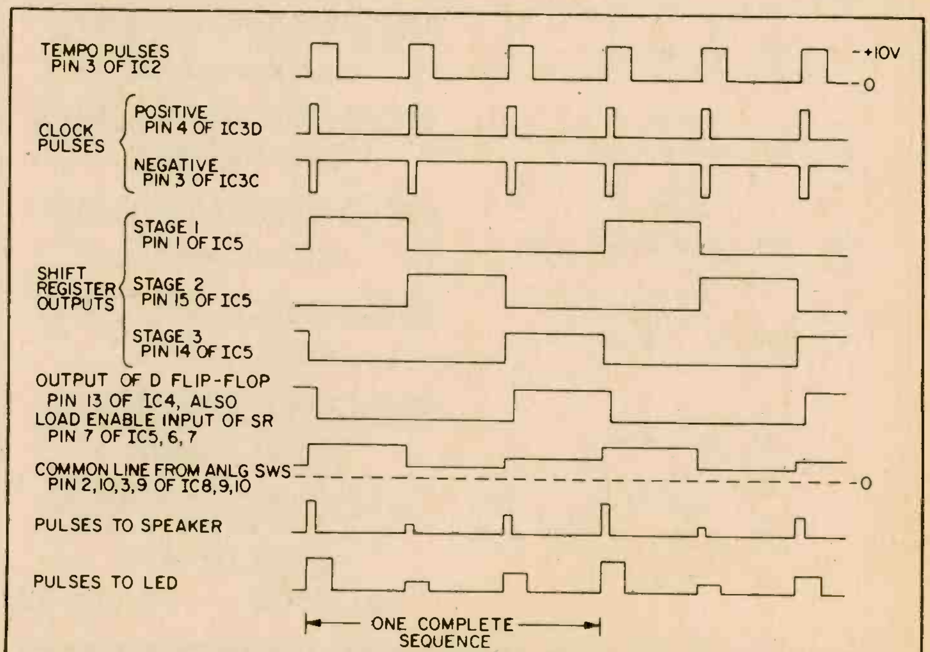


With the cover removed, the placement of all components can be observed. When wiring the beat control potentiometers, it's a good idea to tag the wires from the PC board for easy identification. Install only every other control at first for working room.

Performance. After going through the circuit description and checkout, you should have a general idea of what the synthesizer does. To use it, decide how many beats you need for your rhythm. This will be the *Sequence Length* setting. Turn the appropriate number of beat controls up to emphasize a beat, down to de-emphasize it, or off to delete it. As you have have seen, the R&B Box can operate in two modes: *Single-shot*, or *continuous*.

For *single-shot* operation, set *Sequence Length* (S3) to *off*. In this mode, a single sequence of 12 clicks is produced each time the *Reset/Start* switch (S2) is pushed and released. The sequence always begins from the left with beat control number one. If fewer than 12 beats are required, turn the unused beat controls completely off to silence unwanted clicks.

For the *continuous* mode, set the *Sequence Length* to the number of beats required for your rhythm. The beat control with that number will be the last click in the sequence. The sequence will repeat itself indefinitely in this mode. Since you have preselected the number of beats already, the settings of the unused beat controls are irrelevant.



Need an adjustable waveform generator? The Rhythm and Blues Box can handle that too. Simply tap in at the appropriate point, hook up your scope, and you're ready to go.

Examples of how to accomplish various rhythms are shown in the pictorial. In these examples, the initial beat is emphasized only for the purpose of clarity, and of course is not mandatory.

Example #1 is a simple waltz rhythm with three beats; LOUD-soft-soft. Set *Sequence Length* to 3, beat control #1 fully clockwise, and beat controls 2 and 3 about halfway clockwise as shown. *Tempo*, *Volume* and *Light* may be set as desired.

Example #2, a "dotted" rhythm, has two notes of unequal duration; the first (dotted eighth) is three times as long as the second (a sixteenth). The shortest time unit in the pattern is a sixteenth, and the total length of the pattern is four times this (2/8 or 4/16). Consequently, *Sequence Length* should be set to 4. Beat control #1 should be fully on, number 4 should be halfway on, with numbers two and three fully off. As illustrated by the example, a rule of thumb is that the *Sequence Length* setting should equal the total length of the pattern, divided by the shortest time unit.

Example #3 begins with a "triplet", whose note each have a time value of 1/12; the total pattern has a time value 3/4 or 9/12. Thus a *Sequence Length* of 9 is used.

Example #4 is a common rhythm and is a straightforward set up on the Synthesizer.

Example #5 is an uneven rhythm typical of Eastern music. Such rhythms are frequently troublesome, but are easily handled with our rhythm synthesizer. If you need to analyze such rhythms it may be helpful to turn on the "silent" beats slightly; in this example #2, 3, 5, and 7.

The final example, #6, illustrates how the synthesizer can accommodate fairly complex rhythms. All twelve pots are needed since the smallest time unit is a 1/16 note and the total pattern duration is 6/8 or 12/16.

Off-Beat Uses. As mentioned at the beginning, the rhythm synthesizer is also useful as a programmable controller for electronic music synthesizers and other equipment. The *Control Voltage Out* jack (J2) puts out a se-

For example, the sequence of voltage levels can be fed to a VCO (voltage controlled oscillator) to generate programmed melodies of up to twelve notes. If you want to try this, two simple VCO circuits which can be controlled in this way by the rhythm synthesizer are given in the figure.
quence of voltage levels corresponding to the settings of the numbered pots.

You can also use the R&B Box as a waveform generator for square, pulse, staircase, and other waveforms, again by using the signal from the *Control Voltage Out* jack. To get an idea of the possibilities, connect an oscilloscope set at a slow sweep rate to J2, turn *Tempo* all the way up, set *Sequence Length* to 12, and vary the numbered pots.

In case you want to run your rhythms through another amplifier or speaker, an *External Amplifier* jack (J3) and *External Speaker* jack (J4) are provided.

Get into the swing of things with our Rhythm and Blues Box and be the most percussive constructionist who ever drummed up a storm! ■

New Products
(Continued from page 7)

ers and distributors, or direct from Continental Specialties Corporation, 70 Fulton Terrace, New Haven, CT 06509.

Stalker CB

The new Stalker V, 40-channel AM mobile CB radio by Teaberry is compact, handsomely styled, and offers features most CB'ers could desire, including Channel 9 Priority. Among the other features of the Stalker V are: SWR meter, "S"/RF meter, ANL/NB switch, tone control, RF gain control, delta tune, dim/brite switch, mike gain, and transmit and receive indicators. The Stalker V also boasts detachable dynamic mi-

CIRCLE 68 ON READER SERVICE COUPON

crophone, positive/negative ground, PA function, external speaker jack, and plug-in DC power cord. The Stalker V has a suggested retail price of $159.95. Get all the facts direct from Teaberry Electronics Corp., 6330 Castleplace Dr., Indianapolis, IN 46250.

How Much Noise

The new Realistic Sound Level Meter from Radio Shack may be used for measuring sound intensity in homes, schools, offices, or other environments for compliance with noise standards established by federal, state and local agencies. It can also be used to check the acoustics of studios, auditoriums, and home hi-fi installations. The hand-sized meter features a weighting selector for measuring either wideband sound

CIRCLE 32 ON READER SERVICE COUPON

level ("C" weighting), or the 500 to 10,000 Hz range ("A" weighting), which is the area of greatest sensitivity to the human ear. A range switch selects six sound level ranges, each spanning 16 dB, for an overall range of 60 to 126 dB

Junk Box Special
(Continued from page 86)

If you wired R2 correctly it should be full counterclockwise. Then set S1 to *on*. The meter should rise instantly to 5 volts DC. As R2 is adusted clockwise the output voltage should increase to 15 VDC or slightly higher. If R2 can adjust the output voltage only over the range of approximately 12 to 15 VDC, or 12 to 15+ VDC, IC1 is defective, or has been damaged. ■

Touch 'n Dim
(Continued from page 73)

make a particular unit that you use. In general, a small heat sink is desirable. *Be sure that nothing carrying line voltage protrudes outside the case.* I mounted the Triac in the prototype on a small piece of sheetmetal and held the assembly down with quick-drying epoxy. Be sure to roughen the space on the plastic where you put the cement.

I soldered Diac Q1 directly to the gate lead of the Triac and covered the connection with heat shrink tubing. If you just leave two thin wires about 8" long for connection to PC1, the whole dimmer circuit can be wired and tested separately. When you are satisfied that the dimmer works, mount the circuit board in the case on a couple of spacers and solder its AC line input terminals in place. Tape I1 and PC1 together as shown in the photo. Wire in PC1, turn R14 up for maximum intensity and plug the unit in. The touch control and dimmer should now function independently of each other. The only other step is to make a couple of mounting holes in the top of the case for mounting the touchplates.

For convenient operation and adding atmosphere to kitchen or living room, Touch 'N Dim is a hard combination to beat. As noted above, the circuitry can also be fitted into a lamp having a non-metallic base. Just take care that you use the same touchplates as are in the prototype. That way you won't have any problem, due to improper capacitance. Enjoy! ■

Super Soother
(Continued from page 91)

Super-Soother connects to your radio or tuner between its FM detector and de-emphasis filter. If you connect after the de-emphasis filter you will find the 67 kHz subcarrier has been filtered from the Detector's output signal and you will get nothing but noise from the Super-Soother. The drawing shows a typical FM detector output, the de-emphasis network, and the correct connecting point for the adaptor. Since it is possible the Super-Soother will load down the detector for normal FM reception I suggest a switch be installed so it can be removed from the circuit when not being used for SCA listening.

Super-Soother is most conveniently connected through a phono jack installed on the rear apron of the tuner or radio.

If you have one of the older FM tuners with an *MPM* output you already have the correct connection because the MPX output *is* the *non-deemphasized* detector output. Similarly, if you have a modern FM tuner with an *FM detector, 4-channel, or FM Quadrasound* output jack you also have the correct connection as they are all FM detector outputs from *before* the de-emphasis network.

Connect the tuner's detector output to the Super-Soother with the shortest possible length of shielded cable, or install it directly inside the tuner or receiver if there is sufficient room. Connect Super Soother's output to any high-gain amplifier such as the microphone input of a hi-fi or general-purpose amplifier.

Locking The Loop. Tune in a station you know (or believe) is transmitting an SCA program (a call to the station should get you the info) and adjust trimmer potentiometer R8 for best SCA sound quality. Normally, the reception will be almost completely garbled and then fade into a clean signal as R8 is adjusted. As R8 is adjusted further the sound will again garble. Set R8 so it is approximately midway between the two settings that produced garbled sound. Usually, the adjustment is quite broad so don't be too fussy.

If you don't know which stations are transmitting SCA set R8 to its mid-position and tune the station very carefully and very, very slowly. When you hear anything that sounds like distorted music try adjusting R8—if it's real SCA it will turn into clean sound as R8 is adjusted. Note that some stereo stations can cause sound bursts that appear to be SCA. If adjusting R8 doesn't clean up the bursts it's not SCA. Note that once R8 is properly adjusted there is no stereo hash interference with SCA signals; hash will only be heard from non-SCA signals.

Problems? The high sensitivity of this system may require that the overall gain be reduced. In the event you cannot receive *any* SCA stations you either have none in your area or you have made a construction error. Here are some hints to help.

1) If your problem is a weak signal resulting in high frequency noise try changing C12 and C14 to 0.05 uF.

2) If your problem is background breaking through from the main channel the problem is probably caused by adaptor overload (clipping). Simply change C1 and C9 to approximately 300 pF. This will attenuate the subcarrier and clean up the breakthrough on very strong signals, though very weak signals might get lost (you can't grab, or hear, them all). A second, simple corrective procedure is to install a 100k ohm resistor in series with the input from the radio or tuner's detector. This effectively cuts down the input signal and eliminates overload. ■

Precision Pet
(Continued from page 103)

same locations a are indicated in the components location diagram. If you're a beginner at constructing electronic projects, you'll find as you progress to more complex projects that making up a printed circuit board saves construction time and improves the project by making it neater and much more reliable (rigid mechanically) than other construction methods. However, you may, like many other beginners be hesitant about making such a board the first time. If so, making a fairly simple printed circuit board such as the one shown for this project is a good idea. Although not necessary for this project, it is good practice and training for much more complex projects, where use of a printed circuit components board is virtually mandatory.

There are numerous other practical applications for PET, such as measuring your freezer and refrigerator's temperature. (Consumer's Union recommends a temperature of 37°F in the center of the fresh food space and 0°F in the freezer) PET's variety of use is limited only by your needs. ■

New Products
(Continued from page 117)

and includes a position for checking battery condition. The meter also has a slow/fast response switch for checking average or peak noise levels. The Realistic Sound Level Meter is priced at $39.95. Available exclusively from Radio Shack stores and dealers, nationwide.

Active Audio Processor

For the audiophile, Heath Company has introduced the AD-1304 Active Audio Processor. The AD-1304 is designed to

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reduce high-frequency noise and increase the dynamic range of the source material in a high fidelity system. The AD-1304 connects electrically between the tape output and tape monitor jacks on your receiver, preamplifier, or integrated amplifier. A built-in tape monitor replaces the one used to connect the Audio Processor. The AD-1304's single ended design makes it compatible with any program source since it does not require a preprocessed source. The AD-1304 provides up to 7 dB of dynamic range expansion and up to 10 dB of apparent noise reduction. The dynamic range of source material is thereby increased by 17 dB. Sensitivity controls and LED indicators make adjustment of the Audio Processor quick and easy for any program source. For more information on the AD-1304 Audio Processor kit, which is mail order priced at $199.95, write to the Heath Company, Dept. 350-36, Benton Harbor, MI 49022.

Fuzz for Fun

The Boss DS-1 distortion unit produces the fuzz sound so popular today. The $89.50 unit uses a high gain amplifier to overdrive its own circuitry and provide the distortion. With the level con-

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trol turned up, the musician can also achieve a high degree of sustain. The output wave form is basically square and is very rich in odd order harmonics. Get data on the Boss DS-1 distortion unit from Roland Corp., US, 2401 Saybrook Avenue, Los Angeles, CA 90040. ■

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Disco King

(Continued from page 22)

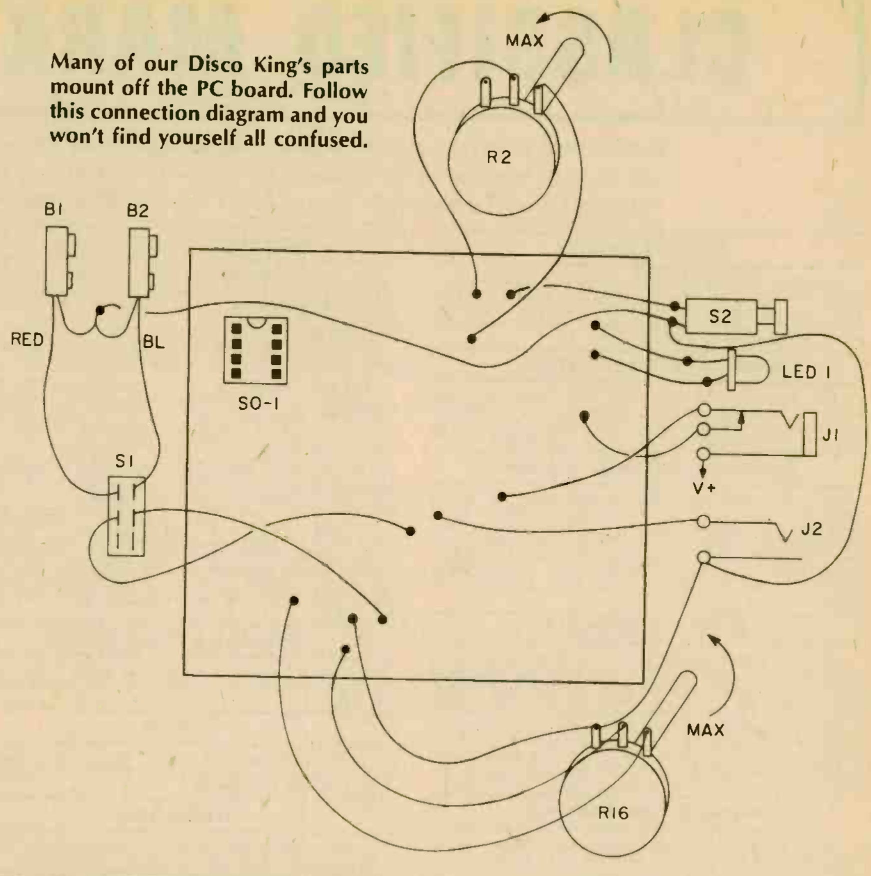
R2 varies the Tempo from extremely slow to very rapid and that LED 1 lights each time the base drum is heard. Depress and hold S1 and note that the sounds stop. Release S1 and note that the sounds restart with the base drum. If you plan to use the manual base drum triggering facility, you may construct a simple footswitch. Connect the footswitch to J1 (*Base Drum Trigger*) and note that the base drum sound is heard each time the footswitch is pressed.

Drum Up a Storm. Once adjustment and checkout have been completed as indicated above, operation of the unit should be clear. The most common Disco percussion pattern is obtained with the jumper connecting SO-1 pins that R16 can adjust the cymbal volume from full off to maximum. Note that 4 and 5 (note that SO-1 pins 1 through 4 are wired together). The other three pattern variations are obtained by connecting pins 1 & 8, 2 & 7 or 3 & 6. Removing the jumper disables the cymbal generator. To use the unit as an electronic base drum you can either set R16 to minimum or remove the jumper from SO-1. Always turn the unit off when not in use to prolong battery life.

You may wish to substitute a push on-push off switch for the momentary switch S1. This will allow sustained off periods without having to keep S1 depressed. You may also wish to substitute a rotary switch for the socket and jumper method of pattern selecting. A wiring diagram for this substitution is shown.

You'll find that Disco King is quite a conversation piece. All your friends will ask how you fit Ringo Starr into such a small box! ■

Many of our Disco King's parts mount off the PC board. Follow this connection diagram and you won't find yourself all confused.

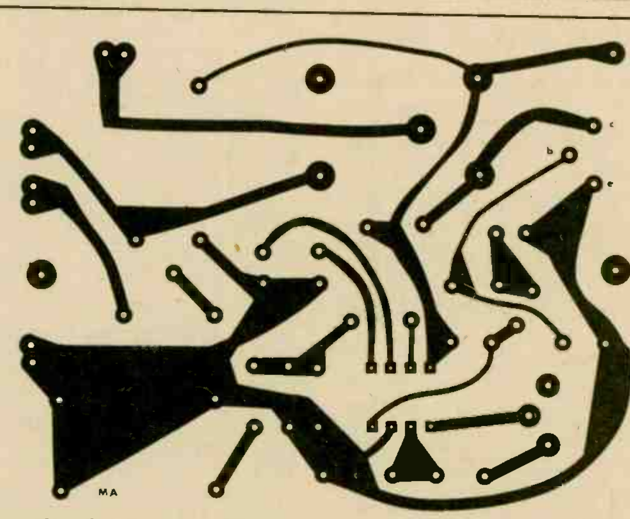


Ma Bell's Zipper

(Continued from page 98)

out of the external speaker. Tune in on a local mobile telephone channel. If you have located a mobile channel you will either hear the 2000 Hz tone or someone talking. Once the channel has been located, wait until it is clear and you hear the 2000 Hz tone. Turn Zipper's toggle switch *On*. Adjust trim pot R4 (slowly) until the relay drops out and the tone is no longer coming from the speaker. That's all there is to the adjustment procedure.

Now you can just sit back and enjoy shutting Ma's mouth—automatically, and opening it the same way, when there's mobile-telephone talk to eavesdrop on. Enjoy! ■



Full-size template for the printed circuit board. Note the two rows of four holes each into which the IC-mounting socket is placed.

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