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Volume 5, No. 12

DECEMBER 1988

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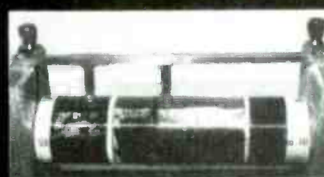

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Hands-on Electronics®

DECEMBER 1988

THE MAGAZINE FOR THE ELECTRONICS ACTIVIST!

COMBINED WITH Popular Electronics

Popular Electronics is in our blood

After reading last month's Editorial, a few readers called to tell the staff how excited they were that **Popular Electronics** was coming back. They cautioned, however, not to claim that we are the old **Popular Electronics** just because of past associations with that magazine.

They are right! We are not the *old* **Popular Electronics**; rather, we are the *new* **Popular Electronics**, a magazine that is undergoing a change for the better. Look at the type style we are now using. It is up-to-date and easy to read. To allow us to bring you more information each month, we have gone to a three-column format in our feature and construction stories. Our reader's letters, books, and new-products departments, as well as our regular columns, have been modified in style, title, and content. Greater attention, and we hope creativity, is being paid to the appearance of almost everything you see in this magazine. In short, what you see today is the development of a new and exciting look.

But we do have many strong links to the old **Popular Electronics**. Herb Friedman, our associate editor, sold his second article to **Popular Electronics** in 1958. He wrote for the magazine for many years thereafter and currently writes a column for us. A fine technician and author, Homer L. Davidson, has written for **Popular Electronics** for over 20 years and is currently writing for us. There are several other authors who share the same distinction. Andrew Duzant, our technical illustrator, was on the **Popular Electronics** staff for more than 20 years and now he is on our staff.

Many authors who wrote for the old **Popular Electronics**, and even previous staff members who worked for **Popular Electronics** in the past, will be contacting us after they see the familiar **Popular Electronics** logo on the newsstand.

Maybe we'll all get together one day for a big party. You see, **Popular Electronics** is in our blood.

The Editorial Staff

STAFF

Volume 5, No. 12

December 1988

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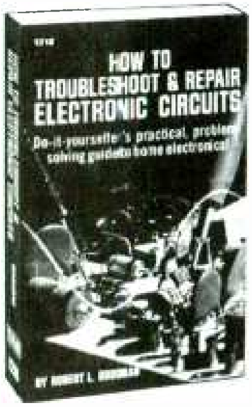

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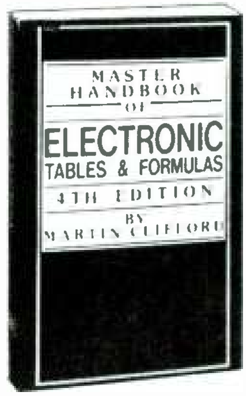

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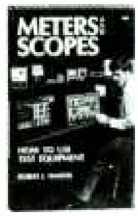

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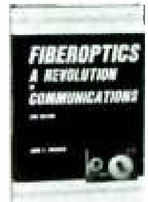

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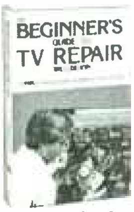

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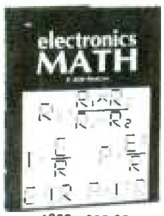

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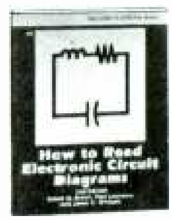

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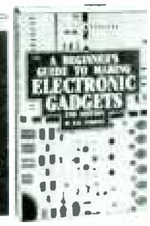

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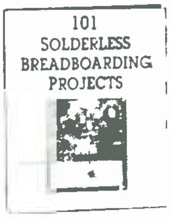

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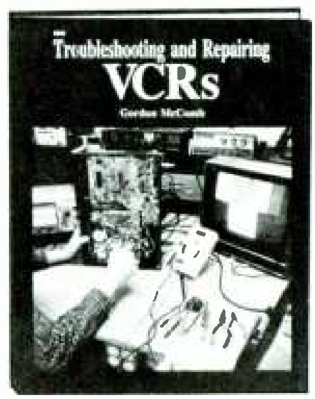

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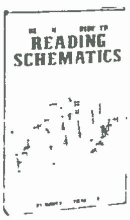

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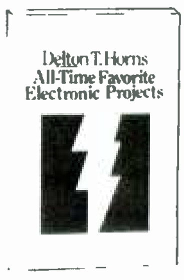

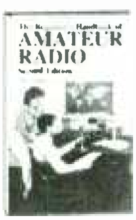

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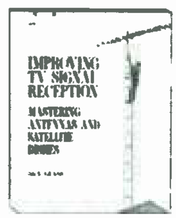

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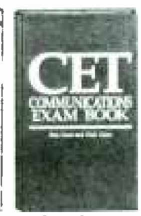

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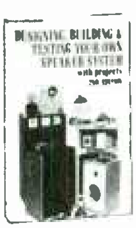

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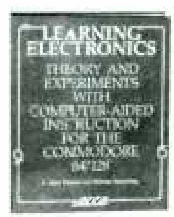

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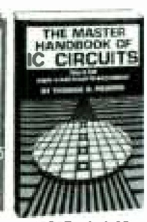

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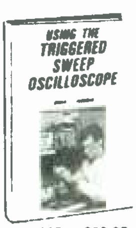

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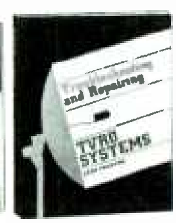

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Letters

COMPUTER PROS. . . .

In response to the letter from A.R. of Hackensack, NJ (August, 1988): What is he so afraid of? Computers can only intimidate people who refuse to understand them. They are made of electronic components, and were invented by the same kind of people who do the electronics projects in magazines like **Hands-on Electronics/Popular Electronics**.

It's true that computers in cars have made car repair more complex. However, the difficulty in finding mechanics who can repair them is not the fault of new technologies—it is caused by the reluctance of our society to overcome the anti-computer attitudes of people like A.R. Can the average person repair a calculator, or a VCR, or even a child's toy these days? Does that mean that we shouldn't have them, or that we all need more education?

I have an AAB in Computer Programming and an AAS in Electronic Engineering, and it's a good thing I got the computer degree first. Almost all the electronics courses I took required the use of a computer at some point. Computers and electronics are inseparable—your magazine would be shortchanging its readers if it pretended that computers don't exist.

I'm also writing to ask if you know where I can get a low-cost device for bending soft metals, such as aluminum; I like to make my own boxes for the circuits I build. Thanks very much.

P.J.C.
Louisville, OH

. . . AND CONS

As an avid and highly appreciative reader of **Hands-on Electronics/Popular Electronics**, I completely agree with the views on including computer projects that were expressed in A.R.'s letter in the August issue. The fewer the better—your magazine is one of the few left that a true "experimenter," "messer-around," or "hacker" can really enjoy.

I am an R&D Engineer with one of the large aerospace corporations here in Silicon Valley. I, and many of my cohorts in the field, thoroughly enjoy your magazine and the projects it presents.

I returned to the U.S. a couple of years ago, after living in Southeast Asia for 17 years. While overseas, I used many of the projects in **Hands-on Electronics**, and in **Radio-Electronics**, as teaching aids at the university where I was a consultant. How 'bout that? I'll bet you didn't know that those magazines are used in areas where up-to-date texts are very hard to come by! Although the magazines were anywhere from one- to three-months late by the time they reached there, the information was still more current than that in the usual texts.

Again, the fewer articles on computers, the better; there are enough computer magazines. Keep up the good work!

R.A.G., CET
San Jose, CA

And the debate rages on. The previous two letters represent a cross-section of the mail we've received on the "computer" issue. In general, people want either more, less, or just about the same number of computer-related stories in each issue.

As we've said in the past, computers represent only one segment of the electronics field, albeit an important one. Because of that, and because of our dedication to serving all facets of the hobby, you will never see this magazine go to an "all computer" format. Likewise, you will never see us completely ignore the computer field, especially the hardware end of it, because if we left it solely for others we would be shortchanging our readers.

READER RECOMMENDATIONS

For all the electronic tips, tricks, fun, and education you've provided for me since I subscribed to your magazine, now I'd like to reciprocate.

In the September 1988 "Letter Box" B.E. of Delray Beach, FL asked for a recommendation of a good book on basic electronics. As a fellow, **Hands-on Electronics/Popular Electronics** reader and electronics enthusiast, I'd like to recommend *Getting Started in Electronics* by Forrest M. Mims III. Basic electronic theory cannot be made any simpler. The book contains 128 hand-written and hand-illustrated pages, has experiments that **work**, and costs only $2.49. The book, as well as any of the parts needed for the experiments, can be purchased at any Radio Shack store.

Don't be turned off by the childish-looking nature of the book's method of teaching. You'll be relieved by its simplicity, and how well it gets the message across. I might not be working as an electronic technician now without the foundation I built from this book.

Good luck—I hope it helps!

J.D.
Brooklyn, NY

In the September issue of **Hands-on Electronics**, B.E. asked for recommendations on some books to get him started in electronics. There are certainly a plethora of books to choose from, but I've found Heathkit's (Benton Harbor, MI 49022) series of books/courses to be particularly helpful. They combine hands-on experience with the clearest explanations of electronic theory that I have ever read. More importantly, the series allows one to progress as far into electronics as even the most avid hobbyist might dare to venture.

The books/courses are outlined in meticulous detail in the Heathkit Catalogs. I would recommend trying the Soldering Course (*EI-3133*), followed by the "Concepts of Electronics Course" (*EI-3140-A*). The latter requires an "Analog Trainer" (*EI-3600*), but that trainer can be used with numerous other Heathkit courses. The combination of theoretical knowledge and practical skills presented in those courses are of inestimable value to the beginner.

P.E.B.
Ft. Lauderdale, FL

We received a number of responses to B.E.'s request and we would like to thank all the readers who took the time out to lend a helping hand. While many different books, courses were recommended, the previous two received overwhelming support. Judging by the response, you can't go wrong following either recommendation.

PARTS SEARCH

Two recent articles by Larry Lisle—"The Building-Block Radio" (May 1988) and "The Simplest Ham Receiver" (June 1988)—each call for Fahnstock clips and transistors SK3835 or ECG103A. I can't locate either of those items anywhere. Can you please tell me where I might be able to get them?

B.B.
Bedford, IN

Fahnstock clip is the proper name for a spring-tension quick connect/disconnect clip. If you can't find Fahnstock clips at your local supplier, just about any other type of terminal or binding post can be used.

SK and ECG part numbers are RCA and Sylvania, respectively, industry-standard substitute part numbers. Those are used and recognized by the vast majority of major component distributors. We provide those when the original part may be hard to locate. The GE-59 used in the projects falls

*"Don't tell me . . .
we're out of bananas again!"*

into that category. Hence, we provided the substitute. If you still have difficulty finding the part, here's a suggestion: Try making friends at your local TV and radio repair shop. The owner may be willing to order the part for you, or put you in touch with a local distributor that carries it.*

PERPETUAL CALENDAR VARIATION

I built the "Perpetual Calendar" project that appeared in the July 1988 issue. However, I didn't attach it to a clock. Instead, I used a Schmitt trigger and a 6.3-volt AC transformer to derive the pulse. It works quite well, too.

By the way, I love your magazine, especially the "Circuit Circus" column.

W.G.K.
Ozone Park, NY

BUILD IT FROM SCRATCH

In his letter in the July 1988 issue, J.V. from Tacoma, WA, mentioned that he would like to see more projects in kit form. That seems like a good way to get started in electrnics—but after you put together 4 or 5 of them, it starts boring. Just read the enclosed literature, warm up the ol' soldering iron, and get ready to follow the step-by-step procedures. After putting together a few kits, the fun and excitement just isn't there any more.

What I find highly gratifying is following the "How to..." or "Build Your Own..." articles in electronics books and magazines. I search around for needed parts, etch or breadboard my own circuit board, learn the theory and principles behind the device itself, and spice it all up in a nice enclosure with custom emblems and dry-transfer letters.

I am 15 years old and fascinated with electronics, computers, and amateur radio. I've been building electronic gadgets for a number of years now, and I've learned a lot through fine publications like **Hands-on Electronics/Popular Electronics**.

I do agree with J.V. about "The Power Play" article (February 1988). I built that power supply on a breadboard for about $50.00, and it covers all my needs.

M.A.G.
Jackson, MI

NOT-SO-RAPID FIRE

In building the "Rapid Fire" circuit (September 1988) I noticed several discrepancies between the schematic and the printed-circuit board. I believe the board is in error; am I correct?

E.P
Las Vega, NV

Yes, you are. There were a couple of problems with the board. There is a trace missing in the foil pattern. To correct that, add a jumper between the cathode of D1 and pin 3 of U1. Next, eliminate the connection to J1 pin 8 and add a connection to J1 pin 6 at the anode end of D1. Finally, reverse the NORM *and* AUTO *labels on switch S1.*

LETTERS

SCANNING CONTROLS

I just read "Saxon on Scanners" in the September 1988 issue, and I am disturbed by the offer of information for modifying the Radio Shack PRO-2004 scanner to receive the cellular mobile-telephone frequencies. When I saw the original mention in the April issue I assumed there would be little Interest. But, obviously, there are a number of people who wish to eavesdrop on phone calls.

I comment as the owner of three scanners and a cellular phone. I believe in the right of the individual to listen to general communications—and, indeed, feel that our police, fire, and government agencies may be kept on their toes knowing that countless listeners are out there. Those transmissions—as well as those of marine and aircraft radios, and old-style, high-power car phones—were never intended to be picked up by only one receiver. Their users are aware that others are listening in on those shared frequencies.

The cellular-phone system, on the other hand, was designed for private, individual phone calls. There is no reason for, or value in, anyone else listening. The near-microwave frequencies, very low power, near-by reuse of channels, frequent channel changes as a vehicle moves, and lack of recognizable identification eliminate the likelihood of DX; the conversations taking place should have no interest to anyone who does not have a sick mind. On a recent visit to a local parts store that carries scanners I found two customers engrossed in listening to one side of a conversation in which a woman was describing—in graphic detail—her child's illness, apparently to a doctor.

The FCC has been considering regulations to ban scanners from receiving those frequencies. Articles like yours simply add fuel to the fire. Any such ban, once enacted, is likely to lead to other bans of police and government reception. Aside from those possible ramifications, one must consider our continuing loss of privacy, and the immorality of unnecessarily furthering that loss.

How would Mr. Saxon feel if *his* home-phone conversations were being picked up inductively by his next-door neighbor? Would he defend his neighbor's right to do so?

Think about it. The manufacturers who have deleted the cellular band deserve praise and support for doing so, not criticism and plans to beat the system.

E.F.W. Jr.
West Roxbury, MA

HAVES AND NEEDS

I'm looking for two schematics. The first is for a True Tone Model D117 2-band table radio. The second is for a Sears Model 1484, chassis number 185.11040 guitar amp. I've tried my Sears service outlet with no luck.

Larry E. Arnold
608 Ellen Drive
North Little Rock, AR 72117

GROUNDED

On page 36 of your October 1988 issue, the schematic diagram (Fig. 2) for the "Solid-State Tesla Coil" shows the ground side of the power supply going to the emitters of the transistors. Obviously, if the circuit is wired up that way, no operating current would be delivered to the high-voltage circuit, and hence it would not work.

M.M.
Atlanta, GA

Of course, you are correct. For proper operation, reroute the connection to the emitters from the bottom of C3 to the top of that capacitor. All should now work fine.

REPLACEMENT PARTS

I enjoy reading your magazine, and I've noticed your emphasis on readers helping each other. This letter is in response to L.J.'s question in the September "Letter Box."

The U1 op-amp (MC3401) for the "Wind Witcher" project (February 1988) can be replaced by an LM3900N. That's what I used, and it turned out great.

By the way, pin 7 is repeated twice in the schematic. The correct pin 7 should go to ground.

R.F.S.
Sun City, AZ

MINIMUM ORDERS

We just received our first copy of **Hands-on Electronics** (the August 1988 issue) here at work, and I was really impressed with the article "Low-Battery Alarm." It presented a solution to a problem I'd been working on.

I jumped right in and called Jameco, as the article suggested, just to find out that the $0.99 8211 would cost me $20.00—their minimum order. I called around locally, but no one sells or can order one for me.

Is this a new chip, or hard to get? Do you have a cross-reference to ECG or others?

A.S.
Addison, NY

Mimimum orders are a problem for hobbyists, but unfortunately there are few ways around them. There are relatively few well-stocked mail-order parts distributors left, and just about all have a minimum order or a service charge for orders below a certain amount. That comes about because of the cost of doing business by mail. Unless the order exceeds a certain amount, retailers actually can lose money filling an order. And while $20 may seem high, it is less than that charged by many long-established, mail-order distributors.

Unfortunately, we don't have an ECG (or other) cross reference for the 8211, nor an alternate source. Often, we buy components for several projects at a time. We suggest the same approach. Get the catalogs from as many parts distributors as possible and try to lump your parts-buying together. You'd be surprised how quickly you can reach most distributor's minimums. ■

Electronics Library

CRASH COURSE IN MICROCOMPUTERS (Second Edition)

by Louis E. Frenzel, Jr.

This revised edition of a very popular book on microcomputers was written by one of our favorite authors, Lou Frenzel. In his usual easy-to-follow style, he's put the key facts and essential subject matter together in question-and-answer form.

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By sticking to the fundamentals, the author manages to cover a broad range of microcomputer topics clearly and concisely. Some of the areas discussed are number systems, memories, architecture, input/output operation, peripherals, mass storage, software, machine-language programming, BASIC, 16-bit microcomputers, and applications.

Crash Course in Microcomputers (Second Edition) is available for $21.95 from Howard W. Sams & Company, 4300 West 62nd St., Indianapolis, IN 46268; Tel. 800-428-SAMS.

CIRCLE 95 ON FREE INFORMATION CARD

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by Martin S. Matthews and Carole Boggs Matthews

With the release of version 3.0, the PageMaker's ease-of-use and production capability are significantly improved. This 579-page second edition has been updated to include the program's new features—including style sheets, keyboard shortcuts, increased control of scanned graphics, a program for generating soft fonts, and the automatic flowing of text over columns and pages and around graphics.

The reader will learn how to create brochures, newsletters, financial reports, forms, catalogs, and announcements. The book explains how to use PageMaker with other software, including WordPerfect, Microsoft Word, and MultiMate for word processing; and Micrografx Clip Art Collection, 1-2-3, PC Paintbrush, and Windows DRAW! for graphics. And it thoroughly explains what to do with the material imported from other programs once it is in PageMaker.

For newcomers to PageMaker and desktop publishing in general, Part One is a tutorial on the basics and terminology. The use of mice and Microsoft Windows—both required for using PageMaker—are also described. Subsequent sections take a hands-on approach to creating increasingly advanced publishing projects. Scanned images for photographs and other art are also discussed.

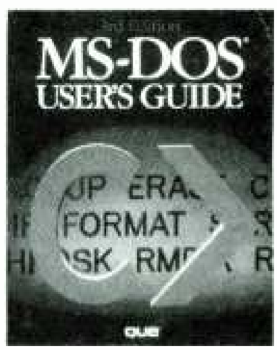
Using PageMaker for the PC: Version 3 (Second Edition) is available for $22.95 from McGraw-Hill Book Company, 1221 Avenue of the Americas, New York, NY 10020.

CIRCLE 96 ON FREE INFORMATION CARD

MS-DOS USER'S GUIDE (3rd Edition)

by Chris DeVoney

This comprehensive volume was written for anyone who wants to become proficient at using MS-DOS. Newcomers to computers and experienced users alike will benefit from this combination of reference book and step-by-step tutorial. This edition has been updated through MS-DOS version 3.3.



The opening chapters provide some background material on disk drives, operating systems, and copying disks, as well as the basic commands needed to get started and hands-on exercises. Subsequent chapters teach the reader how to prepare diskettes; create, copy, rename, and erase files; streamline directory management; back up and restore the hard disk; and take advantage of improved disk-storage capabilities. For readers who use a network, information is included about network servers, file storage and location, file sharing (and cautions on sharing), communicating with other users, and using different printers.

A detailed, DOS command/message section, arranged alphabetically, is a quick and convenient reference source. There are several useful appendices—including special commands for users of COMPAQ, Epson, Leading Edge, and Zenith operating systems. A handy, tear-out "Quick Reference" card that highlights important DOS keys and frequently used DOS commands is also provided.

MS-DOS User's Guide, 3rd Edition costs $22.95. It is available from Que Corporation, P.O. Box 90, Carmel, IN 46032; Tel. 1-800-428-5331.

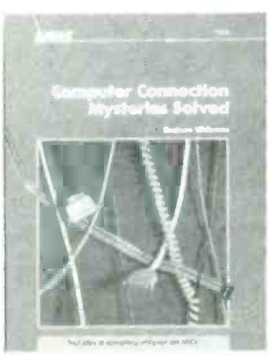
CIRCLE 94 ON FREE INFORMATION CARD

COMPUTER CONNECTION MYSTERIES SOLVED

by Graham Wideman

Using a lively writing style enhanced by clear technical illustrations, this book describes how to properly connect computers to their peripheral devices. It covers the subject comprehensively without getting overly technical.

Keeping in mind the broadness of the subject, and how quickly systems become obsolete, the author emphasizes basic principles and techniques rather than specific cases. Readers are encouraged to put those principles and techniques to practical use by learning to apply them to their own particular computer setups.



The book begins with basic descriptions of computers, electronics, and signals, then moves from simple to more-advanced connection problems. Step-by-step instructions are presented, along with troubleshooting charts and practical examples in the form of case studies. The role of software in interfacing is also discussed.

The RS-232 serial interface—used for connecting terminals, modems, computers, printers, plotters, mice, and other devices—is covered in detail. The Centronics parallel interface, which is used primarily for connecting printers to computers, is also covered. The book examines video, power, and disk-drive hook-ups, as well as MIDI, the Musical Instrument Digital Interface.

Computer Connection Mysteries Solved is available for $18.95 from Howard W. Sams & Company, 4300 West 62nd St., Indianapolis, IN 46268; Tel. 800-428-SAMS.

CIRCLE 95 ON FREE INFORMATION CARD

SUPERCONDUCTIVITY:
The Threshold of a New Technology

by Jonathan L. Mayo

Using easy-to-follow terminology, Jonathan Mayo presents the full spectrum of superconductivity and its applications. He begins with a brief explanation of the recent advances in high-temperature superconductivity, and progresses to the more-technical aspects. The properties of superconductivity—what it is, what it can and cannot do, and its advantages and drawbacks—are described, and a thorough history is provided, to help the reader fully understand and appreciate the science.

The impact of its applications is discussed, including their effect on the electric lines, generators, and motors that comprise our power systems; and on the high-density, high-speed integrated circuits used in today's electronics. In science and medicine, the book examines containment of fusion reactions and increasing the power of particle accelerators, and medical-imaging systems. Transportation applications include electromagnetic trains and electric automobiles.

The future of superconductivity is also explored. The book discusses advanced research and applications, international efforts and competition, and governmental influences. Dozens of relevant photographs and illustrations accompany the text, and a comprehensive glossary is included.

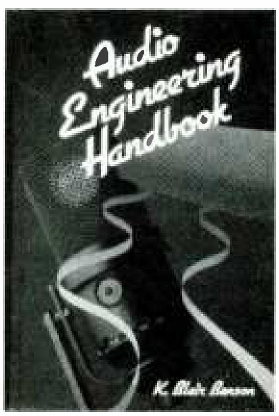
Superconductivity: The Threshold of a New Technology is available for $12.95 from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

AUDIO ENGINEERING HANDBOOK

edited by K. Blair Benson

There have been revolutionary developments in audio technology—including noise-reduction, digital-processing, and laser-recording systems—in recent years. This authoritative, 1040-page handbook is designed to help audio engineers, and anyone who designs, maintains, or operates professional- or consumer-audio equipment, to update their knowledge and broaden their base of expertise.



The *Audio Engineering Handbook* is a collection of contributions from 33 experts at such companies as Dolby Labs, Sony, Philips, and RCA Records. It encompasses all the latest methods of the generation, transmission, storage, and reproduction of sound and audio signals. Over 700 informative schematics, tables, charts, photographs, and diagrams are included.

The book provides a thorough tutorial in the basic principles of sound, hearing, and acoustics; sound pick-up, amplification and reproduction; the audio spectrum and its characteristics; and radio- and television-stereophonic broadcasting. It takes an in-depth look at both digital and analog processing and recording—on disc and on tape—and provides a helpful overview of related digital and analog noise-reduction techniques.

Such state-of-the-art technologies as compact-disc and digital audio-tape recording and reproduction are examined. Complete details about studio-program production, post-production, and editing, and related techniques for film recording and reproduction are also included. Of particular interest to specialists in the field is the extensive section devoted to industry standards and recommended practices.

The Audio Engineering Handbook is available in hardcover for $79.50 from McGraw-Hill Book Company, 1221 Avenue of the Americas, New York, NY 10020.

CIRCLE 96 ON FREE INFORMATION CARD

UNDERSTANDING SECURITY ELECTRONICS

by John E. Cunningham
revised by Joseph J. Carr

In today's world, everyone is concerned about security. This book covers all aspects of electronic-security systems—basic principles, applications, and advantages and disadvantages of various methods.

The book presents an overview of both electronic-security measures, and the countermeasures used by criminals. The emphasis is on deterrence, by making intrusion and theft difficult, time-consuming, and attention-getting. The installation and principles of proprietary, central-station, and local-alarm systems are described.

Virtually every type of electronic-security system is examined. Electromechanical, photoelectronic, infrared, ultrasonic, and microwave intrusion detectors are discussed, in terms of how they work and how they are set up. Proximity detectors, including Beat-frequency, Bridge-type, and FET detectors; alarm and signalling systems, from simple bells to complex "auto-dialing" systems; audio and video monitoring; metal, magnetic-gradient, and explosives detectors; time, key-operated, electrical-combination switches, and card-lock access-control systems; and hold-up and assault alarms are described in detail.

The roles of digital electronics and computers in designing and implementing security systems are explained. There are sections on computer crimes and their detection and prevention, protecting automobiles and their components, and how to recognize and defeat electronic-surveillance devices. There is also plenty of practical advice concerning risk assessment, how to select the proper system, and how to install and test systems.

The 292-page book is designed as a learning tool. It contains dozens of informative illustrations and photographs, and a comprehensive glossary of security-electronics terms. Each chapter concludes with a self quiz; answers are supplied at the end of the book.

Understanding Security Electronics is available for $16.95 from Howard W. Sams & Company, 4300 West 62nd St., Indianapolis, IN 46268; Tel. 800-428-SAMS.

CIRCLE 95 ON FREE INFORMATION CARD

MORE ADVANCED ELECTRONIC SECURITY PROJECTS

by R.A. Penfold

This sequel to *Electronic Security Devices* (Order No. BP56) contains slightly more complex security projects, but most of them should still be within the capabilities of electronics hobbyists—even beginners.

Although the projects are not excessively difficult, they do involve some advanced techniques; it is assumed that the reader

is already familiar with standard burglar-alarm techniques. The section dealing with computer-based systems, however, does provide general background information on that subject.

The projects presented include a passive infrared detector that can be used with a variety of lens systems, a fiber-optic loop alarm, an unusual ultrasonic intruder detector, and computer-based security systems. The description of each project is accompanied by relevant illustrations.

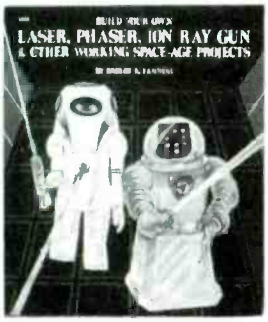
More Advanced Electronic Security Projects (Order No. BP190) costs $7.95, including shipping. It is available from Electronics Technology Today, P.O. Box 240, Massapequa, NY 11762.

CIRCLE 97 ON FREE INFORMATION CARD

BUILD YOUR OWN LASER, PHASER, ION RAY GUN & OTHER WORKING SPACE-AGE PROJECTS

by Robert E. Iannini

If you've been wanting to get involved with tomorrow's technologies, the do-it-yourself guidance offered in this book will prove invaluable. It demonstrates how to build an array of practical and just-for-fun projects using workable lasers, along with ion-producing devices, ultra-high-frequency



power supplies, Tesla coils, and security devices such as infrared viewers and a voice-operated, wireless phone transmitter.

You'll learn how to build a hand-held, battery-operated, visible laser-light source that is capable of illuminating low-level clouds and can be used for special effects, light shows, long-range sighting, and holography. The magnetic-field distortion detector lets you listen to, measure, and record solar activity, aircraft, UFO's, and other objects by sensing the slightest change in Earth's magnetic-force field.

Detailed building instructions for each project are reinforced by plenty of illustrations and complete parts lists. Listings of parts suppliers for all the materials needed to construct the high-tech devices are also included.

Build Your Own Laser, Phaser, Ion Ray Gun and Other Working Space-Age Projects costs $16.95. It is available from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

RADIO OPERATOR'S LICENSE Q&A MANUAL (Tenth Edition)

by Milton Kaufman

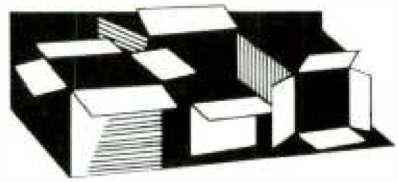
This study guide contains all the information necessary for the successful completion of the General Radiotelephone Operator's License, the Marine Radio Operator Permit, and the Radar Endorsement examinations. The tenth edition includes the 1984 FCC rules and regulations, and critical information needed to pass the technician-certification tests given by various non-government certifying organizations. Some of the new topics covered are digital-logic circuits, op-amps, phase-locked loops, mobile-radio equipment, receiver sensitivity, field-effect transistors, RF interference, modulators and mixers, and more.

Typical FCC-type questions are presented for each element of the examinations, a clear answer follows every question. In most cases, a short discussion—designed to give the reader a thorough knowledge of the specific topic—is also included. Each section concludes with an FCC-style practice test, and the correct answers are provided at the end of the book. An extensive section on troubleshooting offers practice examples in solving the kinds of problems that appear on the actual exams.

Radio Operator's License Q&A Manual (Tenth Edition) is available for $16.95 from Hayden Books, A Division of Howard W. Sams, 4300 West 62nd St., Indianapolis, IN 46268. ■

CIRCLE 95 ON FREE INFORMATION CARD

CIRCLE 15 ON FREE INFORMATION CARD

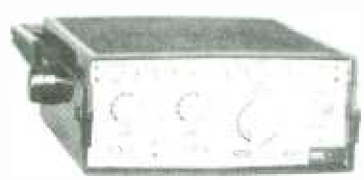


New Products

To obtain additional information on new products covered in this section from the manufacturer, please circle the item's code number on the Free Information Card

ANALOG-TO-DIGITAL SCOPE CONVERTER

A new device from *B&K-Precision* cuts the high cost of owning a digital-storage oscilloscope. The *Model 2501 Digital Storage Adapter* adds the features of a true digital-storage oscilloscope to almost any analog oscilloscope. It provides dual-channel operation, waveform-store and -magnify capabilities, an output connector for a hard-copy plotter, and 10-megasample-per-second capability.



The Model 2501 is easy to use, even for those with no previous digital-storage scope experience. Once it's connected to the analog oscilloscope—with a simple three-lead hookup—that scope can be used to capture single-shot events, to store and magnify waveforms for analysis, and to view pre-trigger information at zero, 50%, or 100%.

It provides digital-storage memory of 2048 × 8. The vertical resolution is 8-bit, and sampling is 10 megasamples per second to 2.5 samples per second.

The Model 2501 Digital Storage Adapter has a suggested list price of $795.00. For additional information, contact B&K-Precision, Division of Maxtec International Corporation, 6470 West Cortland St., Chicago, IL 60635.

CIRCLE 74 ON FREE INFORMATION CARD

MULTIMETER ACCESSORY

The *80i-kW* current/power probe from *John Fluke* Co. is a clamp-on multimeter accessory that measures DC current, AC current, and AC power in kilowatts. It accepts conductors of up to 2¼-inches in diameter. That, along with its ability to measure power and current over a wide range, make the 80i-kW well-suited for industrial- and utility-service applications, and for energy-management needs.

Its measurement range is from 1- to 1300-amps DC, from 1- to 1000-amps AC, and 0.5 to 330 kW. The switch-selectable output signal is 1-mV per amp or 1-mV per kW. For conducting energy surveys, the power factor can also be calculated from data measured by the 80i-kW.

Special voltage-test leads—with alligator clips for safety—are provided with the probe. Those test leads provide a voltage input that, in conjunction with the current input, gives a readout in kilowatts on the multimeter.

The rugged carrying case provides space for additional accessories, making it a portable service-tool kit that can be customized to meet individual needs. Also included with the probe are an instruction booklet,

battery, and quick-reference guide.

The 80i-kW has a suggested list price of $395.00. For more information, contact John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, WA 98206; Tel. 800-443-5353, ext 77.

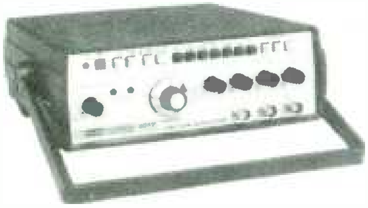
CIRCLE 75 ON FREE INFORMATION CARD

SWEEP/FUNCTION GENERATOR

B&K Precision's Model 3017 sweep/function generator provides a full range of capabilities—including variable-duty cycle—to fill the need for an accurate signal source for sine, triangle, and square waveforms as well as TTL- and CMOS-pulse signals. Its special features include internal- or external-sweep/source capability, with continuously adjustable-sweep width to a maximum 1000:1 ratio. The Model 3017 covers from 0.2 Hz to 2 MHz in seven ranges.

Separate outputs are available for TTL/CMOS and other waveforms. For engineering applications, a variable-DC offset simulates the presence of a DC signal on the generator output. That is useful for matching the DC voltage at the signal-input point to prevent changes when the test signal is applied, for evaluating the effects of DC bias on AC circuits, for shifted-operated points of a DC-coupled amplifier, etc.

The Model 3017 features adjustable-sweep time from 0.5 to 30 seconds, with linear or logarithmic operation. Sweep-start and -stop frequencies can be set independently. Sine-wave distortion is less than 1 percent at 100 kHz, with square-



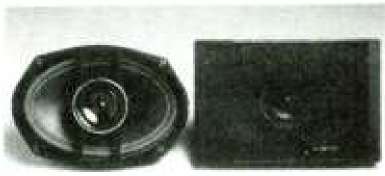
wave symmetry of better than 98 percent at 100 kHz and triangle-wave linearity of 98 percent. The unit's output level is continuously adjustable from zero to −20 dB. A 20-dB-step attenuator extends the range from zero to −40 dB.

The Model 3017 sweep/function generator has a suggested price of $319.00. For additional information, contact B&K Precision, Division of Maxtec International Corp., 6470 West Cortland St., Chicago, IL 60635.

CIRCLE 76 ON FREE INFORMATION CARD

TWO-WAY CAR SPEAKERS

Phase Linear's PL2690 is a two-way, molded and felted graphite-cone speaker system. With graphite woofer cones and polycarbonate tweeters, the speakers offer spectacular transient response, high efficiency, and great power handling. For



sophisticated custom installations, the 6 × 9-inch speakers also have bi-amplifiable terminals.

The low-mass, high-rigidity cones offer 80-watts continuous power handling with a peak capacity of 180 watts. Frequency response is 38 Hz to 24 kHz.

The Model PL2690 speaker system sells for $150.00. For more information, contact Phase Linear, 4136 North United Way, Schiller Park, IL 60176

CIRCLE 77 ON FREE INFORMATION CARD

TELECOMMUNICATIONS TEST SET

The *AR-180T* telecommunications test set from *American Reliance* is packed with the functions and features needed by telecommunications and data-communications technicians. Those features include level measurement, noise measurement, AC volts, DC volts, DC current, and resistance. In addition, the unit will generate four precision tones for frequency-response measurements.

A true-RMS AC converter is used for AC-voltage and level measurements. For noise measurements, the unit incorporates a built-in "C-message" noise-weighting filter.

The AR-180T is switchable between either 600-ohm terminated or bridge measurements at an impedance of 1 megohm. An audible continuity beeper is also featured.

The AR-180T, including test leads, carrying case, operator's manual, battery, spare fuse, and a one-year warranty, sells for a suggested retail price of $249.95. For further information, contact American Reliance Inc., 9241 East Valley Blvd., Rosemead, CA 91770.

CIRCLE 78 ON FREE INFORMATION CARD

TWO-WAY RADIO

T-Berry Electronics' Communicator, a crystal-controlled, two-way radio, is an easy-to-use communications system. Weighing only 20 ounces, it fits easily in the palm of one's hand.

Available in VHF or UHF, the Communicator produces up to 5 watts on its six available channels, giving it a range of several miles. It is encased in a rigid, die-cast metal chassis, ensuring years of reliable performance. The radio's easy-access controls include a Hi/Low Power switch for conserving energy, and a Tone On/Off switch for optional tone-coded privacy. Indicator lights are provided for Channel-Busy verification and Transmit/Low Battery warnings.

The Communicator comes with a 9.6-volt, 500-mA-per-hour NiCad-battery pack, a wall-mount battery charger, a flexible antenna, and an operator's manual. It is backed by a one-year limited warranty. Optional accessories include a long-life, 800-mA/hour NiCad battery pack, a desk-top drop-in rapid charger, a five-unit multi-charger, and tone-coded squelch. An "intrinsically safe" model—designed for use in hazardous, potentially explosive environments—is also available.

The VHF Communicator costs $429.00; the UHF model costs $489.00. For further information, contact T-Berry Elec;ronics Corporation, 15 Technology Drive, Noblesville, IN 46060; Tel. 800-648-8683.

CIRCLE 79 ON FREE INFORMATION CARD

LAPTOP LEARNING AID

JC, The Junior Computer, an electronic-learning aid for children 6 years and older, is designed to look like a laptop computer with a pop-up screen and built-in carrying handle. It incorporates 16 learning activities that are designed to be fun and educational.

INTEG, Inc's JC speaks instructions in a clear, easily understood voice. Two optional, plug-in learning cartridges are available. The ROM Activity Cartridge comes with a story book for learning additional spelling and vocabulary. The RAM Cartridge lets users create and store animations and music.

JC's touch-sensitive keyboard contains 76 keys; it has 36 alphabet and number keys, a 12-key cursor-control keyboard, and 18 function keys. The unit, which runs on four C-size alkaline batteries, turns itself off if left unattended for 5 minutes.

"Computer" games challenge users to supply missing letters of words, to spell the names of objects appearing on the screen, to decipher scrambled words, and to guess the meaning of on-screen images. There are three levels of addition, subtraction, multiplication, and division exercises. JC's graphics offer puzzle-reassembly and image-duplication features.

JC, The Junior Computer, has a suggested retail price of $69.95. The optional RAM cartridge costs $19.99. For further information, contact INTEC, Inc. (International Toys, Electronics, and Games), 2674 N. First Street, San Jose, CA 95134.

CIRCLE 80 ON FREE INFORMATION CARD

PANAVISE WORKHOLDING SYSTEM

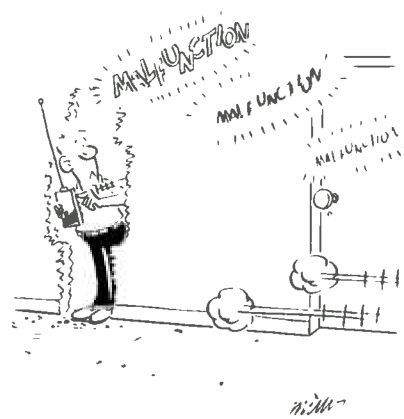
Designed for maximum flexibility, the *PanaVise Workholding System* features several interchangeable components. The system will work securely in any position for precision assembly, adjustment, soldering, or any similar operation.

The standard *PanaVise* (Model #67B301) can use any of three interchangeable jaws—nylon (#67B343), nylon with "V" slot (#67B344), or steel (#67B353). The unit fits into either of two screw-down *PanaPositioner* base components, a 3¾-inch high-profile base (#67B127) or a 2½-inch

low-profile base (#382B305). Another option is a vacuum base (#67B154) that adheres to almost any smooth surface.

All components are die-cast from rugged zinc-and-aluminum alloy, and reinforced with steel for extra strength.

(Continued on page 22)



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NEW PRODUCTS

(Continued from page 18)

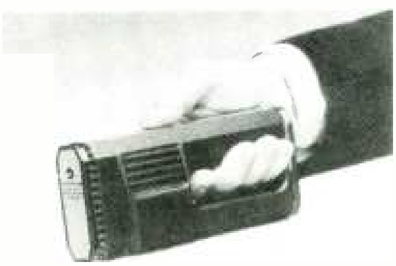
The standard PanaVise costs $35.95. The two nylon jaws cost $4.25 each, and the steel jaw costs $4.95. The high-profile, low-profile, and vacuum PanaPositioners cost $16.50, $16.95, and $26.95, respectively. For more information, contact Jensen Tools, 7815 South 46th St., Phoenix, AZ 85044.

CIRCLE 81 ON FREE INFORMATION CARD

PORTABLE LASER POINTER

Laser Photonics' THE POINT is a hand-held laser device designed to replace the standard wooden pointer in classrooms and at sales conferences and business meetings. Its operating range of up to 100 feet permits the speaker to "work the room;" it is no longer necessary to stand next to the display board to point out specific details.

The attention-getting device is a portable, rechargeable, battery-powered laser pointer that weighs less than one pound and measures only 7½ × 3¼ × 1½ inches. With it, the presenter can stand anywhere in the room and aim a steady, powerful, thin (1-mm) beam of bright red light at the object of attention.



THE POINT can be operated continuously or intermittently for an hour before requiring recharging, or can be used continuously with a 110-volt wall adapter. (Recharging time is 12 to 14 hours; it has built-in overcharge protection.) The unit fully complies with the Bureau of Radiological Standards' 21CFR 1040.10.

The laser pointer, complete with AC wall charger and shatterproof carrying case, costs $339.00, including shipping. In quantities of five or more, THE POINT costs $239.00. For further information, contact Laser Photonics Inc., 12351 Research Parkway, Orlando, FL 32826; 1-800-624-3628.

CIRCLE 82 ON FREE INFORMATION CARD

HIGH-DEFINITION TUNER AMPLIFIER

Nakamichi's TA-1A high-definition tuner amplifier is a 35-watts-per-channel AM/FM stereo receiver. Its custom-designed discrete-output circuitry provides high peak-curreny capability and superior sound at a relatively low cost.

By using output devices with an extra margin of safety, the TA-1A is able to deliver peak currents of 10-amps per channel into low-impedance loads. It provides exceptionally good performance with "difficult" speakers. Its unusually high voltage gain enables the tone controls to be incorporated into the output stage itself. That eliminates the need for a separate tone-control amplifier and provides a more direct signal path through the amplifier.

The tone controls are designed to permit alterations in bass and treble response without midrange coloration. They provide a maximum boost or cut of ±10 dB at the frequency extremes, without changing the response in the two-octave midrange band (300 Hz to 1200 Hz). The TA-1A's defeatable "Loudness Contour" compensates for loss in hearing sensitivity at low listening levels by increasing in effect as volume is reduced.

Nakamichi's "Isolated-Ground Topology"—whereby the positive and negative supplies are regulated by passing current between the two supplies instead of between each supply and ground—prevents power-supply current from flowing in the ground system. The audible result is improved signal-to-noise ratio and musical definition, and stable imaging.

The TA-1A's quartz-synthesized tuner provides manual or auto-seek tuning and 10 station presets. In addition to its CD and tape-monitor inputs, it features a third line-level input to switch the audio feed from a video source. A subsonic filter, built into the phono preamp, prevents tape and speaker overload when recording or playing a warped record.

The TA-1A high-definition tuner amplifier has a suggested retail price of $329.00. For further information, contact Nakamichi America Corporation, 19701 South Vermont Avenue, Torrance, CA 90502.

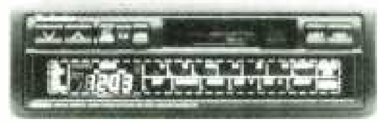
CIRCLE 83 ON FREE INFORMATION CARD

CAR RECEIVER/CASSETTE PLAYER

With *Technic's CQ-R9550* audio head unit, the user can control the functions of its quartz-digital receiver, its full-logic cassette player, or an optional CD changer by simply tapping a touch-sensitive face on the front panel. That LCD face serves as the control and display panel; it actually changes to match each of the three sources. A palm-size wireless-remote control also accesses the main functions of all three sources.

Each source has its own illuminated function legends. When a new source is activated, the user hears a beep to confirm it, and a corresponding marker lights in the corner of the switch area.

There is another audio-control setting display for volume, balance, bass, treble, and fader. Those adjustments are confirmed by indicators on the edge of the panel. The CQ-R9550 audio head unit also features muting, loudness, two-step dimmer, and illuminated power switches, and an automatic antenna lead.



The built-in receiver has 24-station presets (12 FM and 12 AM) and preset scan; it can be tuned manually or by scanning. It will automatically preset 12 stations when traveling out of range of the local preset stations. A dynamic-range controller avoids sudden fluctuations in volume, and an FM-optimizer circuit controls stereo separation, treble, and muting. Multipath distortion is suppressed automatically.

The cassette player features tape-program search, allowing the user to skip to the start of any song up to nine songs ahead or eight songs behind the current position. It also has tape-scan, repeat, and blank-skip features. To prevent damage, the CQ-R9550 automatically disengages the pinch roller when it is switched to the CD or radio mode. Play resumes immediately upon return to the tape mode. The tape player has a double-cut narrow-gap head to optimize head-to-head contact, a Dolby Noise Reduction system, a metal-tape selector, and more.

The Technics *CX-DP11*, an optional trunk-mounted, 12-disc CD changer, can also be controlled with the CQ-R9550. CD functions—accessible from both the touch-sensitive front panel and the remote control—include 35-step random-access programming, skip, intro-scan/memory scan, and random play.

The CQ-R9550 also has a built-in stereo amplifier. A preamp output and a built-in fader permit almost unlimited system expansion.

The suggested retail price for the CQ-R9550 is $750.00. For further information, contact Technics, One Panasonic Way, Secaucus, NJ 07094. ■

CIRCLE 84 ON FREE INFORMATION CARD

AUDIOVOX AUTOMOBILE ALARM

Install your own auto burglar alarm system, save a few bucks, and give the perpetrator an earful!

Imagine you've parked and left your car in an unfamiliar neighborhood, only to find upon your return that the car is held suspended in the air by four milk crates (the tires are long gone), the windows have been knocked out and the sound system is missing. To top it off, a few key parts (such as half of the components that make up the engine compartment) have mysteriously vanished from beneath the hood. And you know what, no one saw or heard a thing. How's that for a mystery?

You vow to go out and have the best auto burglar-alarm system that money can buy installed in your (now restored) prized possession, only to be dissuaded from your mission by the nemesis of the common man—a big price tag, but little money. It's enough, after all you've been through, to make a rock cry out in pain.

Let's face it, a whole lot of sweat went into the purchase of your modest carriage. And you can ill afford to let some "night crawler" slither in and misappropriate your goods. Fortunately, one firm (seeing the plight of those on a tight budget) has provided the answer; install the *Audiovox Security AA-9135 Ultrasonic Passive Alarm System* yourself and cut your cost to less than half of what you'd expect to pay for an alarm system with professional—he's done it a few times more than you—installation. Sound interesting? Read on. The best is yet to come!

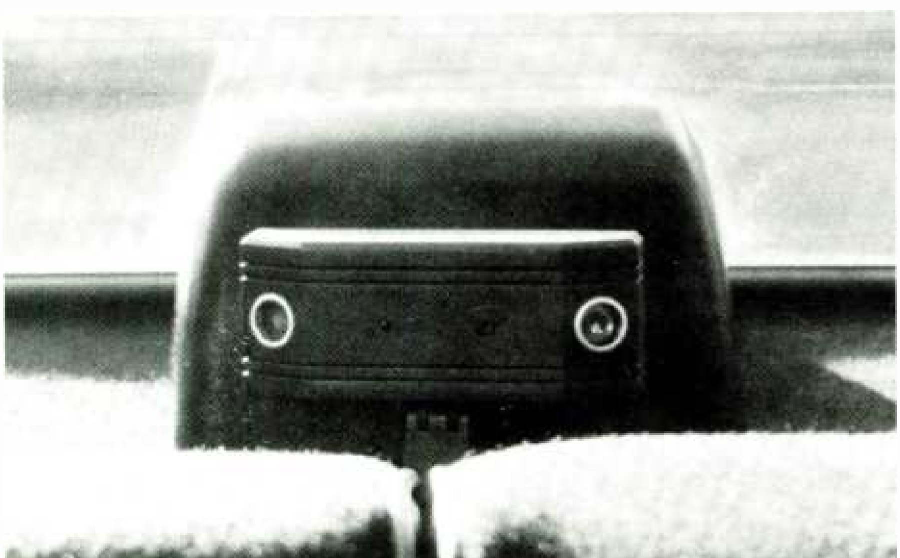
System Installation. The Audiovox Security AA-9135 Ultrasonic Passive Alarm System features an ultrasonic sensor that bathes the interior of the vehicle with high-frequency sound waves, which, when disrupted, trigger the alarm. Protection is also provided for doors, hood, and trunk. The system also features a 12-second entry/60-second exit delay, automatic reset, module-mounted valet/panic switch, and a high-power siren. An optional motion detector is also available.

The Audiovox AA-9135 system is easy to install. First disconnect both negative and positive battery terminals. Then decide where the siren is to be mounted; under the hood in the engine compartment is probably the best location. It will be necessary to drill four small mounting holes at the site chosen for the siren.

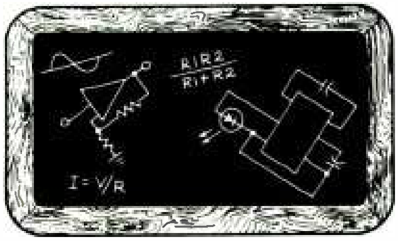
Mount the Alarm System VALET/PANIC switch, out of sight, perhaps underneath the dashboard in the passenger compartment, but in a place where it can easily be reached in case of an emergency. Run the interconnecting four-conductor color-coded wire harness provided (terminating in a four-conductor plug) from the valet/panic switch to the siren in the engine compartment, and connect it to the matching four-conductor socket. (There is only one that matches.)

Mount the ultrasonic sensor in the passenger compartment as I did. If your auto has a brake light in the rear window, the brake light housing provides excellent cover. The ultrasonic sensor's cord terminates in an ordinary phono plug, which mates with a phono jack at the rear of the siren. The wire

(Continued on page 96)



Mount the ultrasonic sensor in passenger compartment. If your auto has a brake light in the rear window, the brake light housing provides excellent cover.



Think Tank

By Byron G. Wels

THE UBIQUITOUS 555

Before you can play any game, you've got to know the rules—and how to be a winner. *Think Tank* wants you to submit your own favorite schematics and share them with your fellow readers. Now that does not mean that you can freely copy a schematic from another magazine or a book and send it in. That's called plagiarism, and the legal penalties can be pretty stiff.

We also are limited as to space. We can't use circuits with more than one or two solid-state devices. A transistor and an IC are fine. Two transistors are OK, as are two ICs. So don't submit a twenty-transistor amplifier circuit...it will never see the light of the printed page.

We also have to put some text in with your circuit, so always add a description of the circuit's application, why you liked it, and—most important—how it works!

So what do you get for all that? Back in the early days of radio, our founder, Mr. Hugo Gernsback, used to write a special feature article for every April issue. The hero of those articles was one Mohammed Ulysses Fips. To an electronics enthusiast, the "Fips" stories, as they came to be known, resulted in gales of laughter. But so knowledgeable was Gernsback, and such a clever author, that people who didn't have the know-how in the subject often tried to actually duplicate the experiments—with disconcerting results.

We've assembled all of those articles into a book of some of the funniest reading you'll ever do—provided that you know one end of a resistor from another. We sell the book for $12.95 plus postage, but if we use one of your circuits, we'll send you one absolutely free of charge! Now let's get started.

Before the 555 timer arrived on the scene, we had everything from time-delay relays to complex timer-transistor circuits. Nowadays you can hardly see a circuit that doesn't use a 555. We've gotten so many offerings that we assembled all of them here.

Lights-On Warning. How many times have you gotten out of your car and left the lights on? It's really no big deal, because when you get out to the car in the morning, you'll find that the lights are out—because the battery is dead. The circuit in Fig. 1 is designed to help keep that from happening. If you leave the light switch on and turn the ignition off, that little gem sounds an alarm to remind you to turn off the lights.

Because power for the circuit is pirated from the car's side lights, the circuit can't oscillate unless the lights are on. The reset pin on the 555 connects to transistor Q1. The base of Q1 is connected through R1 to the ignition auxiliary terminal on the car's fuse box. When the ignition is turned on, power is supplied to the base of Q1, turning it on. With Q1 turned on, pin 4 of U1 is tied low, disabling the oscillator and inhibiting the alarm.

However, if the ignition is turned off while the lights are on, power is applied to the 555 and Q1 is turned off, and the alarm starts.

Switch S1 is an optional override. If you desire to use the system for parking, for example, you can disable the alarm circuit with that switch.

—*Sam Jaffe, Brooklyn, NY*

Thanks Sam. This is the sort of thing we're looking for! Your Fips book is on the way.

Continuity Tester A friend who works for a fairly large electronics company went to the stock room to check out a VOM so that he could "ring out" a cable he had just put together, only to find that they were all in use and he'd have to wait for at least another day. So we put this little continuity-tester circuit together in my basement workshop.

The continuity tester has the advantage of an audible indication of continuity, so he doesn't have to take his eyes off his work to read a meter. Now it sits on his bench at work, and he's already been asked for the schematic several times.

The box has two external test leads labelled POSITIVE and NEGATIVE. Put a dead short between them, indicating continuity, and you get a 2-kHz beep; with a 5000-ohm resistance between them, it's a 1-kHz beep; and at 80,000 ohms, it's a 100-kHz signal.

Because the current flowing in the circuit is low, the circuit can be used around semiconductors with no damage. The circuit is seen in Fig. 2. It is

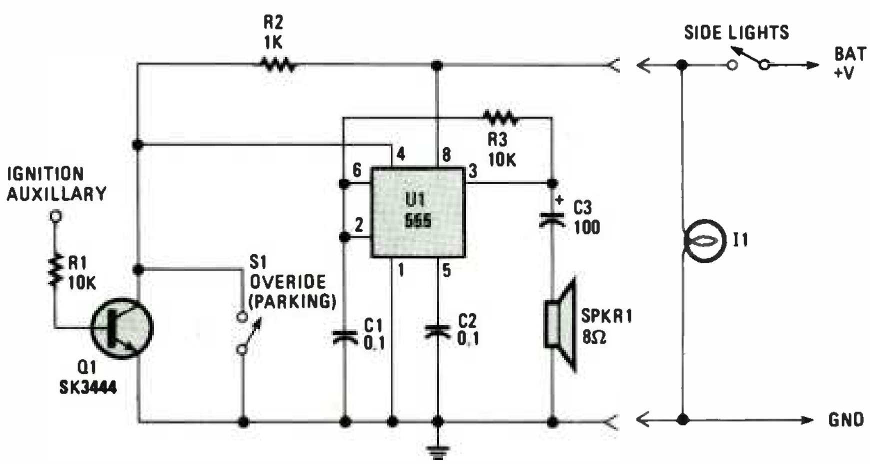


Fig. 1. Power for the Lights-On Warning circuit is pirated from the car's side lights. The heart of the circuit is a 555 oscillator/timer that's activated and de-activated by way of a control signal applied to the base of Q1.

a conventional 555 astable circuit with the test leads in series with the charging resistor. The output drives a small loudspeaker. Because the current at the leads is unidirectional, from positive to negative, you can use this device for testing diodes, or to perform simple diode tests on transistor junctions.

Be careful when doing on-board tests. Sometimes you can get strange results due to sneak paths through power supplies and the like. Anyway, my friend is happy with his continuity tester and so are some of his friends. I hope you are too!
—James Condon, Ft. Smith, AK

Good going Jim. All circuits don't have to be complex to be good. In fact, we figure that by putting in a three-way rotary switch and adding the necessary resistors, this would make a fine code-practice oscillator with a choice of three different tones! You've earned your copy of the Fips book. Hope you like it!

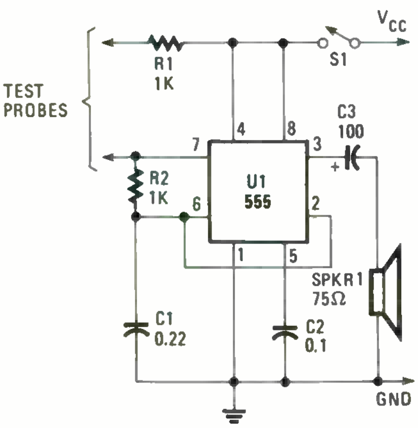


Fig. 2. The Continuity Tester feeds a voltage through the positive probe to the circuit-under-test, while the negative probe serves as the return line. Voltage returning to the Tester through the negative probe triggers the circuit, giving an audible indication of continuity.

Courteous Courtesy Light. The so-called "courtesy" light in a typical car is a misnomer. Sure, when you open the door to get in, the light inside comes on. But after you close the door, when you need the light the most, to find the ignition switch, etc., the light goes out, leaving you in the dark. The circuit shown in Fig. 3 keeps the courtesy light on for 30 seconds after you close the door.

The lead from the door switch is removed and connected to the 555 cir-

New solid-state and digital TV sets, stereos, and videorecorders are tougher to repair than old-fashioned tube type sets and require special training for the service technician who works on them.

Only a few states have laws requiring competency tests for licensing technicians who repair consumer electronics, but fifteen years ago the International Society of Certified Electronic Technicians (CET) began its own certification program to qualify these technicians and those in industry. To carry the CET designation, technicians must have four years experience and pass a rigid examination on general electronics and a specific area of expertise such as audio or radio-TV.

Many consumers look for a Certified Electronic Technician in the shop when they need any electronic item repaired.

Free Consumer Checklist

A consumer checklist for selecting a service shop is available free by sending a stamped, self-addressed envelope to: Checklist, ISCET, 2708 West Berry, Fort Worth, TX 76109. The list reminds consumers to check such items as "Does the business have the parts for your particular brand?", "Did you get an estimated price?", and "Did you check this company with the Better Business Bureau?"

Modern electronic equipment such as digital TVs or stereos should be repaired by specially trained people.

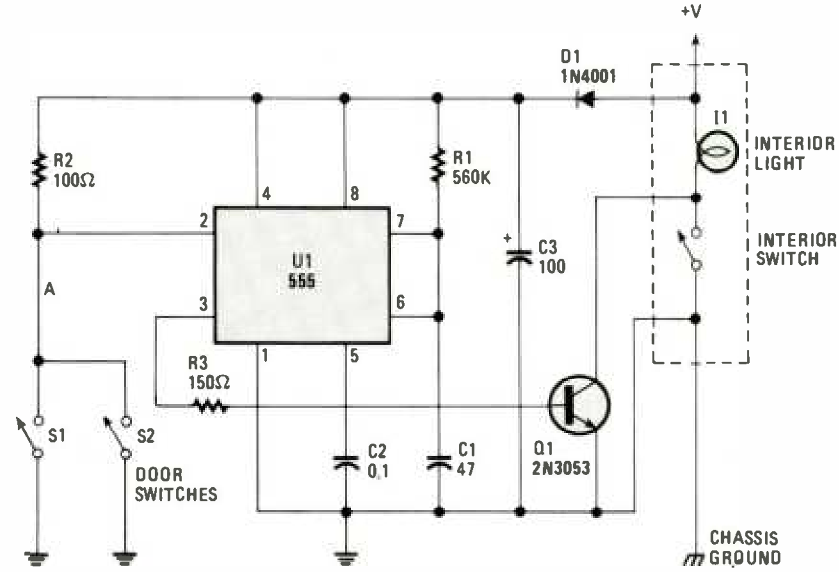


Fig. 3. The Courteous Courtesy Light circuit—built around a 555 (configured as monostable multivibrator) that's controlled by the auto's door switches—keeps the courtesy light on for 30 seconds after the door is closed.

cuit. The 555 is arranged in a monostable mode, and is triggered by the door switches. The output drives Q1, which is connected across the interior light switch. The interior light is turned on for 30 seconds after the door is opened. If the door(s) are held open for longer than 30 seconds, it will not reset until after the doors are closed. In that case, the lights go out immediately.

One additional advantage also becomes apparent. Door switches often fail because of dirt, which can cause the lights to go dim or flicker. This circuit needs only the shortest momentary contact to operate, meaning that it works even with dirty door switches. And with a bit of careful designing, the circuit can be made small enough to fit inside most interior car-light fixtures.

—Fred Mullins, Madison, WI

Good thinking Fred! Keep on the lookout for your copy of the Fips book. It's on the way.

Signal Injector. In the early days of radio, it was customary to simply put a finger on the grid caps of the tubes in a receiver. That way, you could hear the 60-cycle hum. As the circuit in Fig. 4 indicates, we've come a long way, baby!

The unit is great for checking amplifiers of all sorts. It provides a square-wave output that is rich in harmonic content. The circuit's output frequency can be varied from 50 Hz to 15 kHz. The heart of the circuit is a 555 astable connected in its equal mark/space mode. The frequency is controlled by potentiometer R2 and capacitor C1.

Resistor R3 controls the output level with the output AC coupled through C3.

To prevent stray radiation from getting into the circuit, it should be housed in a metal box and the output fed through a length of coaxial cable. Since the current drain is small, the unit should run for months (depending on use) with a nine-volt transistor-radio battery.

—Frank Pierce, Sioux Falls, SD

Thanks to you, Frank. This is exactly the sort of thing we're looking for. Simple, short, and sweet—and useful.

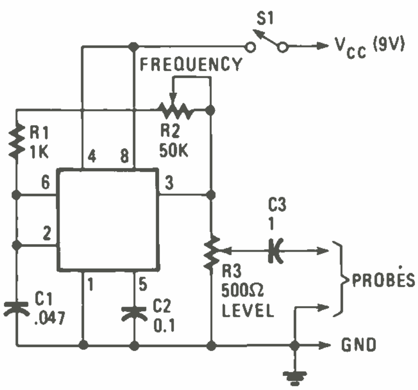


Fig. 4. The Signal Injector, although rather basic in design, is one of the most useful troubleshooting aids. When used in conjunction with an voltmeter or oscilloscope, it makes short work of troubleshooting circuits down to the component level.

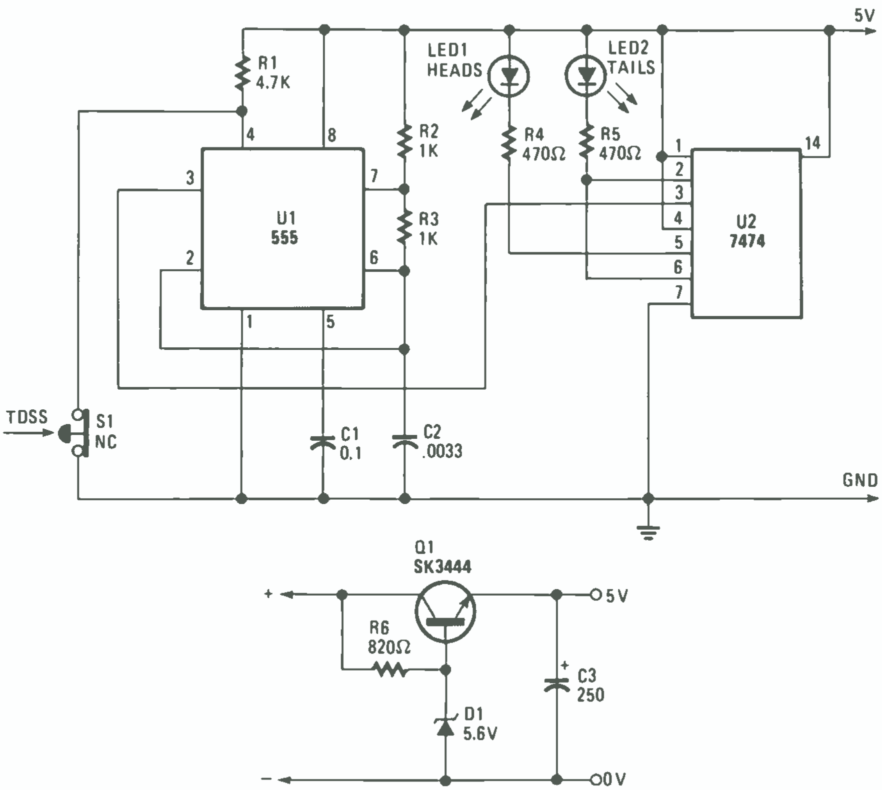


Fig. 5—The Coin Tosser consists of a 555 oscillator/timer feeding a 7474 dual J-K master/slave flip-flop that's configured as a divide-by-two counter.

Coin Tosser. Sure, you could sit there flicking a coin into the air then catching it and slapping it on your wrist—that's the traditional way. But this is an age where we live on the cutting edge of technology. The box in which the circuit is built has a pair of LED's labelled HEADS and TAILS. There's also a push-button switch (see Fig. 5) labelled TOSS. When you press the TOSS button, one of the two lights randomly lights, indicating heads or tails.

Integrated U1 is a 555 configured as a free-running oscillator. The oscillator is enabled or inhibited by S1, the TOSS switch, which is connected to the reset terminal of U1 at pin 4. The frequency is set for about 100 kHz, so that in the 0.5 second that the button may be pressed, about 50,000 pulses are produced.

Those pulses are fed to U2, a 7474 J-K master-slave flip-flop, with complementary outputs. Connected as shown, it becomes a divide-by-two counter, so one and only one of its outputs will be at binary 1; the other at binary 0. Which output is at binary 1 depends on whether the number of

(Continued from page 103)

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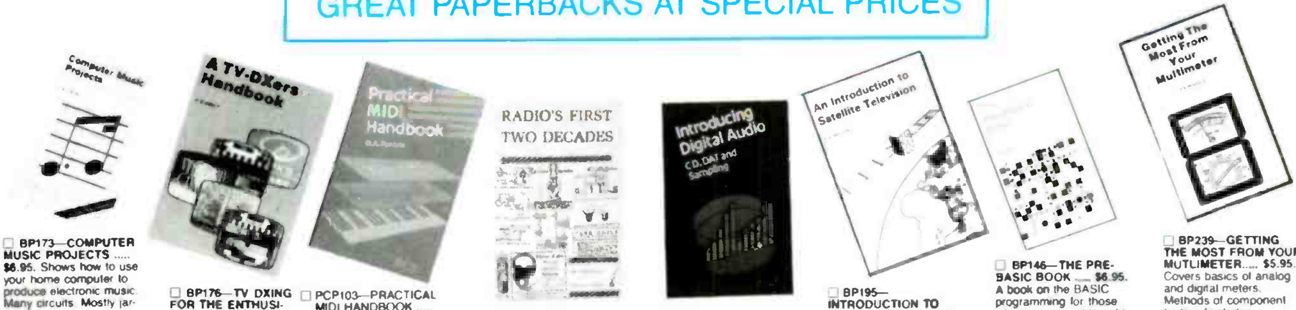

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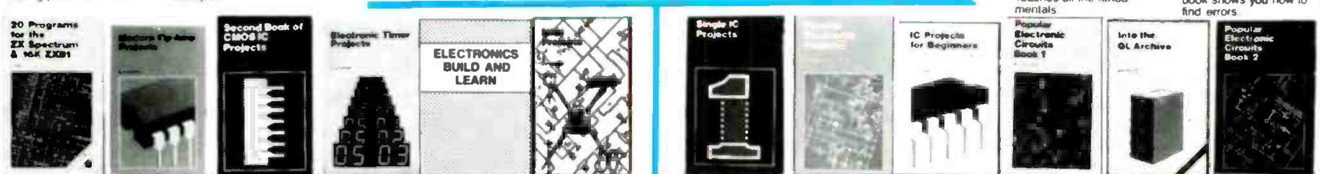

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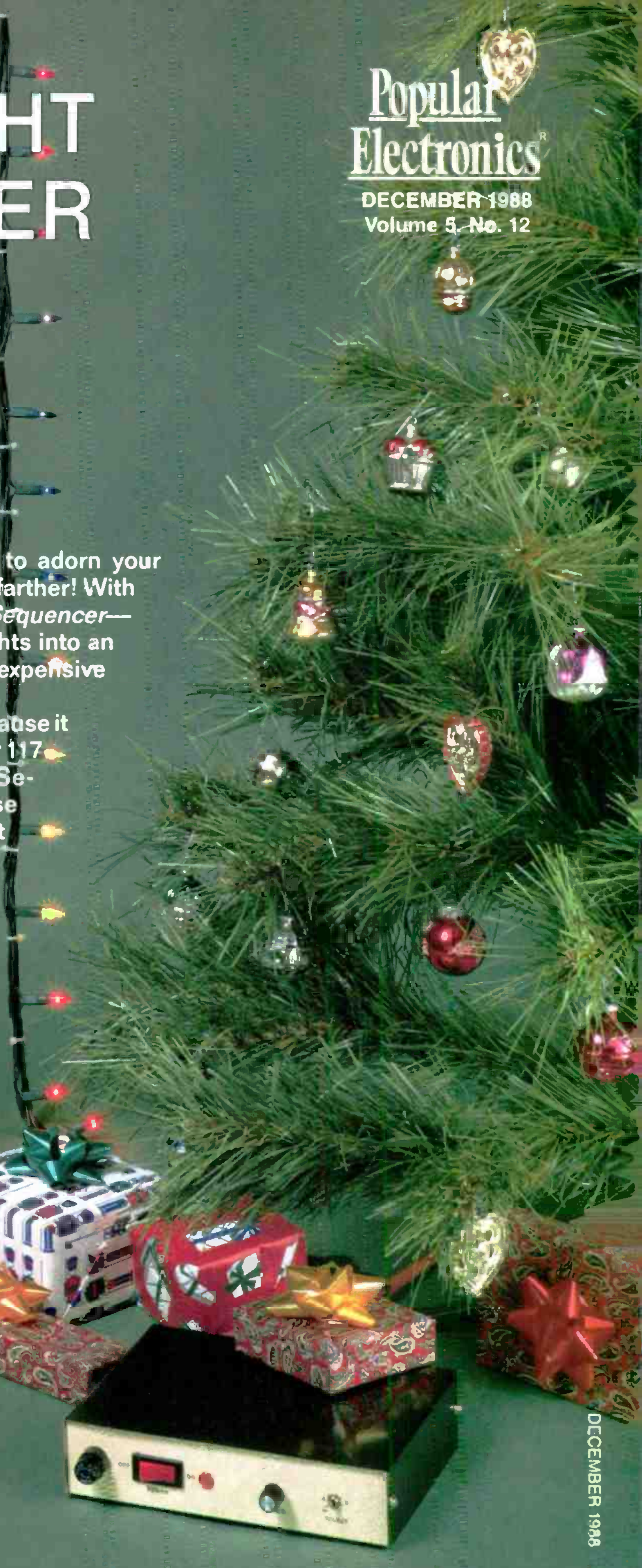
Popular Electronics
DECEMBER 1988
Volume 5, No. 12

HOLIDAY LIGHT SEQUENCER

Illuminate your Yuletide celebration with this light-controller circuit

BY DANIEL P. RAY



If you are looking for that special decoration to adorn your humble home this holiday season, then look no farther! With this easy-to-build project—the *Holiday Light Sequencer*—you can transform your standard Christmas lights into an exciting display that will rival even the most expensive commercial systems!

The Holiday Light Sequencer is so-named because it interfaces a digital sequencing circuit with four 117-volt AC (household-current) sockets. The Sequencer consists of a variable-frequency pulse generator and four D-type flip-flops. The circuit produces several different selectable sequences that are fed to the four AC sockets via optoisolator/couplers (with triac-driver outputs) and power triacs.

To see how the circuit operates, refer to the schematic diagram of the Holiday Light Sequencer circuit shown in Fig. 1. Integrated circuit U1 (a 555 oscillator/timer) is wired as a conventional pulse generator. The frequency of the pulse generator is controlled by potentiometer R11. Resistor R2 puts a reasonable limit on the highest speed attainable.

The output of the pulse generator is fed to the common clock input of U2, a 74C175 quad D-type flip-flop. Each flip-flop is configured so that its Q output is coupled to the D input of the subsequent flip-flop (as shown in Fig. 2).

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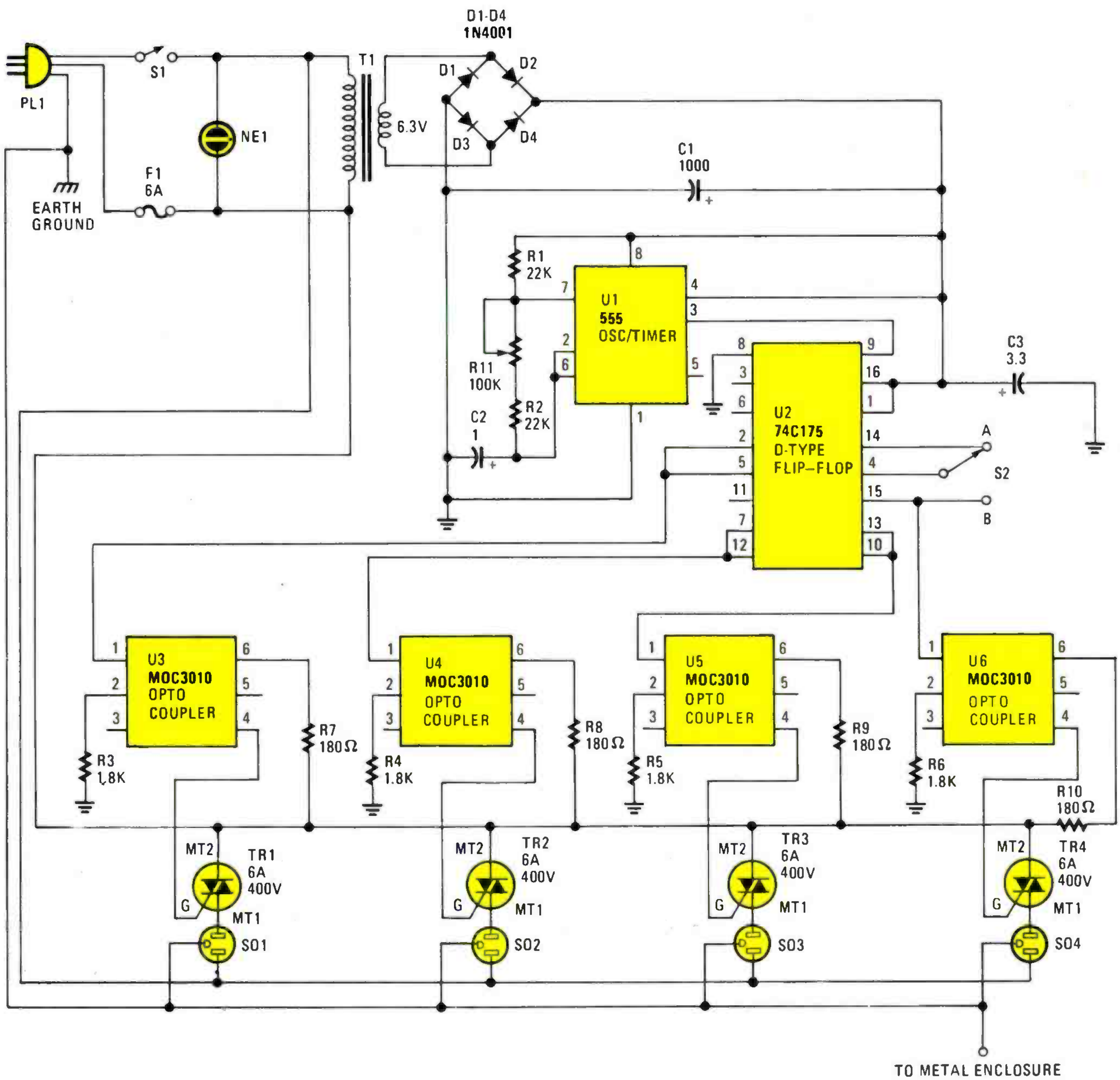


Fig. 1—The Holiday Light Sequencer circuit consists of a 555 oscillator/timer (configured as a pulse generator), feeding a 74C175 quad D-type flip-flop. The four flip-flops, in turn, drive four MOC3010 optoisolator/couplers, which are used to trigger four triacs to provide power to the four strings of lamps.

Information on the D input of each flip-flop is transferred to the Q (and $\overline{Q}$) outputs on the leading edge of each clock pulse. Switch S2 allows you to invert the information on the D input of the first flip-flop at any time during the cycle. That allows you to create a number of different sequences, which are determined by the state of the CQ output at the time of the switching.

Some of the possible sequences are:

- 1 through 4 on, 1 through 4 off;
- 1 of 4 on sequence;
- 1 of 4 off sequence;
- 2 of 4 on sequence;
- 1 and 3 on to 2 and 4 off;
- and others where the sequence of events is difficult to determine.

However, if S2 is switched to position B while all outputs are high or all are low, which seldom occurs, the sequence stops and the outputs remain either all on or all off. If that happens, you only need to switch back to position A for at least one pulse duration, and then back to position B again.

Likewise, S2 should be in position A (pin 4 connected to pin 14) each time the power is turned on. That's because the data on pin 4 must be a logic 1 in order to start a sequence; otherwise all outputs remain at logic 0 regardless of the clock pulses.

Interface. Each output of the sequencing circuit is connected to an MOC3010 optoisolator/coupler (U3–U6), which contains an infrared-emitting diode with an infrared-sensitive diac (triac driver or trigger) in close proximity. (See Fig 3.) The diac is used as a trigger for the triac, which carries the 117-volts AC.

Each time the infrared-emitting diode receives a logic 1, it turns on, causing the diac to conduct. With the optoisolator/coupler's internal diac conducting, the triac turns on, and power is supplied to whatever load is plugged into the corresponding AC socket. So the sequencing circuit and

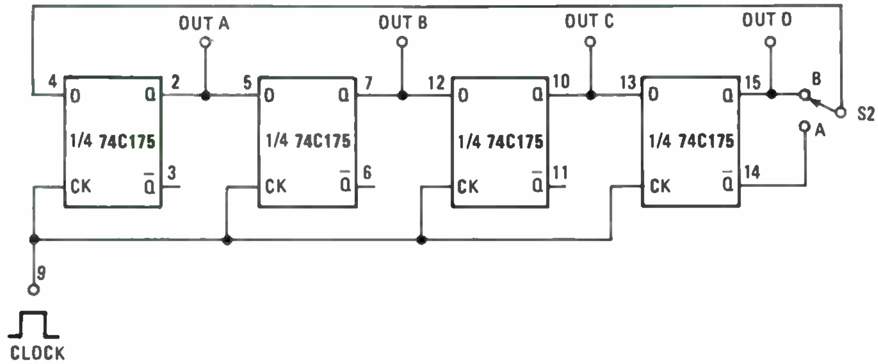


Fig. 2—Shown here is a functional diagram illustrating the actual configuration of the four flip-flops in the Holiday Light Sequencer circuit.

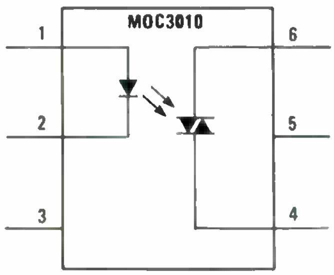


Fig. 3—This block diagram shows the inner workings of the MOC3010 opto-isolator/coupler. Its output element is a diac or triac driver.

the 117-volt AC outputs are "optically coupled" and are effectively isolated from each other.

Power for the sequencing circuit is provided by a 6.3-volt miniature transformer. The output of the transformer is rectified by a four-diode bridge circuit, the output of which is filtered by C1 (a 1000-µF electrolytic capacitor). Capacitor C3 is added at the supply pin of U2 to suppress transients.

Construction. First of all, you absolutely must break off the links between the terminals on the duplex sockets (SO1–SO4), so that each socket can be controlled individually. That is very important! Do it before anything else so you can't forget later. Next, mark the locations of all the components that are to be mounted to the front and rear panels of the enclosure.

Drill and cut holes in the metal enclosure for the panel-mounted components. The holes for the sockets are a little hard to make. However, you can use a wall plate (socket cover) as a template to mark the holes, and then drill with the largest size bit available (without going oversize). The socket holes can then be shaped and/or enlarged as needed with a small file or grinding wheel.

The author's prototype was built on printed-circuit board, the foil pattern for which is shown in Fig. 4. Once the board is etched and drilled, begin installing the board-mounted components, using Fig. 5 as a guide. Note from the diagram that R2 is not mounted on the PC board, but is soldered directly to potentiometer R11. Use #18 insulated wire (or heavier) for all 117-volt AC connections. Use a copper or aluminum heat sink for the four triacs if you plan on using high-wattage lamps. Mount the circuit board on insulating spacers, making sure that none of the connections on the foil side touch the metal case. Make sure that the AC ground is connected to the appropriate terminal on all the sockets and to the metal enclosure. Secure the power cord with a suitable connector or strain relief.

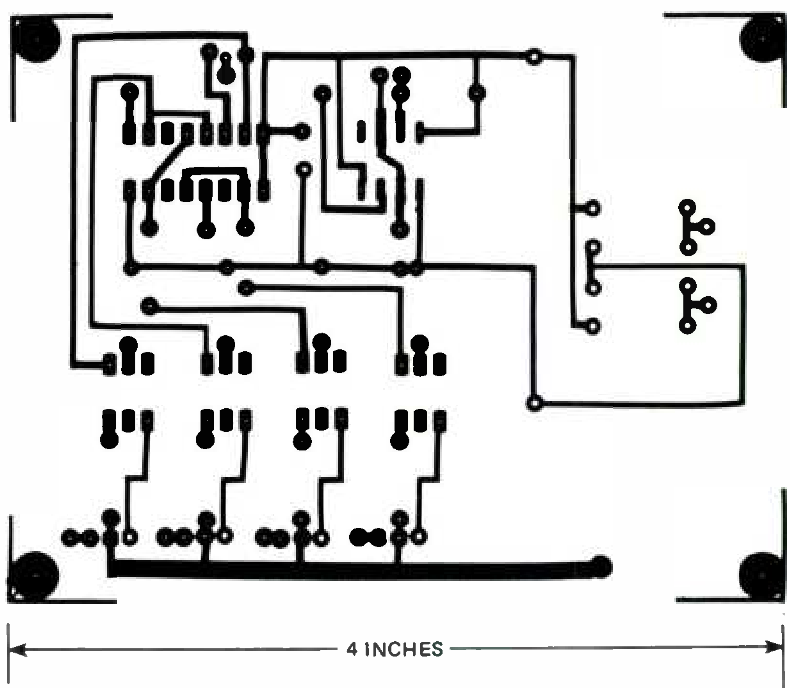


Fig. 4—Shown here is a full-size foil pattern for the Holiday Light Sequencer's printed-circuit board.

The Lights. For the Holiday Light Sequencer to produce the aforementioned sequences, the lights must be arranged in sequence also. Figure 6 shows how that's done. No wires are shown in the diagram because it is the positioning of the lights that is important. The lamps are kept in their proper positions by wire ties or electrical tape around the wires.

The plugs should be marked with the letters A, B, C, and D so that they can be plugged into the corresponding sockets on the Holiday Light Sequencer. If your lights are the "flashing" type, locate the flasher bulb and replace it with an ordinary one.

Warning. Always keep in mind that household current (117-volts AC) can be lethal! Never turn on the power unless the circuit is completely enclosed. Never try to make repairs or modifications to the circuit without first unplugging the unit. The AC fuse must not be omitted from the circuit. The fuse assures that the project won't be damaged in the event of a wiring error.

The Holiday Light Sequencer is intended for indoor use only. Do not use it outdoors, unless you can completely shield it from all forms of precipitation.

Troubleshooting. After checking your wiring several times, put the cover on, plug in the Holiday Light Sequencer, and plug the four sets of lights into the corresponding sockets. (You should check all the lights beforehand by plugging them into a household wall socket).

With R11 set at mid-position and S2 to position A, flip on the power switch, S1. If nothing happens after several seconds, you should set S2 to the other position. If the lights now start to se-

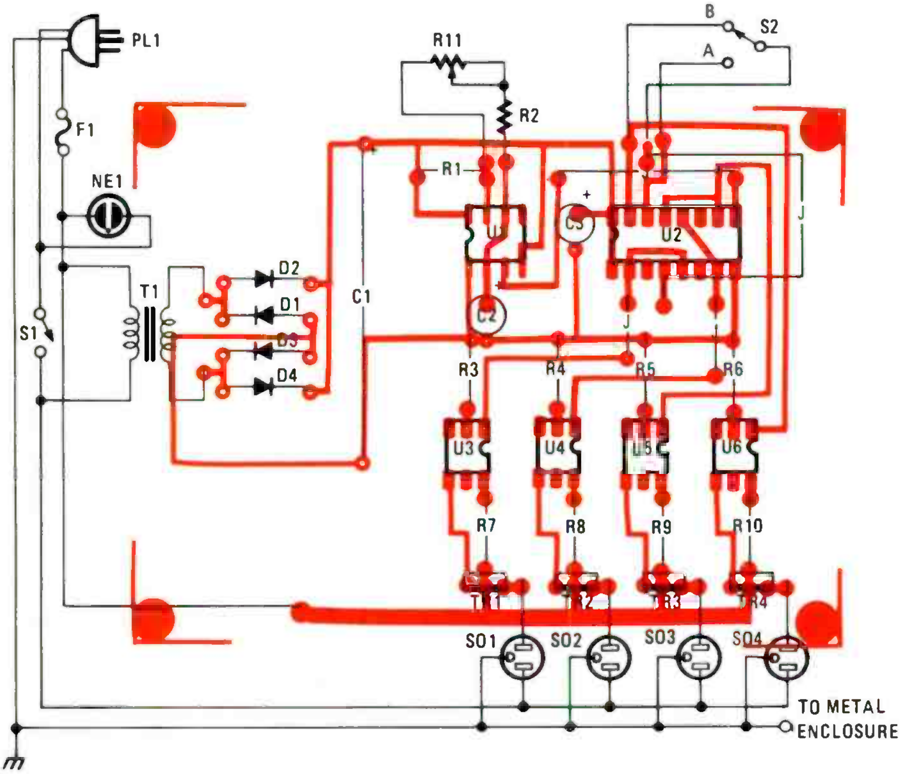
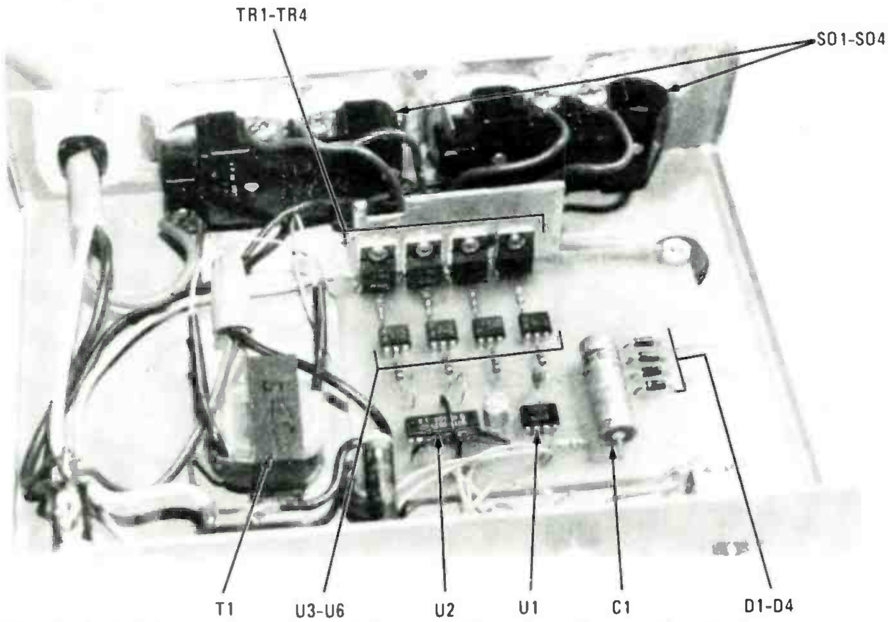


Fig. 5—Shown here is the parts-placement diagram for the Holiday Light Sequencer. When installing the parts, pay strict attention to the orientation of the components. Also it is a good idea to use sockets for the six ICs.



Here is the finished project prior to being sealed into its enclosure. Note that SO1–SO4 consist of two duplex sockets, which come with a shorting bar between the two individual sockets. It is necessary to sever the shorting bar between the sockets to allow the strings of lamps to be controlled individually.

PARTS LIST FOR THE HOLIDAY LIGHT SEQUENCER

SEMICONDUCTORS

U1—555 oscillator/timer, integrated circuit
U2—74C175 or 40175B quad D-type flip-flop, integrated circuit
U3–U6—MOC3010 optoisolator/coupler (Radio Shack 276-134 or similar), integrated circuit
TR1–TR4—6-amp, 400-volt triac (Radio Shack 276-1000 or similar)
D1–D4—1N4001 (or similar) 1-amp, 50-PIV, silicon rectifier diode

RESISTORS

(All resistors are ¼-watt, 5% units, unless otherwise noted.)
R1, R2—22,000-ohm
R3—R6—1800-ohm
R7—R10—180-ohm
R11—100,000-ohm potentiometer

CAPACITORS

C1—1000-µF, 16-WVDC (or better) electrolytic
C2—1-µF, 16-WVDC (or better), Tantalum or radial-lead electrolytic
C3—3.3-µF, 16-WVDC (or better) Tantalum or radial-lead electrolytic

ADDITIONAL PARTS AND MATERIALS

T1—117-volt primary, 6.3-volt secondary, miniature power transformer
F1—6-amp fuse 3AG
S1—Single-pole, single-throw, rocker switch
S2—Single-pole, double-throw, miniature toggle or slide switch
NE1—117-volt snap-in neon lamp
PL1—117-volt AC molded 3-conductor plug with power cord
SO1–SO4—117-volt AC sockets

Printed circuit or perfboard materials, metal enclosure (Radio Shack 270-272 or similar), IC sockets, fuse holder, hookup wire, solder, hardware, etc.

quence, then either the wires to S2 should be reversed (with the unit unplugged of course), or that setting can be marked as position A.

If nothing happens with S2 in either position, check the fuse. If it is blown, then unplug the unit and look for a short in the 117-volt AC wiring. Solder bridges are another possible problem. For instance, solder bridges on the triacs may cause the corresponding socket(s) to stay on constantly.

Improper orientation of the IC(s), missing jumper wires, or poor solder connections can also cause problems. But, if the schematic diagram of the circuit is followed very closely, there should be no problem in getting the Holiday Light Sequencer to work.

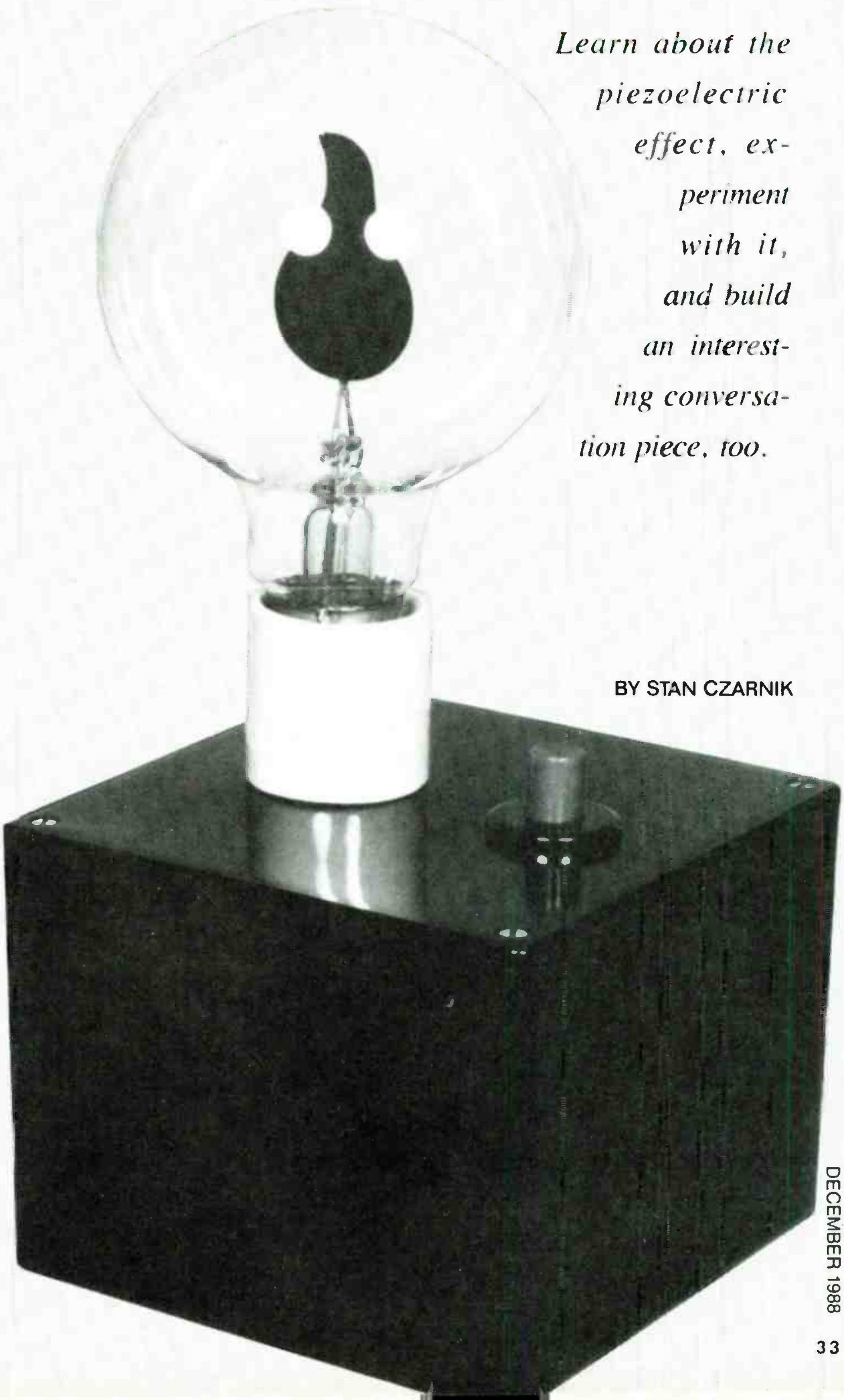
Operation. While the sequencer is working properly with S2 in position A, try switching to position B at various times during the cycle to create an amazing variety of sequences. Several other sequences are obtainable by plugging set B into the C socket and vice versa. Adjust potentiometer R11 for the desired rate and just sit back and enjoy the show!

And when the Yuletide season is over, don't pack the Holiday Light Sequencer away with the rest of the decorations. Try plugging in a 150-watt floodlamp (to any socket) for wild strobe-type lighting effects! Or maybe you can do something with your patio lanterns. ■

FUN WITH PIEZOELECTRIC GENERATORS

Learn about the piezoelectric effect, experiment with it, and build an interesting conversation piece, too.

BY STAN CZARNIK



There is a complex, crystalline, silicate mineral called *tourmaline* that, when heated, attracts small bits of various materials. The powers of tourmaline have been known in Europe since the early 18th century. That's when the crystals were first brought over from Ceylon by Dutch merchants, and thus the name "Ceylon magnet."

An electrical characteristic of tourmaline was established in 1756 by Franz Ulrich Theodor Aepinus (1724--1802). Aepinus found that hot tourmaline crystals become polarized—negative at one end and positive at the other. That polarization was observed in other crystalline substances and, in 1824, received the general designation *pyroelectricity*—literally, electricity from fire.

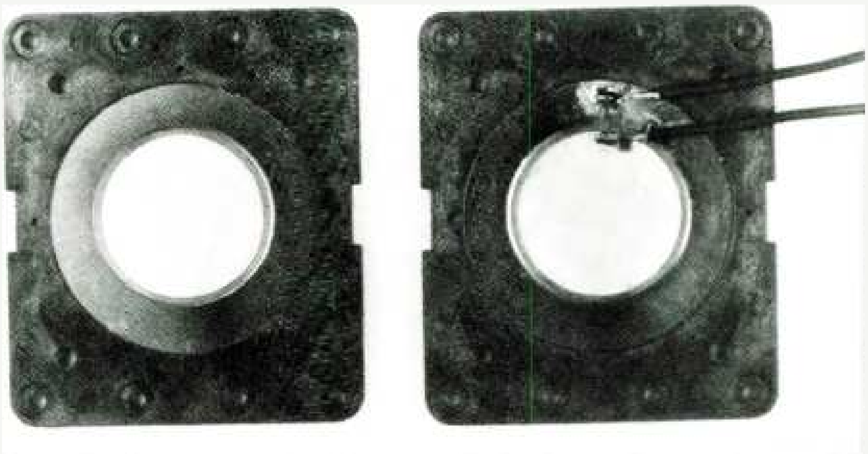
Pyroelectricity should not be confused with thermoelectricity, which refers to a voltage created by the difference in thermal energy between dissimilar metals joined together in a circuit.

The modern understanding of the pyroelectric effect, and its relevance to crystal physics, can be traced to Pierre Curie (1859-1906). The structure of crystals persuaded Pierre Curie, along with his brother Paul-Jacques (1855-1941), to explain pyroelectricity in mechanical terms. They decided that the pyroelectric effect was due not, strictly speaking, to heat, but to thermal stress caused by the heat. That led to the discovery in 1880 of what we now call *piezoelectricity*, literally, electricity from squeezing or pressing.

The Curie brothers found that many sorts of crystals exhibit the piezoelectric effect, including sodium chlorate, calamine, topaz, tartaric acid, Rochelle salts, quartz, and even cane sugar.

How It Happens. Piezoelectricity is not the easiest thing to understand. It has, in fact, been called one of the most complicated branches of crystal physics. The following should be considered a very simplified explanation.

Imagine a crystal of barium titanate, a common piezoelectric material. Barium-titanate crystals have a roughly cubic structure. The word "roughly" is necessary because the positively charged titanium ions (*cations*) are slightly off-center. Thus, the crystal is polarized. In the presence of an electric field, the titanium ions are shifted towards the negatively charged elec-



Here are a couple of piezoelectric discs from JerryCo Inc., mounted in plastic frames. Two types of the discs are available, one with and one without wire leads.

This piezoelectric spark button, only 3½-inches long, generates enough electricity to throw a small spark. The spark button comes complete with a plastic nut for mounting.

trode. That happens, of course, because opposite charges are attracted to each other. As the orientation of the ions changes, so does the shape of the crystal.

The reverse effect, which happens to be the original piezoelectric effect, can be understood in the same terms. If the barium-titanate crystal is subjected to mechanical stress, it becomes electrically charged. In other words, pressure on the crystal means a displacement of ions which, in turn, means that opposite faces of the crystal take on opposite electrical charges.

Piezoelectric Parts. You don't need crystals of tourmaline or barium titanate to experiment with piezoelectricity. A couple of terrific piezoelectric devices can be ordered from a science surplus house called JerryCo, Inc. (601 Linden Place, Evanston, Il 60202). Among them are a piezoelectric disc and a high-voltage piezoelectric spark button. Note that the company requires a minimum order of $10.00 and there is a flat $3.00 fee for shipping and handling. In addition, Illinois residents must add 7% sales tax.

The piezoelectric disc is about 1¼ inch in diameter and, in most cases, comes mounted in a plastic frame that measures about 2 by 2¼ inches. It's available with or without wire leads. Without leads, the piezoelectric discs are $2.25 for a package of three (catalog number 6793). With 6-inch wire leads, the discs are $3.00 for a package of two (catalog number 6790).

I recommend ordering discs complete with wire leads. Soldering your own hook-up wire to the discs can be difficult. Also, you may want to order several discs. The piezoelectric ceramic material is fairly brittle and that means it can break.

The high-voltage sparker is a black-plastic cylindrical object about 3½-inches long. It has a red button on one end, a high-voltage terminal on the other end, and a grounding tab in the middle. One spark button costs $3.75 (catalog number 3261). The sparker is meant to be the ignition device for gas-fired barbecues; in fact, it may be possible to pick one up locally at larger hardware/houseware stores.

The Disc. A quick, sharp rap on the piezoelectric disc with your finger produces an abrupt electrical transient, otherwise known as a spike. The best way to examine that spike is with an oscilloscope. But not everybody has an oscilloscope. There are at least a couple of alternatives.

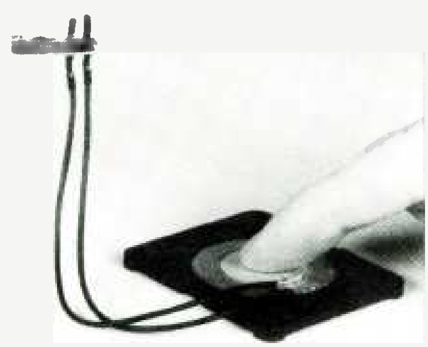
One alternative involves attaching a piezoelectric disc to an NE2 neon lamp. When the disc is hit, the lamp flashes brightly. The experiment works best in a darkened room.

That simple set-up allows you to show that the piezoelectric disc will not only generate a voltage when pressure is applied, but also when pressure is removed. Place the disc on a hard surface, and depress the center of the disc firmly with your finger and watch the lamp closely. The neon gas around one electrode will glow. When the pressure is released, the neon around the other electrode will glow. That happens because the two voltages are moving in opposite directions from one another. Current flows only when the pressure is changing.

Note: The preceding works best with piezoelectric discs that come mounted in a plastic frame. If you purchase the unmounted variety, you may need to support the edges of the disc on a couple of wooden matchsticks or something similar. That way, the disc is free to bend.

Another way of illustrating the piezoelectric action of the discs begins with connecting two of them to-

This piezoelectric disc has been connected to an NE2 neon lamp. Rap the disc, and the lamp will flash.



The circuit can be used to demonstrate the reversal of piezoelectric polarity. Press the piezoelectric disc slowly, but firmly, and only one neon electrode will glow. Release the pressure, and the same will occur at the other electrode. That happens because the two voltages are of the opposite sign.

This might be called a piezoelectric communicator. Hold one disc close to your ear and tap the other gently against a table top. The electrical impulses generated in one disc will be converted back to mechanical vibrations in the other disc. If you happen to have a small tuning fork, the system will pick up and transmit the musical tone.

gether. Two or three feet of flexible hook-up wire between the two discs makes that arrangement more interesting. Hold one of the discs to your ear or have a friend do the same. Then scratch the other disc with your fingernail or knock it gently against the side of a table. The noises you hear are created by the electrical impulses from the first disc being converted into mechanical vibrations in the second disc. That illustrates what is sometimes called the *converse* or *reciprocal* piezoelectric effect.

A small warning: If you happen to hold the second disc too close to your ear, you are liable to receive a tiny electric shock, so be careful.

Getting a continuous tone from the piezoelectric discs seems to require a fairly strong high-frequency signal. If you happen to have the electroluminescent glow strip featured in the August 1988 issue of **Hands-on Electronics**, you already possess a device capable of producing the necessary waveform. That device is the voltage inverter, the output of which is about 140 volts at 400 Hz.

Just as the inverter excited the glow strips, it can also excite your piezoelectric discs. Connect a piezoelectric disc to the output of the inverter, apply 6-volts DC to the input, and your efforts will be rewarded with a moderately loud high-pitched buzz.

The Spark Button. Without any alterations whatsoever, the piezoelectric spark button is already an interesting and entertaining device. Every press off the button delivers a weak, but clearly visible ¼-inch spark.

Hold the spark button in your fist so that your little finger touches the grounding tab in the middle of the cylinder. With your other hand, bring some small metal object (such as a nail) close to the high-voltage end of the sparker. Press the button and a thin spark will jump between the two metallic points. If you are holding both the nail and the grounding tab firmly, you will feel only a very slight shock.

Clearly, that high-voltage generator, like any high-voltage device, can be misused. You will want to exercise good judgment and a lot of good taste. Above all, keep the spark button away from small children who may not understand the power of such a small and unfamiliar object.

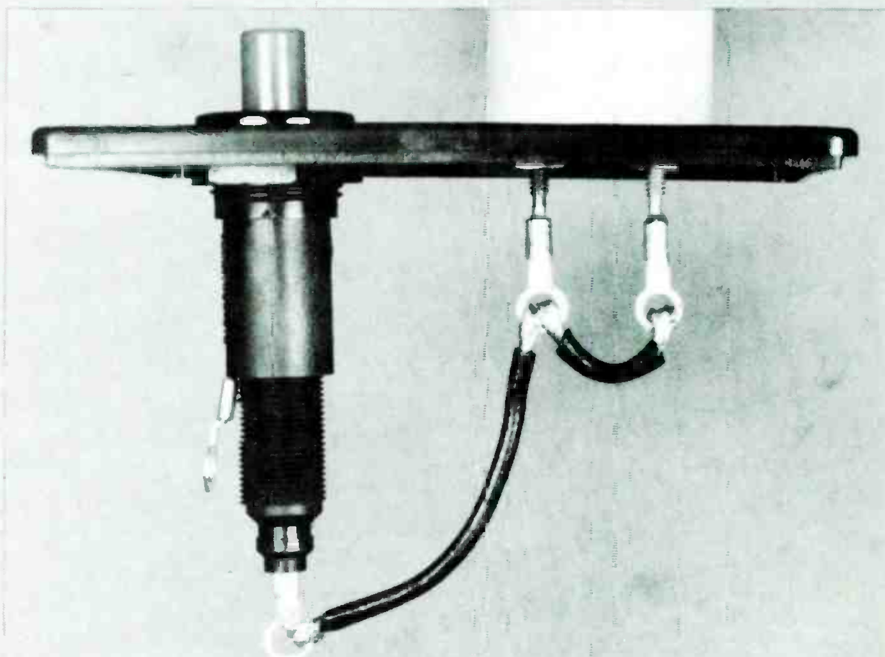
A High-Voltage Neon Ionizer. The high-voltage potential of the piezoelectric spark button makes it possible to build an ionization machine that operates without batteries or house current.

MATERIALS LIST

Automobile battery clip
Binding post (or functional equivalent)
Decorative neon flame lamp (see text)
NE2 neon lamp (Radio Shack 272-1102 or equivalent)
piezoelectric discs (3 or more)
piezoelectric spark button
Porcelain lamp socket
Project box (3½ or 4-inches deep, see text)
Hardware, hook-up wire, solder, soldering lugs, etc.

Apart from the sparker, the major components are a project box, a porcelain lamp socket, and a decorative neon flame bulb. The project box should be at least 3½ or 4 inches deep to accommodate the length of the piezoelectric device. It should also be fairly strong. Thin plastic or thin wood tends to bend when the spark button is pressed. Other than that, the size and shape of the box are not too important.

Any kind of lamp socket may be used. I like the kind that fits flush against a surface with the electrical connections made through the hardware for mounting. A socket of that type contributes to a neat, uncluttered appearance when the project is complete.



Soldering lugs attached to terminals on the spark button and lamp socket makes wiring a lot easier. Keep all wires as short as possible.

I have been unable to find out for certain whether large neon-flame lamps are still being manufactured. The one I used is about 4 inches in diameter. It's been lying around my shop for at least five or six years, and frankly, I can't remember where it came from! What I do know is that smaller versions, such as flame-lamp No. 03660 from the Abco Corporation, are available at many large hardware stores and lighting-supply companies. A smaller bulb will work just as well as a large one, although the effect may not be quite as dramatic.

Prepare the top of the project box by drilling holes for the lamp socket and a 13/16-inch hole for the spark button. Make sure the sparker does indeed wind up on the top of the box, and not on the side. That prevents the box from moving when you press the button. Mount the lamp socket and secure the spark button with the large plastic nut provided with the unit.

Attach the lamp socket terminals together with a short piece of heavy stranded wire. Then run another piece of wire from the high-voltage end of the spark button to one of the lamp-socket terminals.

To ensure proper operation, the system should be grounded. Run another piece of wire from the grounding tab on the spark button to a binding post, banana jack, or some other sort of connecting device located on the outside of the cabinet. Make sure that the wires coming off the spark button are as far away from each other as possible. They must remain at least 1-inch apart after you close the box. If the wires get too close or make electrical contact, the unit may perform very poorly or not at all.

The ground wire may be any 3- or 4-foot piece of flexible cable. The piece I used came from a length of ordinary lamp cord. Attach an automobile battery clip to one end of the ground wire. A large alligator clip works too. Screw the neon bulb into the lamp socket and the project is complete.

The high-voltage piezoelectric ionizer will look something like this when you're finished. The ionizer makes a unique and educational conversation piece.

This is the grounding system. The large automobile battery clip permits connection to large grounded objects, like water pipes.

Operating the Ionizer. Connect the ground wire to a grounded object, such as a water pipe or water faucet. Place the ionizer on a hard, flat surface. Now turn off most of the room lights or, better yet, darken the room completely. Grasp the neon bulb gently with one hand so that the palm of your hand is visible through the glass bulb. Press the spark button with your other hand. A quick, sharp, firm push of the button seems to work best. The area inside the bulb just next to your hand will turn to bright orange neon plasma. Touch the bulb with a single fingertip and then push the spark button again. A thick shaft of ionized gas will leap between your finger and the electrodes within the bulb.

For more experiments and demonstrations with piezoelectricity, see *Nature's Electricity*, written by Charles K. Adams (published by Tab Books, Blue Ridge Summit, PA) and *Crystals and Crystal Growing*, written by Alan Holden and Phylis Singer, (published by Anchor Books, Garden City, NY). ■

Build a Sliding Bar "Antique" Radio

Take a trip into the past with our sliding-bar radio, and bring some solid state with you for an up-to-date twist!

BY HOMER L. DAVIDSON

The Sliding-Bar Crystal Radio is nothing new to real old timers, who started building those radio sets after World War I. Despite their antiquity, a sliding-bar assembly helps to separate and tune in the broadcast band well. The receiver contains two coils that can be adjusted by moving pointers (brushes) back and forth along an exposed portion of their surfaces. By tuning the radio in that fashion, even strong local stations can be separated.

Sliding-Bar Construction. The sliding-bar assembly is made from square tubes found at most popular hobby stores. The small square brass tubes sell for about 99-cents each. You will need two different stocks (sizes): 3/16-inch square and 1/4-inch square. The 3/16 square tubes fit snuggly into 1/4,-inch square tubes. A long section of 3/16-inch stock (called the main bar) is placed above the coils and between the wooden supports for the tuning coil (see photos). The two pointers (cut from the 1/4-inch stock) slide upon it to tune the coils.

When you are cutting a piece, it is best to have it secured in a vise rather than just holding it. Be careful not to squeeze the piece out of shape when using a vise. Start by cutting a 7-1/2-inch section of 3/16-inch stock for use as the main bar (see Fig. 1). Drill holes in the ends for mounting screws used later. Cut two pieces 1-1/2-inches long from the 1/4-inch stock. Those pieces (sliders) will actually ride back and forth on the main bar. They will carry the pointers, which actually make contact with the coils.

To make the pointers you must cut two 3/4-inch pieces from the larger stock to form sleeves, and two 3/4-inch

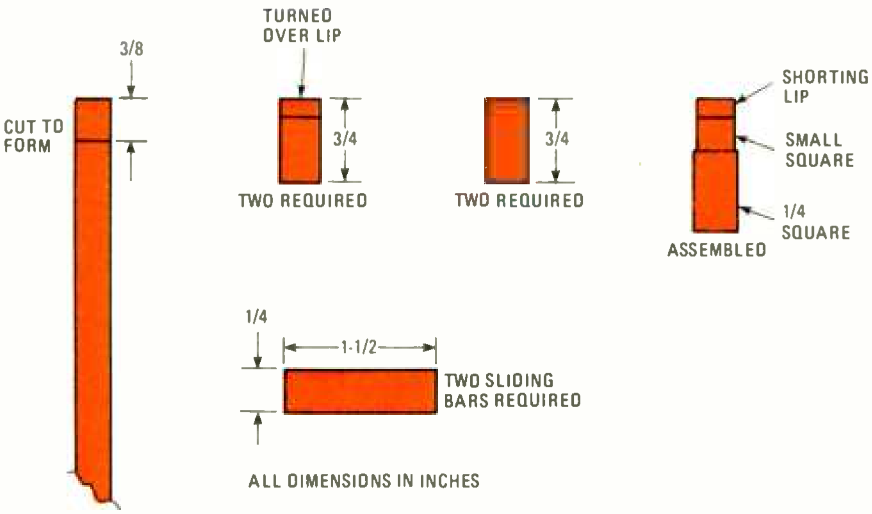


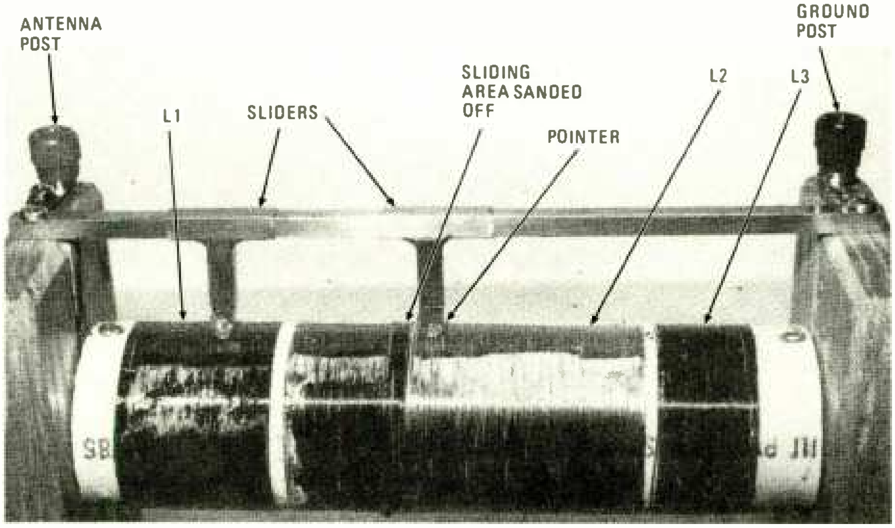
Fig. 1. The sliding bar is made up of the larger 1/4 inch stock so the slider bars will ride or float outside the larger piece. A brush is formed on the end of the pointer.

pieces of the smaller stock to make into brushes. Use a hacksaw to cut out a lip about 3/8-inch tall in the two brush sections. The lips are to be used as contact points so they must be gently folded back toward the tubes to form smooth curved surfaces. Be sure the lips completely cover the openings so they can hold the springs in place.

Sand the curved tips of the brushes for good contact against the coils. Good contact must be made between the outside of the main bar and the inside of the sliding bars, and between the inside of the sleeves and the outside of the brushes. So sand or use steel wool to shine up and remove any coating on the brass tubes so the tubes will have no resistance between them. Square up all the ends of the pieces cut and remove any burrs.

The brass tubes solder up nicely with a 150-watt soldering gun. Tin the middle of a slider on one side. Mount the square edge of a sleeve against it there and apply solder on each side. That makes a strong bond between the two pieces. If the two pieces are not perfectly perpendicular, re-melt the solder and try it again.

The brushes must be able to slide in and out of the sleeves freely, so clean them further if necessary. Locate a couple of small springs and place them inside the sleeves. Place the brushes inside the sleeves and make sure the springs push the brushes out. If the springs are not long enough, just carefully pull them apart to the desired length. You may wish to perform that procedure again after the main bar and coil are in position on the frame to adjust the force they will apply.



A close-up of the entire sliding-bar tuning-coil assembly showing how the coils are placed and the pointers in position ready for action.

Coil Winding. The prototype's coils were wound on a 7-1/2-inch long × 1-1/2-inch inside-diameter, PVC pipe. The outside of the pipe is almost 2 inches across. Any non-magnetic coil form with approximately the same outer diameter and length will do. The main coil, L2, is wound with 145 turns of No. 22 or 24 enameled wire, while L1 and L3 have 65 and 45 turns, respectively, of No. 24 or 26 enameled wire. Remember while you're making them, that the coils must be tightly wound so that when the pointer moves over the turns, they will not spread apart.

Drill two small 1/16-inch holes 1/2-inch from one end of the pipe (see Fig. 2), and about 1/4-inch apart from each other. Follow that procedure when drilling the rest of the holes in the tube using Fig. 2 as a guide.

Now you can start winding L1. Beginning with a pair of holes close to one end, thread some of the wire for L1 through one hole, back out the other, and loop it back through the first hole leaving about 6 inches of wire inside the pipe. All coil ends are to be prepared that way with some portion of the wire left inside the tube until they are to be wired. Now wind 65 turns without gaps between the strands (close wound). Slip a piece of cellophane or masking tape over the coil winding to keep it from unwinding as you terminate the coil, in the same way it began, at the next set of holes.

Now begin the main coil, L2, at the holes 1/4-inch from the end of L1, and wind 145 turns of No. 22 or 24 enameled wire, but leave a 10-inch piece inside. If your fingers get cramped or tired while winding the large coil, place a piece of tape over the winding to hold it in place so you can flex your fingers.

Wind the last coil, L3, with 45 turns, using the remaining holes to terminate its ends, leaving about 8 inches on each end for hookup.

Coil Preparation. On the side of the pipe, opposite the coil holes, place two strips of cellophane or masking tape on each side of a 1/2-inch wide area. You will remove the enamel insulation from the wire in that area. Do not use a knife or razor blade; instead slowly rub a piece of sandpaper on the exposed area between the strips of tape, working back and forth in the direction of the windings. The insulation comes off really easy that way.

The coil windings may be held in

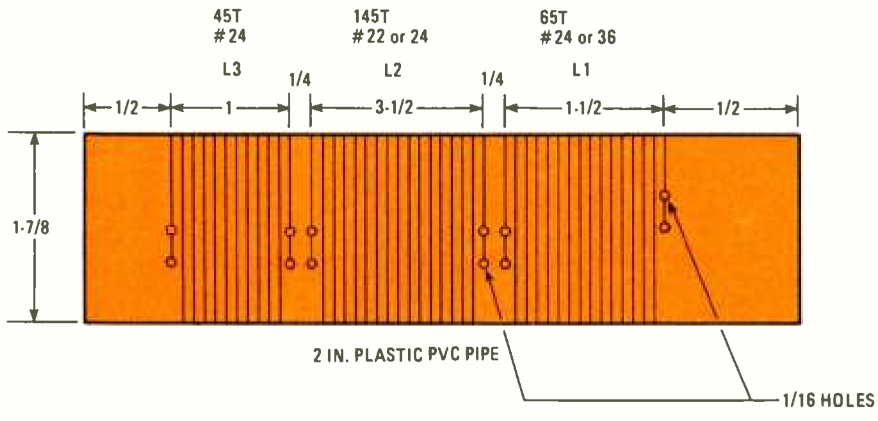


Fig. 2. Here's a drawing of the three coils placed on the pipe and the dimensions of the PVC pipe itself. Mark and drill the holes before winding the coils.

place with coil dope or plastic-model cement. Even a light coat of rubber silicone will do. Place a light layer on each side of the scraped area to keep the wire from shifting. Likewise, place the adhesive on the first and last turns of each coil to help keep them from unwinding.

Drill a ⅛-inch hole at each end of the tubing adjacent to the sanded area. Screws through those holes will hold the coil form to the wooden end supports. Make a small hole close to each mounting hole to be used to pass some hookup wires through.

Connect one terminal from each coil together and solder them to a piece of hookup wire. That wire will be used to connect the coils to ground, so you may tuck the three leads back into the tube. Allow the wire to stick out of the small hole on the side of the coil where L3 is located. Connect the other terminals of L2 and L3 together and solder them to a piece of hookup wire, which will be used to connect them to the tuning capacitor. Thread the wire through one of the prepared holes at either end. Take the remaining lead from L1 and solder it to some hookup wire also. Since the wire will be running to the antenna, it should run out the small hole on the side of the tube opposite the ground wire. Mark the wires for easy identification when the coil-assembly ends will be covered.

Wood Work. The main board measures 5-½ × 12 inches (see Fig. 3). The prototype has a discarded piece of walnut purchased from a souvenir store as a base. Scrap wood pieces may be found at hobby stores if you haven't any yourself, and, of course, any type of wood will do. Drill two ⅛-inch holes into it to accommodate screws to attach the left and right support pieces to the board. The holes must be a little over 7 inches apart; the actual distance will depend on the thickness of the side supports you make.

The dimensions of the two prototype supports are 3 × 7 inches and were cut from a piece of oak. Pieces of walnut and oak are very hard to work with, but when finished appear nice and solid. Glue and nail two round circles of soft wood to each support 1-⅛ inches from the top to hold the coils in position. Be sure that the pieces you use are small enough to fit inside the tube. Drill two holes in each board at a slant to be used to attach the center panel (see photo). Be mindful of the clearance needed for the coils when determining the angle and elevation of the board you desire.

Cut the center (slanted) piece 7-½-inches long × 3-inches wide. Drill two ⅜-inch holes in the slanted panel for mounting the volume control and variable capacitor. Drill a ¼-inch hole in the board to mount the earphone jack.

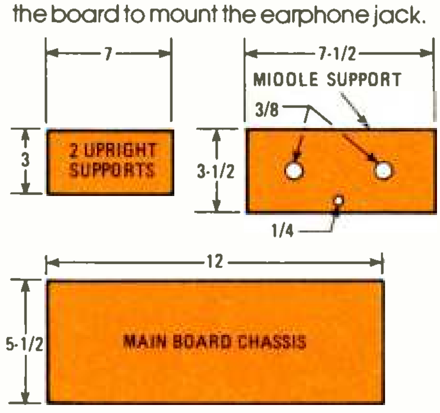


Fig. 3. These are the dimensions of both wooden supports, the panel, and the chassis. They are to be predrilled according to the text.

Sand down the boards and bevel all edges if a bench sander is handy. Make sure all pencil and pen marks are sanded away. Spray a couple of clear coats of lacquer or gloss spray over the wood (or stain if you wish) before putting the pieces together. Now sand down the finish with steel wool.

Once finished, attach one support to the base with screws through the holes made previously, put the tube in position up against the support, and secure the other support to the base with a screw. Place screws through the holes at the ends of the PVC tubing to secure it to the side supports with the sanded surface facing away from the base.

Mount binding posts to the top of the side supports and run the ground and antenna wires to their respective posts and connect them.

Now mount the center panel. After all the wooden pieces have been assembled, cover the exposed surface of the coils with tape, and carefully spray on two more coats of finish. When dry, remove the tape.

This is a close up of how the oak supports are tied to the panel.

The Amplifier Board. The circuit itself is really just a crystal radio with amplified output (see Fig. 4). The antenna is tuned by L1. The tank circuit consists of L2 and L3 both in parallel with the tuning capacitor, C1. Any variable capacitor around 365-pF will do for C1. You may even use one section of a dual miniature capacitor. Some of those capacitors can still be found at certain electronic-parts stores. The tank-circuit output is demodulated (rectified) by diode D1. Capacitor, C2 provides an AC path to ground for the incoming audio, which is picked off of the VOLUME control, R1, for the amplifier, U1. The output of the amplifier is then

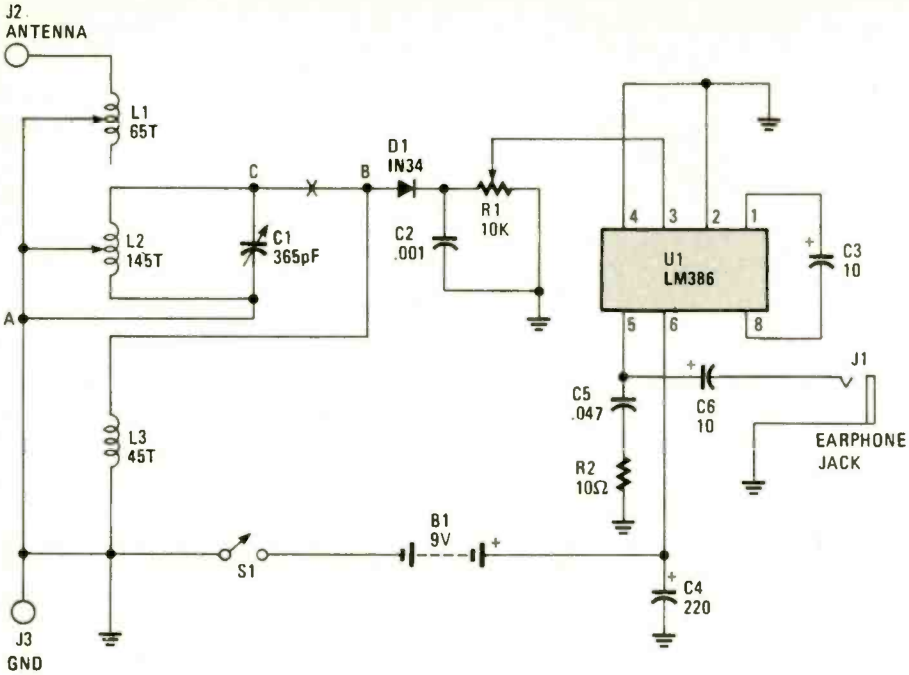


Fig. 4. In this schematic diagram of the Sliding-Bar Receiver, the section marked A is actually the sliding-bar tuning-coil assembly itself. The section marked C is the hookup wire from the coil assembly, and section B is the diode.

AC coupled to the earphone jack for listening.

To start circuit-board construction, cut off a ½ × 2-½-inch piece of perfboard from a larger piece. Mount the IC socket in the center of the board. Place C4 close to socket pin 6 and solder its positive lead to that pin. Wire C3 across pins 1 and 8.

Solder a piece of bare hookup wire on pin 2, loop it around pin 3 and solder it to pin 4. It will be used as the ground wire for the board, so make the loop large enough for several other components to be connected to it. Solder the minus side of C4 to the ground wire, and solder C5 and the positive side of C6 to pin 5. Connect R2 between C5 and the ground wire.

Solder a 6-inch piece of hookup wire to pin 3 to be used to connect the resistor-wiper connection. Bring another 5-inch piece of wire from the minus side of C6 to be used to connect it to the earphone jack. Connect a 6-inch hookup wire to pin 6 for connection to B+. Run three wires from the ground wire to connect it to the VOLUME control, switch S1, and the tuning capacitor.

Final Assembly. Slide the pointers onto the main bar and push the springs and brushes into their sleeves. Tape them in place for now. Place the sliding-bar assembly over the coil and rest its ends on the side supports. Position the main bar so that the brushes are directly over the sanded area of the coils, and secure it to the supports with screws through the holes made in the bar. Remove the tape. Each slider should be placed over either L1 or L2. A drop of solder should be placed on the square bar near the ends of L1 and L2 so that the pointers can not slide off the coil's useful area. Connect a wire between the ground terminal and the brass sliding bar.

PARTS LIST FOR THE SLIDING-BAR RECEIVER

CAPACITORS

C1—365-pF, variable
C2—.001-µF, 50-WVDC, ceramic-disc
C3, C6—10-µF, 35-WVDC, electrolytic
C4—220-µF, 35-WVDC, electrolytic
C5—.047-µF, 50-WVDC, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

D1—1N34 crystal diode
J1—Earphone jack
J2, J3—Binding posts
R1—10,000-ohm potentiometer with SPST switch
R2—10-ohm, ¼-watt resistor
S1—SPST switch (part of R1)
U1—LM386 audio-amplifier integrated circuit

2" OD × 7-½" PVC-plastic pipe; 8- to 38-ohm earphone or equivalent headphone; 9-volt battery; 9-volt battery clip; number 22 or 24 wire, and number 26 enameled wires for coils; oak-, walnut-, or pine-wood pieces for chassis and supports; hookup wire; IC socket; solder, wood screws, etc.

Connect capacitor C2 across the two far terminals of R1. Connect the wiper terminal to the hookup wire from pin 3 on the perfboard. Solder one of the ground wires coming off the circuit board to one of the outside terminals of R1.

Connect the black lead of the battery clip to S1 (the switch on R1), and the other terminal of S1 to one of the ground-hookup wires from the circuit board. Run a wire from that same terminal to the ground binding post.

Connect the remaining terminal from the coil (the one attached to L3 and L2) to the stator of C1. Connect the other side of C1 to the grounded terminal on R1. Mount R1 and C1 in the panel and connect D1 between the stator of C1 and the ungrounded side of R1.

Connect the wire from C6 to the earphone jack, and the remaining terminal from the jack to the grounded side of C1. Install the jack and attach the perfboard to the underside of the panel. Your unit is ready for testing.

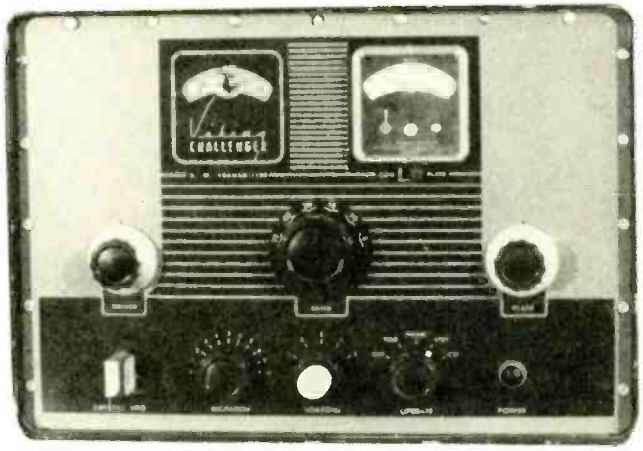
Testing. Connect an antenna wire to the antenna terminal, and a cold-water ground to the ground post. Plug in the earphones, and turn the switch on. You should hear some sound in the earphones. Rotate the tuning capacitor to tune in local broadcast stations. Stations at the lower end of the dial will tune in with the slider towards the grounded end of L2. Slide the antenna tuner, L1, to separate close stations. By using the two sliders and the tuning capacitor, most stations can be separated.

If nothing is received, check the small amplifier circuit. If a VOM or DMM is handy, check the circuit voltages, in particular those at pins 5 and 6 of U1. If there's little voltage at pin 6 instead of the near 9-volts and the battery and switch check out okay, then test for excessive current by inserting the milliampere meter between one battery terminal and the clip. Suspect a leaky IC or improper connections if the current is above 20 milliamps.

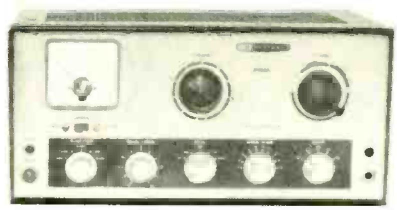
If pin 6 is fine, but pin 5 has no output, measure the diode for possible leakage with a low-resistance measurement and reversed test leads. If that fails to turn up anything, recheck the circuit for poor wiring connections.

Once everything is working, you are ready to have some old-fashioned fun, with a modern twist. Happy listening. ■

Those Indestructible Novice Transmitters



A lot of great ham sets were introduced in the fifties. If you know a little about them, your next hamfest could be a ham feast!



BY LARRY LISLE, K9KZT

Back in 1951 the Federal Communications Commission had a neat idea: let people who wanted to become ham radio operators get on the air after passing minimal tests in morse code and theory, and learn by doing.

The idea was a great one and the fifties was a period of rapid growth for ham radio. Manufacturers responded with transmitters for the new novices that were easy to operate and would stand the abuse of the inexperienced new hams—in short, they were just about indestructable.

In the Beginning. Novice-type transmitters were made by many companies during the fifties, but among the most popular were those made by Heath, Johnson, and World Radio Laboratories. They are still encountered in large numbers at hamfests.

Crystal control of the transmitter frequency was mandatory; a separate plug-in crystal was needed for each frequency on which you wanted to transmit. Consequently, all of the transmitters described here could use crystals, though some had built in variable-frequency oscillators (VFOs, for short), and most of the rest could use an external VFO by simply flipping a switch. The power limit was 75-watts input to the final stage for novices, but a few transmitters would go a little beyond that.

Using the Morse Code was the most popular communication mode, although novices could use voice on two meters until the 1960's. Some transmitters had built-in modulators for AM voice work for when the novice advanced to a higher-class license.

Recently, voice operating privileges have been reinstated for novices, this time allowing for single sideband on 10 meters, but more on that later.

Let's take a look at some of the famous "rigs" of the fifties. Many are still in use, others are gathering dust but could do a good job for a new generation of novices, if they knew about them and how they worked.

The Heath Company really started something in 1953 with the AT-1. A self-contained, band-switching transmitter for only $29.50, it helped a lot of novices get on the air.

The Heath Company. By the early 1950's the Heath Company of Benton Harbor, Michigan, had already been making electronic kits for years, and was well regarded in the ham ranks for their test equipment. But it was a red-letter day in July, 1953 when Heath announced its first ham transmitter: the famous *AT-1*.

If the word classic means "often imitated" the AT-1 certainly deserves the title. The AT-1's tube line up of a 5U4G rectifier, a 6AG7 oscillator-multiplier, and a 6L6 final amplifier was typical of the period—with the 6L6 being known for its ruggedness and tolerance for the inexperienced. The great things about the AT-1 were that it was easy to build, easy to use, was entirely contained within an attractive cabinet, could change bands with the flip of a switch, and, best of all, sold for just $29.50! That was considerably less than the cost of the parts if purchased separately!

A year later, Heath introduced the *VF-1* VFO kit for only $19.50. Even allowing for the greater purchasing power of the dollar in those days, that was a pretty inexpensive way for a new ham to get on the air.

The next transmitter, introduced by Heath in May, 1955 was at the other end of the scale; the *DX-100*. Though not really intended for novices (featuring 200-watts input, plate modulation, and a built in VFO for $189.50), the DX-100 was a heck of a transmitter. The "100," by the way, refers to its *weight*! (Not quite the unit to casually drop on your card table.)

I've found the DX-100 to be one of the best rigs for novices to use, simply because I've never found another novice-class transmitter that's as effective for making contacts using Morse Code. Maybe it's my imagination, but when the DX-100 speaks, people *do* tend to listen. Maybe you could call it a novice rig after all.

By the way, I bought my DX-100 a few years ago for $25, which is the most I paid for any of the transmitters mentioned here. They are still terrific bargains today.

March, 1956 saw the introduction of the *DX-35* at a cost of $56.95. The DX-35, and the improved *DX-40*, which replaced it in 1957, were "in-between" transmitters. They would run 65-watts input for code transmission and


The DX-100 was a big transmitter, but it put out a signal to match. The "100" refers to its weight! Not a unit to casually drop on your card table.

had a built-in modulator for voice work. The modulator was of the "controlled-carrier" type, which was not nearly as effective as plate modulation, but it was a lot cheaper and it didn't require a heavy modulation transformer.

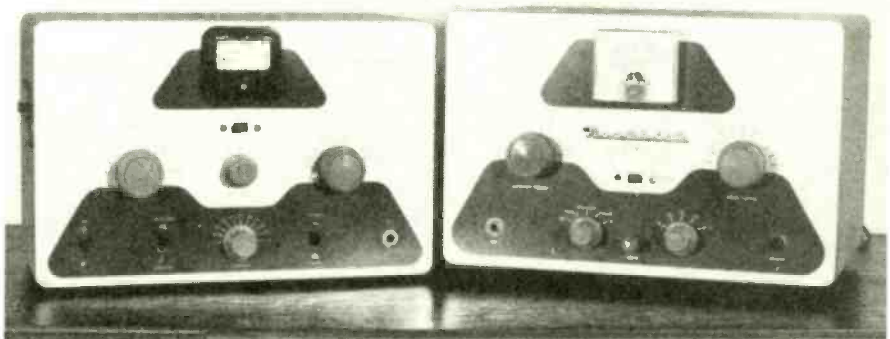
One of the important features of the DX-35 and DX-40 was the use of a "pi-network" output circuit. That was a carry-over from the DX-100, and an improvement on the AT-1. The pi-network had two great advantages. First it helped suppress harmonics and eliminate TVI (TV interference). Second, it meant that darn-near anything could be used as an antenna. People used to kid about loading up a brass doorknob, and they weren't far from right. The DX-40 is my favorite "loaner" transmitter for new novices because it will give good service on 40 meters with just 25 feet of wire strung around a room as an antenna, if nothing better can be set up. It's also extremely rugged electrically. You really have to work at it to damage a DX-35 or DX-40.

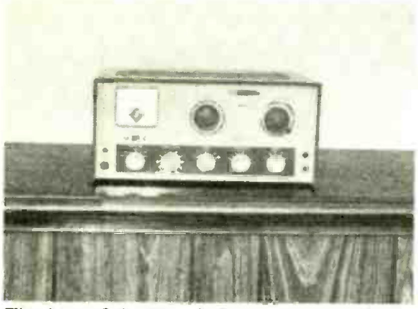
In December of 1956 Heath replaced the AT-1 with the code-only *DX-20*. The DX-20 retained the simplicity and ease of construction of the AT-1, but boosted the output with more-efficient circuitry and a pi-network output. At $35.95 it was a real buy.

The output element was a television "sweep" tube, a 6DQ6A, which wasn't quite as resistant to off-resonance operation as the 6L6 or the 614's used in the DX-100, DX-35 and DX-40, but was much cheaper to replace if it became necessary.

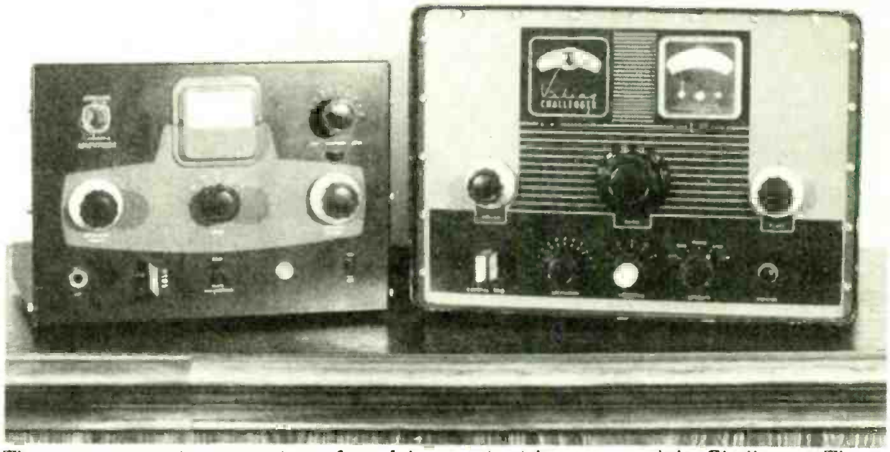
The last of the Heath DX series was the *DX-60*, introduced in November, 1960 as a replacement for the DX-40. The circuitry of the two was similar, but the DX-60 had a smaller cabinet and updated styling. It had a pi-network, output but, reflecting a trend that has continued until the present (unfortunate, I think), it was only set up to match 50- or 75-ohm antennas.

The Heath Company is still very active in the amateur arena and has plans for a dramatically expanded product line in the near future. First up will be a new high-frequency, all-


Two more popular Heath transmitters, the DX-20 for code only and the DX-40 for code or voice. Both had a pi-network output circuit.



The last of the Heath DX series was the DX-60. It was essentially the DX-40 in a stylish cabinet with basic frills.



These are two novice transmitters from Johnson, the Adventurer and the Challenger. The Adventurer was a cute little transmitter, but boasted a rugged 807 final amplifier. The Challenger was similar, but would also operate voice.

mode transceiver with nine-band transmit capability and general-coverage receiver, dual VFOs, and all the bells and whistles. Early in 1989 Heath plans to announce a novice transceiver for 10-meter single sideband. Eventually Heath will be offering new transceivers for all the new novice frequencies.

Johnson Viking. The E.F. Johnson Company of Waseca, Minnesota, was the creation of Ed Johnson, 9ALF, in 1923. (In those days ham calls didn't have country-identifying prefixes.) Johnson ham gear came to be known for high quality, great styling, and relatively high prices.

Johnson's entry into the novice market was the *Viking Adventurer*, which made its debut in November, 1954. The Adventurer was practically a cube of eight inches by eight inches by ten inches—just the right size for easy assembly and good ventilation. The Adventurer was a cute little transmitter that didn't take up much room on a table.

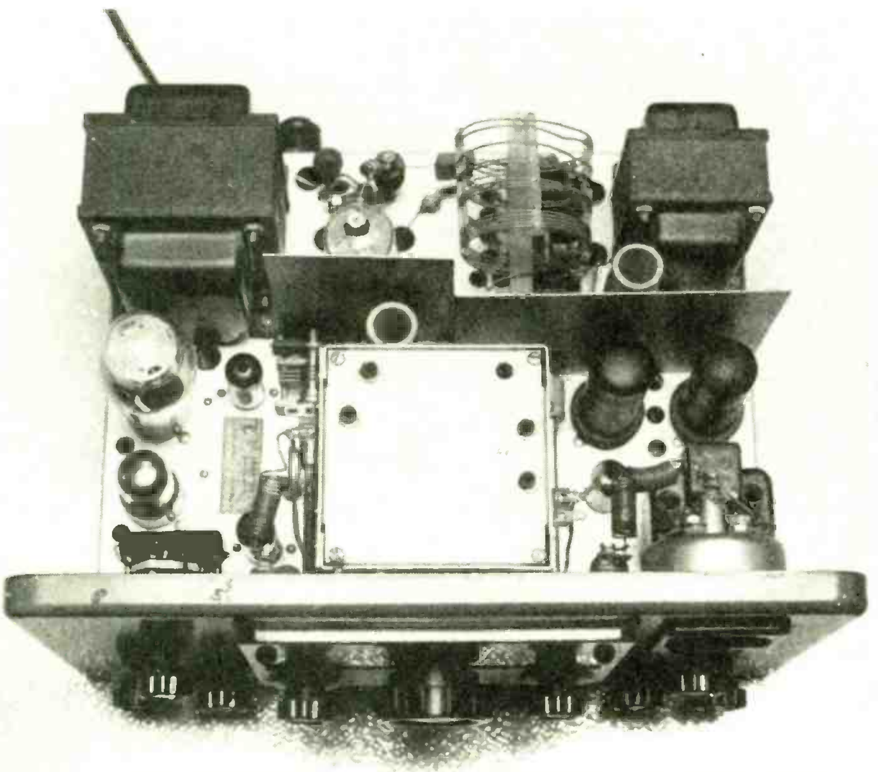
The tube line up consisted of a 5U4G rectifier, a 6AG7 oscillator-multiplier, and an 807 final amplifier. The 807 has been described as a 6L6 with a thyroid condition. It was just as tough as its little brother, but gave almost twice the output. The Adventurer offered one-switch band changing and pi-network output coupling for loading almost any antenna. The only drawback was the price of $54.95 (in kit form only).

The next Johnson transmitter for the novice operator was the *Viking Challenger*, introduced in December, 1958. Like the Adventurer, the Challenger was a band-switching transmitter with a pi-network output circuit. However the Challenger could run up to 120-watts input, and had a built-in controlled-carrier modulator, features that would be of interest when the novice went on to get his or her general-class license. The Challenger was a good transmitter, but expensive at $114.75 in kit form, or $154.75 wired and tested.

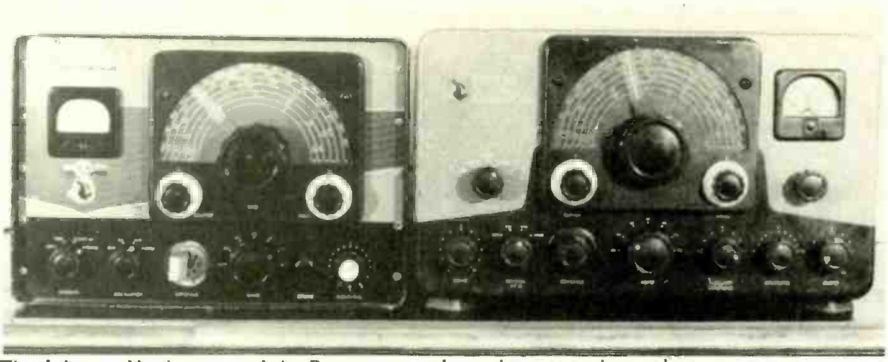
Two other Johnson transmitters should be mentioned, not so much because they were used by novices, but because we all wanted them so badly—the *Ranger* and the *Navigator*.

The Johnson Viking Ranger should be listed among the all-time classic ham transmitters. It had a 6146 final amplifier and a pi-network output that would match an antenna impedance from 25 to 2000 ohms! It had a super-stable VFO and timed-sequence keying so you could operate "break-in" with no chirp. The five-tube audio and modulator system was practically flat from 250 to 3000 Hz for broadcast-quality sound.

There was a "clamp" tube to protect the final amplifier, and three separate



They don't make them like this anymore. This is an inside view of the Johnson Ranger. The Ranger had practically broadcast-quality modulation, an output circuit that could load up a brass doorknob as an antenna, and many other features. It was priced to match its performance.



The Johnson Navigator and the Ranger weren't novice transmitters, but we all wanted them. The Ranger was one of the best medium-power voice operation transmitters ever, while the Navigator was a code-only model.

World Radio Laboratories sold a ton of novice transmitters. The code-only Globe Chief and the code or voice Globe Scout were very popular rigs in the fifties.

power supplies. In addition, each and every lead out of the transmitter—even those to pilot lights or the accessory socket—was bypassed and filtered to prevent TVI.

In short, Johnson simply set out to build the best medium-power transmitter they possibly could, and they built it with style. The Ranger has to be one of the best-looking ham transmitters ever manufactured.

Of course the Johnson people expected to be paid for their efforts. When brought on the market in June, 1954, the Ranger could be had for $179.50 as a kit and $258.00 wired and tested. The wired price was well over $300 before the end of the decade. I bought the one in the photo for $25 at a hamfest.

The Navigator was a code-only version of the Ranger and was priced at $149.50 per kit, or $199.50 wired, in November, 1957.

The E.F. Johnson Company is still very much in business, but hasn't manufactured ham gear for many years. While they did though, they set a high standard for others to aim at.

World Radio Laboratories. World Radio Laboratories of Council Bluffs, Iowa was the brainchild of Leo I. Meyerson, WFGQ. Shortly after the war WRL began building ham transmitters, including the famous *Globe Scout*. The Scout went through a number of changes through the late forties and fifties without a change in name (so be sure your instruction book matches your transmitter.)

The best seller was probably the *Globe Scout 680* from 1957. It contained a 6V6 oscillator-multiplier driving a 6146 final amplifier to output on all bands from 80 to 6 meters. That was great for technician-class operators who could use six-meter voice operation. The Scout was plate modulated by a 6L6GB (though not quite to 100%) and the audio amplifier used a couple of small printed circuits—a foreshadowing of what was to come.

The price of the Scout was $89.95 as a kit or $99.95 wired.

It was a good rig, and in addition to the usual pi-network, it had an "L" network that could be switched in. The Scout would load "any reasonable antenna," and a lot of unreasonable ones too!

The *Globe Chief* was announced in August of 1956. A CW-only transmitter, it had a pair of 807s in the final that would really churn out the watts. It was a great buy for $49.95 as a kit or $64.95 wired. Sadly, World Radio Laboratories has ceased operations.

There were many other novice transmitters manufactured during the fifties: *Knight* made a ton of them, as did *Eico, Hallicrafters*, and others, and many hams built their own. The ones presented here were very popular, and, in the case of the Johnson units, at least, among the most sought after.

The question might be asked, "Weren't you under a terrific handicap back in the fifties, having to use crystal control and less than 75-watts input?"

The answer is no. Crystal control wasn't a problem because all novices were "rock bound" so when someone called "CQ" (a general call to any station) they would tune around and listen for a reply up and down the band from another crystal-controlled station. Even today it's not difficult to make contacts if you have a few crystals.

Likewise, everybody was limited to 75-watts input, so there was no need for higher power.

The top of the line models, such as the Collins 75A-4, the Hammarlund HQ-170, and the Hallicrafters SX-101 will compare favorably with those in use today, but most of us couldn't afford them and had to make do with medium- or low-priced units with little selectivity or stability.

You can find a good novice-type transmitter at almost any hamfest for a very low price if you'd care to try one. Instruction books for practically all of them can be had from HI Manuals, P.O. Box 802, Council Bluffs, IA 51502; their catalog is $2.

If you do decide to try one on the air, remember that tube sets used voltages that can be lethal. Be careful if you're used to low-voltage transistor circuitry. Don't touch anything under the chassis or behind the panel when the transmitter is plugged in, and short out the filter capacitors after you've unplugged it. Also, put the key in a plastic bag when operating. Some transmitters had a lot of voltage across the key terminals. Finally, be sure to protect the input of a solid-state receiver, if you use one.

If any of those safety tips aren't clear, please ask an experienced ham to help you. Old rigs are safe, easy, and fun to use if you're careful. But then again, I grew up with them. Don't be afraid to ask for help in getting one on the air. ■

GIZMO®

DECEMBER 1988 CONSUMER ENCOUNTERS OF THE ELECTRONIC KIND VOLUME 1, NUMBER 10

CIRCLE 40 ON FREE INFORMATION CARD

Robo Remote

CAPSELA COMPUTER REMOTE CONTROL CONSTRUCTION SYSTEM. Manufactured by: Play Jour International, Ltd., 200 Fifth Ave., Rm. 1024, New York, NY 10010. Price: $140.

When we were kids, two of the toys which made a big impact on us were "Robbie the Robot" and the venerable *Erector Set*. Robbie, inspired by one of the era's science fiction movies, was very much the mechanical man. A hand crank propelled him forward, while a small record concealed in his back gave him the power of (limited) speech. The Erector Set needs no introduction to the generations of kids (and ex-kids) who have bolted and built using the toy's trademark girders, rods, and wheels. Nowadays, the Erector Set has added "lasers," while Robbie is of interest only to toy collectors. But a contemporary product from Play Jour International, Ltd. combines some of the elements that made those two playthings classics.

Called the *Capsela Computer Remote Control Construction System*, it's an update of the company's intriguingly intricate Capsela system of interlocking, interchangeable parts and gear capsules. Available in a number of configurations, ranging from a 36-part "starter set" to a 108-part "expert set," the heart of the Capsela system is its namesake feature. The system is built around a series of transparent plastic capsules, each encasing a mechanical function: a motor, worm gear, crown wheel, or power transmission. Connector components—a small octagonal sleeve—link the capsules and their battery power source, allowing the play-time engineer to build a variety of electro-mechanical devices.

With the attention to changing times that marks the toy industry, Play Jour has updated the Capsela with the introduction of what are called the "2000 Computer Control System" and a companion "5000 Infrared Remote Control System." According to the firm, the "computer memory stores up to 94 commands and has 17 different functions." Power comes from four "AA" batteries and one 9-volt battery. The same unit is part of the 5000 system, but that system also adds an infrared remote control (the "Selectronic Transmitter") with a range of up to 25 feet. The expanded system requires eight "AA" batteries and one nine-volt unit.

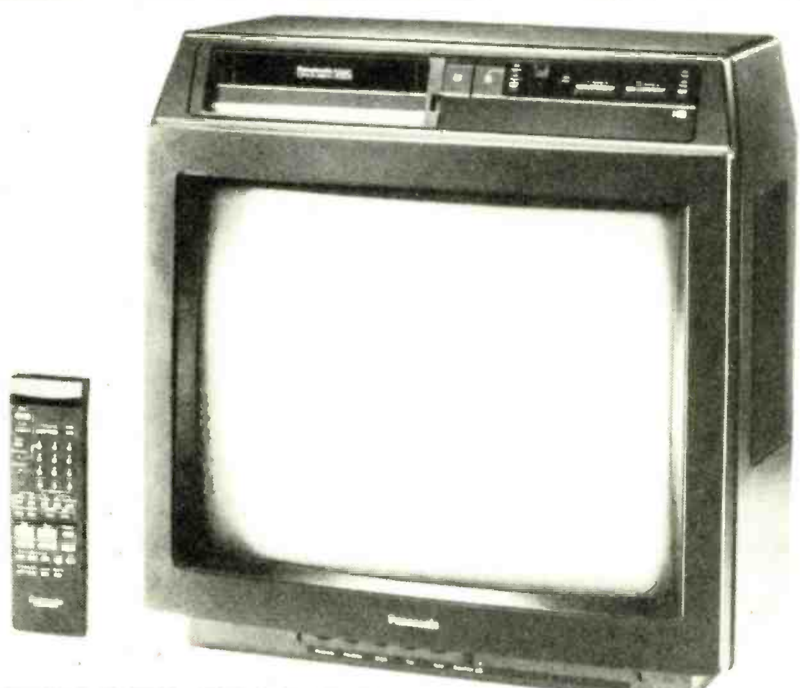
In addition to the parts and components already mentioned, the Capsela systems use an array of gears, axles, chains, reflectors, and wires. There are also lights and audio (the "laser lite" and "sonic sounder"). The resulting constructions are wonderfully off-beat, looking like a combination of the electronic future and the mechanical past. Completed and running, any of those sets would be a wonderful spur to the imagination with which kids are equipped.

But completed and running can present a problem. The Capsela kits are intricate enough that we have to wonder about the age guidelines Play Jour provides. "Eight years old and up" seems a judgement that's overly optimistic about the ability of youngsters to deal with the tedium of construction, carefully following instructions and connecting wire "A" to component "C-1."

An adult we know, not particularly mechanically or electrically inclined, found the Capsela circuitry (simple enough in itself) beyond his skills and grasp. He only completed the set with the help of a friend more conversant with circuity than he was. The profusion of parts also gave him pause, particularly as he tried (and sometimes failed) to recognize each one in the diagrams and illustrations in the Capsela instruction booklet. Still, his finished Capsela figure was a sight to behold, a wonderfully complicated collection of components in motion, lights, and action.

Learning to program the "command keyboard" of the remote added at least another dimension of learning, and sometimes frustration. The remote transmits commands for execution to the system's "computer," or it can send "instant demand" commands, skipping the memory storage stage. But as with grown-up computers, the "Selectronic Computer's" command programming and responses were sometimes difficult for the non-electronic brain to understand.

The Capsela's ideal playmates would probably be a knowledgeable adult and an eager and curious kid. The grown-up could negotiate the intricacies of the construction system's circuitry and mechanical linkage, at least at first, while the youngster could use his or her imagination to design the final assembly. After a few sessions, the junior partner would probably pick up on what he or she has seen dad or mom do, learning in the most painless way possible. Handing a child a Capsella kit with the instructions and expecting him or her to master it is a little like teaching a youngster to swim by throwing the kid into the deep end of the pool. In both cases, the child is more likely to be overwhelmed than entranced. Science and mechanics can be fun, and fun to learn, but not if the student is in over his head. ■



CIRCLE 41 ON FREE INFORMATION CARD

Double Play

PANASONIC COMBINATION VCR (PV-M2028). Manufactured by: Panasonic Co., One Panasonic Way, Secaucus, NJ 07094. Price: $780.

At first glance, the combination TV/VCR appears to be the TV/hi-fi console of the "home entertainment center" era. Scorned by video aficionados as a suspect and probably inferior combining of components, in reality the TV/VCR has a good deal in its favor.

The suspicion that such combo units might be less than the sum of their parts may have had some justification when they first came onto the market a few years ago. But with more manufacturers offering the product, the combination TV/VCR shows signs of coming of age.

Panasonic's Combination VCR, the remote control equipped *PV-M2028* offers video recording capabilities and features that not too long ago were available only on deluxe, stand-alone video recorders. Among its high end-style features is "HQ" circuitry and on-screen programming instructions and cues. The 20-inch (diagonally measured) screen TV is a standard Panasonic set, with the addition of a compact VCR mounted topside.

Compact and lightweight, the PV-M2028 is 20$\frac{1}{16}$-inches wide, 20$\frac{9}{16}$-inches tall, and 19½-inches deep, and weighs a not-excessive 53.6 pounds. The unit saves space (and a fair piece of change) by using the same quartz tuner for both the TV and VCR.

Although that voids one of home video's drawing cards—the ability to watch one program even as the VCR records another—it seems a small trade-off. A cable-service subscription also knocks out the record-and-watch option for essentially the same reason, a single tuner; in that case the tuner is the one provided by the cable system.

The PV-M2028's two-head recorder is programmed using the remote control, with on-screen graphics providing step-by-step instructions for timer functions, clock and calendar setting, etc. There's also double-speed playback, automatic rewind, eject and power off, and an expanded "one-touch" record capability. Timer functions include one-month/four-event recording and a 30/60/90-minute automatic power off feature. An "auto repeat" function will play a cassette continuously, automatically rewinding and beginning the tape again until another of the unit's functions is engaged. Inputs are provided for dubbing from a second VCR, along with the usual instruction-manual phrases warning about "unauthorized copying of copyrighted recordings." Panasonic also provides UHF and VHF antennas.

The combination of on-screen cues and a logically designed remote-control panel makes timer programming easy to execute. We were also impressed when we hooked the PV-M2028 to the cable connection and the picture was immediately sharp and clear. An electronic component that works right out of the box is always impressive. At least some of the credit for the immediate picture belongs to Panasonic's "colorpilot control," an automatic system that monitors and controls color and tint. "Sharpness," "bright," and manual color and tint controls are mounted below the TV screen, along with the "colorpilot" button. Panasonic also includes a "Panabrite control," which the instructions say "adjusts the intensity of the picture by adjusting contrast and color level in the proper balance."

The unit's "one-touch" recording feature includes a standby function that expands the flexibility of that popular capability. The button labeled "standby" allows the viewer to delay recording start time (or continue recording past a preset end time) while retaining the convenience of single-touch recording. If, for example, a viewer just misses capturing some key moment in a televised sports event, standby keeps the one-touch record function at the ready while waiting for the inevitable instant replay.

Another useful convenience is the TV set's automatic tuning. The PV-M2028 tuner fine tunes and sequentially orders all available channels, with unused frequencies automatically deleted. If a new station comes on-line, a press of the "auto-set" button adds it to the set's memory in the correct numerical order. Anyone who's gone through the hunt-and-peck of manual station presetting should appreciate that feature.

The VCR half of the PV-M2028 is also clearly no stripped-down recorder. It has the features and capabilities of a standalone VCR which, in addition to those already noted, includes three play speeds, pause and still picture (although with the video noise that's typical of two-head units), and the usual forward-and-reverse picture search.

For consumers with limited space, the Panasonic Combination VCR might be an ideal product. Likewise, as an unobtrusive second VCR in a bedroom or small den, the PV-M2028 would fill the bill in many households.

Neither the TV's or the VCR's performance appears to have been compromised by this marriage of consumer convenience, while the neatness factor (one less component, one less set of connections and cords) will likely win some consumers over to the combo alternative. In this, the age of the couch potato and the video lifestyle, a VCR/TV combination makes a heck of a lot more sense than the old TV/hi-fi console ever did. ■

Double Entry

TOSHIBA STEREO RADIO CASSETTE RECORDER (RT-7066). Manufactured by: Toshiba America, Inc., 82 Totowa Rd., Wayne, NJ 07470). Price: $189.95.

CIRCLE 42 ON FREE INFORMATION CARD

The unsung genius who dreamed up the boom box deserves a medal, from both the audio industry and the consumer. Those portable, comparatively low-priced units have put quality audio (again, comparatively) within reach of an extremely broad market. And thanks to those portable audio systems, securing a music source is no longer a consumer decision fraught with the kind of peril associated with buying a car or taking out a mortgage.

There are, of course, trade-offs. But at this stage of boom box development, what you see is usually what you hear. The speakers furnished with most of those units won't be mistaken for those in a concert-hall sound system, but the way most boom-boxes are used, detailed sound would be beside the point.

All of that, and more, occurs to us after having tried out a *Toshiba Stereo Radio Cassette Recorder (RT-7066)*. As lifelong music listeners, we had gotten by with the usual home stereo system. Boom boxes, we half figured, were for kids. Besides, their sound reproduction couldn't be very good, at least if a couple of generations of stereo sales people were to be believed. Where were the oiled mahogany cases for the speakers?

What we found is that even around the house, the RT-7066 added a new portability to listening. And away from the house, its dual cassette system put an hour of uninterrupted music at our disposal.

The versatile tape decks were our favorite aspect of the unit. Besides allowing recording from other sources (the back of the unit includes stereo inputs for connection to an another component), the dual system can be set for continuous play, and a dubbing function allows either normal or high-speed tape duplication.

Throughout, the combination of RT-7066 features made it a pleasure to use. Outside, for example, we didn't have to annoy others with our selection of music. The unit includes a front-panel input for headphone listening.

Power is supplied via the standard AC/DC system. A removable cord allows the unit to be powered from a wall outlet, and 8 "D" batteries are used to power the unit for fully portable use. Because of the RT-7066's radio-station memory functions, two "AA" batteries are also required for "memory back-up." According to Toshiba, those should last about a year. The instructions don't venture a figure for the life of the main-power batteries, but we noted that the unit is outfitted with a power indicator light.

The radio's electronic-tuning system, which includes station pre-set and auto-tuning capabilities, was fast, and despite limitations, did a usually adequate job pulling in the strongest signal (even if the display didn't always exactly correspond to the station's frequency). The LCD digits are large enough to be easily read, although the display can be difficult to see under some lighting situations. Also, the only way to check the progress of a cassette behind the unit's doors is with a flashlight. The combination of slightly tinted plastic, and the cassette's own casing makes for near zero visibility.

At the top of the front panel is the RT-7066's elaborate radio tuning system. Band (FM/AM) selection, function selection, volume, and speaker balance are grouped at either side of the unit's five-band graphic equalizer. Dubbing speed, "FM mode," and "AM Sensor" all share the same control. "FM mode" selects between stereo and mono, while the AM system offers "DX" ("for normal AM selection") or "local," to be used when "reception is very strong and the sound tends to be distorted."

Much of this, however, is subverted by the unit's telescoping antenna. In an urban environment, radio reception depends as much on the strength of the signal received as on the RT-7066's reception system. Which is to say, some stations came in splendidly, while others were a lost cause. The same performance we'd expect from a budget-priced clock radio. Although manufacturers probably know more about how those units are used than we do, it still seems that giving some extended attention to the problem of radio reception would give some brand an advantage over its competitors.

Although the graphic equalizer clearly made a difference in how music sounded via the RT-7066, we still have to wonder about that feature. Pretensions to audio engineering aside, when it comes to recording the instructions reveal, "the graphic equalizer works on the monitor tone in recording, but does not affect the content of recording." If automatic control is good enough for recording-fidelity purposes, it's probably good enough for listening. Besides, "tone" and "bass" controls take up less space than the equalizer's sliders and indicators do; that's an important consideration.

Taping directly from the unit's own radio produced cassettes of exceptional clarity (provided, of course, the signal was clear and strong). Recording from records or even CDs, at least using our beat-up office stereo, produced tapes of slightly less fidelity. The least satisfactory copies, although certainly listenable, were dubs of tapes. We could not detect any flutter (tape speed variation) in our test unit (which was brand new from the Toshiba warehouse). Cheaper systems, especially those with considerable mileage on them, often suffer from that problem.

With proper care, the RT-7066 would give years of use. Of course, portable units are often subjected to more than their fair share of abuse. Further, the tape deck's rather flimsy push-down controls (though no flimsier than those used in many competing models) seem like breakage waiting to happen. And the design of various other controls also are not a tribute to durability. The combination dub-speed/reception-mode control and FM/AM selector seem especially vulnerable to early destruction. But, we suppose that it is better that cost cutting take place in the cosmetics and casing of the unit than in its electronic and audio components.

Although grown-up enough in its audio performance, the boom box remains a younger (and more fragile) sibling to home and auto stereo. While portable, their cases tend to be less than fortified. Likewise, being on the move can shake up and potentially damage the tape system and various other features and functions. But if the consumer is aware of their limits, portable audio systems can fulfill a real function. But given the near ubiquity of these systems today, that's something consumers realized long ago. ■

Vacuum Acumen

SHARP VACUUM CLEANER (EC-8530). Manufacturer: Sharp Electronics, Inc., Sharp Plaza, Mahwah, NJ 07430. Price: $369.95.

The parallels between two otherwise unrelated industries, automobiles and vacuum cleaners, are kind of curious. Both became "consumer products" at about the same time—the turn-of-the-century—and both industries were soon dominated by a few well-known manufacturers. Over the years, car makers and vacuum moguls came to depend as much on salesmanship as product innovation and the vacuum cleaner and the car is each a symbol of American consumerism.

In recent years the parallels have continued: After years of having the market very much to themselves, American vacuum manufacturers suddenly were confronted with overseas competition establishing itself in the U.S. The newcomers changed the rules, both in design and marketing, and a general scramble ensued among makers of that humble home appliance.

Among the newer brand names in the field is *Sharp Electronics* and the top of its

CIRCLE 43 ON FREE INFORMATION CARD

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vacuum-cleaner line is the *EC-8530*. Among its electronic refinements is regulation of suction power and a sensor that automatically registers when the machine's disposable dust bag is full.

A canister-style cleaner, the unit features a powered "suction nozzle" at the end of the usual hose and two metal tubes. Our first impression of the EC-8530 out of the box was that from the tip of its suction nozzle to the built-in tool compartment in the rear of the wheeled canister, this was truly a Cadillac of vacuum cleaners.

Unfortunately, it also seemed to be about as long as a Volkswagen. Even its "180 degree" hose swivel didn't allow for much maneuverability in smaller rooms or alcoves. This is definitely the machine for people with acres of carpet and floor to keep manicured.

The cleaner's "auto power-control" LED turned out to be something like a graphic equalizer. Red indicator lights trace the upward curve of suction power over a graph-like wedge. A trio of "variable-power switches" offers "high," "low," and automatic power-levels. The last leaves judgement of cleaning conditions and appropriate power to the vacuum cleaner's sensors, which is at least one less thing the home-cleaning engineer guiding the EC-8530 will have to worry about. Because, as they say, there's more.

They weren't kidding about the suction head being powered. Fabricated of plastic and metal, the business end of the EC-8530 features a wrap-around headlight that would do many smaller cars proud. Powerful enough to read the instruction booklet by, Sharp promises "increased visibility in dark corners and under the furniture." A rocker switch adjusts the head for floor or carpet cleaning. Set for rugs, an agitation brush rolls, pulling the suction head along at a brisk clip. It also means that the operator is fighting the power action if the familiar back-and-forth motion of pre-electronic vacuum cleaning is used. Again, it helps to have a large enough room that the machine can turn and double back. A spinning gauge (actually that's simply the end of the agitation roller, which has been marked barber pole-style) indicates if for some reason the power roller isn't spinning.

The power-suction nozzle assembly includes a cord that clips to the underside of the connecting tubes and hose, plugging into the handle and the canister mounted motor ("a thousand watts of cleaning power,"Sharp says). With the suction head removed, the cleaner's attachments can be fitted onto the end of the metal tubing. They stow neatly, and for once, logically, in the built-in tool compartment. The unit's power cord is spring loaded, so it too disappears for storage.

Getting down to the nitty-gritty, the EC-8530 displayed superior suction power under a variety of cleaning conditions. Enormous amounts of unseen dust and dirt were pulled in by the machine. Although the chamber housing the paper dust bag was dirtied up in the course of cleaning, leakage from the EC-8530 was not detectable. A "triple micron filter system" includes an "electrostatically-charged micron filter" and a second filter located in the motor exhaust. An illustration of that used by Sharp makes it look like something out of a Defense Department testing laboratory.

But it does work, and in our month-long test it worked quite well. In terms of its electronic dust sensor, too well. After our first week or so of use, the sensor light would come on, indicating a full bag, any time we had the machine adjusted to maximum suction power. Turning the machine off, opening the dust-bag chamber, and shaking the bag would usually disengage the sensor for a time, and putting the unit on low power would keep the warning light off. Even installing a new dust bag wouldn't alleviate the constant (and therefore useless) electronic-sensor warning.

In contrast to some other home appliances made from plastic, the EC-8530 seems a sturdy enough unit, although the plastic housing likely demands more maintenance to keep it clean than the metal vacuum-cleaner bodies of the past. On the plus side, it doesn't weigh as much as those behemoths of yore; just a trim 11 pounds in the case of the canister. The electronics of the cleaner seem rather secondary to its strengths, although we can't say we didn't enjoy the control panel effect of the LED "power display."

Using the vacuum was something like taking a high-powered automobile for a test spin. While appreciating its virtues, we doubted it would fit in our garage, and smaller Sharp vacuum cleaners do not offer the allure of electronics. If Sharp really wants to revolutionize the vacuum cleaner field electronically, it ought to develop a remote-control model. That would mark a really new era in the 20th Century saga of vacuum cleaning. ■

Gizmo/Bytes

Compact-Disc Cleaning Fluid

It's a sure bet that the compact-disc market has established itself when *Discwasher, Inc.* (4310 Transworld Rd., Schiller Park, IL 60176) decides to market a large economy-size container of the firm's popular *CD-1 Cleaning Fluid*. The new 6-ounce refill bottle comes with its own premeasured application spray-top, while the fluid inside is "specially formulated to lift and suspend contaminants from CDs," leaving "virtually no residue behind." So what's next, a quart bottle? Price: $10.95

CIRCLE 44 ON FREE INFORMATION CARD

Coin Telephone

This may be just what parents of teen-agers have been looking for, the *TY-006 Coin Telephone*. Besides accepting only quarters, the unit is outfitted with a lockable coin box and will make calls only locally. It can limit call time, either 3 or 9 minutes, or can offer limitless calling and can be converted to a regular phone with a special "owner's key." It will also accept incoming calls and allow coinless calls to emergency numbers and the operator. Its distributor, *Data & Voice Communications Plus, Ltd.* (219-03 Northern Blvd., New York, NY 11361) also offers the instrument in other service configurations (long-distance call capability for example) and in a second, slightly more expensive model that allows calls to two area codes. Price: $349.95.

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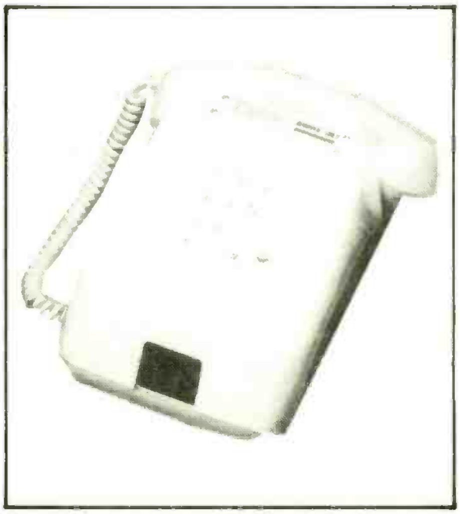
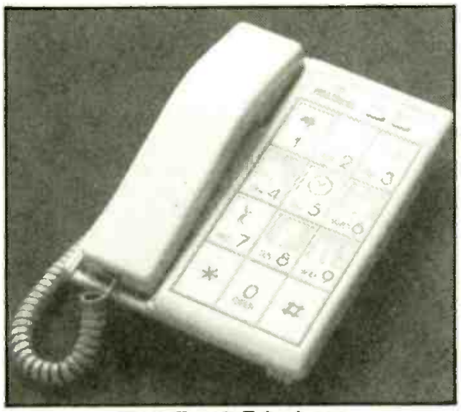


Coin Telephone

Gizmo/Bytes

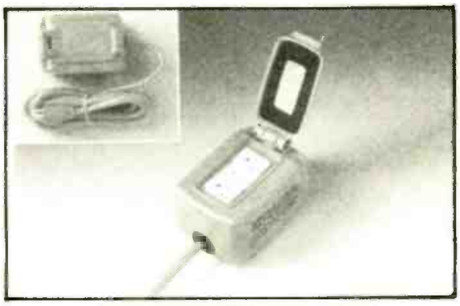


PhotoTouch Telephone

PhotoTouch Telephone

A new telephone offered by *Northwest Bell Phones* (9394 W. Dodge Rd., Suite 100, Omaha, NE 68144) isn't hard to picture. Dubbed the *PhotoTouch Telephone*, the instrument features a flat, large-key dialing pad that "doubles as a photo collage." Users can insert photos of friends or relatives into the "window memory keys" and then insert their respective phone numbers into the nine-entry, two-step memory. Instead of photos, symbol cards for numbers like police, fire, or emergency services can be used with the appropriate telephone number programmed into the PhotoTouch memory. Northwest Bell Phones says that other big-number telephones tend to be bulky, this one features a "slim, streamlined design" for use at home or office, either mounted on the wall or sitting on a surface. Other features include last-number redial, adjustable ringer volume, a 14-foot line cord, a 10-foot spring-coiled handset cord, and tone/pulse switchability. The instrument is sold with a set of symbol cards and is hearing-aid compatible. Price: $69.99.

CIRCLE 46 ON FREE INFORMATION CARD



Shockproof Extension Cord

Shockproof Extension Cord

Electrical safety begins at home and there's no better place to start than with the *Shockproof Extension Cord* offered by *Hammacher Schlemmer* (147 E. 57th St., New York, NY 10022). The 6-foot cord, rated at 15 amps, features a built-in circuit interrupter that monitors and automatically discontinues the current flow within 1/40 of a second if a variance of over five milliamps is detected. The interrupter housing has a protective snap-shut cover and Hammacher Schlemmer says its safety feature is "the same type required by government regulatory agencies on construction sites." Price: $42.50.

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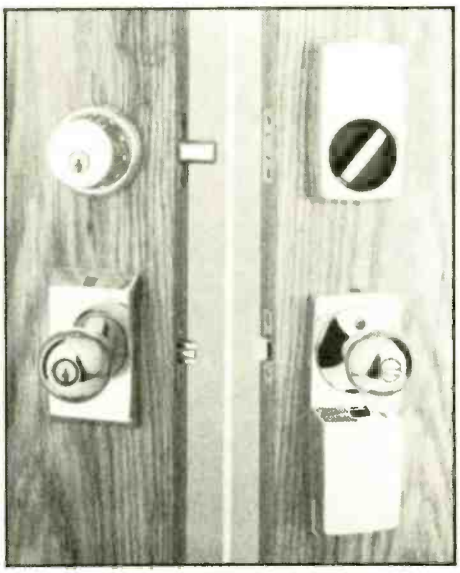

Key 'N Keyless Lock System

Key 'N Keyless Lock System

Besides being a new wrinkle in home security, the *Key N' Keyless Lock and Deadbolt System* may be a big favorite with those among us who can't seem to hold onto their keys. From *Schlage Lock Co.* (P.O. Box 3324, San Francisco, CA 94119), the system features a heavy-duty knob lockset. At the top of the lockset panel is an electronic display for identification and entry of a personal access code (for which there are ten thousand possible choices). Codes are entered by turning the knob to the left or right and entering the correct digits as they pass the illuminated display. Power comes from four "AAA" batteries and a single 9-volt battery; when not in use, the lock's illuminated display turns off. The Key N' Keyless system includes a low-battery warning signal and a key override feature. When the correct code is entered, the display shows the letter "U." The lock also "sends a wireless infrared signal to the deadbolt allowing it to be retracted using the rotating security ring. The same ring can also be used to extend the bolt to locked position when leaving the home." For security, the lock recloses immediately after operation. Finally, Schlage offers a local-alarm option that gives pre-entry warning of tampering with the lock or multiple attempts to break the user code. The lock can be operated with two separate access codes. Price: $84.

CIRCLE 48 ON FREE INFORMATION CARD

Wet/Dry CD Cleaning System

Wet/Dry CD Cleaning System

Keeping those compact discs pristine and spotless seems to have become a growth industry. *Signet* (4701 Hudson Dr., Stow, OH 44224) has just introduced an *Automatic Wet/Dry CD Cleaning System (SK315)*, which, besides mimicking the appearance of a portable disc player, "combines the benefits of wet and dry cleaning" in about 40-seconds time. A few drops of the supplied cleaning fluid are applied to a wet-cleaning pad and a CD is inserted into the mechanism. A touch of a button activates "radial-like cleaning motion created by dual rotation of the disc and pad." After 15 seconds, the wet pad automatically retracts and a "dry-cleaning chamois-type pad" moves into position, rotating in the opposite direction of the wet treatment, for about 25 seconds. Power for that radial-like cleaning motion is supplied by four "AA" batteries (included). Price: $60.

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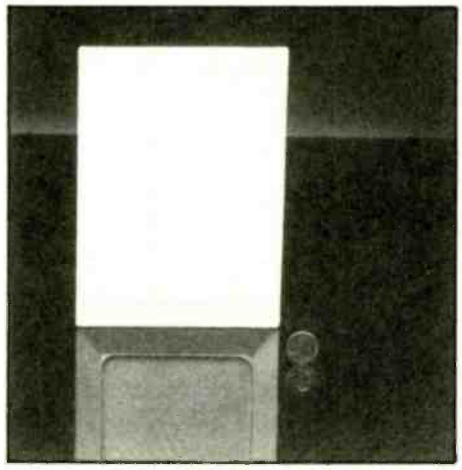
Gizmo/Bytes

Sonance In-Wall Speaker

Built-in stereo systems are kind of the ultimate in home listening, at least if, like so many consumers, you resent the miles of cords and wires surrounding most home entertainment systems. *Sonance* (32992 Calle Perfecto, San Juan Capistrano, CA 92675) which calls itself "the world's largest manufacturer of in-wall high-fidelity speaker systems" has just introduced the firm's "smallest two-way speaker system" ever for built-in installation. The *In-Wall Speaker (M-30)* uses a 4-inch woofer and a 1-inch "proprietary polycarbonate tweeter." The company calls the product ideal for locations such as bathrooms, saunas, showers, and kitchens. The M-30 is sold with either retrofit or new construction brackets and the speaker can be oriented either vertically or horizontally and installed "in less than 15 minutes from the time a hole is cut." Speakers are available with either a cloth or metal grill. Price (per pair): $300–$400.

CIRCLE 50 ON FREE INFORMATION CARD



Sonance In-Wall Speaker

"Bozo" One-Piece Telephone

Direct from a featured appearance at the Summer Consumer Electronics Show and the label of Capitol Records for many years, it's Bozo the Clown, only this time he's a *One-Piece Telephone*. The instrument's merchandiser, *Kash 'N Gold Ltd.* (360 Smith St., Farmingdale, NY 11735) call it "the first laughing telephone" in that it guffaws instead of ringing (although an alternative, conventional ringer is available). The unit also features tone/pulse switch and last number redial. Finally, when the phone rings, Bozo's nose lights up. We can't help but think this might inspire a certain amount of clownish behavior on the phone. Price: $110.

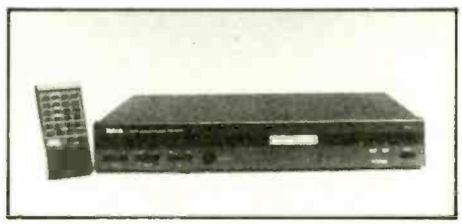
CIRCLE 51 ON FREE INFORMATION CARD

"Bozo" One-Piece Telephone

Digital Audio Environment Processor

Not only can music listeners hear music reproduced with rigorous fidelity in the privacy of their own homes, but thanks to digital technology, they're now offered the chance to hear music as if it were being performed in a specific environment. *Lexicon, Inc.* (100 Beaver St., Waltham, MA 02154-8425), a long-established manufacturer of professional and studio components, has entered the consumer market with its *Digital Audio Environment Processor (CP-1)*. Lexicon says it offers "a wide variety of acoustic spaces such as concert halls, small clubs, or arenas" replicated for the home listener. In addition, the CP-1 "provides reference-quality Pro Logic decoding of Dolby Surround videotapes." Which means that CP-1 owners will "be able to create multi-channel surround-sound in the home that rivals the listening experience in the best movie theaters." The unit's dozen programs generate "reverberation, ambience, panorama, and surround-processing." The Processor can be used with a conventional two-speaker system or with up to 6 additional speakers. Price: $1200

CIRCLE 52 ON FREE INFORMATION CARD



Digital Audio Environment Processor

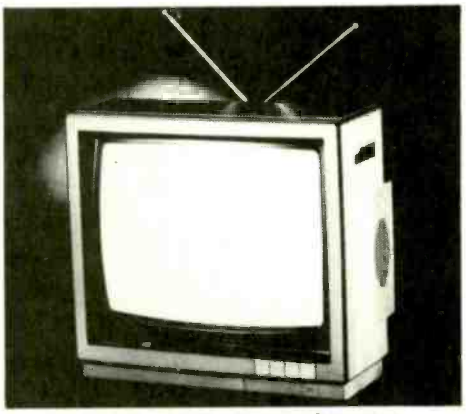
Wizard Electronic Organizer

The contest to put an office full of electronic equipment into the consumer's pocket continues. The latest entry in this product sweepstakes comes from *Sharp Electronics Corp.* (Sharp Plaza, Mahwah NJ 07430). Designated the *Wizard Electronic Organizer*, the unit integrates such functions as appointment diary, personal computer, calendar, phone directory, notepad, calculator, and world clock into one 4- by 6-inch unit, weighing 8 ounces. A hard-wire computer link-up accessory enables users to load schedules, phone listings, etc. from a personal computer or move information from the Wizard into a PC. Memory capacity is 32K and the display is either a large 16-character/8-line or 10-character/4-line panel. Optional IC (integrated circuit) software cards can transform the Wizard into a dedicated machine. Scheduled for an October market introduction, IC cards available include a time management system, a thesaurus/dictionary, and an eight language translator, with others slated for later development by Sharp. Price: $299.

CIRCLE 53 ON FREE INFORMATION CARD

Wizard Electronic Organizer

Gizmo/Bytes



Color TV with On-Screen Graphics

Color TV with On-Screen Graphics

On-screen "programming" as a television feature sort of came in through the back door with the video recorder. Now the capability is being offered as one of the features of a "moderately priced set" from *SSangyong (USA) Inc.* (601 16th St., Carlstadt, NJ 07072). The tabletop cable-ready *Color TV with On-Screen Graphics (CT-1940R)* is a 19-inch screen model with remote control. The screen display shows the television's functions when they're engaged: volume level, mute, channel indicator, clock, sleep and on/off timer, TV/CATV, and TV/video. The sleep timer allows the somnambulant viewer to set the tube to go off. Similarly, the on/off timer assures that a favorite TV program (provided you have one) need never be missed again. The 22-key remote allows reception of up to 139 channels. Other features include audio/video input terminals, auto fine-tuning, a quick-start picture tube, peak automatic gain control, and a dot-matrix screen. A companion model, the *CT-1340R* offers the same features with a 13 inch screen. Price: $399.

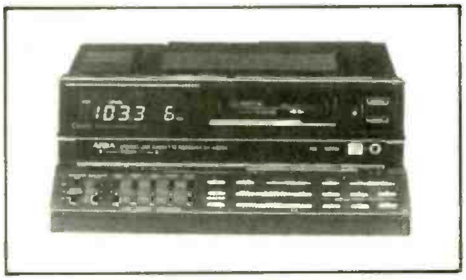
CIRCLE 54 ON FREE INFORMATION CARD

Two-Title Superimposing 8mm Camcorder

Two-Title Superimposing 8mm Camcorder

Camcorders appear to be evolving towards the point where users will soon be carrying a miniature production facility on their shoulders. The newest camcorder from *Yashica* (100 Randolph Rd., CN 6700, Somerset, NJ 08873) is the *Finemovie Two-Title Superimposing 8mm Camcorder (KD-1700U)*. The unit offers digital superimposing of two titles in any of eight colors during video recording. The titles can be written by hand or "even copied from magazines or other sources." According to Yashica, the KD-1700U offers "more video playback and recording function (up to two hours) than most VCRs." Other camcorder features include a 6× power zoom, date and time recording, and fully automatic operation. Price: $1,695.

CIRCLE 55 ON FREE INFORMATION CARD

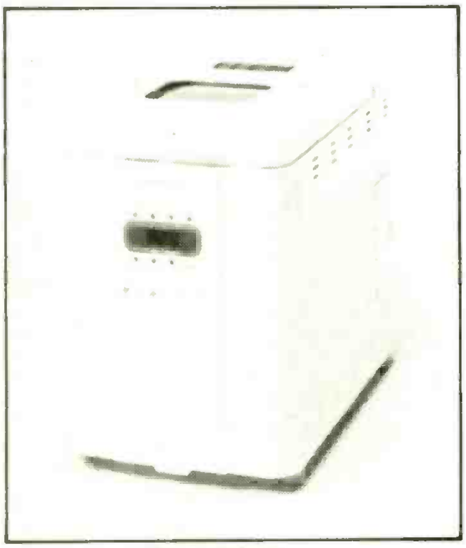


Auto-Reverse Cassette Receiver

Auto-Reverse Cassette Receiver

A new car *Auto-Reverse Cassette Receiver (CT-X5600)* from *Aiwa America, Inc.* would seem to have a number of attractive audio and playback features, including its namesake auto-reverse cassette deck, quartz-synthesized tuning, a CD jack for portable units, and something dubbed "Auto Tuning Reception Control" for "improved FM reception in all signal conditions." We also liked the "tape-ready" tuner monitor that enables the radio to play during fast forward and rewind operations, and which automatically activates the tape-play mode after the tape has finished winding. And that doesn't even take into account the CT-X5600's five-band graphic equalizer and three-way fader control. So what did Aiwa highlight in its product release on this new product? The receiver's security aspects. A sign of the times, we guess. The unit is described as "completely theft-proof" in that it features the company's "STOP" design. STOP is the "stereo total operation panel" that "folds right up into the chassis...blending in with the car's dashboard as well as keeping dust—and thieves—out." The CT-X5600 can also be removed quickly by the owner for storage or to be carried away "in a customized Aiwa carrying case." Price: $500.

CIRCLE 56 ON FREE INFORMATION CARD



Home Bakery

Hitachi Home Bakery

Consumers considering the purchase of an automatic home bread maker now have a choice of makes. The Panasonic Co.'s Bread Bakery (*GIZMO*, August 1988) has been joined in the marketplace by the *Home Bakery (HB-A101)* from *Hitachi Sales Corp. of America* (*401 W. Artesia Blvd., Compton CA 90220*). The Home Bakery mixes, kneads, rises, and bakes in three hours and 50 minutes, cutting a whopping 10 minutes off the Bread Bakery's preparation time for a loaf. The HB-A101 offers timer functions, an automatic convection cool-down feature, and a window on the top of the unit that "permits easy viewing of the whole process." Lights and a buzzer keep the home bread maker in touch with each phase of the process. Price: $329.95.

CIRCLE 57 ON FREE INFORMATION CARD

ProGolf Electronic Golf

Don't think that the *ProGolf Electronic Golf* game is just any ordinary electronic amusement device. According to *Hammacher Schlemmer* (147 E. 57th St., New York, NY 1002) the device can "actually sharpen your golfing instincts." A computer-animated 18-hole course offers fairways, doglegs, water hazards, and sand traps, with the unit's "large liquid crystal screen vividly simulating the terrain and action of real golf." The player has a selection of a dozen clubs to chose from against an audio backdrop of "realistic sound effects." As the club nears the ball on screen, the user presses a button at the moment of impact. Press the button too late and it's a hook shot, press too soon and the golfer slices. After each shot or putt, ProGolf displays the distance remaining and the screen changes to show the new position of the ball. An electronic scorecard automatically keeps score for a single player, two-player stroke games, and two-player match games. The unit is pocket-size and will run for approximately 200 hours on two calculator batteries (included). Fore! Price: $69.

CIRCLE 58 ON FREE INFORMATION CARD

ProGolf Electronic Golf

Freedom Stick Wireless, Infrared Joystick

President Franklin Roosevelt wasn't thinking of video games when he outlined his famed "four freedoms" a generation ago. Regardless, *Camerica, Ltd.* (*230 Fifth Ave., Suite 1100, New York, NY 10001*) has latched on to the "four freedoms" tag in introducing its *Freedom Stick Wireless Infrared Joystick*. The unit, claimed as both "the first wireless infrared joystick" and "compatible with Ninetendo, Sega, Atari, and Commodore video-game systems," offers the "freedoms" of "playability, movement, competitiveness, and choice." The unit's range allows play from a distance of over 20 feet from the video screen and offers players the choice of auto rapid fire or manual action. Available nationally since July, the Freedom Stick sounds like a new deal in home video games. Price: $69.95.

CIRCLE 59 ON FREE INFORMATION CARD

Wireless Video Game Joystick

JBL Cascade Loudspeaker System

JBL (*240 Crossways Pk. W., Woodbury, NY 11797*) has introduced a "radically innovative speaker design" with the *Cascade Loudspeaker System*. According to the product announcement: "The new system uniquely employs four three-inch, edge-driven, pure-titanium dome midrange transducers in a vertical array teamed with revolutionary crossover technology." The result is midrange sound reproduction of clarity, power, and dynamic range that overcomes the audio compromises JBL says have always been involved in "reproduction in the critical midrange." The Cascade Loudspeaker is a floor-standing model that's five-feet tall. Price: $1,800.

CIRCLE 60 ON FREE INFORMATION CARD

Cascade Loudspeaker System

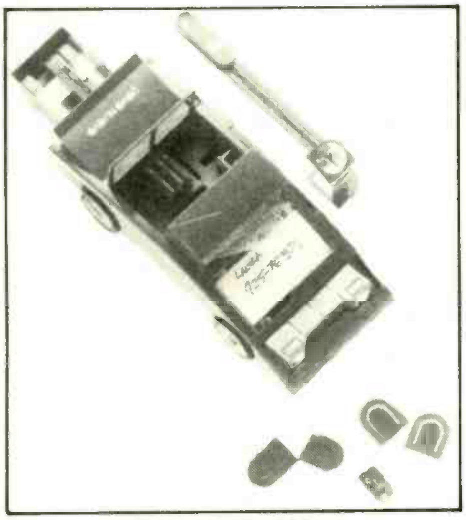
Automotive CD Changer

Listening to music in the car has become part of the American "automotive experience," and now *Kenwood U.S.A. Corp.* (160 Newport Center Dr., Suite 21, Newport Beach, CA 92660) has a new product custom tailored for the long-distance driver. It's the company's first *Automotive CD Changer (KDC-C100)*. With a 10-disc capacity, the KDC-C100 is equipped with the obligatory anti-theft design and has several features specifically tailored for vehicular use. A system called "Optimum Servo Control" is said to eliminate the "common skipping and repeating caused by dust, fingerprints, and scratches," surprising problems for those who recall CDs being introduced as virtually indestructible only a few years ago. Further, Kenwood's "Multi-Point Mechanism Insulator" anti-vibration system blocks "any chance of laser mis-tracking under severe road conditions." In its changing functions, the KDC-C100 offers random shuffle play, program play (selection of up to ten tracks from any of the changer-loaded discs) and the usual music search. Large volume controls are controlled electronically and their positions indicated by the unit's LED. There's also a mute button as well as stereo-balance, speaker-fader, and separate bass and treble controls. Price: $1,199.

CIRCLE 61 ON FREE INFORMATION CARD

Automotive CD Changer

Gizmo/Bytes



Executive Tool Kit

Remote Control Golf Bag Carrier

Remote Control AM/FM Stereo Receiver

Video Telephone

88 Milano Executive Tool Kit

Weren't sleek, uncluttered surfaces the design rule among the executive desk-set not too many seasons ago? That would appear to be decor history if *Plus U.S.A. Corp.* (10 Reuten Dr., Closter, NJ 07624) has anything to do with it. The firm's newest product introduction is the *88 Milano Executive Tool Kit*. Looking like a shiny red sports car, the 88 Milano holds a complete set of writing, drawing, and drafting tools inside various compartments that pop up, eject, or flip open. There's also a built-in flashlight, which does double duty as the car's headlamp. Drawing and drafting tools include magnifying glass, lead sharpener, eight mini templates for numbers, letters, circles, and other shapes, an eraser, ruler, ballpoint pen, and mechanical pencil. The 88 Milano uses two "AA" batteries. Price: $29.95.

CIRCLE 62 ON FREE INFORMATION CARD

Video Tape Storage Cabinet

Although designed for trade and retail use, the stackable *Alpha-Stack Video Tape Storage Cabinet* from *Nieman Design Systems, Inc.* (P.O. Box 888, Mt. Prospect, IL 60056) are probably of interest to the dedicated home-VCR enthusiast. Each unit can hold 180 VHS tapes, 60 in each of its three drawers. Dimensions of the standard three drawer unit are 37½ inches long by 20½ inches high and 20¾ inches deep. A master-drawer locking system is optional. Price: $319.

CIRCLE 63 ON FREE INFORMATION CARD

Remote Control Golf Bag Carrier

Do you know somebody who is the ultimate long-distance golfer? They might want to know about the *Shedda Remote Control Golf Bag Carrier (LG)*. A robot caddy, the unit is controlled with a small transmitter clipped to the golfer's waist, in back. The Shedda (a translation of the Scottish word for "shadow"), using two antennas, follows its user's movements. When the transmitter-equipped golfer turns, the Shedda follows at a top speed of about 4.5 mph. According to *Getting Engineering & Manufacturing Co.* (One Streamside Pl. E., Spring Mills, PA 16875-0085) the unit utilizes six circuit boards and more than 500 electrical components. The Shedda LG draws power from a 24-volt battery (which should be charged every 18 holes) and carries a full load of 100 pounds. Its maximum range when fully charged is given as 27 plus holes. Price: $2,350.

CIRCLE 64 ON FREE INFORMATION CARD

Remote Control AM/FM Stereo Receiver

Let's face it, your basic stereo receiver is not the most exotic piece of technology on the home-audio front. Everybody knows about receivers, they've been around since phonographs began breaking up into stereo systems. Still, change occurs. Last summer *Sanyo Fisher (USA) Corp.* (21350 Lassen St., Chatsworth, CA 91311-2529) introduced three new units, including a new *AM/FM Stereo Receiver* with remote control (RS-615). Rated at 60 watts per channel, the RS-615 features a quartz digitally synthesized tuner with "Autoscan," random-access, and 24-station (18 FM and six AM) preset tuning. A motorized volume control can be operated manually or with the receiver's 15-function wireless infrared remote control, which also includes four functions for Fisher's separately sold *AD-724* CD player. Price: $349.95

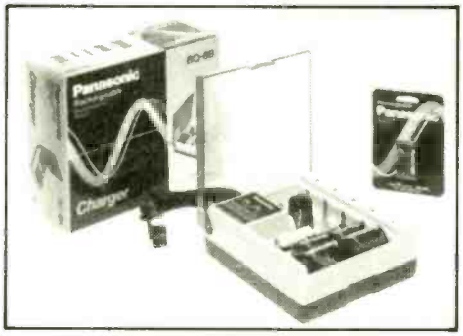
CIRCLE 65 ON FREE INFORMATION CARD

Video Telephone

Telephone videography marches forward: *Panasonic Co.* (One Panasonic Way, Secaucus, NJ 07094) is bringing to market its new *Video Telephone (KX-TV10)*. That unit features a four-inch diagonal screen and integrated telephone featuring speakerphone function, speed dialing, and last-number redial. The KX-TV10 video components include a black-and-white CCD camera outfitted with a 2.8-mm lens. Still-picture transmission is at two rates, 5.7 seconds and 9.4 seconds. The slower time "offers a more vivid picture." The KX-TV10's companion model is a monitor (*WG-R2*), minus the handset, which plugs directly into a standard telephone. It retails for a hundred dollars less than the more elaborate KX-TV10. Price: $499.95

CIRCLE 66 ON FREE INFORMATION CARD

Gizmo/Bytes

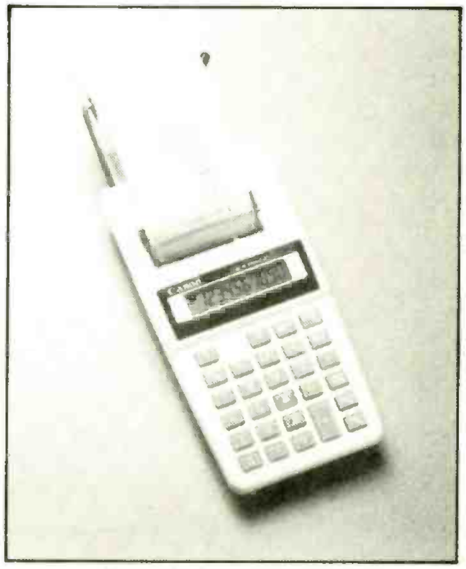


Eight Cell Battery Charger

Eight Cell Battery Charger

Been feeling that your household is in what *Panasonic Industrial Co.* (Two Panasonic Way, Secaucus, NJ 07094) calls the "heavy-use, heavy-drain category?" That would be owners of portable stereos, radios, toys, photo flashes, telephones, and calculators, all of which eat up batteries at a sometimes alarming rate. Panasonic Industrial researched the situation thoroughly and says it discovered that "young people and married couples with children" are among the nation's heaviest battery consumers. All of which was in preparation for the introduction of a new *Eight-Cell Battery Charger (BQ-8B)*. The unit will revitalize up to eight "AA," "AAA," "C," or "D" batteries, and as many as four 9-volt batteries without the use of any adaptors. There's also an LED indicator to show when recharging is taking place. Price: $23.99.

CIRCLE 67 ON FREE INFORMATION CARD



Portable Printing Calculator

Portable Printing Calculator

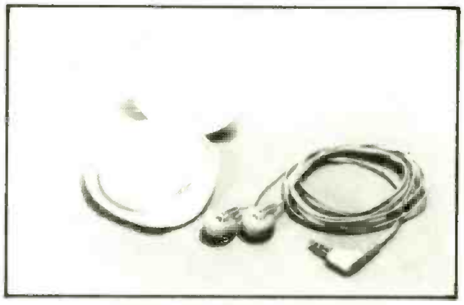
Everything's conducted on the go today, even in business. So naturally, electronic manufacturers are trying to respond to this market on the move. *Canon U.S.A., Inc.* (One Canon Plaza, Lake Success, NY 11042) has introduced a new *Portable Printing Calculator (MP1D)*, another in the firm's popular "palm printer" series. Besides providing a 2¼-inch plain-paper printout, the MP1D has an LCD display (angled for easy reading) and features an AC/DC power source, an algebraic operation system, and a 10-digit serial impact-type printer. Power comes from four "AA" batteries or Canon's optional AC adaptor. Price: $29.95.

CIRCLE 68 ON FREE INFORMATION CARD

Personal Headphone Stereo

Can't hear the bass as you bop around wearing your miniaturized music playback system? *Sharp Electronics Corp.* (Sharp Plaza, Mahwah, NJ 07430) has designed a new *Personal Headphone Stereo (JC-K15G)* to address just that audio problem. Special circuitry compensates for the small headphones and low wattage of those small units. The auto-reverse cassette player incorporates Dolby-B noise reduction, metal-tape capability, and an LED power-on indicator. Power is supplied by two "AA" batteries and the unit is sold with a pair of lightweight inner-ear headphones. Finally, the unit is incased in "Durasilk," which Sharp says is a "smooth, smudge-proof surface," available in black, blue, or gray. Price: $129.95.

CIRCLE 69 ON FREE INFORMATION CARD

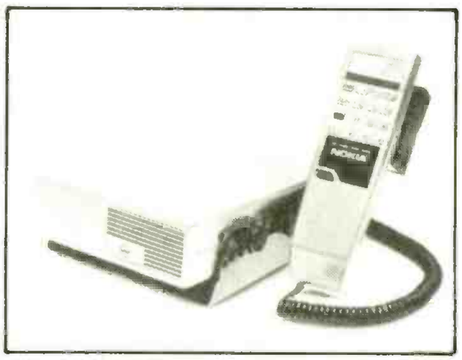


Compact "Rap" Earphones

Compact "Rap" Earphones

Don't ask us what makes this item especially designed for "the current rap-music revolution," but according to *Ora Electronics* (20120 Plummer St., P.O. Box 4029, Chatsworth, CA 91313) its new *Compact Earphones (GH16RP)* has some special quality that makes them the earphones to use in rap. Besides this and a mention of the phone's in-ear design, Ora doesn't offer much information. Also in the product's favor is its exceptionally low price. Price: $2.99

CIRCLE 70 ON FREE INFORMATION CARD



Mobile Cellular Telephone

Mobile Cellular Telephone

The cellular revolution in mobile telephoning seems to be rolling along, at least judging by how often we have seen some driver with one hand on the wheel and the other grasping a handset. *Nokia-Mobira, Inc.* (2300 Tall Pines Dr., Suite 100, Largo, FL 34641) imports and merchandises a new *Mobile Cellular Telephone + (M-10)* from Finland and says it's an "economically priced unit" with "all the quality and reliability" of more expensive Mobira instruments. The M-10 features 832-channel capacity, standard hands-free operation, and A/B system select. An inexpensive transceiver-mounting kit allows the system to be easily transferred from one vehicle to another. Convenience features include call timer, backlit keypad, scratch-pad memory, single keystroke redial, unanswered call indicator, and touch-tone compatibility. Price: $895.

CIRCLE 71 ON FREE INFORMATION CARD

Build Your Own SLAVE FLASH TRIGGER

When triggered properly, a slave flash can give your photographs a professional look.

BY JOHN CLARKE AND GREG SWAIN

You own one of those fully automatic cameras with built-in automatic focus, strobe, automatic film loader, clock, LCD program display, and a host of other goodies; yet your indoor flash pictures leave much to be desired: Close-up faces are washed out with too much light because the background is too dark. Group shots are ruined because of unsightly shadows. Wedding photos are disappointing because the camera's flash buries the subtle lighting effects stained-glass windows provide.

Most of those problems come about because the scene is illuminated by only a single source—your flash gun. While a single flash gun may be adequate in some situations, often photographs suffer from harsh shadows. Alternatively the photograph can appear to lack contrast and depth, particularly if all the light is coming directly from the front.

The best way around those problems is to use a second flash gun. By correctly positioning and aiming that second flash, you can fill in any shadows that would otherwise be created and greatly improve the "depth" of your photographs. You can also use a second (or even a third or fourth) flash to light the background scenery behind a subject.

Of course, for that to work the multiple flash units must be made to fire at the same time. That can be done by simply connecting them in parallel with the camera's flash socket via a multi-way adapter cable. Although that technique generally works okay, cable-connected flash guns do have their limitations. For example you may be prevented from positioning a flash gun exactly where you want it because the cable isn't long enough. Cables are also a nuisance—they're easy to trip over, they get in the way, and they're often unreliable.

A far better method is to use an electronic slave-flash trigger such as the unit described in this article. That device automatically triggers a slave flash-gun whenever it detects high-intensity light from the primary flash-gun. That eliminates trailing cords, which means that you can place the slave flash gun anywhere you want.

Commercial slave-flash triggers are expensive, so you can save money if you build one yourself. As you'll see from the Parts List, only a handful of parts are required to assemble the Slave-Flash Trigger*, and the unit will only take an hour or so to put together. The performance of our "homebrew" unit is on a par with expensive commercial units; it has excellent sensitivity and will not false trigger.

How it Works. Take a look now at Fig. 1. The circuit is really very simple. It uses a phototransistor (Q1), an SCR (C106D1), three resistors, and a 9-volt battery.

The SCR takes the place of the camera contacts and is wired across the trigger circuit of the flash gun. Normally, the SCR is off, so the flash gun is able to charge to its trigger voltage.

Phototransistor Q1 is used to monitor the light level. When a high-intensity flash occurs, Q1 briefly conducts and supplies gate current to the SCR. That causes the SCR to turn on, which then triggers the slave flash-gun via the hot-shoe adapter terminals. Once the flash gun has triggered, the SCR quickly turns off again. That happens because the current in circuit quickly falls below the SCR's holding current.

*This story first appeared in *Silicon Chip*, Australia (April 1988); reprinted with permission.

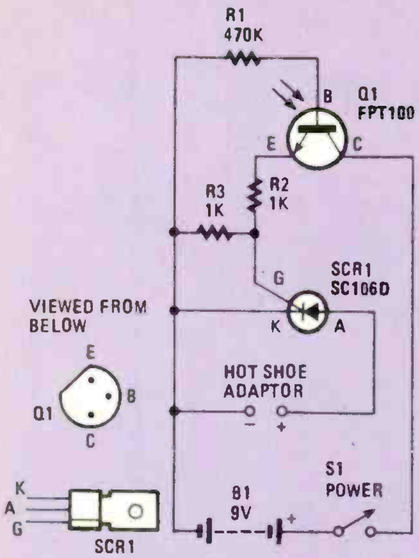


Fig. 1. The circuit uses a phototransistor (Q1), a silicon controlled rectifier (SCR1), and a few resistors. When a high-intensity flash occurs from a nearby strobe or flashbulb, Q1 conducts and turns on SCR1, which triggers the slave flashgun via the hot-shoe adapter terminals.

The resistor at the base of Q1 (R1) determines the sensitivity of the circuit. If you wish, you can reduce the sensitivity simply by reducing the value of the resistor from that shown. The 1K resistor between the gate and cathode of the SCR (R3) prevents the SCR from false triggering if high voltages are applied between the anode and the cathode.

Power for the Slave-Flash Trigger is derived from a 9-volt transistor-radio battery. Switch S1 disconnects power when the Slave-Flash Trigger is not in use.

Let's discuss parts availability for a moment before we get to the actual assembly. The unit specified for SCR1 is a GE C106D1. Many electronics-parts retailers carry an equivalent unit made by Teccor. That unit, the T106D1, can be used with no problems.

The phototransistor presents more of a problem. The Fairchild FPT-100 used in the original project is no longer manufactured, although it may still be available from a number of surplus sources. However, thanks to the sensitivity of the C106 and its equivalent, the phototransistor required by the project is not critical and almost any reasonably fast (switching time less than about 10 µs) substitute can be used. One possibility is the GE L14G2, which is available from Digi-Key (PO Box 677, Thief River Falls, MN 56701) and others.

The hot-shoe adaptor is a photographic accessory that is available from most photographic supply stores.

Assembly. We made up two versions of the Slave-Flash Trigger—one on a small printed-circuit board and the other on *Veroboard*—a pre-etched, pre-punched board that is quite handy. The Veroboard layout, shown in Fig. 2, can also be used by those readers who wish to use ordinary perforated construction board and point-to-point wiring. Figure 3 shows the template for the printed-circuit board, while the printed-circuit layout is shown in Fig. 4.

When building the printed-circuit version, mount Q1 upright, about ½-inch above the surface of the board. The body of the SCR should be mounted flat against the board, with the leads bent 90° to mate with the appropriate holes.

The assembly details of the Veroboard version are similar. You can make the required cuts in copper tracks with an oversized drill bit. As always, be careful when working with Veroboard; mistakes are easy to make but are difficult to correct.

PARTS LIST FOR THE SLAVE FLASH TRIGGER

SCR1—C106D1 or T106D1 silicon controlled rectifier
Q1—FPT 100 phototransistor (or equivalent, see text)
R1—470,000-ohm, ¼-watt resistor
R2, R3—1000-ohm, ¼-watt resistor
B1—9-volt transistor-radio battery
Plastic case (3¼ × 2⅛ × 1⅛ in.), printed-circuit board materials or Veroboard (see text), hot-shoe adaptor, photographic shielded cable with connector, RTV cement, battery clip, wire, solder, hardware, etc.

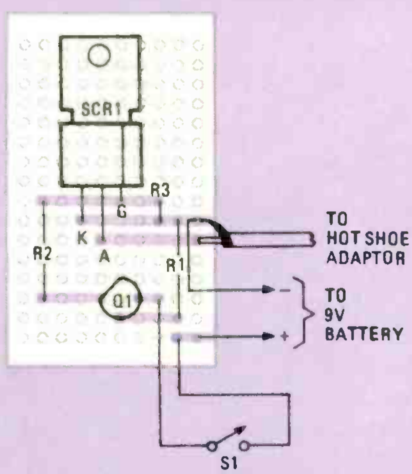


Fig. 2. Parts layout for the Veroboard version of the project.

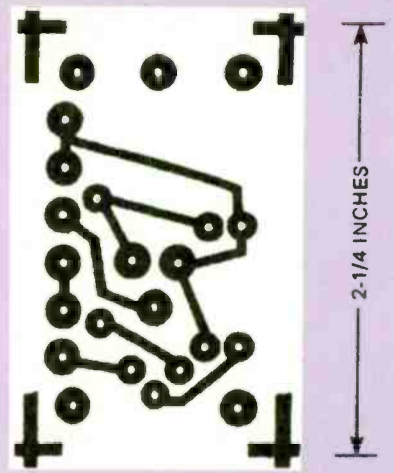


Fig. 3. Here is the full-size template for the printed-circuit version of the project.

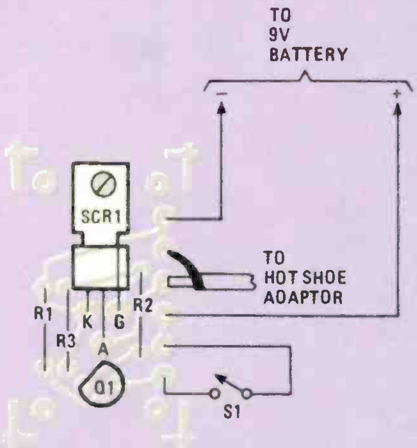


Fig. 4. Wiring diagram for the printed-circuit board version. The SCR is mounted flat against the board while the phototransistor should stand about ½- inch above the board.

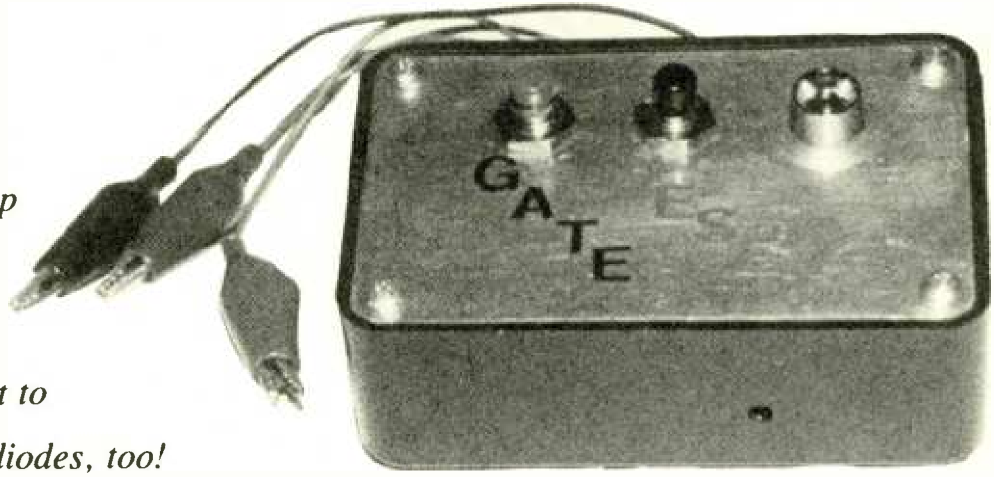
We mounted the completed board assembly in a small plastic case; the one we used measured about 3¼(L) × 2⅛(W) × 1⅛(H) inches. The case is used upside down, with the lid becoming the base. The hot-shoe adaptor is secured to the top of the case using a screw, while the on/off switch is mounted at one end.

A third hole is drilled at the other end of the case to accept a mounting bezel for the phototransistor. The board is then supported vertically in the case when the phototransistor is clipped into the bezel. You might want to use a bit of RTV cement to hold the board securely.

Note that some flash guns do not

(Continued on page 103)

Build Your Own SCR Tester



Make SCR testing a snap with this simple, easy-to-build, and easy-to-use tester. Use it to test Triacs, LEDs, and diodes, too!

BY ALBERT R. COVINGTON

A few months ago, a man who had a handful of what looked like transistors came into the school shop. He said the parts were off of a marine engine and he could not locate replacements. We tried to reference the part numbers, but to no avail. When the plastic, TO-220-cased parts were tested to see if they were indeed defective, they failed. But that's because everyone had assumed that the devices were transistors.

Then a thought occured to us: Because they were off a gasoline engine, maybe the devices were SCRs (silicon controlled rectifiers). An SCR checker wasn't immediately available, so one was rigged up using a power supply, a current meter, and a couple of resistors. Sure enough, the mysterious parts were SCRs, one of which was defective.

Since then, microwaves, TV sets, and other pieces of electronic equipment that use SCRs have come to the school shop for service. Rigging up a makeshift tester every time a few SCRs showed up was awkward and inconvenient. Because of that, the SCR tester described in this article was built.

The SCR tester has proven to be a very effective test instrument. In addition to testing SCRs, it is useful for checking Triacs, diodes, and LEDs. The entire tester can be built for about $5.00 or for about $1.00 if you have a well-stocked junkbox.

SCR's and Transistors. The SCR—invented by General Electric in 1957—is a versatile and useful semiconductor device. It can be used as a fast-acting latching switch and as a sensitive amplifier. Further, it can be used as a rectifying device since it will pass current only in one direction.

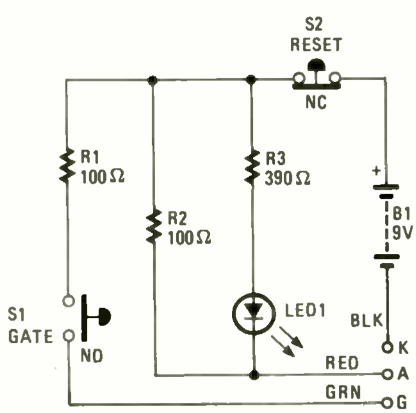


Fig. 1. Testing an SCR is a relatively simple matter that is made even easier with this SCR tester. It uses just a handful of easily found components.

SCRs offer some important advantages over transistors and other devices in certain applications. That's because the device is either on (conducting) or off (not conducting). Though they too can be used as on-off switches, transistors, in contrast, can be more-closely likened to variable resistors.

The SCR is turned on by applying power momentarily to its gate terminal. After that, as long as the forward or latching current remains above a certain threshold, the device remains in conduction, regardless of the presence or absence of a signal at the gate terminal. In contrast, transistors need a continuous current through their base to remain on.

Testing SCRs. The easiest way to test a positively-triggered SCR is to momentarily trigger the gate on with a positive voltage; that should latch the device on. (While negatively-triggered SCR's exist, the vast majority of devices that you are likely to encounter as a hobbyist will be positively trig-

PARTS LIST FOR THE SCR TESTER

B1—9-volt transistor-radio battery
LED1—Jumbo red LED, (Radio Shack 276-068A or equivalent)
R1, R2—100-ohm resistors
R3—390-ohm resistor
S1—SPST, momentary-contact, normally open switch, (Radio Shack 215-1547 or equivalent)
S2—SPST, momentary-contact, normally closed switch, (Radio Shack 215-1548 or equivalent)
Experimenters box (Radio Shack 270-230 or equivalent), battery holder (Radio Shack 270-236 or equivalent), battery clip, insulated alligator clips, wire, solder, lettering for case, etc.

gered. This tester will test only positively triggered SCRs.)

The difficulty with checking SCRs with typical analog or digital ohmmeters is that they don't supply enough current to hold (latch) the SCR on; that's important, since a key test for determining the condition of an SCR is that the unit should remain latched until the latching current is interrupted.

In many cases, SCRs require a latching current of 50 to 100 mA; generally, the larger the SCR (that is, the greater its current-carrying capacity), the more latch current required. Our SCR tester supplies enough latch and gate current to test most SCRs and Triacs used in consumer-electronics circuits.

The Circuit. The schematic diagram of the SCR tester is shown in Fig. 1. As you can see, the circuit is extremely simple. The device-under-test's (DUT) cathode, anode, and gate are connected to the unit's K, A, and G terminals, respectively. Pressing switch S1 feeds a gate current to the DUT, which triggers it on. Resistor R1 limits the gate current to the appropriate level. Resistor R3 limits the current through the LED to about 20 mA, which, with the current through R2, results in a latching current of about 110 mA.

The LED is used to monitor the latching current. If the DUT is good, once the gate is triggered with S1 the LED will remain lit, indicating that the device is conducting. To end the test, turn off the device by interrupting the latching-current flow using switch S2. The LED should turn off and remain off.

The preceding procedure will work with SCRs and Triacs. To check LED's and other diodes, connect the anode and cathode leads to the anode and cathode of the diode; LED1 should light. When the leads are reversed, the LED should remain off.

Construction. The tester can be built in about an hour and will fit into a 2 × 3-⅛-inch cabinet.

Begin construction by preparing the box. First, drill three small holes in the side of the box. The test leads will pass through those holes when the project is assembled. Those holes should be just small enough for the wire to go through, but not a strain-relief knot. Next, drill the holes for the switches and the LED. A front-panel template for the box is shown in Fig. 2. The holes should be no farther than ½-inch from the edge of the box so that there will be enough room inside the box for the battery.

Assemble the circuit on the front panel using Fig. 3 as a rough wiring guide. About the only critical factor in assembling the circuit is identifying the LED leads. Often, but not always, the short lead is the anode. Be sure which lead is which before doing the wiring.

We suggest using color-coded wires for the test leads as indicated in the figures. Use wire lengths that are long enough to allow for easy use of the tester. Tie strain-relief knots in each of the leads and thread them through the three side holes. Terminate each lead with an insulated alligator clip. To keep the battery from bouncing around, use a 9-volt battery holder and secure the holder to the bottom of the box using screws or glue. Place the wired front panel on the box, insert and tighten the screws, and you are done.

Well, almost. It's a good idea to label the switch and lead functions using press-type or any other technique that suits you. Not only does that give the tester a more finished or "professional appearance," but it can save some head scratching later on. ■

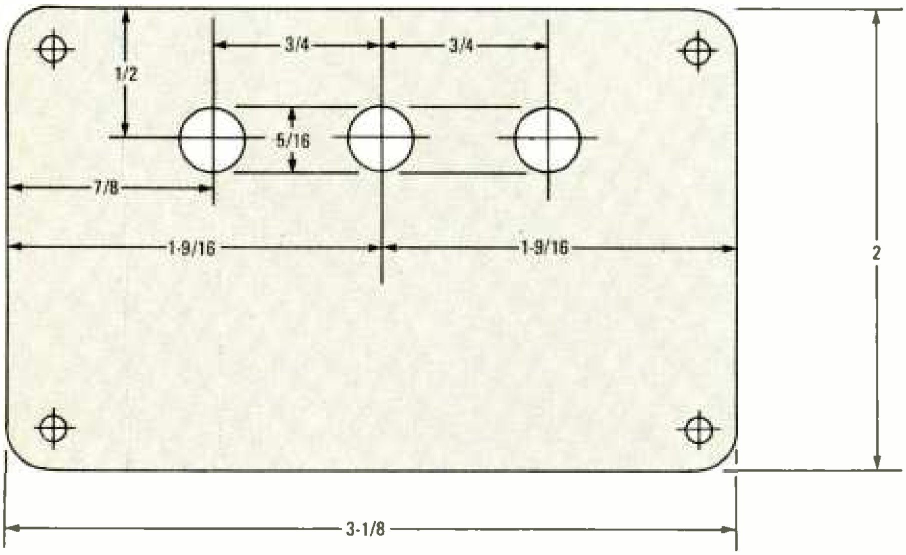


Fig. 2. The SCR tester can be assembled within a small experimenters box. If you use the box specified in the article, use this template when preparing the front panel.

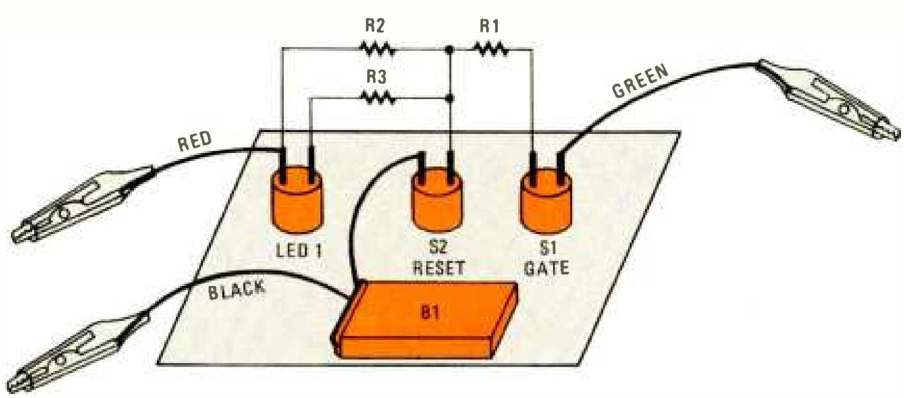
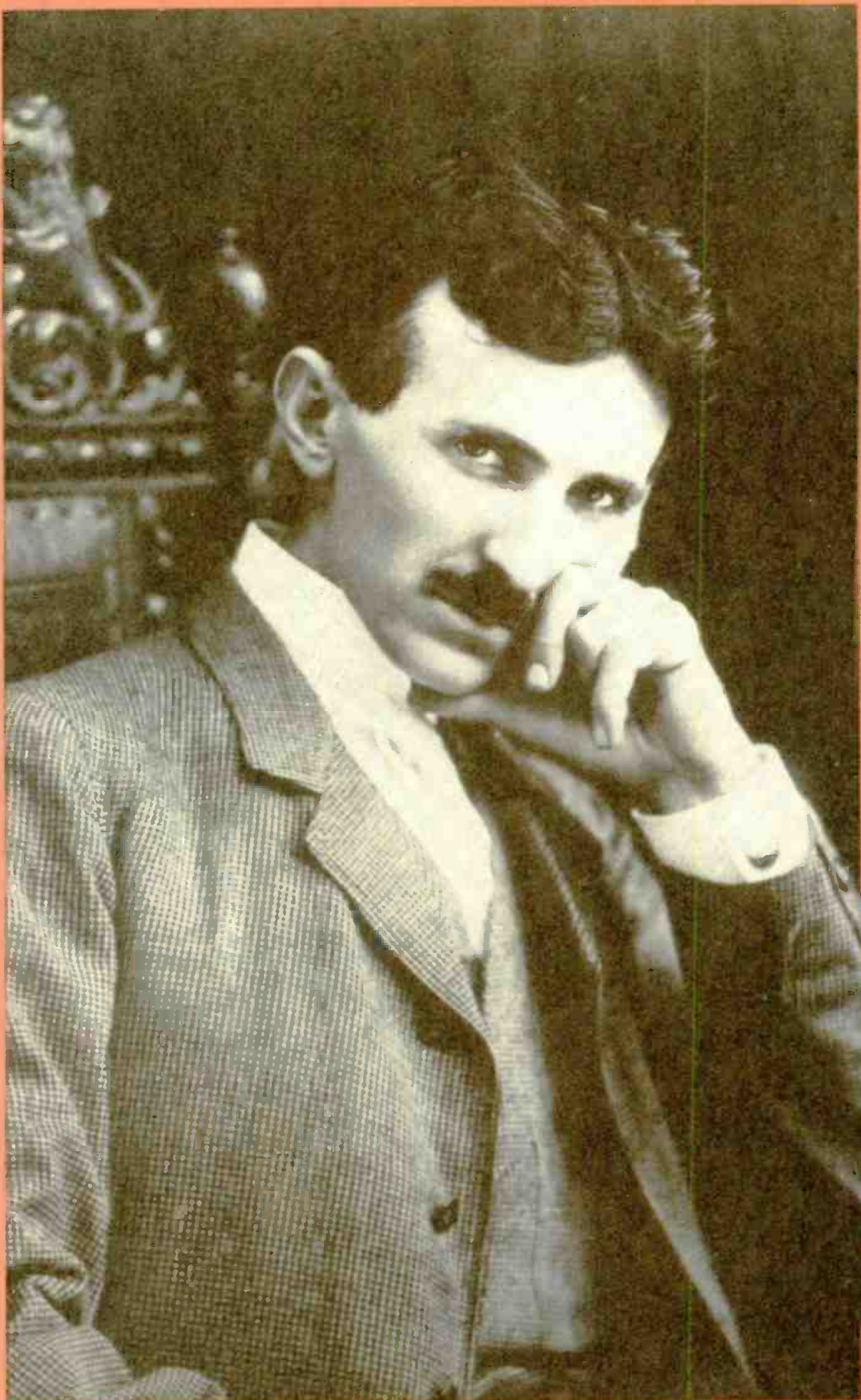


Fig. 3. The circuit is simple enough to be put together using point-to-point wiring. We suggest using color-coded wires for the test leads, as shown here, to avoid confusion.



And this is the picture of Mars at mid century: a small planet which three-fourths is cold desert, with the rest covered with a sort of plant life (most likely lichen) that our biological knowledge cannot encompass...Mars is not the dead planet...but neither can it be inhabited by the kind of intelligent beings that many people dreamed of in 1900" (*The Exploration of Mars* by Werner von Braun, Willy Ley and C. Bonestell, 1956).

Nikola Tesla: Interplanetary Communicator?

Througout his life, inventor Nikola Tesla was convinced that he had received a message from beyond the Earth. Was he right?

BY MARC J. SEIFER

Introduction. At 8 p.m. on June 20th, 1957, in the Ballroom of the Hotel Diplomat in New York City, a meeting was held to coordinate an expected visit by "the Space People" to Earth. The meeting was planned by three people: George Van Tassel, author of *I Rode a Flying Saucer*; George King, telepathic contactee with the extraterrestrials and editor of *Cosmic Force*; and Margaret Storm, author of an occult-oriented biography of Nikola Tesla entitled *Return of the Dove*, a book whose "transcripts (were) received on the Tesla set, a radio-type machine invented by Tesla in 1938 for interplanetary communication." By July 1, it was assured, the "Martians" would have "full scale operations" in Washington D.C., New York and "general North American areas." It was also revealed that "Tesla was a Venusian, brought to this planet as a baby in 1856, and left in a remote mountain province in what is now Yogoslavia [sic]."

In attendance at that meeting was a man who preferred to remain unnoticed. He was an FBI agent assigned to continue the growing file on the enigmatic Serbo/Croatian inventor, Nikola Tesla. *The Interplanetary Sessions Newsletter* from which the preceding information was taken came from the Tesla FBI file released to me through the Freedom of Information Act.

From this same dossier it is clear that Tesla had been watched in his waning years by J. Edgar Hoover, who wrote, on January 21, 1943, during the height of World War II, "A review of the Bureau files reveals considerable information concerning Nikola Tesla and his inventions." It was just two weeks after the inventor's death, and Hoover feared that Tesla's creations, including his well publicized "death ray," could get into the hands of "the Axis Powers" or the Soviet Union as Tesla's nephew, Sava Kosanovich, ambassador to the newly created Communist country of Yugoslavia was demanding that his uncle's estate be shipped to a museum that was being erected there in his honor. Hoover wrote that "Kosanovich might possibly make certain material available to the enemy."

The Teslascope. Margaret Storm's supposition that Tesla was born from another planet to give our world such devices as the induction motor, fluorescent and neon lights, remote control, robots, the radio, and also our entire electric-power distribution system, stemmed from a colorful history of the inventor's ties to the group-fantasy that life on Mars was a virtual certainty. Storm was also influenced by the times [e.g., the mid-1950's interest in UFO's; the general state of paranoia fueled by the fear of communist infiltration, *i.e.*, the McCarthy period), her readings in Theosophical literature which linked Tesla to the so-called sixth-root race. (the new species of human that was evolving on the planet), and also to her friendship with Arthur Matthews, a bizarre electrician, who as far as I know is still alive and still contends that he and his employer, Tesla, had traveled many times to nearby planets aboard a Venusian spacecraft.

Storm's choice of 1938 as the date for the invention of the interplanetary communicator appears to be a year off. On Tesla's 81st birthday, he announced the invention of what has come to be called the "teslascope."

An article in the July 11, 1937 *New York Times* quoted Tesla: "I have devoted much of my time during the last year to the perfecting of a new small and compact apparatus by which energy in considerable amounts can now be flashed through interstellar space to any distance without the slightest dispersion."

The article went on to describe "a new form of tube" able to produce potentials in excess of 18 million volts. "It is of ideal simplicity...it will carry heavy currents, transform any amount of energy within practical limits, and permits easy control and regulation of the same."

Schemes and apparatus for an interplanetary communicator for the octogenarian, however, were anything but new. For instance, in a 1907 *New York Times* editorial, Tesla said, "My magnifying transmitter...can easily bridge the gulf which separates us from Mars." Many years later (1921), Tesla published a short article in the *Electrical World* entitled "Interplanetary Communication." There, he restated that he had received impulses stemming from Mars in 1899 and that since that time had developed "numerous designs...(for) thoroughly practical apparatus."

Tesla: Cosmic Star of the Gilded Age. Kings of Belgium and Serbia, and upper echelons in England, France, Germany, Austro-Hungary, Italy, and Russia knew the electrical genius intimately. Tesla was an international figure who moved among the very pinnacle of social circles. At the turn of the century, his American friends, enemies, and associates included: Col. John Jacob Astor, perhaps the greatest landowner in New York City and builder of the Waldorf Astoria, Tesla's lodging for over a decade; industrialists George Westinghouse and John Hays Hammond; financiers Henry Clay Frick, builder of the Frick Museum, Equitable Insurance director Thomas Fortune Ryan, J. Pierpont Morgan, investor in many Tesla products and schemes and most powerful economic force on the planet, and banker Jacob Schiff; editors Robert Underwood Johnson of *The Century*, T.C. Martin of *Electrical World* who was the compiler of the first Tesla collected works and a biography of Edison, and Joseph Collier of *Collier's Magazine*; artists such as composer Dvorak and writers Rudyard Kipling and Mark Twain; and, of course, inventors such as Oliver Lodge, Guglielmo Marconi, Elihu Thomson, and Thomas Edison— Tesla's employer from 1884–85 and arch-enemy/competitor for the next 35 years.

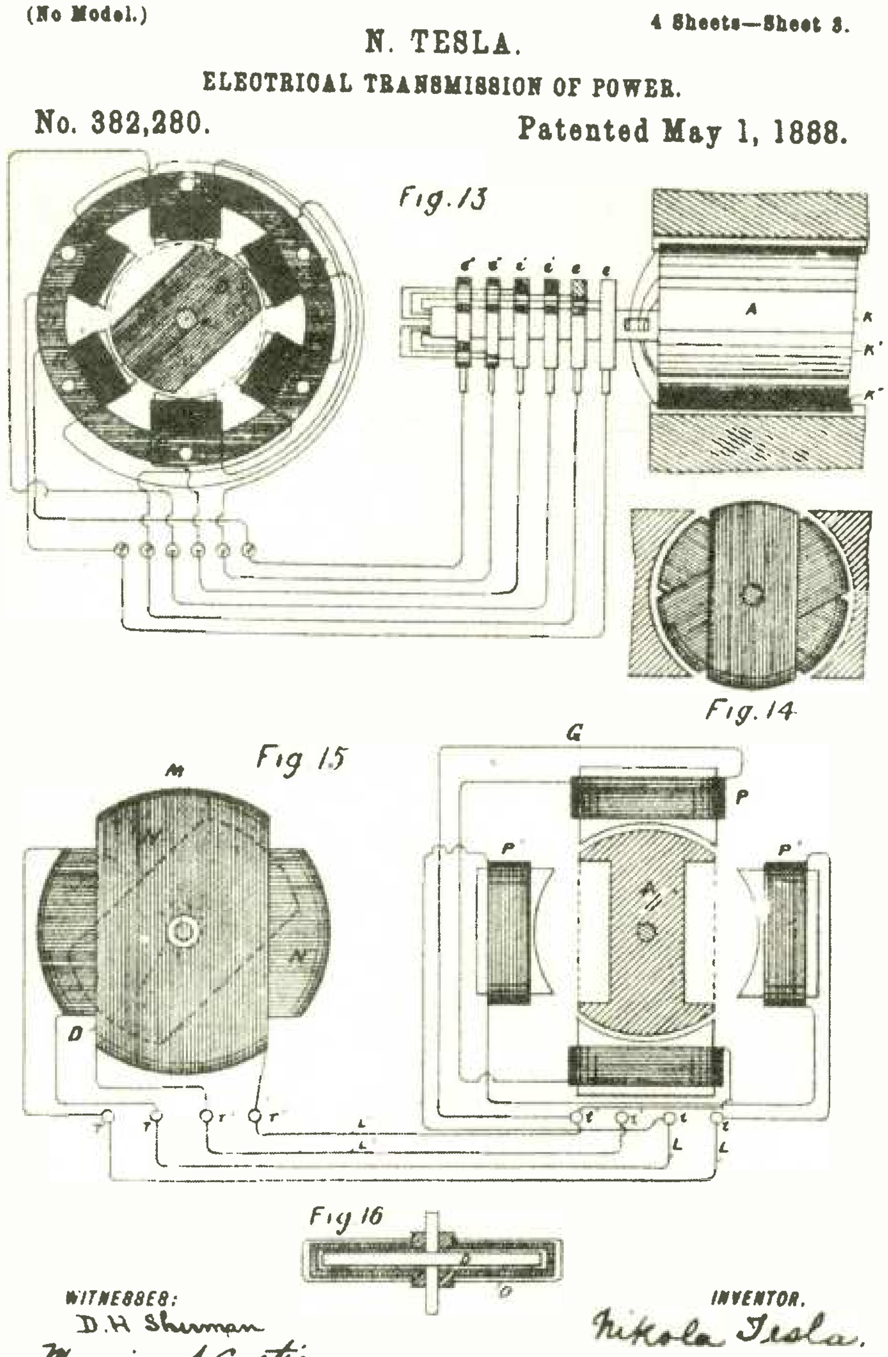
Tesla's invention of the induction motor and alternating-current polyphase system, sold to Westinghouse as a 40-patent package for $85,000, plus royalties, in 1888, changed the course of history in a dramatic and intimate way. The electrical genius had conceived a means of sending electricity more than one mile.

Before Tesla, that was about the extent of the budding electric-utility industry's ability to transport energy, and then only to illuminate lightbulbs. After Tesla, power to run factories could be transported hundreds of miles—for example, from Niagara Falls to New York City. Tesla made impossible dreams industrial realities and he was heralded at the time for his brilliance. Remember that when you see a jewel-lit city and surrounding network of illumed surburbia some night, it is a monument to the Serbian Aladdin who believed in interplanetary communication.

After changing the course of history from a future envisioned by Edison backers, which would have required a power station every square mile across the civilized continents, to one containing just a small number of mighty transmitting sources, Tesla decided to go one better. In 1893 he pieced the wireless puzzle together from his own experiments in cordless vacuum lamps and from research by Sir William Crookes, Sir Oliver Lodge, Heinreich Hertz, and Sir William Preece. Tesla discovered that the Earth itself could be used to transmit energy. Thus, the need for constructing hundreds of thousands of miles of transmission lines was unnecessary, for proper apparatus could transport huge amounts of energy from one point on the globe to another without any wires.

The inventor's scheme was actually quite simple. Tesla realized that this giant electromagnet called Earth has resonant frequencies (which today are known as telluric currents). By building giant broadcasting towers to pump large voltages into the earth and ambient medium, and by building identically designed receiving stations, both in exact mathematical relationships to the size of the Earth and its period of frequency, terrestrial carrier waves would abolish the need for transmission lines. Once power was "jumped" that way from, say, a waterfall to a distant city (i.e., from tower to tower) and converted to more useable frequencies, energy could be transported locally by means of conventional wire transmission lines or via resonant receiving devices such as remote controlled clocks, telephones, teletype, and lighting fixtures. At the same time, Tesla reasoned, even greater charges set up in such a way as to amplify the naturally flowing Earth current could transmit a significant impulse from this planet to another.

Interplanetary Communication. To prove his wireless scheme and begin plans for inauguration of his World Telegraphy System, in 1899, Tesla moved his operations to Colorado Springs where he constructed a laboratory and 200 foot transmission tower with plans of circumscribing the globe with electrical impulses. One summer night, while in his wireless laboratory high in the Rockies, Tesla was en-



Tesla's invention of the induction motor and the AC polyphase system changed the course of world history. His inventions made it possible to transmit electrical power over wires for long distances. Previously, the maximum distance possible was limited to about one mile.

gaged in tracking thunderstorms within a radius of 1200 miles with sensitive electrical devices. During that time he received "three fairy taps" on that radar-like apparatus. He speculated in a series of articles, one in 1901 in *Colliers Magazine*, that those impulses probably originated from intelligent sources exterior to the Earth such as from Venus or Mars.

In the *Colliers* article, Tesla said "I can never forget the first sensations I experienced when it dawned upon me that I had observed something possibly of incalculable consequences to mankind...the feeling is constantly growing in me that I had been the first to hear the greeting of one planet to another."

Stating in the same article that he "could feel the pulse of the globe as it were," the electric sorcerer rejected the idea that he may have intercepted a mere earthly message from such wireless colleagues as Professor Marble in Connecticut, Dr. Riccia in France, Professor D'Azar in Rome, or rival Guglielmo Marconi who two years later sent "3 fairy taps" across the Atlantic Ocean to capture the imagination of the world with the first transatlantic wireless message.

During the very months Tesla was perfecting long-range wireless transmission and radar tracking devices, Marconi was experimenting with pirated Tesla oscillators in broadcasting the Morse code for the letter S (*i.e.*, dot-dot-dot) over hundreds of miles in Europe and across the English Channel. Modifying the extraterrestrial encounter, recent biographers such as Hunt and Draper, and Cheney, have suggested that Tesla may have picked up the vibrations from a stellar quasar. In either case, however, Tesla was perceived as returning to New York City and his home at the Waldorf, having received messages from outer space.

A few years later, the awful truth dawned upon Tesla: he had received the electromagnetic echo of Marconi's experiments; however, that realization was too painful and Tesla defended vehemently against it in a classic psychoanalytic way: he rationalized by seeking alternative hypotheses and regressing to a more-primitive belief structure. In a 1921 article, Tesla admitted as much but disguises it as a denial:

"I was naturally very much interested in reports given out about two years ago that...these supposed planetary signals were nothing else than interfering undertones of wireless transmitters, and since I announced that fact other experts have apparently taken the same view. These disturbances I observed for the first time from 1906 to 1907. At that time they occurred rarely, but subsequently they increased in frequency. Every transmitter emits undertones, and these give by interference long beats, the wavelength being anything from 50 miles to 300 or 400 miles."

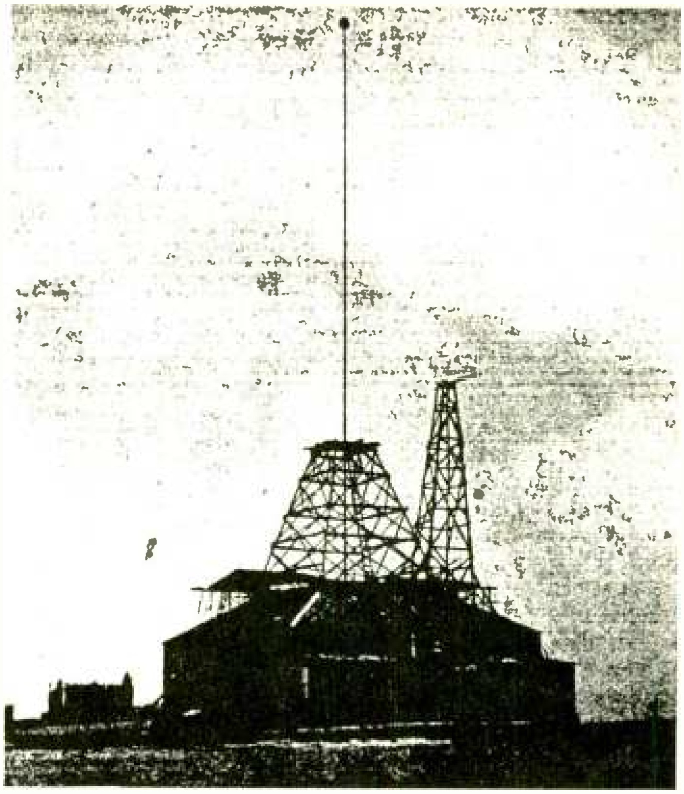
To further support the claim that Tesla's reception of so-called Martian signals was based upon self-delusion, it is clear that for at least seven years prior to 1899, Tesla desired to transmit and receive impulses with nearby planets. For instance, in 1896, fully three years before Tesla's alleged ET encounter, the *New York Sun* published a Tesla interview under the spectacular title "Tesla May Signal to Mars." The inventor said: "If there are intelligent inhabitants of Mars or any other planet, it seems to me that we can do something to attract their attention."

Three years later when he arrived in Colorado, after announcing to the reporters once again that he could signal Mars, Tesla fulfilled his own oft-stated boast by being the first human to hear from the space people. Rather than accept the more likely hypothesis, that deep within himself he probably/possibly knew was the correct one (*i.e.*, undertone receptions from Marconi), Tesla opted for the more exotic scenario of space communications. With each succeeding year, the event became slightly more exaggerated as it took on more and more symbolic importance.

The reclusive Balkan inventor clung to the extraterrestrial motif throughout his life, repeating the speculation publicly on many occasions such as in 1931 for a Time Magazine cover story celebrating his 75 birthday:

"Nothing can be more important than interplanetary communication. It will certainly come some day, and the certitude that there are other human beings in the universe working, suffering like ourselves will produce a magic effect on mankind and will form the foundation of a universal brotherhood that will last as long as humanity itself."

In no way was Tesla alone in his belief in the existence of extraterrestrial intelligence. The theme of space beings wishing to communicate with Earthlings can be traced to biblical tales of burning bushes, aerial wheels of electrum, cosmic commandments, and bright stars traversing the sky to point out the birth of Christ; or to the mythological gods of ancient Rome or Greece such as Zeus, Thor, Hermes, Venus, and Apollo. However, it was modern "scientific" and literary fiction that inspired the more apparent basis for Tesla's suppositions.



Tesla's experimental laboratory in Colorado Springs, Colorado. Here, while working on his theory of worldwide power transmission, he received "three fairy taps" he felt were sent by intelligent life on Mars or Venus.

The Plurality of Worlds. As anyone who has stared at the star-lit night sky knows, the belief that we are not alone is a very plausible hypothesis. With millions of galaxies each containing billions of stars, there are virtually an infinite number of potential star systems with satellites similar to our own probably capable of sustaining life. This idea, called the plurality-of-worlds hypothesis, is a concept that through the ages has counted numerous scientists among its ranks. Early astronomers such as Bruno, Kepler, Newton, Laplace, and Herschel took that position, along with such modern-day astrophysicists as Willy Ley, Werner von Braun and Carl Sagan.

Naturally, at the same time, numerous artists and authors also have seized that notion and fashioned tales of extraterrestrial travel and intrigue. Two thousand years before Steven Speilberg's movie "ET" earned over $300,000,000, and the phrase "ET phone home" became embraced by the public, Lucian of Samoa, a contemporary of the Greek philosopher Plutarch, wrote *The True History*, a fable about a sailing ship that was hurled to the moon by a whirlwind. That theme of planetary travel was also echoed by Bishop Goodwin in 1638 when he authored a story about a man who was towed on a sleigh to the same heavenly body, and by Cyrano de Bergerac 20 years later in his books *Empires of the Sun* and *Voyage to the Moon.*

In 1835, Richard Adams Locke, of the *New York Sun* created a series of front page articles on astronomer Sir John Hershel and his alleged discovery of advanced life forms on the moon. Locke's hoax, which spread around the world before it was exposed, was predicated on the fact that Herschel was in South Africa at the time, and therefore out of contact with the press. Hershel's supposed discoveries of unicorn-like animals and winged humanoids were made via a marvelous (and fictitious) telescope that weighed 15,000 pounds, was 150 feet long, and could magnify the heavens 42,000 times.

In 1865, Jules Verne reawakened the idea of journeying to the moon, but by the late 1870's, focus shifted to Mars. That planet became the most likely candidate for the home of higher beings for fiction writers and astronomers alike, not only because of its similarity to the Earth in size and position, but also because of the dynamic and changeable nature of its surface as seen by the astronomers. For instance, Mars has ice caps that grow and diminish with the seasons.

The first attempts to create a map of Mars and delineate those lines can be traced back to Bernard de Fontana, Christain Huyghens, and Mr. Cassini in the mid-1600's. More detailed drawings were done by the discoverer of Uranus, the well-known astronomer Sir John Herschel in 1830 and by numerous other scientists such as Mr. Schmidt (1862), R.A. Proctor (1867) and Camille Flammarion (1873).

The year 1877 was a watershed for Martian influence on Earthlings. During a particularly close pass to our planet that year, two fabulous discoveries were made: Mars had its own moons and its surface was adorned with a matrix of symmetrical furrows.

The first discovery by Professor Asaph Hall confirmed Kepler's supposition of 1610 that two small satellites circled the "Planet of War." That find was of particular importance because it also supported claims for two Martian moons put forward by novelists Voltaire and Johnathan Swift, the former in a philosophical treatise on the Solar System and the latter in his classic tale *Gulliver's Travels*. In the December 1887 issue of *Cornhill Magazine*, Astronomer Hall wrote dramatically that the path of one of the moons across the zodiac: "passes...the feet of the Herdsman, the body of the Serpent...over the Bow of the Archer...the head of the Crane, and along the Southern fish...Thence the Martian moon passes athwart the Sea Monster and the River Eridanus...(and) very near the celestial equator of the Martian heavens."

The widely read monthly concluded that "Martian moonlight is but small in amount, and certainly can not go far to compensate the Martians—as compared with us terrestrials." However, no real evidence regarding the prevailing theory of the plurality of worlds was obtained.

That theory was championed by the flamboyant French astronomer and psychical researcher Camille Flammarion in his classic works *The Plurality of Worlds* and *Mars and Its Inhabitants*. Both "scientific treatises" were written after his more mystical tale, entitled *Stories of Infinity*, about a conversation the author had with a comet named Lumen was published.

Flammarion's belief that Mars housed life stemmed not only from his daily studies with his own telescope of the mountains and craters of the planet, but also from the more detailed observation supplied by Italian stargazer Giovanni Schiaparelli, who announced to the world that the Red Planet was etched with geometrical and parallel trails which he named "canali." Renamed "canals," instead of the more literal translation of "channel," Flammarion boldly suggested that: "these canals may be natural...or they may be grooves excavated by the inhabitants for the distribution of water..."

After discussing the size of the oceans, (which were no larger than the Mediterranean), the changing climates, and a snowfall photographed by Professor Pickering of Harvard in 1890, Flammarion concluded "it is obvious...that the world of Mars is...vigorously alive." He also suggested that due to the lightness of the atmosphere: "the inhabitants of this planet may have received the privilege of flight... May they not rather be like dragonflies fluttering in the air above the lakes and the canals?"

Influenced rather dramatically by those bold words and scientific observations, which appeared in *Review of Reviews* and *North American Review*, the *Time Magazine* and *Saturday Evening Posts* of the Gay Nineties, the hypothesis that Mars was inhabited by an advanced civilization was given further observational corroboration by Percival Lowell, discoverer (30 years later) of the planet Pluto, and builder of a magnificent telescope in Flagstaff, Arizona.

A descendant of the prestigious Bostonian Lowell family and brother of the president of Harvard University, Percival captured the front page of the *New York Times* with "Mars Inhabitated" headlines on a number of occasions as he published the results based upon his detailed Martian maps in the prestigious science journals such as *Nature*, and in a magnificent text published by Macmillian entitled *The Canals of Mars*: "Suggestive of a spider's web seen against the grass of a spring morning, a mesh of fine reticulated lines overspreads...the globe from one pole to another...That Mars is inhabited by beings of some sort or other we may consider as certain as it is uncertain

Located in Shoreham, NY, this tower was built by Tesla for experiments in world-wide telegraphy and power transmission. The tower never became operational.

what those beings may be...Girdling their globe and stretching from pole to pole, the Martian canal system not only embraces their whole world, but it is an organized entity...the first thing that is forced on us in conclusion is the necessarily intelligent and non-bellicose character of the community which could act as a unit throughout its globe."

Not to be undone, novelists and newspaper columnists embraced this group fantasy with ardor. In 1896, George duMaurier, grandfather of Daphne, wrote the novel *The Martian* in which he described the telepathic winged beings "that descends from no monkey," but are able to excavate, adorn with marble statues, and irrigate the entire planet. H.G. Wells went one better with in his serialized 1897 horror story *War of the Worlds*, when he had terrible extraterrestrials invade and destroy the Earth. George Lathrop, son-in-law of gothic writer Nathaniel Hawthorne, combatted the Red Planet's warriors on the pages of *The New York Journal* in 1895 with disintegrating death rays invented by the Wizard of Menlo Park, Tom Edison.

Other scientists such as Lord Kelvin suggested that the light from New York City created a clear signal of progress to the Martians; Elihu Thomson of General Electric brought his telescope to his factories in order to show his workers the canals of Mars with their own eyes!

Tesla and the extraterrestrials. Quite naturally, Tesla, who like the others, had followed the interplanetary developments for decades, did not want to be eclipsed by such competitors as Thomson or Edison. Therefore, he proclaimed boldly that the time finally arrived: communication with our extraterrestrial neighbors had (probably) begun.

Perhaps due in part to a friendly sparring match of spectacular articles, the brother-in-law of George Lathrop, *Philadelphia North American* columnist Julian Hawthorne came to Tesla's aid and authored a series of rather detailed treatises on the inventor's philosophy, laboratory, and fabulous electronic experiments...and also his work in interplanetary communication.

In an article entitled, "And How Will Tesla Reply To Those Signals From Mars?" Hawthorne wrote: "Mars, for example, is several millions years older than this little dot of an Earth of ours...How we stare at the Neanderthal skull and try in vain to reconstruct for ourselves a mode of existence the date of which in contrast with the superiority in age of Mars over us, is but as yesterday...Think what prophecies we are hazarding as to the miracles we will achieve before the year 2000...Measuring against that standard, then, to what height shall we have attained this day in a million years?...

"The other day, there happened to Mr. Tesla the most momentous experience that has ever visited a human being on this Earth. Three soft impulses travelling with the speed of light were received by Tesla in Colorado from some Tesla on the planet Mars!

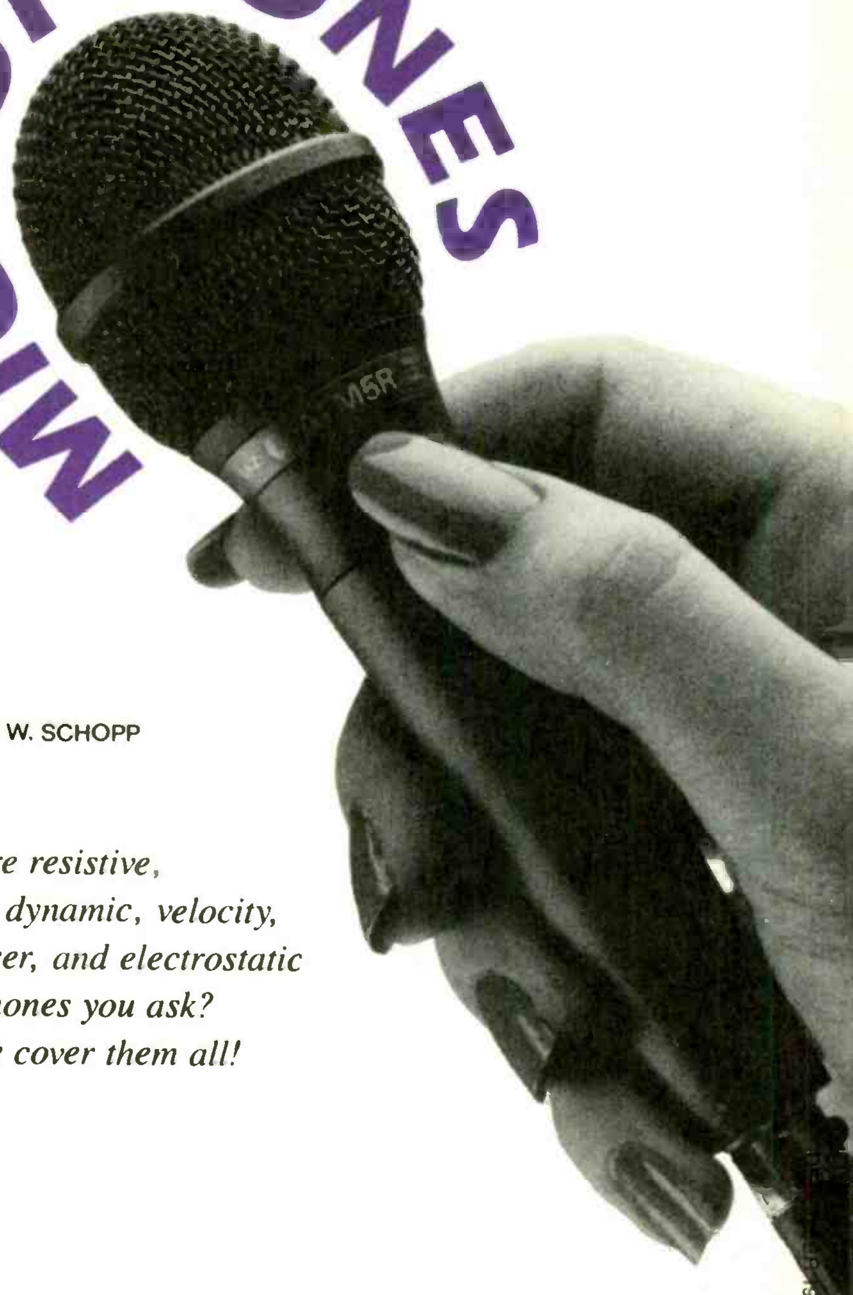
"...No thoughtful man can have much doubt then, that little as we are aware of it, we must for many ages have been subjected to the direct inspection and familiar approach of the men of Mars and of the other older planets. They visit us and look us over...year after year; and report at home: They're not ready yet! But at

(Continued on page 102)

All About MICROPHONES

BY WALTER W. SCHOPP

What are resistive, crystal, dynamic, velocity, condenser, and electrostatic microphones you ask? Here we cover them all!



No matter how many times you have watched the news on TV, you may never have noticed the small microphone clipped to the tie or lapel of the newscaster. Those microphones are about the diameter of a pencil, and are less than an inch long. Often, two of the tiny microphones are worn side by side in case one fails during a broadcast. Fifty years ago, if you were even able to fit two high-quality microphones on your lapels the odds are that they would have ripped the lapels off your suit. Over the years, research has reduced the size and increased the performance of microphones, but the principles for converting sound waves to electrical signals have remained the same.

You can use the sound waves striking a thin diaphragm to alter inductance, capacitance, or resistance, or compress a crystal to accomplish that conversion. Further, there are enclosure-design modifications that will make the microphone directional or non-directional. And there are microphones with a variety of output impedances and output levels. Without getting bogged down in the technical aspects of all the variations, let's look at some of the basic methods used to convert sound waves into electrical signals.

Variable Resistance. One of the earliest conversion methods used was to vary a resistance. That method was used in the design of the carbon microphone; see Fig. 1. Carbon microphones are very rugged, which is why they were used for telephone and military communications well into the 50's.

The theory of their operation is simple: As the sound waves impinge on the diaphragm, causing it to vibrate, the carbon granules behind the diaphragm are compressed. As the pressure on the carbon particles is increased and decreased, the resistance across the granules changes, and the current through the carbon varies with the audio.

One of the idiosyncrasies of that type of microphone is that occasionally the granules will compress and stick together. When that happens, the microphone suddenly becomes insensitive and can only be fixed by sharply rapping it against a solid object to jar the granules apart.

As a further inconvenience, since those microphone do not generate an electrical signal, they require a power

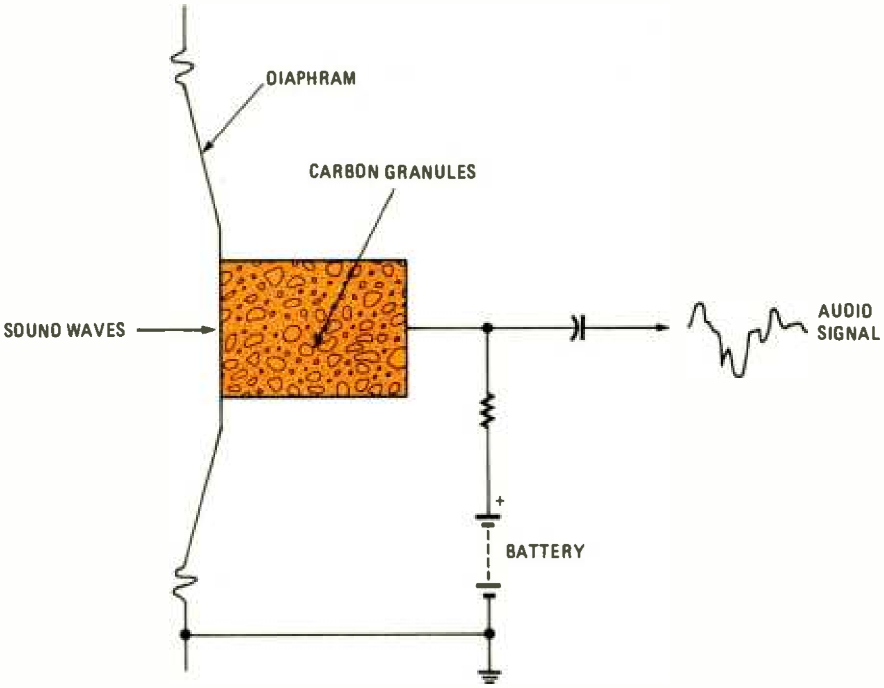


Fig. 1. The carbon microphone is one of the oldest audio-to-electric conversion devices around. It was developed by Thomas A. Edison.

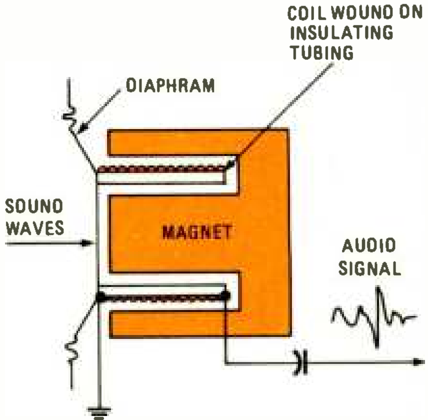


Fig. 3. A dynamic microphone works by inducing a current in a vibrating coil around a stationary magnet.

source that they can modulate to produce an electrical signal.

Crystal Microphones. It has long been known that a Rochelle-salt crystal will change voltage into mechanical movement or mechanical movement into voltage. A microphone can be designed based on that *piezoelectric* effect of the crystal; see Fig. 2. As the sound waves cause the diaphragm to vibrate, pressure is applied to the crystal. An alternating output voltage is produced that follows the input sound waves. That type of microphone needs no external power supply and will produce a hefty output in the millivolt range. Crystals have a disadvantage because their output is affected by high temperature and moisture. However, research has found that certain types of ceramic materials also display the piezoelectric effect. Those can be used for making microphone elements that are not affected by temperature and humidity.

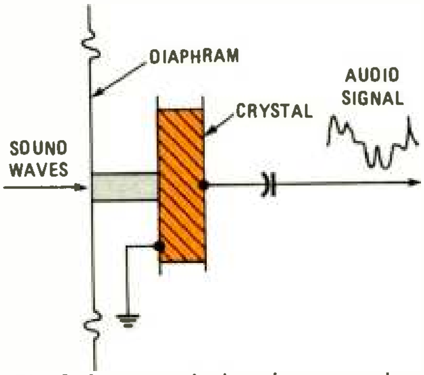


Fig. 2. In a crystal microphone, sound waves push the diaphragm into a piezoelectric crystal to produce voltage, which is then amplified.

Dynamic Microphones. The dynamic microphone uses the same principle as the loudspeaker, but in reverse. A loudspeaker will not only change an audio voltage into sound, but it will also change sound into an audio voltage; see Fig. 3. As the sound waves strike the diaphragm of the microphone, the diaphragm moves in and out. A small coil located in a magnetic field is attached to the diaphragm. As the coil moves in the magnetic field, it cuts through magnetic lines of force, inducing a voltage in the coil winding. The alternating voltage induced in the coil follows the sound waves in both intensity and direction (forward movement/positive current; reverse movement/negative current). When built with the proper materials, that type of microphone is fairly rugged and insensitive to heat and humidity. Dynamic microphones are inherently low-impedance devices, but their output impedance can be matched to any desired impedance by using a matching amplifier or transformer.

Velocity Types. The ribbon or velocity microphone was originally introduced in 1934 and represented a great improvement in frequency response over other microphones of that era. The microphone uses a thin, corrugated-aluminum ribbon suspended between the two poles of a magnet, see Fig. 4. When sound waves cause the ribbon to vibrate, the ribbon cuts through the magnetic field, causing a small current to be induced in the ribbon.

The physical arrangement of the parts making up the microphone element only allow sound to directly impinge on the ribbon from the front or back side. That makes the element bidirectional

The output impedance of the ribbon is very low and must be raised by using a step-up transformer. The voltage produced by it is very small and must be amplified to a usable value.

Condenser Microphones. Another type of high-fidelity microphone is the condenser or capacitor type. That microphone uses a diaphragm as one plate of a capacitor. Sound waves striking the diaphragm change the geometry of the plates, and hence the capacitance. See Fig. 5. The diaphragm is a tightly stretched metal or metalized plastic film. Behind the diaphragm is a metalic "button" that acts as the other capacitor plate.

The capacitor is polarized by applying 100–200 volts DC through a very-high resistance. As the diaphragm vibrates, capacitance changes appear as voltage changes when taken from the top of the load resistor in Fig. 5. Used with that circuit configuration, the microphone will directly convert capacitance variations into a varying audio-signal voltage.

The polarizing voltage can be re-

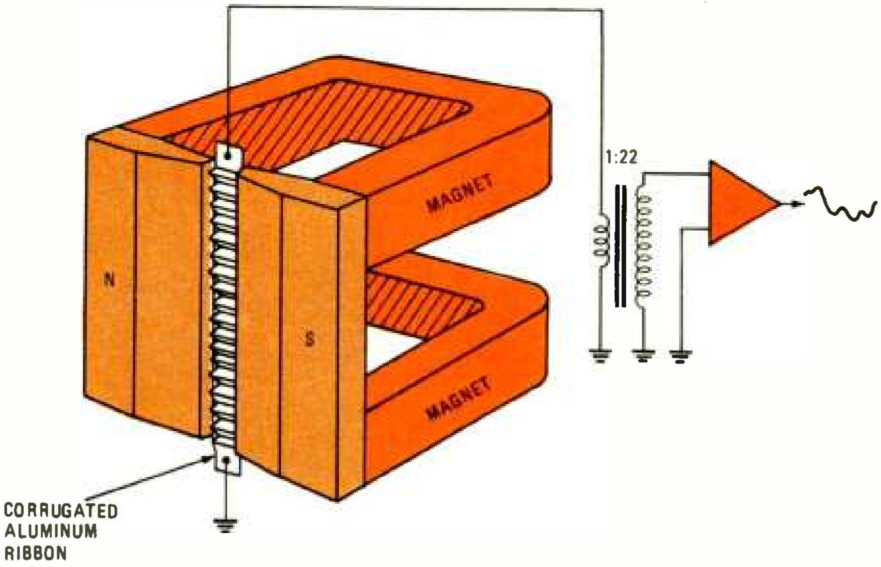


Fig. 4. Velocity microphones are rather interesting devices that are somewhat similar to dynamic microphones. However, the voltage is induced in a vibrating corrugated strip of aluminum instead of the windings of a moving coil.

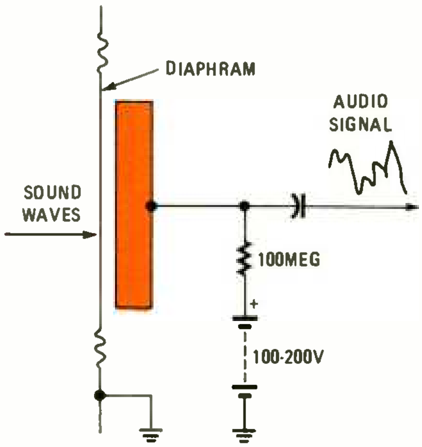


Fig. 5. The condenser microphone has a diaphragm that is one plate of a capacitor whose value varies with the sound waves striking it.

moved and the element connected as one of the resonant LC components of an oscillator circuit (see Fig. 6). That type of circuit will produce a frequency-modulated output that will deviate with the sound wave input. When used in such a configuration, frequency drift must be minimized to prevent changes in sensitivity.

Electrostatic Units. Originally developed in 1935, the electrostatic capacitive microphone is not new. But it gained popularity slowly due to technical problems and production costs. Today, modern plastics and solid-state developments have made it a very economical choice.

The plastic film used for the diaphragm has a thickness of .0025 to .005 inches. A gold conductive surface around 200-angstroms thick is evaporated onto one side of the plastic film. An angstrom is one-hundred millionths of a centimeter, and a centimeter is .3937 of an inch. It is obvious that the metallic coating is very thin.

The plastic film is then sandwiched between two metal plates charged with high voltage. Those plates are heated to a temperature just less than the melting temperature of the plastic and then cooled. When the plastic is cooled, the molecules in the plastic are permanently rearranged so that the plastic film retains a static charge. That makes a polarizing high voltage becomes unnecessary.

In operation, the capacitive changes are introduced between the charged film and a field-effect transistor gate (see Fig. 7) just as they are in the conventional condenser microphone. The output is taken from the top of a source resistor. That configuration lowers the high impedance of the capacitor element to a usable value determined by the value of the source resistance. The diaphragm can be made quite small in diameter and the FET can be an intricate part of the element housing. That method of construction accounts for the small physical size of that microphone.

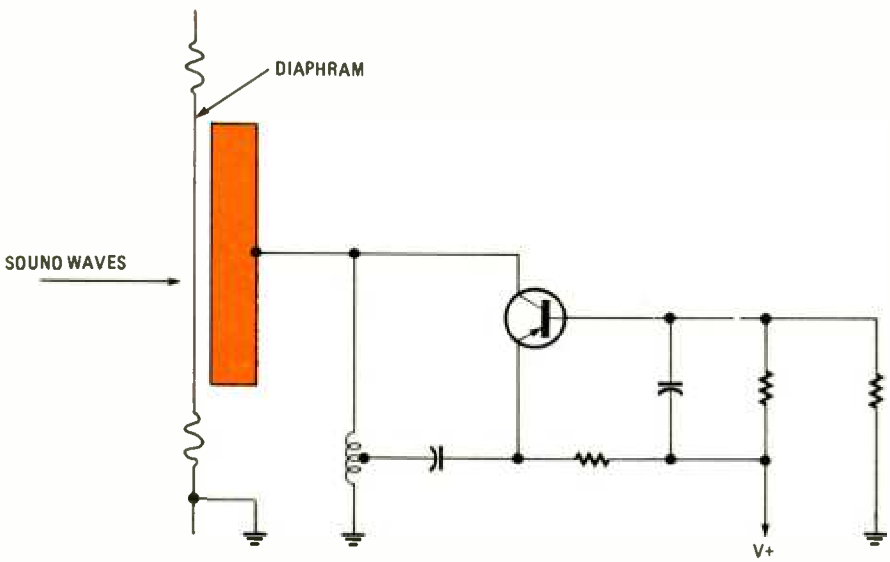


Fig. 6. When a condenser microphone is used as part of a tank circuit, it can use audio signals to frequency modulate a carrier directly.

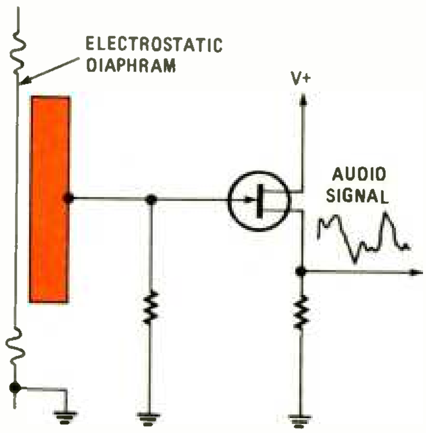
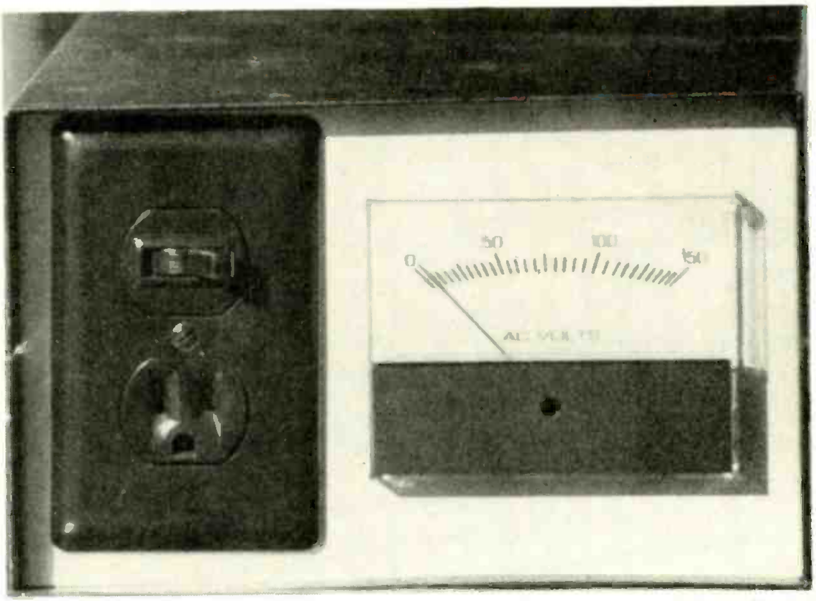


Fig. 7. Electrostatic microphones are really hi-tech condenser microphones with one capacitor plate made of a metalized plastic sheet.

Future microphone research may or may not turn up any radically new methods of converting sound into voltage. Research will surely continue to improve frequency responses, develop more predictable directional traits, and reduce susceptibility to adverse conditions. ■

Isolate Yourself and Stay Alive!



Our hobby is fun, but it is easy to make a mistake that could do you harm. Our Isolator prevents problems so you can avoid cures.

BY JOSEPH J. CARR

Few people see electronics as a potentially dangerous hobby on a par with, say, motorcycle racing or watching a British soccer match; but there is danger aplenty for the the unaware or careless hobbyist. The 110-volt alternating current from an AC-power socket can wrench your life away from you wihtout much ado.

And don't believe a lot of "old wives tales" about it being current that kills, not the voltage, whatever *that* is intended to mean. A 117-VAC line is darn dangerous and will kill you. Unfortunately even physicians believe such misinformation (sigh). For almost eight years I worked in the bioelectronics laboratory of a major east-coast medical center. One day I overheard an intern stating with annoying authority: "They told us in medical school that it's not the voltage that kills, but the current; so don't worry about the 117 volts from the wall socket—it's safe."

I looked across the table at him and asked in a semi-sarcastic tone: "Have you ever heard of Ohm's law, Doctor?"

What the young doctor was unknowingly referring to is the fact that the presence of high current density in a certain region of the heart is what causes death by electrocution. The mechanism of death is *ventricular fibrillation* (irregular and uncoordinated heart action), which leads to death in minutes if no one initiates cardiopulmonary resuscitation (commonly called CPR) and gets the victim to the hospital immediately. Since immediate CPR treatment is the only support mechanism that will get the victim to the emergency room alive, it is wise for all shops to have a few people trained in CPR. Also, families in which a member works with electronics would do well to have another member trained in CPR.

Source of the Danger. Figure 1 shows a simplified schematic of the standard residential-power system used in the United States. The power company distributes electrical power in the form of high-voltage alternating current (denoted HVAC). That form of current can be more efficiently transmitted than low-voltage current because the ohmic losses are less. When the power line gets to a point close to your home it is connected to a step-down transformer (called a "pole pig") with a center-tapped secondary that produces about 240 VAC across the two extreme ends, and 117 VAC between the grounded center-tap and either extreme end. That is the reason why the power company brings three lines into your home: neutral (which is grounded at some point), HOT1, and HOT2.

Those lines are distributed to the branch circuits in your home through an electrical box (or fuse box). Each 117-VAC line consists of at least two wires: a hot line and the neutral. Most modern outlets also have a ground line that is connected to the electrical box at the service entrance.

So, where's the trouble? If you are barefoot, or are wearing conductive shoes (such exist!), or have canvas, rubber or leather soles that are soaking wet, then you are effectively grounded. Accidental contact with the 117-VAC hot line will allow current to pass through your body, setting off ventricular fibrillation—leading to death.

There are a number of dangerous scenarios that can lead to injury for an electronics hobbyist: frayed power cords on power supplies or tools; troubleshooting live equipment without paying careful attention to where the AC snake is coiled; plugging in a project that is not ready to receive power safely; and the list goes on.

The Solution. The best solution to the problem is to "lift" the AC power line off ground through a floating-AC power system. Figure 2 shows a transformer-

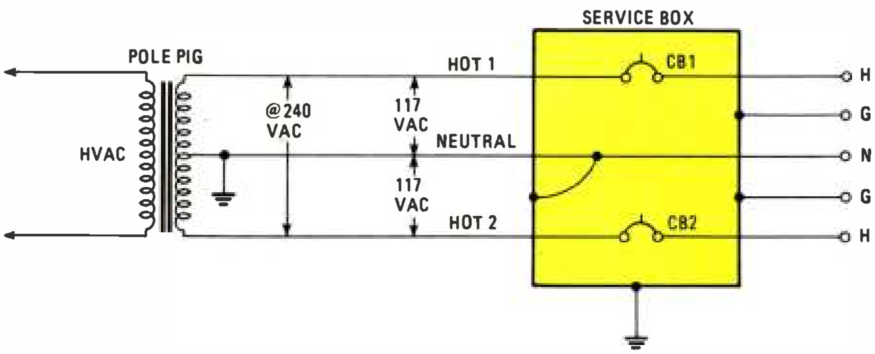


Fig. 1. Unlike what you may have imagined, two hot lines enter your house at the same time; each of them carries 117 volts potential to ground (also used as neutral).

isolated AC power system. The transformer has a 1:1 turns ratio so 117 VAC can be "converted" to floating 117 VAC. The important thing to note is that the primary circuit is ground referenced because the AC power line is grounded through the neutral, but the secondary is completely floating—neither line is connected to ground.

The isolation-transformer idea is an old one, and one you should take advantage of if you work on live circuits or in building DC power supplies. In a hospital, it is common practice to use an isolated power supply in each operating room for patient safety. In fact, if you are unfortunate enough to have surgery, take note of the stainless-steel alarm panel on which the clock is mounted. Behind that panel is a 5-, 10-, or 20-KVA isolation transformer and various monitoring devices to keep the system safe.

Television- and audio-service technicians also use isolation transformers. One of the photos shows a typical service-person's isolation transformer. Such devices allow the service technician to adjust the voltage level to the specified value (e.g. 117 VAC) even though the actual line voltage is anything between 105 and 125 VAC.

Alternatively, the technician might want to set the voltage either lower or higher to check some particular aspect of the device under test.

Another form of isolation transformer is for use with computers, digital electronics, and other sensitive instruments (see photo). It not only provides necessary isolation, but also noise suppression. The author has seen those transformers solve a lot of odd intermittent problems in computer installations. Power-line transients can disrupt digital circuits (of course including computers), and the transformer suppresses those transients.

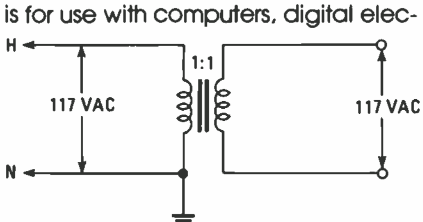


Fig. 2. The 117 volts that is grounded on the primary (power) side of the transformer, is lifted in the secondary.

Making Your Own Isolation Unit. Isolation transformers can be bought from any number of sources, including many major electronic-parts suppliers. They can also be bought from electronics-surplus outlets, or local electronics parts stores. I bought an industrial-surplus transformer at a local shop and built the bench isolator shown in the photos.

Figure 3 shows the circuit for the isolator box that I built. The transformer has three 117-VAC windings. The transformer mentioned in the Parts List is rated at 115 volts, so keep that in mind if you build your Isolator with that unit. The primary winding is connected to an AC power switch, S1, and a fuse, F1.

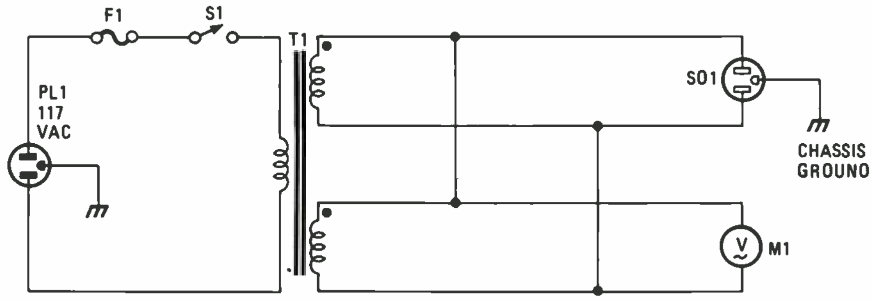


Fig. 3. The dots above the secondary coils for the Isolator indicate their phasing. Be sure they are in phase before completing the wiring of the unit.

PARTS LIST FOR THE ISOLATOR

F1—6-amp fuse (based on transformer value; see text.)
M1—150-VAC meter
PL1—Three contact AC-line computer plug
S1—AC-power switch, wall-mount type or equivalent.
SO1—AC-outlet type socket
T1—115-VAC, isolation transformer

Computer power cord, cabinet, face plate (if needed; see text), fuse holder, grounding lugs, locknuts, screws, solder, wire, etc.

A 115-volt, 0.2-amp per secondary transformer, Type PPC-29, (stock no. 44F2392) is available from Newark Electronics; Tel. 312/989-7800 for the branch nearest you.

It receives power from the AC line through a standard computer cord. The size of the fuse depends on the size of the transformer. The transformer used in the prototype was a 650 volt-ampere unit, so by 650-VA/117-V we know that it will produce a little more than 5 amperes. That is more than the unit specified in the Parts List will produce, so select a more powerful (read that: more expensive) unit if you require it. (The supplier mentioned in the Parts List offers a wide variety of appropiate units.) I selected a 6-ampere slow-blow fuse accordingly.

Note from the photo that the AC outlet and the power switch are part of the same assembly, mounted behind an outlet cover plate. Both the cover plate and the switch/outlet were purchased at a local hardware store. The output meter is a 0–150-VAC meter bought at a local electronics supply house for about $16. The cabinet is a standard hobbyist-grade metal cabinet. The fuse holder and power socket are mounted on the rear panel of the unit.

It is important that you connect the ground lead from the AC input socket on the rear panel, and the ground lead from the AC outlet on the front panel, to the chassis. The paint should be scraped off the chassis if necessary,

(Continued on page 101)

E-Z MATH

NORTON'S THEOREM and CURRENT SOURCES

By Louis E. Frenzel

Norton's equivalents are not look-alikes from The Honeymooners; *they can help break any circuit down into a current source and resistance*

There are lots of different ways to analyze electronic circuits. In the past two issues, we have shown you how to use Thevenin's theorem and the superposition theorem to convert circuits into equivalent voltage sources. Any complex circuit can be rearranged so that it can be represented by an equivalent voltage source in series with an internal resistance and the load. With the circuit in that simplified form, calculations regarding output voltage and current for different load values can be quickly and easily performed.

But not all circuits respond to such treatment. Some circuits contain current sources rather than voltage sources. For those, other techniques must be used. For example, Norton's theorem can be used to convert a circuit into a simple parallel network containing a current source and a parallel-internal resistance.

In this month's installment we are going to introduce you to Norton's theorem and a method of circuit analysis using it. Later, we will discuss practical current-source circuits and some of their applications.

Current Sources. A current source is a generator that supplies a fixed current to any value of load resistance connected to it. An ideal current source will supply that fixed value of current into an open circuit or a short circuit and any resistance value between the two. Of course, there are no perfect current sources. However, in practice it is possible to construct current sources that will supply a single current to a wide range of loads with little deviation.

Most electronic circuits are designed to be voltage sources. As you may recall from the last two articles of the series, we defined a voltage source as a generator that produces a constant output voltage regardless of the load impedance. In order to achieve that kind of performance, a voltage source must have zero internal resistance. Such perfect voltage sources do not exist, but many do have extremely low internal resistances, and so closely approximate a perfect voltage source. Batteries and electronic power supplies are excellent voltage sources. Any electronic circuit with a low output impedance (low internal resistance) is a good voltage source.

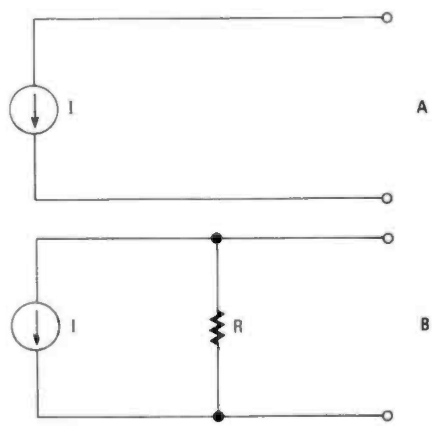


Fig. 1. The standard current source (A) is really like an ideal current source in parallel with its inherent internal resistance (B).

With low output impedance, varying load resistance has little or no effect on the output voltage.

There are some applications in electronics that require a constant current rather than a constant voltage. That is where current sources become useful. With a constant output current, varying load resistances have little or no effect on the output current.

A current source is usually represented by the symbol shown in Fig. 1A. The arrow points in the direction of current flow. If we were to observe electron flow (and we will for our discussion), the arrow points in the direction of the electron flow. If conventional current flow (the movement of holes) is assumed, the arrow would point in the direction of that flow.

Just as practical voltage sources have a finite internal resistance, so do current sources. A practical current source is shunted by an internal resistance, designated R in Fig. 1B. In a cur-

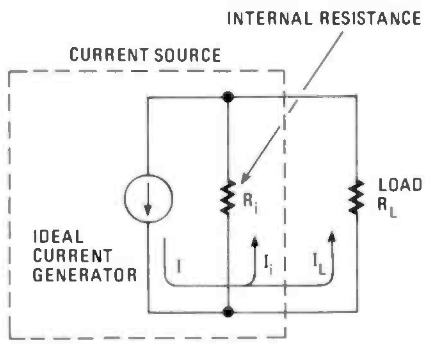


Fig. 2. The internal resistance of a practical voltage source steals some of the current from the supply.

rent source, the internal resistance appears in parallel with the source. A perfect current source will have an infinite value of R. The internal resistance in a practical current source will not be infinite, but will instead be some finite but usually high value. The higher the internal resistance, the better the current source.

You can see why that is by simply looking at the current source in Fig. 2. If it generates a fixed current, I, some of that current will pass through the internal resistance, R_i. The current supplied to the load, I_L, will be less than the current produced by the generator. In Fig. 2:

$$I_L = I - I_i$$

where I_L is the load current, I is the constant current produced by the generator, and I_i is the current through the internal resistance. A high value of internal resistance compared to the load resistance, will only shunt away a small amount of current so that most of the current produced by the generator will pass through the load.

When no load is connected to the current source, then all of the current produced by the generator will flow through the internal resistance. When a load is connected, the current will be divided between the internal resistance and the load.

The primary reason for working with a current source rather than a voltage source is because it is sometimes easier to analyze a network in terms of current. That is particularly true when the circuit you are working with contains many parallel branches. If the circuit is primarily series, then it is usually better to use a voltage source and Thevenin's theorem for analysis.

Norton's Theorem. Norton's theorem states that any linear circuit can be replaced by an equivalent circuit consisting of a current source and its parallel internal resistance connected to the load. Norton's theorem defines the mathematical procedures used to compute the Norton's-equivalent circuit. The process is best illustrated with an example.

Refer to Fig. 3A. That network consists of a battery plus a resistive network connected to a load. Our job is to convert that circuit into its Norton's equivalent. The battery plus the circuit consisting of R1 through R3 will be translated into an equivalent current source with its internal resistance.

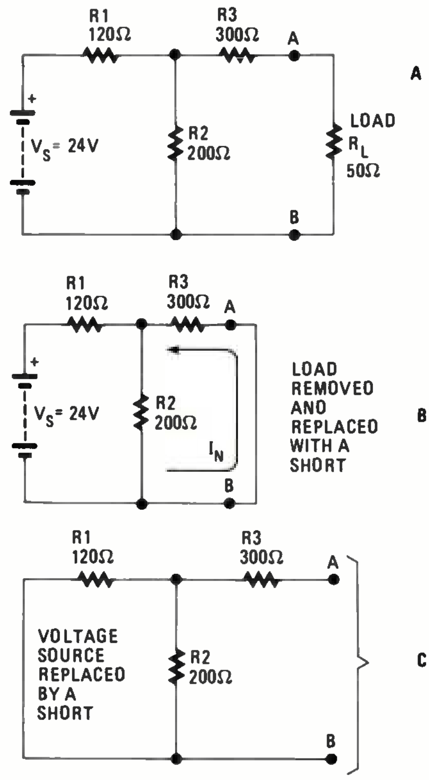


Fig. 3. The steps in calculating the Norton's equivalent of a circuit (A) are reviewed diagramatically here. Drawing B displays the load replaced by a short, and C shows the source replaced by a short.

There are two steps to determining the Norton's equivalent of a circuit. The first step is to calculate the Norton's-equivalent current, I_N. That is usually referred to as the short-circuit current. That is the amount of current that will flow if the load is replaced with a short circuit. It is also the current that a load will see when connected to the Norton's-equivalent generator.

The other part of the calculation is to compute the equivalent internal resistance, R_N. That is the total resistance appearing across the load terminals. Now, let's take a look at the procedures you use to calculate the Norton's-equivalent generator.

The rules for determining the Norton's-equivalent circuit can be summarized as follows:

1. Disconnect the load from the output.
2. Short across the output (load) terminals.
3. Calculate the current in the short. That is the Norton's-equivalent current, I_N.
4. Remove short from output terminals.
5. Replace voltage source with a short.
6. Calculate resistance between the output terminals (with the load still disconnected.) That is the Norton's-equivalent resistance, R_N.
7. Connect a current generator, I_N, in parallel with R_N to form the complete Norton's equivalent.
8. Reconnect the load and make any additional calculations.

Let's apply those steps to the circuit in Fig. 3A. First, we remove the load between terminals A and B. Then, we short terminals A and B. It is through that short that the Norton's-equivalent current will flow. See Fig. 3B. The Norton's-equivalent current, I_N, then is the current through R3 and the short. We can use Ohm's and Kirchhoff's laws in determining that current value.

To do that, we must first calculate the total circuit resistance. That is the parallel combination of R2 and R3 in series with R1:

$$R_T = R1 + R2R3/(R2 + R3)$$
$$R_T = 120 + 200(300)/(200 + 300)$$
$$R_T = 120 + 60{,}000/500$$
$$R_T = 120 + 120 = 240 \text{ ohms}$$

The total current drawn from the voltage source is:

$$I_T = V_S/R_T = 24/240 = .1 \text{ amp}$$

That current produces a voltage across R1 of:

$$V_1 = I_T R1 = .1(120) = 12 \text{ volts}$$

Now, according to Kirchhoff's law, that leaves:

$$24 - 12 = 12 \text{ volts}$$

across R2 and R3. The current in R3 is the Norton's equivalent, which we can calculate by Ohm's law:

$$I_N = 12/300 = .04 \text{ amp}$$

Next we need to compute the Norton's-equivalent resistance, R_N. To do that, we remove the short from between terminals A and B. Then we replace the battery with a short circuit. We can now compute the total resistance of the network between terminals A and B as shown in Fig. 3C. That is the resistance of R1 and R2 in parallel connected in series with R3. The resistance calculations are as follows:

$$R_N = R1(R2)/(R1 + R2) + R3$$
$$R_N = 120(200)/(120 + 200) + 300$$
$$R_N = 24{,}000/320 + 300$$
$$R_N = 75 + 300 = 375 \text{ ohms}$$

Now, the total Norton's equivalent can be drawn. It is a current source with a value of .04 Amp in parallel with the Norton's-equivalent resistance, R_N, of 375 ohms. When the load is recon-

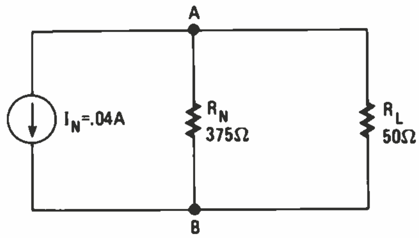


Fig. 4. Finally you will arrive at this Norton's equivalent of the circuit in Fig. 3 after you follow the steps.

nected, the value I_N will flow in the load. See Fig. 4. The load voltage, V_L, is then:

$$V_L = I_N R_L$$
$$V_L = .04(50) = 2 \text{ volts}$$

As you can see, a complex circuit with a voltage source can be reduced to its Norton's equivalent containing a current source. That allows you to make current calculations in a parallel circuit. You can, of course, convert the circuit to its Thevenin's equivalent and work with a voltage source and a series circuit. The choice is yours. In either case, you simplify the original circuit to make analysis and design faster and easier.

Exercise Problem. Now try the procedure yourself.

1. Convert the circuit in Fig. 5 into its Norton's equivalent.

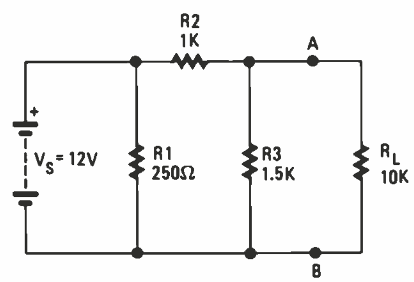


Fig. 5. Remember to use what you've learned to solve for this circuit.

Converting Thevenin to Norton. As you saw in the previous example, a circuit with a voltage source can be converted into a Norton's equivalent with a current source. You can also take a circuit with a current source and convert it into a Thevenin's equivalent with a voltage source. It all depends on the circuit and the kinds of calculations you want to make. You may wish to convert back and forth to make the optimum calculations on a given circuit. The easiest way to do that is to convert between the Thevenin's and Norton's equivalents. Let's consider how to do that.

In the previous example, we converted the circuit in Fig. 3A into its Norton's equivalent shown in Fig. 4. Suppose we want the Thevenin's equivalent instead. We could go back to the original circuit and apply the Thevenin's conversion steps, but that is too time consuming. It's easier to use some simple conversion formulas.

To convert the Norton's equivalent to the Thevenin's equivalent, first remove the load and apply these formulas:

$$V_{Th} = I_N R_N$$
$$R_{Th} = R_N$$

Remember, V_{Th} is the Thevenin's-equivalent voltage while R_{Th} is the Thevenin's-equivalent series resistance.

Using our previous example then:

$$V_{Th} = I_N R_N$$
$$V_{Th} = .04(375) = 15 \text{ volts}$$
$$R_{Th} = R_N = 375 \text{ ohms}$$

So, the Thevenin's equivalent of the circuit in Fig. 4 is given in Fig. 6.

You can also go the other way. Assume the Thevenin's equivalent in Fig. 7A. To get the Norton's equivalent, you use these formulas:

$$I_N = V_{Th}/R_{Th}$$
$$R_{Th} = R_N$$

Applying them with the values in Fig. 7A, we get:

$$I_N = V_{Th}/R_{Th} = 7.5/100 = .075 \text{ amp}$$
$$R_{Th} = R_N = 100 \text{ ohms}$$

The Norton's equivalent is shown in Fig. 7B.

Exercise Problems. Practice the concepts with these problems:

2. Change the Norton's-equivalent circuit you derived from Fig. 5 into its Thevenin's equivalent using the conversion formulas. 3. Convert the circuit in Fig. 8 into its Norton's equivalent using the conversion formulas.

Superposition with Current Sources. In the previous article, I discussed the superposition theorem. It is extremely helpful in simplifying circuits with two or more voltage sources. It can also be used on circuits with two or more current sources.

The superposition theorem states that:

"The current through (or voltage across a component in a linear circuit is the algebraic sum of the currents (or voltages) produced by each current (or voltage) source acting independently."

To use the superposition theorem, you disable all but one source, then calculate the various currents and voltages. Then, you repeat that with the other sources. Finally, you add up

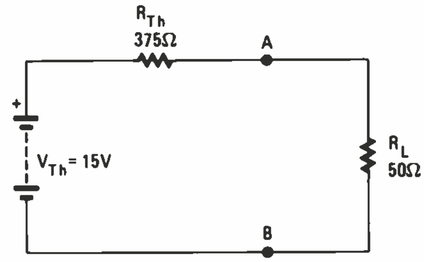


Fig. 6. This Thevenin's equivalent can be generated from the Norton's equivalent in Fig. 5.

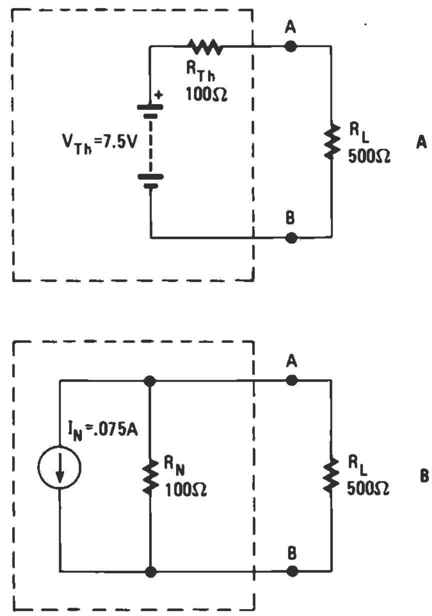


Fig. 7. The Thevenin's equivalent in A can be converted into a Norton's equivalent shown in B.

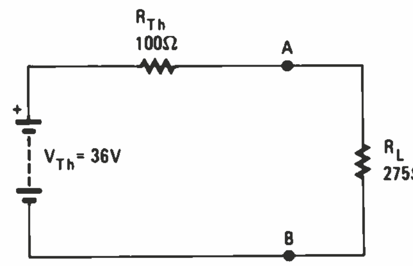


Fig. 8. Use the handy formulas in the text to convert this Thevenin's equivalent into a Norton's equivalent.

the currents and voltages to get their combined effect. Let's see how to do that in a circuit with two current sources.

Refer to Fig. 9A. We want to find the voltage drop across R2. Note that current source I_1 produces current flow in one direction through R2, while source I_2 produces current in the opposite direction.

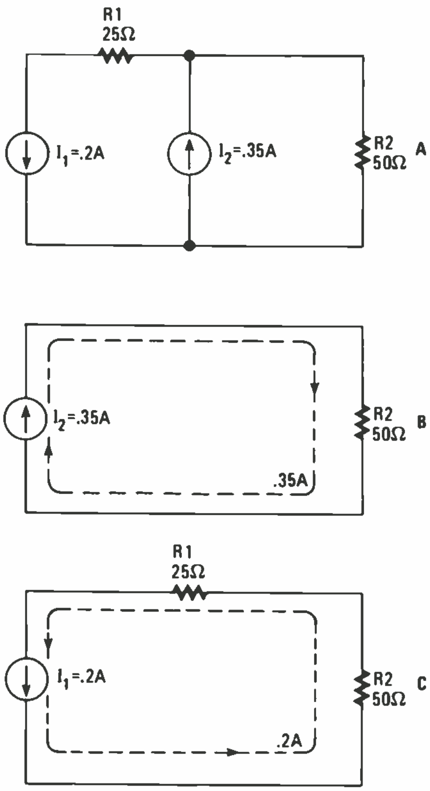


Fig. 9. When analyzing the circuit in A use the superposition theorem and ignore I_1 (as in B) first and I_2 (as in C) second and sum the results.

To solve the problem, we first disable I_1. To disable a current source, you remove it from the circuit and you leave the circuit open at that point. That's like replacing the current source with an infinite resistance. When working with voltage sources, you disable them with a short. You disable a current source with an "open." Anyway, the resulting equivalent circuit is shown in Fig. 9B. Note that R1 is removed since it is effectively not in the circuit. So the current in R2 is .35 Amp.

Now, we put I_1 and R1 back, and disable I_2. The resulting circuit is in Fig. 9C. The current in R2 then is .2 Amp, but in the opposite direction.

The composite current in R2 is then simply the algebraic sum of the two currents. Since the currents flow in opposite directions in R2, they oppose one another. So, the total current is the difference between the two currents, or:

$$.35 - .2 = .15 \text{ amp}$$

The direction of current flow is in the direction of the largest current. So in Fig. 9, the composite current in R2 flows from top to bottom.

Knowing the current in R2, we can find the voltage drop with Ohm's law:

$$V_2 = I_{R2} \times R2 = .15 \times 50 = 7.5 \text{ volts}$$

Exercise Problem. See how easy the process is by doing it yourself.

4. Find the current in R3 in the circuit in Fig. 10.

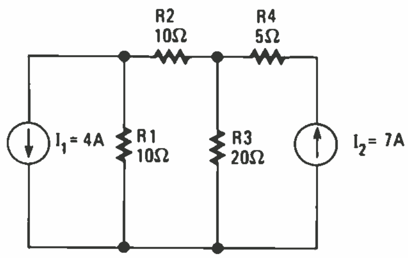


Fig. 10. Make use of superposition when analyzing this circuit.

Practical Current Sources. The basic characteristics of a current source are a constant output current regardless of the load resistance, and very high internal resistance.

Such a current source is difficult to realize with everyday electronic components. Therefore, we settle for a less than ideal current source which, in most cases, will do the job if we restrict the range of loads over which the current source must work. In practical applications, that is usually not a problem. With that in mind, we can now take a look at some of the ways that real-world current sources are implemented.

Voltage Source with Resistance. The easiest way to make a current source is to connect a very large value of resistance in series with a voltage source as shown in Fig. 11. The value of the resistance is made very high compared to the load resistance. In order for the circuit to act like a current source, the internal resistance, R_S, should be at least one hundred times the load resistance. If we assume a load resistance of 100 ohms, then the current-source resistance should be at least 10,000 ohms. In the example, we use an internal resistance of 1 megohms along with a voltage source of 15 volts.

We can use Ohm's law to figure out what the constant current supplied by the current source is. The load current, I_L, is:

$$I_L = V_S/(R_S + R_L)$$

Because R_L is so much lower than R_S, we can virtually ignore its effect. Therefore, the current supplied is very nearly equal to:

$$I_L = V_S/R_S = 15/1{,}000{,}000$$
$$= 15 \text{ microamperes}$$

If we should increase the load resistance from 100 ohms up to 10,000 ohms, suddenly the load resistance now becomes a much larger portion of the total-circuit resistance. Therefore, its effect must be taken into consideration. The total-circuit resistance in that case is:

$$1{,}000{,}000 + 10{,}000 = 1{,}010{,}000 \text{ ohms}$$

We can calculate the load current as before with Ohm's law:

$$I_L = 15/1{,}010{,}000 = 14.85 \text{ microamperes}$$

As you can see, the current in the load is less than the desired 15 microamperes, however, it is very close. For most applications, that value would be adequate. In fact, the current is actually 99% of the current with a zero ohm load. A 1% error is tolerable in most electronic circuits.

To maintain the current so that it is 99–100% of the constant current value, simply be sure that the load resistance is less than one-hundredth of the internal resistance of the source. In Fig. 11, with a 1-megohm source, the maximum value of load resistance is 1,000,000/100 = 10,000 ohms or 10,000

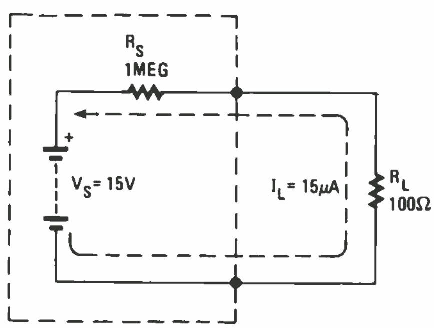


Fig. 11. If the load is restricted to a certain range, a voltage source with a resistor can be used as a simple constant-current source.

ohms. For values of load between zero and 10,000 ohms, the current will be within the 99–100% of the constant current value.

When designing a current source of that type, the job is to select supply voltages and series resistances that will provide the desired amount of current in the load. When very high values of current are required with high impedance, it is often necessary to use very high voltage values. That is usually impractical since most solid-state circuits use low-voltage power supplies. You can get the desired current by using a lower value of resistance, but often that resistance will be too low in value compared to the load to provide the constant-current effect. When that happens, some other form of constant-current source must be used.

Bipolar-Transistor Current Source. The simplest way to make a current source is to use a bipolar transistor as shown in Fig. 12A. A voltage divider made up of R1 and R2 applies a voltage, V_B, to the base of the transistor. That forward biases the emitter-base junction causing the transistor to conduct. Emitter current flows through resistor R_E. The amount of voltage across the emitter resistor is V_E. The value of V_E is equal to the base voltage less the voltage drop across the emitter-base junction, V_{BE}. Since V_{BE} is typically 0.7 volt in most silicon transistors, then V_E can be computed as follows:

$$V_E = V_B - 0.7$$

As an example, suppose voltage divider R1/R2 produces a base voltage of 5.7 volts. The voltage across the emitter resistor then is:

$$V_E = 5.7 - 0.7 = 5 \text{ volts}$$

Now assume that the emitter-resistor value is 2000 ohms. The emitter current then is:

$$I_E = V_E/R_E = 5/2{,}000 = 2.5 \text{ mA}$$

The emitter current flows into the emitter of the transistor, through the base, and into the collector. It then flows through the load resistance, R_L, to the supply. Remember in a high-gain transistor, the collector current is very nearly equal to the emitter current. In most cases, the base current that it uses up is extremely small and can be ignored. So, the collector current, being equal to the emitter current, provides a constant load current of 2.5 mA.

The way to set up a constant-current source is simply to choose the voltage-divider resistors R1 and R2 to provide the correct value of V_B and select a value of emitter resistance that will give the desired constant current with V_E. The nice thing about designing constant-current sources like that, is that you don't have to fool around with all of the transistor parameters such as

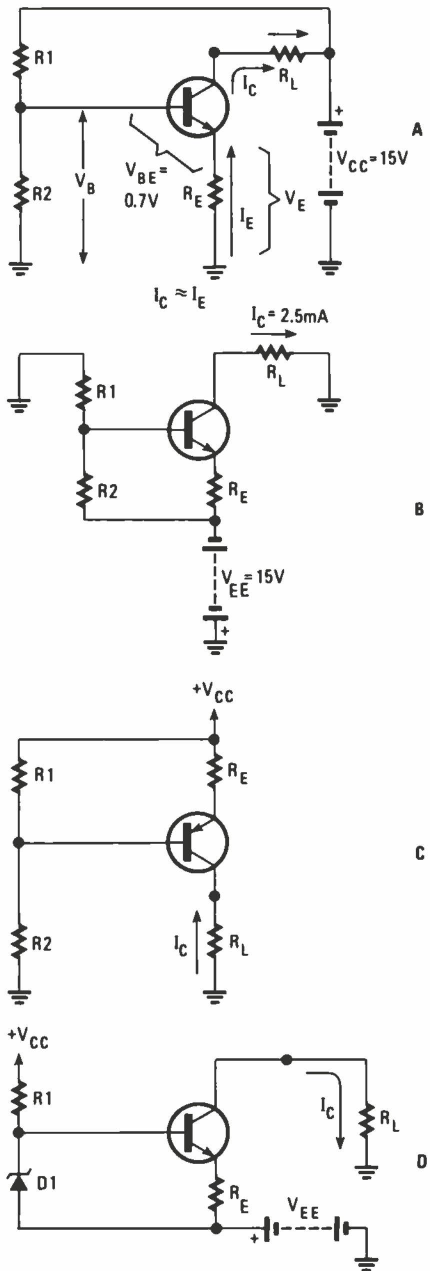


Fig. 12. The current source in A leaves the load floating. If the load must be grounded, the circuit in B can be used. If you also need the current to flow through the load in the opposite direction you can use the circuit in C. An improved current source with a Zener diode is shown in D. The diode sets the base voltage.

current gain. Because the circuit uses heavy negative feedback by way of the emitter resistor, the circuit characteristics are strictly a function of the external applied voltages and resistor values.

The circuit in Fig. 12A acts as a current source over a relatively wide range of load-resistance values. In the circuit, the load can be any value from zero up to approximately 4,000 ohms. By referring to the circuit, you can see why that is so.

When current flows through the circuit, 5 volts is dropped across the emitter resistor, some voltage is dropped across the emitter-collector connection of the transistor, while the remaining voltage is dropped across the load. The total of the three voltages must add up to 15 volts to satisfy Kirchhoff's law. As R_L is made higher and higher, the voltage redistributes itself and soon the relationship no longer holds true. For example, if the load resistance is made 10,000 ohms, the transistor would ordinarily try to force 2.5 milliamperes through it. That, of course, would produce a voltage of 25 volts across R_L. Since the supply voltage is limited to only 15 volts, naturally the circuit won't work. So even though you are limited to a narrow range of load-resistance values, again that is usually not a problem in most electronic circuits.

One of the problems with the circuit in Fig. 12A is that the load is floating. That is, one end is connected to the collector and the other end is connected to the positive terminal of the supply voltage, V_{CC}. In many applications, the load must be grounded. The problem can be corrected by simply rearranging power supplies and grounds in the circuit.

A different version of the circuit is shown in Fig. 12B. Here, nothing has changed except that we have switched from a positive supply voltage to a negative supply voltage connected to the emitter. The resistor values and the constant-current amplitude are the same.

If you need a grounded load, but the current must flow through the load in the opposite direction to that shown in Fig. 12B, you can use the alternate circuit shown in Fig. 12C. That circuit uses a PNP transistor, but otherwise all the resistor values are the same. With that arrangement, current now flows through the load in the opposite direction.

An improved current source is shown in Fig. 12D. That circuit is similar to that shown in Fig. 12B, but a Zener diode, D1, is used to set the base voltage. Resistor R1 sets the bias level through the diode. In critical applications requiring a very constant current, a Zener diode provides a stabilized voltage at the base of the transistor. That ensures that the output current remains constant despite circuit variations. In temperature-critical circuits, one or more standard silicon diodes are usually connected in series with the Zener diode to provide temperature compensation for both the Zener and the emitter-base junction of the transistor.

FET Current Sources. Field-effect transistors make ideal current sources because the drain current remains very constant with wide variations in source-to-drain voltage. That means that you can connect a wide range of load resistances to a basic FET circuit and maintain a constant current through it.

The basic FET constant-current source is shown in Fig. 13A. Here, an N-channel FET is connected so that its source and gate are shorted together. The drain is connected to the load resistance, R_L. The supply voltage, V_{DD}, completes the circuit. With that arrangement, the constant current supplied through the load is equal to the I_{DSS} current value of the FET. Most FET's have an I_{DSS} value in the zero to 10 mA range. By selecting an FET whose I_{DSS} value is the desired constant current, then the simple circuit in Fig. 13A can be used.

Again, the circuit in Fig. 13A contains a floating load. You can rearrange that circuit as shown in Fig. 13B so that the load is grounded. The gate and source are still shorted together, but a negative-source supply, V_{SS}, is used instead of the positive-drain supply as in Fig. 13A. By using P-channel FET's and making other changes in the power supplies, the direction of current flow through the load can generally be anything desired.

Levels of constant current different from the I_{DSS} FET value can be obtained by connecting a resistance in series with the source as shown in Fig. 13C. With the resistor R_S inserted, the constant current supplied to the load will be some value less than I_{DSS} depending upon the value of R_S selected. The higher the value of R_S, the lower the constant current in the load.

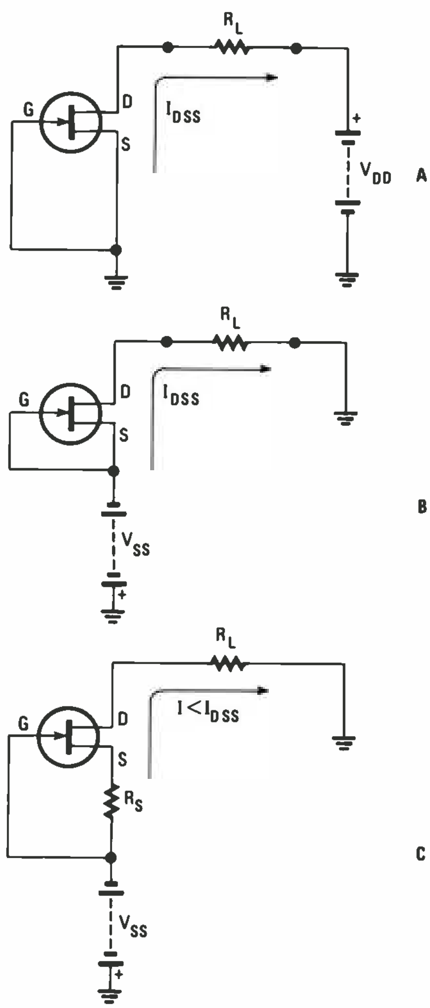


Fig. 13. FET current sources are very common now. Shown are the floating load type (A), grounded load type (B), and a circuit that can be set depending on R_S.

Pre-packaged FET current sources are also available. Those two-terminal devices are often referred to as constant current diodes or current-regulator diodes. They consist of an N-channel or P-channel junction FET with the gate and source connected together and/or with an appropriate source resistor. They are available in a wide range of current values. Such a component provides a convenient means of obtaining a constant-current source in a single two-lead package. The schematic symbols often used to represent constant current diodes are illustrated in Fig. 14. Simply connect one of the diodes in series with the load to the voltage source to provide the desired constant-current value.

Op-amp Current Sources. You can also use an IC op-amp as a current source as shown in Fig. 15A. That configuration is the familiar non-inverting

Fig. 14. Constant-current FET diodes are depicted in either of the two ways shown here. They are treated as diodes.

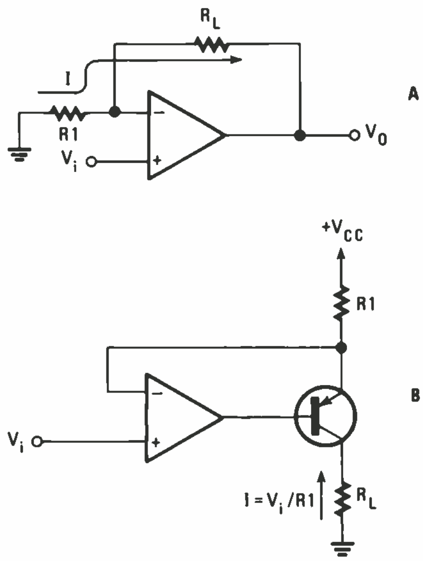


Fig. 15. You can also use an IC op-amp as a current source as shown in A That configuration is the familiar non-inverting amplifier circuit. If you don't want the load to float then the circuit in B is useful.

amplifier circuit. Ordinarily an input voltage, V_i, is applied to the non-inverting (+) input and the output is taken from the op-amp output and is designated V_O. That circuit can be used as a current source simply by connecting the load resistance, R_L, between the output and the inverting (−) input as shown in Fig. 15A. Since the op-amp inputs draw little or no current, then the current through the load resistance is equal to the current through the input resistor R1. Because of the feedback provided from the output of the op-amp back to the inverting input by R_L, V_O in the Fig. 15A is a virtual ground. That means the voltage across R1 is essentially equal to V_i. Because of that, you can now calculate the amount of current supplied to the load. That is:

$$I = V_i/R1$$

For example, if V_i is 6 volts and R1 is 4700 ohms, then the constant current through R1 is:

$$I = 6/4700 = 1.28 \text{ mA}$$

That current will also flow through the load.

In that circuit, the load is floating. Since that is often a disadvantage in some circuits, some means is usually required to use a grounded load. One arrangement is shown in Fig. 15B. A PNP transistor is connected to the op-amp output. The load is connected between the collector and ground. The output current is still equal to the value of the input voltage divided by R1. Other arrangements of NPN transistors and different power supply polarities will permit any desired output-current direction to be achieved.

So what do you do with a constant-current source? There are lots of different applications, but there are some widely used ones with which you should be familiar.

LED Driver. Current sources are often used as driver circuits for light-emitting diodes. To cause an LED to turn on, it must be forward biased so that a certain level of current passes through it. The brightness is directly proportional to the current value. When current flows through the LED, a voltage appears across it. For different LED's, that voltage can vary from approximately 1.7 volts to 2.5 volts for a single value of current.

One common way of driving an LED is to use a transistor switch as shown in Fig. 16A. Whenever a positive voltage is applied to the base of the transistor,

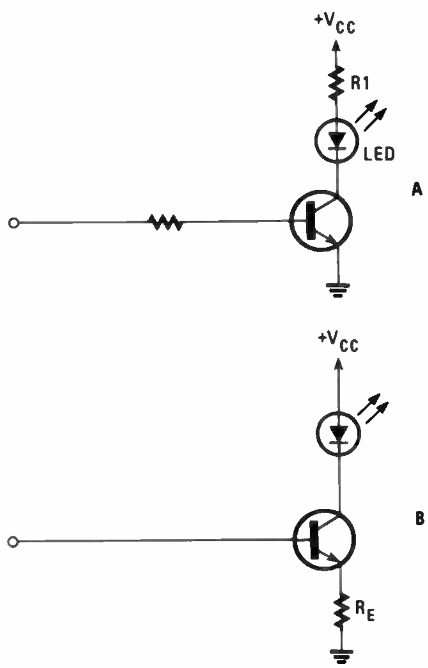


Fig. 16. LED drivers such as voltage drivers (A) and current drivers (B) can be made with one transistor.

the transistor turns on and acts as a very low value of resistance. It effectively grounds the cathode of the LED, turning it on. Resistor R1 is chosen to drop the supply voltage down to a voltage suitable for the LED. However, in using a voltage source to provide a particular LED voltage drop, LED's of the same type may have varying brightness levels because the current will be different in each, depending upon the value of R1 selected. As an example, assume multiple LED's are used to display a binary number. It is esthetically pleasing for all LED's to have the same brightness. The circuit in Fig. 16A doesn't guarantee it.

An improved method of driving an LED is to use a current source as shown in Fig. 16B. Whenever a positive voltage is applied to the base of a transistor, a voltage is developed across the emitter resistor, R_E. That sets the amount of current supplied to the LED. When multiple circuits are used, the current will be the same in each LED. While the voltage drops may vary, the brightness will be consistent.

Differential Amplifiers. A differential amplifier is an amplifier with two inputs and a single output. The output voltage is the difference between the two input voltages multiplied by the gain. A typical differential amplifier is shown in Fig. 17A. Bias is provided to the emitter-base junctions by way of the emitter resistor, R_E, and the emitter supply voltage, $-V_{EE}$.

In order for that circuit to perform correctly, the current supplied by $-V_{EE}$ and R_E must be equally divided between transistors Q1 and Q2. The currents are not always equal because of differences between the emitter-base voltage drops, transistor current gains, and the driving impedances of the inputs V_1 and V_2. Further, the input impedances of V_1 and V_2 should be made as high as possible. They are dependent on the value of the emitter resistor.

The basic approach to achieving those goals is to make the negative-supply voltage and the value of R_E as large as possible. But in practical circuits, there are limits. That is particularly true when differential amplifiers are made in integrated-circuit form as most of them are.

To overcome those problems, most differential amplifiers use a constant-current source in place of R_E. That is illustrated in Fig. 17B. Transistor Q3 is the

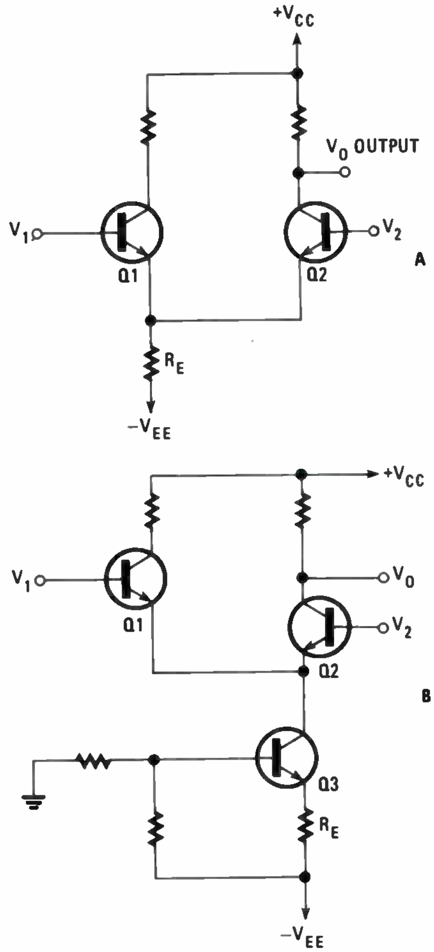


Fig. 17. A differential amplifier such as the one in A, can be improved if it receives constant current from the source. The circuit added to it in B provides it with constant current.

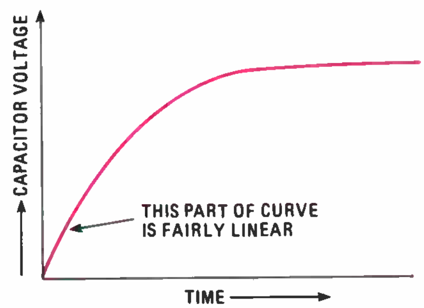


Fig. 18. As you can see, capacitors hardly charge in a linear fashion.

current source as described p' viously. It is biased by a voltage divi in that circuit, but a Zener diod other biasing arrangements may used in more critical application: any case, the constant-current sour greatly improves the performance of differential amplifier. Most differenti amplifiers used in integrated-circu

(Continued on page 9

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Circuit Circus

By Charles D. Rakes

CRYSTAL DIODE DETECTORS

I can't think of a more nostalgic time of the year than the present (when mother nature is tuning up for her *coup de grace* and the jolly old geezer in his red undies is about to play chimney sweep) to go back in time and reminisce about the good old days when all soldering was done with an American Beauty iron and batteries only came in A, B, and C sizes. And if the term solid-state was used at all, it was in reference the stature of a prominent citizen.

No, I wouldn't think of going back technically to the good old days, but it could be adventurous to enter a special "time machine" and apply our present day know-how to a popular subject of yesterday. As a youth, when the cold winds of winter howled outside, I could really enjoy settling down to building the latest-published AM-broadcast receiver (BC) circuit and stay up all hours of the night to see how well it would pull in those distant stations.

Of course, now you can purchase a super-sensitive AM/FM radio for less than a "Hamilton" and pick up Cuba and Canada almost any night. But, even in today's fast-paced world, there's still an-itch-that can only be scratched by the performance of a self-made project.

I'm sure you've noticed fewer things are free today, and getting something for nothing legally is a rare occurrence indeed, but with a smidgen of electronic wisdom and a few inexpensive parts it can happen.

RF Power Cell. Our first circuit turns back the hands of time to an era when the crystal-diode detector—better known as a crystal set—was in vogue, and listening to KDKA was the norm. Those very early diode detectors required no battery power and when operated close to a strong station, they could drive a horn speaker to a level that would allow several people to enjoy the program without wearing earphones.

Those crystal sets also did not require an off/on switch, because all operating power came in on the antenna from the station's transmitter, free to the listener. The majority of the stations in the early years were low powered and would not offer much volume to the crystal set user. However, today the air is saturated with a hodgepodge of energy spread throughout the entire RF spectrum.

The simple circuits shown in Figs. 1 and 2 are designed to take advantage of that abundance of free power. The circuit in Fig. 1 is nothing more than a modern-day version of a vintage crystal set with the tedious cat's-whisker detector, of Grandpa's day replaced with a modern 1N34A germanium diode. If you have ever tried to keep a cat's whisker detector in adjustment, you're sure to appreciate the solid-state replacement used in our circuits.

Note: The circuit shown in Figs. 1 and 2 are not designed for radio reception, but instead are designed to serve as *RF power cells*. Granted the output obtained from a single RF cell won't cause the local power company to shudder, but it doesn't send out bills.

Here's how the something-for-nothing circuit works. A long-wire antenna and an earth ground are connected to a parallel tuned circuit

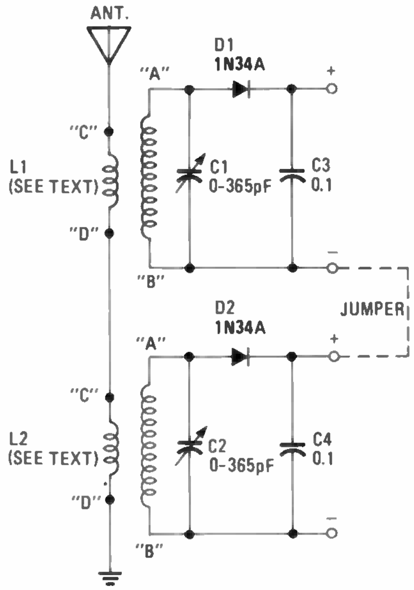


Fig. 2—The single power cell of Fig. 1 can be connected in series, as shown here, to increase the output voltage. A higher current can be obtained by connecting two cells in parallel.

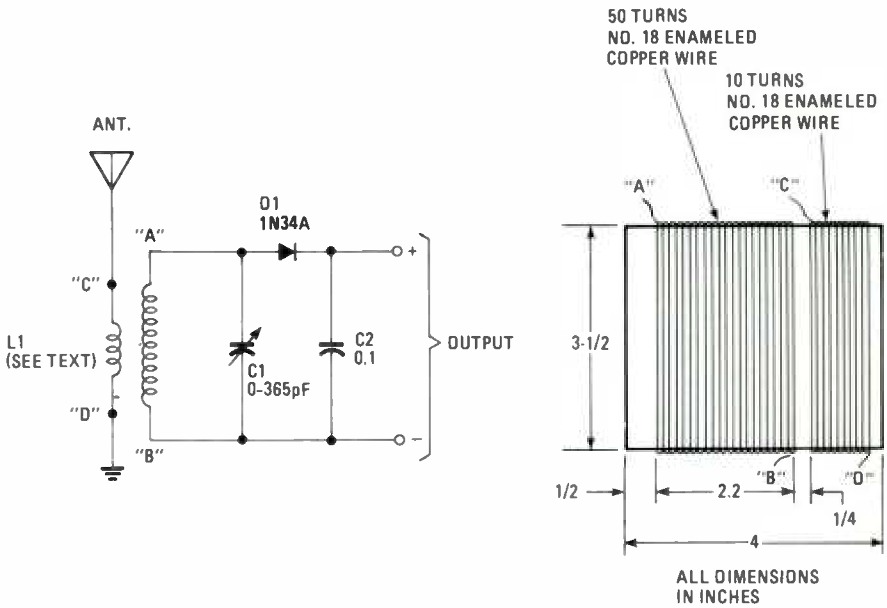


Fig. 1—Shown here is a modern-day version of a vintage crystal set with the cat's-whisker detector replaced by a 1N34A germanium diode. The circuit is designed to serve as an RF power cell.

(consisting of L1 and C1) that's tuned to the strongest local AM broadcast station in the area.

The RF energy is converted (or rectified) to DC by D1. Capacitor C2 removes any RF ripple from the output. If a powerful station is close by, it's possible to obtain a 1- to 3-volt output at a current of several milliamps. The output voltage won't blow your socks off, but it can power a variety of conservative electronic circuits.

The dual cell shown in Fig. 2 is nothing more than two of the tuned circuits connected together with their outputs in series to increase the output voltage. For a higher current output, the two cells can be connected in parallel. If you are a dedicated experimenter, that's an area where an unlimited number of circuit arrangements can be tried to obtain the maximum power output.

First, some real hands-on chores must be completed before testing can begin, such as winding three identical coils; see the winding details in Fig. 1B. As shown, a 4-inch length of 3½-inch diameter PVC tubing is used as a coil form. About 50 turns of #18 enamel-coated copper wire is wound (in solenoid fashion) on the form, leaving at least six inches of wire at each end. Leaving a space of about a quarter inch, wind a second coil of about 10 turns in the same direction. Leave at least six inches of wire at each end.

At the beginning and end of each winding, drill two holes slightly larger than the wire size to loop the ends through to keep the winding in place. Use 100-grit sandpaper to remove the enameled coating from each end of the four wires, and then tin the ends.

It's best to start off with a single RF cell to see how much power is available in your area. The antenna should be as high and as long as possible to pull in the maximum RF signal. A good earth ground should be used to complete the RF path.

Although a 365-pF variable capacitor is specified for C1, almost any salvaged broadcast tuning capacitor will do. The exact capacitor value isn't too critical, so try what you have on hand. If new tuning capacitors are needed, try one of the poly-film RF tuning capacitors available from a few of the mail order houses for about two bucks each. If you want to be old fashioned and stick with the all-metal variables, be ready to spend about 10 dollars each.

PARTS LIST FOR THE RF POWER CELL

D1—1N34A germanium diode
C1—365-pF, variable capacitor
C2—0.1-µF, ceramic disc capacitor
L1—See text
Wire, solder, hardware, etc.

PARTS LIST FOR THE DUAL RF POWER CELL

D1, D2—1N34A germanium diode
C1, C2—365-pF, variable capacitor
C3, C4—0.1-µF, ceramic disc capacitor
L1, L2—See text
Wire, solder, hardware, etc.

Stick with the 1N34A or a similar germanium diode for D1, because using a silicon diode here requires about twice the threshold voltage for forward conduction and will produce a lower output voltage. Of course, if you live in a real RF hot spot, just about any type of rectifier suitable for RF will produce an output.

With a good antenna and ground connected to the cell, hook either a sensitive ammeter or voltmeter across the output and tune C1 for the greatest output. Here's a chance to travel back in time by connecting a high-impedance set of headphones across the output, and listen to the radio like Gramps did years ago.

The output of two cells can be tied in series, as shown in Fig. 2, or paralleled; whichever configuration best meets the load requirement. If only one strong radio station is available, separate antennas can be used with individual cells to increase the power output even more. That's an area that's wide open for experimentation. VHF and UHF signals are another area where an enormous amount of RF energy is just waiting to be tapped.

Single Transistor BC Radio. The *Single Transistor BC Radio* circuit shown in Fig. 3 is an ideal test circuit for the RF cells. The RF cells and the transistor radio can be built in a nostalgic fashion on a 12-inch square piece of wood, or for a more modern approach use perfboard and pins. In any case, the circuit is non-critical, so build to suit.

The antenna input to the transistor receiver can be connected to the same antenna that drives the RF cells through a small trimmer capacitor (say, about 10 to 50 pF), or operated from a separate antenna. But the best method to use depends on the available signal level found at the antenna(s) terminal.

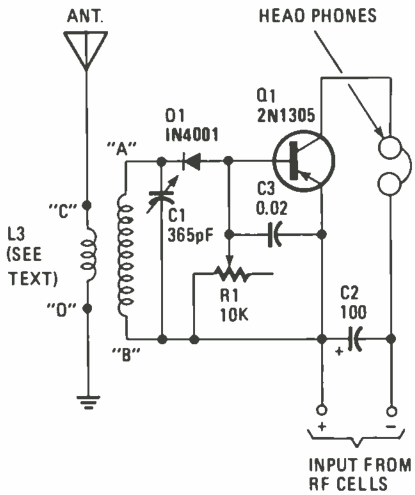


Fig. 3—The Single-Transistor BC Radio circuit can be powered by the RF power cells presented in Fig. 1, and the input to the receiver connected (via a small trimmer capacitor) to the same antenna that drives the power cells.

PARTS LIST FOR THE SINGLE-TRANSISTOR BC RADIO

Q1—2N1305 general-purpose PNP germanium transistor
D1—1N34A germanium diode
C1—365-pF, variable capacitor
C2—100-µF, 16-WVDC, electrolytic capacitor
C3—0.02-µF, ceramic-disc capacitor
R1—10,000-ohm potentiometer
L3—See text
Printed circuit or perfboard materials, enclosure, high-impedance headphones (2000-ohms or better), wire, solder, hardware, etc

Resistor R1 should be adjusted to produce the maximum audio volume, while maintaining the best sound quality. That adjustment controls the transistor bias, which is derived from the incoming RF signal. If the receiver offers ample sensitivity, but falls short in the selectivity department, try tapping L3 at its mid point and connecting D1 to the tap. That's just another area that's ideal for trying various schemes to get the best overall circuit operation.

SSBC Reciver. Figure 4 shows the schematic diagram of a *Super-Sensitive BC Receiver*, which is built around a Ferranti ZN414 TRF (tuned radio-frequency) amplifier. With the SSBC receiver, you should be able to pull in stations with a three-foot antenna just about anywhere in the U.S.

(Continued on page 99)

Computer Bits

By Herb Friedman

MACRO ADD-ON

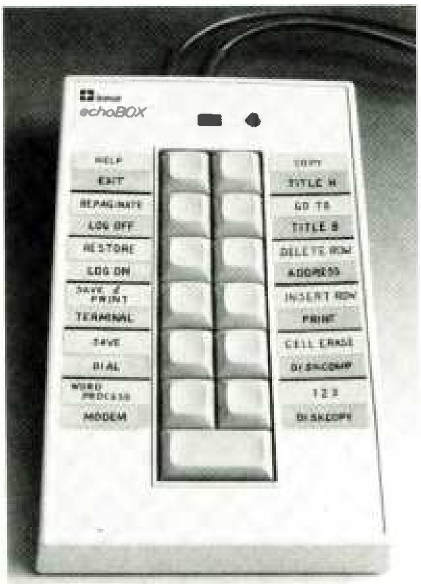
There is rarely an easy way to use software. Whether it's a word processor, a spread sheet, a database, or whatever, it often takes what seems like endless keystrokes to do the simplest of things. And if you must enter a substantial number of the same keystrokes over and over, the process can seem like a new version of the old Chinese water torture.

For example, every month I send out about 20–30 letters asking for review loans of hardware and software that at first glance appear to be something that **Popular Electronics** readers might be interested in knowing about. Except for the item itself, and maybe for a line or two of additional comments, the letters are identical. If I had to type each letter individually, I would probably be climbing the walls after the fifth version.

Of course, many of you are shaking your head and saying "Aha! Why doesn't he use my word processor, which has a dynamite mail merge?" I don't use what you use because I don't want to compile address lists before I type a letter. I find a merge without an automatic pull-up after a keyboard entry is more trouble than it's worth; and I don't want to wait while the program tries to append or merge from a disk file.

In The Keys. I do my mail by preloading my keyboard with *macros*, a macro being a string of characters or graphics that is unleashed by pressing a single key, or a combination of keys, such as ALT-I or CTRL-T. For example, some writers for, and all editors at **Popular Electronics**, must include the codes for the typesetting computer in their copy. For example, look at the boldface we use for the name of this magazine. You see it as **Popular Electronics**. I write it as "+bPopular Electronics+r." The +b tells the typesetting computer to switch to boldface; the +r tell the typesetter to return to the type that was originally specified for this column.

Now I have to use almost 50 typesetting codes, of which some 15 are entered repeatedly. I also have about 20 commands for my word processor that are also repeatedly used, as well as complete text paragraphs, such as those asking for the loan of software or equipment. I simplify everything by using a program called *SmartKey*, which allows me to program almost any key for anything. For example, pressing ALT-L (L for "letter") keys in a two-paragraph request for the loan of software or equipment, while CTRL-L keys in the rest of the letter—right through "Yours very truly,"—after I keyboard-enter the name of software or the equipment I want to borrow.



Twelve keys and a double-width shift allow 24 individual macros to be programmed into the Echobox. You can change the programming even while running an applications program.

Stacking Up. Obviously, SmartKey is a software package that remains resident in the computer, and all would be fine if that's all I used. But over the years I have added other memory-resident programs, such as *Blank 3*, which blanks the screen if the keyboard is unused for 3-minutes. Also memory resident, I have a printer spooler, a calculator, and the Panasonic software that allows my computer to function as a FAX even as I use the computer for something else, such as writing this column. Before I even start to load my word processor, of my computer's 640K of RAM, less than 400K is available for the applications program—and 400K is no great amount of RAM when running my *XyWrite III* word-processor with all its bells and whistles, or when using *Lotus 1-2-3* or *dBase III*.

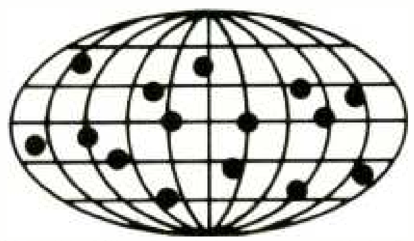
But notwithstanding my reduced free RAM, my memory-resident programs worked well—until recently. I often need more free RAM than is available, and when I try to unload one or more resident programs they get in each other's way because they must be removed LIFO (last in, first out). Unfortunately, if the one I want to unload is in the middle or at the top of the memory stack it can't be done—PC-DOS does not allow any holes from the top of memory down.

Titans Clash. Also, I started to run into the problem of an application program trying to use the same addresses as a resident program—which results in everything crashing, or the computer simply locking up.

For those times when I needed all the free RAM I could get—or when an applications program clashed with the resident software—I needed something that could *synthesize* memory-resident macros without actually using any memory.

I found what I needed in a *PC/XT* keyboard peripheral called an *Echobox Smart Keypad* (Inmar, Inc., 1223 Peoples Ave., Troy, NY 12180. Tel. No. 518-271-6692). Basically, the smart keypad is a microcomputer containing enough memory to store 950 keystrokes. (A model for the *PC/AT* and *PS/2* computers stores 650 keystrokes.) It has a single cable, with male and female connectors, that connects in series between the keyboard and the computer. The device gets its power from the computer. When the computer is off, an internal long-life battery

(Continued on page 94)



DX Listening

By Don Jensen

THE SUNSPOT CYCLE

Mother Nature has slipped us a surprise: The sunspot count is climbing much faster than expected. What that could mean for shortwave listeners is some of the best reception conditions ever during the next few years!

Sunspots are those periodic and violent eruptions on the surface of the Sun, which have a major effect on distant radio reception.

Sunspots have been observed as black areas on the Sun's surface since the development of the telescope in the early 1600's. Listening enthusiasts, particularly since the 1930's, have been aware of the sun's effects on long-distance radio reception.

Sunspot activity peaks approximately every 11 years. The high points in the sunspot cycles that occurred in 1936 and 1947 offered excellent shortwave reception, radio monitors noted. At such times, the shortwave bands open up, particularly on the higher frequencies, as the maximum usable frequency (MUF) moves upward.

Sunspots, of course, can cause reception problems in the short run. Massive solar flares—as some of you probably have noted already—can cause short-term blackouts of shortwave reception. But, basically, reception conditions improve significantly during the high sunspot-count years.

As good as SW reception was during the peak years of the mid-1930's and 1940's, the granddaddy of them all was the legendary "Cycle 19"—the 19th cycle since man formally began studying that natural phenomenon—which topped out in the late 1950's.

During those years, the sunspot count hit an all-time high of 201.3 in March 1958. Compare that with the upper-end numbers during the peak of Cycle 18, about 160 in early 1947, and the maximum of about 110 during Cycle 20 in the early part of 1968.

Now, as we near the end of 1988, Cycle 22 is underway and the sunspot count is going up. But not only is it ahead of the previous cycle's rate-of-climb, the data is quite similar to that of the historic "Cycle 19" of the 1950's!

The early phase of the sunspot cycle tends to be a gauge for the entire period. And so far, the data suggests that the current cycle will peak sooner and reach a higher maximum than experts were predicting as recently as two years ago. We could see the highest sunspot totals since radio was developed!

From a practical standpoint, we as SWLs can probably look forward to two to four years of truly excellent reception, particularly on the shortwave frequencies from about 10,000 to 30,000 kHz.

Correspondingly however, down at the bottom end of the shortwave range (particularly the 60-, 90- and 120-meter bands, where the lower powered, domestic "tropical-band" stations lurk) conditions probably will be less favorable as the lowest usable frequencies climb as well.

But, overall, the next couple of years should be a great time to be SWLing!

Receiver Reviews. Eleven years ago, Larry Magne originated the systematic laboratory and "hands-on" evaluation of shortwave radios and SWLing accessories. For several years, those reviews have appeared in print in Radio Database International's annual *Passport To World Band Radio* and on the air monthly on *Radio Canada International's SWL Digest*, where they have gained a considerable following among those who want the lowdown on the equipment market.

Now the broadcast reports also are carried monthly on *Radio Japan's DX Corner* program. The program is broadcast to North America, Europe, and the Middle East at 1525 UTC, Sunday on 9,505, 9,695, 11,815 and 21,700 kHz. There is a repeat to the Americas at 0125 UTC on Mondays (remember that's actually Sunday night in North America) on 5,960, 15,195, 17,810, and 17,845 kHz.

Feedback. This is the place for your letters, with questions and comments on shortwave, and the highlights of some of your own DX listening. So why not join us?

It's easy to join in. Send your letters—photos, too, if you would like to see you

Pittsburgh DXer Larry Yamron is introducing his young son to the fascinating world of shortwave listening. Larry wasn't too much older when he became an SWL himself back in 1969. He does his listening today on an ICOM R71 receiver and enjoys tuning the Asian and African stations.

and your "radio shack" featured in this column—to *Jensen on DXing*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735.

Our first letter is from Alvin Mirabal, Cupey, Puerto Rico who writes "I found your column quite by accident and found it very interesting. Because I am a very new SWL, I'm reading everything I can on the subject.

So far, with my Panasonic RF-2200 receiver, I can hear quite a few stations, but most interesting is *Radio Tirana* in Spanish, from 0130 to 0200 UTC."

Alvin says that this could be of interest to other SWLs because of "a little weirdness" in the programming from the Albanian station with its "most particular point of view."

Besides enjoying SWLing, the 34-year-old listener also is a hardcore free-diver, spearfisherman, and underwater photographer.

Another reader, J.N.M. Legate, says he is 77-years young and a relatively recent immigrant to Newfoundland, Canada, from the United Kingdom. His interest in radio began back in the 1920's as a teenager when he built his own receiving gear.

"I can remember when 2LO, the London transmitter, started up. And later, Belfast was heard when I was living in Ireland, about 50 miles from that city. I succeeded in hearing it at times on a single-crystal detector and fairly consistently after adding a tube audio stage."

Reader Legate says that after his teen years, he left radio, ending up as an engineer engaged in the power side of the electrical industry. It is only since his retirement that he has picked up his earlier interest.

Resuming an earlier interest in radio, particularly an interest in shortwave radio, is a theme that runs through quite a few letters received from you readers. As many of you know, SWLing is a terrific retirement hobby!

Down the Dial. What are you hearing these days? What are you looking for on the SW frequencies?

Africa—3,290 kHz. *Radio South West Africa* (RSWA) has been reported on this frequency between 0100 and 0200 hours UTC with easy listening music and English language ID as the "National Service."

El Salvador—3,470 kHz. *Radio Venceremos*, a clandestine broadcaster directing its Spanish language programming to listeners-in has been noted here with political talks and brief bits of music around 0300 UTC.

Europe—21,745 kHz. With the increasing sunspot numbers, look for more and more broadcasters on these high bands. One to start with is *Radio Free Europe* (RFE), which has been noted on this frequency in Bulgarian at 1815 UTC. You can expect some jamming here.

Germany—7,260 kHz. *Sudwestfunk* is one of the lesser known shortwave outlets of Germany, certainly not heard as regularly as the external service of Deutsche Welle, but still a reasonably likely catch at around 0630 hours UTC. Pop music, plus ads and announcements in German, is the broadcast fare.

Guatemala—4,800 kHz. *Radio Buenas Nuevas* is good news for listeners looking for new SW catches in Central America. This new religious outlet in Guatemala has been logged recently around 0000 hours (midnight) UTC.

Kampuchea—4,907 kHz. Exotic sounding Southeast Asian music can be heard from the *Voice of the Kampuchean People* (VKP), which has a parallel frequency of 6,090 kHz, at around 1230 hours UTC. This is the government station at Phnom Penh, Kampuchea (formerly Cambodia).

Marianas Islands—11,900 kHz. *KYOI* on Saipan in the Northern Marianas Islands, also in the Pacific, now is operated by the Christian Science Monitor's broadcasting division. It has been heard with the CSM's World Service programming in English at 1130 UTC.

Mexico—9,680 kHz. One of several Mexican SW outlets currently operating is *XEQQ*. That station has been logged recently in Spanish, with programming that includes play-by-play soccer and beer commercials.

Oman—6,060 kHz. The *British Broadcasting Corporation*'s shortwave relay station at Masirah Island, Oman, in the tense Persian-Gulf region, has been reported with Afghan music and programming in what is presumed the Pushto language at around 0200 to 0300 hours UTC. ■

CREDITS: Rowland Archer, NC; Richard D'Angelo, PA; Norman Bobb, MN; Paul Brouillette, IL; Mitch Sams, KS; Rufus Jordan, PA; Peter Dillon, Greece; Tom Lasowski, IN; Richard Eckman, CA; North American Shortwave Association, Box 45, Levittown, PA 19057.

Antique Radio

By Marc Ellis

THE SHUTTER-DIAL SET PLAYS

If you've been a regular reader of this column, you know that the last four issues of *Ellis on Antique Radio* have been devoted to the ongoing restoration of one of Zenith's more interesting receivers—a Model 7S232 "shutter dial" set. For those who have just joined us, the "shutter dial" is an ingenious mechanism for displaying only the frequency calibrations in use on a multi-band set.

Zenith installed the mechanism in many of its broadcast/shortwave models beginning in the late 1930's. On that type of dial, the calibrations for individual bands were printed on sets of movable semicircular shutters that were linked to the band-change switch. The shutters moved with the switch in such a way that only the calibration for the selected band was visible behind a strategically-placed window in the dial.

By the close of last month's column, most of the mechanical problems had been solved. The damaged shutter-dial assembly had been repaired (though not yet re-installed on the set); a replacement for the missing dial belt had been fashioned from dial cord; and the set had been given a badly-needed deep cleaning. But, I still had to find a dial glass, as well as a set of knobs for the volume, tone, and band controls.

From a purely electronic point of view, I'd found very little wrong with the set. There was some squealing and distortion when I first tried it out, but that disappeared after I deep-cleaned the chassis and reseated the tube shields (both of which were loose) so that they were properly grounded.

However, I wasn't quite satisfied with the radio's performance. It picked up signals on all three bands, but lacked "pep." The tuning eye's response was very sluggish on the broadcast band and non-existent on shortwave.

Close-up taken just before installation of the dial glass shows the action of the shutters. The broadcast-band shutter set is being swung out of the way to reveal short-wave band calibrations.

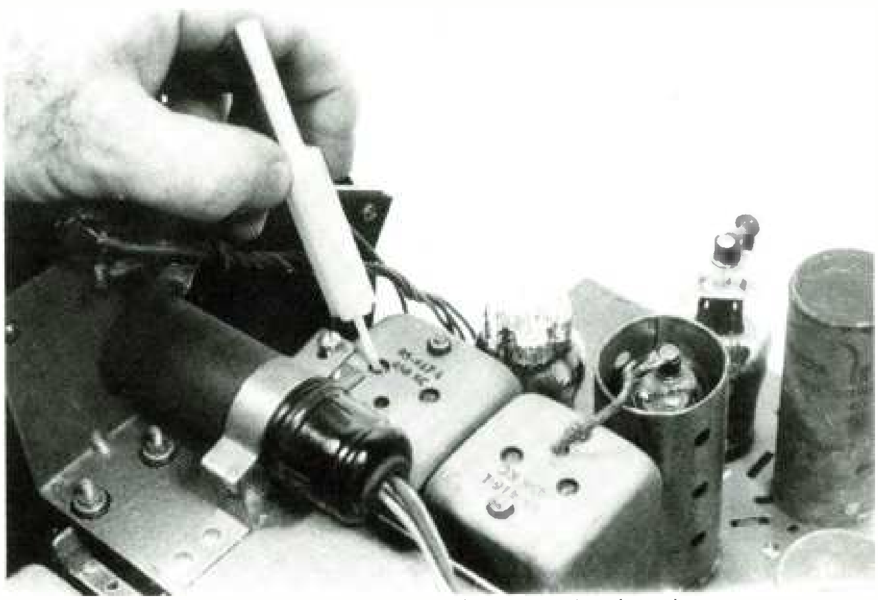
The problem didn't seem to be in the tubes; everyone of them had given a good account of itself in my very unforgiving retired military tester. My hunch was that a realignment would do the trick. But first, as a measure of the radio's general condition, I decided to check all of the voltages at the tube sockets.

Interpreting the Readings. In comparing the measured voltages with the ones published by the manufacturer, I found two discrepancies that I felt warranted investigation. First, the plate and screen voltages throughout the set tested more than 15% below the manufacturer's specifications. Second, the no-signal grid-bias voltages on the first-detector and amplifier tubes were reading about -0.5 volt instead of the published -2 volts.

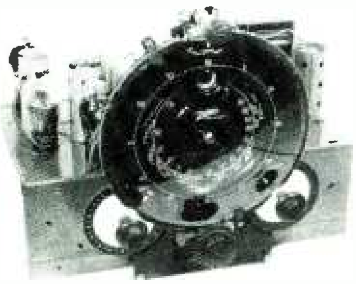
The most-obvious possible causes of consistently low plate/screen measurements are a weak rectifier tube and leaky filter capacitor(s). The first two possibilities were quickly ruled out through a line-voltage check and my previous results with the tube tester. As for the filter capacitors, I had already spot-checked them for leakage and found no problems.

In addition, the set was running with no trace of hum; another good sign. But just to make sure, I monitored the plate voltage, while bridging each of the filter capacitors, in turn, with a known good unit. There were no significant changes. So I concluded that the plate/screen voltage discrepancies were not important and decided to ignore them.

The discrepancy in grid-bias voltage however, seemed a little more serious, since it amounted to a four-hundred percent difference. Suspecting trouble in the automatic volume-



Tweaking the IF transformer trimmers helped a lot in restoring the set's sensitivity and "pep."



Completely restored chassis waiting for installation in cabinet.

control circuit, which controls the bias to the two tubes in question, I checked it out very thoroughly. But, once again, I was unable to find anything wrong.

After puzzling over the problem for quite some time, it suddenly exploded in my mind that the published value of minus two volts had to be a mistake. With that much negative voltage on the control grids of the tubes in question, the "eye" tuning indicator (which is tied into the same circuit) would have to be fully, or nearly, closed. Such an indication would obviously be incorrect for the "no signal" condition specified.

To confirm my growing suspicion that the published grid bias voltages were incorrect, I decided to check my Rider's manuals for Zenith sets with similar circuitry. I soon found a couple and, sure enough, the published voltages for the equivalent circuit points were very close to what I had measured on my own set. So once again I decided that the "discrepancy" was meaningless and could be ignored.

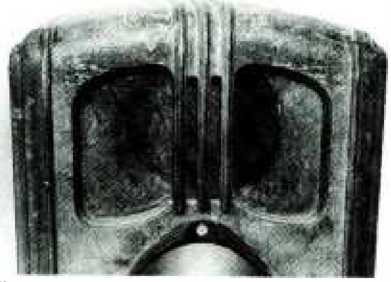
Troubleshooting of this kind is particularly frustrating. It would obviously be a whole lot easier to deal with a set that didn't work at all. In such cases, you can usually trace the problem to some failed component, replace it, and congratulate yourself on a job well done. But when faced with more ambiguous "problems," such as the ones I had, the trick is to realize when you are trying to fix something that "ain't broke" and to stop before expending vast amounts of time and energy. It isn't always an easy decision to make!

Realigning the IF, RF, and oscillator circuits per the manufacturer's published instructions finally brought the set back to life. Reception is now quite satisfactory on all bands, and the tuning indicator's response is very lively on both the broadcast and the shortwave bands.

Scrounging For Parts. The problem of the missing knobs was solved without much effort on my part. Soon after the original column in this series hit the streets, I received a post card from reader John Cram (Troy, Ohio), who graciously offered a set of original Zenith wood knobs.

When they came, they turned out to be a very close match to my missing and broken ones—Zenith logo and all! They look great on the set, John. Thanks a million!

The replacement dial glass was ob-



This close-up of the cabinet top shows the ravages of a furnace explosion. By next month, I hope to have cabinet looking beautiful again.

tained, indirectly, through a want ad that I placed in *Antique Radio Classified Magazine*. At the time, I was looking for both the glass and the dial belt. Three of the items were carried by *Antique Electronic Supply* of Tempe, Arizona. One of my own readers (Mark Cochenour, Beaver Falls, PA) sent me the same information and enclosed photo copies of the catalog pages, to boot.

I have to admit some embarrassment over that, since *Antique Electronic Supply* is a well-known firm (see *Suppliers of the Month*, below) and an advertiser in this publication. In any case, I immediately made a call to Arizona and found that the A.E.S. people had also been following the restoration and were about to contact me! Thanks to the magic of VisaCard, the dial glass was shipped to me via UPS the same day—along with a 6F5G tube I needed to complete my program of substituting original G-type (tall glass) tubes for the three "GT" (short glass) replacements that had been made in the set over the years.

The dial glass slipped into the old mountings perfectly, and was the last piece I needed to complete my restoration of the set. It's now ready for reinstallation in the cabinet. I wish the cabinet were also ready for the reinstallation. But, as you can see from the photos, it's definitely not!

If you've been following this series from the beginning, you know that the shutter-dial set was the victim of a minor furnace explosion—which is why the last owner was willing to part with it. That's the reason for the charred speaker grille and the rather distressed condition of the finish.

Let me get something off my chest right now, fellow antique-radio lovers. I hate cabinet refinishing! I can happily spend hours trying to track down a subtle malfunction in a radio circuit, but the fussy detail work involved in creating an acceptable furniture finish really drives me nuts.

However, once having gone through the trouble of restoring an interesting and unusual radio chassis, I obviously can't neglect the cabinet. Next month, I'll let you know how I made out.

Here is another mysterious Philco device (see text). Write me if you can identify this thingumajig.

Suppliers of The Month. Last month, we gave some space to *International Components Corp.*—dealers in receiving and industrial tubes. As I encounter other suppliers of interest to antique radio hobbyists, I'd like to continue the practice. So if you sell services or parts our readers would like to know about, send me a catalog and/or letter and I'll work you in as space permits. Here's this month's installment.

Antique Electronic Supply is operated by the father-son team of George H. and George A. Fathauer. George A. (the son) writes that he was an antique-radio restorer and collector who "turned pro" in 1982 when he and his dad bought a collection of 40,000 early vacuum tubes and 300 radios. The two Georges used the collection to start a brand-new radio sales, radio repair, and mail-order parts business.

(Continued on page 106)

Ham Radio

By Joseph J. Carr, K4IPV

GETTING ON 10 METERS

Have you been watching the propagation charts, or listening to the higher HF amateur-radio bands? The sunspot cycle is on the upswing, and that means one thing to hams: DX! As the sunspot cycle rises, high-frequency shortwave propagation goes wild. With the sunspot cycle on the upswing, it is possible for even very low-power stations to work lots of DX.

This time around, the sunspot cycle is not likely to be as good as the one in the late 1950's (when a 5-watt oscillator and a wet string could earn DXCC). But it will be exciting nonetheless...especially to younger amateurs who haven't been in the hobby long enough to remember previous highs in the (generally) 11-year sunspot cycle.

A Little Background. The impending sunspot cycle is a good reason to dust off some HF antenna theory. So, for this month's column, we are going to take a look at antennas for getting on the 10-meter band. Ten meters—which occupies the spectrum from 28,000 kHz to 29,700 kHz—is the highest amateur band in the HF region, and it is adjacent to the 11-meter citizen's band (a fact that we can exploit).

Novice- and technician-class operators can use CW from 28,100 to 28,300 kHz, and voice from 28,300 to 28,500 kHz. General-, advanced-, and extra-class licensees can use those frequencies, plus all others in the range of from 28,000 to 29,700 kHz.

What kind of propagation can you expect on 10-meters? If you have some CB experience, then you know a little about that issue already. During the warm months, you can expect a mixture of short and long skip. The short skip is on the order of a few hundred miles. Typically, during the summer at my northern Virginia QTH, I can hear stations in North Carolina and Pennsylvania due to short-skip propagation.

Long skip, which occurs occasionally during the warm months and a lot during the cooler months, is transcontinental and intercontinental in nature.

During a previous sunspot high, I worked (using a 100-watt transmitter) a three-way QSO with a missionary doctor ham-operator in South Africa and a ZL in New Zealand.

Antennas For 10 Meters. The key to working 10 meters is the antenna. While it is always wonderful to have a six-element, single-band beam towering 100-feet in the air, for most of us that's a pipe dream. So let's get our heads out of the ether and take a look at some practical antennas. We'll forget the wire dipole on the grounds that it's too obvious for most readers.

The short lengths of 10-meter antennas open up possibilities for amateurs that are lacking on the lower bands where mechanical sizes make certain designs prohibitive. The length (in feet) of a half-wavelength antenna (in free-space) is $492/F_{MHz}$. Close to the Earth's surface, we use a modified formula: $468/F_{MHz}$.

A quarter-wavelength antenna is half that length, while a ⅝-wavelength antenna is 1.125 times that length. Note: The lengths calculated are approximates only. We do not live in an "ideal" world, and the actual length, while very close to the calculated value, is affected by objects near the antenna and its height above ground. So the actual length should be adjusted to produce minimum VSWR.

Table 1 gives a list of approximate lengths for various frequencies throughout the 10-meter band. One option open on the 10-meter band is to

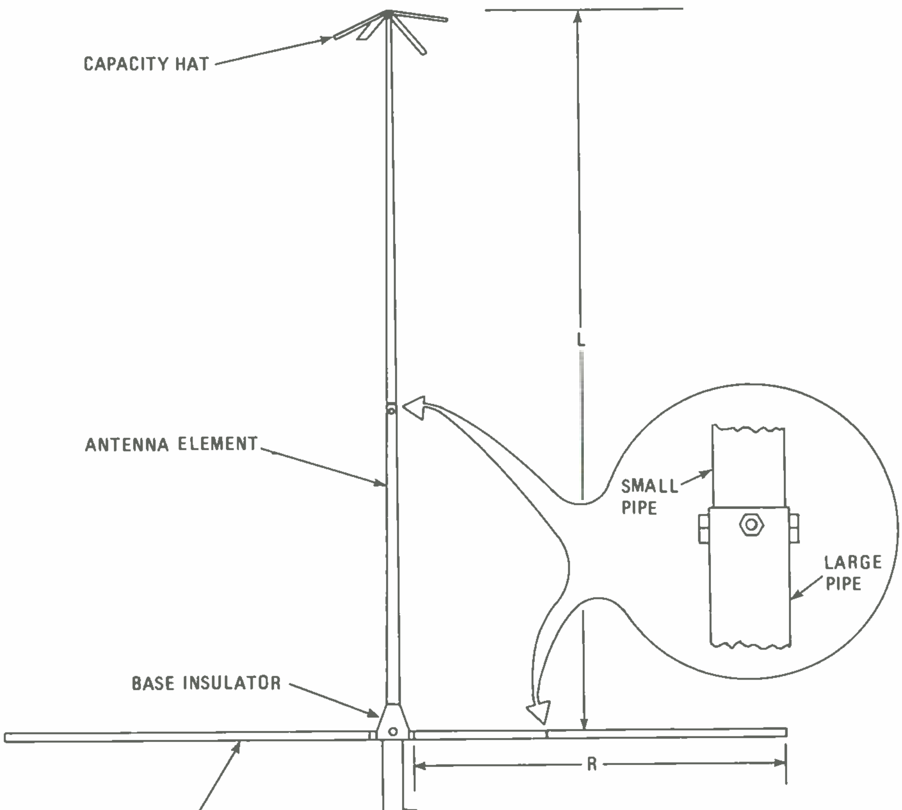


Fig. 1—Citizen's band ground-plane antennas come in both ⅝-wavelength and ¼-wavelength versions. Both types can be shortened only a few inches for use on the lower end of 10-meters where novice and technician operators are permitted.

use a commercially available CB antenna. In fact, if you're a formerly active CB operator who still has an old set of CB antlers on the roof, then here's a chance for you to put them back into service.

There are two types of antennas that are easily modified, both of which are ground plane types: the ⅝-wavelength and the ¼-wavelength antennas. Figure 1 shows a ⅝-wavelength CB ground-plane antenna fitted with ¼-wavelength radials. On the citizen's band, the dimensions L (length) and R (radial) are slightly longer than for the amateur band. Because the antenna is fitted with slip joints, most such antennas can be shortened a few inches for use on the lower end of the 10-meter band.

For example, a ¼-wavelength radial is approximately 8.7 feet at 28,200 kHz (novice/tech band) and 9.04 feet in the middle of the citizen's band. The slip joint construction makes it easy to reduce the length of the antenna without butchering it beyond repair with a hacksaw.

Figure 2 shows a ¼-wavelength ground-plane antenna with drooping radials. According to standard wisdom, such antennas give a lower angle of radiation than do the type shown in Fig. 1 due to the drooping radials. A low angle of radiation is good for working DX.

However, there are other factors that affect radiation angle, so I doubt that "wisdom" holds true in all installations. In fact, I know that it doesn't; for instance, a ⅝-wavelength radiator generally has a lower angle of radiation than a ¼-wavelength vertical.

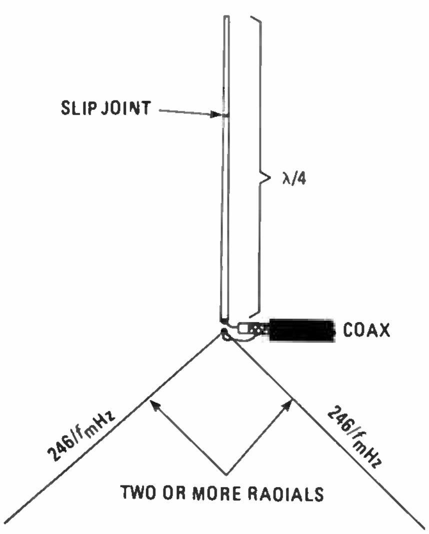


Fig. 2—Cheap and dirty ground-plane for 10-meters built from aluminum tubing (0.5 to 1.25 inch O.D.), and #14 or #12 wire radials (two or more).

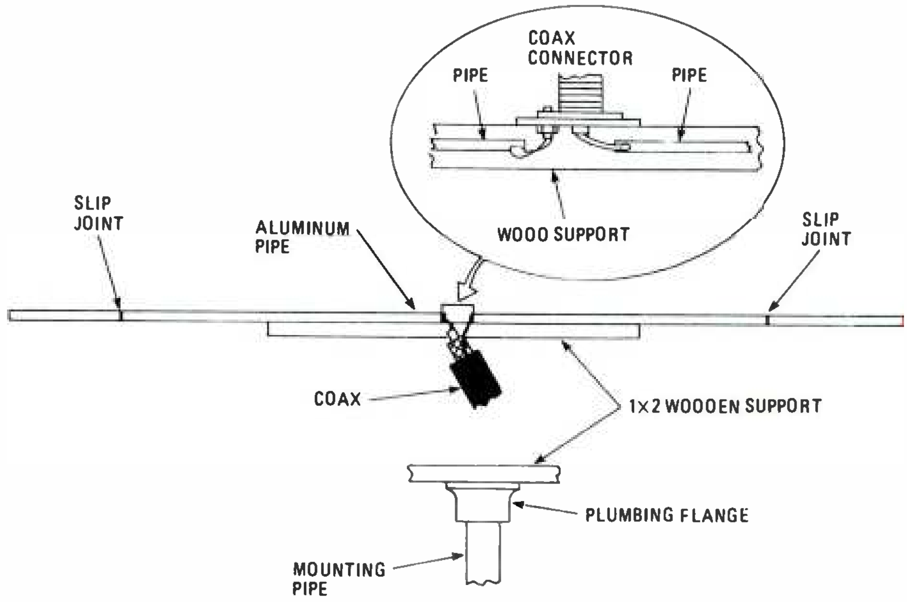


Fig. 3—Rotatable dipole made from tubing and 1 × 2 lumber. This antenna can be rotated with a TV-antenna rotor.

TABLE 1 FREQUENCY TO WAVELENGTH CONVERSIONS

FREQ. kHz	λ/2	λ/4
28000	16.71	8.35
28050	16.68	8.34
28100	16.65	8.32
28150	16.62	8.31
28200	16.59	8.29
28250	16.56	8.28
28300	16.53	8.26
28350	16.5	8.25
28400	16.47	8.23
28450	16.44	8.22
28500	16.42	8.21
28550	16.39	8.19
28600	16.36	8.18
28650	16.33	8.16
28700	16.3	8.15
28750	16.27	8.13
28800	16.25	8.12
28850	16.22	8.11
28900	16.19	8.09
28950	16.16	8.08
29000	16.13	8.06
29050	16.11	8.05
29100	16.08	8.04
29150	16.05	8.02
29200	16.02	8.01
29250	16.00	8.00
29300	15.97	7.98
29350	15.94	7.97
29400	15.91	7.95
29450	15.89	7.94
29500	15.86	7.93
29550	15.83	7.91
29600	15.81	7.9
29650	15.78	7.89
29700	15.75	7.87

The charm of the antenna shown in Fig. 2 is that it's cheap and dirty, and can be built from commonly available materials. The radiator can be made of aluminum tubing like that sold at many hardware stores, while the radials are made of regular antenna wire.

Construction Schemes. Two methods of construction can be used: solid and slip-joint. The solid-tube method starts with a length of tubing that is longer than necessary, which is then cut to length. When that is done, we need a 10-foot pipe for frequencies below about 29,275 kHz, and an 8-footer for those above 29,275 kHz. A disadvantage of that type of construction is that any mistake is fatal to the antenna. If you whack off too much tubing, you'll have to start all over again. The slip-joint method, on the other hand, allows you to set the frequency to any point that you like, and tune for minimum VSWR.

Now let me tell you an antenna-construction secret. Keep it under your hat, and drag it out only when you want to impress newcomers: consecutive sizes of aluminum tubing will form a slip joint. In other words, the inside diameter of one size is the outside diameter of the next smaller size...and it's planned that way to make slip joints possible.

To make a slip joint, it is merely necessary to have two consecutive sizes of tubing for each element. Keep in mind that only a few inches of adjustment is

(Continued on page 94)

Scanner Scene

By Marc Saxon

SCANNING THE WORLD

Sometimes a scanner comes along and looks good enough to put on the parlor table. The Cobra SR-900 is one scanner that would certainly qualify with its handsome appearance in different tones of gray and red accents. But the SR-900 is more than just another pretty face. Beneath that nice look, there's a full-featured, gutsy, scanner offering coverage that runs from 29 to 54 MHz, 136 to 174 MHz, and 406 to 512 MHz.

Fully keyboard programmable, the SR-900 (priced at $149.95) has a priority channel, instant NOAA weather selection, individual channel lockouts, automatic 3-second scan delay, 4-hour memory protection, 16-channel scan memory, direct manual channel access, and a large LED display.

The Cobra SR-900 (from Dynascan Corporation, Cobra Consumer Electronics Group, 6500 West Cortland Street, Chicago, IL 60635) operates on both AC and DC and comes with a telescoping antenna. Its sensitivity is rated at 0.3 μV on frequencies below 174 MHz, and 0.5 μV on the UHF bands (+/–3 kHz deviation 12-dB SINAD). Its IF-selectivity rating is specified at –55 dB at +/–25 kHz. Not at all a bad package, we'd say.

You'll note that the SR-900's coverage includes the 6-meter ham band (50 to 54 MHz). In the past, when I've mentioned that, I've received letters from readers pointing out that all communications on that band are in upper-sideband (USB) mode, and that because scanners can't receive sideband, any such coverage is rather meaningless.

Not so, friends. There's FM-simplex activity between 51.10 and 52.00 MHz, and FM-repeater activity between 52.00 and 54.00 MHz. That's an excellent DX band when skip conditions are right, and the way the sunspot count is going, it looks as though the next few years are definitely going to be a period of spectacular skip propagation on all frequencies.

The Cobra SR-900, which offers coverage from 29 to 54 MHz, 136 to 174 MHz, and 406 to 512 MHz, is fully keyboard-programmable, and features a priority channel, instant NOAA weather selection, individual-channel lockouts, automatic 3-second scan delay, 4-hour memory protection, 16-channel scan memory, manual channel access, and a large LED display.

Speaking of DX. Louie Perrigine of Pennsylvania reports that during a recent search/scan session at the controls of his trusty Realistic PRO-2004, his rig locked onto signals at 35.28 MHz. What he heard there, of all things, were Spanish-language radio-paging announcements and tones. That was in the late afternoon. A little diligent monitoring revealed that what he was copying was originating from none other than the *Central-Mexico Radio Paging Service*.

When Lou's letter arrived, I punched that channel into my own scanner and sure enough, within a few days, there was the paging service in Spanish. But it didn't take me too long to realize that what I was copying wasn't Lou's station, it was the *Madrid Radio Paging Service*, Madrid, Spain!

That's what I meant about skip conditions on the upswing. For the next few years, there'll be a whole world out there waiting to be scanned. The 30- to 50-MHz band should be producing coast-to-coast and transoceanic DX openings. During the last sunspot DX cycle a few years ago, we were even hearing Soviet stations popping through on occasion. That exciting aspect of low-band VHF monitoring has collected a huge and enthusiastic following of DX fanatics. And I'm happy to admit that I'm one of them.

The Long Ranger. Here's a good idea sent in by Wayne Ferguson, of El Paso, TX. Wayne reports that he was getting excellent (70- to 90-mile) reception from his handheld Bearcat BC-100XLT scanner using the factory-supplied antenna. He wanted to see if he could push the unit to receive stations that were 200 miles away.

He was, therefore, pleasantly surprised when he hooked up a Radio Shack 15-1113 TV/FM antenna booster and ran it with an Antenna Specialists VHF high-band mag-mount whip antenna on his mobile unit. He had great long-distance reception.

Does anyone else have similar tips for increasing reception range? If so, pass them along to **Popular Electronics** and we'll share them with your fellow scanner enthusiasts.

Meet Me in St. Louis. Reader Harry Brown, of St. Louis, MO, has a question that he's says is a bit of a puzzler.

Harry believes that there is an F-8 channel used by his county police for car-to-car work. The problem is that he doesn't have that frequency listed in any of his reference sources and he's seeking our help. You came to the right place, Harry.

Hope we've taken the mystery out of the situation by telling you to toss an ear on 154.89 MHz and see if that's the hidden channel you're seeking.

This One's a Whopper. A few columns back, we ran information sent in by a reader regarding the McDonald's drive-up order window.

You're not going to believe this, but the crew at a McDonalds in south Florida just wrote in to say that the Burger King window frequencies (in their area) are 467.7875 MHz for headsets receive, and 457.5625 MHz for inside to cars. The CTCSS (PL) code used is #1A (103.5 Hz).

We've heard of knowing the competition's innermost secrets, and I suppose that is a perfect example. Does anyone know if those frequencies are used at all Burger Kings? (Hold the onions.)

A Rainy Night in Georgia? Danny Lee Harris, of Atlanta, GA, asks a question that's a peach. He says he was searching through the VHF aeronautical band when the scanner stopped on 122.0 MHz. At that point, he heard a station called "Flight Watch" giving a severe weather alert to the pilot of a small plane. After locating the frequency, he entered it in his scanner's memory and has heard regular communications there, mostly related to aviation weather.

It looks as though he's stumbled onto the FAA's "Enroute Flight Advisory Service," which operates on 122.0 MHz around the nation from many local stations between 6AM and 10PM (local time).

Pilots usually use that frequency to report thunderstorms and other hazardous weather conditions, and the ground stations send the same type of information to pilots when bad weather appears on their radar.

For those who live in areas that are especially prone to sudden severe weather conditions (such as tornadoes), that is a worthwhile frequency to keep on tap in the ol' scanner. It could well be your first warning that something is on the way.

We appreciate your letters, questions, and comments. Please send them to Marc Saxon, *Saxon on Scanners*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. And we'll be looking forward to being with you again next issue! ■

FRIEDMAN ON COMPUTERS

(Continued from page 84)

keeps the programming of the Echobox live (for up to five years).

As you can see from the photograph, the device has 13 keys, a slide switch, and an LED. Twelve keys are active, the dual-size one at the bottom is a shift key that allows 24 individual macros to be programmed into only 12 keys. The slide switch is labeled PGM (program) and RUN, which is self-explanatory. The LED simply indicates that the unit is ready for use.

Programming. To program a key, you simply set the slide switch to PGM, press the Echobox key that you want to program, type whatever you want the key to represent (you'll see it on the screen, because being a keyboard entry it is fed into the computer), then set the slide switch to RUN.

From then on, to enter the macro you simply press the Echobox key. You will see the macro appear on the screen character by character at moderate speed. The macro's characters don't zip into the computer to avoid getting ahead of the computer's type-ahead buffer, in which case you would lose many of the characters that came after the buffer filled. So don't think that the Echobox is feeding characters slowly; it's simply ensuring that nothing gets lost in the computer.

Naturally, you can reprogram the Echobox keys. Repeating the programming procedure for a given key erases the existing macro and records the new macro.

The PC/XT model is priced at $189.95, though we suggest you check the price with Inmar in case there was a change. Notice we have stressed PC/XT and not "compatible." We found the Echobox worked with an IBM PC/XT, and some, but not all, compatibles. If you use a compatible we suggest you check with Inmar first. ■

CARR ON HAM RADIO

(Continued from page 91)

needed, so the smaller size tubing used for the end piece can be only a couple of feet long...and that makes it possible to use one or two pieces of tubing for all radial and radiator elements.

For example, if we have an 8.2-foot design length, we can shorten an 8-foot section to, say, 7.5-feet (discard the 6-inch piece), and then slip-joint fit an 18-inch section of the next smaller size to form a tunable element. For four radials and a radiator, we need five 8-footers, plus one 8-footer of the next smaller size.

Finally, we have the rotatable dipole shown in Fig. 3. Using a 1 × 2 piece of wood for support, and pipe clamps to hold the two radiator elements down, we can make a decent rotatable dipole antenna.

A right-angle plumbing flange serves as a mounting element. There's no reason why you can't simply connect the ends of the coax to the antenna elements, but if you prefer a little nicer set-up, use the coaxial connector method shown in the inset to Fig. 3. The antenna can be rotated by a simple TV antenna rotator. With such a lightweight installation there's no need to buy one of the heavy-duty amateur or commercial antenna rotators.

Conclusion. The 10-meter amateur band is due to come alive in the next few months and years. Although it's winter now, you can make plans to implement one of the above antennas in the springtime. It should last for the next several years until Old Sol cools off and makes 10 meters once again a band that's only good for local chatter. If you tune up on 10 meters this afternoon and hear something exciting, get busy converting that ol' CB antenna for 10 meters.

Note: In the next few months, I plan to do some experimenting with helically-wound CB mobile antennas on amateur bands from 10 MHz through 24 MHz. If any reader has any experience in that area, how about letting me in on it (ol' Joe has lost 120 lbs over the past year, but I'm still too big to get onto the roof any more times than is necessary).

In the meantime, if you have any comments or suggestions for this column, write to Joe Carr, K4IPV, PO Box 1099, Falls Church, VA 22041. ■

E-Z MATH

(Continued from page 80)

op-amps and other linear devices use constant-current sources.

Ramp Generation. Another common application for a constant-current source is in the generation of a linear (straight line) voltage ramp. A voltage ramp is required whenever it is necessary to generate a sawtooth or triangular waveform. Such signals are usually produced by charging (or discharging) a capacitor through a large resistance. A typical charge curve is shown in Fig. 18. Because of the exponential shape of the capacitor charge curve, the output is naturally not linear. One way to overcome that problem is simply to use only a narrow portion of the charge curve as shown in Fig. 18. The lower part of the curve is relatively linear but that restricts the output-voltage swing. Improved swings can be obtained by using very high DC voltages and very large values of charging resistance. However, that is often impractical in solid state circuits. The way to overcome that problem is to charge the capacitor with a constant-current source.

The voltage across a capacitor is directly proportional to the charging current (I) and the length of time (t) that the charging takes place, and is inversely proportional to the value of the capacitor (C). Expressed mathematically, we find that the capacitor voltage, V_C, is:

$$V_C = It/C$$

For a fixed value of capacitance and a constant current, I, you can see that the capacitor voltage will rise linearly with respect to time.

For example, if a .2 µF capacitor is allowed to charge for 30 milliseconds with a current of .1 mA, the output voltage will be:

$$V_C = .1 \times 10^{-3}(30 \times 10^{-3})/.2 \times 10^{-6}$$
$$= 15 \text{ volts}$$

With that arrangement, the voltage across the capacitor will rise in a straight line from 0 to 15 volts.

The key to making that relationship work is a constant current to charge the capacitor. A typical circuit for doing that is illustrated in Fig. 19A. Here the PNP transistor Q1 provides a linear charging current for the capacitor. The

(Continued on page 100)

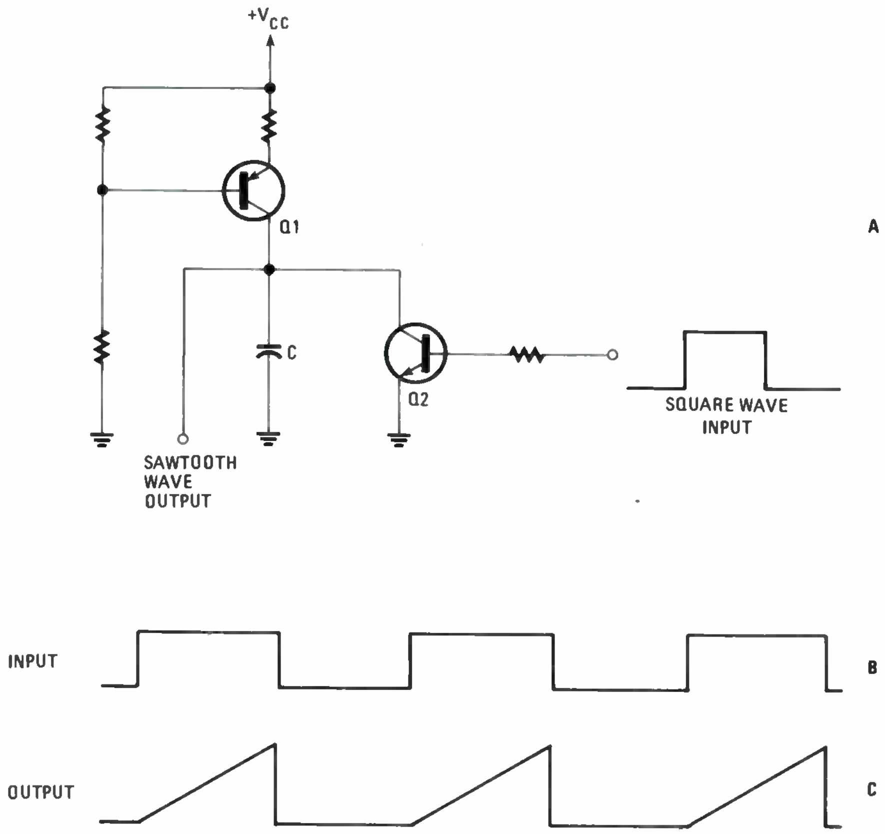


Fig. 19. If the constant-current source (A) charges the capacitor based on the square wave input (B), the output is a sawtooth wave (C).

AUTOMOBILE ALARM

(Continued from page 23)

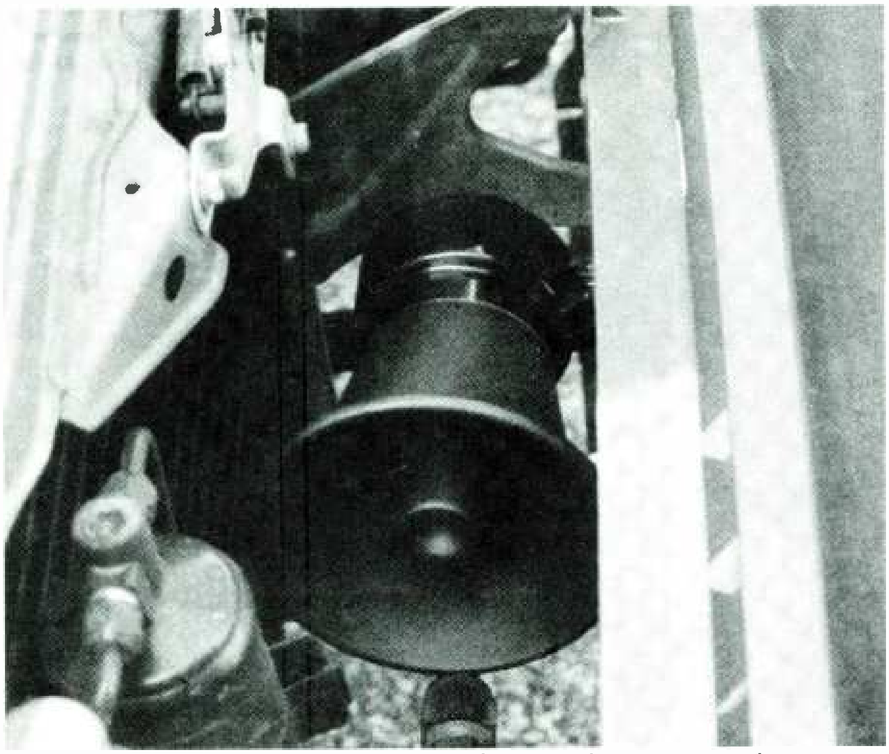
from the sensor is then brought out to the engine compartment and mated with its matching connector.

Using the brackets provided, mount the normally closed hood and trunk pin switches (optional). The switches must be mounted so that when the hood or trunk is closed, its respective switch is depressed, causing its contacts to open. Note: When installed, the bodies of the pin switches must be grounded. Solder a bullet connector to the blue wire of the harness, and another to one end of the extra blue wire. Connect the hood pin switch to the blue wire of the four-conductor wire harness by pushing the bullet connector into the bottom of the pin switch. An additional blue lead is then spliced into the blue wire of the harness, run from that point to the trunk, and is connected to that pin switch.

The last part of the installation consists of connecting the power-supply system. First locate the auto's fuse box and connect the fused, red wire to a *constant-on*, 12-volt source. If necessary, connect it to the positive battery terminal itself. Connect the black wire to chassis ground. Be sure that the point you connect to is indeed ground—there are so many plastic parts on a car that the metal you connect to may be insulated from the chassis ground. Splice the yellow wire to an existing wire in the vehicle that's only alive when the ignition is turned on, perhaps an accessory like the radio. Finally, reconnect the auto's battery cables and check out the system's operation.

System Checkout. After completing the installation, it is necessary to test the Alarm System for proper operation. Any failures can be cleared up by referring to the applicable installation procedure. Close the hood and trunk, enter the car and make sure that all the doors are closed. Switch on the ignition, and check that the red LED on the VALET/PANIC switch lights. If so, depress the green valet button, and the light should go out, indicating that the Alarm is activated.

Turn off the ignition, exit the vehicle, and close the door within 60 seconds. Wait at least two minutes (from the time that the engine was turned off) and then open a door. The siren should sound after twelve seconds—just enough time for a driver to insert the key into the ignition and turn the key to the accessories position. To stop the siren, enter the car and turn the key. Repeat the same procedure to check all covered entry points. The hood and trunk pin switches should *instantly* trigger the siren. If all checks perform as expected, the next step is to adjust the sensitivity of the ultrasonic sensor.



Where is the siren to be mounted? Under the hood in the engine compartment is the location usually selected by the pros. It's necessary to drill four mounting holes at the chosen site. Just don't drill into vital engine parts.

Mount the Alarm System VALET/PANIC switch out of sight, perhaps underneath the dashboard in the passenger compartment, but where it can easily be reached in case of an emergency.

Enter the vehicle and turn the ignition to the on position. Using a small screwdriver, adjust the control on the ultrasonic sensor to about the mid position. Open a window enough to allow you to place your arm inside. Exit the vehicle (within 60 seconds). After 60 seconds place your arm through the open window and move it around. Check to see if the red LED on the ultrasonic sensor flickers as you move your arm around the interior of the car. If it does, the siren should sound in about 12 seconds. If it does not flicker, repeat the initial adjustment procedure, this time increasing the sensitivity, and test again.

Once that phase of the adjustment procedure is completed, exit the vehicle, and wave your arm about the outside of the front and rear windows, taking note of the sensor's red LED. The LED on the ultrasonic sensor should not flicker. If it does, the sensor's sensitivity is too high and must be adjusted downward. Otherwise, someone merely passing the vehicle may be able to trigger the siren.

Normal Operation. Operating the Audiovox AA-9135 system is simple. The system is automatically armed 60 seconds after the engine is turned off, and the VALET (green) switch is depressed. All passengers must exit the vehicle and all covered entry points must be closed (including the hood, trunk, and

(Continued on page 106)

CIRCUIT CIRCUS

(Continued from page 83)

The ZN414 is designed to operate from supply voltages of 1.2 to 1.6 volts, and has a recommended operating voltage of 1.3. The actual voltage is determined by the ZN414's internal AGC action, which depends on the strength of the incoming RF signal.

Resistor R4, along with Q1, simplifies the job of setting the best operating voltage and provides some degree of regulation. Always keep the voltage at the emitter of Q1 below 2 volts, so as not to damage the IC.

Modified SSBC Receiver. If you're located in an area where stations are difficult to pick up, you might try the *Modified SSBC Receiver* circuit shown in Fig. 5. An FET RF-booster stage is connected in front of the SSBC receiver to supercharge the incoming signal. Two RF-tuned circuits (consisting of L1/C1 and L2/C2) are used to add selectivity.

The booster's gain is controlled by R7 and for best results should be kept as low as possible so as not to over drive the input circuitry of the ZN414. The small trimmer capacitor, C5, provides RF coupling between the two tuned input stages to sharpen the selectivity of the booster circuit.

The receiver can be used to drive an external power amplifier or a pair of high-impedance headphones. ■

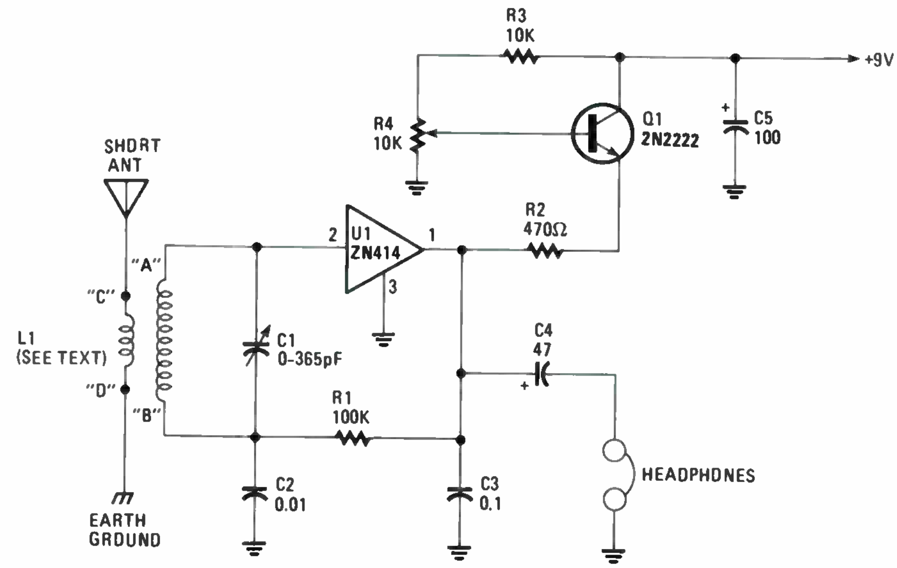


Fig. 4—Shown here is the schematic diagram of the Super-Sensitive BC Receiver, which is built around a Ferranti ZN414 TRF (tuned radio-frequency) amplifier.

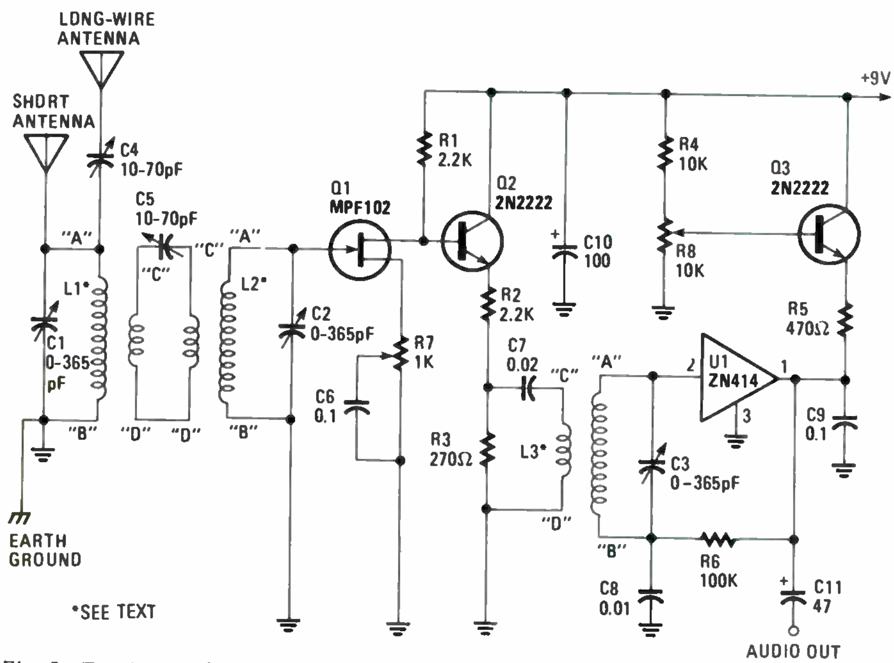


Fig. 5—This is a modified version of the SSBC Receiver. A booster stage is connected in front of the ZN414 receiver to supercharge the incoming signal, and two RF tuned circuits are added to increase selectivity.

PARTS LIST FOR THE SSBC RECEIVER

U1—ZN414 tuned radio-frequency amplifier, integrated circuit
Q1—2N2222 NPN general purpose transistor
R1—100,000-ohm, ¼-watt resistor
R2—470-ohm, ¼-watt resistor
R3—10,000-ohm, ¼-watt resistor
R4—10,000-ohm potentiometer
C1—365-pF, variable capacitor
C2—0.01-µF, ceramic-disc capacitor
C3—0.1-µF, ceramic-disc capacitor
C4—47-µF, 16-WVDC, electrolytic capacitor
C5—100-µF, 16-WVDC, electrolytic capacitor
L1—See text
Printed-circuit or perfboard materials, enclosure, IC sockets, pins, short pull-up antenna, high-impedance headphones (2,000-ohm or better), 9-volt battery and battery holder, wire, solder, hardware, etc

PARTS LIST FOR THE MODIFIED SSBC RECEIVER

U1—ZN414 tuned radio-frequency amplifier, integrated circuit
Q1—MPF102 or similar field-effect transistor
Q2, Q3—2N2222 (or similar) general-purpose, NPN silicon transistor
R1, R2—2200-ohm, ¼-watt resistor
R3—270-ohm, ¼-watt resistor
R4—10,000-ohm, ¼-watt resistor
R5—470-ohm, ¼-watt resistor
R6—100,000-ohm, ¼-watt resistor
R7—1000-ohm potentiometer
R8—10,000-ohm potentiometer
C1, C2, C3—365-pF, variable capacitor
C4, C5—10-70-pF, trimmer capacitor
C6, C9—0.1-µF, ceramic-disc capacitor
C7—0.02-µF, ceramic-disc capacitor
C8—0.01-µF, ceramic-disc capacitor
C10—100-µF, 16-WVDC, electrolytic capacitor
C11—47-µF, 16-WVDC, electrolytic capacitor
L1, L2, L3—See text
Printed circuit or perfboard materials, 9-volt battery and battery holder, knobs, hookup wire, antenna wire, solder, hardware, etc

Note: The ZN414 tuned radio-frequency (TRF) amplifier is available from DC Electronics, PO Box 3203, Scottsdale, AZ 85257, and Circuit Specialists, PO Box 3047, Scottsdale, AZ 85257.

E-Z MATH
(Continued from page 95)

voltage across the capacitor will continue to rise until the power supply limitations are exceeded. Usually a transistor switch Q2 is connected across the capacitor to discharge it prior to that point being reached. A square wave used to drive Q (see Fig. 19B) produces a sawtooth output waveform, as shown in Fig. 19C. By using two current sources, one positive and one negative, triangular waves can also be developed. ■

Solutions to Exercises

1. $I_N = 12$ mA, $R_N = 600$ ohms.
See Fig. 20.

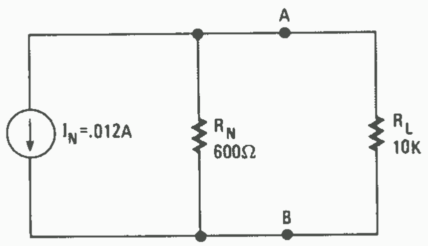


Fig. 20. This is what your solution to exercise 1 should look like.

a. Remove R_L and short A and B.
b. Calculate short current, which is current in R2.
c. The current in R2 is I_2:

$I_2 = V_S/R2 = 12/1000 = .012$ A or 12 mA

Therefore,

$I_N = R2 = 12$ mA

d. Remove short between A and B.
e. Short the voltage source.
f. Calculate resistance between A and B. That is R_N:

$R_N = R2R3/(R2 + R3)$
$R_N = 1000(1500)/(1000 + 1500)$
$R_N = 1{,}500{,}000/2{,}500 = 600$ ohms

The Norton's equivalent is shown in Fig. 20.

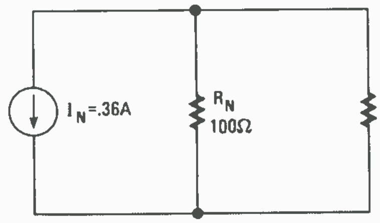


Fig. 21. The Norton's equivalent to problem 3 looks like this.

2. $V_{Th} = 7.2$ volts, $R_{Th} = 600$ ohms
a. $V_{Th} = I_N \times R_N = .012 \times 600 = 7.2$ volts
b. $R_{Th} = R_N = 600$ ohms.

See Fig. 20.

3. $I_N = 360$ mA, $R_N = 100$
a. $I_N = V_{Th}/R_{Th} = 36/100 = .36$ A or 360 mA
b. $R_N = R_{Th} = 100$

See Fig. 21.

4. $I_{R3} = 2.5$ A
a. Disable I_1.
b. Current I_2 flows through resistor R4, then divides, with some of the current flowing in resistors R1 and R2 and the remainder in resistor R3. Since:

$R1 + R2 = 20$ ohms,

and

$R3 = 20$ ohms
I_2 divides equally with 3.5 A in each branch including R3:

$I_{R3} = 3.5$ A

c. Replace I_1.
d. Remove I_2.
e. I_1 flows in R1 and through the combination of R2 + R3. The total resistance of the circuit is R1 in parallel with R2 and R3 in series. Resistor R4 is effectively out of the circuit, so:

$R2 + R3 = 10 + 20 = 30$ ohms
$R_T = 10(30)/(10 + 30)$
$R_T = 300/40 = 7.5$ ohms

f. I_1 produces 4 A in 7.5 ohms. That gives a voltage across R1 of:

$V = I_1 \times R$
$V = 4 \times 7.5 = 30$ volts

g. That 30 volts appears across the R2 + R3 combination of 30 ohms so the current that flows in R3 is:

$I_{R3} = V/R2 + R3 = 30/30 = 1$ A

h. The total current that flows in R3 is the difference of the two currents calculated previously, or:

$I_{R3} = 3.5 - 1 = 2.5$ A ■

ISOLATE YOURSELF

(Continued from page 73)

and a locknut and grounding lug used to secure the ground leads from the sockets to the chassis. Use either a pop rivet or an aircraft grade or locking nut and a 6-32 machine screw to hold the grounding lug.

Alternative Wiring. The secondary windings of the transformer can be wired in three useful ways. You can connect them in parallel with each other to provide a single high-current 117-VAC output. If you connect them in parallel and find the output voltage is zero, then you have connected them out of phase and the two windings are cancelling each other. If that happens, reverse the wires of one (not both) of the windings, and the expected output voltage will be found.

Alternatively, the secondaries can be left floating independently to form two separate 117-VAC outlets, or an outlet and a meter readout like the author's, each of which have half the available power. Finally, we can connect the secondary windings in series (see Fig. 4) to produce a single 240-VAC outlet.

Interestingly enough, it is possible to connect the transformer backwards so that the series-connected "secondary" becomes the primary, and thus drops 240 VAC to 117 VAC. That can be done for use overseas where 230 VAC is common, or in specific applications in the USA where 240 VAC is ordinarily used. That does require a more powerful transformer than the one listed, so pay attention to the specifications of the one you select.

An isolation transformer on your workbench can save your life. It's a no-nonsense solution to a potentially dangerous situation. You and your family will not regret the small investment that is required. ■

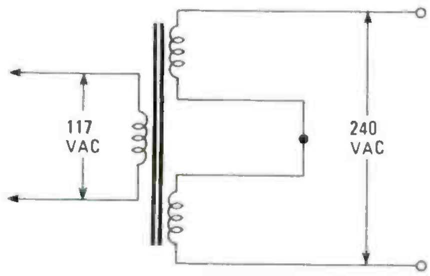
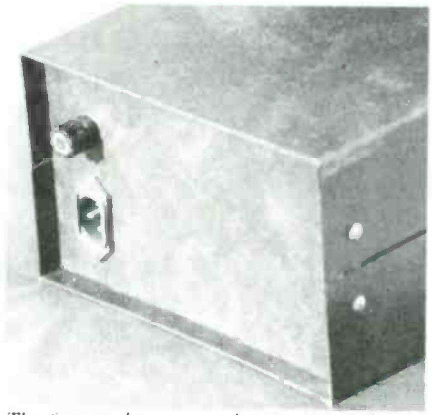
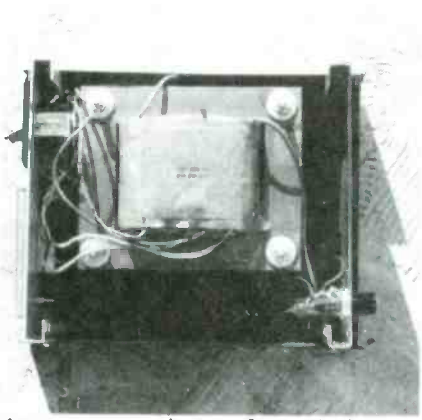


Fig. 4. By modifying the transformer hook up, you can obtain a useful voltage adapter for travel.



The fuse and power socket are located on the back of the author's unit to avoid front-panel clutter.



As you can see, the transformer is the project. Since the cabinet huddles the other parts around it, insulate well.

This professional isolator allows a technician to select the output voltage for the device under test.

Isolators are great devices to protect computers from power-line problems.

NIKOLA TESLA
(Continued from page 66)

length a Tesla is born, and the starry men are on the watch for developments. Possibly they guide his development; who can tell?"

Thus, when Margaret Storm suggested that Tesla was a space being, it is clear that her hypothesis was deeply rooted into a well-ingrained belief that extraterrestrial life was a certainty. Her choice of the year 1938 was somewhat arbitrary in terms of pinpointing a specific date for over 40 years of Tesla dabbling with interplanetary devices. The year 1938 may actually have been chosen by Storm for quite another reason, as that was the year John Houseman and Orson Welles terrified America by broadcasting on the radio an updated version of H.G. Wells' classic tale, *War of the Worlds.*

A Gallup poll taken just a few days after the authentic-sounding broadcast about a Martian invasion, estimated that upward of two million people were psychologically shaken by it. Perhaps fired up by the recent success of the Nazi invasion of Austria, numerous people huddled by their radios and waited for Armageddon.

"When the Martians started coming north from Trenton we really got scared," said one listener. Where another person assumed God was finally punishing humans for their evil deeds, a third radio buff said in resignation to her nephew, "Well, we might as well eat this chicken—we won't be here in the morning."

Tesla's attachment to the Martian hypothesis in the short run fueled controversy and notoriety from admirers and vehement anger from competitors and critics. However, in the long run, those spectacular claims only served to undermine the inventor's credibility and make it more difficult for him to raise the necessary capital for his quite serious inventions in the wireless telegraphy of light, voice, pictures, and power, a project which even to this date has yet to be realized. Eventually and steadily, Tesla's well deserved fame for his patented inventions disappeared from the public eye, as the name of Tesla became associated with the flying saucer crowd, which transformed the Serbian mystic into an extraterrestrial messiah whose secret inventions provided the key for direct communication with the "Great Beings" above.

Epilogue. On May 22, 1983, the batteries on the Viking probe that landed on the Red Planet in 1976 burned out. However, the satellite had served humanity well: Its robot arm, affectionately named Mr. Badger, which scraped up Martian turf and fed it Earth food, had recorded rather astonishing results. Expecting an effect which would have either increased or decreased the amount of organic material presented, the Martian soil reacted in such a way that both increases and decreases were achieved. As quoted in the December, 1976 issue of *Science*, that was called "extraordinary behavior" by NASA scientists Crofton Farmer and Hugh Kieffer.

Although no organic material was discovered and the scientists "warrent(ed) extreme caution in reaching a conclusion concerning the existence of life," Farmer and Kieffer were forced to conclude "despite all hypothesis to the contrary, the distinct possibility remains that biological activity has been observed on Mars." Was Tesla, as he usually had been in all his work, simply ahead of his time again? ■

SLAVE FLASH TRIGGER

(Continued from page 59)

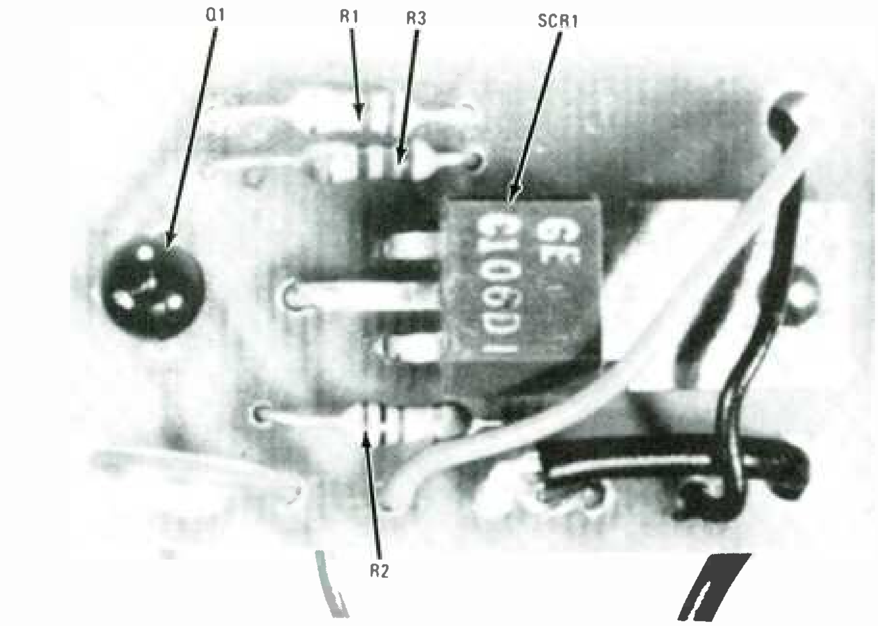
include a hot-shoe plate. In that case, just delete the hot-shoe adaptor and connect a cable and plug instead. Just remember—the center terminal of the plug is positive; it goes to the anode of the SCR.

Finish up the project by placing rubber feet on the bottom of the case. If you like, you can add decals or press-type to dress up the unit.

Firing it up! To test the unit, simply connect it to a flash gun or electronic strobe, switch it on, and check that the flash gun fires whenever the primary flash connected to the camera fires.

If everything is working as it should be, you should find that the unit will trigger reliably at distances of up to 50 feet.

Finally, here's a rather unusual application for your Slave-Flash Trigger. If you have a motor-drive camera, you will probably find that the unit will trigger that as well (depends on the motor drive). That means that you can set a motor driven camera up some distance away and trigger it by setting off a flash. ■



The board for the Slave-Flash Trigger should take only a few minutes to assemble, no matter which version you choose to build. The printed-circuit version is at the left, and the Veroboard version is shown at the right. Phototransistor Q1 must be clipped into an LED bezel at one end of the case so it can be exposed to light.

THINK TANK

(Continued from page 27)

pulses from U1 is odd or even. That, of course, is randomly generated.

The two outputs (heads and tails) are driven from the outputs of U2. The output LED's are lit when the corresponding output is low (at binary 0).

The circuit is best driven by batteries, and requires a 5-volt supply. Three 1.5-volt cells (the equivalent of 4.5 volts) will just barely drive the circuit, so you may want to include the voltage regulator offered, to drive the circuit from a 6- or 9-volt battery.

—Bill Quinn, Philadelphia, PA

Nice circuit; your book is headed your way.

Electronic Metronome. Last year, I didn't even know what a Stradavarius was. Then my young daughter decided she wanted to learn to play a violin so she could join the school orchestra. I think she had her eye on a skinny kid who played trumpet. So, being a dutiful parent, I shelled out the bucks for the violin.

Then I had to start paying for the weekly visits of her violin teacher, and—do you know how much a plush-lined violin case costs? I gritted my teeth and paid, and paid, and paid. Last week she demanded a metronome. Instead of a mahogany pyramid with a back-and-forth waving baton, I built this electronic version.

(Continued on page page 106)

HANDS-ON MARKETPLACE

PLANS/KITS

BUILD this five-digit panel meter and square wave generator including an ohms, capacitance and frequency meter. Detailed instructions $2.50. **BAGNALL ELECTRONICS**, 179 May, Fairfield, CT 06430.

VOICE disguisers! FM bugs! Telephone transmitters! Phone snoops! More! Catalog $1.00 (refundable): **XANDI ELECTRONICS**, Box 25647, 32W, Tempe, AZ 85285-5647.

PC boards made to order. Details—SASE. Eprom programmer plans. $3.50 includes free bonus! **GALLIUM JUNCTION**, 540-C N.E. Northgate Way, Suite 542, Seattle, WA 98125.

CATALOG: hobby/broadcasting/HAM/CB: Cable TV, transmitters, amplifiers, bugging devices, computers, **more! PANAXIS**, Box 130-F(12), Paradise, CA 95967.

CRYSTAL radio sets, plans, parts, kits. Catalog $1.00. **MIDCO**, 660 North Dixie Highway, Hollywood, FL 33020.

KITS*parts*plans*. We have hard to find parts! **Variable** tuning capacitors, tuning **coils, crystal headphones, germanium diodes, shortwave**, crystal, CB radio kits (no soldering). Very inexpensive. Send large SASE for catalog. **YEARY COMMUNICATIONS**, 12922 Harbor #800H, Garden Grove, CA 92640.

Cable TV Converters
Why Pay A High Monthly Fee?

Jerrold Products include "New Jerrold Tri-Mode," SB-3, Hamlin, Oak VN-12, M-35-B, Zenith, Magnavox, Scientific Atlanta, and more. (Quantity discounts) 60 day warranty. For fast service C.O.D. orders accepted. Send SASE (60 cents postage) or call for info (312) 658-5320. **MIDWEST ELECTRONICS, INC.**, 5143-H W. Diversey, Chicago, IL 60639. MC/Visa orders accepted. No Illinois orders accepted. Mon.-Fri. 8 A.M.-5 P.M. CST

SPEAKERS – Subwoofers, Woofers, Midranges, Tweeters for auto, home, MI, Commercial applications. 88 Page color catalog –$2.00. Amplifiers, Microphones, DJ Equipment. **McGEE RADIO**, 1901 McGee, Kansas City, MO 64108.

VIDEOCIPHER II Manuals. Volume 1 –hardware, Volume 2 –software. Either $29.95. Both $49.95. **NEW! Volume 3** –Projects/software – $39.95. All for $79.95. CODs — 1(602) 782-2316. Catalog –$3.00 **TELECODE** Box 6426-H, Yuma, AZ 85366-6426.

BANDSTOP Filters – Remove interfering signals on cable T.V. Channels 2, 3, 4, 14, 15, 16, 17, 18, 19, 20, 21 and 22. $20 each. Money back guarantee. dB ELECTRONICS, P.O. Box 8644, Pembroke Pines, FL 33084.

150W x 2 pre-main amplifier, kit or assembled, dynamite sound, 3 section tone control, class A-DC, $78, discount if wholesale, send check, M.O. **KATLI ELECTRIC**, P.O. Box 5565, Hacienda, CA 91745, details send self-addressed envelope.

PROJECTION TV... Convert your TV to project 7 foot picture. Easy! Results comparable to $2,500 projectors. **Plans and 8" lens** $24.95... Professional systems available... Illustrated catalog FREE. **MACROCOMA** 15HD Main Street, Washington Crossing, PA 18977. Creditcard orders 24Hrs. (215) 736-3979.

FM TRANSMITTER fits in matchbox with "N" cell battery or phoneline powered. Tuneable 60-95MHZ. Super sound, sensitive, powerful. Board, parts, instructions $19.95. **PTS**, Box 1951, Fort Worth, TX 76101.

RADAR Detector kit $39.95. Dazer weapon kit $45.00. **QUANTUM RESEARCH, 17917-77 Avenue, Edmonton, Alberta, T5T-2S1.**

PRINTED circuit boards drilled and etched. Free delivery. **K&F ELECTRONICS, INC.** 33041 Groesbeck, Fraser, MI 48026. (313) 294-8720.

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To run your own classified ad, put one word on each of the lines below and send this form along with your check to:

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( ) Education/Instruction ( ) Wanted ( ) Satellite Television
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Special Category: $10.00

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MANUFACTURE ELECTRONIC EQUIPMENT IN YOUR home for the Army, Navy, Air Force and **NASA** Will supply plan. Inexpensive easy to build equipment. Government pays $4000. Cost you $900. PROFIT $3,100. Send $10 to: **SUB-CONTRACT R & D**, 136-31 222 St. Laurelton, NY DEP REE 11483.

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TRANSISTORS-tubes: MRF421 $24.00, MRF454 $14.50, MRF455-MRF477 $11.75, MRF492 $16.00, SRF2072 $12.75, SRF3800 $17.50, 2SC2290 $16.75, 2SC2879 $22.00, 6LF6, 6LQ6, 6JS6, 8950, etc-call. New **RANGER** AR3500 all mode 10 meter transceiver $319. Quantity discounts! Best prices on hard-to-find parts, antennas, mics, power supplies, & equipment! Catalog $1.00 (refundable), or free with order. **RFPC**, Box 700, San Marcos, CA 92069. For information or same day shipment—**call (619) 744-0728.** Visa/MC/C.O.D.

CABLE TV CONVERTERS, Remotes, Accessories–Tocom, Zenith, Oak, Jerrold, Scientific Atlanta. **FREE CATALOG. ARIZONA VIDEO**, 3661 N. Campbell, #310-B, Tucson, AZ, 85719. (602) 323-3330.

TUBES 59¢. Year guarantee. Free catalog. Tube tester $8.95. **CORNELL**, 4219 University, San Diego, CA 92105.

CABLE TV equipment S.A., Jerrold, Zenith, Hamlin, Oak, Eagle filters remotes and more. Best prices C.O.D.'s accepted dealers needed. Ours work where others failed and we guarantee it! TRANS-WORLD CABLE, CO., 1-(800) 442-9333.

CABLE descrambler liquidation. Major makes and models available. Industry pricing! (Example: Hamlin combo's, $44 each...minimum 10 orders). **Dealers only!** Call **WEST COAST ELECTRONICS**, (818) 989-0890.

DESCRAMBLERS. All brands. Special: combo Jerrold 400 and SB3 $165. Complete cable descrambler kit $39. Complete satellite descrambler kit $45.00. Free catalog. **MJH INDUSTRY**, Box 531, Bronx, NY 10461-0531.

FAIR PRICES SB3, SX3, SA3, Tri-Bi, MLD-1200-3 some Oak, any notch filters. Small dealer only. No Michigan sales. (313) 979-8356.

STOCK MARKET Quotation Monitor and Data Descrambler software for PC; FM Radio, Filter, and Demodulator kits. Send for free catalog or $5.00 for Demo Diskette. **DATArx**, 111 E. Drake Rd., Suite 7041, Fort Collins, CO 80525.

SALTON City, California. Large residential Lots. Enjoyable Living. Boating, Fishing, Hiking. Use or Invest/Hold for Future! $40 down. $40 monthly. **HOE**, Box 35291, Los Angeles, CA 90035.

PICTURE flyer lists quality electronic parts at low prices. Since 1970. Send for 3 sample issues. **Star-Tronics**, Box 683, McMinnville, OR 97128.

Z-TAGS: $50-$70; Savis: $20-$50; M35B: $20-$60; N-12: $20-$80; JSX: $15-$25; JSX DIC: $25-$60; Eagle **PD-3**: $25-$60; **DRX** Die: $75-$125; MLD 1200: $30-$65; New Handhelds Remotes: $10-$20. Hrs 10 AM–5:30 PM EST. **(718) 544-5990.**

EDUCATION & INSTRUCTION

ENGINEERING software for IBM-PC. CompDes—circuit design, CompMath—mathematics, CompView—waveform viewer. $49 each. (614) 491-0832. **BSOFT SOFTWARE**, 444 Colton Road, Columbus, OH 43207.

LEARN new skills fast through our short specialized home study courses. Condensed and highly effective! Passport to success! 50 choices! Diploma awarded! **CIEE-13**, Box 20345, Jackson, MS 39209.

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SATELLITE TV

FREE CATALOG Systems. Upgrades Houston, Uniden, Chapparal, etc. **SAVE $$$$$. SKYVISION** 2008 Collegeway, Fergus Falls, MN 56537. (218) 739-5231.

BUSINESS OPPORTUNITIES

YOUR own radio station! AM, FM, TV, cable. Licensed/unlicensed. **BROADCASTING**, Box 130-F(12), Paradise, CA 95967.

MAKE $250,000 yearly in IBM's computer color monitor repairs, details $1.00. **RANDALL**, Data Display Products, Box 2168 H, Van Nuys, CA 91404.

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CABLE TV CONVERTERS. Scientific Atlanta, Jerrold, Oak, Zenith, Hamlin. Many others. "**New**" **Video Hopper** "The Copy Killer." Visa, M C & Amex. **1-(800) 826-7623. B & B INC.**, 10517 Upton Circle, Bloomington, MN 55431.

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CABLE EQUIPMENT

CABLE TV Secrets - the outlaw publication the cable companies tried to ban. HBO, Movie Channel, Showtime, descramblers, converters, etc. Suppliers list included. $8.95. **CABLE FACTS** Box 711-H, Pataskala, OH 43062.

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SCRAMBLER phones! Phone bug detectors! Electronic countermeasures equipment! Executive and personal protection products! Much more! Catalog $3.00 (refundable with first order). **DIVERSIFIED WHOLESALE PRODUCTS** P.O. Box 1275, Redondo Beach, CA 90278.

SOFTWARE

"**SOFTWARE** Maniacs" Humdinger shareware PD for IBM PC. No minimum order! Low as $2.75 a disk. Send $1.00 for: Catalog/free programs on 5.25 disk to: **TRIBAL ENTERPRISES INC.**, 5722 South Flamingo Road, Department H, Suite 231, Cooper City, FL 33330.

ADVERTISING INDEX

HANDS-ON ELECTRONICS magazine does not assume any responsibility for errors that may appear in the index below.

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ANTIQUE RADIO

(Continued from page 89)

As the catalog business grew, the radio repair and sales business was dropped—and today the Fathauers concentrate their efforts solely on locating and producing parts for those interested in radio restoration. They now employ seven people and operate out of a 4500 square foot office/warehouse facility.

The 1988 catalog that A.E.S. enclosed with my order has a beautiful color picture of an Atwater Kent breadboard set on the cover. And the 23 attractively-laid-out pages inside are filled with items targeted to appeal to antique-radio restorers and enthusiasts. The catalog lists over 1600 tube types, as well as parts such as transformers, chokes, coils, resistors, capacitors, tube sockets and just about any other component you could think of.

Certain key parts of wide interest to restorers, but unavailable through normal channels, are available through that company as reproductions—including power transformers with 2.5-volt heater windings; dial belts; Zenith dial glasses and pointers; Philco dial scales and push buttons; grille cloth; and other items too numerous to mention. Write or call A.E.S. for a copy of their useful and interesting catalog (688 W. First St., Tempe, AZ 85281; Tel. 602/894-9503). There is a minimum order for mail sales, which is $10.00.

Prior to finding my Zenith dial glass at A.E.S., I was beating the bushes for clock-parts suppliers who might have crystals that would fit. In this day of disposable battery clocks, such suppliers aren't exactly common. But one that I did locate suggested that I try a mail-order firm called *Timesavers* (Box 469, Algonquin, IL 60102; phone (312) 658-2266). Timesavers charges $2.00 for their catalog, but it's a browser's delight. In my opinion, it is well worth the money even if you don't buy a thing.

If you need an oddball-size dial glass however, you certainly ought to be able to find it here. About 90 different sizes of convex glasses, ranging from 2 to 8-1/2 inches (my Zenith size) in diameter, are listed. And over most of that range, sizes are available in 1/16-inch increments. In addition to an incredible array of modern and archaic clock parts, the 80-page (profusely illustrated) catalog shows many items that should be of interest, including precision and special-purpose tools, polishes, and lubricants. Minimum order is $15.00.

Recently, I received an updated flyer from Don Diers (4276 North 50th St., Milwaukee, WI 53216-1313). Don is a **Hands-on Electronics/Popular Electronics** reader who was stimulated to enter the electronics-surplus business by reading this column. The four-page flier lists a wide array of tube types and interesting "odd-lot" items, many of them antique. Don's chatty, personal catalog descriptions are fun to read. Send him an S.A.S.E. to get a copy for yourself.

Another Philco Mystery. Last month, we mentioned some pictures of Larry Lovell's mysterious Philco gadget and asked reader's opinions about what it might be. That issue hasn't been published yet, so I don't have any comments to report. However, I thought it might be fun to follow up on Larry's Philco mystery with an interesting one of my own (my mystery item is shown in a photo that appears on page 89.)

The small, highly-chromed device bears a prominent Philco logo and looks to all the world like a miniature speaker for an antique radio. (I've included a pencil in the photo for size reference.) A piece of ordinary rubber zip-cord comes through a grommet on the back panel, which also bears a slide switch labeled ON and OFF. Inside the mystery device is what appears to be an ordinary permanent magnet (PM) speaker heavily damped with a filler that looks like some form of cotton or glass wool.

I spotted this device under a table at a swap meet a couple of years ago, and wondered what it was for quite a while—was it an extension speaker?... tweeter?... display item?, etc.

However, I now know what it really is (none of the above). Here's a hint: I discovered the answer by accident while I was thumbing through the Philco section of Morgan McMahon's popular book, *A Flick of the Switch*. I'm going to let you have the fun of discovering it, too. But even with that hint, you're going to need sharp eyes! Those who figure out the answer, or even send me a good, creative guess, will receive full recognition in the column. Write to Marc Ellis, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

THINK TANK

(Continued from page 103)

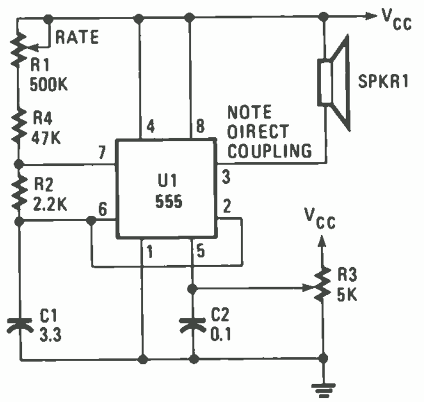

Fig. 8—This Electronic Metronome, using a 555 oscillator/timer, provides 10- to 40-beats per minute.

The electronic metronome shown in Fig. 8 provides a suitable click, with the 555 serving as an oscillator, providing 10- to 40-beats per minute. The frequency is controlled by R3.

If you want to go to the trouble, give the speaker cone a couple of coats of polyurethane varnish. That will improve the tone so that it can't be told from a clockwork version. Just don't get any of the varnish into the coil section.

—*Maxwell Smith, Salem, OR* ■

AUTO ALARM

(Continued from page 96)

all windows) within 60 seconds of turning off the ignition. To disarm the system, simply turn on the ignition switch within 12 seconds of opening any covered entry point.

Pressing the green valet button while the engine is running allows you to bypass the alarm if for some reason more than 60 seconds is needed to exit the vehicle or to complete some task. For example, when removing groceries from a passenger seat, or perhaps when adding fluids to the brake or transmission reservoirs.

The red button on the VALET/PANIC switch is the PANIC button, which should only be depressed when you want to summon immediate assistance. The alarm need not be armed at the time of activation. To stop the siren, press the panic button again. The final standard feature of the system is an automatic reset function. If the alarm is triggered after having been armed, it will automatically reset—turn off the siren and re-arm itself—after 60-seconds of sounding. ■

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