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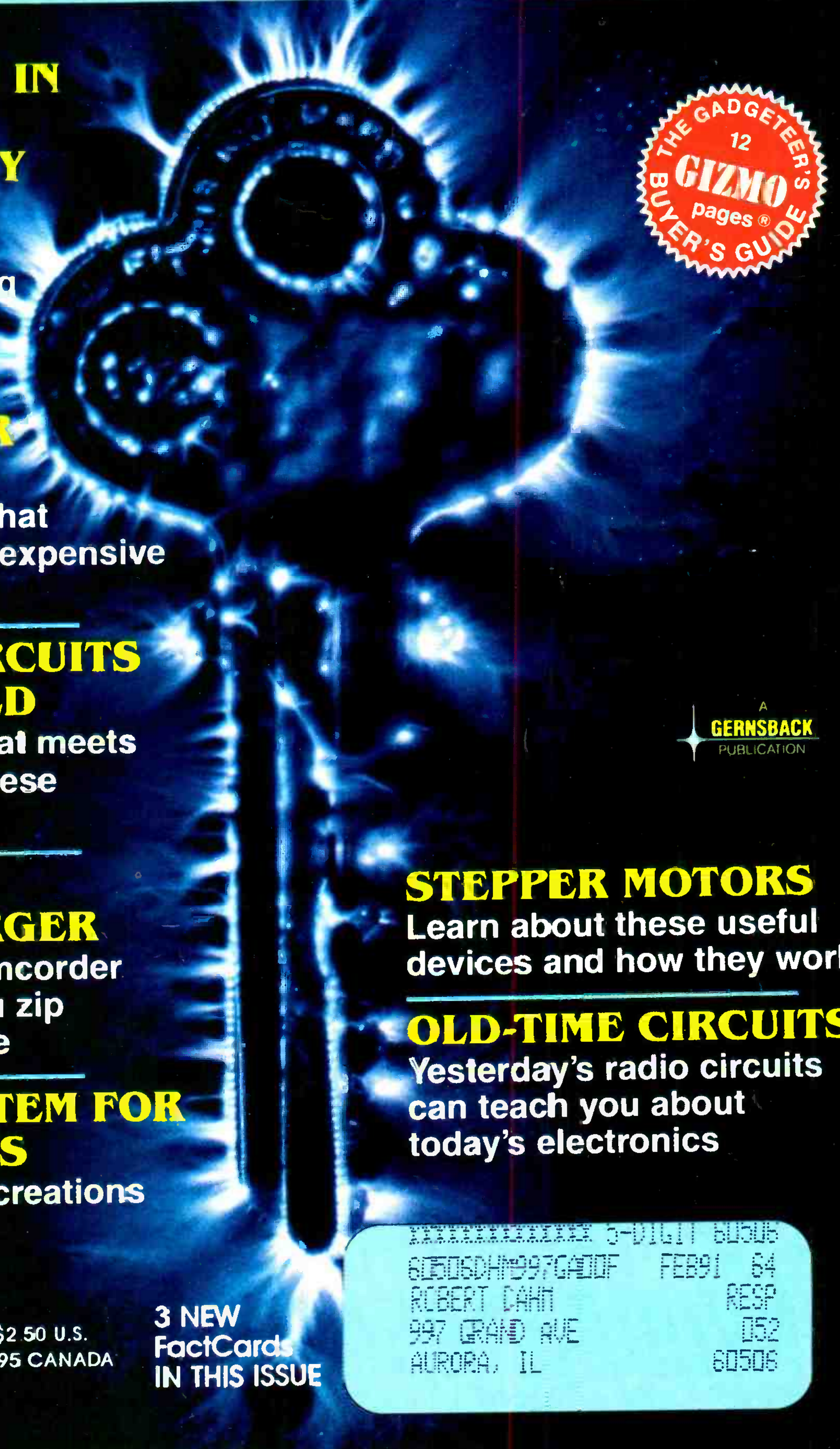
Popular Electronics

MARCH 1990



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MARCH 1990, VOLUME 7, NO. 3

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500-B Bi-County Blvd.
Farmingdale, NY 11735
1-516-293-3000
Fax: 1-516-293-3115
President: **Larry Steckler**
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Editorial

EXPERIMENTER'S DELIGHT

We at **Popular Electronics** try to make each and every issue something special for all of our readers, and this one is no different. However, those whose first love is experimenting will be especially delighted by this month's offerings.

"Experiments in Electrophotography" deals with the fascinating and beautiful world of high-voltage photography. In this article you will learn about the true nature of Kirlian photographs and Lichtenberg figures, and about experiments you can perform with just a minimum of inexpensive gear.

The modern age of electronics experimenting really began with the radio pioneers in the early part of this century. Their efforts launched our electronics hobby, and today's electronics industry. Even now, many an electronics hobbyist's first love is radio and RF experiments. If you're one of these people, you'll want to read "Receiver Circuits You Can Build." This article introduces you to basic radio circuitry, and shows you how to design receivers for your particular area of interest—from VLF (very low frequency) to the shortwave bands.

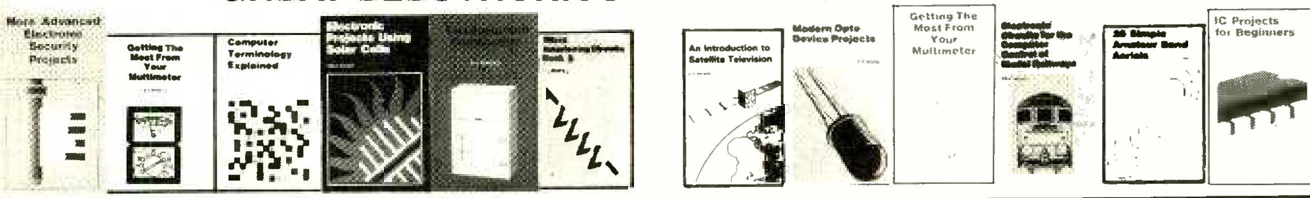
One of the hot areas of the 1990's is robotics. If you are becoming involved in this field, there are two articles of particular interest in this issue. "A Vision System for Robot Toys" describes an easy-to-build way to give your robotic creations the gift of sight, and it can be easily adapted for other applications. In "An Introduction to Stepper Motors" we show you how those motors work, and how they can be used in robots or elsewhere.

And, as always there is Circuit Circus, Think Tank, and a potpourri of other stories and features to help you expand your horizons. It's a true experimenter's delight; read it and enjoy!

Carl Laron
Managing Editor

Electronics Paperback Books

GREAT ELECTRONICS PAPERBACKS FROM ETT



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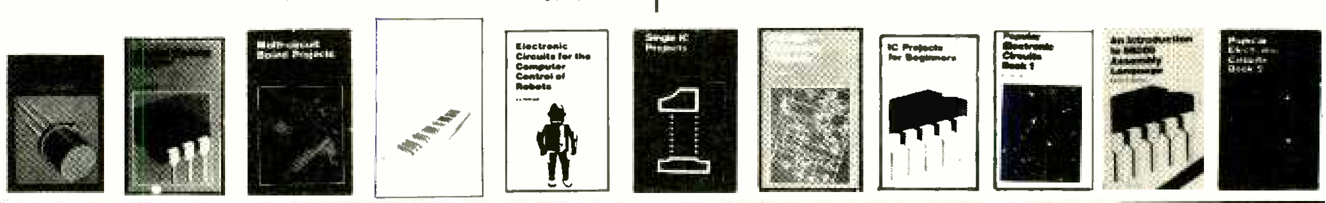

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Letters

A READER RESPONDS

Your request for letters (*Editorial*, **Popular Electronics**, October 1989) came at a good time for me. That particular issue contained a veritable feast of articles germane to my hobby interests—vintage and modern radio in all its aspects.

Items that I've earmarked for further reference include "Tapped-Coil Crystal Radio" (I've ordered the kit), "High-Performance Shortwave Converter" (I ordered that kit, too), "A New Age For Radio," "Electronic Quackery," and the random-wire antenna tuner from "Antenna Measurements for Hams and SWL's." Of course, I always get something out of *Think Tank* and *Ham Radio*. I've also been looking over "The Digital Electronics Course," although I would find one on *analog* electronics more interesting and useful.

I'm sure that the computer hackers wouldn't agree, but I found the October issue nicely "balanced" for a magazine that calls itself **Popular Electronics**. I'd welcome more issues like that one.

J.H.
McLean, VA

CIRCUIT SEARCH

I enjoy the new **Popular Electronics** magazine very much, but I would like to see more RF projects. As a 62-year-old "kid" I enjoy building many of the projects offered, but my passion is receivers, especially regenerative receivers. Over the years I have built dozens of them, covering many of the frequency bands.

Thanks again for a great magazine, and don't go computer on us!

W.S.
Columbus, MS

We aim to please! Check out "Receiver Circuits You Can Build" in this issue for a potpourri of useful and practical receiver circuits. And we have many more RF articles scheduled for the coming months.—Editor

TWR SHORTWAVE AWARD

Many thanks for your November 1989 "DX Listening" column, featuring Trans World Radio and the Confirmed All TWR Shortwave Transmitters Sites Award. I first heard about it from the TWR Sri Lanka Frequency Department. (It seems that **Popular Electronics** reaches Sri Lanka before it gets to the Netherlands Antilles!)

TWR Sri Lanka wanted to point out that the SLBC owns the "TWR medium-wave transmitter" there. As in some countries, a "foreign" organization or group cannot own a transmitter. TWR purchased and installed the equipment and as air time was used it has become the property of SLBC (amortization).

The TWR Sri Lanka Shortwave license is still under renegotiation and, until an agreement is reached, TWR is not on shortwave from Sri Lanka. In the meantime, the Confirmed All TWR Shortwave Transmitter Sites Award is still available. If a listener has the present four TWR confirmed, the certificate will be awarded. If the listener should have all five, it will be awarded for all five. (On a certificate for the four, Sri Lanka will be struck out.)

If a listener has confirmations of Voice of Tangier (forerunner of TWR), or any Long Wave (Monte Carlo) or Medium Wave, these will also be indicated on the certificate.

Total languages broadcast over all the combined TWR stations is over eighty!

In paragraph four of "DX Listening" there was a typo that changed 11815 to 1.815. Sharp readers will have questioned that and caught the correct frequency later—on page 95, in the paragraph that began "TWR Bonaire. This outlet is ..." Unfortunately, that paragraph also has typos; it gave a time of 0115 instead of 1055. It used to start at 1115 UTC.

TWR-Bonaire will confirm reception reports for a period of a minimum of 15 minutes. Outline something of what was heard. Do NOT send a transcript. We don't have time to read transcripts! On the other hand, "English-religious talk" or program title is inadequate! Indicate something of the subject matter, the theme of the program. We do not confirm tape recordings.

Other TWR stations such as KTWR (Guam) may require a longer reporting time. Guam requires 30 minutes.

Chuck Roswell
Trans World Radio
Bonaire, Neth. Antilles

SCA DECODING

I am interested in learning about Subsidiary Communications Authorization (SCA) decoding. A few people I've spoken to said that you have published information on that subject in **Popular Electronics**. How could I go about obtaining the issues that cover SCA decoding?

J.P.C. III
Manchester, CT

See "Subcarrier Adapters for FM Tuners" in the January, 1989 issue of ***Popular Electronics****. You can get a copy from your local library, or it can be ordered from our Reprint Bookstore; see the order blank elsewhere in this issue—Editor*

YOUNG ANTIQUE-RADIO FAN

I just turned 12 in November, and I bet I'm the youngest reader of Marc Ellis' "Antique Radio" column. About a year ago, around the time I first saw the column, my grandmother gave me a Silvertone model 1915 console receiver. I took the chassis out of the case and immediately began my first restoration. I knew very little about electronics then, but I decided to give the set a good cleaning before I did anything else. I used a rag and a mild solvent to clean off a 50-year accumulation of dust and grime. In an hour's time everything looked different—the chassis was clean and the tubes were shiny. I knew I was getting somewhere. I called a friend of mine who fixes radios as a second job. He came over with his tools and we dismantled the set even further. He told me that the power transformer was faulty and the filter capacitors were bad. After a short soldering lesson, he let me install the new parts. He came over the next day with a few gifts—nine tubes and a book, "How to Fix Old-Time Radios."

Since then I've done two full restorations; an Emerson model 503 and an RCA model 96T. I'm now beginning a third. The "Antique Radio" column has been very helpful, and I enjoy reading it.

J.S.
Yakima, WA

HAVES & NEEDS

I am seeking information on an old RCA radio, a Radiola Super-Heterodyne model AR-812, No. 388943. Could anyone advise where I might get a wiring schematic, a photograph, etc.? Any information would be greatly appreciated.

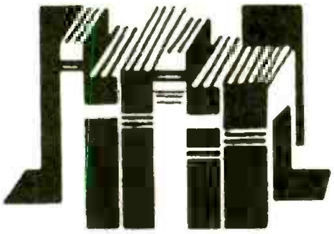
Frank Elliot
3900 Sourdough Road
Bozeman, MT 59715

Can someone come up with circuitry and specs for the defunct Tobe Deuchmann Corp. LCR wide-range, precision bridge, type I-B? Also, while I could live with a vacuum tube or two in this instrument, can someone suggest an equivalent in solid state?

Nils Lysell
30 Brent Street
Dorchester, MA 02124

I have a radio receiver that I don't have much background on. It's a Marconi CSR-5, type 110-930, 79 to 518 KC's, 1.5 to 30 MC's, with six bands. I think it was built in 1927, and it takes 11 tubes and can use 2 crystals. If anyone can provide any history on the set—or any information at all—I would like to hear from them. Thanks for your time.

Paul O'Toole
222 Rose Hill St., Suite 3
Nanaimo, BC
Canada, V9S 5G8■



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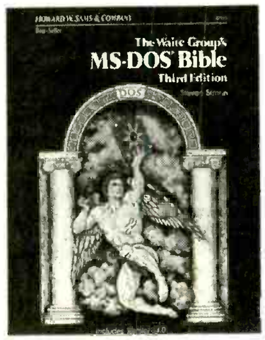
THE WAITE GROUP'S MS-DOS BIBLE: Third Edition

By Steven Simrin

With MS-DOS becoming increasingly popular—it's now running on more than 20-million computer systems—each edition of *The MS-DOS Bible* has been a big seller. The third edition has been completely updated for the new MS-DOS version 4, but follows the same style of its predecessors. It features easy tutorials, hands-on examples, and a step-by-step presentation of the material, and covers the basics right up through advanced programming information.

The tutorials have been revised to include version 4, and contain new information on batch files, memory, file management, disk structure, installable device drivers, and more. Three completely new chapters—covering the DOSSHELL utility, customizing an MS-DOS system, and using the additional RAM with the new Expanded Memory Specification—have also been included. A comprehensive reference section presents descriptions of each command in alphabetical order, including syntax and examples. A section on the SELECT utility guides the reader through MS-DOS installation on a hard-disk drive. Tables of MS-DOS interrupts and functions are provided, including a "jump table" that helps the reader quickly locate the command, procedure, or topic needed.



The Waite Group's MS-DOS Bible: Third Edition is available for $24.95 from Howard W. Sams & Company, 4300 West 62nd St., Indianapolis, IN 46268; Tel. 800-428-SAMS.

CIRCLE 95 ON FREE INFORMATION CARD

SAFETY GUIDES

from the Electronic Industries Association/ Consumer Electronics Group

A trio of brochures from the EIA/CEG—*Video Products Safety, Television Safety,* and *Audio Products Safety*—are provided as a public service to consumers. Each guide contains a mixture of common-sense advice and practical information intended to keep consumer-electronic products functioning properly and safely. They each include information on the proper in-

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stallation and use of the equipment, and describe the warning symptoms that indicate when servicing is necessary. The audio and video guides also explain how to install antennas effectively and carefully. Each brochure is fully illustrated.

Video Products Safety, Audio Products Safety, and Television Safety are available by sending a stamped, self-addressed envelope for each one requested to The Electronic Industries Association/Consumer Electronics Group, P.O. Box 19100, Washington, DC 20036.

CIRCLE 100 ON FREE INFORMATION CARD

TOOLS & TEST EQUIPMENT

from Contact East

This supplement to Contact East's *General Catalog* features a wide assortment of high-quality, brand-name products for assembling, testing, and repairing electronic equipment. Electronics students, hobbyists, and professionals will appreciate the broad selection of items it contains. Included in the full-color, 45-page brochure are precision hand tools, static-protection devices, analog/digital oscilloscopes, soldering supplies and stations, tool kits and cases, tele-/data-communications instruments, wires and cables, and electronic adhesives. New products include a 4-in-1 multimeter, a dual-display 5-digit DMM, and a portable field-service vacuum cleaner. Every item is described in detail with specifications, photos, and prices.

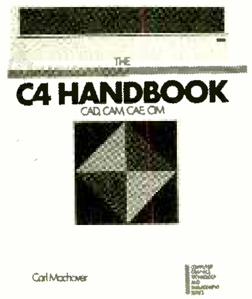
The Tools & Test Instruments Supplement is free upon request from Contact East, 335 Willow Street South, North Andover, MA 01845; Tel. 508-682-2000.

CIRCLE 102 ON FREE INFORMATION CARD

THE C4 HANDBOOK: CAD, CAM, CAE, CIM

edited by Carl Machover

The decade since *The CAD/CAM Handbook* was published has seen not only drastic increases in the versatility, productivity, and applications for Computer-Aided Design/Manufacturing (CAD/CAM), but also the dawn of Computer-Aided Engineering (CAE) and Computer-Integrated Manufacturing (CIM). Together, those four technologies are now known as *C4*. Completely updating the original, this book is a collection of articles written by experts in their respective fields. It provides a comprehensive overview of CAD/CAM, CAE, and CIM concepts, capabilities, and applications, as well as a look at what developments are



likely to unfold in the 1990's.

The book explains exactly what to expect from the latest C4 technology, and how it is being used in industry. It provides complete descriptions of available tools—such as PC workstations, scanners, automated data-capture systems, and solid modelers—as well as the specific roles played by those and other tools. Basic costs are discussed, to help readers determine the economic feasibility of a C4 system in their businesses. The book offers all the resources needed to make intelligent, informed choices and to implement a system quickly and smoothly.

The C4 Handbook: CAD, CAM, CAE, CIM is available for $44.50 from TPR, Division of TAB Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128

CIRCLE 98 ON FREE INFORMATION CARD

ACCESSORIES CATALOG

from Carter-Craft

Billed as the "One Source U.S.A. Consumer Electronics Accessories Company," Carter-Craft presents a wide array of audio, video, stereo, and computer accessories in their *Accessories Catalog #AVC896*. Each item is illustrated, and descriptions include applications and packaging details. Catalog numbers are clearly defined for easy reference, and "video tips," "tape tips," are also helpful. Other product categories include video/camcorder maintenance products; video amplifiers, cables, adapters, and switches; stereo headphones; TV antennas; microphones; and cleaning and maintenance items for heads, tapes, cameras, and cassettes.

Accessory Catalog #AVC896 is free upon request from Carter-Craft, Inc., 1926 Seventh Street, Rockford, IL 61125; Tel. 815-963-1780.

CIRCLE 101 ON FREE INFORMATION CARD

MODERN TELEPHONY

by M. Harb

The telephone is one of the primary communications tools of our society, reliably providing basic as well as sophisticated communications options. This book offers a complete overview of telecommunications signals and links in a clear format that lets readers grasp the fundamental concepts. It is aimed at students as well as telecommunications professionals.

The book explains the nature of sound, the origin of signals, and the electrical representation of speech. It discusses the invention and subsequent "fine-tuning" of the telephone, providing a look at early equipment and the dialing process. The basics of subscriber loops are explained. Practical examples that illustrate the nature of transmission for both analog and digital systems are included. Fiber optics and optical communications are covered, as well as cellular mobile communications.

Each chapter ends with a summary and self-quiz questions. Appendices explain the Fourier series and the spectrum of the frequency-modulation signals.

Modern Telephony is available in hardcover for $29.80 from Prentice-Hall, Englewood Cliffs, NJ 07632.

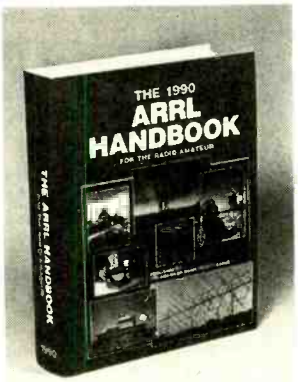
CIRCLE 99 ON FREE INFORMATION CARD

1990 ARRL HANDBOOK FOR THE RADIO AMATEUR

edited by Kirk Kleinschmidt, NT0Z

If you're into amateur radio—and you don't already own one of the previous 66 editions of this popular reference source—you'd be well advised to clear several inches of readily accessible shelf space for a copy of the 1990 edition. For decades The American Radio Relay League's (ARRL) annual publication has been a primary reference source on the technical aspects of amateur radio and radio-communications technology for beginners and advanced hobbyists alike. Over the years it has evolved into a practical resource for engineers and radio technicians around the world, and a popular teaching tool at technical schools and universities.

The handbook, which is revised annually, has something for everyone in its more-than-1200 pages—basic electronics theory, practical circuits, and construction projects. A chapter devoted to component data includes everything from transmitting-tube and transistor specifications to aluminum-tubing sizes. The chapter on space communications has been updated to include current information on OSCAR 13 and a new 4-element helical array for Mode L (1260 – 1270-MHz uplink). New information on Amplitude-Compandored Single Sideband (ACSSB) is included, as is the most



up-to-date data on digital- and RF-communications techniques. More than 2100 tables, charts, and figures illustrate the text.

The construction projects are geared to the abilities of the average amateur-radio operator. They include power supplies, measuring devices, QRP transmitters, VHF/UHF preamps, a high-performance communications receiver, high-power HF and VHF amplifiers, a 1296-MHz transverter, and a digital-audio memory keyer. Many new projects are featured in this edition, including three high-performance VHF/UHF Yagi antennas.

The 1990 ARRL Handbook is available in hardcover for $23.00, plus shipping and handling ($4.50 UPS) from The American Radio Relay League, 225 Main Street, Newington, CT 06111.

CIRCLE 103 ON FREE INFORMATION CARD

1001 THINGS TO DO WITH YOUR IBM PS/2

by Dave Prochnow and Mark R. Sawusch

This book is written not only for IBM-PS/2 owners, but also for those who are considering the purchase of one, and even for those who are intrigued by the hardware but are unsure of its possible applications. One-thousand and one of those possible applications—some utilitarian, some entertaining, some educational—are included in this book, along with full-fledged programs. Its pages are filled with ideas and information designed to stimulate the readers' creativity, encouraging them to stretch the limits of their own problem-solving abilities and of their PS/2 systems. Some of the authors' ideas for using the PS/2 include home planning, grocery-shopping aid, weather forecasting, personal accounting, computer tutor, keeping health records, car-maintenance calculations, personal robotics, statistics, and finance. The programs are complete as they appear in the book; for added convenience an optional diskette containing all the programs can be ordered separately.

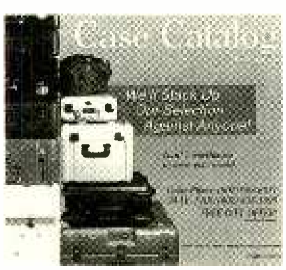
1001 Things to Do With Your IBM PS/2 is available for $17.95 (the diskette, for $24.95 plus $1.50 shipping) from Windcrest, Division of TAB Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

CASE CATALOG

from Jensen Tools Inc.

This full-color catalog contains 32-pages of cases and containers for electronic equipment. Included are lightweight and heavy-duty products for protecting and transporting computers and peripherals, communications equipment, tools, circuit boards, test equipment, and other delicate instruments.



Also featured are vacuum cases, static-shielding bags, magnetic-disk portfolios, hand trucks, and travel carts.

The Case Catalog is free upon request from Jensen Tools Inc., 7815 South 46th Street, Phoenix, AZ 85044; Tel. 602-968-6231.

CIRCLE 104 ON FREE INFORMATION CARD

PROTECTING ENGINEERING IDEAS & INVENTIONS: 3rd Edition

by Ramon D. Foltz and Thomas A. Penn

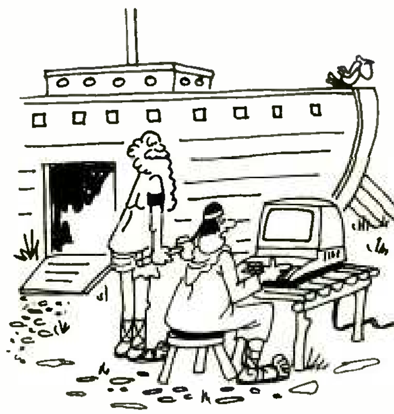
Co-authored by a corporate patent lawyer and a research-and-development manager, this book covers everything that technical personnel need to know about protecting their company's investment in technical work. The book is designed to be used as an easy reference source on patents, copyrights, trademarks, trade secrets, secrecy

(Continued on page 12)

How the *Computer* could have changed history!

By Harry Nelson

"Our data base says the odds on a Custer massacre are 7 to 5 in our favor."

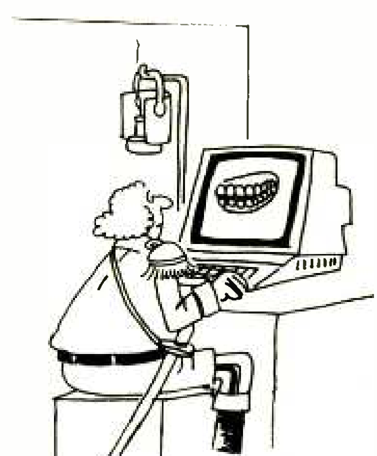


Sorry! According to the specs, it's two cubits too short!

"Sire, our graphics program suggests that a round table isn't a practical shape!"

"All the clues point to Sir Malcom? Pity, they executed Lord Hallbrook yesterday."

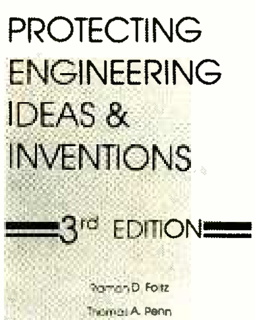
"There's the trouble, Xerxies, we've been using only six tanna leaves."



"Strength of materials report indicates that the material wood is inappropriate!"

Electronics Library
(Continued from page 8)

agreements, licensing, and warranties. To that end, laws, concepts, and legal procedures have all been translated into plain English, and unique diagrams and examples simplify the complex concepts. The book explains the best way to work with intellectual-property lawyers and outside consultants, and how to handle outsiders' ideas. Worksheets and checklists that make it easy to keep records, to itemize the costs in-



volved in getting a patent, and to give the legal experts the information they need are included in the appendices. The appendices also include samples of registration forms and ready-to-use legal letters and contracts.

Protecting Engineering Ideas & Inventions is available for $49.00 in softcover and $59.00 in hardcover from Penn Institute, Inc., P.O. Box 41016, Cleveland, OH 44141; Tel. 800-426-7495.

CIRCLE 105 ON FREE INFORMATION CARD

LEARNING ELECTRONICS: THEORY AND EXPERIMENTS WITH COMPUTER-AIDED INSTRUCTION FOR THE IBM

by R. Jesse Phagan and William Spaulding

Approaching electronics from a novice's viewpoint, this book shows how to use your IBM PC/XT/AT or compatible computer to help build your electronics skills. In a self-study format, it ties together the three areas needed to achieve proficiency in electronics—theory, to explain how things work; math, to perform the necessary calculations; and hands-on experience to fit everything together.

The book is divided into learning units that you can tackle at your own speed. Each section contains completed sample problems followed by practice problems and exercises, and concludes with tests. What sets this book apart from other electronic tutorials is that each chapter also has a computer program designed to quiz you on the important concepts of theory, math, and the use of test equipment. Some of the programs provide practice with ohmmeters, voltmeters, ammeters, and the oscilloscope. Other topics covered include DC and AC circuits, soldering techniques, and even engineering notation. The programs are listed at the end of the book, or are available on an optional diskette.

Learning Electronics: Theory and Experiments with Computer-Aided Instruction for the IBM is available for $16.95 (the disk costs $24.95 plus $1.50 shipping) from TAB Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

THE RS-232 SOLUTION Second Edition

by Joe Campbell

For anyone looking to save time and avoid frustrating errors when hooking up peripheral equipment to any PC or Macintosh serial port, this newly revised book could come in handy. It includes details on how to link printers, modems, terminals, and plotters to a computer—and requires no expensive tools and only minimal knowledge of electronics.

The book is divided into two sections. The first covers all the details about the basics of interfacing, including cabling, connector pins, noise, cabling tools, handshaking, tricks and tips, and logic levels. Part II uses real-life examples to explain some common interfaces for IBM PC, Apple Macintosh, Spinwriter, KayPro, Epson, Smartmodem, and other computers. Each chapter outlines an increasingly complex procedure and then describes the techniques and tools needed to install, test, and troubleshoot the connection.

The RS-232 Solution, Second Edition is available for $21.95 from Sybex, Inc., 2021 Challenger Drive, Number 100, Alameda, CA 94501.

CIRCLE 106 ON FREE INFORMATION CARD

TOOL CATALOG

from Techni-Tool

Featuring more than 18,000 high-quality items from more than 850 manufacturers, *Techni-Tool Catalog 37* selection of tools and accessories for today's high-tech environment is sure to have something for everyone. Included is an extensive line of standard tool kits and cases, test instrumentation for various applications, production equipment, field-service rework and maintenance equipment, and static-control products. Customized tool kits and cases can be designed to fit specific needs. Power and hand tools are offered, including drills, grinders, pliers, cutters, screwdrivers and nutdrivers, wrenches, vises, and grips.

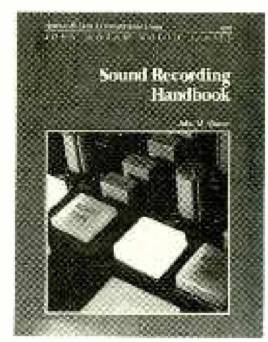
Catalog 37 is available from Techni-Tool, 5 Apollo Road, Box 368, Plymouth Meeting, PA 19462; Tel 215-825-4990.

CIRCLE 107 ON FREE INFORMATION CARD

SOUND RECORDING HANDBOOK

by John M. Woram

Those who work—or who would like to work—in the professional audio field could benefit from the author's more-than-25 years of experience in and around the recording industry. Written for the serious professional, this comprehensive reference contains the nuts-and-bolts technical information needed to get around today's complex recording studios. Concise explanations, accompanied by clear illustrations—and math, when needed—take the reader from the basics to the most recent developments in the industry. The book provides in-depth studies of recording-studio fundamentals



and the complete sound-recording chain—microphones, loudspeakers, delay and reverberation systems, equalization, compressors and limiters, tape and tape recorders, noise-reduction systems, recording consoles, and more. New technologies, such as Soundfield and Boundary Layer microphones, Dolby Spectral Recording, and SMPTE Time code, are also covered. Besides a complete glossary of terms, the book provides a convenient listing of commonly used audio abbreviations, acronyms, and symbols.

The Sound Recording Handbook is available in hardcover for $49.95 from Howard W. Sams & Company, 4300 West 62nd St., Indianapolis, IN 46268; Tel. 800-428-SAMS.

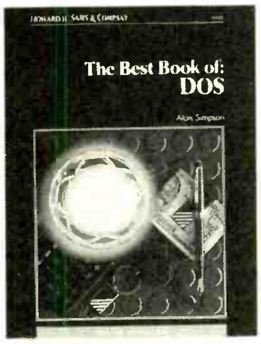
CIRCLE 95 ON FREE INFORMATION CARD

THE BEST BOOK OF DOS

by Alan Simpson

Written with the computer novice in mind, this book strives to make the learning experience less confusing, more productive, and—ideally—enjoyable. Those who have some computer experience but want to learn how to get the most power from their computers will also appreciate the simple, plain-English approach to DOS. Tutorial chapters contain margin notes, icons, troubleshooting sections, and clear examples. A comprehensive reference section and plentiful illustrations round out the text.

Starting from scratch, the book explains the basics of DOS and how it is used to manage a computer before getting into custom applications. All DOS versions, including the new 4.0, are covered. The book explains how to optimize computer performance with extended memory, expanded memory, RAM disk, and disk caching. Tips for using such options as high-resolution graphics, fax boards, high-speed modems, and the mouse are provided. The book also discusses "hot topics" in today's computer industry, including LAN networks, device sharing, and virus protection. All the information is presented with the minimum of technical jargon.



The Best Book of DOS is available for $24.95 from Howard W. Sams & Company, 4300 West 62nd St., Indianapolis, IN 46268; Tel. 800-428-SAMS.

CIRCLE 95 ON FREE INFORMATION CARD

INTERFACING: A Laboratory Approach Using the Microcomputer for Instrumentation, Data Analysis, and Control

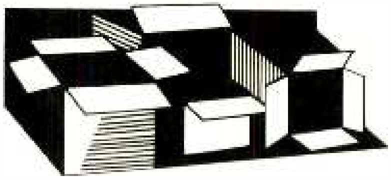
by Stephen E. Derenzo

Using practical explanations and 24 hands-on exercises, this book shows how to use microcomputers to sense quantities such as temperature, force, sound, and light; rapidly analyze the results; display those results; and use the results to perform a control function. It is aimed at practicing engineers and scientists, and could be useful as a text for lab courses in electronic transducer and microcomputer interfacing.

In its five chapters, the book covers digital tools, analog tools, conversion between analog and digital signals, sensors and actuators, and data analysis and control. The concepts most useful for design and implementation functions are emphasized, taking advantage of today's relatively low-cost microcomputers that are powerful enough to support high-speed parallel input/output ports, disk operating systems, and high-level programming languages. Avoiding the specific bus protocol and native language of any individual microprocessor, the book demonstrates the problems in data-acquisition analysis, display, and control that can be solved cost-effectively with microcomputers. Some of the topics given in-depth coverage include biomedical signals and processing; easy-to-use formulas for statistical analysis and least-squares fitting; computer algorithms for Fast Fourier Transforms, numerical integration, and nonlinear fitting; and more.

Interfacing: A Laboratory Approach Using the Microcomputer for Instrumentation, Data Analysis, and Control is available for $30.80 from Prentice-Hall, Englewood Cliffs, NJ 07632. ■

CIRCLE 99 ON FREE INFORMATION CARD

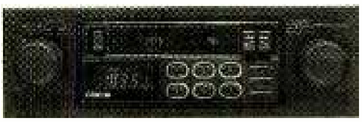


New Products

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

CAR STEREO/CASSETTE PLAYER

Convenience features make *Clarion's 8202R ETR* AM/FM stereo cassette receiver easy to use while keeping your eyes on the road. Twelve FM and 6 AM stations can be stored in the unit's memory and recalled at the touch of a button. Using the PRESET SCAN button, the stations previously set into memory can be reviewed for five seconds



each. When traveling, the AUTO STORE feature lets the listener call up the six strongest local stations by simply pushing a button. The 8202R also has four-way balance control, back-lit function buttons, and a reverse LCD display.

The 8202R ETR AM/FM stereo cassette receiver has a suggested retail price of $189.95. For additional information, contact Clarion Corporation of America, 5500 Rosecrans Avenue, Lawndale, CA 90260.

CIRCLE 71 ON FREE INFORMATION CARD

CD-CHANGER SYSTEM

Blaupunkt's first CD-changer system, the *CDC 01*, can hold up to 12 compact discs in two 6-disc magazines for playback in a variety of programmable and random-play sequences. The system consists of the *CDC 01 Commander*, used to control the operation of the changer; the *CDC 01 Trunk Unit*, which can also be used with home CD changers from other manufacturers; and a separate, compact audio-preamplifier control interface that links the system to other car-stereo components, via its RCA preamp outputs and trigger lines.

The Commander can be easily mounted in a standard DIN or ISO dashboard-radio slot. Alternately, because it is less than 1-inch deep, it can be mounted almost anywhere with Velcro and hidden out of sight when not in use. The Commander's controls can be used to adjust the volume level, balance, front/rear fader, bass, and treble, as well as to program play-back sequences. Besides normal sequential playback, repeat function, and direct access to any track, the CDC 01 can be programmed to play any sequence of up to 50 selections in any order and from any combination of discs. The audible, variable-speed fast-forward/-backward search control makes it easy to locate a specific part of a song. The TRACK SCAN feature samples the first 10 seconds of each track on every disc; DISC SCAN samples the first 10 seconds of each disc.

The system has a high-performance, 3-beam laser pickup, dual linear 16-bit D/A

converters, and 4 times oversampling. The isolated player mechanism is highly resistant to vibrations and road shock, and a special circuit allows the laser to recover its position almost immediately after a severe shock.

The CDC 01 Commander and Trunk Unit have suggested retail prices of $249.00 and $629.00, respectively. For more information, contact Robert Bosch Corporation, Blaupunkt Division, P.O. Box 4601, North Suburban, IL 60198.

CIRCLE 72 ON FREE INFORMATION CARD

TWO-LINE PHONE

For home-office workers and others who want convenience features usually associated with business telephones, *Soundesign* has introduced the model *7278* two-line phone. Conference calls are easy using the phone's separate push buttons for LINE 1, LINE 2, and CONFERENCE. Each line has an LED indicator as well as an electric

ringer, so the ringer can be lowered or turned off during important calls. The HOLD button features its own LED indicator and auto release.

Other features to help the home-office worker include last-number redial and tone/pulse switchability. An incoming volume boost helps compensate for household background noises. The desktop-style phone has non-skid rubber feet, a lightweight handset with 7-foot cord, and a 7-foot telephone-line cord.

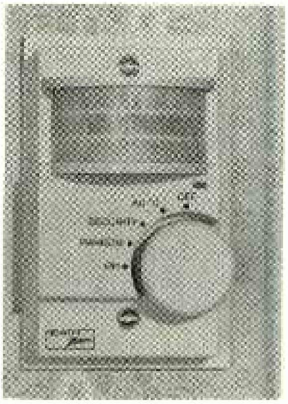
The model 7278 two-line telephone has a suggested retail price of $39.95. For additional information, contact Soundesign Corporation, Telecommunications Division, Harborside Financial Center, 400 Plaza Two, Jersey City, NJ 07311.

CIRCLE 73 ON FREE INFORMATION CARD

LIGHT-SWITCH SECURITY

Combining the simplicity of a light switch with the security offered by a motion sensor, *Heath Zenith's SL-6120 REFLEX* motion-sensing security system/convenience light switch offers five operating modes, including the unique "security" and "random" modes. The "on" and "off" modes let the unit be used as an ordinary light control. In "auto" mode, the switch automatically turns on the lights when someone enters the room—and warns users when the lights are about to be turned off again by dimming them for a brief period of time.

In the "security" mode, the lights begin to flash rapidly when someone enters a



room, to warn an intruder that a security system is being used. In that mode, lights remain on to indicate that an intrusion has occurred. In the "random" mode, a built-in timer turns the lights on at random for up to 4½ hours after dusk and for a varying period of time each evening, so that it seems as if someone is at home.

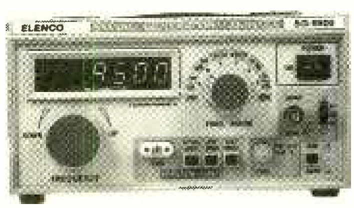
The UL-listed light switch is designed for indoor use with incandescent lamps or ceiling lights up to 500 watts. It replaces the existing switch and is easy to install. Other features of the REFLEX include a test LED that indicates that the passive infrared motion sensor is covering the desired area, and an adjustable photocell that lets the user determine the proper light level.

The SL-6120 REFLEX motion-sensing security system/light switch, which is covered by a one-year warranty, has a suggested retail price of $34.97.

CIRCLE 74 ON FREE INFORMATION CARD

SIGNAL GENERATOR/COUNTER

Combining an RF generator and a switchable frequency counter in one compact unit, the *Elenco SG-9500* is a doubly useful bench-top instrument. It generates RF frequencies from 100 kHz to 150 MHz and measures external frequencies up to 150 MHz. The SG-9500 offers accuracy of ± count ± one digit, and RF output of 100



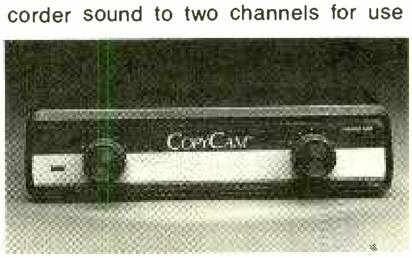
mV rms (up to 35 MHz). It has a switchable 20-dB attenuator, along with a fine-adjustment control. A built-in crystal oscillator accepts a variety of crystals, using an HC-6-volt socket. The SG-9500 has user-selectable gate times of 1.0 or 0.1 seconds. Input impedance is 1-ohm HF or 50-ohms VHF.

The SG-9500 costs $349.95. For additional information, contact Elenco Electronics, Inc., 150 West Carpenter Avenue, Wheeling, IL 60090.

CIRCLE 75 ON FREE INFORMATION CARD

AUDIO/VIDEO SIGNAL ENHANCER

If something's lacking in the audio and video clarity of your home-audio productions, *Videolink's 601 CopyCam* might help. The audio/video enhancer boosts and clarifies weak camcorder microphone sound with an adjustable volume control, sharpens picture details with an adjustable sharpness-enhancement control, and adapts mono camcorder sound to two channels for use



CIRCLE 20 ON FREE INFORMATION CARD

with stereo VCR's and monitors. Sold complete with everything required for installation—including audio and video-patch cables—the CopyCam can be hooked up quickly and easily.

The CopyCam increases the sharpness of blurred images during playback or dubbing by increasing edge definition. When the audio is too low or too high, the unit can increase or reduce gain, resulting in more professional, balanced audio throughout the tape.

The model 601 CopyCam has a suggested retail price of $59.95. For more information, contact Videolink, 12950 Bradley Avenue, Sylmar, CA 91342.

CIRCLE 76 ON FREE INFORMATION CARD

HIGH-END S-VHS VCR

Hitachi's top-of-the-line consumer VCR, the *Studio Edit VT-S730A*, features a flying erase head, the S-VHS format (including separate Y/C signals), and new amorphous heads that improve picture quality. High-quality audio features include hi-fi sound with 90-dB of dynamic range, 10-segment-LED level indicators, microphone input, and a headphone jack with volume control.

The Studio Edit VCR makes editing easy with features such as a jog-shuttle dial, title and date recording, tape-time remaining bar display, and double VCR control. "Synchro edit" allows synchronized operation of the VT-730A and a second VCR when dubbing. All functions—including edit functions—can be controlled from the viewing position using the "Video Brain" remote control. The remote can command two Hitachi VCR's and 10 different late-model TV's from various major manufacturers.

The VCR has a quick tape-loading mechanism, digital auto tracking, an index-

search system, a built-in MTS decoder, 2-speed visual search, a cable-ready 181-channel tuner, and an instant recording timer (for 8 programmable events over one year). It also has audio/video-input and -output jacks, audio/video-input selector, and a 30-minute memory backup.

The Studio Edit VT-S730A S-VHS VCR

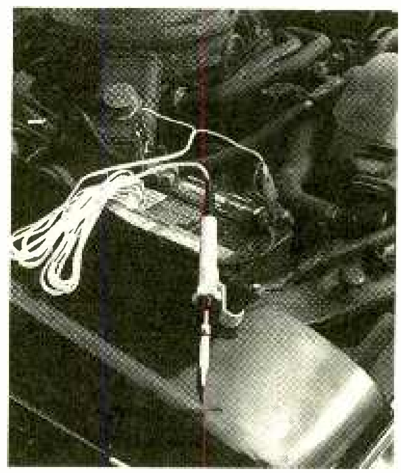
New Products

has a suggested retail price of $1199.95. For additional information, contact Hitachi Sales Corp. of America, 401 West Artesia Blvd., Compton, CA 90220; Tel. 800-262-1502, ext. 578.

CIRCLE 77 ON FREE INFORMATION CARD

PORTABLE SOLDERING IRON

M.M. Newman's Antex MLXS 12-volt soldering iron can be operated from any automotive- or marine-type 12-volt battery. The industrial-grade, 25-watt soldering iron heats up to 800°F in less than two minutes, yet it stays cool because the heating element is under the replaceable tip. It comes as a complete kit with a slide-on tip, a spool of



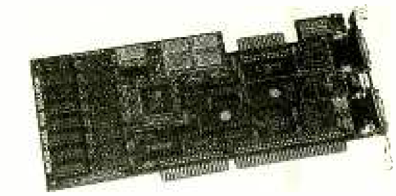
solder, a vinyl carrying case and instructions. The 8-inch-long portable soldering iron also comes with a 15-foot-long cord with two alligator clips that connect to auto or marine 12-volt battery terminals for soldering in the field.

The Antex MLXS soldering-iron kit costs $29.95. For more information, contact M.M. Newman Corporation, 24 Tioga Way, P.O. Box 615, Marblehead, MA 01495.

CIRCLE 78 ON FREE INFORMATION CARD

VGA SOLUTION BOARD

Significantly faster than the IBM VGA board, the *Micro-Labs VGA Solution* is a high-performance 8- or 16-bit graphics board for the IBM PC/XT/AT/386 and compatibles, and PS/2 models 25 and 30. The board supports all 17 IBM-PS/2 VGA modes, as well as all EGA/CGA/MDA/MCGA/Hercules modes, at both the hardware (register) and software (BIOS) levels. That provides complete compatibility with currently available display monitors and software (including OS/2), without the need for special drivers or patches. The VGA Solu-



tion features hardware zoom, windows, split screen, pan, and scrolling. It can display as many as 18 character fonts at the same time. The board comes with a 58-page manual and four disks that contain a font editor and loader, fonts, diagnostics, utilities, RAM-BIOS, and demonstration programs and pictures. Both 9-pin digital (TTL) and 15-pin analog monitor connectors are standard.

The VGA Solution provides maximum resolution of 1024 × 768 pixels if you use 16 colors, and 800 × 600 using 256 colors. Both resolutions are supported by AutoCAD, GEM, Ventura Publishers, and Microsoft Windows 2.x/286/386. High-definition text can be displayed in 132 columns with 25, 28, or 44 rows, and in 80 columns by 60 rows with such programs as Lotus 1-2-3 and Symphony.

The VGA Solution graphics board costs $295.00 with 256K of video memory, and $350.00 with 512K. For more information, contact Micro-Labs, Inc., 7309 Campbell Road, Dallas, TX 75248.

CIRCLE 79 ON FREE INFORMATION CARD

POWER SUPPLIES

Two modular, chassis-mountable power supplies from *Calex* have dual 12-volt DC outputs for powering amplifier and CMOS circuits. Models *CM2.12.120* and *CM2.12.240* provide ±12 volts DC at ±120 mA and ±240 mA, respectively. Line and load regulation for each unit is better than 0.05%, and ripple and noise is below 1 mV rms. The output voltages are factory set to ±1% or better. Both units have current limiting for continuous short-circuit protection.

The rugged, vacuum-encapsulated power supplies come in tough plastic cases that have four molded-in threaded inserts and

four through holes, providing a choice of ways to fasten the supply case to a chassis. The unique step-down upward positioning of the barrier strips prevents them from being easily damaged and allows the unit to be wired from the top.

The CM2.12.120 and CM2.12.240 power supplies each carry a 5-year warranty. Prices start at $88.00. For additional information, contact Calex Mfg. Co., Inc., 3355 Vincent Road, Pleasant Hill, CA 94523; Tel. 800-542-3355.

CIRCLE 80 ON FREE INFORMATION CARD

CAR STEREO WITH CD CONTROL

Alpine's model *7288* is a pull-out, 16-watts-per-channel × 2 tuner and cassette player that can also be used to control Alpine's *CD Shuttle* compact-disc changer. The full-logic cassette offers such features as soft loading and eject, auto-blank skip, repeat, and scan, along with Dolby-B noise reduction, music sensor, and a dust-guard cassette door.

The built-in *T-10 II* tuner system has dual-gate MOSFET's for increased signal-to-noise performance and high-cut, soft-mute, and blend circuits to reduce noise in fringe reception areas. An engine-noise suppressor circuit eliminates ignition noise interference. The tuner has 24 preset stations, including six direct-access presets for storing both FM and AM stations on one preset band, and a matrix-type preset address in display. The unit has "bi-level" capability and selectable fader for easy sys-

tem upgrades, negative-feedback bass and treble controls, audio interrupt (muting), and a radio-monitor feature that allows the radio to be played while the cassette is in fast-forward, rewind, or pause mode. When used with the CD Shuttle, the 7288 offers skip-up/down, direct disc-selection, play/pause, fast-forward, reverse, and random-play control of compact discs.

The 7288 car-stereo head unit has a suggested retail price of $500.00. For further information, contact Alpine Electronics of America, Car Audio Division, P.O. Box 2859, Torrance, CA 90509.

CIRCLE 81 ON FREE INFORMATION CARD

AUDIO-COMPONENT SYSTEM

Designed for those who want a lot of sound without using a lot of space, *Pioneer's CCS-5000* compact audio-component system provides sophisticated listening, recording, and programming options. It includes a multi-play CD player with a 6-disc changer, a dual auto-reverse cassette deck, a 50-watt-per-channel amplifier, a 7-band graphic equalizer, a pair of magnetically shielded 3-way speakers, and a remote control unit.

The twin-tray CD player offers non-stop listening and uninterrupted recording. Its convenient filing-and-storage capability lets the user create a library of favorite CD's in a 6-disc magazine; a random-play feature will play a mix of tracks from those discs without a single repeat. When recording from a CD, the cassette deck's 3-mode auto-synchronous editing system fades music playing at the end of the cassette and replays the entire song on the cassette's reverse side. The cassette deck also has normal- and high-speed dubbing, relay record and play, auto fade, music search, Dolby noise reduction, and parallel record. The amplifier has a motor-driven volume control that lets the volume be controlled remotely. It features twin wake-up timers that

(Continued on page 22)

CIRCLE 15 ON FREE INFORMATION CARD

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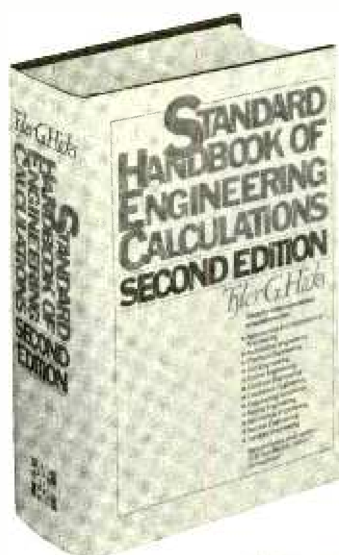
- uses USCS and SI units in all calculation procedures



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Publisher's Price $98.50

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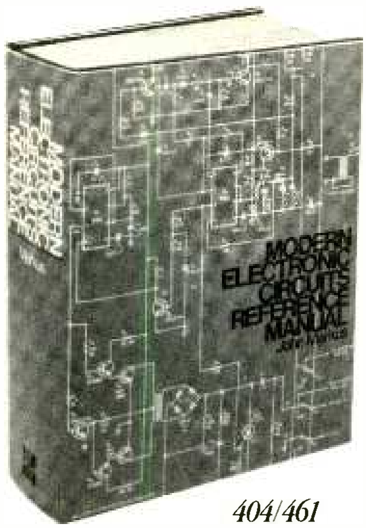

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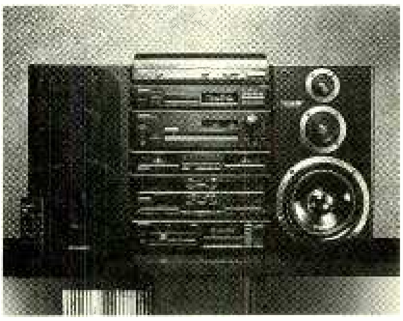

can be used from any source and come on with a gradual volume increase. The amplifier has CD-direct and DAT-in/-out jacks and a built-in speaker matrix surround-sound circuit.

The CCS-5000 audio-component system has a suggested retail price of $1300.00. For further information, contact Pioneer Electronics (U.S.A.) Inc., 2265 East 220th Street, P.O. Box 1720, Long Beach, CA 90801-1720.

CIRCLE 82 ON FREE INFORMATION CARD

SURGE PROTECTORS

Data Spec's UL-listed surge protectors safeguard electronic equipment—including personal computers, printers, modems, fax machines, and telephones—from destructive voltage spikes and surges. The *DSTM2* is specifically designed to protect equipment that transmits and receives data via telephone lines, such as fax machines, modems, and telephone systems. The compact unit features maximum energy dissipation and plugs directly into any AC socket. The *D6OUTSP* AC-surge protector is a six-outlet strip that offers continuous spike protection, a built-in safety circuit breaker, a master switch with pilot light, a 3-wire plug, and a 6-foot heavy-duty power cord. The injection-molded power strip is color-coordinated to match today's personal-computer

systems. Offering the same surge-suppression technology as the *D6OUTSP*, the wall-mounted model *SP011* converts a dual wall outlet to six outlets while adding protection to all attached equipment. It features a power indicator and automatically resets for repeated use after brownouts or surges.

The models *DSTM2, D6OUTSP*, and *SP011* surge protectors have list prices ranging from $23.95 to $35.95. For additional information, contact Data Spec, 9410 Owensmouth Avenue, Chatsworth, CA 91311.

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AUTOMOTIVE SUBWOOFERS

Two subwoofers from *Jensen* meet the demand for custom installations with deep-bass performance. The 12-inch *JW1200* has peak power handling of 325 watts, with 125-watt continuous power handling. It has a powerful 40-ounce magnet with a usable frequency response of 20 Hz to 2.5 kHz. Its sensitivity is 92 dB (1 watt, 1 meter), and its impedance is 4 ohms. The 10-inch *JW1000* has a 30-ounce magnet, 250-watt peak-power handling, 100-watt continuous

power handling, 91-dB sensitivity (1 watt, 1 meter), 4-ohm impedance, and usable frequency response of 25 Hz to 2.1 kHz. Each subwoofer is equipped with a heavy-duty multiple-layer voice coil that provides higher power handling and superior heat dissipation. The subwoofers can be used singly or in pairs, and can be added on to existing systems.

The JW1200 and JW1000 automotive subwoofers have suggested retail prices of $79.95 and $69.96 each, respectively. For further information, contact International Jensen, 4143 North United Parkway, Schiller Park, IL 60176.

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DIGITAL MULTIMETERS

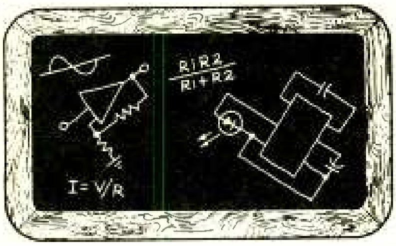
The three handheld digital multimeters in *Soar's 3200 Series* go from analog to digital with a simple rotary switch. The handheld DMM's measure voltage, current, resistance, and continuity, and provide 3200 counts per range for better resolution. Each one has basic DC accuracy to 0.35%, a 332-segment bar-graph display, and is easy to use. Functions are selected via a convenient 8-position rotary switch—then the meter automatically selects the range that offers the greatest resolution and accuracy. Models *3220* and *3230* each have a RANGE button that prevents them from changing ranges, saving time on repetitive go/no-go checks. They also have an audible continuity feature that beeps when the circuit being tested is closed. The model 3230

also has a DATA-H button that automatically ranges and locks the reading on the display, allowing the user to concentrate on the test points. Each of the 3200 Series DMM's include safety test leads, a users' manual, a spare fuse, batteries, and a 3-year warranty.

The models *3210, 3220*, and *3230* digital multimeters each cost less than $100. For further information, contact Hub Material Company, P.O. Box 526, Canton, MA 02021. ■

CIRCLE 85 ON FREE INFORMATION CARD

"He's a good worker, but he tends to get irritated easily."

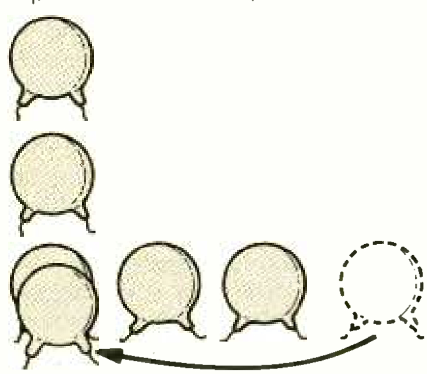


Think Tank

By Byron G. Wels, K2AVB

THE ANSWER, AND ANOTHER QUESTION...

Alright, alright. I give up. Here's the answer, and don't get mad! All you have to do is move the fourth capacitor on the right so that it sits on *top* of the capacitor in the corner, like this:



Now I never said you couldn't pile one on top of another, did I? And you'll have to admit, it gives you four capacitors in each row, right? Right. Omigosh! What terrible names you guys must be calling me now!

Meanwhile, guess who came knocking on my door last night? Yup! My friend Murray. Now this time, I wasn't building a thing, I was straightening out the shop, sorting out a bunch of quarter-watt resistors. Naturally, I didn't stop. I had dumped a huge cigar box of assorted resistors into muffin pans. I kept working at it, and Murray asked "Whatcha doing?." He went to my cupboard, took out a cup, and emptied about twenty 1k resistors into the cup. I knew better than to say anything. "You know how to sort these out?" I assured him that I could, and asked what it was that he was up to. Now he added a handful of 10k resistors to the cup, and mixed them up.

"Byron, if you put your hand in *without looking*, and took only one out at a time, how many times would you have to put your hand in to make a pair of either one?"

"Murray," I protested, "I'm too busy to..."

"Okay," he said, "See you around." Then he left.

I went back to sorting, but the question intrigued me. I hope it will intrigue you too. What exactly, is the minimum number of times that you have to reach into the cup, taking one resistor out at a time, to get a matching pair of either one? If you get the answer, be sure to send it in.

And by the way, we *do not* give out books for the answers. But because you're nice guys, I'll give you the answer next month.

We frequently get letters asking where certain parts are obtainable. Usually, we try to make sure before we use a part, that it's easy to find, or we get a source that we can list. Sometimes, one will get away from us, but that's part of our hobby, isn't it? If you can't find a specified part, try a substitute.

Some Good News: I've been chomping at the bit to give you this news, and the boss just told me we can finally talk about it. I'm sure that all of you have a copy of the "Think Tank Book." Well now we can offer "Think Tank II." It's a compilation of circuits from past installments of "Think Tank." After a lot of number crunching, we decided to keep the price at $3.50 per copy for the new book, plus $1.25 for shipping and handling. (New York State residents, please add the necessary sales tax.) If you still don't have the first edition, you can get it for the same price. And if you want to save half a buck, order both Think Tank I and Think Tank II, and take fifty cents off the entire price. And, we're going to start rewarding submissions with Think Tank I.

Now let's see what you've all been up to this month!

Stereo Mixer. Hi, Byron! I'm a 14-year-old that's trying to get a band started, with not much luck so far. That's what led me to the enclosed circuit (see Fig. 1). I'm certain that you've come across assorted simple mixers, but this one is—what I consider—a great improvement.

THINK TANK

Instead of being just a common monophonic (mono) mixer, this one is a stereo mixer. Actually, it is comprised of two mono mixers with a modification to the microphone inputs.

Its operation is simple: When a microphone is "in use," the mike's output is fed to the MIC input of the circuit. The signal is then run into R1 or R2 (which are used as faders). The signal is then split into two different paths by resistors R3 and R4 with which you can change the place of the MIC inputs within the stereo panorama. The stereo line inputs are just for that. Joining the MIC inputs with the output of some other source, such as a tape deck, turntable, etc., all the signals are fed to the inverting input of an op-amp. The output reaches the master-fade potentiometers, which control output power.

This circuit is also easy to modify. For example, I substituted low-noise amplifiers for the 741's, and used 1% metal-film resistors. I also used slide potentiometers for the faders and line-level controls. I changed the number of inputs as well. Instead of only two MIC inputs and one line input, I needed to have a total of eight MIC inputs and four LINE inputs.

—*Andy Mussgnug, Belgrade, MT*

Good Andy! And the way it looks to me, if things don't work out in the music business, you'll have a bright future in electronics. It never hurts to have a good, solid, back-up career, especially when you're heading into a competitive field like music.

Full-Cup Detector. By, my wife and I are totally blind, and have often burned our fingers trying to tell if the coffee cup is full. There is a commercially available unit, but I wanted to build my own. (See Fig. 2.) To use the one I designed, simply place the probes of the unit in the cup, and turn it on. The 555 starts to tick at about 15 Hz. I then press the valve on the percolator to pour a cup of coffee (or any liquid) and release it promptly when I hear the higher tone of about 500 Hz. That occurs when the coffee bridges the probe contacts.

The circuit is a modified 555 astable multivibrator (oscillator) circuit. The probe was fashioned using two terminal strips, about four feet of AC line, and about 8 inches of twisted-pair hookup wire like that used for doorbells. One terminal strip is mounted on the project box with two screws exposed; the line cord will be attached to those screws. The other end of the cord is soldered to the solder lugs on the other terminal strip. One end of the 8-inch twisted pair is connected to the screws on that terminal strip. The other end is untwisted about 1½ inches. Each lead is stripped about one inch and a hook fashioned so the two leads are about ⅛-inch apart and capable of hooking over an ordinary coffee cup.

By having the leads stripped, the wires can be bent to precisely signal at the desired liquid level. I tested my unit by pouring cold water from the unplugged percolator. For safety's sake, I held the probe in place while pouring coffee. You can easily compensate for slowness in stopping by bending the probe contacts to signal earlier.

By the way, I "read" your magazine using an Optacon, which provides

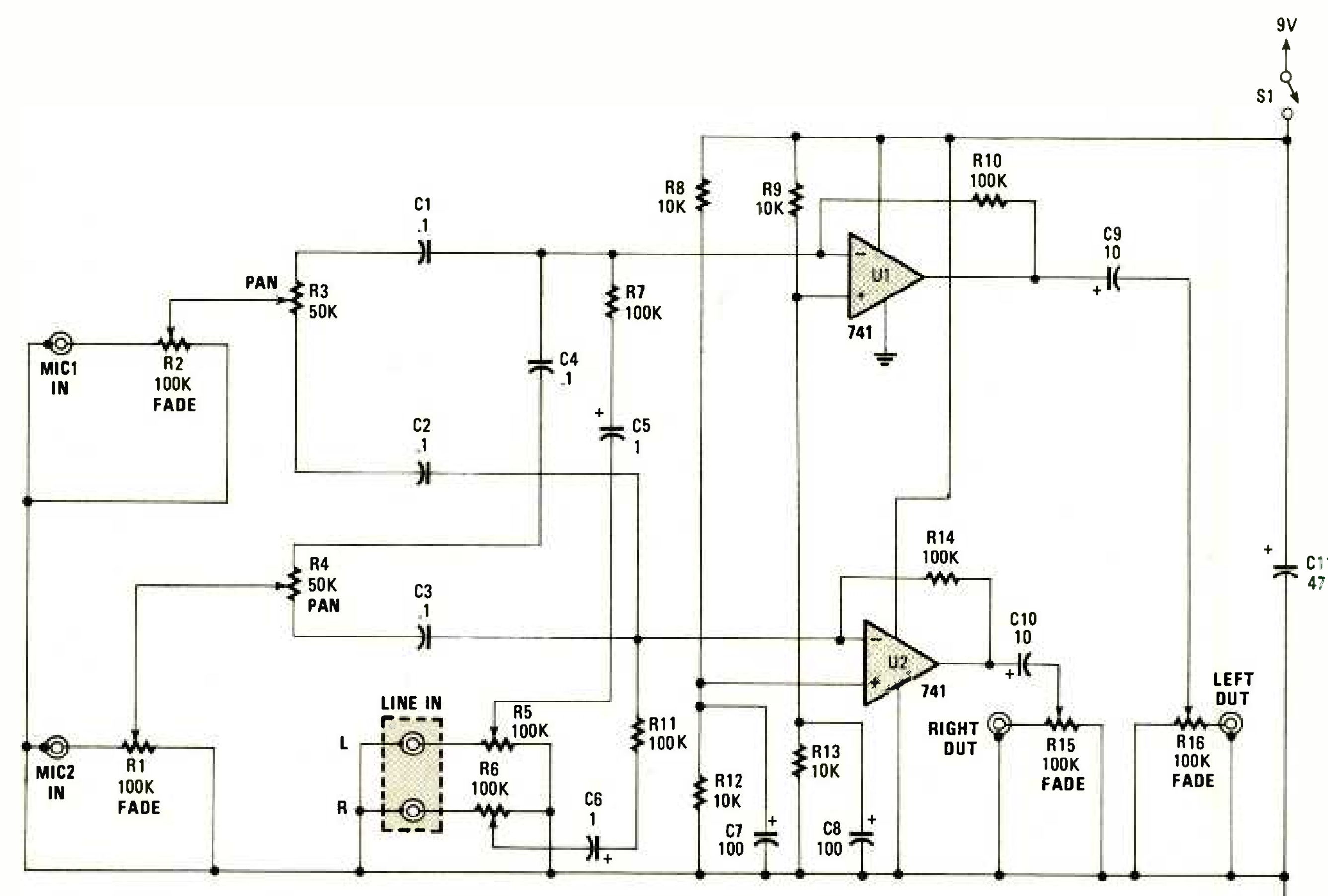


Fig. 1. This Stereo Mixer is actually comprised of two monophonic (mono) mixer circuits with a modification to the microphone inputs.

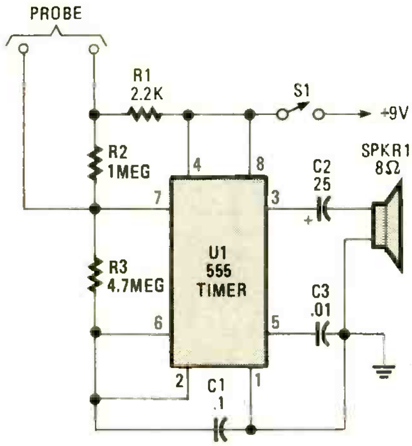


Fig. 2. At the heart of the Full-Cup Detector is a 555 oscillator/timer configured to produce a 15 Hz click, until its probe contacts are bridged, at which time its output frequency goes to about 500 Hz.

raised letters that I can feel. It also enables me to trace the schematics. So how 'bout it, do I get a Book?

—*David Plumlee, Independence, MO*

David sent in two schematic diagrams, which were very roughly drawn; one was made by punching pin holes in a plastic sheet, and is the one that we followed. His accompanying letter thoroughly detailed this worthwhile project, and his undaunted spirit lifted my own. David, we're very proud to have you as a reader. God bless. And yes, David, you've more than earned your copy. (Would that all our readers were so dedicated.)

Super Continuity Checker. Have you ever thought you were getting a good reading and then found you were actually reading through a coil or low resistance device? This valuable time saver solves that problem and can also check resistances of up to about 150k.

See Fig. 3. As shown, a reference voltage (as set by potentiometer R1) is applied to the inverting input of U1 (¼ of an LM339 quad comparator with open collector outputs). Potentiometer R1 can be a trimmer if you plan to use the unit for continuity checks, and should be a multi-turn type for ease of calibration.

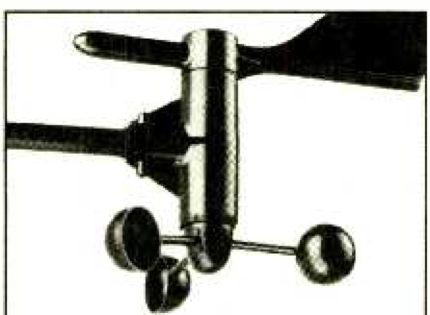
The connection to be tested is applied through test leads to ground and the junction of R2 and R3. Components R3 and D1 protect against accidental application of voltage to the circuit. Since the non-inverting input has a high impedance, the junction of R3 is virtually the same as the non-inverting input as far as measurements are concerned.

When the voltage at the non-inverting input of U1 at pin 5 falls below that at the inverting input, the output goes low. That causes the buzzer to sound, indicating continuity.

Potentiometer R1 sets the threshold at which the buzzer sounds. When resistance is applied to the R2/R3 junction and ground, a voltage divider is formed, which is referenced against the voltage divider created by potentiometer R1. If the resistance is low enough compared to the setting of R1, the buzzer sounds.

To calibrate the tester, you need two resistors; 100 ohms and 120 ohms. Connect the 100-ohm resistor to the test leads and adjust R1 until the buzzer sounds. Now connect the 120-ohm unit and make sure the buzzer does not sound. The tester is now set to check any resistance under 100 ohms.

None of the parts values are critical, and neither is the battery voltage since the comparator is looking at voltage



ratios, not absolutes. Ground all unused pins of the LM339.

—E. Kirk Ellis, Selma, NC

Good circuit! Our readers are always interested in test equipment, and this certainly fills that bill. Your book is on the way!

Electronic Bird. Byron, here's a simple "electronic bird" that chirps and warbles. (See Fig. 4.) It uses non-critical, easy-to-obtain parts. As a matter of fact, an old transistor radio will usually supply all you need except the switch, but more on that later. It's a natural experimenter's circuit, as it is a good idea to begin by breadboarding the circuit and trying different parts values to see what happens. Then you can wire it up on a perfboard for permanent installation in an enclosure.

The type of switch is up to you. I've built the circuit into cereal boxes, using a small mercury switch. When they pick up the cereal box in the morning and hear the bird, it really wakes them up! It can also be used similarly in a cigarette package, or with a microswitch, in a drawer. Any general-purpose transistor could be used, and if you want to use an NPN, just reverse the polarities of the battery and the electrolytic capacitor.

I've taught electronics for 15 years and this circuit has been a very successful first project for hundreds of beginning students in our field. It almost always works the very first time, except when a transistor is installed incorrectly.

—David Russell, Agana, Guam

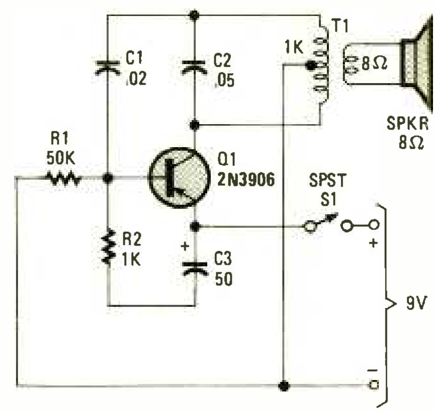


Fig. 4. The Electronic Bird circuit was assembled from non-critical, easy-to-obtain parts. Any general-purpose transistor you have on hand could be used for Q1; if you use an NPN unit instead of the PNP transistor shown, just reverse the polarities of the battery and of the electrolytic capacitor (C3).

Love it Dave! In fact, when I get home tonight, I'm going to throw one together myself! I'll bet this thing could drive a cat absolutely nuts.

Simple Delay Timer. Not long ago, I built a stereo amplifier and it sounded great—as long as you weren't around to hear it when the power was turned on. The loud "pop" was so bad it almost cleared the dust off my stereo cabinet. What I needed was a timer that would allow me to put a dummy load on the amplifier output while the speakers sat in silence for a few seconds. Then, when the speakers kicked in, all I would hear is music. But finding a suitable circuit wasn't easy. All the schematics I found

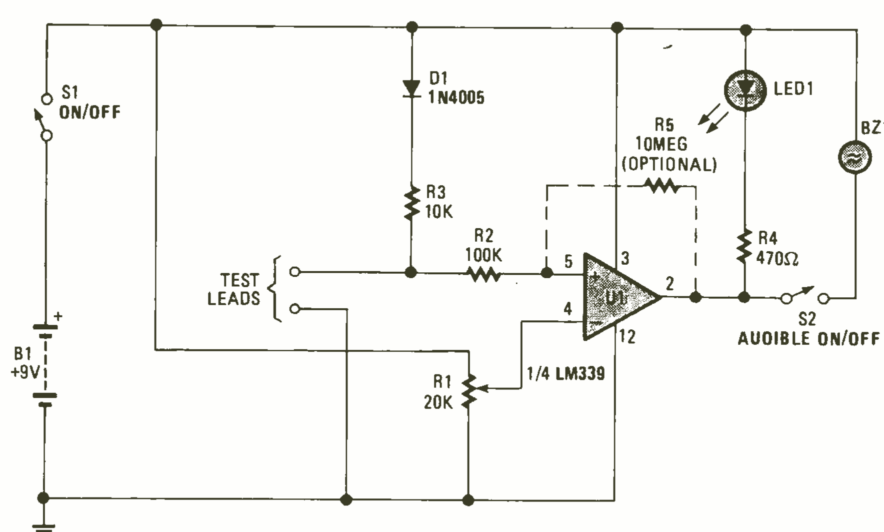


Fig. 3. This continuity checker—built around an LM339 quad comparator with open-collector outputs—eliminates false readings caused by coils or low resistance devices in a circuit.

were either too complex or tried to do too much.

The circuit I came up with (see Fig. 5) is simple, compact, and inexpensive. Transistor Q1 and resistor R1 form an inverting amplifier. When power is turned on, capacitor C1 starts to charge through resistor R2. As C1 charges, the voltage at Q1's base drops, allowing Q1 to turn off, causing Q1's collector voltage to rise.

As the voltage from the collector of Q1 rises, the Triac is triggered into conduction and the relay is energized, closing its normally-open contacts. That

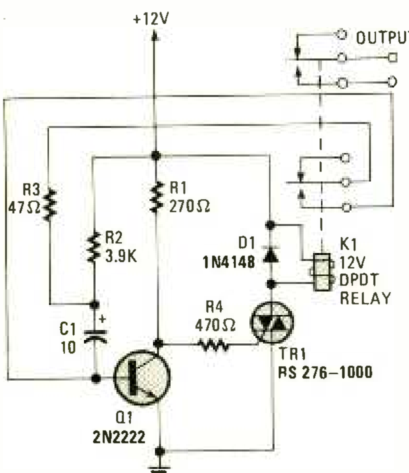


Fig. 5. In this delay timer circuit, transistor Q1 and resistor R1 form an inverting amplifier; while the charge/discharge cycle of C1 provides the time-delay function.

causes C1 to discharge through R3, which causes Q1 to turn on. The circuit remains activated until power is removed.

I used a 220-µF capacitor for C1. It provided about four seconds of delay time. You can play with the values of C1 and R2 for different delays. You can also substitute an SCR for the Triac, but if you do, remember to increase the resistance of R4 to about 1000 ohms.

This circuit has enough applications in other areas to fill a book.

—Al Versaevil, Woodstock, Ontario, Canada

Good circuit, Al. And you're quite right. There are lots of other applications where a time delay is required. This one is a clip-and-save circuit if you're into clipping and saving!

Two-In-One. This circuit is a combination of two circuits that used to save me many hours of work. (Refer to Fig. 6.) In

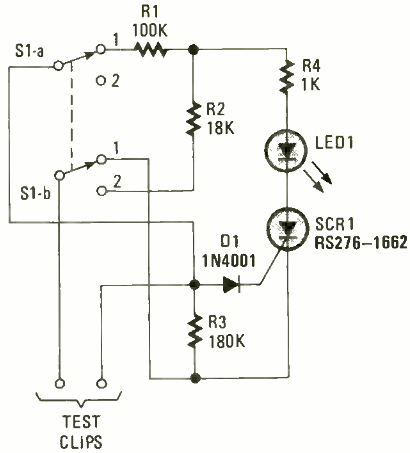


Fig. 6. This circuit can be used to test for opens in cables, bad circuit-board traces, or intermittent circuits (swingers) in security systems.

the closed position, it will latch on any open circuit no matter how short it may be. Testing for opens in cables, bad circuit board traces, or intermittent circuits (*swingers,*) in security systems is easy with this tester.

In the open position, it will latch on any conductive path of up to 100k. When making up cables, I did not try to label each lead as I soldered it. Instead,

THINK TANK

I grouped five or six leads in a bunch, and used the tester to quickly separate the lead of interest. A small box with 10 switches and clip leads speeds up the process even further. You can form and label a harness in half the time it takes to label each lead as installed. Book Byron?

—James A. Perrigo, Beaver, OR

On the way, Jim. And I'd suggest that any of our readers who are involved in industrial electronics take note. Bring this circuit to work the next time you're doing a big cabling job, and you'll be a hero!

A/B Switch. I just resumed my electronic hobbying after a nine-year hiatus. My renewed interest was sparked by a friend who wanted an A/B switch for his video cameras, but rejected the commercial units due to the cost. I went through the catalogs, dug out old schematics, all to no avail. After an afternoon of drawing and breadboarding, I came up with this circuit (see Fig. 7). Now I'd like to share the circuit, and thought that your column would be the ideal vehicle.

The circuit consists of three IC's and a handful of resistors. Two gates from a 4011 quad 2-input NAND gate (U1-a and U1-b) are configured as a monostable multivibrator (one-shot) that, when switch S1 is pressed, triggers a 4017 decade counter/divider, which has been set to recycle after a count of two. The outputs of U2 at pins 2 and 3 are fed to the control inputs of U3 (a 4066 quad bilateral switch) at pins 12 and 13. Depending on which control input is high, either the J1 or J2 output is selected.

With a little modification, the switch could be set to trigger at a set rate (automatically); and with the addition of another 4066, it could have as many as eight channels. One application that comes to mind would be in a security surveillance system.

—Chris Coates, Woodstock, Ontario, Canada

Very nice Chris. You have done exactly what we recommend—find a need and fill it. However, Chris, there is one thing that bothers me. We electronics hobbyists have a tendancy to over design—such is the case here; there is a bit more hardware in the circuit than is really necessary. But seeing that you've been away from electronics for so long, I think that what you managed to come up with is great. Nice going, Chris!

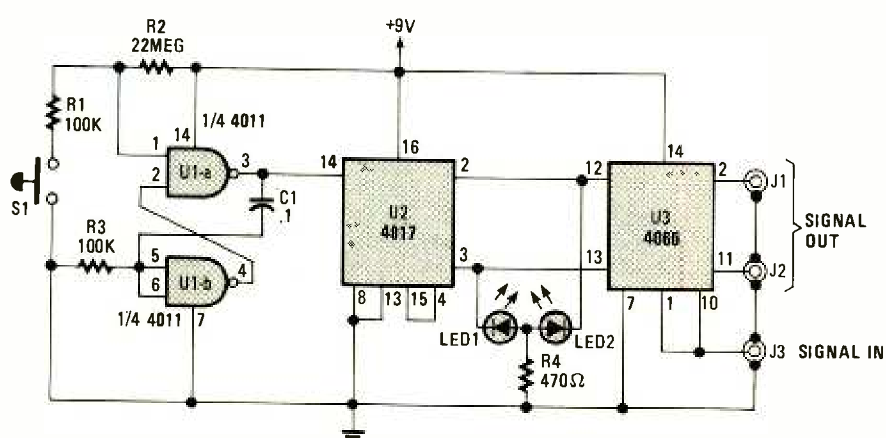


Fig. 7. The A/B Switch circuit consists of three IC's and a handful of resistors. Two gates from a 4011 quad 2-input NAND gate (U1-a and U1-b) are configured as a monostable multivibrator that, when switch S1 is pressed, triggers a 4017 decade counter/divider, which has been set to recycle after a count of two.

IR Remote Extender. I use this circuit to operate my VCR or CD player from another room. It's really an infrared signal repeater. The signal from my remote is received and then retransmitted over wires to an infrared LED. The beam from the LED is then picked up by the receiving window on the VCR or CD player.

See Fig. 8. The visible light LED (LED1) in series with the "IR" unit (LED2) is there to indicate that the transmitted signal has been detected. The 100k trimmer potentiometer (R1) adjusts the repeater's sensitivity. The resistor that one usually finds in series with the LED's was omitted, as the voltage reading was about 1.0 volt DC because of the voltage drop across the lines.

Incidently, I used 50 feet of #24 speaker wire. All components are readily available and you should have no trouble in duplicating this circuit.

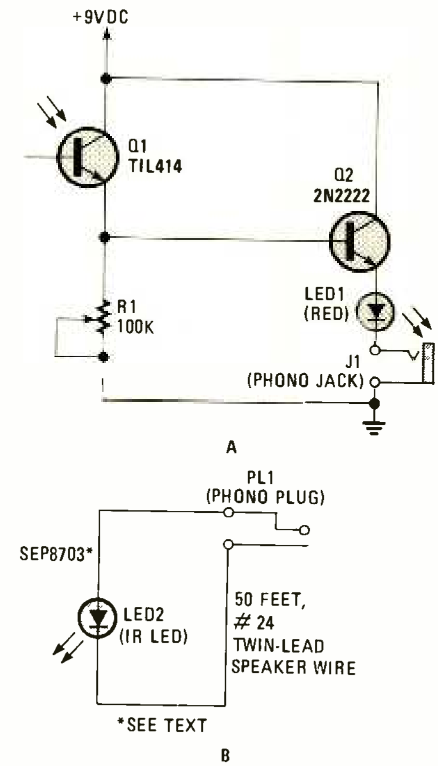


Fig. 8. The IR Remote Extender is an infrared repeater circuit; e.g., IR light detected by Q1 is re-transmitted by LED2. It can be used to operate any infrared-remote controllable device from another room.

—Jean-Pierre Dube, Moncton, N.B., Canada

Tres bon, Jean-Pierre! Good circuit, and with many practical applications. We'll be sending you a book, and I know you'll enjoy it. Now get busy and send in another circuit. We've got lots of other books!

Electronic Chime. Byron, awhile back, I was wondering how to create a bell or chime tone electronically. This (see Fig. 9) is the circuit that I came up with. It's ideal for sounding an audible attention-getter without the raucous sound of a buzzer.

The circuit is built around a 556 dual oscillator/timer, which is wired to generate two separate square waves. The first, an audio tone that sets the pitch of the bell, is used to drive the base of Q1 via R5. The second square wave provides the "striker." It has a full cycle of about one second, a duty cycle of about 95%, and provides the collector voltage for Q1 via C5 and R6.

When the striker signal goes high, Q1 conducts and the audio tone is present at the speaker. As C5 charges, the

(Continued on page 104)

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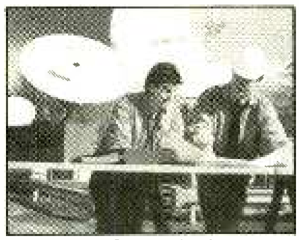

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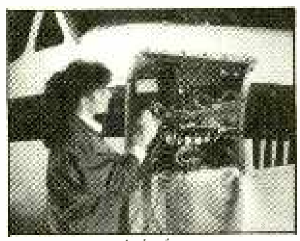

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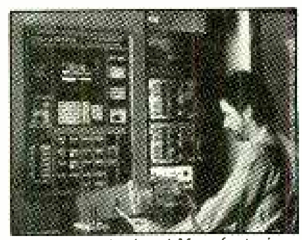

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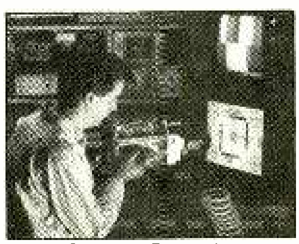

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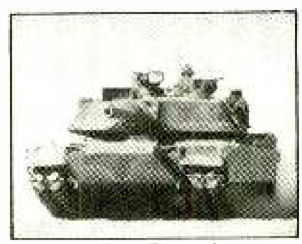

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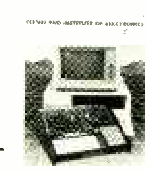

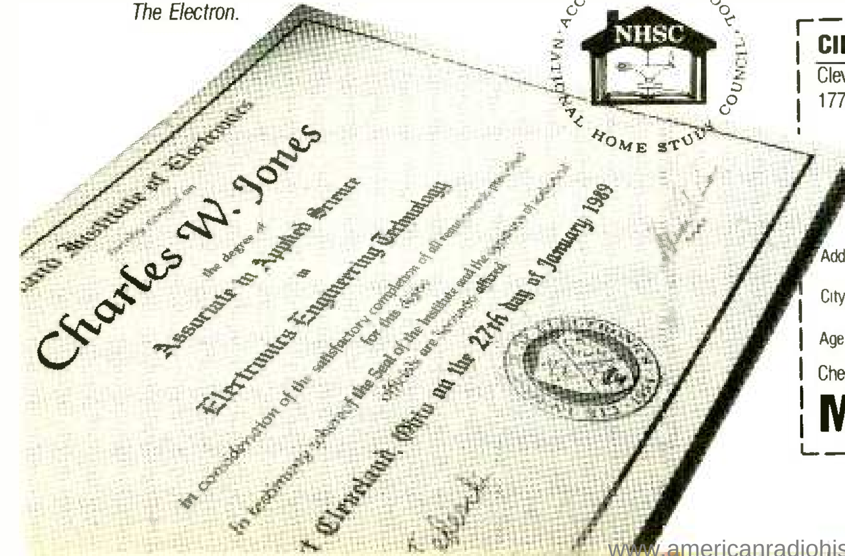

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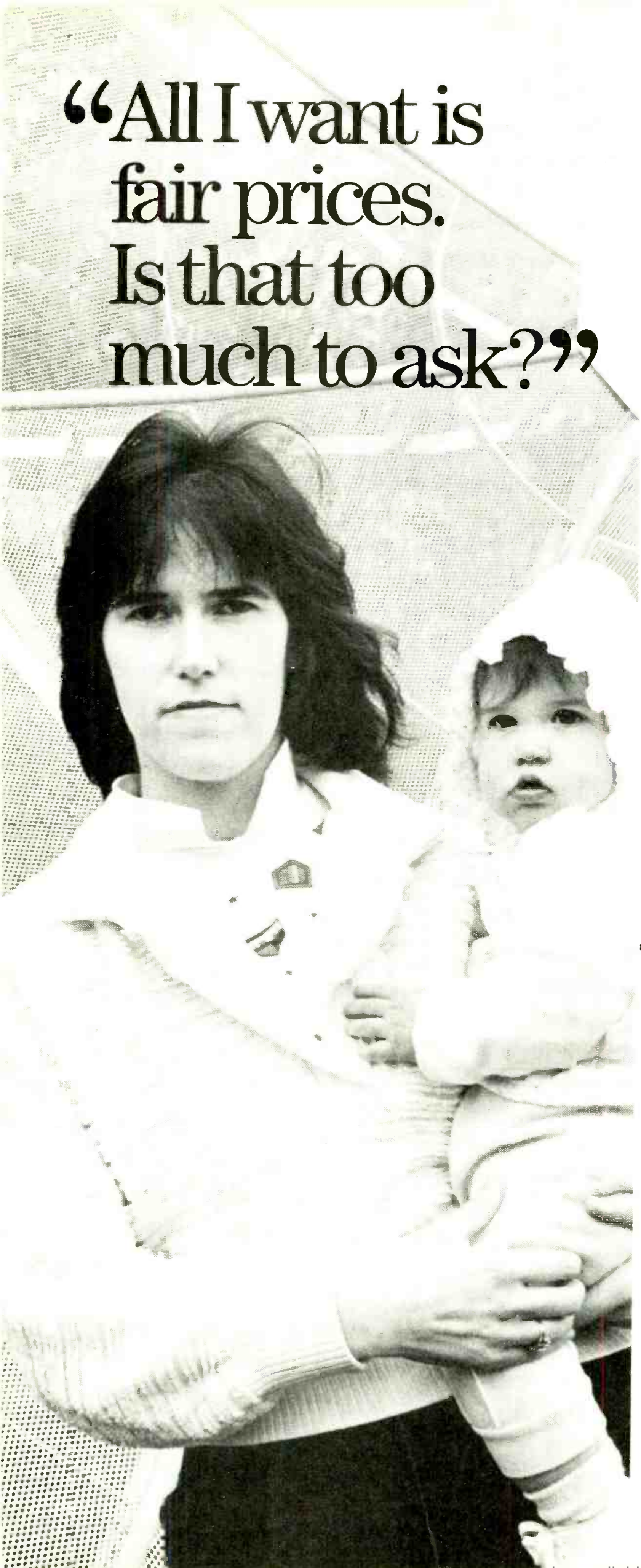

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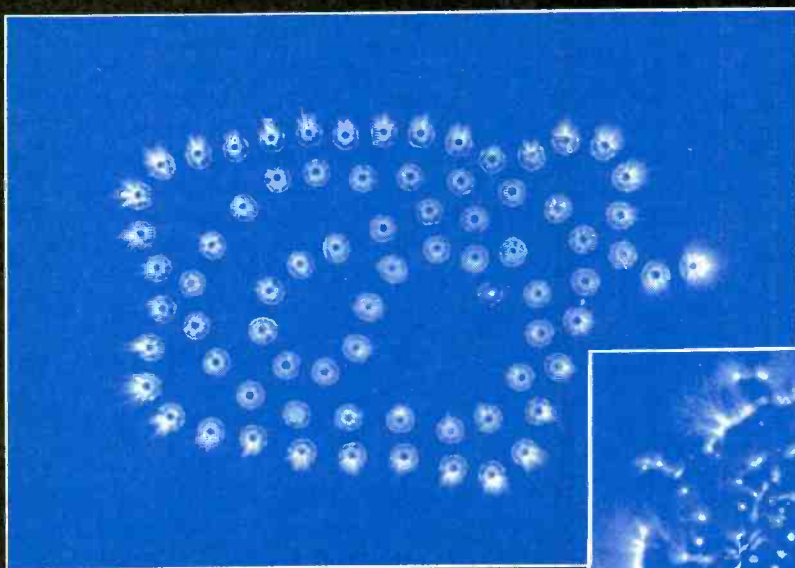
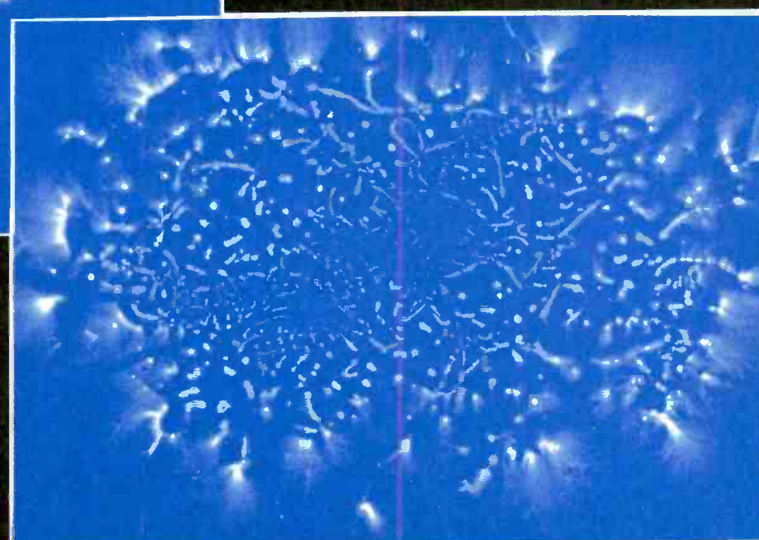




Experiments In Electrophotography

Learn about Kirlian photography, Litchenberg figures, and more when you explore the world of electrophotography.

BY STANLEY A. CZARNIK

In 1939, a Russian technician by the name of Semyon Davidovich Kirlian noticed a spark jump from the high-voltage glass electrode of an electrotherapy machine to the skin of a human being. He wondered if the flash could be photographed without using a camera and proceeded to investigate.

Kirlian replaced the glass electrode with a metal one to avoid exposing the film, put his own hand on the surface of the electrode, and turned on the high-frequency current. Semyon Kirlian's hand was badly burned, but the experiment worked. When the film was developed, it showed a very unusual image of his fingers.

Kirlian and his wife, Valentina, found that any object capable of conducting electricity could be photographed in the same way. No ordinary illumination was necessary, only the bluish-white corona surrounding the conductive object when connected to an appropriate high-voltage circuit.

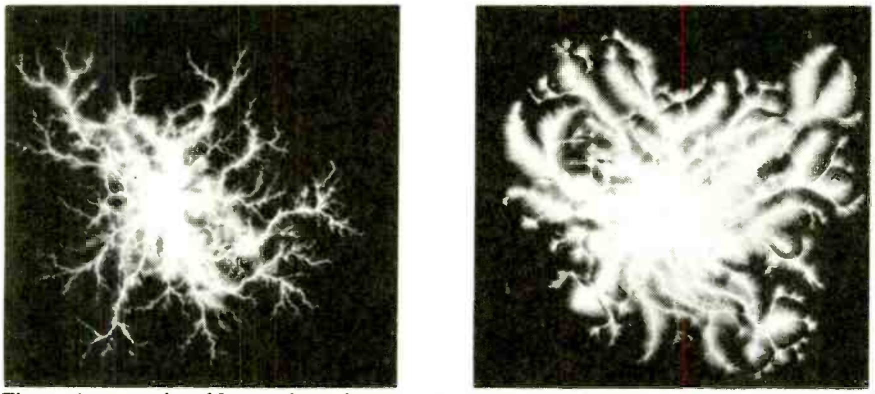
In 1949, Semyon and Valentina Kirlian obtained a patent for "a method of photography with the aid of high-frequency currents." That method is now often called "Kirlian photography."

WARNING

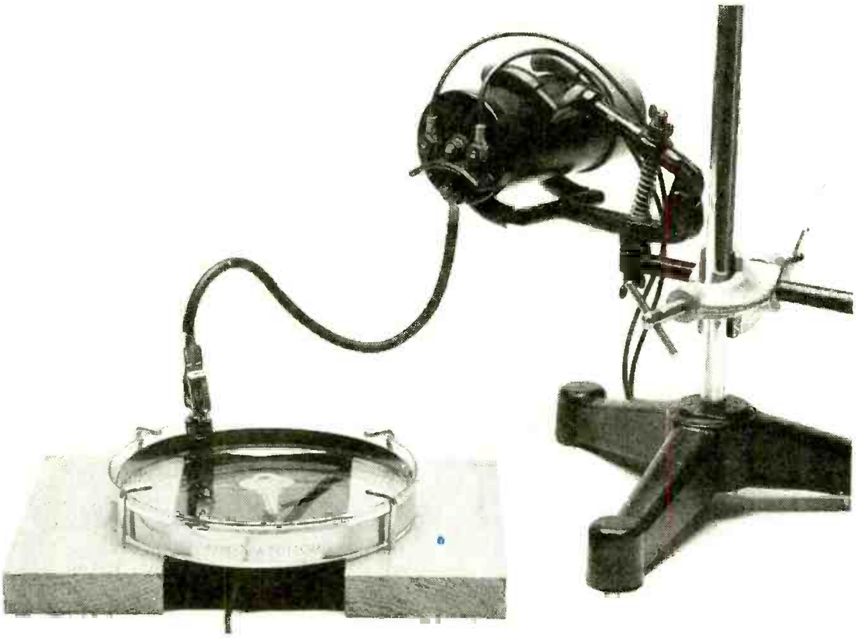
This article deals with and involves subject matter and the use of materials and substances that may be hazardous to health and life. Do not attempt to implement or use the information contained herein unless you are experienced and skilled with respect to such subject matter, materials and substances. The publisher makes no representations as to the accuracy of the information contained herein and disclaims any liability for damages or injuries, whether caused by inaccuracies of the information, misinterpretations of the directions, misapplication of the information, or otherwise.

Lichtenberg Figures. The story of Semyon Kirlian has become common knowledge. What is less well-known is that the creation of "electrical-spark" pictures actually occurred much, much earlier in history. They can be attributed to one of the most thoroughly unusual scientists ever, a man by the name of Georg Christoph Lichtenberg, born in the little village of Ober-Remstadt near Darmstadt, Germany, on July 1, 1742.

As a Professor of Mathematics and Physics at the University of Gottingen, Lichtenberg found himself attracted to experimental science. He was fascinated by the complexity of things in their natural state, and experimentation provided him with a way of experiencing that complexity. Lichtenberg, justly famous for his proverbs and aphorisms, phrased it like this: "The way to determine the secret workings of Nature is from analogous cases where one has caught her in the act." Lichten-



These photographs of Lichtenberg figures were taken about 1914 by J. Ernest Woodland of the College of Wooster, Ohio. He obtained high-voltage output from an induction coil. Such patterns form at the intersection of a conductive point and a plane separated by a dielectric. The positive figure is on the right; the negative figure is on the left. These pictures appeared originally in Sparks, Lightning, and Cosmic Rays *(1939).*



Here's one good way of arranging your electrophotographic equipment. The high-voltage lead wire coming off the induction coil is connected to an alligator clip attached to a couple of flexible brass strips on the inside edge of the Petri dish. The subject, a key in this case, is held up against the bottom of the dish with a small spring. The spring support mechanism is hidden under a few layers of black velvet. The ground wire, coming out from beneath the velvet, is attached to a metal utility sink. The induction coil is supported by an ordinary laboratory ringstand.

berg's unique intelligence won him the respect and admiration of William Herschel, Allesandro Volta, Goethe, Kant, and many others.

Lichtenberg had access to a simple static device known as an electrophore, invented by Volta in 1775. An electrophore is a system of conductive and dielectric components arranged in a layer-cake fashion that, once charged, can be made to deliver a number of electrical impulses. Lichtenberg's electrophore was very large. The dielectric, probably made of resin, wax, and turpentine, weighed 50 pounds by itself.

According to Lichtenberg, it so happened that the cover of the giant electrophore was for a time lifted off the resin base. That permitted dust to settle on the electrified dielectric. The dust did not settle evenly. Instead, designs appeared and patterns formed. The results were completely surprising and utterly spectacular. Lichtenberg saw stars, suns, branches, beams, clouds, arches, and various other shapes. He was delighted.

We know now that such "Lichtenberg figures" are created by electric sparks gliding over the exterior of the dielectric; the paths taken by the sparks are made visible by the dust.

Lichtenberg had other ideas. He thought that his dust patterns might indicate the presence of electricity in the same way that iron filings indicate the presence of magnetism. He also thought that the designs were somehow similar to the lines and angles formed in the winter by frost on a window. Remember that Lichtenberg's interpretations were first put forward over 200 years ago.

Methodology. The traditional method of creating electrophotographic corona images requires a metal-plate electrode, a dielectric plate (usually made of glass), and a piece of sheet film. The film is placed over the dielectric. The dielectric is placed over the metal electrode. The metal electrode is connected to a high-voltage power supply. Finally, the subject to be photographed is pressed flat and firmly against the film from the top.

That device is very similar to some-

Books and Articles.

Corona Discharge Photography; By D.G. Boyers and W.A. Tiller, Journal of Applied Physics No. 44, July 1973, pp. 3102–3112.

Gaseous Conductors; By J.D. Cobine, New York, Dover, 1958.

Aura Phenomenon Puzzles Experts; By E. Edelson, Smithsonian No. 8, April 1977, pp. 109–113.

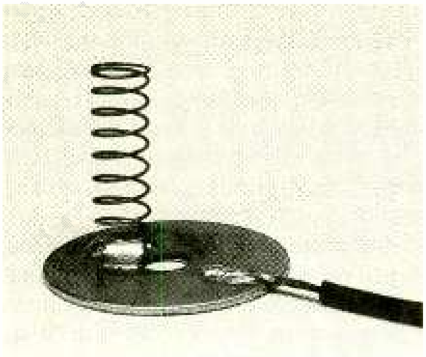
Kirlian Photography in Theory and Clinical Application; By L.W. Konikiewicz, Journal of the Biological Photographic Association No. 45, July 1977, pp. 115–134.

The Atomphysical Interpretation of Lichtenberg Figures and Their Application to the Study of Gas Discharge Phenomena; By F.H. Merrill and A. von Hippel, Journal of Applied Physics No. 10, 1939, pp. 873–887.

Remarks on G.C. Lichtenberg, Humanist-Scientist; F.H. Mautner and F. Miller, Journal of Applied Physics No. 43, September 1952, pp. 223–231.

Image Modulation in Corona Discharge Photography; By J.O. Pehek, H.J. Kyler, and D.L. Faust, Science No. 194, 15 October 1976, pp. 263–270.

Lichtenberg: A Doctrine of Scattered Occasions, By J.P. Stern, London, Thames and Hudson, 1963.



The subject support mechanism can be made with one large metal washer and a small spring. You can do the work with any high-wattage soldering iron. Make sure the surface of the washer is clean and shiny, otherwise the solder may not stick. The ground cable can be connected directly to the washer.

thing known as a klydonograph, which is used to record surge waves on transmission lines. The klydonograph is sometimes called a Lichtenberg-figure camera.

The conventional electrophotographic procedure has one major drawback: it is almost impossible to get any clear idea of what the image will look like until the film is developed. The method outlined in this article gets around that problem completely. That is accomplished through the use of a transparent-fluid electrode placed over the subject instead of under it. The transparent-fluid electrode we'll be working with is ordinary tap water. The water electrode allows you to actually see the entire corona image before, or without, taking a single photograph! In other words, you do not need a camera to experiment with corona-discharge images.

A similar, but not identical, method was devised independently by L.W. Konikiewicz in the mid-1970s (see the boxed text entitled *Books and Articles*).

Power Supplies. The traditional power source for corona-discharge photography is a Tesla coil. Semyon Kirlian used a Tesla coil, and so have many later researchers. However, Lichtenberg's figures were produced under the influence of a strong static charge. When Lichtenberg died in 1799, the Tesla coil was still many years away. The point is that almost any source of high-voltage electricity can be harnessed to the purpose of creating corona-discharge images.

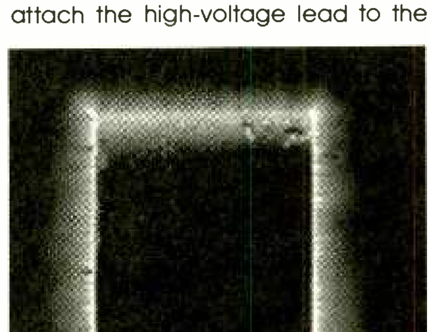
For most of my own experiments, I set up an automotive induction coil equipped with a mechanical vibrator mechanism and driven by a 6- to 12-volt DC power source. That very useful coil, available from Vintage Auto Parts (see the Parts and Materials List for ordering information), was featured in the June 1989 issue of this magazine. The coil from Vintage is well-made, easy to operate, and comes in handy for all sorts of experimental purposes.

Dielectric Dish. The apparatus necessary to create the corona images is very simple. Apart from the high-voltage power supply, the main requirement is a suitable glass dish for the water. The dish should be at least 4 or 5 inches in diameter and made of thin, clear, clean glass. The perimeter of the dish should be vertical and the bottom should be absolutely flat.

An ordinary laboratory Petri dish meets all of those needs perfectly. A large Petri dish about 5-¾ inches in diameter and about ¾ inch high is available from Chem-Lab (catalog number D2005-6); see the Parts and Materials listing for more information.

If you can't obtain a Petri dish, another glass dish may work just as well. But do remember that, whatever you use, the features noted above are still important. You will also need two blocks of wood, some black velvet, a small spring, one or two flexible metal strips, and the usual hardware and hook-up wire.

Setting Up. Take the metal strips and bend them into a couple of semicircles. The size of the semicircles should match the interior dimensions of the Petri dish. Then, very gently, fit the strips around the inside perimeter of the glass. The vertical edge of the dish will hold the strips in place. The purpose of the metal strips is to provide a reliable conductive access to the water in the dish. You can attach the high-voltage lead to the strip with a large alligator clip. To avoid breaking the glass with the clip, fashion a small sleeve out of metal and slip it over the edge of the dish before attaching the wire.



Uniform objects without sharp points or rough surfaces, generate fairly uniform coronas. Shown here is the discharge of such an object.

PARTS AND MATERIALS LIST FOR THE ELECTROPHOTOGRAPHY EXPERIMENT

Black velvet
Cable release
Camera, 35mm
Close-up lens
DC power supply, 6 to 12 volt
Film, Ektar 1000 (see text)
Flexible metal strips
Induction coil with vibrator mechanism
Petri dish
Tripod
Wood blocks (2)

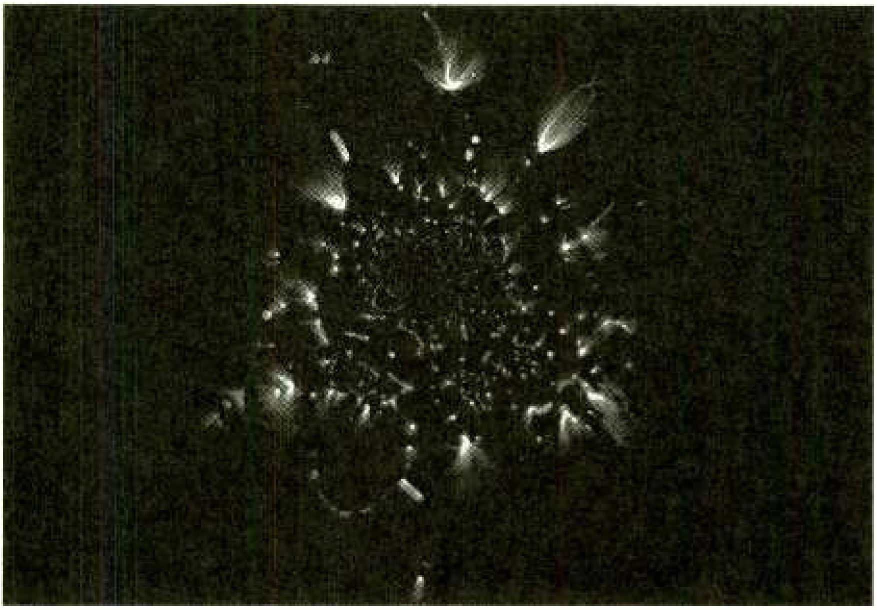
heavy gauge hook-up wire (or spark-plug wire), small springs, alligator clips, metal hooks, and assorted hardware.

Ignition coils, complete with vibrator mechanism, are available for $29.50 plus $3.00 shipping and handling from Vintage Auto Parts, Inc., 24300 Highway Nine, Woodinville, Washington, 98072. When you place your order, ask for a "12-volt spark coil."

Petri dishes, 150 mm in diameter and 20 mm high (that's about 5¾ × ¾ inches), are available from Chem-Lab, 1060-C Ortega Way, Placentia, California 92670. The Chem-Lab catalog is $5.00.

The purpose of the two wood blocks is to hold the dish about ¾ inch away from your working surface. Since the subject must press up against the glass from the bottom, it may be necessary to find some means of holding the dish down. One solution involves fastening the dish to the wood blocks with a few metal hooks, some tape, or whatever else you can think of. Keep in mind that a Petri dish is very delicate and cracks easily.

The spring has two purposes. One is to keep the subject flat against the bottom of the Petri dish. The other is to provide a connection between the subject and ground. It must be mounted on something, otherwise it will keep falling over. One way of stabilizing the spring is to solder it to one side of small piece of metal, like a large washer. Then solder the ground wire to the other side of the piece of metal. The ground cable can be any long piece of heavy-gauge hook-up wire with a large alligator clip connected to the



Unusual arcs and constantly varying shapes can be generated by using an odd- shaped subject for study.

other end. Attach the clip to a cold-water pipe.

The black velvet provides a smooth, dark, non-reflective background for your electrophotographs. Black velvet can be obtained at any large fabric store. Cut a small piece of the material, fold it over a couple of times, cut a slit in the center with a sharp knife, then carefully push the spring through the slit. Make sure the metal-spring support and the ground wire are under at least two layers of velvet. Do not allow the ground cable to touch the bottom of the Petri dish.

Suitable Subjects. The item you study may be any small, flat, conductive object. Small metallic subjects are the easiest to work with. There are a great many examples: keys, rings, gears, paper clips, aluminum foil, old jewelry, scrap metal, clumps of wire, and so on. Note: **The procedures outlined in this article are not intended for use with human or animal subjects.**

The object to be photographed is placed on top of the spring support. Make sure that there is a good metal-to-metal electrical contact between the spring and the subject. Then, gently lower the Petri dish over the whole assembly. When everything else is ready, pour ⅛ to ¼ inch of clean water into the dish.

Film and Photography. Over the years, amateur and professional researchers have tried many kinds of film in an effort to capture the sheer beauty of corona discharge. In general, fast films with ISO numbers of 400 or more are preferred; but, even very slow films will work if given a longer exposure time.

If I had to make a recommendation, it would be Ektar 1000, a new high-speed color-print film manufactured by Eastman Kodak. The clarity and detail possible with that film, not to mention the color, are superior. All of my own electrophotographic experiments were done with Ektar 1000.

Even with high-speed film, a very dim corona will usually require a time exposure. It is very difficult to be more specific. In any particular case, a longer or shorter exposure time will affect the appearance of different objects in different ways. One important variable seems to be surface texture. Another is moisture. Yet another is the pressure with which the object is held up against the bottom of the Petri dish.

Successful electrophotography requires a lot of experimentation. Do not be disappointed if your first efforts are not satisfactory; stick with it!

Beyond that, you do not need an extensive theoretical knowledge of photography to take pictures of corona discharge images. What you do need is a 35mm camera, a close-up lens, a cable release, a good tripod, and a room that can be made completely dark.

You must position your equipment so that the camera is held stationary over the subject matter in the center of the Petri dish; the lens, of course, must point straight down. One way of accomplishing that involves placing the dish, the wood blocks, and the subject support mechanism near the corner of a small table. That allows you to put the subject matter between the legs of the tripod. It is then much easier to get the camera into the proper position.

And remember, make sure that the high-voltage lead wire and the ground wire are both well away from the legs of the tripod. If either of these conductors gets too close to the photographic equipment, you are liable to get an electric shock when you touch your camera!

More Precautions. Before you begin your experiments, it is a good idea to place a small desk lamp or flashlight near your apparatus. Moving around in the dark with high-voltage equipment in operation is very, very dangerous. If you need to find something, like the end of your cable release, momentarily turn on your nearby light.

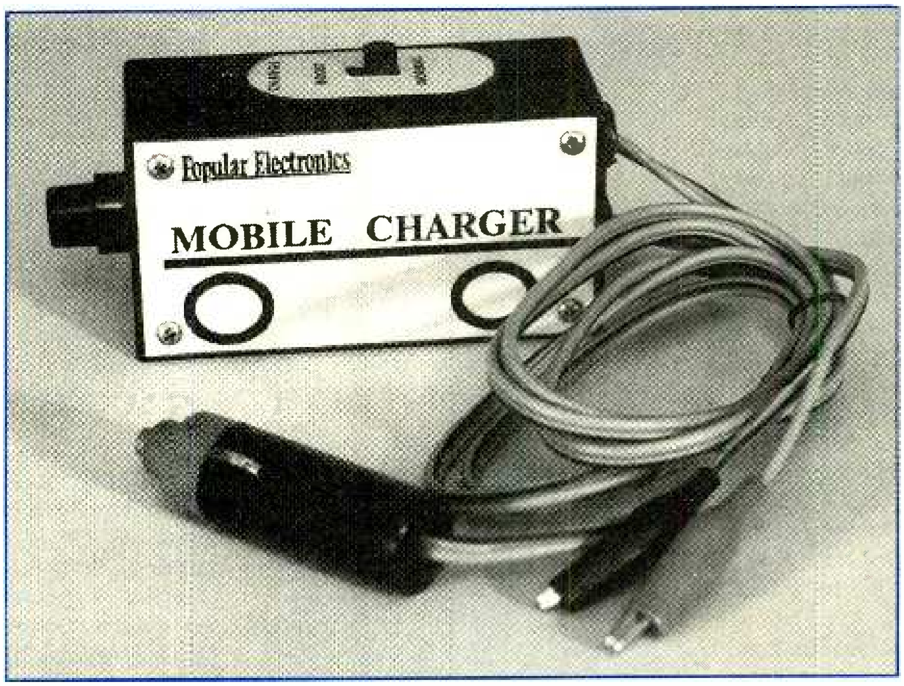
And speaking of light, you can do all of your framing and focusing under normal illumination. But, of course, take the corona photographs in a dark room. Even small amounts of ordinary light may ruin your pictures.

This is also a good time to say that dogs, cats, small children, and other unpredictable creatures should not be allowed in your experimental area. electrophotography is best done alone or with no more than one assistant who knows *exactly* what's going on and the proper precautions to follow.

Finally, do not leave the high-voltage power supply on for too long or without some conscious supervision. The area right around the conductive subject has a tendency to become warm. And watch carefully for any unnecessary heavy sparking. If anything begins to look suspicious, turn off and unplug your equipment, and then check for trouble.

This article was written based on the assumption that most of you will be getting your high-voltage output from a small induction coil. **However, some of you may want to use something larger. If you do choose to experiment with a stronger source of high-voltage current, the entire arrangement of props and hardware may have to be modified or completely redesigned. The larger your high-voltage power supply, the more careful you must be.** ■

MOBILE



BATTERY CHARGER

BY LUTHER M. STROUD

Do the batteries in your portable equipment seem to go dead just when you need them most? Then build this take-along NiCd charger, and save time and aggravation!

The most expensive source of electrical power is the battery. With the upswing in availability of take-along devices, and the ever increasing cost of using disposable batteries, rechargeables make an attractive renewable alternative power source for portable electronic devices.

Video camcorders, cordless power-tools, and other high-current devices are rapidly increasing the popularity of the rechargeables, chief among them are NiCd batteries, despite their high initial cost. NiCd rechargeables, which are available in many sizes and shapes, are often placed in multiple-unit holders, and charged as a single unit, called quick-change packs. The quick-change packs allow the user to replace the old power source with a previously charged pack fresh from an AC line-operated charger system with minimum effort.

Of course for every convenience there is a price to pay. In this case, the downside is that in order to make those packs truly convenient, you must have more than one for each piece of equipment that you intend to use whenever you're away from an AC outlet for any length of time.

However, the *Mobile Charger* described in this article eliminates the need to be near an AC source in order to replenish your portable power packs. The Mobile Charger can be used with almost any type of NiCd battery while you are away from AC-line power. And that alone can save you a bundle in extra battery cost. In addition, even those NiCd batteries that have terminal voltages greater than the available source voltage can be recharged.

About Rechargeable Batteries. Most of the batteries that you are likely to come across are of the slow-charge variety, which have charge-current rates specified for periods of 12 to 14 hours. The rate of charge that a rechargeable can handle is about 10 percent of rated battery capacity and is sometimes printed right on the label.

Table 1 shows some typical charge currents for popular-size batteries. The so called "fast-charge" type use a vari-

TABLE 1—RECOMMENDED NiCd CHARGE RATE

Cell Size	Amp/hr rate	R4 value (14 hr rate)
N	150 mA	120 ohms @ .25-watt
AA	500 mA	47 ohms @ .5 watt
C	1500 mA	12 ohms @ .5 watt
D	1500 mA	12 ohms @ .5 watt
D (HIGH CAPACITY)	4000 mA	3.3 ohms @ 2 watt

ety of charge-current rates and should be monitored for cell voltage, charge time, and sometimes even battery temperature by rather sophisticated charging circuits.

Although they are specially designed for abusive charge/discharge cycles, they will be very happy with the Mobile Charger's constant-current charging system and will likely last longer too. The discussion of fast charging of NiCd batteries is beyond the scope of this article.

About the Circuit. To charge a 12-volt NiCd battery, one needs a DC source of at least 15 volts, more than what a 12-volt auto electrical system with the engine running can deliver. But that's no problem with the Mobile Charger; it converts the 12-volt DC source from an automobile's cigarette-lighter socket to nearly twice that amount with an AC-to-DC converter followed by a half-wave voltage doubler.

The heart of the circuit (see Fig. 1) is a TDA2003 audio power-amplifier integrated circuit (U1), which is intended for automotive-stereo applications. The TDA2003 has internal overload protection for automotive electrical systems and provides a peak-current output of 3.5 amps. In this application, U1 is used as a power square-wave oscillator.

Resistors R1 and R2 set the operating point of U1's non-inverting input at about 2 volts. Capacitor C1 (which is tied between pin 2 of U1 and ground) charges toward 2 volts through a 220k resistor internal to U1. When the charge on C1 reaches about 2 volts, pin 4 is pulled to near ground potential, causing C1 to begin discharging.

When C1 is sufficiently discharged, the sequence of events is repeated, producing a pulsating DC voltage that continues as long as power is applied to the circuit. The repetition rate of that action (oscillation) is about 4 kHz, producing a 12-volt peak-to-peak square-wave output signal at pin 4 of U1. The output of U1 causes C2 to rapidly charge through D1 and then discharge through D2 on alternate half cycles.

As C2 discharges into D2, that charge is combined with +12-volts DC from the cigarette-lighter plug, causing C3 to charge to nearly twice the available supply voltage. During each half cycle of the pulsating DC waveform, the charge on C3 is dumped to the battery through a constant-current circuit. The charge-current level is determined by the value of R4 and the voltage drop across LED1.

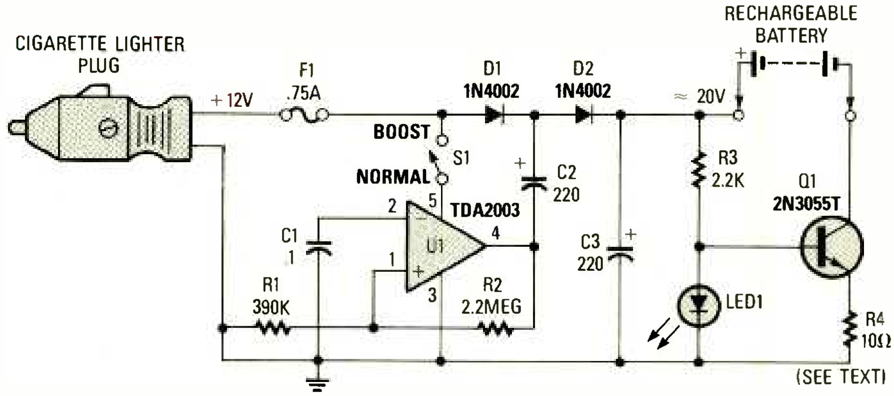


Fig. 1. The heart of the Mobile Charger circuit is a TDA2003 audio-power amplifier, which is configured as an oscillator. The pulsating output of U1 is fed to a voltage-doubler circuit to provide an output signal that's nearly twice the magnitude of the available source voltage.

PARTS LIST FOR THE MOBILE CHARGE

SEMICONDUCTORS

U1—TDA2003 or LM383 audio-amplifier, integrated circuit

Q1—2N3055T or TIP31 NPN, silicon power transistor

D1, D2—1N4002 1-amp, 100-PIV, rectifier diode

LED1—Jumbo red light-emitting diode

RESISTORS

(All resistors are ¼-watt, 5% units, unless otherwise noted.)

R1—390,000-ohm

R2—2.2-megohm

R3—2200-ohm

R4—10-ohm, ½-watt (see text)

ADDITIONAL PARTS AND MATERIALS

C1—0.1-µF, 50-WVDC or greater, ceramic-disc capacitor

C2, C3—220-µF, 25-WVDC, electrolytic capacitor

F1—¾-amp fast-blow fuse

S1—SPST toggle or slide switch

Printed-circuit materials, enclosure, IC socket, auto-lighter plug, alligator clips, fuse holder, wire, solder, hardware, etc.

Note: The following items are available from Pershing Technical Services, PO Box 1951, Fort Worth, Texas 76101: A kit of parts containing all electronic components, fuse holder, switch, enclosure, blank PC board (wire, connectors, and hardware not included) for $23.00, postage paid. Texas residents please include appropriate sales tax. Please allow from 6 to 8 weeks for delivery.

When a battery is connected from the collector of Q1 to the +V source, the charge current's rate of flow is essentially constant regardless of the load. Whether it's an 18-volt battery or a dead short, the current flow remains unchanged. Keep in mind that the dissipation of Q1 increases as the voltage drop across the load goes down. At a dead short, Q1 will dissipate 2.4 watts. If batteries below 12 volts are being charged, it's best to open S1, disabling the voltage-doubler stage (D1, D2, and C2) and minimizing the heat dissipated by Q1.

Putting It Together. The Mobile Charger is a simple project that can be assembled in any form the reader chooses. The author chose to cut isolated areas in a printed-circuit blank (unetched board) and solder the circuit components directly to large areas of the copper. In the author's layout the large copper areas serve as a heat sink and lid for the plastic enclosure.

The areas of copper can be isolated in a variety of ways. You can score the copper foil with a sharp knife and peel away the narrow strips or grind isolated paths into the copper foil with a hobby moto-tool. If you want to etch the isolating tracks into the blank, completely mask the unetched circuit PC board with tape and peel away narrow strips where you want the etchant to remove the copper.

If you plan to use the Mobile Charger to replenish batteries requiring more than 300 mA of charge current, you may need to increase the size of the heat sink used on U1 and Q1. Mounting U1 and Q1 on a large heat sink and increasing C1 and C2 to 1000 microfarads should allow charging currents of nearly 1 amp to be developed for charging fast-charge type batteries.

If you plan on using the project with several different sizes of NiCd batteries, you can add a multi-position switch with which to select resistors of the appropriate values for R4.

(Continued on page 94)

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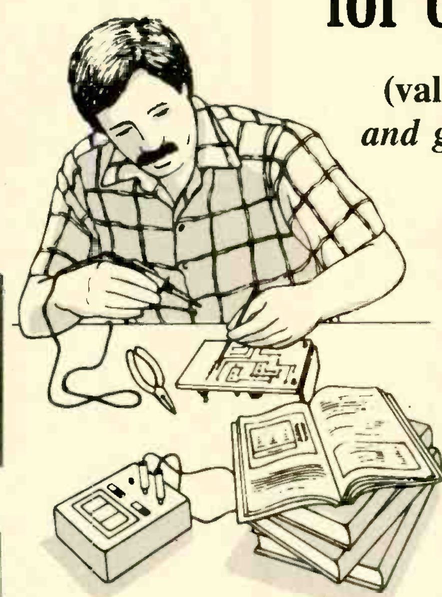

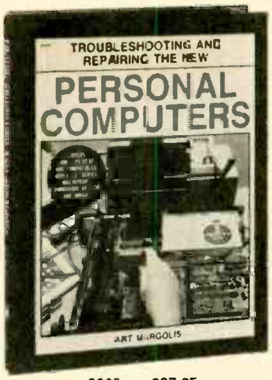

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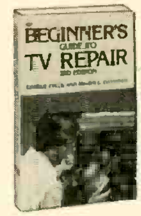

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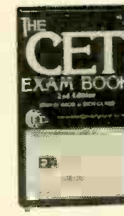

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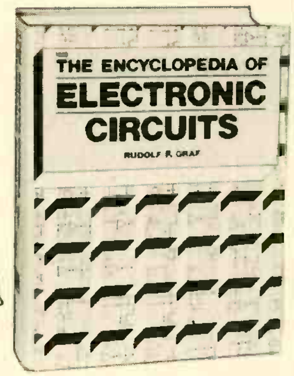

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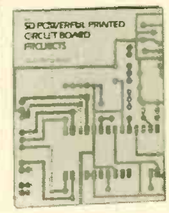
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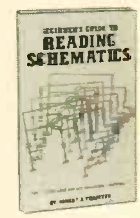

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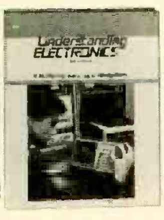

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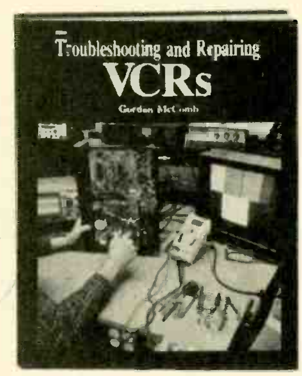

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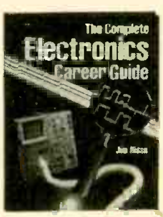

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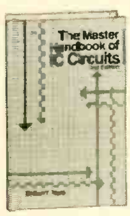

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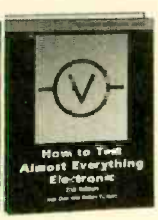

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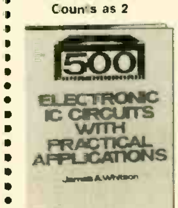

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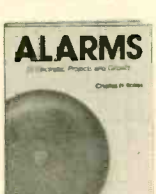

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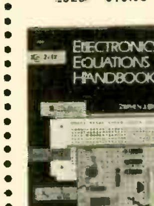

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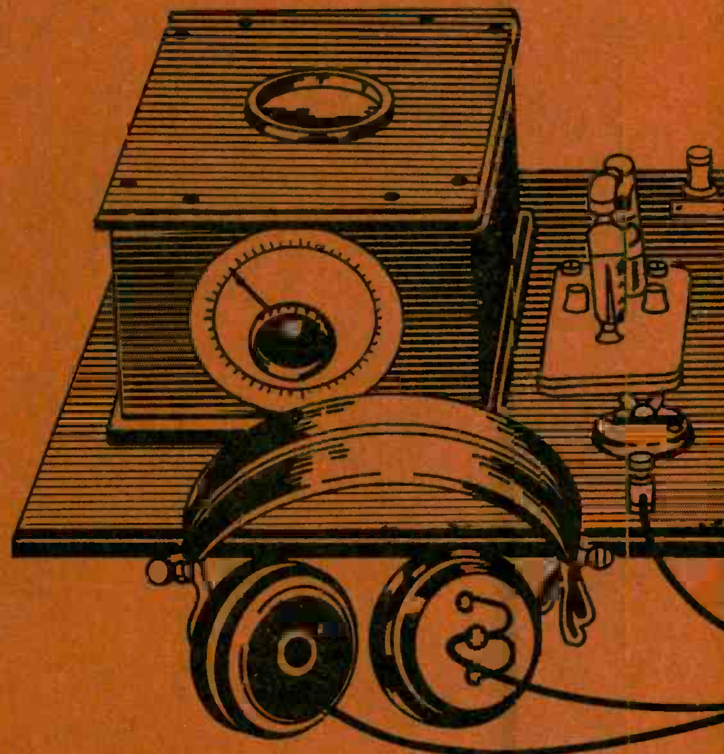


OLD-TIME

Studying radio circuits from years ago might seem unrewarding, but there are advantages to doing so: The circuits are often so simple especially in comparison with modern receivers, that they provide an excellent way of learning basic circuit operation. Further, some old radio circuits, or portions of them, are still used today.

Beginning with Galena. The crystal-radio receiver shown in Fig. 1A is probably the most fundamental receiver ever designed. The series reactance of the coil combined with the overall capacitance of the circuit makes the circuit series resonant for a narrow band of frequencies. By selecting different taps on the coil, the resonant frequency of the circuit can be adjusted to tune in a desired signal.

The coil, L1, in Fig. 1A could be eliminated and we would then have a receiver with just two parts—the crystal detector and the headphones (then called a telephone receiver). Such a circuit would be used when there was only one station in the area powerful enough to be received, so the circuit lost its popularity as more stations went on the air. However, should you live *next door* to a radio station, the circuit will work very well.

Figure 1B is the same circuit as Fig. 1A minus coil L1. The circuit is now recognizable as a halfwave rectifier, and is very much like the rectifiers used in power supplies. The input signal from the source (whether a power transformer or an antenna system) is AC; thus, the output waveform is pulsating DC. The voltage rises and falls like half of a sinewave.

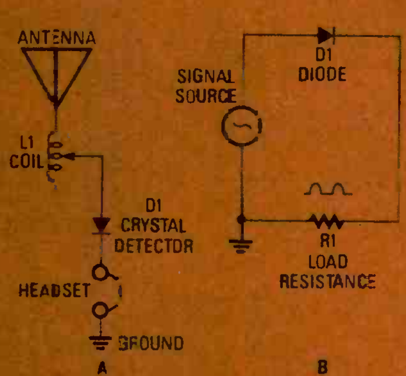


Fig. 1. The diagram on the left (A) might be of the very first crystal radio. The half-wave rectifier (B) is a direct relation of the detector circuit in a crystal receiver.

The important difference between the circuits is not in the circuits themselves, but their inputs. The circuit in Fig. 1B works on one signal that's usually at 60 Hz, while the circuit in Fig. 1A works with a minimum of two frequencies at a time: the radio frequency and that of the audio signal. Let's look at how an audio signal is "placed" on a radio wave so the two waves can travel together.

The Modulated Signal. Let's take a radio signal of one megahertz (1 MHz) as an example. The signal is a sinewave that repeats one million times a second (see Fig. 2A). If it was received by the circuit in Fig. 1A nothing would be heard, mainly because we can't hear sounds at those frequencies, but also because the headphones can't respond at such high frequencies. The capacitance between coil windings in the headphones makes it appear like a short to such frequencies. Almost all of the carrier frequency is bypassed past the headset to ground. In fact, a capacitor is often deliberately shunted across the headphones to provide a better path to ground for the high frequency signals. That effectively makes the headphones insensitive to anything but audio signals.

In Fig. 2B there is a 1000-hertz (1 kHz)

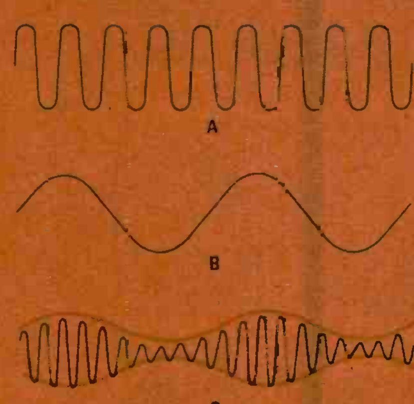
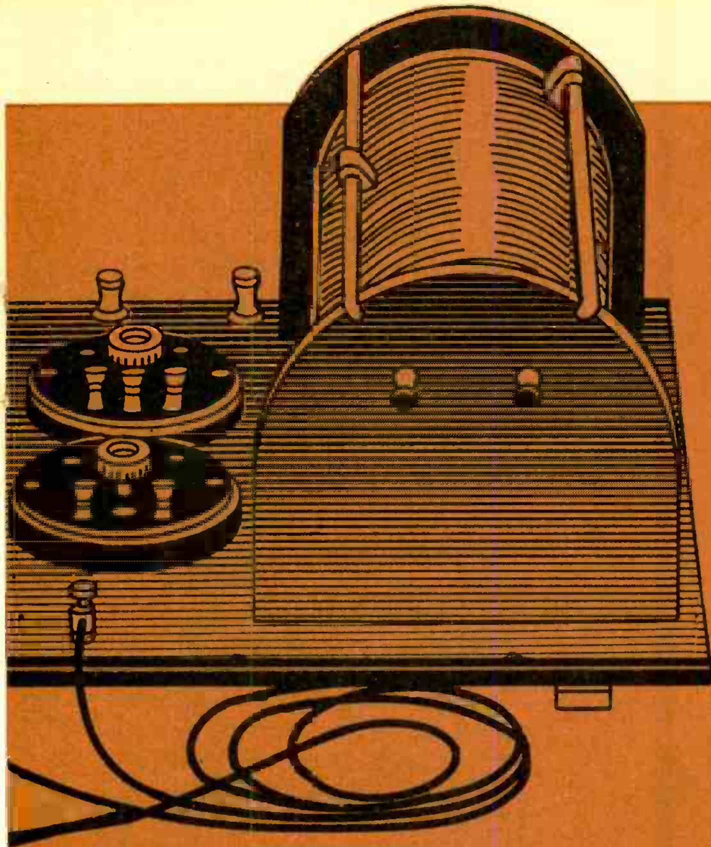


Fig. 2. A 1-MHz radio-frequency carrier (A) is shown without amplitude modulation, and below it is the modulating audio signal (B), which combine to form the modulated carrier in C.



Journey back with us and find out about the radios of the past. A peek at what once was might help you understand

BY MARTIN CLIFFORD

CIRCUITS

sinewave that we can use to control or "modulate" the amplitude of the 1-MHz sinewave. The two waves when combined that way are often drawn as shown in Fig. 2C. Note the variation in amplitude coincides with the amplitude of the 1-kHz wave. The original 1-MHz signal is called the "carrier" and the superimposed audio waveform is said to "modulate" the carrier.

When a modulated carrier is received by the radio, it is rectified to become a pulsed signal that is sent to the headphones. The height of the pulses corresponds to the amplitude of the modulating audio signal. While the headphones cannot respond to each pulse individually because of their high frequency, it does tend to average out the bumpy waveform, which gives you the audio signal back again. The process of picking the audio off a carrier is called "demodulation."

Selectivity. The problem with the receiver in Fig. 1A is that it has very little frequency selectivity. That means that two carriers close to each other in frequency can pass through the receiver with practically equal strength causing two audio programs to be heard in the headphones at once.

Better selectivity can be had with the circuit of Fig. 3. The antenna's radio-frequency coil (actually a transformer designed to operate at radio frequencies) has a tapped primary winding for tuning, while the secondary winding is tuned by a variable capacitor. The secondary's taps are used to set the frequency band.

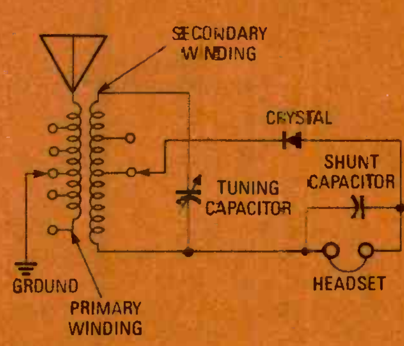


Fig. 3. This is an improved crystal radio of vintage 1910–1920. The efficient, tuned antenna-coil circuit provided better sound performance with reasonable selectivity.

To tune that receiver, the primary and secondary windings must be selected, and the tuning capacitor and crystal had to be adjusted. That means four tunning controls in all. The crystal could be adjusted by positioning one of its contacts (often called a "cat's whisker" because it is made out of very thin phosphor-bronze wire) in the best spot on the crystal.

The crystal set had no ON/OFF switch since it runs on carrier-signal energy. Consequently, the receiver could remain on all the time. No fuses were ever needed and the utility bill was never affected.

Selectivity was still very poor, even with those rigs, but if two stations were heard simultaneously it was regarded as a low price to pay for free in-home entertainment that required so little maintenance.

Antennas and Grounds. Those receivers had no volume control; reception was so weak one was never needed. Therefore, the most important criterion was loudness and the greater the volume the better the receiver. Since a crystal only rectifies the incoming signal and does not amplify it, the only way to get more volume from a set was to make the antenna as long as possible. Considering the broadcast frequencies used, that was a valid solution.

Another technique was to expand the antenna from a simple long line to several lines in parallel. Those techniques worked fine for listeners in rural areas, but in big cities experimenters were very often limited to antennas within the home, say an attic or bedroom. The antenna was often mounted near the ceiling. Sometimes even a bedspring would be used.

An antenna is classically regarded as the signal source, but a signal is a voltage that requires some reference, or ground. That means the receiver must have a ground connection also. Heating radiators and plumbing in general make good grounds. Having a rig with a long-wire antenna and heating-pipe ground, is strange by todays standards, but years back, it was the cat's meow!

Before Vacuum Tubes. There were three problems facing early radio pioneers: signal detection, signal selectivity, and signal amplification. The first of those, signal detection, was made easier by the introduction of the crystal diode. Signal selectivity was somewhat improved with tapped or tuned inductors. But prior to the invention of the triode, signal amplification remained stubborn and nearly unsolvable.

A mechanical amplifier seemed the obvious answer and one was based on the concept of a lever. Take a short length of any rigid material (see Fig. 4) and pivot it around any point except the middle. One end will trace a longer arc than the other end. For a little variation at one point you can get a big variation somewhere else. The problem, of course, was how to translate that fundamental idea into a practical audio- or radio-frequency amplifier.

The task was accomplished with the Brown amplifying circuit shown in Fig. 5. The input is supplied at points A and E and it goes to a pair of coils, identified as C. Below those coils are another pair of coils marked M that are receiving direct current from the battery (B). The field set up by the M coils is disturbed by the C coils as the audio signal passes through them. That causes a highly-flexible metallic armature, denoted as V (for vibrator) in the figure, to vibrate in step with the audio. That in turn compresses and releases a small disc (D) of resistive material such as carbon. The resistance of the disc varies with the amount of pressure applied, so the current flow in the headphones is controled by the armature motion, which is in turn controlled by the current through the C coils.

A pair of such "amplifying-relay" circuits could be used to produce even greater signal amplification. However, the device had its disadvantages. The most serious fault was that any noise or vibration in the room would also be detected and amplified.

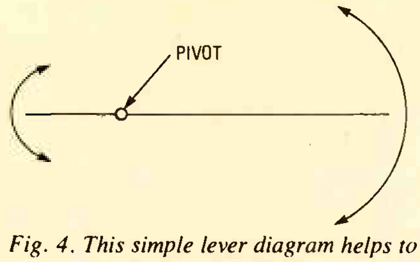


Fig. 4. This simple lever diagram helps to explain mechanical amplification. Little movements to the left of the pivot are translated into large movements at the right.

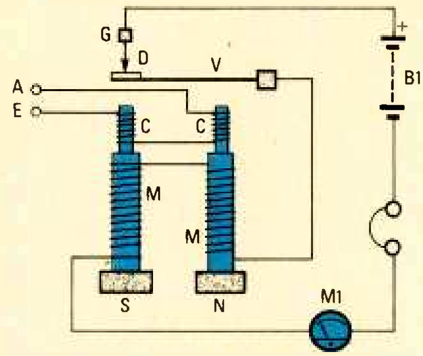


Fig. 5. The Brown amplifying circuit was a magnetic mechanical amplifier for weak audio signals. The signal was applied to terminals A and E. The battery provided sufficient current to "almost" pull a metallic armature away from a carbon pad. The audio signals thus varied the pressure on the pad causing the contact resistance to vary. It worked almost like an old telephone transmitter.

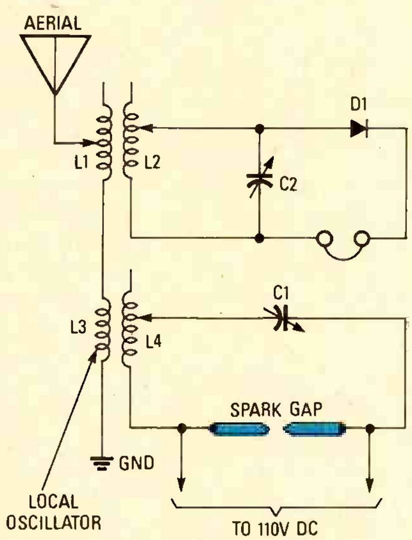


Fig. 6. An early heterodyne receiver using a carbon arc as a local oscillator. Coil L4 and capacitor C1 were tuned for the heterodyning frequency, which was usually about 1 kHz above or below the radio-signal frequency.

Introducing Heterodyning. The heterodyne receiver was an important step in improving selectivity. Heterodyning is the process of taking two signals of different frequencies and adding them to get a resultant frequency (whose frequency is usually the difference between the two parent frequencies).

In the earliest hetrodyne receivers, the heterodyning action took place between the received radio signal and one produced by a local oscillator. The frequency of the oscillator was about 1 kHz above that of the received signal. The beat frequency produced by adding the waveforms was sent to the headphones as the "audio" signal. It was just a single tone that indicated the presence of the carrier, but that is all that is needed for Morse code CW (continuous wave) reception. The tone spelled out the dots and dashes.

The problem, however, was that of developing a local-oscillator signal with vacuum tubes still some time in the future. The local oscillator prevalent at the time was based on a carbon arc connected to a 110-volt DC power line. (See Fig. 6.)

The frequency of the spark was tuned by a series circuit consisting of L4 and C1. Additional tuning was provided by making the inductance of L4 variable by using a slider or a tap of the type then popular with crystal sets. The arc circuit was inductively coupled to L3, which was directly connected to tuning coil L1. The heterodyning (or signal beating) action took place in L1. The heterodyned wave was inductively coupled into L2 which was tuned by variable capacitor C2.

As we mentioned earlier, a capacitor was ordinarily shunted across the headset (T) in home crystal sets, but that was found to be unnecessary. The inductive reactance of the headphones plus its internal-wiring capacitance worked as an LC filter, separating the audio signal from the much higher frequency of the rectified carrier.

As simple as it was, the heterodyne receiver was an important advance, for it could be considered as the basis for the development of the superheterodyne. However, when vacuum tubes finally came along, it took a few years before the superheterodyne made its appearance in home receivers.

With the arrival of the triode vacuum tube and its use as an oscillator and a detector, the carbon arc was dis-

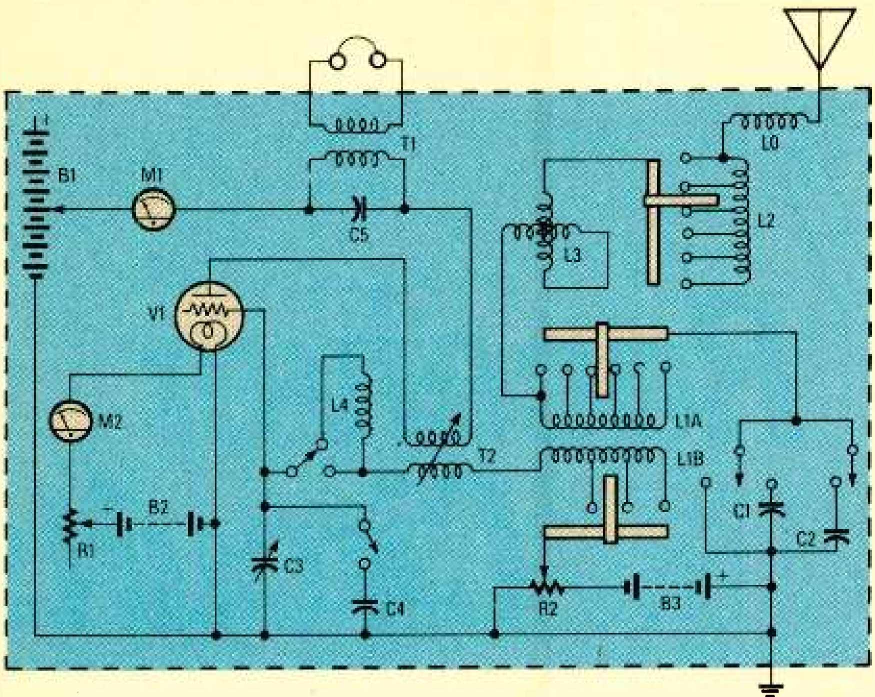


Fig. 7. One-tube radios of the World War I variety were loaded with various tuning circuits to improve their selectivity. A loading coil was used to effectively increase the antenna length.

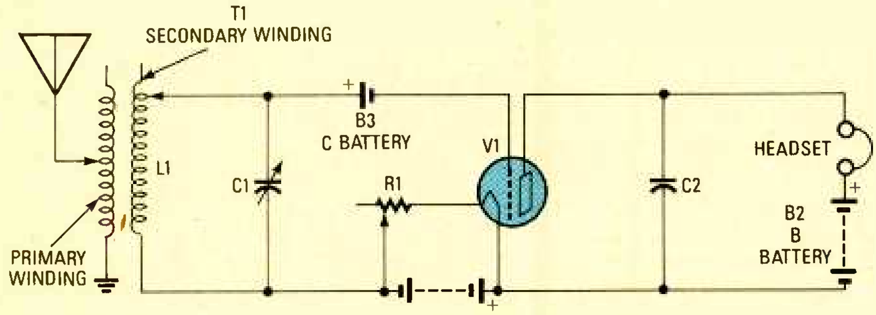


Fig. 8. The circuit is extremely simple and was assembled by thousands and thousands of experimenters across the nation. It had loud volume and variable-capacitor tuning.

carded. Unlike other components, it has never made a comeback.

Then Came Tubes. The circuit in Fig. 7 dates back to 1916/1917 and is unusual in a number of ways. Ordinarily the signal input starts at the left with the signal moving progressively to the right. Here the opposite prevails, with the signal brought in at the antenna terminal (A) at the right and the headset output at the left.

The elaborate arrangement of coils was used to separate signals better. The receiver was used for both broadcast and long-wave reception of CW and voice.

From point A, the signal was brought into a loading coil, L0. It served to increase the apparent length of the antenna. Loading coils are still used for CB reception except that the coils are now built into the antenna.

The first physical tuning stage was L2, a tapped coil using a slider. From the slider the signal was fed into L3, a *variometer* that was a type of *variocoupler*. The unit shown consisted of two coils with a primary winding (called a tickler) capable of rotating 180° inside a fixed secondary winding. The position of the movable coil determined the amount of mutual inductance. That was at maximum when the coil currents were in phase; minimum when they were out of phase.

From the *variocoupler* the signal was brought into a transformer (L1) having taps on both primary and secondary windings. The slider of the primary winding was also connected to a pair of switches capable of putting either C1, C2, or both, in series with L1, adding somewhat to the selectivity.

The triode tube, V1, functioned as a diode/triode, with the filament and control grid as the diode section, and the filament, control grid, and plate as the triode. As shown here, the symbol for the filament is the same as that of an electric light bulb, but it was subsequently modified.

The triode uses three separate DC-voltage sources, all batteries. An "A" battery is used for the filament current, a "B" battery for plate voltage, and a "C" battery for bias. Note that the filament battery (B2) is in series with a rheostat (R1) and an ammeter. The rheostat was necessary since there was considerable variation in tube characteristics. The rheostat was adjusted until the ammeter indicated the correct amount of filament current.

The plate (anode) current was also measured by an ammeter (M1). The best plate voltage was selected by using the positive plates of the cells in B1 as taps.

Bias for the tube was obtained from a bias battery (called the "C" battery), B3, shunted not by a rheostat but by a potentiometer, R1. The bias battery supplied voltage for the control grid, but there was no current flow from the battery to that tube element. The purpose of the battery was to permit the tube to operate from the bottom end of its characteristic curve, thus supplying signal rectification.

To be able to work as a continuous wave (CW) radio, the receiver was equipped with a feedback transformer, T2. Regeneration was controlled by adjusting the coupling between the transformer's windings. With the correct amount of feedback the triode tube bordered on the edge of oscillation. With its frequency and that of the incoming signal heterodyned, the CW signal was converted to an audible signal. Voice signals could also be heard by adjusting regeneration below the point of oscillation.

Variable-capacitor C3 in the grid circuit of the tube also helped control feedback. A supplementary capacitor, C4, could be switched in parallel with C3 to modify the tuning range.

The audio signal was coupled to the headphones by transformer T1. It was an iron-core unit. The primary winding of T1 is a tuned audio-frequency circuit, peaking the audio signal at some selected frequency.

Another Receiver. Figure 8 shows a simpler circuit. The selectivity of the receiver was no better than that of its

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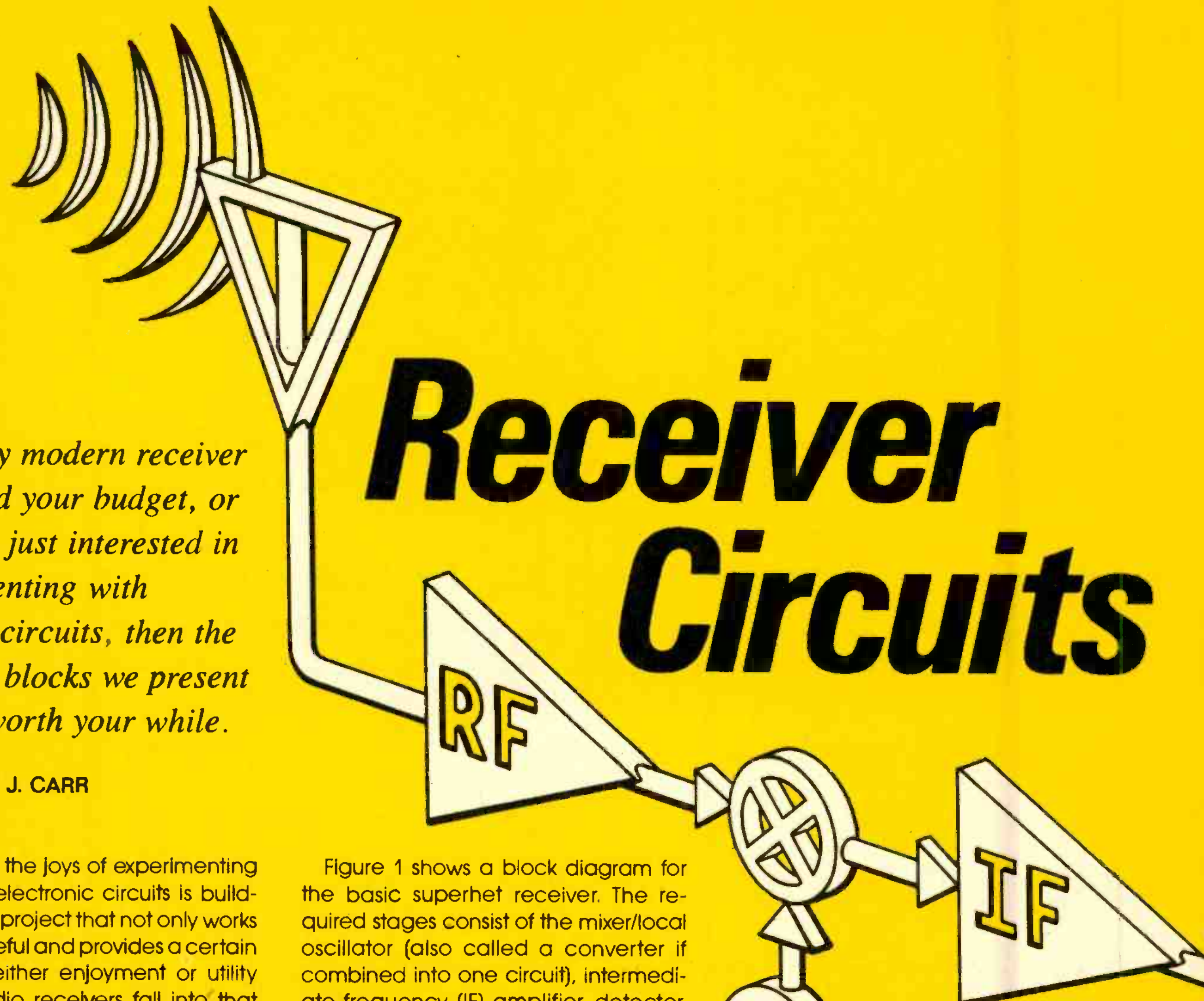


Receiver Circuits

If a fancy modern receiver is beyond your budget, or if you're just interested in experimenting with receiver circuits, then the building blocks we present will be worth your while.

BY JOSEPH J. CARR

One of the joys of experimenting with electronic circuits is building a project that not only works well, but is useful and provides a certain amount of either enjoyment or utility later on. Radio receivers fall into that category, but are generally considered advanced projects that cannot be accomplished by the average experimenter. Many people erroneously believe that only kit-built receivers are candidate projects for them because of the alleged complexity of radio receivers.

However, modern integrated-circuit electronics makes it a lot easier to design and build your own receiver today than ever before. In this article we will look at a few of the types of circuits that make up a radio receiver, and offer some suggestions for custom-tailoring your own radio for the VLF, AM-broadcast, or shortwave bands.

Figure 1 shows a block diagram for the basic superhet receiver. The required stages consist of the mixer/local oscillator (also called a converter if combined into one circuit), intermediate-frequency (IF) amplifier, detector, and audio-frequency (AF) amplifier. The AF amplifier is subdivided into preamplifier and power-amplifier or output-amplifier sections, although today they are usually combined into one integrated circuit. The RF amplifier is optional, but highly recommended.

The superhet receiver operates on a frequency-conversion technique. The received radio frequency (RF) is converted to another frequency by mixing (*i.e.* "heterodyning") it with a local oscillator (LO) frequency. The new frequency generated by the mixing of the RF and LO signals is called the intermediate frequency (IF), and can be either the sum or difference between RF and LO; that is, the IF is equal to RF + LO, RF – LO, or LO – RF. In most radios, other than classy communications receivers, one of the difference frequencies is used for the IF because lower frequency circuits are easier to design, build, and tame.

The IF frequency is produced by mixing the LO and RF together in a nonlinear element called the mixer circuit, or the converter if the LO and mixer are in a single circuit. The main gain of the receiver is provided by the IF amplifier. Gain figures can approach 100 dB in some receivers, which in most instances means multiple IF stages.

The detector circuit is used to demodulate the signal at the output of the IF amplifier, and thereby produce an audio signal that represents the modulation of the original radio carrier. That signal is then passed on to the audio-amplifier chain where it is built-up to a point where it can drive a loudspeaker or earphones.

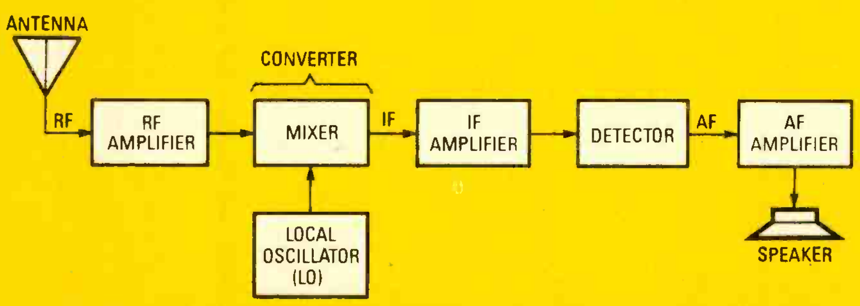


Fig. 1. This block diagram for a superheterodyne receiver displays its most significant sections. Note a converter can be considered a combined mixer and local oscillator.

You Can Build

Direct-conversion receivers (popular with homebrewers) also use a frequency-translation process, but it is entirely different in its nature from the superhet principle. The straight superhet will not demodulate CW and SSB signals unless a product detector is used in place of the envelope detector that "decodes" AM. But the direct-conversion receiver is basically a product detector that operates at the RF frequency to demodulate that signal directly to audio. Figure 2 shows the block diagram of such a receiver. The local oscillator is tuned to the same frequency as the RF signal coming into the antenna. The difference frequency, when the LO is adjusted correctly, is the modulating audio frequency in the case of SSB, and a selected sidetone frequency for CW (*i.e.* the frequency of the tone you hear in the output).

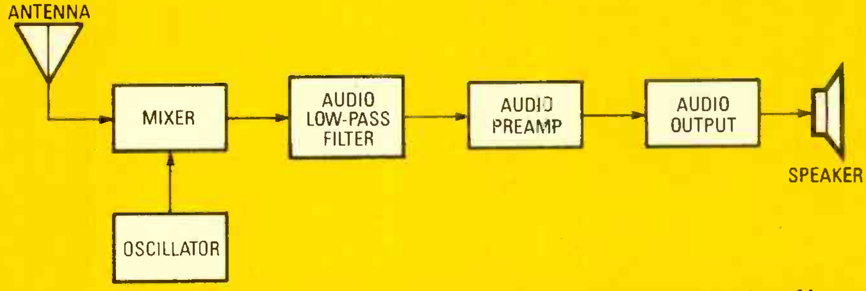
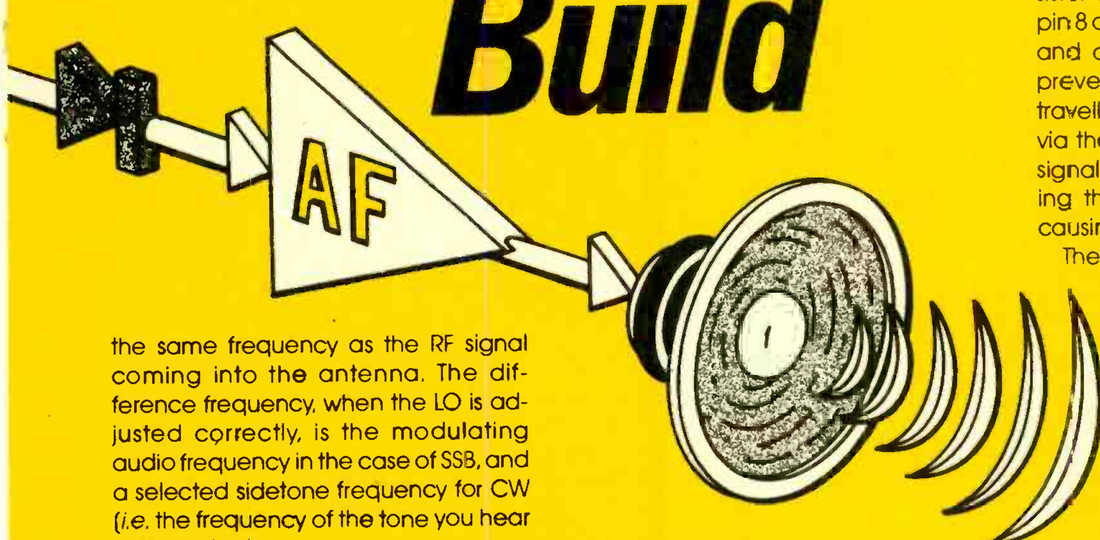


Fig. 2. This block diagram for a direct-conversion receiver gives you some idea of how simple they are. No real IF stage exists; tuned RF is converted directly to audio.



The output of the superhet converter stage in a direct-conversion receiver is audio, but may contain some residual elements of the RF and LO signals, or other mixer products than the difference frequency. In order to smooth this output signal, a low-pass filter that passes only the audio signals is typically used downstream from the converter.

We will not cover the direct-conversion receiver in detail, but the reader may infer the design principles from the superhet discussions that follow. In order to discuss the circuits that you can use to make your own home-designed receiver, let's start at the front-end and work towards the detector and audio amplifier stages.

Front-End Circuits. The front-end of the radio receiver consists of the RF amplifier (if used) and the converter or mixer/LO stages. The basis for our designs will be the Signetics NE602 balanced-mixer integrated circuit. That device has limited dynamic range, but is sufficient for our purposes because it compensates with a better-than-average noise figure and sufficient conversion gain to eliminate the need for an RF amplifier in most projects.

The pinouts for the NE602 IC converter are shown in Fig. 3. There are two inputs that together form a balanced pair, along with two outputs. In some cases, both outputs are used but in others only a single output (pin 4) is used. Either an internal or external oscillator can be used with the NE602, and both versions will be presented here. In the circuits that we present here the supply voltage for the NE602 will be +5 to +9 volts DC.

Figure 4 shows a superheterodyne converter circuit based on the NE602 IC. The input circuit is broadbanded by using an RF transformer built on a toroid powdered iron form. The ratio L2/L1 is typically 10:1 to 12:1; *i.e.* there are 10 to 12 turns on L2 for every turn on L1. Experiments and published data show good starting numbers are 20 to 24 turns on L2, with 2 to 3 turns in L1 for frequencies in the upper-shortwave region. As frequency is decreased, the number of turns is increased to about 34 to 40 turns on L2 at the AM-broadcast band.

The capacitors and the 100-ohm resistor in the V+ circuit (connected to pin 8 of the NE602) are used for isolation and decoupling. Those components prevent RF in the NE602 circuit from travelling to other stages of the radio via the DC power line, or alternatively, signals from other stages from modulating the converter stage (or possibly causing oscillation).

The oscillator circuit of Fig. 4 consists of the components attached to pins 6 and 7 of the NE602 IC. The actual tuning is set by a variable capacitance diode (varactor), D1. That diode is essentially a voltage-tuned capacitor. The oscillating frequency should be set 455 kHz above the desired RF frequency using the following expression:

$$f = 1/(6.28\sqrt{LC})$$

or, if you know (or have on hand) either the capacitor or the inductor:

$$L = 1/(39.5f^2C)$$

or,

$$C = 1/(39.5f^2L)$$

In all three expressions, the frequency is in hertz, inductance in henrys, and the capacitance in farads (don't forget to convert units from microhenrys, megahertz or kilohertz, and picofarads).

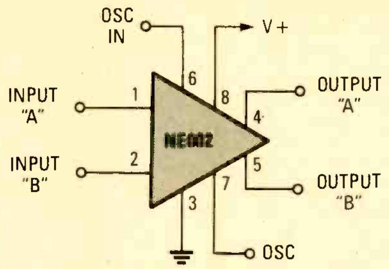


Fig. 3. The Signetics NE602 converter IC makes building a good mixing stage easy. It can provide you with RF gain and IF conversion in a single stage.

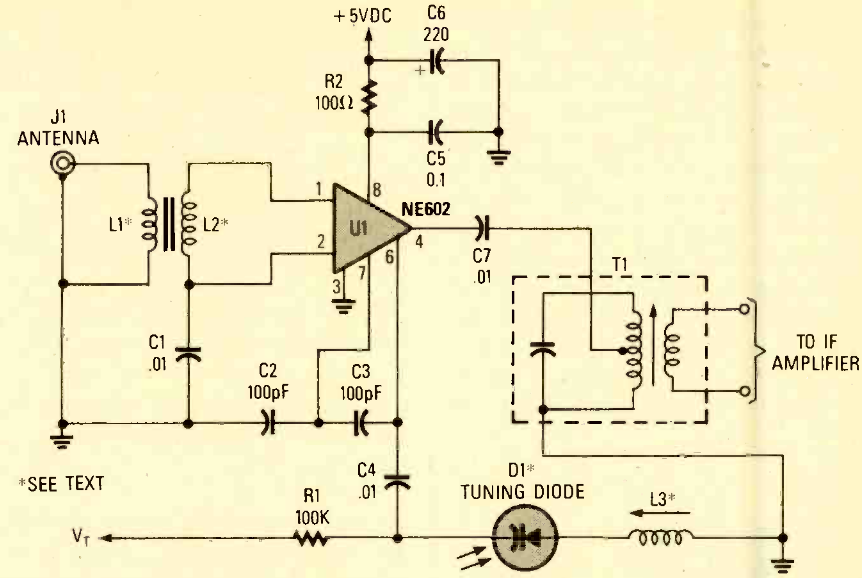


Fig. 4. Here's an NE602 in superhet front-end configuration. The varactor tuning diode may be replaced with an air-variable capacitor, if desired.

Example. Find the value of capacitance needed to resonate a 3.4-μH inductor at 9 MHz:

$$C = 1/(39.5f^2L)$$
$$C = 1/(39.5(9{,}000{,}000)^2(0.0000034))$$
$$C = 1/1.088 \times 1010 = 9.19 \times 10^{-11} \text{ farads}$$
$$C = 91.9 \text{ pF}$$

When making calculations allow about 10 pF for stray circuit capacitances. Also, the tuning circuit can consist of the diode plus a parallel capacitance. I've used a 22-pF varactor, a 27-pF ceramic disk, and a 6- to 70-pF trimmer capacitor to tune HF receiver projects. Standard tuning diodes are available from replacement-parts vendors such as NTE. Part numbers for use in the HF region are the NTE-613 (22 pF) and NTE-614 (33 pF). For a wider tuning range you can select the NTE-618 (440 pF).

The output of the NE602 must be tuned to the IF frequency, by a tuned IF transformer (T1 in Fig. 4). For most receiver projects, the difference frequency should be 455 kHz because of the easy availability of the coils. Several sources offer those coils, but perhaps the easiest to obtain are Bell/J.W. Miller (19070 Reyes Avenue, Rancho Dominguez, CA 90224) coils and Toko coils marketed by Digi-Key (P.O. Box 677, Thief River Falls, MN 56701-0677; 1-800-344-4539), and others.

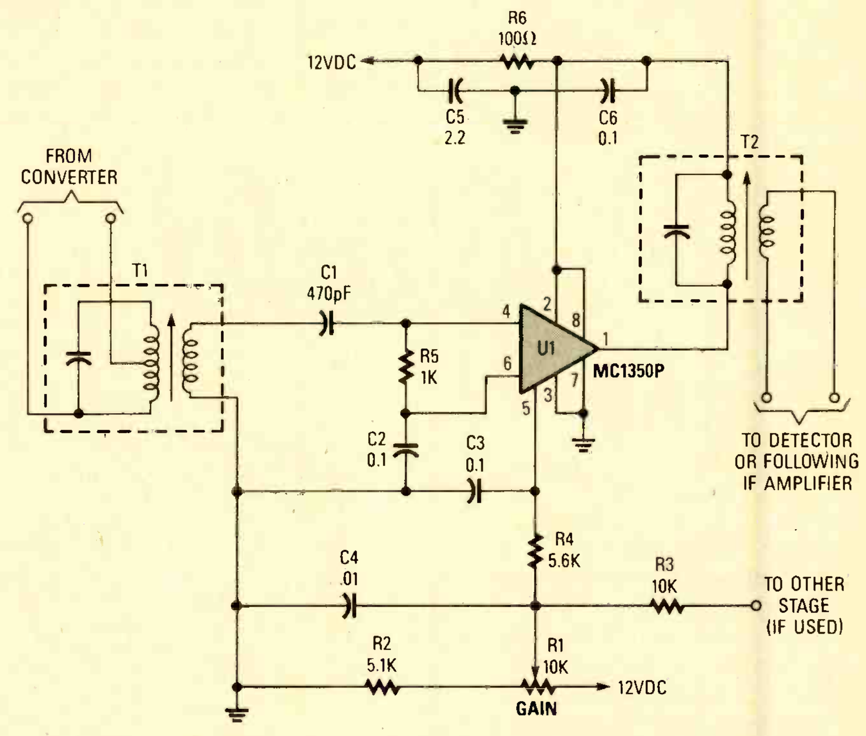


Fig. 5. This is an IF amplifier design based on the MC1350P chip with a manual IF-gain control. Stages such as this can be ganged to provide greater gain.

IF-Amplifier Circuits. The IF amplifier provides most of the gain in a superhet receiver, and it also supplies the narrowest bandwidth in the signal chain. Thus, the IF amplifier is chiefly responsible for both the sensitivity and selectivity of the radio receiver. In fancy radio receivers, the IF amplifier can be quite complex, as witnessed by the designs used in modern shortwave and ham-radio receivers in the "kilobuck" range. Ours is a considerably simpler design, but is nonetheless effective. For those who need a more complex design I highly recommend *The ARRL Radio Amateur's Handbook.*

Figure 5 shows the basic circuit for an IF amplifier building block. For receivers requiring moderate gain (for example an AM receiver that is intended primarily for local reception) only one stage need be used. In shortwave receivers, or wherever superior sensitivity is sought, it is permissible to cascade two or three such stages to boost amplification as required. The gain of the stage is on the order of 50 dB, and some projects might need gains of as much as 80 to 110 dB.

The basis for the IF amplifier is the MC1350P gain-block chip (that chip is also available as a replacement part from NTE as part number NTE-746).

The input circuit is tuned by either a single- or double-tuned transformer of the same sort used at the output of the NE602 stage discussed previously. The secondary impedance of that transformer should be on the order of 1000

(Continued on page 100)

MARCH 1990

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VOLUME 3,
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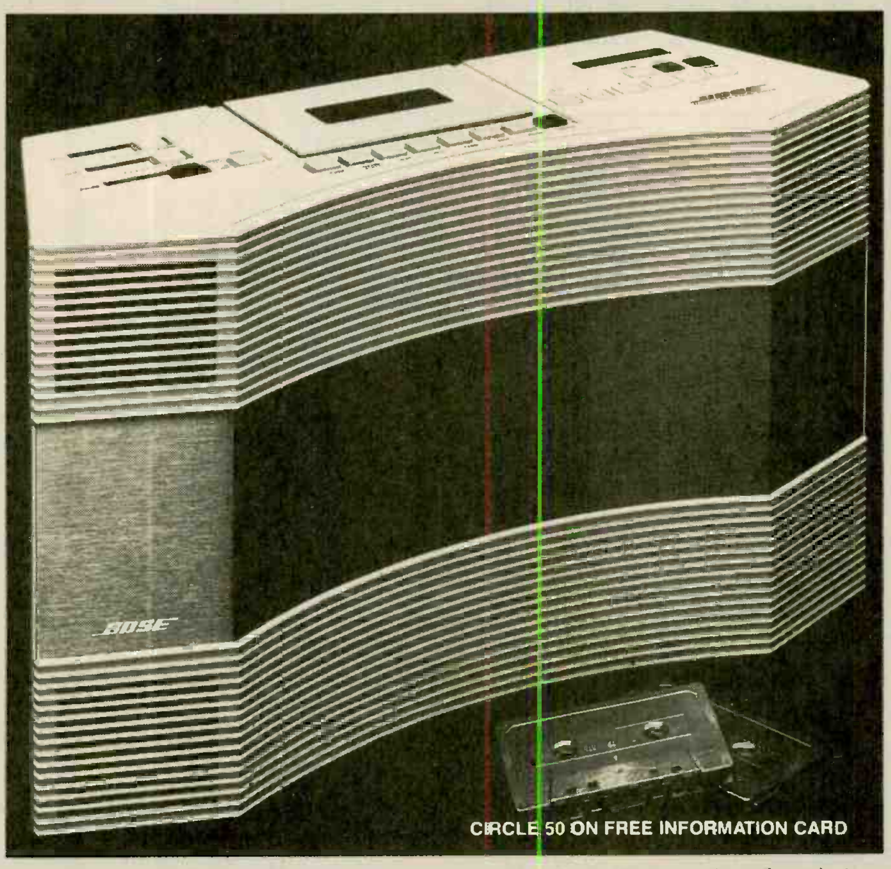

CIRCLE 50 ON FREE INFORMATION CARD

Big Kids' Boom Box

BOSE AW-1 MUSIC SYSTEM. Manufactured by: Bose Corporation, The Mountain, Framingham, MA 01701-9168. Price: $829.

Getting good quality sound in a small space—a college student's dormitory room, for instance, or a "first" apartment—can be a problem. There just isn't any place to put all the components you need to do it right. Money can be a factor, too. The all-too-frequent solution is an inexpensive "boom box," usually designed to run from flashlight batteries and best carried around on one's shoulder. The sound emanating from those atrocities might most charitably be described as being ... "audible." Besides, the knobs and buttons sometimes have a tendency to fall off.

For someone who seeks quality, as well as convenience and small size, there must be a better answer. Well, *Bose Corporation* thought so too, and came up with its *AW-1 Acoustic Wave Music System*. The approximately boom-box-size unit contains an AM/FM stereo receiver and cassette deck coupled to a truly amazing speaker system (Bose, just to refresh your memory, is a speaker manufacturer of some repute) to which we'll return in a moment.

The AW-1 box—which resembles in appearance a scale model of one of those 10,000-room Miami Beach or Las Vegas hotels—has no handle; it weighs 18 pounds and is intended to repose more or less permanently in the corner of a room or on a bookshelf (although a car cigarette-lighter cord and dry-cell battery pack are available separately from the manufacturer if you desire to take the unit somewhere with you). The speaker system consists of a single 4½-inch low-frequency driver that operates up to 500 Hz and a pair of four-inch high-frequency drivers that take over above that. Each speaker has its own amplifier, which helps keep the phase relationships of the signals for each clean and uncomplicated—the crossover function is performed electronically at low signal levels, rather than by a more brute-force method on full-strength signals at the speakers.

The low-frequency response of the AW-1 system has to be heard to be believed; clean, rich bass is not supposed to come out of a box this size. The quality of the sound is due primarily to Bose's Acoustic Wave enclosure, which creates a labyrinthian wideband waveguide structure whose resonant characteristics enhance bass response without making it boomy. We suspect that a good portion of the AW-1's weight comes from the partitioning and bracing that make up the waveguide. Bose claims to have invested more than fourteen years and several million dollars in that technology, and the investment certainly seems to have paid off.

Although you can detect some stereo effect if you seat yourself directly in front of and just a few feet away from the unit, its stereo separation and imaging are not much to write home about. However, since the aim of the unit is to provide high-quality sound coupled with convenience, we doubt that its purchasers will be concerned about that deficiency. We have noted an appalling (to us, at any rate) number of "stereo" installations where all but the most blatant of left-right effects disappear, and even some where the right- and left-channel speakers are stacked in a corner one atop the other. Aaargh!

However, our observations do confirm a point that Bose also makes, namely that lots of people do not need, want, or just plain care about the features—all the bells, whistles, and flashing lights—without which we hard-boiled audiophiles do not consider a system complete. They just want to turn their system on and hear the

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TURN PAGE FOR CONTENTS

This month in GIZMO®

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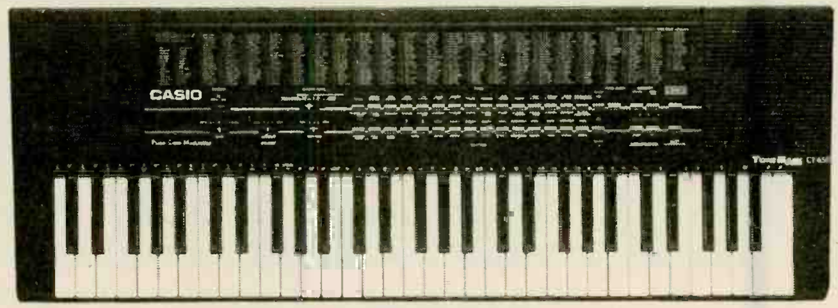


CIRCLE 51 ON FREE INFORMATION CARD

So You Want to Lead a Band?

CASIO CT-650 TONE BANK KEYBOARD. Manufactured by: Casio, Inc., 570 Mt. Pleasant Ave., P.O. Box 7000, Dover, NJ 07801. Price: $399.

We've always wanted one of these devices. From time to time we come up with an idea for an amazing piece of music, but since we can't afford our own orchestra or band—or even piano player, come to think of it—the concept remains just that and is never heard in the light of day. One such composition was the *Autumn Leaves March*, a lively piece of music that probably would have made Cole Porter turn over in his grave. (John Philip Sousa would have loved it, though.) We've carried the music around in our head for more years than we'll disclose here, but until we got our hands on *Casio's* big (61-key) *CT-650 Tone Bank* keyboard, we never heard it. You just can't play that sort of thing on an acoustic guitar or nose flute!

We suspect that this keyboard is more for self-amusement than it is for professional use, but it is far from being a toy. To begin with, the CT-650 offers 465 different sounds. Note that we didn't use the terms "voices" or "instruments." Neither does Casio. That is probably because some of the sounds that come out of the unit's two 4½-inch speakers—it plays in stereo, by the way—could never come from conventional musical instruments. Sure, there are the usual piano, organ, and harpsichord voices, and brass and string sounds, but the CT-650 goes far beyond that. Among the 30 individual sounds that can be selected are also such synthesizer "instruments" as "Fantasy" and "Miracle," and one labeled simply "Metallic Sound." There is a percussion selection, too, with gongs, triangles, wood blocks, cymbals, and drums of different types and sizes assigned to different keys. The percussion effects, by the way, are said to be digitized representations of sounds recorded from real instruments. There's even a very realistic "bells" sound that produces lingering cacaphonic "aftershocks" of dingings and dongings, just as you would expect real bells to do.

That accounts for a few of the sounds, but where do the rest of the 465 come from? The CT-650 includes a feature that Casio calls "Tone Bank" that allows you to combine pairs of the 30 basic sounds to produce new ones. All the combinations—435 of them—are listed on a plate above the keyboard. Many of the combinations made sense to us—voices such as "16-8 Pipe (organ)" and "Woodwind Ensemble"—while others the likes of "Weird Fusion" and "Zydeco" probably have some significance of which we're not aware in the world of pop music. A few of the combinations, though—"Metal Tines," "Full Metal Racket" and "Ghostly Voices," for example, not to mention "Polka of Doom"—seem to have gotten their names simply because those sound combinations had to be called *something*. Whatever they're called, the sounds are all interesting and fun to experiment with, and most of them are even musical.

(Note to Casio: There are *more* than 465 "sounds" in the CT-650—surely you have to count each of the different drums, gongs, triangles, etc. separately. That makes at least 513, by our count.)

As we've already mentioned, this is less a performance instrument than it is a device for self amusement. And, with the CT-650 you can do more than lead a band—you can *be* the band. First comes chord accompaniment for the musical equivalent of hunt-and-peck typists. A function called "Casio Chord" divides the keyboard into two sections, the top portion of which is used by your right hand to play the melody, and the lower portion—the bottom 18 keys—to produce chords. You don't have to know how to finger chords the old-fashioned way; pressing just a single key will generate a major triad (three-note chord). Each of the chord-producing keys is inconspicuously labeled that so all you have to do is match the letter to the chord name appearing in the musical notation you may be working from. If you want a minor chord, press the proper key and *any* key to the right of it; for a major seventh chord, pressing the tonic key and *two* to the right does the job. Finally, pressing four keys at once gets you a diminished seventh chord. It's a neat system, once you get used to it—you never have to worry about which fingers are supposed to be on the black keys and which on the white ones, and transposing from one key to another becomes as easy as falling off a log. An AUTO HARMONIZE button adds right-hand harmony in the key (major, minor, seventh, etc.) selected by the left.

If accompanying yourself with simple chords and harmony isn't enough, how about some rhythm? The CT-650 offers 20 different rhythm accompaniments, from ROCK through REGGAE, to MARCH and WALTZ. And if you want still more, the keyboard will back you up with a "neutral" instrumental accompaniment for each of the rhythms. The backup (and rhythm) instruments are fixed, regardless of the voice(s) you choose for the melody.

With the press of a button you can, if you like, have the keyboard play a bar or two of introductory rhythm (with musical accompaniment, if you want it), as well as one or two bars to get you out of a piece. Another button adds a little riff to the rhythm whenever you feel it's called for. The rhythms and accompaniments are always the same, but they are neutral enough not to become too irritating with repetition. They do restrict you somewhat in your repertoire—not all waltzes work the same way, for instance—but they can also provide a good measure of fun. It's said, for example, that John Philip Sousa's famous march *Stars and Stripes Forever* was originally written as a waltz. When that didn't work, he simply played it faster and a little differently. You can do the same sort of thing on the CT-650.

Once you've found a sound/rhythm/accompaniment combination you like you can store it as one of four presets, recallable instantly. And, if you want still *more* music, the keyboard has a record/play memory that can store sequences of approximately 1250 notes. On playback, you can play along with the recording. All told, and depending on the mode it's in, the CT-650 has a polytonic capability of ten tones at once.

With all the bells and whistles cranked up and running full tilt, you can have yourself a grand time! The keyboard almost seems to—actually, it *can*—play itself. A couple of times we got so caught up in the music we and the keyboard were producing that we took our left hand off the keyboard to conduct and forgot to get it back in time to change chords.

For more serious work, the CT-650 is also equipped with a *M*usical *I*nstrument *D*igital *I*nterface (*MIDI*) port that allows it to be used in conjunction with a computer or other MIDI-equipped gear. The percussion sounds can be transmitted directly to the keyboard's MIDI port for use elsewhere.

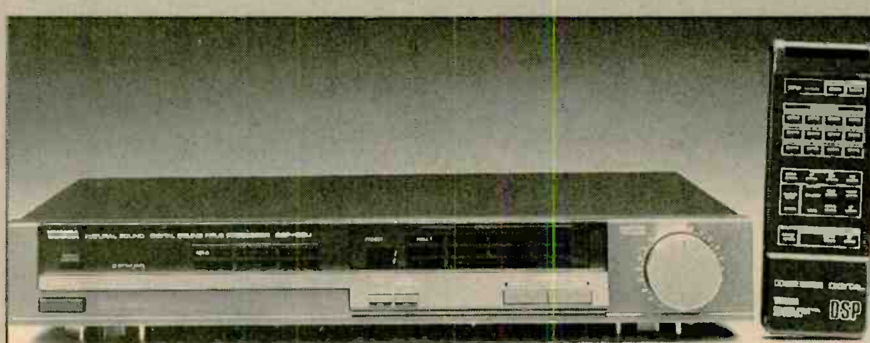
The manual accompanying the CT-650 is not much, although it does have a nice section on MIDI. Casio also includes an instructional videotape with the keyboard. It is instructional, however, only to the point of mentioning and briefly demonstrating some of the unit's features. It does not show you how to use them. There is also a demonstration melody built into the CT-650, supposedly to illustrate the keyboard's versatility—but, unless we missed something, all it does is play an endless repetition of a popular melody in the PIANO voice.

At the rear of the keyboard are several jacks and controls. There are the MIDI connectors, of course, and two phone jacks for signal output to an external stereo-amplifier/speaker system. Using those jacks, though, does not disconnect the built-in speakers. There's also a headphone jack that does cut off the speakers, and a jack for an AC adapter. The keyboard's six "D"-size cells will power the keyboard for six hours or so, but using an external power supply will eliminate the need to stop and replace exhausted dry cells in the midst of a long concert performance. There are also jacks that permit you to add optional sustain and volume pedals. Finally, there's a knob marked TUNE that allows you to adjust the pitch of the entire keyboard within ±30 cents (hundredths of a tone).

We had a lot of fun with the CT-650. While we sometimes found it awkward to switch between the keys and control buttons (to get the keyboard to play us out a tune, for instance), with practice that got easier. Besides, we were having such a ball that we hardly noticed. ■

Listening Rooms to Order

YAMAHA DSP-100 DIGITAL SOUND FIELD PROCESSOR. Manufactured by: Yamaha Electronics Corporation, 6722 Orangethorpe Avenue, Buena Park, CA 90620. Price: $699.



CIRCLE 52 ON FREE INFORMATION CARD

When you attend a live concert, or even when you listen to recorded music in an environment such as a discotheque, you become immersed in what is referred to as a "sound field." The sound field is made up of all the sound reaching your ears—not only that directly from the instruments, but also the reflected sounds from walls, ceilings, and other surfaces that give the listening space its particular ambience.

When music is recorded, several techniques for providing some sort of ambience may be used. In classical music, recording sessions may take place in an actual performance environment such as a concert hall or cathedral, and the natural sound characteristics of the performance space captured on the master tape. Recordings made "in concert" may also include ambient sound reflecting the recording environment.

More frequently, though—and almost exclusively in popular music—recordings are made "dry" in anechoic surroundings such as soundproofed studios designed to eliminate sound reflections. Those recordings would be pretty dull and lifeless acoustically if they were not enhanced through the use of signal-processing equipment bearing names such as Lexicon and Fosgate, which add reverberation in various fashions and degrees to simulate the sound field that would be created in a performance or other listening environment—anyplace other than a recording studio.

The problem with those sound fields is that they are all pretty much two-dimensional. Even though the word "stereo" refers to a sound field's being solid, and does not mean "two channels" (as many people seem to think it does) the sound field from a conventional stereo system, while it clearly indicates left and right, does not have a perceptible foreground and background. And, unless you still have some old quadraphonic equipment and recordings left over from the '70's, or are running your music through your video system's surround-sound processor, even echoes from the back of the room come from the front of the room.

That is where *Yamaha* enters the picture. Its *DSP-100 Digital Sound Field Processor* can provide you, the listener, with as many as 33 distinct sound-field environments. The DSP-100 is, optimally, a six-channel system and requires six channels of amplification and six speaker systems, although the four "effect" speakers and the amps that drive them need not be of the same power or caliber as the two "main" ones.

The "main" speakers are the ones you normally use in your stereo listening. The two "front effect" speakers are located behind and to the sides of those and provide a digitally synthesized sound representing that which would be reflected to your ears by the surfaces in the immediate vicinity of the performers, particularly behind them.

The "rear effect" speakers, which you situate behind you at a distance about equal to that separating you from the "main" speakers, provide synthesized ambience for the area behind (and sometimes above) you. All together, the six channels envelope you in a synthesized sound field that can provide the experience of listening to a performance in the type of surrounding for which it was originally intended. In a pinch when six speakers are not available or practical, a switch at the rear of the DSP-100 lets you squeeze by with a four-channel system by combining the main and front effect channels.

Yamaha uses five parameters to establish a sound field. *Room size* determines the apparent size of the listening area by adjusting the timing between the early reflections. That is the first group of reflections you hear before the subsequent, dense, reverberation begins. *Liveness* refers to the apparent reflectivity of the listening area. A room with bare plaster walls is extremely "live," while one whose walls are covered with draperies and that may be filled with people is much less so. The *initial delay* parameter changes your apparent distance from the source sound. Changing the *reverberation time* alters the apparent size of the acoustic environment by adjusting the amount of time it takes for the level of the dense subsequent reverberation sounds to decay (by 60 dB). Finally, modifying the *high frequency reverberation* time affects the quality of the sound by varying the cutoff frequency of the high-frequency reverberations. By combining digitally-delayed signals derived from a recording (or movie or live broadcast) in various degrees according to those parameters, different listening spaces can be emulated.

The DSP-100 includes preset parameters for 12 main environments. Those include Concert Hall (three sizes), Church, Chamber, Rock Concert, Jazz Club (two sizes), Discotheque, and Movie Theater (two sizes).

With the exception of CHURCH and CHAMBER, each preset has two "subprograms." There is also a Dolby Surround Sound mode, making for a total of 21 predefined listening environments. The DSP-100 allows you to modify the parameters of all of those sound fields to create your own, and to store twelve of those custom environments in memory for immediate recall. In all, then, the DSP-100 sound processor can make a total of 33 sound fields instantly available to you at any time you desire.

Yamaha claims to have derived most of the preset environments from acoustic measurements made at actual locations. Two of the JAZZ CLUB settings, for instance, reproduce Greenwich Village's Village Gate and Village Vanguard clubs, and one of the ROCK CONCERT presets is derived from Los Angeles' Roxy Theater. While the concert halls are not named, enough information about them is given to allow someone familiar with European, American, and Japanese locations to make informed guesses about the origins of most of the presets.

The DSP-100 is easy enough to set up and use. There are 18 "Setup & Adjustment" pages in the manual, but they are not hard to follow and cover several different variations on the number-of-amplifiers-and-speakers theme. Adjustment is not complicated and is made easier both by a TEST button that sends several combinations of front-rear and left-right pink noise to your speakers to help you in balancing the system's sound output, and by a remote control that—among other things—lets you vary the degree of effect sound and even to mute it entirely for comparison with the original stereo version of your material. You can also change presets and vary effect parameters using the remote from your listening position (which is nice, because you can't do it from the unit itself).

Yamaha has very thoughtfully included a video character-generator chip in the DSP-100 so that parameter settings can be viewed all together on your TV screen, rather than one-at-a-time on the unit's built-in two-digit, seven-segment display. A useful feature.

The DSP-100 adds a lot to the listening experience. How much, exactly, depends on the content of the material it processes. In recordings already containing a significant amount of ambient sound—either real or synthesized—it manages to add an enormous degree of spaciousness and degree of immediacy, due largely to the sound emanating from the "effect" channels. Note that this is not a surround-sound or multi-channel processor (except for the Dolby Surround section) that puts instru-

(Continued on page 6)

BOOM BOX

(Continued from page 1)

music come out. It is with those people in mind that Bose designed the AW-1.

A less-sensitive reviewer might call the AW-1 "an idiot's delight." We'll say, instead, that it is extremely easy to use. All the push-button operating controls—the few that there are of them—are on top of the unit. You turn the radio on and off with a brownish one (most of the others are silver-gray to match the case) and push another to select AM or FM reception. The frequency that you select with the UP and DOWN buttons appears on an LCD which should be, but unfortunately isn't, backlighted. Five buttons in a row allow you to store and recall the frequencies of your favorite stations, five AM and five FM. A telescoping FM antenna is built into the rear of the unit, as are screw terminals for attaching an external antenna via 300-ohm twin lead. The performance of the unit's tuner, while not outstanding, is certainly adequate.

Volume, bass, and treble are controlled by sliding levers. It's interesting that the "normal" position of the bass control is turned all the way up—from NORMAL you can only reduce the amount of bass, but not increase it. That may appear strange, but we found that we had more than enough bass at the "normal" setting, and usually operated the AW-1 with the control at its midpoint, that is, with the bass level cut somewhat. The sound of the AW-1, as we have mentioned, is quite good, and there's more than enough of it to fill a good-sized apartment with ease and still have some left over.

At the rear of the AW-1 are RCA-type jacks for line-level inputs (to the amplifier and tape deck, for a CD player or other device) and outputs (to a second tape deck, for instance). Bose also sells a "power microphone" that allows the AW-1 to be used as a PA system. What is lacking is a headphone jack, but in view of Bose's reputation as a speaker manufacturer, and considering the quality of the Acoustic Wave system of which Bose is (justifiably) extremely proud, that is perhaps an understandable oversight.

We were *almost* deeply disappointed by the tape deck built into the unit until we caught on to what was going on. There was no noise-reduction selector, and the deck apparently accepted only ordinary ferric-oxide cassettes. Then we read the instructions, and got an insight into the way Bose's thinking worked. Since the AW-1 was designed for convenience, the switches (or buttons) for which we were looking were left off. The tape section has Dolby B noise reduction built in—and permanently switched on—and has had its performance tailored specifically to Type II (high-bias, chromium-dioxide) tapes. (You can also

(Continued on page 6)

A1 and A-Two and ...

CANON A1 Hi8 8mm CAMCORDER. Manufactured by: Canon U.S.A., Inc., One Canon Plaza, Lake Success, NY 11042. Price: $2295.

CIRCLE 53 ON FREE INFORMATION CARD

The first thing that strikes you about *Canon's* multi-featured *A1* 8mm high-band camcorder is its shape. Most 8mm camcorders resemble their home-movie predecessors with everything arranged more or less along an axis running between the lens and the viewfinder. Not the A1. It looks more like a somewhat tubby 35mm still camera with a larger 4 × 5 film back attached at a slight angle. A curious arrangement at first glance—but one that, when you stop to think about it, makes as much sense as the more conventional arrangement since there is no need for optical coupling between the lens and the electronic viewfinder. And, maybe it makes the body a little easier to grip and hold steady.

The Canon A1—although it features autofocus, auto white-balance, and auto-this and auto-that—is not a simple point-and-shoot video-snapshot machine. Far from it. Every automatic adjustment can be overridden and fine-tuned manually. Furthermore, as we shall see, the A1's design obviously lends itself to professional-caliber tape production. That's what really attracted us to the unit. That and the distinctive shape, of course.

The A1 uses high-band recording technology, often called "Hi8" or something similar, in which a video bandwidth greater than that specified by the 47-year-old NTSC standard is used in recording to achieve greater resolution. We don't know exactly what the target resolution of the A1 is, but the camera is equipped to output separate luminance and chrominance signals through an S-video cable, a provision that would not have been made if there were not something extra there. The quality of our video was quite high, and was certainly significantly better than that from a standard VHS deck manufactured several years ago. The A1 also records its audio in stereo (the built-in mike has two elements) and the resulting soundtrack, coupled with a big, high-quality picture, could make for some spectacular productions.

The Hi8 format requires a special metal-formulation videotape, but the camcorder can record on the more ordinary (and slightly less expensive) 8mm type as well using the ordinary 8mm (not high-band) format. That is done mostly for compatibility with other equipment. There is only a single recording speed, SP (Standard Play), but depending on the length of the cassette, that can give you up to two hours of recording. And, given the size of the 8mm cassettes, carrying a spare or two presents no problem.

The A1 operates from an easily removable nickel-cadmium battery pack that powers it for about 70 minutes. Another, 85-minute, pack is available as an option. It's a good thing that the battery pack is so easy to get in and out, since it can't be charged while it's in the camcorder. A separate charger, which operates from house current, gets attached to another small box that Canon calls a "charge coupler," and into which you clip the battery pack. Provision is made for attaching two batteries at once; when the first has been charged, the charger switches to the other. A red LED flashes to indicate that charging is taking place, and glows steadily when the pack is "full," which takes about two hours from "empty." The charge coupler can be attached to the camcorder in lieu of the battery pack to power it from AC, but there's no way to both run the camera and charge its battery at the same time. One more connector, Canon, on a camera that already had so many of them (and so many buttons!) would not have hurt.

Speaking of buttons and connectors, there are plenty, some of them in duplicate. That doubling up of the recording controls and on the information displays (one display in the viewfinder, another atop the unit in the form of an LCD) allows you two different ways to grip the camcorder. (One grip, says Canon, is for short-but-steady shots, the other for longer takes that may not require a stable-as-a-rock picture. With a 1:10 zoom ratio—equivalent to a focal length range of approximately 35mm to 350mm in 35mm-camera terms—you need all the stability you can get.) The LCD simplifies using the camcorder mounted on a tripod as you should do (but undoubtedly won't) most of the time, or when using the unit in its self-timer or time-lapse modes. (A timer also allows you to program the camcorder to begin unattended taping at any time within a 24-hour period.) There's even a wireless remote control that permits you to adjust the focal length of the lens from a distance, although it's recommended that you view the scene in a monitor as you do so you can tell how far you've gone. The information displays, by the way, are quite versatile and have vocabularies that are somewhat larger than those of a number of people of our acquaintance.

There are two doors on the A1 concealing a variety of jacks and controls. One on the left opens to reveal a number of video and audio input and output jacks; on the right another door hides controls for setting the time and date, for selecting timing functions, and for adding two-line, 16-character titles to your videos (which we found to be an awkward and time-consuming process that most people will probably just ignore after they've tried it once or twice).

As we said earlier, this is no simple point-and-shoot camcorder. Indeed, it seems almost too high-strung for that purpose. What we mean by that is that we found its reaction times and ranges of response to be not especially well suited to the casual videotaper. For example, the system exhibits a noticeable lag in compensating for exposures when it is panned from a dark to a bright area, or vice versa. And, its exposure latitude—that is, the range of dark and light it can handle comfortably within a single frame—is rather restricted. We sometimes were treated to noticeable symptoms of overload and a couple of spectacular cases of color flare. The black-and-white CRT serving as a viewfinder was adequate under most conditions, but our eyes required some time to accommodate to its dimness when shooting in bright outdoor light. There seems to be no user-adjustable brightness control for the viewfinder.

The autofocus mechanism was also quite touchy and we frequently found it "hunting" back and forth for the proper focus during a distant shot. We later discovered, going back to the instruction manual, that the system has both narrow- and wide-field focus zones. Switching to the wide-field system, which encompasses almost the entire picture area (as opposed to the narrow one, which uses a only a small horizontal rectangular portion at its center) caused the camcorder to behave less confusedly. However, the default system—the one that is used unless you specify otherwise (and you have to have read the manual to know that)—is the narrow-field one. The optical system is also very sensitive to objects passing close in front of it when it is focused on a distant subject, and the lens barrel does a lot of twisting back and forth as it tries to accommodate its focus to what it thinks you want it to concentrate on. That does neither a viewer's eyes nor the camcorder's battery pack any good. Fortunately, you can override the autofocus mechanism. In fact, there are two manual focus modes for you to choose from.

You can also control the exposure manually, which is a nice feature to have on any system, and particularly desirable on this one. In the manual mode an "exposure ruler" appears in the viewfinder and "+" and "−" buttons on the camcorder's body move a pointer along it as the exposure is varied. Since the pointer seems to move in jumps, however, and since you can go from underexposure to overexposure very, very, quickly, your best bet is simply to set the exposure so you get the best detail in the viewfinder.

Another very useful feature of the A1 is also controlled by the EXP button. If you need to bring out the detail in an object being shot against a bright background, you zoom in on your subject and press a button to lock in that exposure, which presumably is the proper one. You can then zoom back out to include some background, but the exposure will remain set for the subject. The background may wash out in your recorded video, but you'll see the detail you want to concentrate on. The camcorder will remain locked at that exposure until you release it. And, speaking of exposure, the A1 includes a FADE button to get you in and out of scenes. Curiously, however, it fades to (and from) white, not black.

An extremely valuable feature not found on many point-and-shoot systems is a WHITE-BALANCE control. As you may have noticed, the same color can appear quite different when viewed under different types of lighting, or by natural light at different times of day. The function of the automatic white balance control found on most other camcorders—and on this one, until you tell it you'd rather do it yourself—is to compensate for those changes in lighting so that colors remain relatively constant from scene to scene. However, the automatic system is more easily fooled than the human eye, and may sometimes produce unwanted results. For example, in scenes that include a lot of sky, the color balance of the rest of the scene may take a turn toward pink as the camcorder's white-balance circuitry tries to compensate for all that blue.

To set the camcorder's white balance manually, you point the lens at a white object—a piece of paper, shirt, maybe even a sidewalk—and press the WHITE BAL button for a second or two. The words "WHITE BAL" flash momentarily in the viewfinder and on the LCD screen and then appear steadily, indicating that the white balance has been set so that the white paper (or shirt, etc.) you aimed at will now be recorded as white under the current lighting conditions. The colors of other objects will fall into place around it and you can throw the paper away. The white balance will remain unchanged until you set a new one or return to automatic operation.

While the Canon A1 does have some shortcomings, such as its inconvenient-to-use power supply system and rather finicky automatics—making it, in our opinion, unsuitable for casual family-style videomaking—the amount of control available to the photographer who knows how to take advantage of it is rewarding. That, and the stereo sound (not an easy feature to find in a camcorder of any type) and high-band 8mm quality make the Canon A1 a fine instrument for the serious amateur, or even perhaps the low-end professional. ■

BOOM BOX

(Continued from page 4)

play metal tapes, but because of their extra-high bias requirements, you cannot record on them.) There is no RECORD LEVEL control. A slow-acting ALC (automatic loudness control) circuit ensures that the proper level signal gets onto the tape without the dynamics of the music being overly affected. And, although the tape-transport mechanism uses mechanical, as opposed to "soft-touch" controls, it is easy to operate. The only precaution you have to observe is to not leave the tape mechanism in the PAUSE mode for more than a few minutes, lest the pressure of the capstan deform the unit's rubber pinch roller.

Although we feel that the more-than-eight-hundred-dollars Bose asks for the AW-1 is a bit exorbitant there are, we understand, a large number of people who have gladly paid that price simply to get everything they wanted in a single package and to not have to concern themselves with all the confusing controls found on other music systems with what may be inferior sound. And we have to admit once more that the sound is exceptional for a unit this size.

Where can you go out and hear an AW-1? You can't. In fact, until you read this review you probably didn't even know the system existed. Except for sponsoring Paul Harvey on radio, and an occasional direct-mail campaign, Bose doesn't advertise the AW-1. In a few parts of the country the AW-1 is sold door-to-door by the consumer-electronics equivalent of the Fuller Brush man. By calling a toll-free number (800/282-BOSE) you can find out whether you can arrange for a visit in your area from one of those salespeople for an in-home demonstration. And, if you can't, Bose will sell you an AW-1, complete with demonstration tape, over the phone. The unit comes with a 14-day no-questions-asked, money-back, guarantee; if you're not satisfied with the way it works or sounds you can return it for a full refund. Bose tells us that they have rarely been asked to honor that arrangement. We are not surprised. ■

SOUND PROCESSOR

(Continued from page 4)

ments or performers in front of, alongside of, and behind you. Rather, the main sound sources stay before you all the time; the effects channels merely create the illusion of sound reflections to simulate a listening environment of a particular type as selected by the user.

The effect of the processor is most obvious when it is operating on a simple "dry" sound such as the voice of a radio announcer working from the usual sound-proofed and acoustically dead booth. It does indeed then seem as though that person were speaking from the stage of a concert hall, a stadium (one of the ROCK CONCERT subprograms), or a church. The effect on material already containing ambient sound is less distinct.

Certainly, the device does add a large degree of spaciousness, which can be changed and fine-tuned according to the music. Given the fact, however, that the material's built-in reverb is an unknown factor, the accuracy of reproduction expected from a given preset becomes somewhat problematical. If used in moderation, though, the overall effect of the sound processor is quite pleasing. ■

The Ol' Switcheroo

SMARTMAX FAX SWITCH. Manufactured by: MaxTrek (Division of EBCO Enterprises), 5627 Stoneridge Drive, Suite 317, Pleasanton, CA 94566. Price: $199.

People are constantly asking whether we're equipped for fax. They express great concern that if they can't immediately fax us a hot press release, or a picture of their brand new VCR, we (or they, perhaps) are going to miss out on a once-in-a-lifetime opportunity. The letdown they feel as we remind them of the alternative services offered by Federal Express, UPS and even the U.S. Postal Service is palpable. To keep from disappointing those people we've looked into having a phone line for fax brought in, but our calculations indicate that it would cost us about $250 the first year, much more than our need for facsimile service could justify. Now, though, we may have found something that makes fax more affordable.

The answer is a device called *SmartMax*, manufactured by a California company by the name of *MaxTrek*, that lets you use your telephone, phone answering machine, and facsimile machine all from one and the same phone line. You connect SmartMax to an ordinary RJ-11 modular phone jack, and plug your phone and fax equipment into similar jacks on the back of the unit. Then, when someone calls, the smart switch determines whether the call is voice or fax, and routes it accordingly.

Actually, the process is a little more elaborate than that. When SmartMax detects a ring signal—which is a momentary jump in phone line voltage to about 80 volts—it immediately listens for the carrier, known as the "CNG tone," that indicates an incoming fax. If the carrier is detected, the call is switched to your fax machine, which is plugged into the unit. Your fax transmits a tone back to the sending unit indicating that it is ready to receive, and the fax transmission begins.

If there is no CNG tone, however, SmartMax does something completely different. Acting as a buffer between the equipment connected to it and the phone line, SmartMax synthesizes a couple of signals. For the answering machine and phone, it can synthesize a series of those 80-volt ring signals. And, for the caller, it generates a sound of the sort normally produced by equipment at the phone company's central switching office to indicate that a phone is ringing. (You didn't think that you were really hearing the phone at the other end ring when you made a call, did you?) It generates up to eight rings before giving up. If you are handy when a call comes in, you hear your phone ringing (courtesy of SmartMax) and pick it up (if it's a fax call, you can switch it over—as we describe later—and let SmartMax take it from there). If you're not around, your answering machine—assuming you have one—picks up after the prerequisite number of rings and delivers and takes messages as usual. Very convenient, and all on one phone line.

CIRCLE 54 ON FREE INFORMATION CARD

A rocker switch on the front of SmartMax allows you to select PHONE, FAX, or AUTO modes. In the AUTO mode operation takes place as we've just described. LED's indicate which mode of operation SmartMax is set for or using at the moment.

There's a type of fax call that we haven't considered yet. That's the kind that originates from one of those fax machines with the phone built in, and where the originator of the fax calls you first, using that phone. His intent is to tell you that in a moment he's going to switch over and send a fax to your machine, which (he assumes) is, like his, also on the same line as the phone. If you're at hand when you get one of those calls, you can throw SmartMax's switch manually when the time comes to go from voice to fax. Alternatively you can press "4" on your phone's *Touch Tone* keypad to command SmartMax to make the switchover.

You can use that tone-activated switching to turn SmartMax into a poor man's voice mail. (For that suggestion, we're indebted to a young lady manning MaxTrek's customer-service line; she provided us with more information about faxing than we could possibly pass on to you here. Thanks, Ruth.) Here's what you do:

Record an outgoing message on your answering machine that says something like, "If you want to leave a message for me, start speaking after the beep. If you want to leave a fax on my machine, press "4" on your phone and then transmit your document." Clever.

SmartMax is not difficult to connect—you plug your fax machine into one jack and your answering machine (with your phone plugged into it) into the other. The SmartMax unit itself gets plugged into a telephone wall jack, and into an electrical outlet. (SmartMax has no power switch; we suppose that since you never know when you're going to get a phone call or a fax, you'll always leave it turned on. Besides, not having a switch keeps the device from being turned off accidentally.) If you have no answering machine, you just plug the phone directly into SmartMax.

Although SmartMax is designed for single-phone operation, there are ways of connecting it for use in multi-phone, multi-jack, situations. Some of those are described in the accompanying instructions, and MaxTrek has a very friendly, informative, and helpful staff at the end of an "800" line to hold your hand or provide advice should you run into problems.

We like the idea of SmartMax. The device is not inexpensive, but within a year it will have saved you the cost of installing and paying for a separate fax line. ■

CIRCLE 55 ON FREE INFORMATION CARD

The Great Equalizer

AUDIOSOURCE EQ TEN COMPUTERIZED GRAPHIC EQUALIZER/SPECTRUM ANALYZER. Manufactured by: AudioSource, Inc., 1327 N. Carolan Ave., Burlingame, CA 94010. Price: $429.95.

We've known for some time that the environment in which we listen to music (and audition audio equipment for Gizmo) could stand some work. When we recently undertook some decorative improvements to the room that involved changing the way the windows—of which there are many—were covered, thus further affecting the room's acoustic qualities, we also took the opportunity to try to balance things out a bit. We contacted *AudioSource*, a manufacturer of graphic equalizers (and other audio equipment, including a line of surround-sound processors) and arranged for the loan of their *EQ Ten* computerized graphic equalizer *cum* spectrum analyzer. Our choice of the EQ Ten, rather than one of AudioSource's less elaborate equalizers, was based on the fact that this one can perform the equalization process automatically, thus eliminating errors due to subjective analysis of the sound produced by the system.

The EQ Ten offers a lot. To begin with, it provides twelve bands of equalization per channel, 24 in all, affording ±12 dB of control. The center frequencies of those bands are: 25, 40, 63, 100, 160, 250, and 500 Hz; and 1, 2, 4, 8, and 16 kHz. Left and right channels can be equalized independently or together. If "ganged" equalization is chosen, the same amount of boost or cut is added to or subtracted from whatever value is currently set for each channel. A pink-noise generator (pink noise is a "hiss" with the energy content of the sound distributed equally across the spectrum; it sounds "warmer" than white noise) coupled with a microphone and microprocessor work together to provide the AUTO EQ function. More about that later.

There is provision for two independent tape loops (AudioSource suggests connecting the EQ Ten via one of your amplifier's existing loops; the loops on the equalizer replace the one "lost" in doing so, and add a second one, to boot), and an equalized signal can be recorded on tape for later playback without the use of an equalizer. Similarly, a tape whose content has been processed through the equalizer can be played back "flat" through the use of a REVERSE function on the unit.

On conventional equalizers, slide potentiometers are used to set the degree of signal boost or cut in each channel. After adjustments have been made, the knobs on the pots form a sort of connect-the-dots graph showing the new frequency response of the system. That is where the "graphic" in "graphic equalizer" comes from. There are no slide pots on the EQ Ten, however. Most of the switches are simple push-button types. Those push-buttons, we discovered, are very light-touch mechanical switches—you can change things (such as turning the microphone on and off) even when the equalizer is turned off. If you don't know about that, you can inadvertently lean on one or two and then wonder why, when you turn it on, the unit is acting the way it is. The controls used to set band-by-band response are "rocker push-buttons" of the electronic "soft-touch" type, where the simple closure of a circuit initiates an action controlled by the unit's microprocessor. Pressing the top of the rocker push-button causes a response in one direction; pressing the lower portion results in a change in the other.

Since there are no slide pots whose knobs can indicate how equalization has been set, a large LED array serves instead to show the curve. Each band is represented by a vertical string of 11 LED's—ten red and one green. The green one is at the middle and represents a boost/cut level of 0 dB, or "flat" response. Two additional strings of LED's at the far right of the display indicate overall volume levels in the left and right channels. (Unfortunately, until you get used to them, you can be confused into thinking that those LED's represent the two top-level frequency bands. They really should be a different color—amber, perhaps.) The LED array doubles as a spectrum analyzer (more properly, a spectrum monitor—analysis of the display is up to you), showing the relative energy content in each of the unit's 12 bands. The unit defaults to that display mode, although when a number of function buttons are pressed it reverts to the equalization display for about fifteen seconds before popping back into its spectrum-analyzer function. A GRAPH button can be used to toggle the unit between the two modes. Another button labeled PAUSE switches the display from INSTANTANEOUS RESPONSE to MOMENTARY PEAK HOLD. Holding the button depressed freezes the display.

An infrared remote control supplied with the EQ Ten enables you to operate it from your listening position. That is especially useful when performing equalization setups, since you can make changes and hear the results without having to run back and forth between your chair and the equipment across the room. Finally, the unit contains four memories to hold equalization curves. That allows you to set equalizations for several different sets of speakers and to switch among them.

The EQ Ten was easy enough to set up; AudioSource even supplies the cables. Using the device effectively, though, was another matter. Most of our difficulties arose from deficiencies in the instruction manual; the majority were cleared up with time and experimentation, but a few required a talk with the company.

We elected to use the AUTO EQUALIZE function because we wanted simply to flatten out our room's response—to eliminate as much as possible the peaks and dips in frequency response that resulted in our listening room's having a somewhat "boomy" quality. We weren't particularly interested in compensating for our speaker system's bass or high-frequency deficiencies—it's pretty good in those areas—just in smoothing things out in the room. Besides, you have to be careful when you start adding low and high-end power; it's deceptive. First off, what you probably think of as a deficiency (or maybe a surplus) of very low frequencies probably isn't. That is where the spectrum analyzer comes in handy. Most of that boomy "bass" you hear (or think you want to hear) is really low-midrange energy, far higher in the spectrum than you believe it to be. Trying to amplify low-bass musical energy—which probably is not there to begin with—will do you no good at all.

However, what may be down at the very bottom of the spectrum is unwanted noise such as turntable rumble and other infrasonic garbage. Boosting that by, say, 12 dB would cause your amplifier to be outputting *sixteen times* the power it would at the "flat" setting down in that range. You might not hear that sound, but your amp and speakers would certainly be working extra hard to produce it. The same goes for high frequencies. You have to be extremely judicious in your use of an equalizer lest you damage some component of your system by overloading it.

For auto-equalization, the EQ Ten is supplied with a microphone that you situate at your listening position, pointing back at the speakers. You then turn on the equalizer's pink-noise generator, push the EQ L or EQ R button (AudioSource recommends that you equalize each channel separately to optimize the compensation for differences in room characteristics from one side to the other) and then the AUTO EQ button and off you go. When the equalization has been performed (which essentially happens instantaneously) you are presented with a graph on the LED display showing the equalization curve for that channel. You then must use the GRAPH button to switch out of the graphic-equalizer display mode and into the spectrum-analyzer one before you can proceed to auto-equalize the other channel. When you're done and satisfied, a two-button sequence stores the equalization curve in one of the unit's four memory locations.

When using the pink-noise generator and AUTO EQ function, you have to remember to turn on the microphone using both the switch on its body and the button on the EQ Ten itself (or the one on the remote). We missed mention of that pair of steps our first time through the manual, and that caused us a lot of initial difficulty. You also have to remember to turn the mike *off* at both ends when you're done with it (it would be a good idea to disconnect it completely if you're not going to use it again soon); otherwise it will pick up sound from the speakers when you're listening to music, and the spectrum analyzer display will be inaccurate.

As we mentioned earlier, having a remote control was a great convenience. We discovered, though, that several functions controlled from the front of the EQ Ten were not available from the remote. Especially missed was one labeled FLAT, which would have enabled easy comparison of equalized and unequalized sound from our listening position. We questioned AudioSource about that and were told that the controller IC in the remote unit can generate only a certain number of control signals. In designing the unit, a decision had to be made as to whether one of those signals was to control a (very useful) MUTE function or to duplicate that of the FLAT button on the equalizer. MUTE won. No matter, though. We simply reserve one of the EQ Ten's memories for the flat EQ curve.

Although we've had a few bones to pick with AudioSource concerning some of their design decisions (such as the lack of any indication of how high or low the volume and display sensitivity levels are set), we have to admit that in the end we're rather pleased with the EQ Ten. Our listening room sounds a lot better now. ■

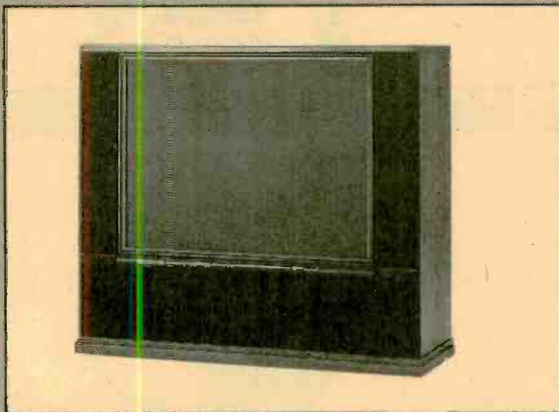
For more information on any product in this section, circle the appropriate number on the Free Information Card.

ELECTRONICS WISH LIST

Surround-Sound Video Theater

"By marrying our outstanding video technology with JBL's renowned acoustic technology," says *Magnavox* (One Philips Drive, P.O. Box 14810, Knoxville, TN 37914-1810) "we have created a surround sound theater." At the top of the line of the four receivers resulting from that collaboration is the model *RK8568*, which is a 52-inch rear-projection video receiver that includes a 100-watt, eight-speaker, six-amplifier Dolby Surround Sound sound system. The RK8568 contains three stereo amplifiers that use a low negative-feedback design, and features individual power supplies and extruded-aluminum heat-sink cooling. Bi-amplification eliminates the need for conventional crossover networks in the speaker systems, which incorporate titanium tweeters, long-throw midrange and woofer transducers, and ported enclosures for the eight-inch low-frequency drivers. The 6.5-inch rear-channel speakers have built-in frequency compensation to balance the front-channel sound. The video portion of the receiver uses three seven-inch picture tubes cooled by a liquid thermal-stabilization system to provide more than 350 foot-lamberts of brightness. Also featured is picture-in-picture capability and a "universal" remote control that can learn the commands of a number of different devices. Price: $3995.

CIRCLE 56 ON FREE INFORMATION CARD


Magnavox Surround Sound Video Theater

Auto-Answer Auto Phone

"Keep both hands on the wheel!" Isn't that what you were always told when you were learning to drive? The *CM-8700* cellular telephone from *Shintom* (20435 S. Western Ave., Torrance, CA 90501) would make your driving instructor very happy. If you don't pick it up after two rings, it automatically answers the call in its hands-free mode, making it unnecessary for you to reach for the handset. Other features of the phone include a 96-location repertory dialing memory (including scratchpad memory), priority/emergency calling with automatic-retry capability, a missed-call display, and a multi-function airtime and call counter. For daredevils, the automatic-answer feature can be switched off. Price $799.95.

CIRCLE 57 ON FREE INFORMATION CARD

Shintom Cellular Phone

ELECTRONICS WISH LIST

For more information on any product in this section, circle the appropriate number on the Free Information Card.

Toshiba Facsimile Machine

Friendly Fax

The *Toshiba* (Telecommunications Systems Division, 9740 Irvine Boulevard, Irvine, CA 92718) model *3300* facsimile machine contains dozens of user-friendly (says Toshiba) features and functions. For example, the unit—which is compatible with all Group 2 and Group 3 systems and can transmit a page in as little as 15 seconds—can double as a personal copier and has a built-in telephone as well. An automatic document feeder allows you to send up to seven documents unattended and a delay function makes it possible for the device to wait until phone rates drop in the afternoon or evening before it starts making its calls. The system can store and automatically dial up to 30 phone and 30 fax numbers and has automatic last-number redial to cope with fax numbers that are busy the first time they are tried. The phone portion of the unit provides a choice of pulse or tone dialing, has an adjustable-tone ringer, and even offers "music-on-hold." A liquid-crystal display shows 20 alphanumeric characters, including the time of day, stored name and phone number, feature activation, call duration, and transmission-error indication. Price: $1395.

CIRCLE 58 ON FREE INFORMATION CARD

Broderbund Videogame Controller

Hands-Off Videogame Controller

Through a proprietary series of electronic sensors and circuitry, *U-Force*, designed by *Broderbund Software* (17 Paul Drive, San Rafael, CA 94903-2101) for use with the Nintendo Entertainment System, senses hand and body movements and allows players to control on-screen videogame action without the use of joysticks, light-guns, or floor pads. Depending on the game, the U-Force "console," which plugs into the Nintendo joystick port and requires no external power source, is positioned upright on a tabletop or is folded flat. There's nothing to hold, press, jump on, or wear—response is determined by the player's motion, velocity, and relative position, which are translated into game actions. For those who find that uncomfortable, Broderbund also provides a "T-bar" and firing handle to hold onto, as well as a "Power Bar" that expands the U-Force playing field. Price: $69.95.

CIRCLE 59 ON FREE INFORMATION CARD

Code-A-Phone Telephone Answering Device

Affordable Time/Day TAD

Code-A-Phone's (16261 S.E. 130th, Clackamas, OR 97015) *Model 1630* is a low-priced relation to the company's 900-series telephone-answering devices that provides the user with an economical time-and-day message-stamping system. As each incoming message is recorded, a voice provided by the machine notes on the message tape the time and date that the message was received. For added convenience the device can be used as a talking clock when it is not otherwise occupied. The system includes "one-touch" message playback, which plays messages and resets the unit to receive new messages with the press of a single button. Additional functions include call screening and announcement, message protection from power surges and outages, and the ability to respond to six remote commands. Price: Under $70.

CIRCLE 60 ON FREE INFORMATION CARD

Emerson Personal Stereo

Personal Stereo

Emerson Radio Corporation (One Emerson Lane, North Bergen, NJ 07047) has introduced a new personal portable stereo unit. The model *AC2112* has an AM/FM/FM-stereo receiver together with an auto-reverse stereo cassette player. The tape transport features an auto-stop mechanism that comes into action when the end of a tape is reached and has a switch to reverse the direction of play. A three-band graphic equalizer allows you to tailor the quality of the sound reproduced by the lightweight headphones that are included with the player. Price: $54.95.

CIRCLE 61 ON FREE INFORMATION CARD

For more information on any product in this section, circle the appropriate number on the Free Information Card.

ELECTRONICS WISH LIST

Personal Robot

Newton can work as a home manager, a roving security guard, a monitor, a tutor, a storyteller, or a game-player. He's a robot. Standing 32 inches tall and powered by a rechargeable maintenance-free battery, Newton, a product of *SynPet* (7225 Franklin Road, Dept. P, Boise, ID 83709), has a friendly, colorful appearance with a rotating head and textured, easy-to-clean polyethylene outer shell. Inside are two microcomputers, one of which is IBM PC/XT-compatible, along with a 20-MB hard disk. That extensive "brain" capacity gives the robot the ability to learn by doing, and once he has been directed through an operation, Newton can repeat the task indefinitely. For example, Newton can learn his environment by mapping and memorizing floor plans, and can then move about without human supervision. In addition to speech-recognition and -synthesis devices, the robot also carries within it a cordless phone and 300-baud modem. Besides being able to take messages, Newton can respond to phoned-in requests for status reports of a home or building, including environmental and security conditions. He can also make programmed calls to any number—doctor, fire, relative, etc.—either upon receiving a voice command to do so or when a schedule or environmental conditions so dictate. Through his modem, Newton can gather all kinds of information from on-line databases, making it possible for him to answer complex questions on many, many subjects. Price: $7995.

CIRCLE 62 ON FREE INFORMATION CARD


SynPet Personal Robot

Home-Surveillance System

The *VC-100S* is a home- or small-business observation system consisting of a black-and-white CCD video camera and monitor from Citizen (2020 Santa Monica Boulevard, Suite 410, Santa Monica, CA 90404). The camera measures only about 3 × 2 × 1 inches, permitting it to be mounted unobtrusively on a wall or ceiling. The CCD camera has an *f*1.8 lens with an electronic auto-iris, and can function at levels of illumination as low as two lux. Its horizontal resolution is greater than 230 lines. The accompanying black-and-white monitor has a 2.9-inch screen and measures approximately 3 × 3.5 × 1 inches. Included with the system are an AC adapter, an AV adapter, mounting brackets, a cable clamp, and 65 feet of cable. Price: $538.

CIRCLE 63 ON FREE INFORMATION CARD

Citizen Video Surveillance System

CB/Weather Radio

Cobra's (6500 W. Cortland St., Chicago, IL 60635) new *Model 18RV* mobile CB radio contains a bonus—a receiver that can be tuned via a front-panel switch to any one of three of the nation's most active National Weather Service information channels operating around 162 MHz. Broadcasts on those channels offer localized weather information 24 hours a day with regional forecasts and summaries as well as weather-related highway and waterway information. Emergency announcements about travel conditions are also transmitted by that service. Coupled with the 40-channel CB radio, the unit provides the user with what Cobra bills as "a complete travel-information center." The Model 18RV also features a front-firing speaker for improved intelligibility, which also makes for easy installation under a car or truck seat as well as custom mounting in dashboards or the overhead instrument panels in off-road and recreational vehicles, pickups, and trucks. Price: $129.95.

CIRCLE 64 ON FREE INFORMATION CARD


Cobra CB/Weather Radio

Little Disks

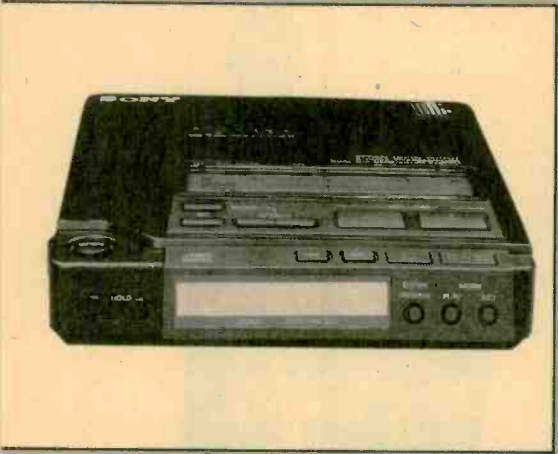
Anticipating a new wave of laptop computers, *Fuji* (555 Taxter Road, Elmsford, NY 10523) has developed a *two-inch floppy disk* with a storage capacity exceeding one megabyte. The little disk, which is housed in a rigid plastic shell with a sliding metal shutter, achieves its high capacity through the use of proprietary magnetic metal particles with high coercivity, high output, and stable magnetic characteristics. Fuji expects that, in addition to finding a niche in the laptop market, these disks will find application in such products as multi-function telephones, multi-function facsimile machines, automotive-navigation systems, and electronic musical instruments. Price: Unavailable.

CIRCLE 65 ON FREE INFORMATION CARD

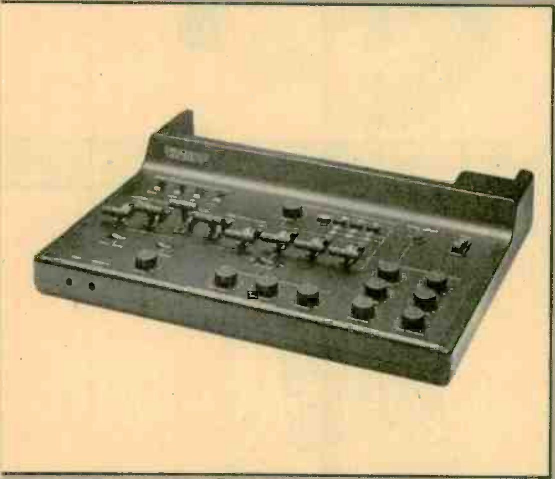
Fuji Diskette

ELECTRONICS WISH LIST

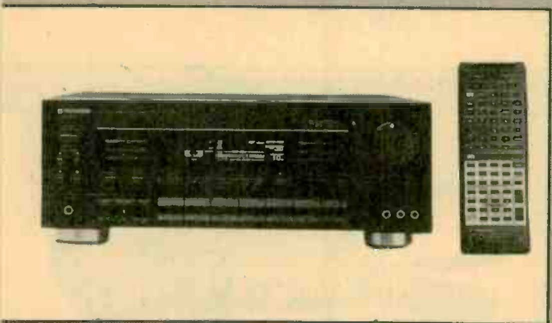
For more information on any product in this section, circle the appropriate number on the Free Information Card.



Sony Portable CD Player



Vivanco Audio/Video Processor



Pioneer A/V Control Center

Kenwood Autosound System

Portable CD Player

Its new *D-555* portable CD player, says Sony (One Sony Drive, Park Ridge, NJ 07656), achieves what is perhaps the most musically accurate performance available from a portable CD player today. The unit, which runs for about two-and-a-half hours on a single charge of its rechargeable battery, utilizes an 8× oversampling digital filter and noise-shaping circuitry, as well as dual D-to-A converters. A special feature of the D-555 is its use of DSP, or Digital Signal Pocessing. DSP provides a bass-boost capability of up to 20 dB, ±10 dB of equalization at five frequency points, and even a version of surround sound that requires only the two earphone elements (or other transducers such as speakers, if they are employed) normally used. The digital system also provides dynamic-range compression for listening to music under high ambient-noise conditions. Wired and wireless remote controls are available as options. Price: $449.95.

CIRCLE 66 ON FREE INFORMATION CARD

Audio/Video Processor

"Don't just copy your videotapes. Improve them." That's what the brochure describing *Vivanco's* (1776 New Highway, P.O. Drawer U, Farmingdale, NY 11735) audio/video processors says. Judging from the claims for the top of the line *Model 4044* audio/video processor, there are all sorts of improvements you can make. You can, for example, make corrections in areas such as sharpness, contrast, signal-to-noise ratio, color balance and saturation, and luminance (brightness) when copying from one tape to another. The 4044 also allows you to make independent audio and video fades; add narration or mix sound effects; and produce adjustable special-effects circles, boxes, split screens, and color. A side-by-side feature allows you to view corrected and uncorrected video together for comparison. The 4044's 5-MHz bandwidth provides a resolution of 400 lines. The unit is supplied with an operator's manual, video-control planning charts, and a VHS-format instructional videotape. Price: $1335.

CIRCLE 67 ON FREE INFORMATION CARD

Audio/Video Control Center

An integrated audio/video amplifier from *Pioneer* (2265 E. 220th Street, P.O. Box 1720, Long Beach, CA 90801-1720), the *VSA-1000*, features Dolby Pro-Logic surround sound with digital delay, sound-field memory, and multi-room capability. The unit has six audio and seven video inputs and pre-out/power-in jacks to accommodate additional components. A five-channel amplifier provides a continuous output of 100-watts-per-channel into eight ohms for the two front channels, and 30 watts-per-channel into six ohms for the two rear and the front-center channels. The built-in sound-field processor provides four surround modes: Dolby Pro-Logic, stadium surround (simulates outdoor ambience), a concert-hall ambience mode, and "studio surround" that is suitable for chamber music or vocals. Also available is a simulated stereo mode. Five surround settings, which can include delay times and front- and rear-channel levels, can be preset and recalled instantly. Remote control is available through a "smart" handheld unit. Price: $1000.

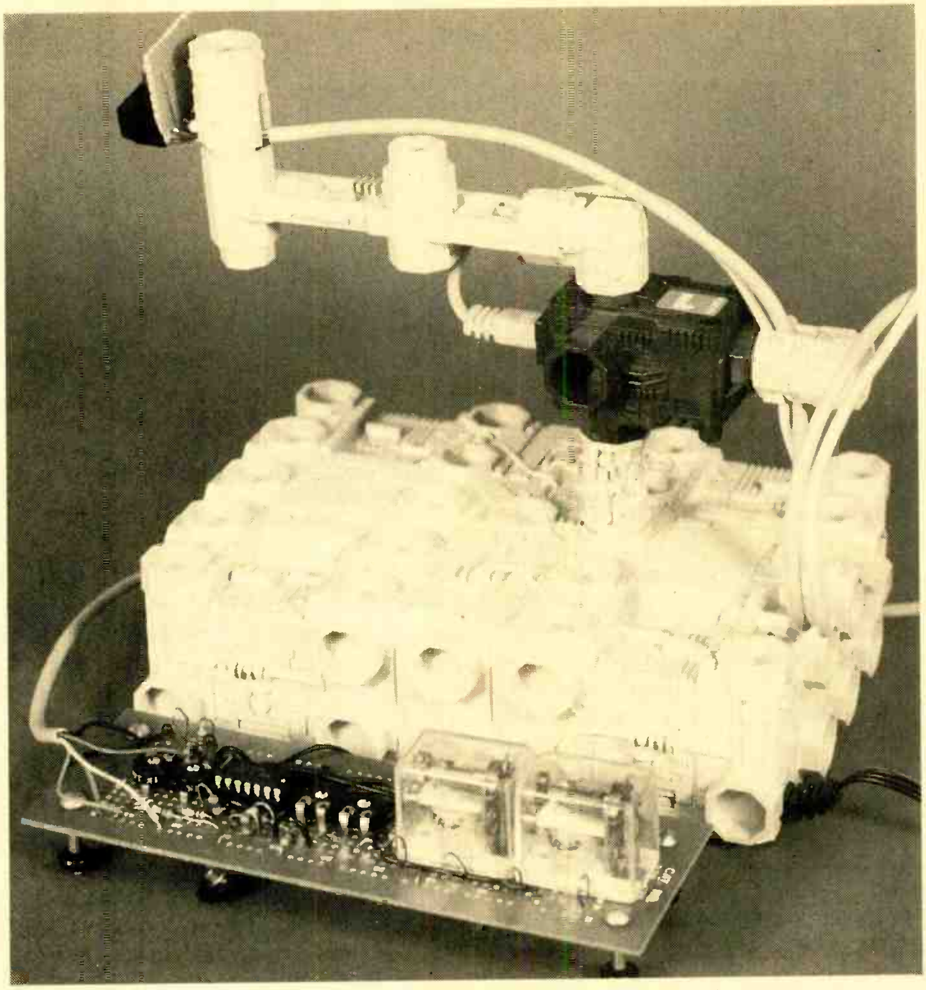
CIRCLE 68 ON FREE INFORMATION CARD

Flexible Autosound System

Besides providing an AM/FM tuner and cassette deck, *Kenwood Electronics'* (2201 E. Dominguez St., Long Beach, CA 90810) *KRC-878/KDC-C200* autosound combination includes a 10-disc CD changer that allows direct access to any selection on any disc at the touch of a button. A 10-key numeric input pad on the KRC-878 allows you to address any radio frequency directly, to program up to 20 compact-disc selections, or to access a particular CD or CD track at will. From the front panel of the unit you can also command random play, track repeat, track scan, music search, manual search, and disc search. The companion KDC-C200 multiple-play CD player can be installed vertically or horizontally anywhere in a vehicle. A high-rigidity mechanism uses a special anti-vibration insulation system to maintain laser-pickup accuracy even under severe highway conditions. The KRC-878 head unit is designed for simple removal and replacement to help foil thefts. Price: $699 (KRC-858), $749 (KDC-C200).

CIRCLE 69 ON FREE INFORMATION CARD

Now you can give the gift of sight to your otherwise blind robotic toys



A Vision System for Robotic Toys

BY
MICHAEL HUGHES

Ever since robots were first invented, they have fascinated us with their ability to mimic our own behavior. The wide selection of robotic toys on the market (not to mention my eleven year old son's room) is a testament to that long-standing love affair. Many of the toys on the market are controlled through radio or hard-wired remote controls, while others move independently with "bump and turn" navigation.

This article describes an inexpensive and easy to build project that will let you equip any robotic toy with that seemingly most-human attribute: vision. The circuit allows your robot to detect and track any bright light source such as a flashlight. The circuit can even be used as a controller to keep solar panels pointed directly at the sun.

Circuit Description. The circuit relies on two light-dependent resistors to form a simple sensor array that's used to detect relative light intensity along a single axis, such as left/right or up/down. Figure 1 shows a block diagram of the circuit. The central component is an LM324 quad op-amp, which contains amplifiers A–D. Amplifier A is configured as a differential amplifier whose output is proportional to the difference in light intensity between light-dependent resistors R1 and R2.

Furthermore, the polarity of the output indicates which sensor is exposed to the greater amount of light. That output is amplified by op-amp B and fed into a "window-comparator" circuit formed by op-amps C and D. The window comparator does two things: First, it closes a set of normally-open contacts for either Output 1 or Output 2 based upon which light-dependent resistor is exposed to more light. The output contacts are connected to the robot's drive motor or motors to enable it to target on the light source.

Second, that circuit establishes a range or "window" within which neither set of contacts is closed. That keeps the robot from "chattering" back and forth between the two outputs when the sensors are near equilibrium.

Circuit Operation. Refer to the schematic shown in Fig. 2 for a more detailed description of circuit operation. Light-dependent resistors R1 and R2 are each connected in their own voltage-divider networks (R1/R3/R4 and R2/R5/R6) with trimmer potentiometers R3 and R5 used to balance the sensors. Let's assume that the light source is on the R1 side of the sensor array. That makes the resistance of R1 lower than that of R2, and hence the voltage at U1-a's non-inverting input at pin 3 more positive than the voltage at pin 2. That results in a positive output at pin 1. The greater the contrast is between R1 and R2, the greater the output is at pin 1.

If the light source were on the R2 side of the sensor array, then the voltage at

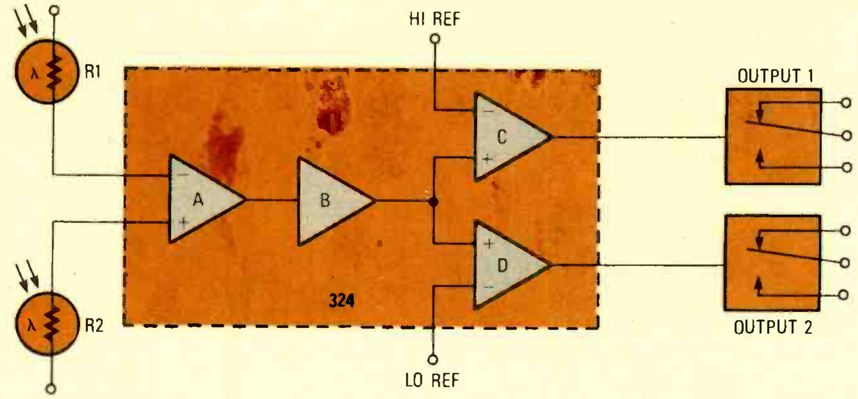


Fig. 1. The central component in the Robotic Vision System is an LM324 quad op-amp, which constitutes most of the control circuitry. One op-amp (A) is configured as a differential amplifier: the B op-amp is set-up as a gain block; and the C and D op-amps form a window comparator.

pin 2, the inverting input of U1-a, would have been more positive, making the output at pin 1 negative. Therefore, the differential amplifier both detects where the light source is and provides a measure of contrast, *i.e.* whether the light source is a little off center or way off center.

Op-amp U1-b amplifies the output of U1-a by a factor of 10 (R11/R12) and feeds that signal to pins 10 and 12 (the non-inverting inputs) of U1-c and U1-d. Potentiometer R14 provides an adjustable high reference to pin 9 of U1-c and R15 provides an adjustable low reference to pin 13 of U1-d. That configuration is the window comparator and is used to control Q1 and Q2.

For example, if a light is focused on R1, the voltage applied to the non-inverting input of U1-a will be more positive than that applied to its inverting input. That produces a positive output, which is fed to U1-b. Because of the way U1-b is configured, it produces an amplified reproduction of the input (in this case positive) that is applied to the non-inverting inputs of U1-c and U1-d.

If that voltage is more positive than the high reference at pin 9, the output at pin 8 goes high (positive), forward biasing the base of Q1 (a 2N2222 NPN transistor) energizing relay K1. The relay's contacts can be used to energize the robot's motor to rotate toward the R1 side of the array. The positive voltage at pin 12 of U1-d also drives the output at pin 14 high, but that output is coupled to the base of Q2, biasing it off so K2 is not energized.

Conversely, if light is focused on R2, a negative voltage is applied to pins 10 and 12 (via U1-b), reverse-biasing Q1 and (assuming the voltage is more negative than the low reference on pin 13) forward biasing Q2. That turns K1 off, and turns K2 on. The relative settings of trimmer potentiometers R14 and R15 determine the sensitivity of the circuit. A visual indication of the output status of U1-c and U1-d is provided by LED1 and LED2, which can be useful in setting up and troubleshooting the circuit.

Interfacing. Figures 3 and 4 show two interfacing techniques. In my case, I used the one in Fig. 3 to control a one-axis arm built from a robotic kit. The sensor array was rotated by the kit's 3-volt DC motor. The result was an amusing little fellow that we affectionately

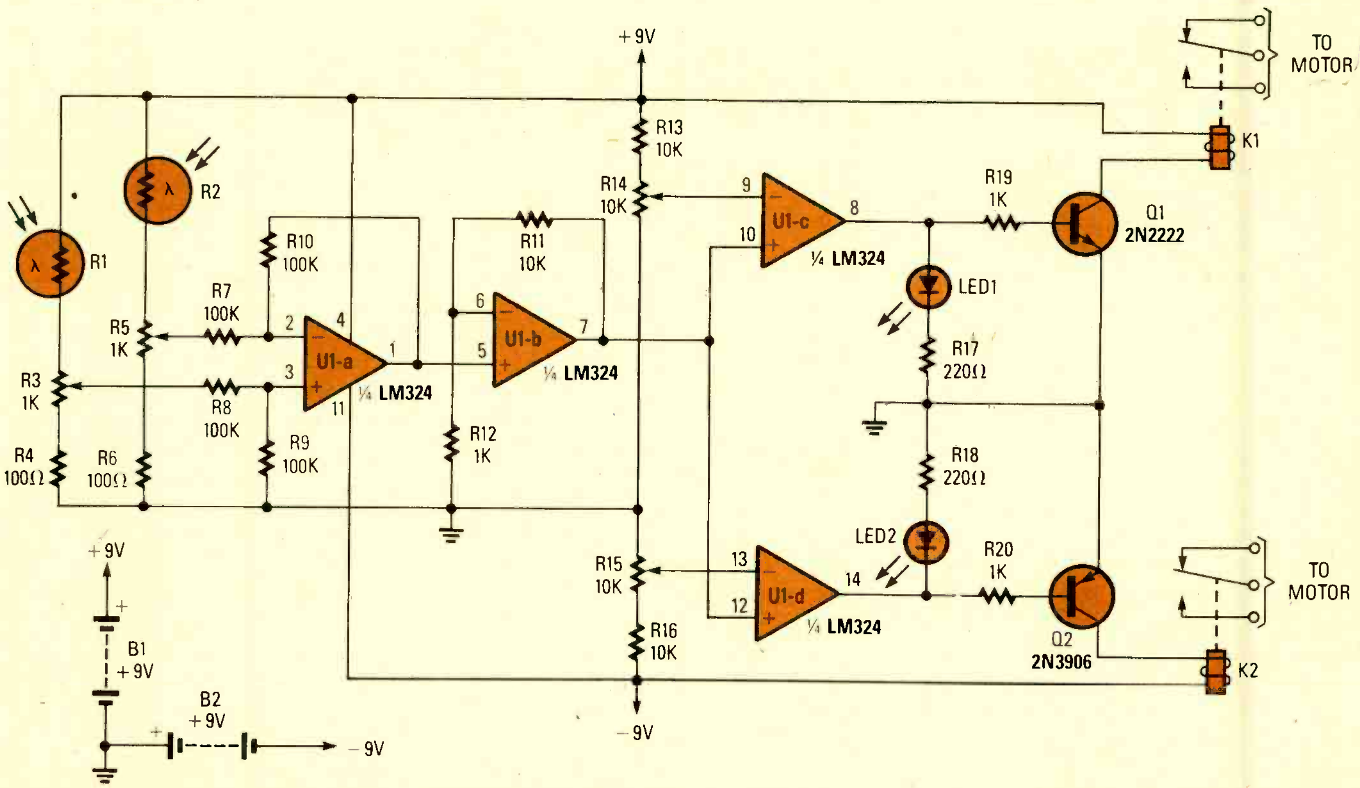
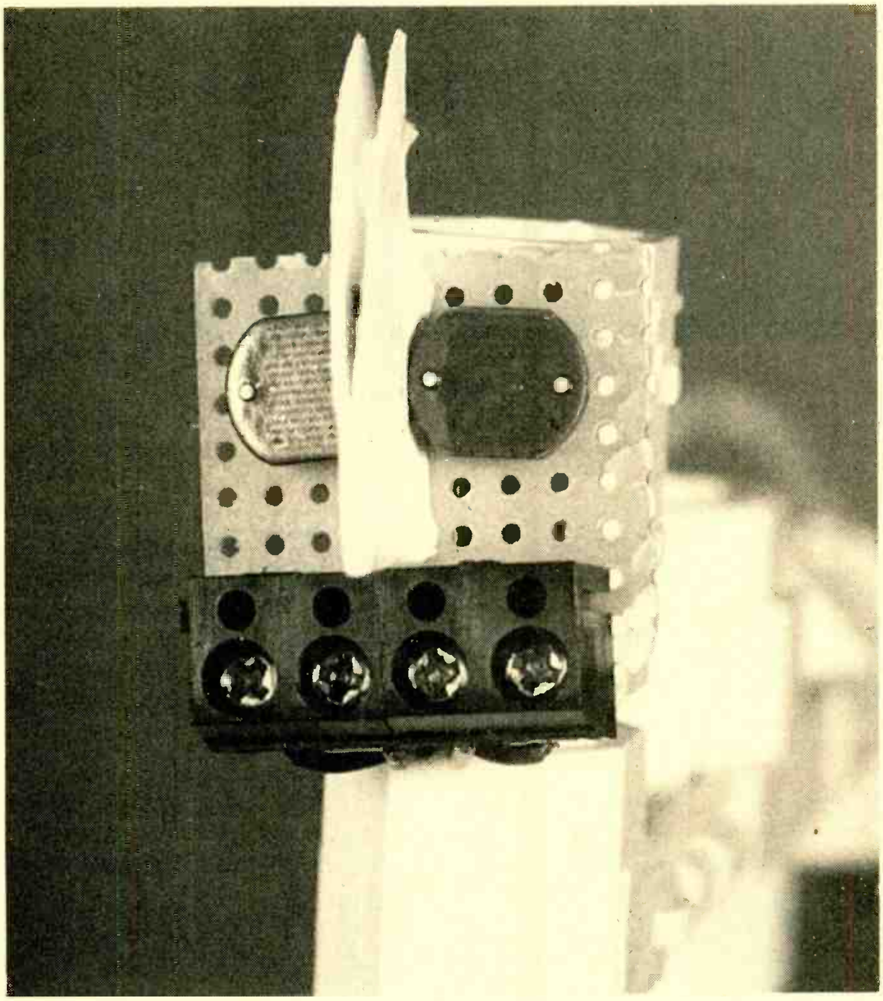


Fig. 2. The Robotic Vision System uses two light-dependent resistors to form a simple sensor array that's used to detect relative light intensity along a single axis, such as left/right or up/down.



The two sensors for the Robotic Vision System are mounted on an arm above the base of the unit, and separated by a small piece of business card. The card keeps the robot from experiencing double vision—e.g., light radiation equally on both sensors simultaneously.

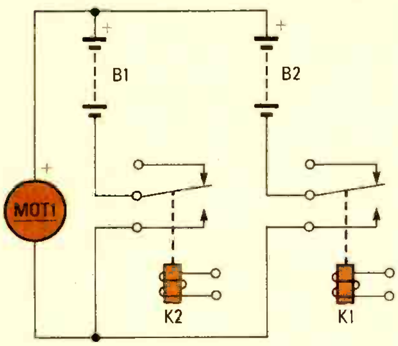


Fig. 3. This circuit was used by the author to control a one-axis arm built from a toy-store-bought robotic kit. The combination was a good one.

refer to as ELMO (short for *E*lectronic *L*ight *MO*nitor).

Even in bright ambient light, Elmo's ability to detect and track a flashlight is impressive. In a darkened room, Elmo is extremely sensitive and accurate. By building a second version of that circuit and fabricating a four-sensor array, a second motor could be controlled to give full two axis tracking (left/right as well as up/down).

Figure 4 shows how K1 and K2 can be used to control two motors as in the case of a tank-style vehicle where each track has its own motor. In that case, the normally closed contacts would be used to keep both motors running when the tank is on target.

If you are only going to temporarily modify a commercially produced toy or kit, the circuit must be "patched in" with clips or the like. Figure 5 illustrates a couple of tips for getting around the "jerry rigger's" nightmares: molded plugs. Although it is easy to clip onto the prongs of a male plug, close tolerances usually cause a short circuit at some point. To eliminate that hassle, use the technique shown in Fig. 5A.

Take some 22-gauge, solid, hook-up wire and strip about ½ inch of the insulation from one end. Wrap the exposed wire tightly around one of the prongs of the plug. Then give the insulated portion about two wraps around both prongs. Do the same thing with a second wire on the second prong, starting right above the insulated portion of the first wire. Those two wires can then be equipped with alligator clips on their free ends.

Figure 5B shows how to patch into a female molded connector. Strip about one inch of insulation from a length of 22-gauge, solid, hook-up wire, and fold the uninsulated section back over itself and secure it with several tight wraps. Leave about a ⅛- to 3⁄16-inch loop in the end. The loop provides spring tension and a mechanical-detent action when it's inserted into the plug. If the wire won't go into the plug, flatten the loop with a pair of pliers. If the wire won't stay in the plug, widen the loop with a small screwdriver.

Construction. The sensor array is easily assembled on a one-inch square section of perfboard. Mount the two light-dependent resistors (R1 and R2) side by side and solder their leads into a terminal block mounted on the same perfboard. Use a piece of cardboard to make a "nose" between the two "eyes." That's necessary to provide a sharp contrast between the two sensors. A business card folded in half and cut to size worked well in that application. Attach a flexible 4-conductor cable to the terminal block and solder it to the control board last.

The control board was assembled on a copper-clad experimenters board (Radio Shack 276-170). In some instances, due to space limitations, it was necessary to vertically mount several resistors; in particular, R10, R11, R12, R17, and R18. Four bare-wire loops were positioned strategically about the relays to provide easy clip-on access to the nor-

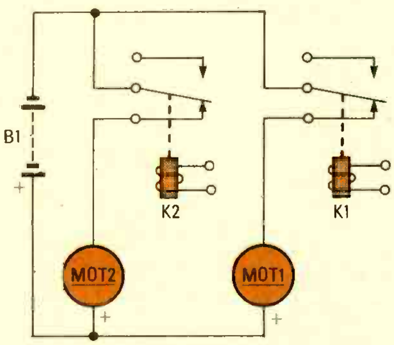


Fig. 4. Relays K1 and K2 can be used to control two motors, as in the case of a tank-style vehicle where each track has its own motor. In that application, the normally-closed contacts of the relay would be used to keep both motors running (and thus both tracks rotating) when the tank is on target.

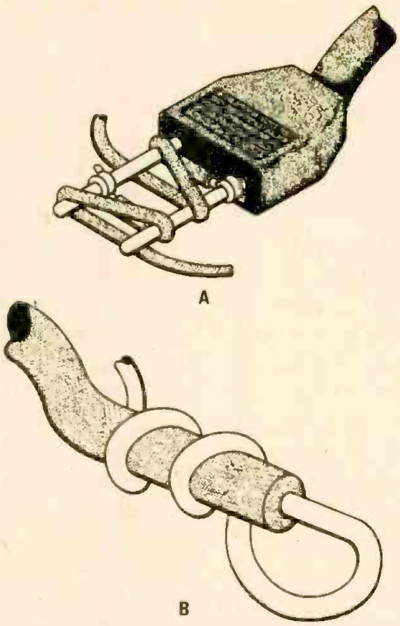
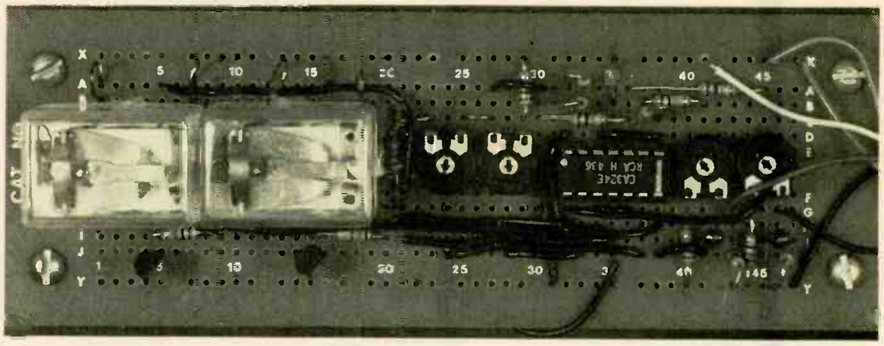


Fig. 5. Although it is easy to clip onto the prongs of a male plug, close tolerances can cause short circuits. To eliminate that problem, 22-gauge, solid, hook-up wire can be wrapped on the prongs of the plug, as shown in "A." The illustration in "B" shows how to patch into a female molded socket.

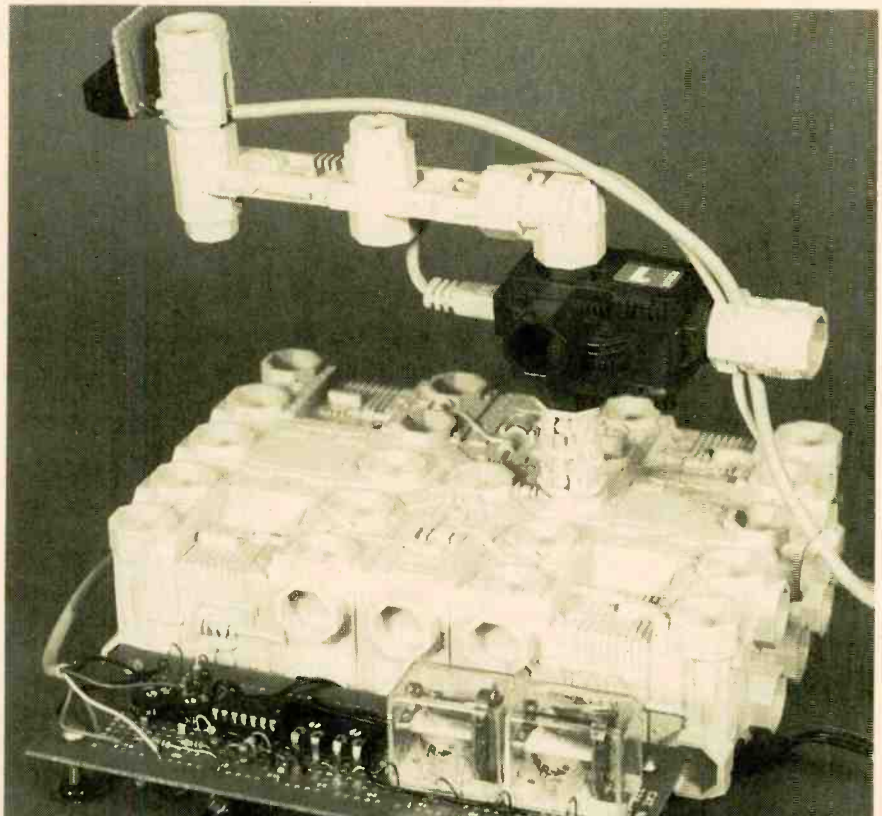


Here is the finshed circuit-board assembly for the Robotic Vision System. If you look closely, you should be able to see four small bare-wire loops just above the two large relays on the left side of the board. Those loops are used to provide easy access to the relays' normally-open contacts.

mally-open contacts of K1 and K2. If the normally-open contacts are to be used, they should be wired in the same fashion.

LED1 and LED2 were each mounted directly below the trimmer potentiometers (R3 and R5) that balance their respective sensors. And op-amp U1 should be socket mounted.

Set-Up. Energize the circuit and check for normal operation using LED1 and



The experimenter's-board-mounted assembly was combined with a robotic kit to test the circuit's operation. The Robotic Vision System can be used with other electronically controlled devices; a tank for instance, where the vision circuit would be used to control the individual tracks of the tank.

PARTS LIST FOR THE ROBOTIC VISION SYSTEM

SEMICONDUCTORS

U1—LM324 quad op-amp, integrated circuit
Q1—2N2222 general-purpose NPN transistor
Q2—2N3906 general-purpose PNP transistor
LED1, LED-2—Jumbo light-emitting diode

RESISTORS

(All resistors are ¼-watt, 5% units, unless otherwise noted.)
R1, R2—Light-dependent resistor (Radio Shack 276-1657, or similar)
R3, R5—1000-ohm PC mount trimmer potentiometer
R4, R6—100-ohm
R7, R8, R9, R10—100,000-ohm
R11, R13, R16—10,000-ohm
R12, R19, R20—1000-ohm
R14, R15—10,000-ohm, PC-mount trimmer potentiometer
R17, R-18—220-ohm

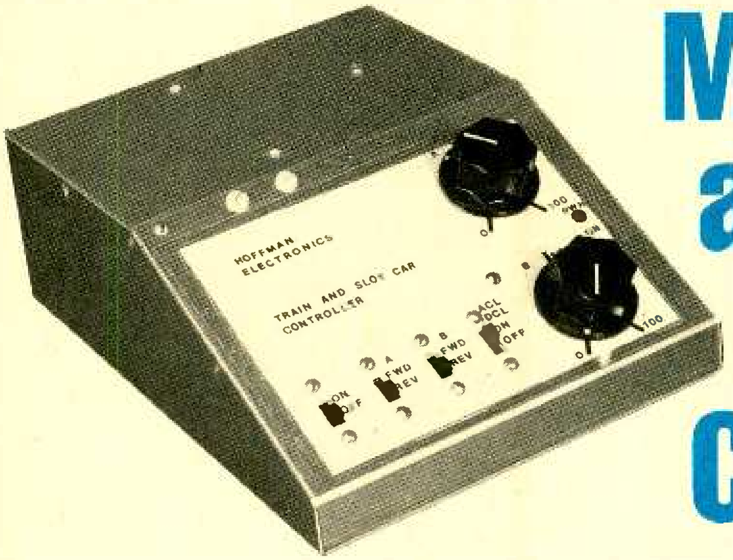
ADDITIONAL PARTS AND MATERIALS

K1, K2—6–9-volt SPDT relay (RS-275-004 or similar)
B1, B2—9-volt transistor-radio battery
Experimenters board, IC socket, 9-volt battery connector, wire, solder, hardware, etc.

LED2 to verify that the controller is working. Interface the robot's motor or motors by clipping onto J1–J4. With the sensor array mounted to the robot, aim a flashlight directly at the array. Adjust R3 and R5 until the robot aims itself directly at the light source. If the robot "chatters" back and forth between the two relays, then broaden the "window" by adjusting R14 and R15.

If the robot won't center on the light source or seems sluggish when the light source moves, then make the "window" narrower. ■

Build a  Model Train and Slot-Car Controller



Here's a controller that gives your model railroad or slot-car setup the realism that makes your hobby enjoyable.

BY RON HOFFMAN

When I was a young boy, my Grandpa who was an engineer for the Baltimore and Ohio Railroad, would show me pictures of Great Locomotives. For years I have looked for a train controller that would allow a train to creep slowly and smoothly, accelerate, and brake gradually like full-size trains; offer instant speed changes to avoid crashes and derailments; be simple to make, and was affordable. Later on I discovered that slot cars need the same kind of power controller, but with two channels.

There are differences of course. Trains need gradual acceleration and braking to provide realistic movement, whereas slot cars require instantaneous speed changes to slow down for sharp curves and resume top speed on the straightaway. By using some inexpensive IC's and a couple of HEXFET output drivers, all of those desirable features (including low cost) have been incorporated into the *Train and Slot-Car Controller.*

How It Works. A schematic diagram for the Train and Slot-Car Controller is shown in Fig. 1. As shown, a 555 timer (U1) is configured as an astable multivibrator (oscillator) with a 400:1 duty cycle and a frequency of 40 Hz. That frequency minimizes headlight flicker and yet allows the motor armature to be pulsed so it can turn over slowly for creeping and slow-speed control.

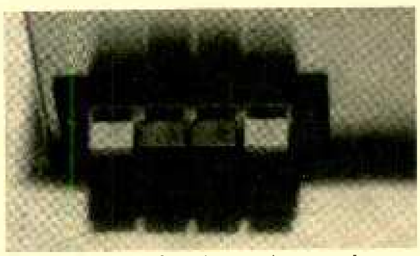
When power is applied to the circuit, capacitor C1 (connected to pin 6 of U1) is discharged and the output of the 555 (which is used to sink current) is low. Capacitor C1 begins to charge via R1 and R2 toward the positive supply rail. When the charge on C1 reaches about two-thirds of +V, the output of U1 at pin 3 goes high.

At that point C1 begins to discharge through R2. When the charge on C1 decreases to about one-third of the supply voltage, the output of U1 returns to the low state, and the cycle is repeated until power is removed from the circuit.

When the output of U1 is low, C3 is discharged into U1 via transistor Q2. When U1 pin 3 goes high, C3 charges through a current source consisting of D1, D2, R3, R4, and Q1. The charge/discharge cycling of C3 produces a stream of pulses that are fed to the inverting inputs of U2-a and U2-b (an LM358 dual op-amp). Two voltage divider networks—consisting of R7, R8, and R9, and R10, R11, R12—set the reference voltage that is applied to the non-inverting inputs of U1-a and U1-b at pins 3 and 5.

Potentiometers R9 and R12 set the low-level duty cycle (5 to 10%) of U1-a and U1-b. They are adjusted so that the train headlights glow, but the motor hums only slightly. Potentiometer R3 adjusts the ramp rate of C3 for 100% duty cycle at the full throttle setting. A double-pole, single-throw switch (S1-a snd S1-b) is used to place R3/C4 and R4/C5 in the circuit.

The R5/C4 and R6/C5 combinations cause the reference voltages presented to the non-inverting inputs to U2-a and U2-b to change very slowly when the throttle is turned up and



The author used spring-action speaker clips for J1–J4.

down. That causes the train to act as if it has to overcome a great inertia when starting or stopping.

When the ACL/DCL switch is turned off, the resistances of the throttle-divider networks are much smaller than those of R5 and R6, so the reference voltages on C4, C5 change "instantly" to the new throttle setting. That helps to avoid crashes and derailments when running trains, and provides for the

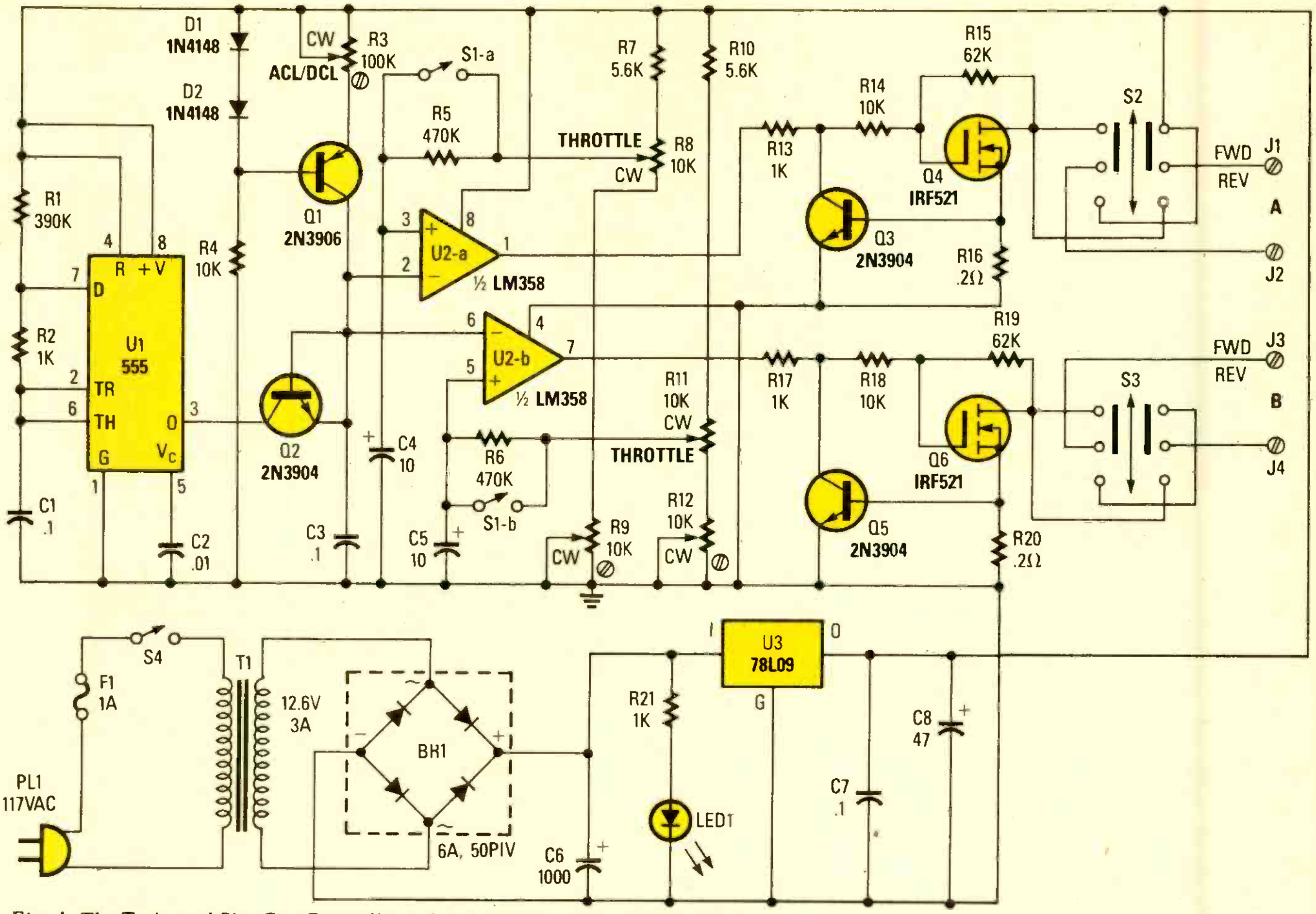


Fig. 1. The Train and Slot Car Controller is built around a 555 oscillator/timer (configured as an astable multivibrator); an LM358 dual comparator, and six transistors (two of which are hexFET's).

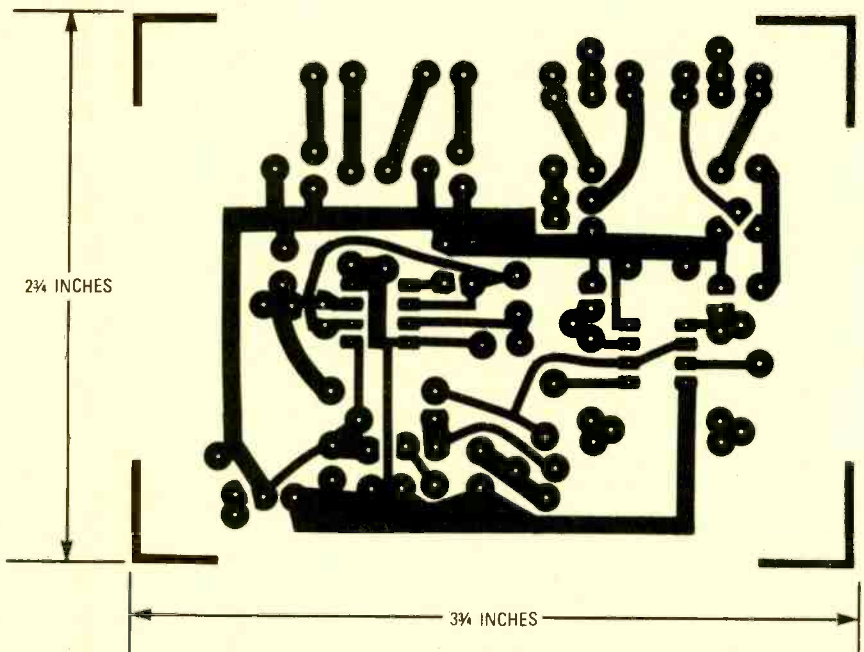


Fig. 2. The author's prototype of the Train and Slot Car Controller can be assembled on printed-circuit board produced from this layout. You can etch your own board or purchase one from the supplier listed in the Parts List.

quick response required to control slot cars going around twisting layouts.

The output drivers consist of resistors R13 to R15, and transistors Q3 and Q4 for output "A;" and resistors R17 to R20, and transistors Q5 and Q6, for output "B."

Components R13/R16/Q3 and R17/R20/Q5 limit the output drive currents of Q4 and Q6 to about three amperes each. Resistors R14/R15 and R18/R19 turn on Q4 and Q5, respectively, before the breakover voltage is reached to prevent damage to the output drivers and dissipate the energy stored in an inductive field such as a motor.

The power supply delivers 18 volts to the track. Voltage regulator U3 (a 78L09 9-volt, 100-mA voltage regulator) supplies power to the control circuits.

Construction. The author's prototype of the Train and Slot-Car Controller was originally assembled on a piece of perforated construction board (perfboard). A printed-circuit layout was then devised for the Train and Slot Car Controller. The printed-circuit layout (with dimensions indicated) is shown in Fig. 2. You can etch your own board or purchase one from the supplier listed in the Parts List.

After you've obtained the printed-circuit board, assembly can begin: Use Fig. 3 as a construction and wiring guide. It is recommended that IC sock-

PARTS LIST FOR THE TRAIN AND SLOT-CAR CONTROLLER

SEMICONDUCTORS

U1—LM555CN oscillator/timer, integrated circuit
U2—LM358N dual op-amp, integrated circuit
U3—AN78L09 9-volt 100-mA voltage-regulator integrated circuit
LED1—Jumbo red light-emitting diode
Q1—2N3906 general-purpose, PNP silicon transistor
Q2, Q3, Q5—2N3904 general-purpose, NPN silicon transistor
Q4, Q6—IRF523-ND (or similar), N-channel hexFET
BR1—6-amp, 50-PIV, full-wave bridge rectifier
D1, D2—1N4148, or similar, general-purpose, small-signal diode

RESISTORS

(All resistors are ¼-watt, 5% units, unless otherwise noted.)
R1—390,000-ohm
R2, R13, R17, R21—1000-ohm
R3—100,000-ohm, linear-taper trimmer potentiometer
R4, R14, R18—10,000-ohm
R5, R6—470,000-ohm
R7, R10—5600-ohm
R8, R11—10,000-ohm, linear-taper potentiometer
R9, R12—10,000-ohm, linear-taper trimmer potentiometer
R15, R19—62,000-ohm
R16, R20—0.2-ohm, 2-watt, metal oxide

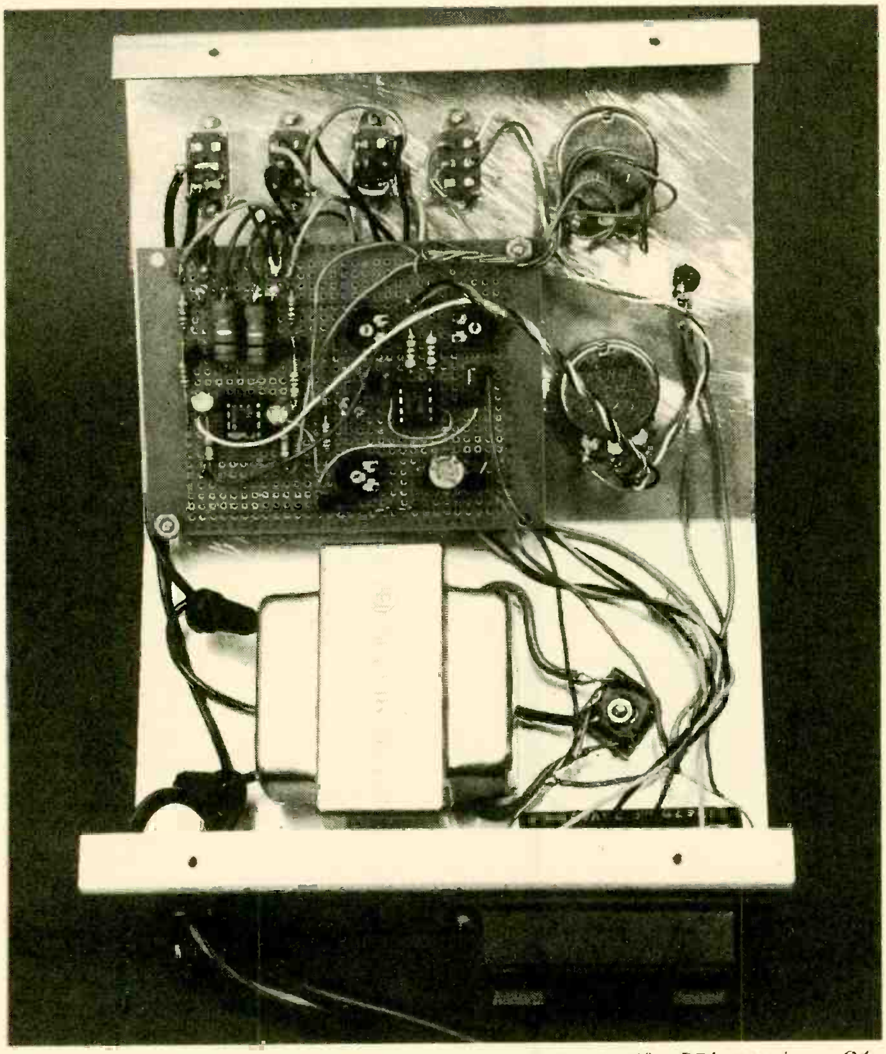
CAPACITORS

C1, C3, C7—0.1-µF, ceramic-disc
C2—.01-µF, ceramic-disc
C4, C5—10-µF, 25-WVDC, electrolytic
C6—1000-µF, 25-WVDC, electrolytic
C8—47-µF, 25-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

S1–S4—DPDT miniature slide or toggle switch
T1—12.6-volt center-tapped 3-amp, power transformer
F1—1-amp slow-blow fuse
J1–4—see text
Printed-circuit or perfboard materials, enclosure, IC sockets, line cord with molded plug, fuse holder, wire, 6-32 × ½-inch nylon screw and nut, etc.

Note: An etched and drilled printed-circuit board is available for $4.95, plus $2.00 shipping and handling from Hoffman Electronics, PO Box 391463, Solon, OH 44139. A complete kit of parts is available, including enclosure, transformer, front panel label, printed-circuit board, control knobs, terminal strip, and all electronic parts for $59.95, plus $4.00 shipping and handling. Ohio residents please add appropriate sales tax. Please allow 6 to 8 weeks for delivery.



In the author's prototype unit, power transformer T1, bridge rectifier BR1, transistors Q4 and Q6 (which are obscured by the circuit board), potentiometers R8, and R11, and switches S1-S4 are mounted to the enclosure.

ets be used for U1 and U2—install the sockets first. Next install the passive components—resistors, capacitors, etc.—followed by the semiconductor devices—diodes, transistors, etc.

Note that Q4 and Q6 are shown in Fig. 3 as being mounted to the printed circuit board; they are actually mounted off-board to the project's metal enclosure, thereby allowing the enclosure to serve as a heat sink. When mounting those units, isolate them from the metal enclosure with mica insulators, and secure them in place with nylon screws and nuts.

Once that's done, begin wiring the off-board components to the appropriate donut pads using lengths of hook-up wire. The author used spring-loaded speaker terminals for jacks J1 through J4; but any desirable or available connector can easily be substituted. The power-supply components for the circuit (excluding the 9-volt regulator) were mounted to the metal enclosure that houses the circuit, and hard-wired to the board-mounted components. You can do the same by assembling the power supply according to the power-supply section of the schematic shown in Fig. 1 (just remember that U3 is a board-mounted component).

Once the printed-board assembly has been completed, and the off-board components have been wired to the board, check your work for the usual construction errors—cold solder

(Continued on page 110)

THE SIMPLEST MICROPHONE PREAMP

BY MICHAEL A. COVINGTON

You can actually build a high impedence microphone preamplifier in less than half an hour; and you can do it with only two parts!

Would you believe you could build a microphone preamplifier (or preamp) from only two components, possibly three at the most if you don't mind erring on the side of caution? No, this is not done with some expensive or exotic new IC, but with a good-old field-effect transistor, or FET for short.

The secret is to recognize which parts you would find in a conventional FET amplifier (see Fig. 1) that can be left out of a microphone preamp. In the typical amplifier of Fig. 1, R_g provides a DC path from the gate of Q1 to ground, and C_g blocks any DC that may be applied to the input. If the input is a dynamic microphone, we can leave both of those components out, since the microphone itself conducts DC but doesn't generate any.

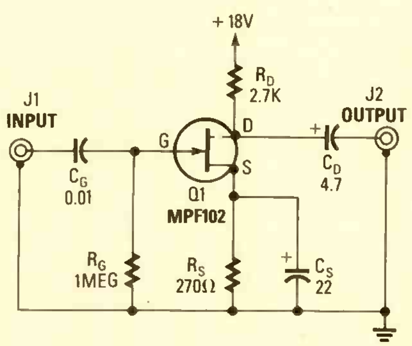


Fig. 1. This is a conventional FET audio amplifier. Many parts can be left out if its input is a dynamic microphone.

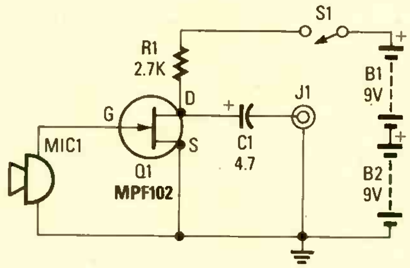


Fig. 2. This preamplifier amplifies any incoming audio signal by 10 to 20 dB. Note that C1 can be eliminated if the following stage has a capacitor at its input.

PARTS LIST FOR THE MICROPHONE PREAMP

Q1—MPF102 or other general-purpose N-channel JFET
C1—4.7-µF, 25-WVDC electrolytic capacitor
R1—2700-ohm, ¼-watt resistor
S1—SPST switch
B1, B2—9-volt transistor-radio battery

The two other resistors, and C_s, form a biasing network. They are necessary because the source voltage should normally be higher (more positive) than the gate voltage. Resistor R_s, therefore, holds the source at about +3 volts when the gate is at 0 volts. Capacitor C_s directs any AC that is present at the source to ground.

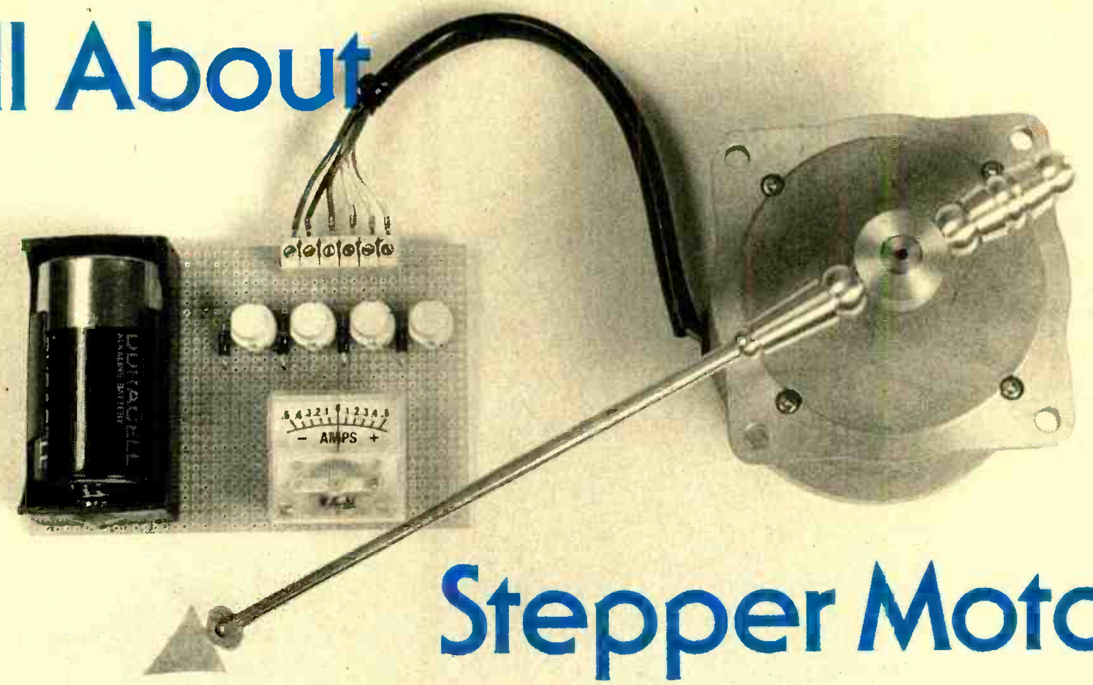
Less is More. However FET's do not always have to be biased. The gate and source voltages can be equal if the input signal swings less than 0.5 volt above ground. Since the output of a microphone is about 0.002 volt peak-to-peak, it's okay to set the gate and source voltages equal. To do that we eliminate R_s and C_s.

That leaves R_d, which is indispensable, and C_d, which can be left out if the the next stage has a capacitor built into its input. The resulting circuit is shown in Fig. 2. As you can see, two 9-volt batteries provide power; a single 9-volt or 12-volt supply will work almost as well. Capacitor C1 takes the place of coupling capacitor C_d, and might not be needed for some applications, as mentioned. Resistor R1 takes the place of the drain resistor, R_d.

Though an MPF102 JFET is specified, any general-purpose N-channel JFET can be used. In fact, because of widespread variations in manufacturing, it may be best to buy several JFET's of the same type and use the one that gives the greatest gain. Be sure to build the circuit in a shielded enclosure to avoid picking up hum.

Don't expect tremendous gain. By itself, the preamp will not take a microphone signal up to line level (500 mV). But it may be just what you need to make up the difference between one microphone and another, or to experiment with using speakers as microphones. ■

All About Stepper Motors



Ever wondered how stepper motors work? Here's a practical run-down on those useful devices.

BY STEVE PAYOR

Most semiconductor manufacturers produce a range of power IC's for driving stepper motors. The data sheets for those IC's cover the driving requirements for stepper motors quite well, but the purpose of this article is to provide some practical experience with stepper motors themselves.

With our simple test circuit, you can demonstrate half-step and full-step drive modes, and regenerative braking. To do all that, you will only need to wire-up 4 pushbuttons, 4 diodes, and a 1.5-volt dry cell.

Figure 1 shows a "conceptual" model of a typical 4-phase stepper motor. (They are not actually built that way, but the illustration makes the operation easier to visualize.) The rotor can be thought of as a permanent magnet that aligns itself with any applied magnetic field.

By energizing one winding at a time, the rotor can be made to move to any one of four positions, 90° apart (Fig. 1A). By energizing two adjacent phases simultaneously, the rotor can be positioned in another four orientations, midway between the first four (see Fig. 1B). The latter driving scheme is more commonly used, since the torque is greater when two windings are energized.

By alternating between the two driving schemes, it is possible to obtain twice as many steps per revolution—that is known as the "half-step" mode. We'll have more to say about that later.

A typical stepper motor has a step angle of 1.8°, so if you can imagine a rotor with 50 poles, and the coils of the stator duplicated 50 times around the circumference of the rotor, you'll have a pretty fair idea of how it works.

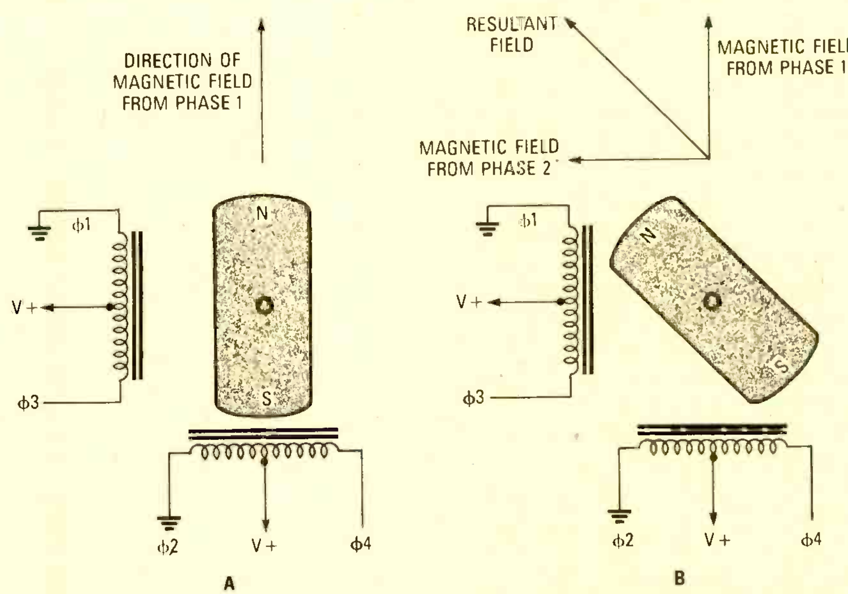


Fig. 1. This is a simplified representation of a 4-phase stepper motor. When φ1 is energized, the rotor aligns itself as shown in A. When φ1 and φ2 are energized, the rotor moves to the position shown in B.

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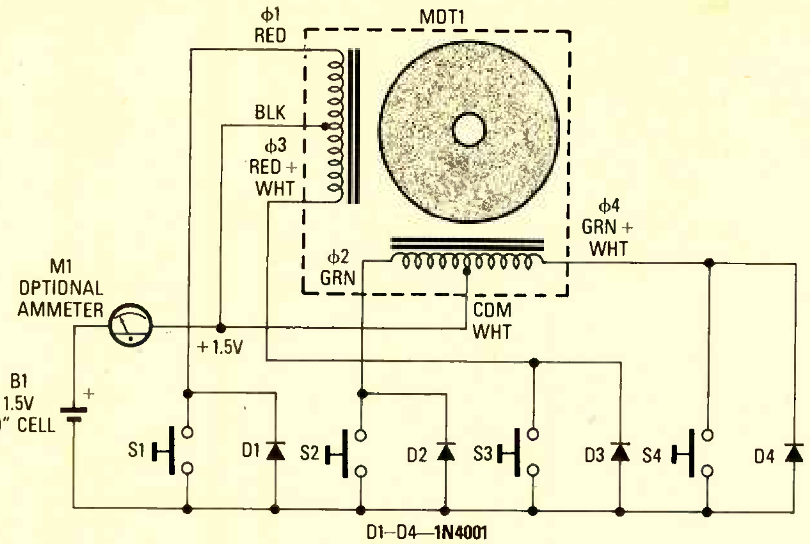


FULL STEPS—ONE WINDING ENERGIZED

ϕ1	ϕ2	ϕ3	ϕ4
ON	—	—	—
—	ON	—	—
—	—	ON	—
—	—	—	ON

FULL STEPS—TWO WINDINGS ENERGIZED

ϕ1	ϕ2	ϕ3	ϕ4
ON	ON	—	—
—	ON	ON	—
—	—	ON	ON
ON	—	—	ON

HALF STEP SEQUENCE

ϕ1	ϕ2	ϕ3	ϕ4
ON	—	—	—
ON	ON	—	—
—	ON	—	—
—	ON	ON	—
—	—	ON	—
—	—	ON	ON
—	—	—	ON
ON	—	—	ON

Fig. 2. This simple demonstration circuit will allow you to take almost any stepper motor for a "test drive." In addition to the stepper motor, it uses just four pushbutton switches, four diodes, a meter and a 1.5-volt battery. The accompanying tables show the step sequences.

By the way, the term "4-phase" stepper motor is really a misnomer. It is actually a 2-phase motor to a power engineer. Yes, it does have four coils, but energizing ϕ3 or ϕ4 is no different than energizing ϕ1 or ϕ2 with the current reversed. Having four windings just simplifies the drive circuitry, since only four SPST switches to ground are needed. The switches are usually just NPN power transistors.

However, only half of the windings can be active at any one time, so large, high-power stepper motors usually dispense with the center-tapped windings and use a single heavy-duty winding for ϕ1 and ϕ3, and ditto for ϕ2 and ϕ4. The drive circuitry must now be capable of reversing the current through the windings so two double-pole double-throw switches, each containing four power transistors, are required.

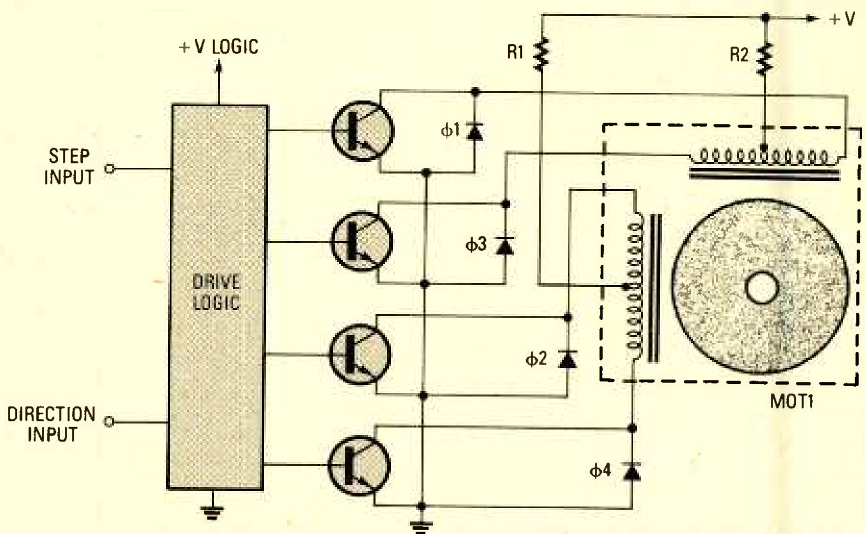


Fig. 3. A typical stepper motor drive circuit. The NPN transistors and their associated clamping diodes are usually incorporated in a "power-pack" IC, along with the necessary logic to generate a 4-phase drive sequence from a series of input "step" pulses.

Demonstration Circuit. Enough of the theory, the best way to learn is by doing, so if you have a stepper motor lying around somewhere, dust it off and wire up the simple demonstration circuit of Fig. 2.

A 1.5-volt "D" cell will provide enough current to demonstrate the torque capabilities of the motor. Four pushbutton switches enable you to drive the motor manually through "full step" or "half-step" sequences.

Diodes D1–D4 prevent sparking at the switch contacts, and actually return the stored inductive energy back to the battery. For example, assume that the ϕ1 switch is closed and a current of 300 mA is flowing from the battery and through the ϕ1 winding to ground. The instant the switch is opened, a current of −300mA flows through the ϕ3 winding via D3.

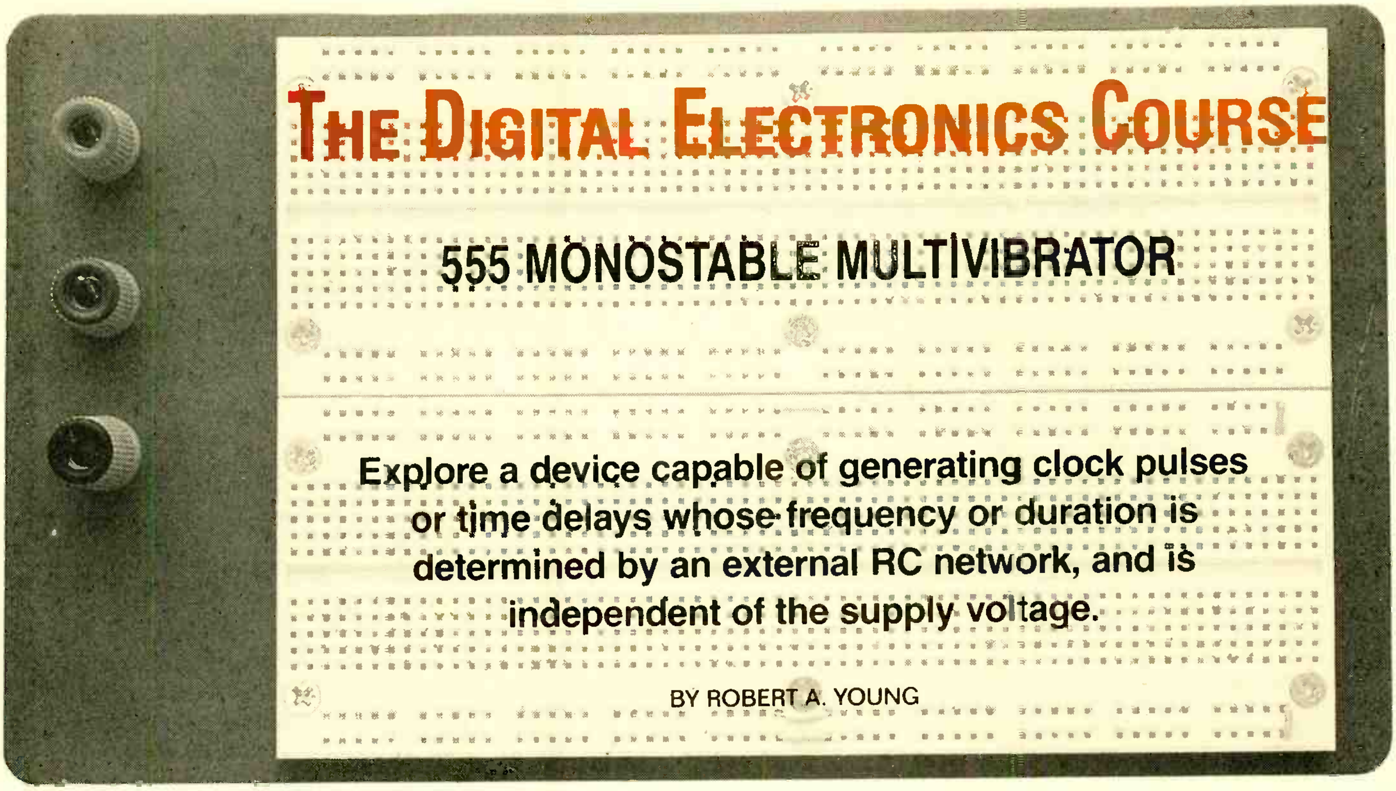
The direction of the current is back towards the battery. The current rapidly drops to zero and the stored energy is returned to the power supply. During this period, the voltage across the open-circuit ϕ2 switch is twice the supply voltage (neglecting diode drops). Remember that when selecting transistors for unipolar drive circuits.

The tables in Fig. 2 show the required button presses to move the stepper motor in a clockwise direction, in either full-step or half-step modes. Reversing is easy—just "walk" your fingers backwards across the buttons.

At this stage, it's a good idea to attach some sort of lever securely to the motor shaft so that you can check out the torque characteristics. Notice that the holding torque is much greater than the "working torque" (the torque developed when moving on to the next phase).

Most stepper motors will develop an impressive torque with only 1.5 volts applied to the windings. The maximum rated continuous DC voltage is usually only 5 volts. Why, then, do some drive

(Continued on page 98)



The Digital Electronics Course

555 MONOSTABLE MULTIVIBRATOR

Explore a device capable of generating clock pulses or time delays whose frequency or duration is determined by an external RC network, and is independent of the supply voltage.

BY ROBERT A. YOUNG

The 555 oscillator/timer has been somewhat of a popular marvel since its development. With a timing cycle that is independent of the supply voltage—ranging between 4 and 16 volts—the 555 is a highly stable clocking device, capable of producing accurate timing pulses. In addition, the device can source or sink up to 100 mA of current.

About the 555. A block pinout diagram of the 555 oscillator/timer is shown in Fig. 1. The 555 integrated timer is made up of several transistor stages, part of which form two comparators—the upper- and lower-threshold comparators—a control RS flip-flop, an output-amplifier stage, and a voltage reference. The key to its operation is its internally set upper- and lower-threshold limits. The 555's upper- and lower-threshold voltages are internally set at ⅔ and ⅓ of the supply voltage by a resistive voltage-divider network.

The 555 can be used in many applications: interval or event timing, pulse generation and shaping, or clock-pulse generation. As an interval or event timer, the 555 would be operated in its monostable mode and used to either control the time interval between events or the duration of an event. Pulse generation and shaping might involve anything: creating time delays, pulse blanking, pulse-width modulation, pulse-position modulation, or even pulse stretching.

In the clock-pulse generation mode of operation, the 555 might be used to provide a clocking signal at some fixed frequency up to 300 kHz.

Our gratitude is extended to the EIA/CEG for the creation of this course, especially to the consultants who brought it to fruition: Dr. William Mast, Appalachian State University; Mr. Joseph Sloop, Surry Community College; Dr. Elmer Poe, Eastern Kentucky University.

Monostable Multivibrator. In the monostable mode of operation, the 555's THRESHOLD and DISCHARGE terminals (pins 6 and 7) are tied together and connected to the junction between a resistor and a capacitor that form an RC network. The RC network determines the output duration of the one-shot.

Figure 2 shows a 555 configured as a one shot. When a timing cycle is initiated, by momentarily bringing pin 2 low, the output of the 555 at pin 3 goes high, and remains high for a period determined by the RC circuit connected at pins 6 and 7. The timing cycle can be aborted by momentarily applying a low to pin 4.

When power is applied to the circuit, the output of the 555 is low, and the capacitor in the RC network is held discharged via pin 7 of the 555. When a timing cycle is initiated by bringing pin 2 (TRIGGER) low, C1 begins to charge exponentially (through R1) toward the supply voltage. When the charge across C1 reaches ⅔ of the supply voltage, the output of the 555 goes low once more. That places a short across C1, causing it to discharge, completing one cycle.

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The timing interval is independent of the supply voltage because the charge on C1, and thus the voltage presented to the threshold input of the 555 at pin 6, are both directly proportional to the supply voltage. The period of the timing interval (T) is given by:

$$T = 1.1 \times R1 \times C1$$

If R1 is set at 1 megohm and C1 is 1 microfarad (μF), the output period of the 555 would be:

$$T = 1.1 \times 1{,}000{,}000 \times .000{,}001 = 1.1 \text{ seconds}$$

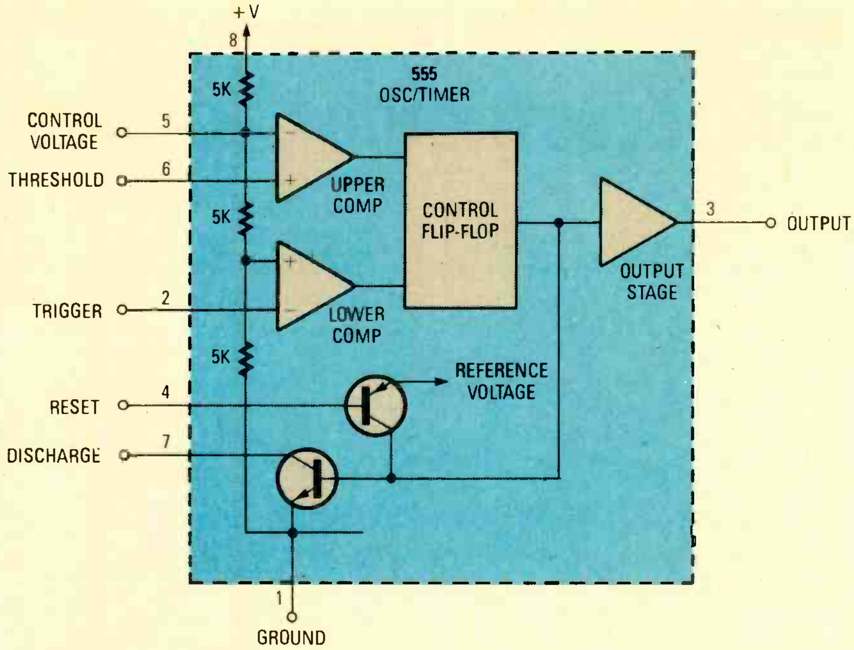


Fig. 1. Here is a block diagram of the insides of the popular 555 oscillator/timer, which is made up of several transistor stages that constitute the upper- and lower-threshold comparators, a control RS flip-flop, and an output-amplifier stage. The upper and lower limits of the comparators are internally set at ⅔ and ⅓ of the supply voltage by a resistive voltage-divider network.

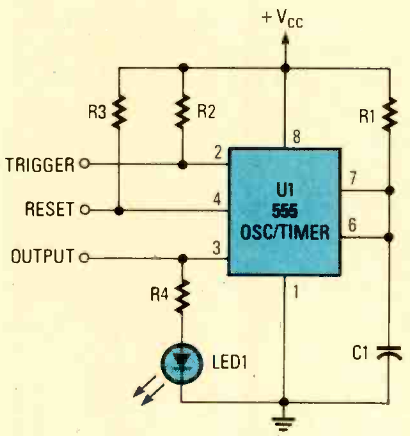


Fig. 2. In the monostable mode of operation, the 555's THRESHOLD *and* DISCHARGE *terminals (pins 6 and 7) are tied together and connected to a resistor-capacitor network that determines the output duration.*

Values for C1 can range from .001 to 100 µF; R1 can be any value between 1000 ohms (1k) and 10 megohms. Capacitor C1 should always be a low leakage unit to ensure timing accuracy.

When the output of the 555 is high, the application of an additional trigger pulse to pin 2 has no affect. However, the output timing cycle can be aborted (cut short) by the application of a negative-going pulse to pin 4 (RESET). That causes the 555's internal flip-flop to be reset, forcing the 555's output low.

A Different Kind of One-Shot. Figure 3 shows a 555 monostable with an auxiliary output. During the quiescent state, the output of that circuit is low and C1 (which is effectively in parallel with R1) is held discharged. When the circuit is triggered by a negative-going pulse at pin 2, the output of the 555 goes high, and C1 begins to charge through R1.

When the voltage across C1 reaches the upper threshold level, the output goes low. That causes C1 to discharge

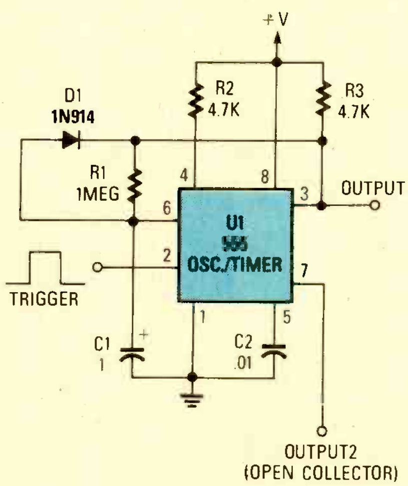


Fig. 3. Here the 555 is configured as a monostable with an auxiliary output. The period of time required for C1 to completely discharge is longer than in a conventional monostable circuit.

PARTS LIST FOR THE MONOSTABLE EXERCISE

U1—555 oscillator/timer, integrated circuit
LED1—Jumbo light-emitting diode
R1—1-megohm, ¼-watt, 5% resistor
R2, R3—10,000-ohm, ¼-watt, 5% resistor
R4—270-ohm, ¼-watt, 5% resistor
C1—10-µF, 15-WVDC, electrolytic capacitor
Breadboard, 5-volt power source, jumper wire, etc.

through D1 initially, until the voltage decreases to between 0.6 and 0.7 volt (the approximate voltage drop across a silicon diode). At that point, C1 discharges the remainder of its charge more slowly through R1.

The period of time required for C1 to completely discharge is longer than in the conventional monostable circuit (the major drawback of such a circuit), and can cause timing errors and/or pulse-width changes if retriggered just after a completed output pulse.

The circuit can be enabled by the application of a positive-going voltage (or pulse) at pin 4, or inhibited by a low voltage level. If a negative-going pulse is applied to the reset input of the 555, the timing cycle terminates or resets the output prior to the normal finish of the cycle.

Still in the Family. One very common task when designing electronic systems is to interface switch contacts with circuitry. Because typical switch bounce and/or noise can generate multiple or sporadic outputs, an interface circuit (commonly referred to as a "switch debouncer") is often used to eliminate those problems.

In the one-shot circuit shown in Fig. 4, the 555 timer is triggered by pushbutton switch S1. Prior to the actuation of S1, C1 is charged to +V through R1. Depressing S1 discharges C1 rapidly through R4, creating a short negative spike. Any sporadic effects of switch bounce that may occur when S1 is depressed are removed by the integrating action of R1 and C1, resulting in a clean, negative-going spike. That spike is then passed through C2 to pin 2 of U1, causing the monostable to fire, generating a clean square-wave output of T = 1.1R1C1. Upon release of S1, C1 recharges to +V, and the circuit awaits the next switch actuation.

The circuit outputs only a single trigger pulse for each switch depression regardless of how long S1 is held down, and will not trigger upon switch release. But the circuit will retrigger as fast as S1 can be reactuated. The minimum output pulse-width of the circuit should be longer than the bounce of the switch used—typically 10 ms or less.

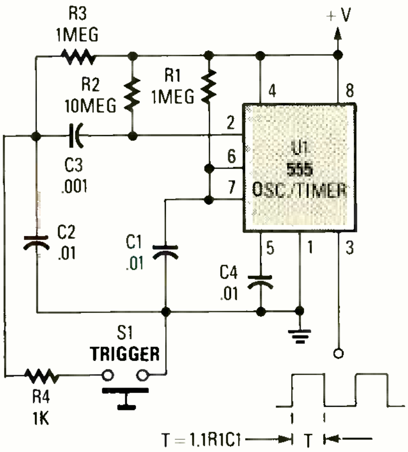


Fig. 4. One very common application of the one-shot is to defeat multiple triggering of a circuit due to sporadic switch closure (bounce).

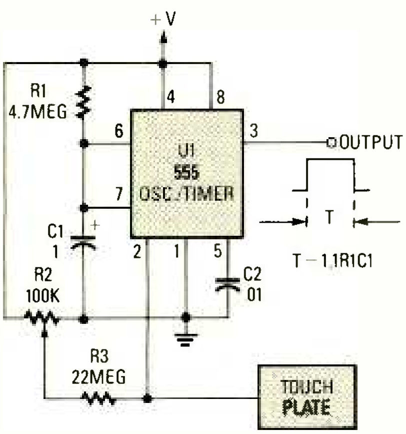


Fig. 5. The touch switch is an interesting application of a 555 monostable, in which the switching action is accomplished without mechanical switch contacts.

Touch Switch. An interesting type of monostable circuit—a touch switch—is shown in Fig. 5. In that circuit, the switching action is accomplished without conventional mechanical switch contacts. The circuit is basically a conventional 555 monostable, with the only major difference being its method of triggering.

The trigger input is biased by R1 (a 22-megohm resistor) to maximize the sensitivity of the circuit. In such a circuit, the trigger input draws negligible current when held above its ⅓ +V threshold.

With the threshold control, R2, adjusted so that the voltage at pin 2 is held above ⅓ +V, the output of the circuit remains low until triggered. When the contact plate is touched, body capacitance (effectively in parallel with R3) lowers the overall impedance between pin 2 and ground, thereby pulling pin 2 below the ⅓ +V threshold. That causes U1 to trigger, producing an output pulse of T=1.1R1C1. The timing period should be made longer than the anticipated contact time, otherwise the timer will retrigger after completion of the first output pulse. In Fig. 5, the timing period is about 5 seconds.

The contact plate can be any conducting material arranged for convenient finger contact. Also, some type of feedback to the operator is desirable, such as a lamp or LED to indicate that switching has occurred as a result of contact.

Retriggerable One-Shot. The circuit in Fig. 6 is yet another variation of the monostable multivibrator in which the normal triggering characteristic of the monostable has been modified. It differs from the others in that it is made up of two 555's, and its output is not reset to begin a new timing period. In Fig. 6, timer U2 is configured as a conventional monostable, and is triggered by a negative-going pulse provided by U1, which is set up as a simplified inverting monostable.

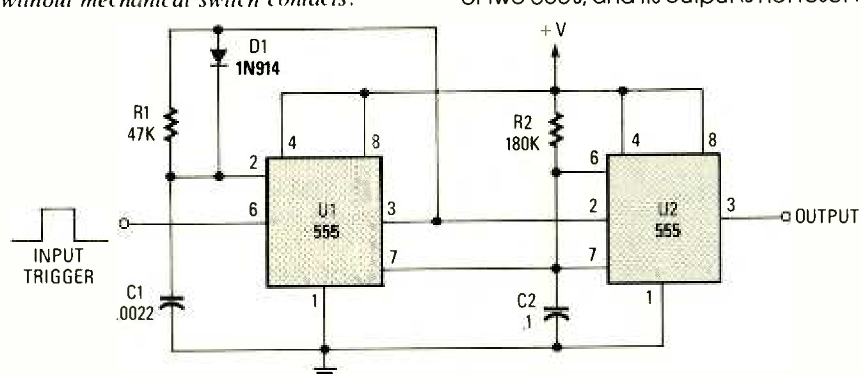


Fig. 6. In this variation of the one-shot, the normal triggering characteristic of the monostable has been modified—the output of the circuit is not reset to begin a new timing period.

The discharge terminal of U1 (pin 7) is used to clamp C2 for the duration of U1's output pulse. During normal operation, when the trigger pulses are longer than the period of U2, the output pulses occur at the input rate, and the output pulse width is equal to 1.1R2C2. When the time between trigger pulses is shorter than 1.1R2C2, the voltage across C2 returns to zero with each pulse.

As a consequence, C2 never reaches the ⅔ +V threshold established by R1/C2 for U2; thus, U2 never times out. Under those conditions, the output remains at a steady high DC level, and continues as such as long as the input triggers are received at a period of less than 1.1R2C2.

The circuit in Fig. 6 can be scaled to operate at virtually any rate consistent with the range of component values allowable with a 555. The output pulse-width of U1 should be kept at some small percentage of that of U2, making sure that the pulse-width is long enough to ensure complete discharge of C2 during U1's timing period.

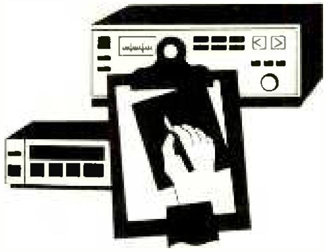
555 Monostable Exercise. Assuming that you've kept the power-supply circuit intact, breadboard the circuit shown in Fig. 2: Make R1 1 megohm; R2 and R3 10k; R4 270 ohms; C1 10 µF. With those values, calculate the length of time (T=RC) that the output (pin 3) of U1 should remain high when a timing cycle is initiated. Apply power to the circuit. The circuit output is indicated by LED1; it will only turn on when the output of U1 at pin 3 is high.

Momentarily bring pin 2 low (ground). The output of U1 (pin 3) should go high and LED1 should light. When the 555 has timed out, again trigger a timing cycle, this time taking note of its duration. How long did the output remain high? How does the measured time compare to the value calculated?

Momentarily bring pin 2 low again, and then momentarily bring pin 4 low. What happens to the output (pin 3) when pin 4 is brought low? Can a cycle be initiated while pin 4 is held low? Record your observations.

Now let's try tinkering with the component values. Recall that we stated

(Continued on page 98)



Product Test Reports

Len Feldman

ZENITH VM7150 VHS CAMCORDER

Most American video enthusiasts, it seems, prefer full-size VHS camcorders over the smaller 8-mm or VHS-C variety. This Zenith model offers good reasons why that is so. The VM7150, though not an S-VHS model, offers just about every conceivable feature the experienced amateur video maker might want. Just a list of these features with brief descriptions of each took a full page of the well written 50-page owner's manual supplied by Zenith.

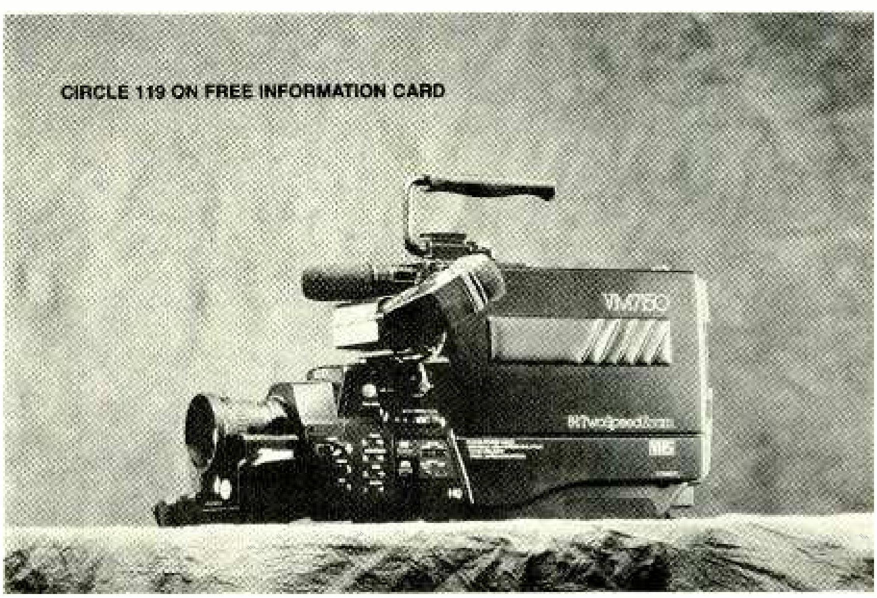
The Zenith VM7150 is equipped with a two-speed 8:1 powered zoom lens. A flying erase-head makes for smooth edits between scenes. There's a variable high-speed shutter with speeds from 1/60th to 1/1000th of a second. Date and time can be entered automatically or manually as you record, and you can even superimpose graphics, pictures, or titles in 8 different colors from a "four-page memory." Focus, white-balance, and iris adjustments are all automatic. Backlight compensation is provided for. You can take shots at 1/4-, 1/2-, and 1-second intervals to produce animation or time-lapse special effects. A 60-second self-timer delay lets you get into a scene before recording begins. A "Retake" feature allows you to stay in the record-standby mode while you fast-forward or rewind a tape to a specific point. Audio/video dubbing from external sources is possible. There's audio and video fade-in/fade-out capability, index-marking capability, and even a provision for connecting a wireless external microphone. Secondary features will be noted as we describe the many controls found on this camcorder.

Controls. Most of the operating controls for this camcorder are found on the left side of the unit. A sub-trigger button is used to stop recording momentarily. The RETAKE buttons (fast-forward and reverse) are nearby, as is the FULL AUTO button that puts focus and white balance under automatic control. Manual focus can be selected by another nearby button. The main POWER switch, the FADER button, and the BACKLIGHTING-COMPENSATION control are up front, near the lens assembly. The DATE/TIME, INDEX. and SHUTTER (speed) buttons are further back along the side surface of the camcorder, and nearby are DISPLAY SELECT, WHITE BALANCE, DATE/TIME SELECT, RECORD TIME ON/OFF (to display elapsed recording time in the viewfinder), and RECORD TIME RESET buttons. A TRACKING control is further back, near the rear of the camcorder housing. The DISPLAY SELECT button sequentially selects date, time, or date and time to be displayed on the viewfinder screen and to be recorded on the tape when recording begins.

The right side of the camcorder houses the cassette compartment, while the hand-grip section up front houses the usual power ZOOM and START/STOP-recording button as well as the battery pack that slips inside the hand-grip section. An ALARM ON/OFF switch near the RECORD button, when switched on, sounds an alarm whenever the record START/STOP button is pressed. Controls associated with the VCR playback function of the camcorder are all grouped together at the rear of the unit. EDIT START and INSERT RECORD buttons are also grouped with the tape-transport controls back there. A liquid-crystal display (LCD) there shows operating mode as well as tape and battery conditions. AUDIO DUBBING, ANIMATION, and SELF-TIMER buttons; an earphone jack; a COUNTER MEMORY button; a DC-input jack; and a remote-control jack are also located at the rear panel of the camcorder. An AUDIO/VIDEO IN/OUT multiple-pin connector is found on the rear surface of the unit as is a BACKGROUND MUSIC INPUT connector. That last named jack lets you mix any audio source with your microphone sound during recording.

Beneath the lens area are more buttons and controls such as the MEMORY button that keeps a desired title or illustration in memory, a COLOR button that selects the color of an illustration or caption, a TITLE ON/OFF button that mixes titles and pictures, a PAGE button that displays title pages one through four in the viewfinder, and an IMAGE REVERSE button. Up front, above the electronic viewfinder, are a wireless-microphone receiver jack and, at the front of the electronic viewfinder there is a tally light that tells your "actors" when a "take" is happening.

About APEL. APEL stands for Advanced Product Evaluation Laboratories, a renowned video-product testing laboratory that is run by Mr. Frank Barr and his associates. APEL is one of the best equipped video testing labs in the



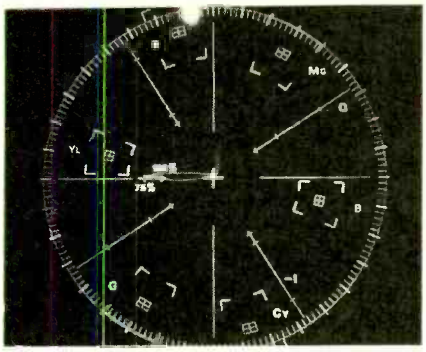
The Zenith VM7150 VHS Camcorder.

United States. Once APEL generates the measurement data for a product, that data, along with the product, is sent to my laboratory where we analyze the data, use the product, and produce the final test report for the product. Many of APEL's measurements are fairly technical and may not be of interest to more casual readers. For that reason, numerical test results are summarized elsewhere in this report, while their significance is reported next.

The Test Results. Minimum illumination required for a full-amplitude video signal to be produced by the camcorder was 6.7 lux. While not the lowest illumination requirement we have ever measured, it is low enough for the camcorder to be used in a room having ordinary lighting. White balance set for optimum produced 11 IRE of chrominance when pointing the camera section at a neutral (uncolored) object. That is about average for camcorders we have tested in recent months. Color contamination, or the amount of color bursts appearing on a fine black and white pattern, amounted to no more than 9 IRE, which is also about average for the breed. Color purity, accuracy, and degree of color saturation were all excellent.

The vectorscope photo that accompanies this article was taken when the camcorder was recording a red field. The white "spot" seen at the top of the photo represents the phase angle and the degree of saturation of the red color. Ideally, that spot should fall exactly in the center of the cross-mark labeled "R" (for Red). As you can see, in the case of this camcorder the white dot location was very nearly (but not quite) perfect.

Horizontal resolution of the camera itself was a very high 400 lines. That means there was more picture detail than you normally receive from broadcast TV. However, after recording and playing back a test pattern, resolution decreased to 240 lines when measured from the video-output jack. That's still slightly better resolution than the



This vectorscope photo was taken when the camcorder was recording a red field. The white "spot" seen at the top of the photo represents the phase angle and the degree of saturation of the red color. Ideally, that spot should fall exactly in the center of the cross-mark labeled "R" (for Red).

average VHS-format camcorder provides. Signal-to-noise ratio for the brightness part of the signal, with optimum illumination, ranged from 42.7 dB to 46.0 dB, while chroma AM signal-to-noise ratios ranged from 44.6 dB to 46.0 dB, Audio signal-to-noise ratio using the external-microphone input was a better-than-average 50.7 dB.

Hands-On Tests. It took us a while to familiarize ourselves with all of the switches and buttons scattered around the camcorder's body, but once we did, we quickly realized just how versatile and feature-laden this Zenith camcorder really is. We were pleased that the fade-in/fade-out feature worked for both video and audio. In many camcorders equipped with fade-in/fade-out, the feature applies only to the video signal and that really doesn't make much sense. In the course of our hands-on experiments, we hooked up an external CD player to the background-music input jack and created our own "background score" for our video "production." All of the special effects, such as time-lapse and the four pages of available "titles" worked well, as did the feature that allows you to superimpose a still picture with the current shot.

This full size unit weighs just under seven pounds and is therefore a camcorder that you will either want to mount on your shoulder or use with a firm tripod. But to compensate for that, the Zenith VM7150 offers features that are usually missing in smaller, lighter "aim-and-shoot" camcorders.

For more information on the VM7150 contact Zenith (1000 Milwaukee Ave, Glenview, IL 60025) or circle No. 119 on the Free Information Card. ■

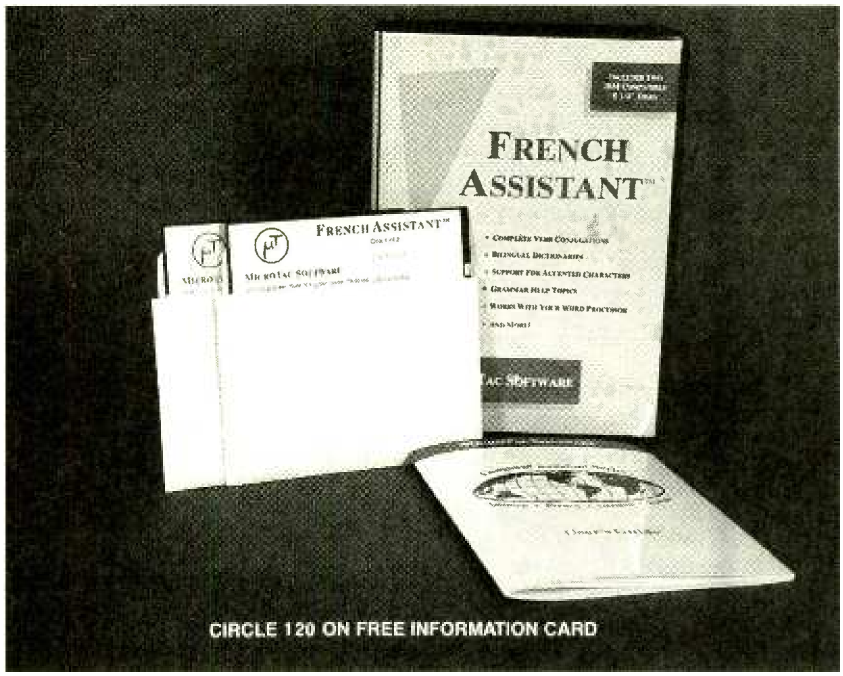
TEST RESULTS—ZENITH VM7150 VHS CAMCORDER

Unlike the case with audio products, video products seldom have many meaningful published specifications associated with them. Thus, APEL's results are tabulated without any reference to manufacturer's specifications, simply because few of APEL's measurements are normally reported by this or any other manufacturer. As Popular Electronics publishes more and more reports, you will be able to make meaningful comparisons between competing products.

Specification	APEL Measured
CAMERA/VCR VIDEO SECTION	
Minimum Illumination	6.7 lux
Horizontal Resolution	
Camera	400 lines
Record/Play Video Out	240 lines
Color Contamination	9 IRE
White Balance	11 IRE
Signal-to-Noise Ratios (Chroma AM/Luminance)	
Camera	
Optimum Light Level	44.6/42.7 dB
Record/Play Video Out	
Optimum Light Level	45.2/46.0 dB
Minimum Focal Distance	39 inches (Macro: ¼ in.)
Lens Aperture	f/1.4
Zoom Ratio	8:1
Focal Length	8.5 mm to 68 mm
AUDIO SECTION	
Maximum Output, Microphone	0.55 volts
External Microphone Input Sensitivity	0.45 millivolts
Signal-to-Noise Ratio	50.7 dB
Additional Data	
Power Requirements	11.5 watts
Weight (including battery and tape)	6⅞ lbs.
Dimensions (H × W × D, in inches)	8⅜ × 8 × 16
Suggested Retail Price: $1499	

Popular Electronics HANDS-ON REPORT

MICROTAC SOFTWARE FRENCH ASSISTANT



Learn French or refine your language skills with an easy to use program. Software is available for learning Spanish, German, and Italian, too!

Believe it or not, I know a 2-year old child that speaks excellent French. Of course he lives in downtown Paris, but bad jokes aside, you can learn French and be able to write and translate letters, newspaper articles, and books with a little determined practice. You may think there's no easy way to learn French, but you've probably never tried the *French Assistant* software package, or moving to France.

The Software. The French Assistant is stored on two diskettes and is designed to help you study, learn, and write in French. You will be able to write memos, reports, study for tests, complete homework assignments, and in general, improve or renew your expertise in the French language. It can work as a powerful memory-resident program for use with your word processor or as a handy stand-alone reference.

The big plus in the French Assistant is that it provides access to complete verb conjugations—over 2000 fully conjugated verbs. You can find and insert the correctly conjugated verb directly into your document with just a keystroke.

Beginners and those seeking a refresher course in French grammar and vocabulary will appreciate the wide coverage provided by French Assistant. You can review test subjects, refer to a particular topic when writing, or refresh your skills by browsing through the grammar help topics.

What makes the French Assistant possible is the French-English and English-French dictionaries that permit the user to quickly locate a word and insert it into a document being processed. There are about 30,000 words in the dictionaries, and you can add new ones that you are apt to use again.

```
          French Assistant    3.10
     Copyright 1989 MicroTac Software

 Main Menu                  <Alt>M

 French to English          <Alt>F
 English to French          <Alt>E
 Topics of Grammar          <Alt>T
 Verb Conjugations          <Alt>V
 Replace Word-For-Word      <Alt>R
 Accent Entry               <Ctrl>'

 Dictionaries Copyright by Random House

E:\FRENASST>_
```

The French Assistant's main menu comes up when the program is first loaded and offers a guide to the hot keys used by the program. If you can't remember which hot key performs a certain action, just bring up the action menu by pressing <ALT-M>.

The real fun comes when you first try the replace word-by-word function. Right before your eyes English words are erased and the French equivalents are put in their place. Words that do not appear in the dictionary cannot be translated, so those words are bracketed to alert the user. Admittedly, the resulting translated word-for-word text is not refined. That is where your language skills and the French Assistant's reference capabilities come into play.

If your word-processing program makes it difficult to add accented characters to the text, French Assistant makes it easier. You'll have no problem with accents, circumflexes, or any punctuation.

Your Computer. French Assistant operates on IBM PC/XT/AT, PS/2, and compatibles with DOS versions 2.0 and above. The minimum RAM required for stand-alone operation is 256K. The recommended minimum RAM for memory-resident use is 512K although the French Assistant occupies only about 98K in that mode.

French Assistant can be installed on a one diskette-drive system, a two diskette-drive system, or, of course, a hard-disk system. The program was reviewed after placing it on a hard disk by following the simple directions in the manual. To run the program in a stand-alone mode, just type:

FRENASST/S<ENTER>

If you want the program to be memory resident for use within the framework of your word-processing program, type:

FRENASST<ENTER>

before you run your word-processing program. Should you use the program frequently, it would pay to include the command in your AUTOEXEC.BAT file. While in your word-processing program, striking <ALT-M> will bring-up the main menu, which appears superimposed over your current work. There are only seven "hot" keys to learn, or if you wish, only one if you go directly to the main menu after French Assistant is loaded-in.

What it Can Do. As an example, let's proceed to change this sentence step by step:

Mary had a little lamb.

To save space in the dictionary and eliminate confusion where one word has multiple meanings, only the English infinitive verbs are recognized by the software. That being the case, the English verb *had* must be changed to its infinitive form: (to) have. The sentence then becomes:

Mary have a little lamb.

Next, the French Assistant is put in its "Replace Mode." That is accomplished by either typing <ALT-R>, or <ALT-M> and selecting the replace mode from the menu. Word-for-word replacement from English-to-French will then take place before your eyes. The end result will be:

[Mary] avoir un peu (m.) agneau.

To congugate the verb avoir in the correct tense, you would place the cursor on the verb, type <ALT-V>, and follow the instructions given in the menu. The correct tense for the word "had" is the simple past, the second choice on the verb-tense menu. To replace the word with its simple-past French equivalent strike the down arrow once and hit F2. The sentence will now look like this:

[Mary] eut un peu (m.) agneau.

Next we remove the brackets from

After striking <ALT-M>, and placing the cursor over the word "verbs" the operator will see a prompt that reads "French Verb:" Type avoir and press the <ENTER> key. The screen will now show the menu for the 14 tenses for avoir. To get to the simple past tense, follow the menu's instructions and select the correct word. Here we find the French word for had is eut.

the word "Mary" since it is a proper noun and need not be translated. The "(m.)" is used to indicate that "peu" (little) is a masculine noun. That is wrong since the word "little" is used as an adjective. To correct the error, the word "little" was reinserted to replace the French noun. The result is:

Mary eut un little agneau.

Now striking <ALT-E> when the cursor is on the word "little" brings up a menu showing a few French words and additional information. You place the cursor on the word "petit" and hit return. The result is:

Mary eut un petit agneau.

and now your sentence is done.

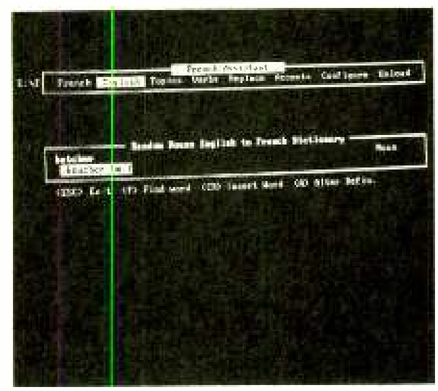
For an Unknown Word. The task becomes easier as the user develops a vocabulary and acquires knowledge of French grammar. For example, take the sentence:

The butcher cuts meat.

Let's say you know how to translate everything except the French word for *butcher*. Depressing <ALT-E> followed by <ENTER> allows you to enter an English word for the software to translate. So you would simply enter the word "butcher" and the French equivalent "boucher" will appear with a note that tells you it is a masculine word.

You can also add a word to the dictionary. If your are looking for the word *butcher* and it isn't in the English dictionary, strike <ALT-A>. After you add the English word, the screen will prompt you to add the French word, which you will have to look up in a standard English-French dictionary.

The Fringe Benefits. There are a few other features you should know about. You can use any accented character found in French, Italian, German, or Spanish. *Hot keys* are selectable for full-time users. The speed at which French Assistant operates is adjustable (slow, normal, or fast)—select the highest speed your computer can handle. To save valuable RAM space when French Assistant is not being used, the software's resident memory can be

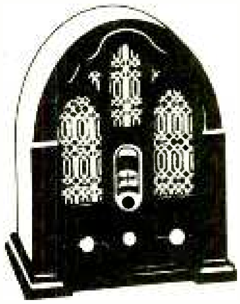


To get the French equivalent of a selected English word, enter the menu and highlight the English-to-French option. Type the word butcher and press the <ENTER> key. The French word boucher appears and the French Assistant tells you that it is masculine.

cleared. The Users Guide is brief and to the point. It is written for all four languages so that if you are a multilingual student, to understand the operation of one language program makes you an expert in all four language programs by MicroTac Software.

Who Can Use It? The French Assistant is not a stand-alone French language self-teaching course, but it is an invaluable tool for the student, and the occasional user of French. If you took French years ago in high-school or college, here is an inexpensive and enjoyable way to refresh your language skills.

You can order French Assistant for $49.95 plus $3.00 for shipping and handling from MicroTac Software, 4655 Cass Street, Suite 304, San Diego, CA 92109, Tel. 1-619-272-5700; VISA and MasterCard are accepted. California residents must add 7% sales tax. For more information, circle no. 120 on the Free Information Card. ■



Antique Radio

By Marc Ellis

GETTING STARTED IN WIRELESS

This definitely isn't the column I'd planned to write for the March issue! What I thought I'd be doing would be reporting to you on the results of applying power—for the very first time—to our restored *Pilot A.C. Super-Wasp* (see July through November, 1989 columns). In January, I talked about the design of the power supply I was building to fire up the "Wasp." Last month we digressed for a visit to Brother Patrick Dowd's fascinating vacuum-tube museum. And on these pages, I was going to show you the completed power supply and then try out the Wasp at last.

My carefully laid plans were shattered by an odd combination of perfectionism and carelessness. I had finished mounting all of the power-supply parts on the chassis, and was just about to pick up the soldering iron to begin wiring, when it happened. I realized that I hadn't made any provision for ventilating the below-chassis bleeder resistor/voltage divider and decided to do something about it.

After prudently removing the resistor to avoid damage, I drilled a series of ventilating holes in the chassis apron near the component's location. Then I remounted the resistor and once again turned to the soldering iron. But something was still bothering me; although I'd spent some time de-burring the new ventilation holes, they still looked a little rough. So I picked up a file, intending to quickly smooth them down.

After working for a few moments, however, I heard a grating noise as my tool rubbed against a porcelain surface. In my impatience to complete the job, I'd slipped and nicked the resistor. And a quick check with an ohmmeter confirmed my worst fears. The resistor was now open. I'd hit it in a vulnerable spot: the "window" where its windings were exposed to make contact with the adjustable sliders.

Since one can't buy Ohmite "Dividohm" power resistors at the local Radio Shack, and the column was due at the Gernsback offices in just a few days, I had to think of something else to talk about—and fast! So I decided to research an era of radio communication I hadn't yet covered in *Antique Radio*:


THE ELECTRICAL EXPERIMENTER

Make It a Real "Wireless Xmas"

NO better Christmas gift for anyone interested in wireless could be imagined than the "Best 1 KW. Transformer Ever Designed," the new

THORDARSON

WIRELESS TRANSFORMER

A new perfected type, with even greater range, power and flexibility than our former model. Exclusive Variable Shunt and Ampere Scale give wonderful accuracy. Comes completely assembled—no chance for mistakes or burn-outs. Five sizes, from ½ to 2½ kw., 10,000—20,000 volts, any cycle desired.

Write for Special Bulletin and Prices

Thordarson Electric Mfg. Co.,

LENZITE WIRELESS DETECTOR

Recognized by leading authorities as the most sen-

A fast-talking teenager who was ready to upgrade his transmitter just might be able to get his parents to put one of these 20,000-volt beauties under the Christmas tree.

the years just prior to World War I, when radio was still called wireless. Here's the result, and I hope you enjoy reading it as much as I enjoyed putting it together. We'll get back to the Wasp as soon as I can locate a replacement resistor.

Setting the Stage. Imagine that it's the spring of 1912. You're a young radio hobbyist who, using ingenuity and scraps of wire, metal, and wood—and a minimum amount of cash—has put together a simple amateur station. One day, you settle down at your receiver for a quiet listening session and pick up the following fragment of a message:

... boats and embarked about six-hundred persons, then the cry went up that the ship was sinking and a frenzied rout began. Ship settled into the sea and it is said that many boats were


SPARK COILS For Wireless

STYLE C SPECIAL 1" COIL $3.50

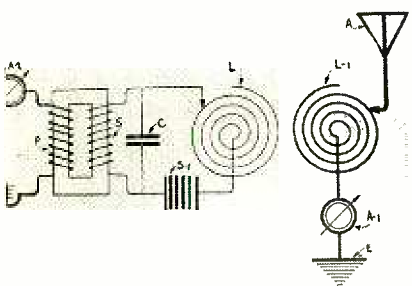
Postage extra

FINE RESULTS WITH THIS COIL

SCHUG ELECTRIC MFG. CO.

254 EAST LARNED, DETROIT, MICH.

This "beginner's model" spark coil had a little more class than a Ford "flivver coil," but still cost only three-and-a-half bucks!



Circuit for a commercial transformer-powered spark transmitter differed little from that used by amateurs.

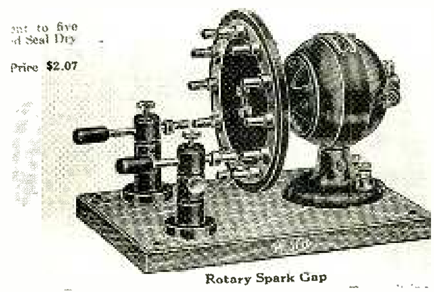
smashed to pieces in davits. Some were swamped in launching, others went down with the ship ...

Not everything on the pre-World War I airwaves was as exciting as that report, actually picked up by a young radio amateur in New Haven, Connecticut, concerning the sinking of the Titanic. But there were plenty of messages to hear and plenty of people to talk with.

Though not yet being used for home-entertainment purposes in those years just before The Great War, radio was well-established as a commercial service. Besides providing indispensable communications for ships at sea, it carried telegrams, business messages, and news—not to mention the conversations of numerous amateur-radio operators. In fact, with government regulations less stringent than they are today, it wasn't unusual for ham and commercial operators to chat with each other on the air!

Now imagine that *you* are a radio-minded individual who'd like to get in on the action and set up a home station. What are the things you'd have to know, and what kind of equipment would be required? In this column, and others to follow, we'll explore the answers. Let's start with the transmitter.

The Basic Spark Rig. If you had a limited budget, or just wanted to get started in the simplest way possible, your transmitter was probably a "flivver coil." Translated into modern terms, that was a spark coil of the type used for ignition purposes in the Model "T" Ford. Every "T" had four of them (one for each spark plug) mounted in a box on the dash panel. Ford coils were plentiful, inexpensive, and easily available on the new or used market.



A factory-made rotary spark gap for amateurs and experimenters cost $12. Some hams cut costs by making their own.

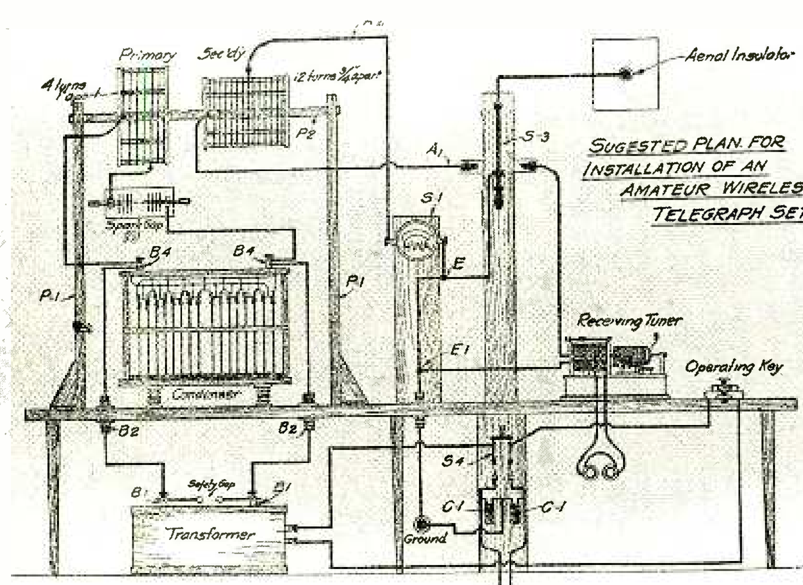
The spark coils were transformer-type devices designed to step up the low voltage available from the Ford's battery to a value (several thousand volts) that would jump the gap at the spark plug. But transformers can't operate on direct (unvarying) current as obtained from batteries; they require current that is alternating (regularly changing polarity) or at least interrupted (turned on and off at a regular rate) in order to do their thing. Accordingly, the Ford coil was fitted with a buzzer-like *interrupter* that automatically turned the current from the battery on and off at a fast enough rate for transformer action to take place.

If you wanted a little stronger signal than the Ford coil would deliver, you might purchase one of the more powerful spark coils sold specifically for radio use. There were also powerful spark coils on the market (as there are today) designed for demonstration purposes in science classes. But whatever kind you might purchase, the hookup was simplicity itself.

Four dry cells, in series with a telegraph key, provided the six volts required to power the coil's primary circuit. With the proper adjustment of the interrupter, pressing the key would cause a couple of thousand volts to appear at the secondary terminals of the coil. Those terminals were connected to a spark gap made of a couple of nails, sections of wire, or other pieces of metal. If the points of the gap were placed just the right distance apart, a lively blue spark would crackle across them as long as the key was held down.

Besides emitting light and sound, the spark was also a source of radio waves. Those were radiated into the atmosphere by an antenna connected to one side of the gap. The other side was connected to a cold-water pipe or a good ground rod. The antenna usually consisted of four to six parallel wires separated by spreaders at each end. You made it as long and as high as you could.

An outfit like that one would transmit on a wavelength roughly equal to the natural one of the antenna and ground system (somewhere between 200 and 600 meters). Most folks didn't worry about exactly what wavelength they were on because the receivers then in-use tuned very broadly indeed, and would respond to almost any electromagnetic disturbance if it was strong enough.



Recommended layout for a 1915-era amateur wireless station. Transmitter section is at left. Note transformer under table; condenser on table top; oscillation transformer, or "helix," on rack above.

Adding a Condenser. With a basic-spark-coil outfit as described, you could easily communicate with your chums in

(Continued on page 106)

Circuit Circus

By Charles D. Rakes

RF CIRCUITS FOR BETTER PERFORMANCE

This month we're going to explore a variety of RF enhancement circuits. Some of the circuits are designed to breath new life into older shortwave receivers, or to pull in a DX broadcast station from across the country on a generic AM radio.

Others are designed to electronically "stretch" a miniature antenna so that it acts like a long wire for the apartment dweller; another can be used to tune out what's not desired to be tuned in.

No matter what listening category you happen to occupy, it's my hope that at least one of the following circuits will enhance your next radio adventure. If you happen to live in an area where outside antennas are *taboo*, try one of the following "wire-stretcher" circuits.

Signal Grabber. The circuit in Fig. 1 takes a short pull-up antenna that has a high output impedance, and couples it to the receiver's low input impedance through a two-transistor impedance-matching network. Transistor Q1's high input impedance and high-frequency characteristics make it a good match for the short antenna, while Q2's low output impedance is a close match for the receiver's input.

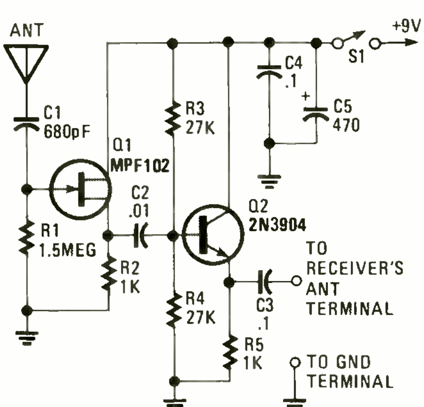


Fig. 1. The Signal-Grabber circuit is designed to make a short pull-up antenna perform like a long wire antenna, while offering no voltage gain. The circuit boosts the receiver's performance only if the signal at the antenna is of sufficient level to begin with.

The impedance-matching circuit allows a wide range of frequencies from below 100 kHz to over 30 MHz to enter the receiver. Even though the circuit offers no voltage gain, the receiver's performance is greatly enhanced. The matching circuit will boost the receiver's performance only if the signal reaching the antenna is of sufficient strength to begin with. If the desired signal isn't making it to the antenna, there's very little chance that any electronic wizardry will produce a usable signal at the receiver.

For the best low-noise performance, the matching circuit should be housed in a metal cabinet and powered from an internal 9-volt battery. But a well-filtered, noise-free external AC-derived power source can be used; or, if available, power can be supplied from the receiver.

The circuit can be assembled breadboard style on a piece of perfboard with push-in pins, or a simple circuit board can be produced; in either case, keep all leads short and follow a neat construction scheme. Just about any replacement pull-up antenna can be used or, if you have the available room, an old ¼-wavelength CB whip antenna would make a dandy signal grabber.

PARTS LIST FOR THE SIGNAL GRABBER

Q1—MPF102, general-purpose, N-channel FET
Q2—2N3904, general-purpose, NPN silicon transistor
R1—1.5-megohm, ¼-watt, 5% resistor
R2, R5—1000-ohm, ¼-watt, 5% resistor
R3, R4—27,000-ohm, ¼-watt, 5% resistor
C1—680-pF, ceramic-disc capacitor
C2—0.01-µF, ceramic-disc capacitor
C3, C4—0.1-µF, ceramic-disc capacitor
C5—470-µF, 16-WVDC, electrolytic capacitor
S1—SPST toggle switch
Perfboard materials, metal enclosure, telescoping antenna, wire, solder, hardware, etc.

Signal Booster. If your receiver needs a higher level RF-input signal than what the matching network can furnish, try the circuit in Fig. 2. The circuit, built around a few transistors and support components, offers an RF gain of about 12 to 18 dB from about 100 kHz to over 30 MHz, and is designed to complement the circuit in Fig. 1.

The RF signal is direct-coupled from Q1's source terminal to the base of Q2, which is configured as a voltage amplifier. The output of Q2 is then direct-coupled to the base of Q3 (configured as an emitter-follower amplifier). Transistor Q3 is used to match and isolate the gain stage from the receiver's RF-input circuitry.

Inductor L1 is used to keep any noise from the power source from reaching the FET (Q1) and any value of RF choke from 0.5 to 2.5 millihenrys will do. The value of R2 sets the bias for Q2 to about 2 volts. If the voltage is less than 2 volts, increase the value of R2 to 1.5k. To go below 100 kHz to the bottom of the RF spectrum, increase the value of C1 to .002 µF.

PARTS LIST FOR THE SIGNAL BOOSTER

Q1—MPF102, general-purpose, N-channel FET
Q2—2N3904, general-purpose, NPN silicon transistor
Q3—2N3906, general-purpose, PNP silicon transistor
R1—1.5-megohm, ¼-watt, 5% resistor
R2, R3, R5—1000-ohm, ¼-watt, 5% resistor
R4—2200-ohm, ¼-watt, 5% resistor
C1—680-pF, ceramic-disc capacitor
C2–C5—0.1-µF, ceramic-disc capacitor
C6—470-µF, 16-WVDC, electrolytic capacitor
L1—0.5–2.5-mH RF choke
S1—SPST toggle switch
Perfboard materials, metal enclosure, telescoping antenna, wire, solder, hardware, etc.

Tunable Trap. The add-on circuit, in Fig. 3, is a tunable trap that can be adjusted to extract undesirable AM signals and pass what is left to the receiver. Inductor L1 is a broadcast loopstick-antenna coil and C1 is a tuning capacitor, both of which were salvaged from an older AM transistor radio.

If the interfering signal originates from the lower frequency end of the broadcast band, set L1's slug about ¾ of the way into the coil and tune C1 for a minimum signal output at the interfer-

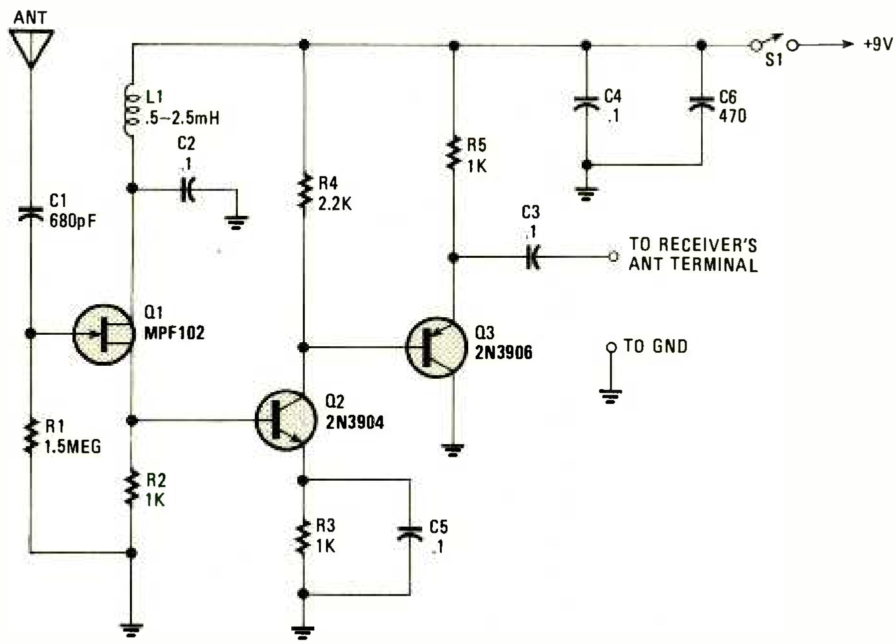


Fig. 2. The Signal Booster, built around a few transistors and support components, offers an RF gain of 12 to 18 dB from about 100 kHz to over 30 MHz, and is designed to complement the circuit in Fig. 1.

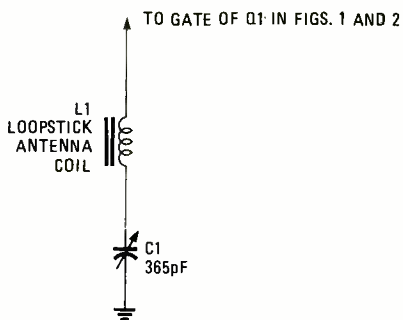


Fig. 3. The Tunable Trap can be adjusted to extract undesirable AM signals and pass what is left to the receiver.

ing frequency. And if the interfering station's frequency is near the upper end of the band, adjust the slug almost all the way out of the coil and tune C1 for a minimum signal.

It is possible that some transmitter other than a standard AM-broadcast type can get into the stretcher circuit. If that does occur, determine the transmitter's frequency and select a coil/capacitor combination that will resonate at that frequency, and connect that combination to the circuit as shown in Fig. 3.

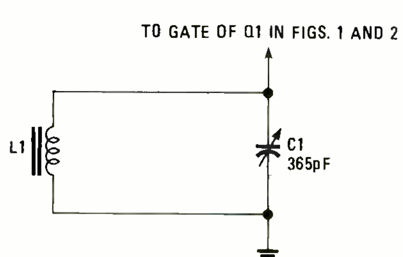


Fig. 4. The Signal Scrubber is a frequency-selective circuit for the wire stretcher. When a desired signal is receivable, but buried in noise, this circuit can pull it out of the mud, clean it up, and send it on to the receiver.

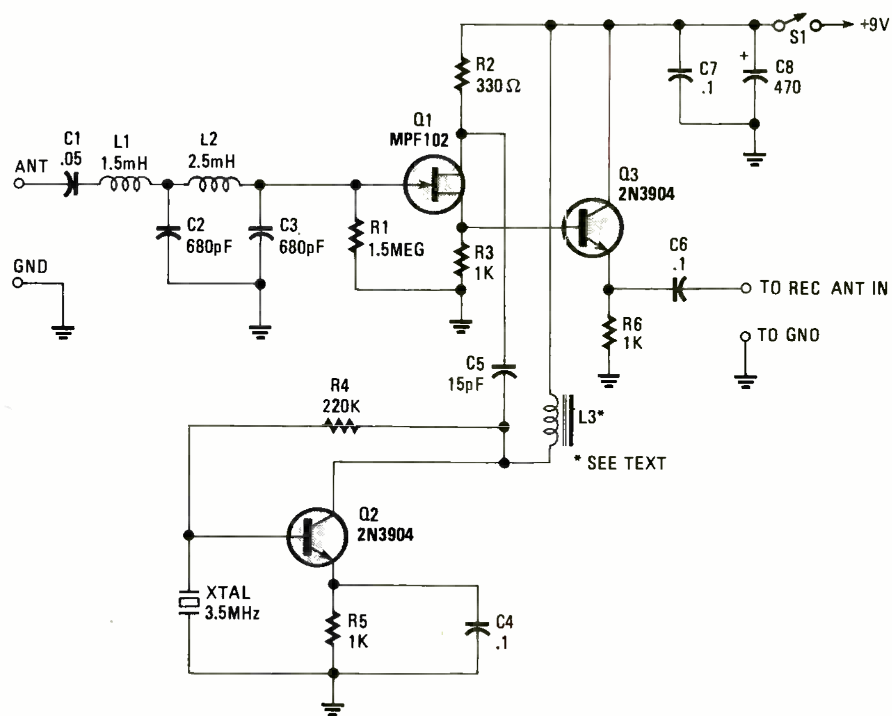


Fig. 5. The VLF Converter can be used to pick up signals for the general coverage of shortwave receivers. A number of unusual signals can be heard on frequencies below 15 kHz.

Signal Scrubber. A frequency-selective circuit for the wire stretcher is shown in Fig. 4. When a desired signal is receivable, but buried in noise, this circuit can pull it out of the mud, clean it up, and send it on through the stretcher to the receiver. At the same time that the tuner is increasing the level of the desired frequency, it's also attenuating all other signals outside its passband. The same combination of values for the coil and capacitor in Fig. 3 can be used in this circuit.

The input of the stretcher circuit is an ideal place to experiment with other types of antennas and selective circuits. A large tuned loop will give the circuit a directivity feature that can help in reducing an interfering signal coming from a different direction. If you don't have room for a large loop, you might try using a large, tuned ferrite coil in its place and retain the directivity feature.

VLF Converter. The majority of the general-coverage shortwave receivers start with the AM-broadcast band and go up in frequency to about 10 meters, or 30 MHz. That common tuning arrangement leaves out a large number of interesting and unusual signals found below the standard broadcast band. Not to fret, for the circuit in Fig. 5 will take you there for a listening adventure.

A number of unusual signals can be heard on frequencies below 15 kHz.
(Continued on page 95)

Computer Bits

By Jeff Holtzman

AND THE WINNER IS...

In case you missed it, back in the August 1989 column I challenged you to come up with the best program of 100 lines or fewer written in Turbo Pascal. Unfortunately, it seems that BASIC remains the overwhelming choice for those of us who have chosen to learn programming at all; even so, we got quite a few excellent responses.

Congratulations to all of the entrants. In my book you're all winners because you've taken the next step and learned an important and powerful programming tool. Now, let's look at some of the programs.

Runners Up. I received several interesting responses that came close to winning but suffered one or two fatal flaws that kept them from taking first place. One, submitted by Chieh Cheng, was a simple 30-line program that allows you to rename an MS-DOS directory. I would have liked the program better if it accepted wildcards and multiple names on the command line, and if it had better error checking; all of that would have been easy to do in 100 lines.

David Muckel submitted half-a-dozen or so decent programs designed to spruce up batch files, to track DOS command-line entries, and to locate a lost file. His programming technique was excellent; a bit more originality would have earned him the prize.

Vic McAlister wrote a nice program for providing a graphic display of your hard disk structure, but it also loses in the originality column.

A program submitted by Doug Martin allows you to change file attributes (hidden, read-only, system, and archive). Its menu-driven approach and use of the CLRSCR statement, however, made it clumsy to use.

The winner. Another entry by Doug Martin, however, earns him first prize: a 12-MHz 80286 motherboard (courtesy of JDR Microdevices) and a package of three Pascal programming tools—*Turbo Professional, Turbo Analyst,* and *B-Tree Filer* (courtesy of the good folks at Turbo Power Software).

As it is, Doug's program probably won't be useful to many people except BBS operators. However, it illustrates several useful programming techniques (in particular, running external programs from inside a Turbo Pascal program) that could be useful in a number of situations.

Doug's program, shown in Listing 1, is called MakeLZH. What it does is search through a specified directory and convert all files compressed in various formats (ZIP, ZOO, PAK, and ARC) to Doug's favorite, the LZH format. Even though the LZH format is not as widely supported as the others, it uses less disk space than they do, and disk space is important to a BBS.

MakeLZH is shown in Listing 1; remember, for the most part you have to read a Pascal program from the bottom up. The program begins around line 72 at the statement *begin MakeLzh.* First the program changes to the specified directory, removes the old work directory (if any), and then creates a new work directory. Then it goes through the same basic process four times, once each for the ZIP, PAK, ARC, and ZOO formats.

First the program executes the *FindFirst* function, which finds the first file (if any) with a name matching the name passed to the function—in this case "*.PAK." Then the program fills a small text buffer (called CmdLn) with the name of the program needed to decompress the given file type, which in the first instance is PKUNZIP. Then it

LISTING 1

```
program Make_LZH;             { Written by Doug Martin, 6/89 }
 uses CRT, DOS;
 {$M 2048,0,0} {$R-} {$I-}
 var     FreeSpace                    : LongInt;
         S,T                          : SearchRec;
         F                            : File;
         OldFile,NewFile,CmdLn        : string[13];

procedure Initialize;
  begin
    OldFile := S.name;                      { File being converted       }
    Delete(S.Name,Length(S.name)-3,4);
    NewFile := (S.name + '.LZH');           { This will be the new file  }
    FindFirst(NewFile, 0, T);
      If (DosError = 0) then          { Are we going to overwrite a file?}
        begin
          WriteLn(^G,NewFile,' already exists!...',OldFile,' retained.');
          RmDir('WORK_DIR');
          Halt(3);
        end;
    If DiskFree(FreeSpace) < (S.size * 5) then
      begin
        WriteLn(^G,'<<< Not Enough Disk Space For Conversion >>>');
        RmDir('WORK_DIR');
        Halt(1);                    { Uh-Oh, not enough diskspace!       }
      end;
  end;    { Initialize }

procedure Do_LZH;
  begin
    Exec(GetEnv('COMSPEC'),'/c LHARC.EXE A /a '+ NewFile +' WORK_DIR\*.*');
    ChDir('WORK_DIR');
    FindFirst('*.*',0,T);
      While (DosError = 0) do       { Delete the extracted files         }
        begin
          Assign(F,T.name);
          Erase(F);
          FindNext(T);
        end;
    ChDir('..');
    FindFirst(NewFile, 0, T);       { look for LZH file                   }
      If DosError <> 0 then
        begin
          WriteLn(^G,'Error ==> ',OldFile,' retained');
          Halt(4);
        end;
    Assign(F,OldFile);              { erase original file                 }
    Erase(F);
    Assign(F,NewFile);              { stamp new file with old file's date }
    Reset(F);
    SetFTime(F,S.time);
    FindNext(S);                    { Look for next file to convert       }
```

LISTING 1 (continued)

```
  end;     { Do_LZH }

procedure Convert_OLD;              { extract files to  WORK_DIR          }
  begin
    while (DosError = 0) do         { do this as long as there are files  }
      begin                         { that need to be converted           }
        Initialize;
        ClrScr;
        WriteLn('Converting ',OldFile,' to ',NewFile);
        WriteLn('Command Interpreter =  ',GetEnv('COMSPEC'));
        Exec(GetEnv('COMSPEC'),'/c copy '+ OldFile + ' WORK_DIR');
          ChDir('WORK_DIR');
            Exec(GetEnv('COMSPEC'),'/c ' + CmdLn + OldFile);
            Exec(GetEnv('COMSPEC'),'/c del '+ OldFile);
          ChDir('..');
        Do_LZH;                       { Now to Archive those files        }
      end;
  end;  { Convert_OLD }

 begin  { Make_Lzh }
   ChDir(ParamStr(1));              { go to specified dir or use current  }
     RmDir('WORK_DIR');             { make sure WORK_DIR has nothing      }
      If IOresult = 5 then          { in it that might be archived        }
        begin
          WriteLn(^G,'Subdirectory WORK_DIR not empty, program halted!');
          Halt(2);
        end
      else  MkDir('Work_Dir');             { We need a work space          }
     FindFirst('*.ZIP',0,S);               { find a ZIP file to convert    }
       CmdLn := 'pkunzip ';                { command line to unzip file    }
       If DosError = 0 then Convert_OLD;   { if file is found, convert it  }
     FindFirst('*.PAK',0,S);               { no more ZIP files...          }
       CmdLn := 'pak e ';                  { ...so find PAK files          }
       If DosError = 0 then Convert_OLD;
     FindFirst('*.ARC',0,S);               { ...then ARC files             }
       CmdLn := 'pak e ';
       If DosError = 0 then Convert_OLD;
     FindFirst('*.ZOO',0,S);               { ...and now ZOO files          }
       CmdLn := 'zoo e ';
       If DosError = 0 then Convert_OLD;
     ClrScr;                               { looks like we're done!        }
     WriteLn('Conversion To LHarc Format Completed...');
     RmDir('WORK_DIR');                    { don't need this any more      }
  end. { Make_LZH }
```

calls the procedure (*ConvertOld*) that does the decompression.

ConvertOld works by first calling *Initialize*, which sets up a new filename (with the LZH extension), ensures that the file being converted doesn't already exist, and ensures that there is enough disk space to work with. The program just terminates if either condition is not met. *ConvertOld* then writes several messages to the screen (lines 61 and 62) informing the user about what is going on.

The real trick comes in the next few lines. The first *Exec* statement (in line 63) starts up a secondary copy of COMMAND.COM, which copies the file being converted to the work directory. Then, in line 64, the program changes to the work directory, and in line 65, executes the decompression program specified in CmdLn. Then the compressed version of the file is deleted, and the program returns to the original directory.

The last statement in *ConvertOld* calls another procedure, *DoLZH*, which uses several of the same types of *Exec* tricks to invoke LHARC.EXE, which compresses the now-decompressed file in the LHARC format. The *FindNext* procedure invoked in line 52 finds the next file by matching the given file type, if any, and returns to *ConvertOld*, which continues to loop as long as there are matching files.

After all files of that type have been converted, *ConvertOld* returns to the main loop, which continues by converting the remaining file types.

All in all, an elegant solution to a problem that would have been a mess to solve manually; enjoy your new motherboard and your software, Doug!

Qedit Update. It's a truism in the computer world that as software evolves, it gets bigger. As features are added (and bugs are fixed!), programs typically require more and more RAM and disk space. Not so with Qedit (discussed here in detail in the July 1989 column), which *shrinks* every time a new version is released.

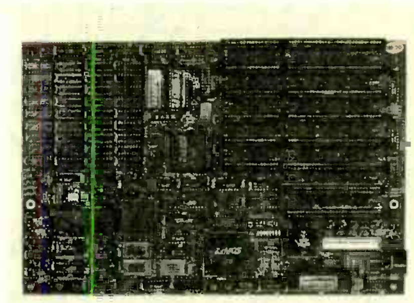
The latest version (2.08) fixes bugs and adds several new capabilities, including sorting, case conversion, and better macros. Qedit now weighs in at 48K, still costs less than $60, and a functionally equivalent OS/2 version is available at the same price. Tell 'em we sent you! (A shareware version of Qedit 2.07 is still available on the Gernsback BBS, 516-293-2283, 300/1200, 8N1). ■

Vendor Information

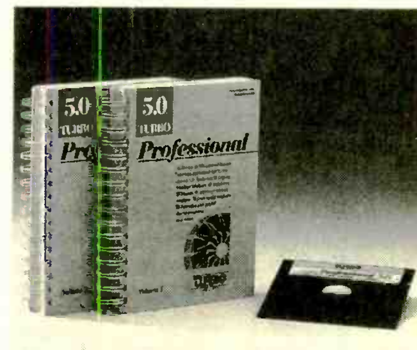
Qedit ($54.95 for DOS or OS/2 version plus $3 S/H or $5 for 2nd day UPS shipping)
SemWare
Suite C-3, 4343 Shallowford Road
Marietta, GA 30062-5003
(404)20641-9002

Turbo Power Software
P.O. Box 66747
Scotts Valley, CA 95066
408-438-8608

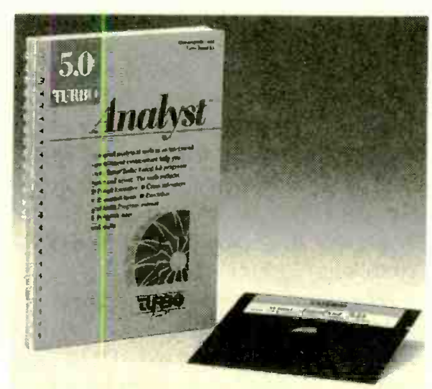
JDR Microdevices
2233 Branham Lane
San Jose, CA 95124
(800) 538-5000, (408) 559-1200



This MCT-M286-12 12-MHz mini 80286 motherboard from JDR Microdevices was one of three prizes won by Doug Martin in our software writing contest.



Turbo Professional (provided by TurboPower Software) contains more than 500 routines that you can add to your own Turbo programs.



Turbo Analyst (also provided by TurboPower Software) helps you analyze the efficiency of your programs.

DX Listening

By Don Jensen

WHAT'S NEW AT VOICE OF AMERICA?

The *Voice of America* (VOA) is the one shortwave station that anyone can hear! With powerful shortwave transmitters in North Carolina, California, and Ohio, the signal quality is excellent, too; VOA signals can be easily heard anywhere in the U.S. or Canada, using even the simplest and most inexpensive receiver.

Buy why bother, you may ask? When it comes to SWL'ing, tuning distant stations half-way round the world is what's interesting and fun. Why settle for plain vanilla when there's all that *tutti-fruitti* DX to go after?

A good reason, I suppose, is to get a better idea of the image of America being presented to those in other lands. If you want to see America as others see it, tune in to VOA Europe, the programming intended for listeners "across the pond."

The Voice of America, now nearly a half century old, was founded during WWII to counter Nazi propaganda. Not surprisingly, its initial target was Western Europe. But gradually, during the post-war years, the audience target shifted eastward to those behind the Cold War's Iron Curtain.

Money problems and the changing emphasis brought reductions to VOA services to Western Europe. Why squander funds on broadcasting to our friends and allies, the reasoning went. Between 1953 and 1961, VOA programs in Portuguese, Spanish, Italian, German, and French were ended.

It wasn't until the start of the 1980's, that there was a revival of interest in again "talking to Europe." A study confirmed that, indeed, America was losing touch with younger Europeans.

What sort of programming would appeal to Europeans, ages 18 to 40? Research suggested that European listeners would be receptive to short features focusing on American life and individual Americans. In October 1985, VOA Europe began broadcasting a full service of news, music, and Americana features.

Perhaps the most interesting, even to listeners on this side of the Atlantic, are the featurettes, usually two-and-a-half minutes or less in length, compiled by what the VOA calls its "A-Team," with the "A" meaning "Americana."

In addition to these short features, the team also has produced special material, including a recent 100-part series called "Voices of America," which featured "sound pictures" of important places in U.S. history.

The "A Team" has taken its European listeners to Plymouth Rock; to Thomas Edison's laboratory; to Ford's Theater, where Lincoln was assassinated; and to Ellis Island, where the distant cousins of many of today's European listeners first got their glimpse of America.

VOA interviewers have talked to state governors, dog catchers, scientists, chimney sweeps, doctors, lawyers, even Indian chiefs, all across the United States. Overseas listeners have heard interviews with a lady jockey, high-school students who run a gourmet restaurant, and an opera-writing judge.

VOA Europe's "Discover America" series focused on European interest in the new world's history, culture, and customs. Program producers researched and answered more than 250 questions about America sent in by listeners in 14 European countries. A question about the origin of the name, "Dakota"—it means "friend" in the Sioux Indian tongue—led to a series of featurettes on how each of the 50 states were named.

Perhaps not surprisingly, the Voice of America soon discovered that its programs intended for Europe were being enjoyed by listeners elsewhere in the world, with letters about them arriving from such places as India and Nigeria. North American listeners, no doubt, will also find some fascinating nuggets in the same programming mine.

Prime-time listening time in Europe is, of course, their evening. English-language VOA programs to Europeans can be heard from 1700 to 2200 UTC. "Early morning" transmissions are aired around 0600–0700 UTC. Programs are transmitted from VOA facilities at Greenville, NC, plus overseas relay stations in places like the United Kingdom and Morocco.

Listeners from all over the world write to the Voice of America after listening to its programs. Here some of that mail is displayed on a hallway bulletin board in the VOA's Washington headquarters for visitors to read.

*CREDITS: Linton Robertson, CA; Dan Sheedy, CA; Leonard Price, VA; Bob Rydzewski, CA; Raymond Bauernhuber, NY; Harold Levison, PA; North American Shortwave Association (45 Wildflower Road, Levittown, PA 19057).

There are many frequencies used, so you should have little difficulty in finding VOA programming if you tune around a bit in the 31-, 25-, and 19-meter bands. Some frequencies you might want to try are 9,700, 9,760, 11,760, 11,805, and 15,205 kHz.

Time Frame. Some things are so basic to shortwave listening that it's necessary to repeat them from time to time. One of those "bottom line" bits concerns Coordinated Universal Time, abbreviated UTC. Since an understanding of UTC is essential to SWL'ing, it is important to explain it for the benefit of those newcomers who are feeling their way into this listening hobby. Others may just skip along a few paragraphs and we'll catch up with you later.

Okay, then, what is this UTC all about? Remember first that at any moment in time, local clock time will be different in different places around the globe. It is simultaneously afternoon in the U.S. and Canada; evening in Europe; and late at night in Asia.

So, to keep everyone on "a level playing field" wherever they may live in the world, SW stations, and listeners, generally use a common time reference called Coordinated Universal Time. To prevent confusion, whatever our local clock reads, we all convert time references to UTC.

You will see, for instance, that all times listed in this column will always be UTC. They also will be given using the 24-hour clock system, in which the hours from midnight to noon are given as 0000, 0100, 0200, 0300, and so on through 1159, and those from noon to midnight are 1200, 1300, 1400, 1500, and so on through 2359.

The most important thing is to be able to convert UTC to your own local time. If, for example, a station broadcasts at 0300 UTC, you'll need to know what that means to you. If you live in the eastern zone of the United States, subtract 5 hours from UTC for Eastern Standard Time (4 hours during EDT periods). In the Midwest, subtract 6 hours (5 during daylight time) to get CST. Those living further west should subtract 7 hours for MST (8 hours for MDT); 8 hours for PST (9 hours for PDT).

Here are some examples: 0300 UTC equals 2200 (or 10 p.m.) EST. 1800 UTC is the same as 1000 (or 10 a.m.) PST. During the summertime, 1300 UTC is equal to 0800 (or 8 a.m.) CDT. And rather than calculate it each time (though with a bit of practice, it's quite easy to do) you might wish to make a simple chart for yourself.

Feedback. Your letters, questions, and comments about shortwave listening are always welcome! Also, I'm always interested in hearing about the SW stations you're hearing, including the times heard and frequencies. Write to me in care of "DX Listening," **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735.

I've received a number of letters from you readers commenting on the listening hobby. M. Harenberg, Baltimore MD, and Arnold Timm, Minneapolis, MN, have, for instance, written long letters with their views. Unfortunately, space just doesn't allow printing them in full. But I'd like to select a few excerpts for the rest of you.

Reader Harenberg writes: "How very exciting and interesting this hobby can be is almost beyond belief...I'd like to share a few ideas with **Popular Electronics** readers. Don't look for cheap receivers. What you get is inferior performance. Buy brand names. Read receiver performance reports such as those in *Passport To World Band Radio* (P. O. Box 300, Penn's Park, PA 18943)...I used to belong to SW clubs but don't any more. Their formats in their monthly bulletins are the same. I scan one band and know what I want to listen to in minutes. Also, don't expect to find listed in any magazine or book all the stations. I find only about a quarter of them are listed..."

Mr. Timm says: "I keep my 42-year-old ears tuned to radio communications...I've been involved, off and on for over 18 years. It seems to me that we could do more to help seniors and students who may be low-income radio hobbyists. Would it not be wise to share information with them. Bring back the basics, with simple circuits to build, operate, and maintain."

Down The Dial. Here are some of the shortwave tidbits some of you have been hearing:

Australia—4,920 kHz. While the *Radio Australia* programs commonly heard are intended for foreign listeners, the Australian Broadcasting Corporation's shortwave outlet at Brisbane directs its home-service programming to listeners within Australia. That outlet has been heard in California with pop music and features during the early mornings.

Chile—6,030 kHz. *Radio Santa Maria* is not an easy station to hear in the United States. But it has been logged as late as 1205 UTC sign off on the West Coast. Its Spanish-language programming includes lottery information for Chilean listeners.

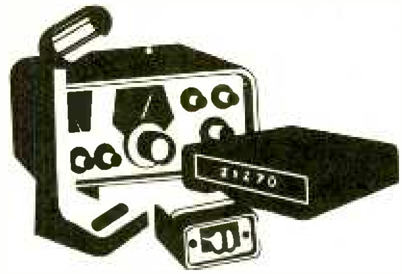
Nigeria—7,255 kHz. The *Voice of Nigeria*, Lagos, can be heard, with rather good signals at times, around 0500 UTC with English news, commentary, and African music.

Canada—9,625 kHz. The *Canadian Broadcasting Corp.* airs Northern Service programs to its Arctic region on this frequency. Tune in around 1700 UTC and you'll hear programming in French and in local native languages.

USSR—9,720 kHz. *Radio Moscow's* long-running letters-from-listeners program, "Moscow Mailbag," featuring the gregarious Joe Adamov, has been heard here at 2310 UTC.

Greece—11,645 kHz. *Voice of Greece*, programming from Athens, has been noted on this frequency with English news read by a woman announcer at 0130 UTC.

Switzerland—21,695 kHz. *Swiss Radio International* uses this "high" shortwave frequency for English programming around 1330 UTC. ■



Ham Radio

WORKING DX HAS ITS OWN "AWARDS"

By Joseph J. Carr, K4IPV

Working DX (*i.e.*, long-distance radio communications) has long been a popular endeavor among hams... ever since the post-World War I era when smug commercial- and governmental-policy makers contemptuously snorted "put 'em [hams] on 200-meters and below—they'll never get out of their back yards with those frequencies!" But "200-meters and below" are the high-frequency shortwaves, which we know today are the very frequencies that make international communications possible. DX'ing quickly became one of the most popular activities in ham radio, and continues to be so today.

How DX Works. The physical phenomena that makes DX'ing possible is ionospheric propagation, or *skip*. Figure 1 shows how it happens. The ionosphere is a region of the Earth's atmosphere where the gas molecules that make up air are far enough apart that ionization can take place. Energy, mostly from the sun, causes electrons to split off atoms creating positive and negative ions in the process. In lower regions of the atmosphere, those stripped-off electrons quickly recombine with other atoms, so there is no net ionization present. But at distances above about 50 miles, the air is so thin that recombination is much slower and a net ionization exists. Solar ionization, which is related to the number of sunspots on the surface of "Old Sol," is a principal factor in determining the "DX'ability" of any given frequency and day.

The HF signals from the Earth's surface see the ionosphere as a "radio mirror" that "reflects" signals back to Earth. The actual process is not reflection, however; it is refraction. In other words, the signals bend in the ionosphere. The amount of bending is a function of frequency. Some signals (*e.g.*, signals 1 and 2 in Fig. 1) never bend enough to come back to Earth...they continue on into space. Other signals (signals 3 and 4 in Fig.1) bend enough to permit a phenomenon similar to the total internal refraction that is seen in fish tanks and other bodies of water when light shines through. In other words, the refraction is sufficient to make the signal behave as if it reflected from a mirror.

In Fig. 1 we see two examples illustrating two situations. One is the case of signal 3, where the angle of radiation is high, so the signal reflects back to earth at point R1. It then reflects back to the ionosphere where it refracts again and drops back to Earth at point R2. Signal 3 will be heard in the immediate vicinities of the transmitter and points R1 and R2. At other points on the Earth's surface, it will not be heard (or it will be very weak).

A longer skip signal (signal 4) also reaches point R2, but with only one "hop." The two signals are examples of single-hop and multi-hop propagation. There is no hard rule for how long each hop is (it depends on several factors), but 1400 to 2500 miles is a good "arguing" point.

DX Awards. There are a number of DX awards available to the amateur operator, but perhaps the two most sought after are the Worked All Continents (WAC) and DX Century Club (DXCC) awards offered by the American Radio Relay League (ARRL, 225 Main Street, Newington, CT., 06111). The WAC is actually co-sponsored by the International Amateur Radio Union (IARU), of which ARRL is the U.S. representative. The WAC is conferred for working, and receiving QSL cards from legal amateur-radio stations on all six continents: North America, South America, Europe, Asia, Africa, Oceania. Note that Middle East stations (including Israel) count as Asia, while Oceania includes the Pacific Ocean islands, Australia, and New Zealand (but Hawaii and the Aleutians are considered states and hence count as North America). There is a special certificate available for amateurs who work all six continents on each of five bands.

The DXCC award is presented to amateurs who can show QSL cards confirming contacts with 100 "countries" (as defined by the ARRL on the DXCC

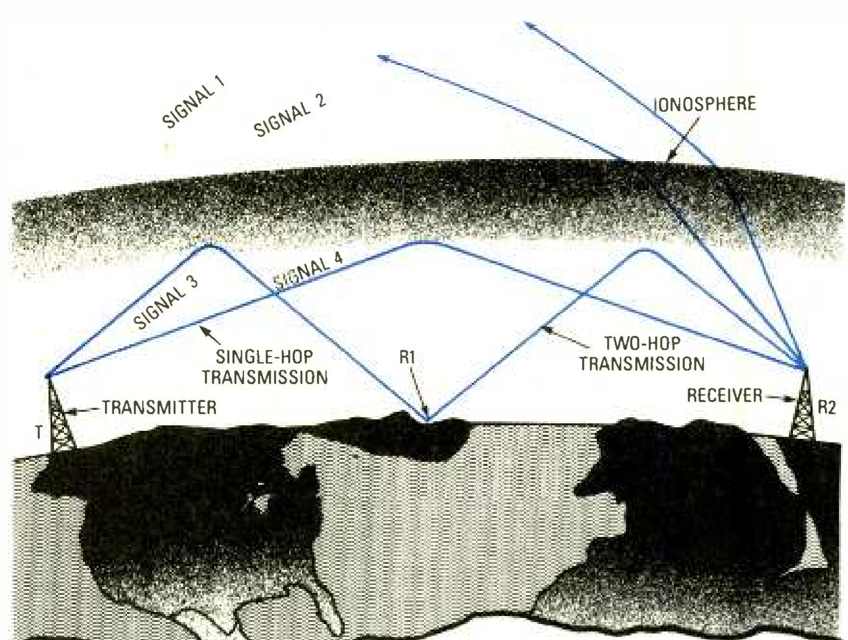


Fig. 1. The mechanism of long-distance "DX" communications is ionospheric skip. Signals refract in the ionosphere and seem to "reflect" back to Earth, where they are received at long distances.

Countries List). There are special certificates available for five-band, single mode, and other special cases. In addition, once the basic certificate is earned one can earn additional endorsement stickers for each additional ten countries worked. Write to the ARRL for the countries list and any aids they currently offer to aspiring DXCC'ers.

In both cases, don't forget that U.S. contacts count. For example, your U.S. contact for DXCC and your North American contact for WAC can be your buddy across town who QSL'ed your first novice contact. Many amateurs forget to count their own country when tallying their QSL cards for the award.

Earning The Certificates. First, you need an HF amateur-radio station of at least Novice grade (although more DX opportunities exist for General-, Advanced-, and Extra-class licensees). Don't lament too much if you can't afford a kilowatt and a tri-band beam. While these neat hunks of wattage are really nice to have, they are not terribly necessary until one reaches the 200+ countries point. Even at those exalted levels, a low-power operator with skill will beat out the high-powered "lid"(a lid is a ham with poor operating habits) given enough patience. I know a number of amateurs who worked DXCC using 50 watts and either a long-wire or dipole antenna.

The antenna should be one that offers a low angle of radiation (see signal 4 in Fig. 1). I prefer having two or more antennas for the same frequencies. One should be a low angle of radiation vertical such as the half-wavelength Cushcraft (48 Perimeter Rd., Manchester, NH 03108) Model R5. The second should be a multi-band dipole (unless you want to work only one band), "G5RV," "Carolina Windom" or some similar antenna. It frequently happens that a signal will be heard on one antenna well, and on the other poorly or not at all. This phenomenon is caused by differences in location (a few yards can be critical, especially above 20 meters), and the antenna's angle of radiation. Of course, if you can afford a beam or quad, then do it...it never hurts.

Second, buy some QSL cards; those who don't QSL rarely get QSL's back...and you need those foreign QSL cards to confirm those contacts. Also, file an envelope with the ARRL QSL Bureau that serves your call area (write to the ARRL), and join the ARRL in order to use their out-going QSL bureau when appropriate.

Third, become familiar with the bands and their activity. If you work 40-meters CW in the daytime or evening, then you are used to contacts in the 200- to 1000-mile range. But what about the wee hours between midnight and dawn? An awful lot of JA, ZL, and VK activity from the Far East shows up at those times on "good ol' 40 meters." Also, learn to use the Gray Line Terminator for odd-ball communications. MFJ Enterprises, Inc. (Box 494, Mississippi State, MS, 39762; 601-323-5869) offers DX'er software for Gray Line and HF-propagation applications. Those programs will help you plan your DXCC operations. Also, monthly DX-propagation predictions appear in *QST*, the ARRL magazine that comes along with your membership.

Finally, learn some good operating techniques. The principal error of newcomers (and oldsters who never got the word) is to call "CQ DX" over and over again. The DX station has a zillion North American, especially U.S., stations to select from...so will only occasionally respond to "CQ DX." It might be worth a single call to get it out of your system once and for all, but in the main, calling "CQ DX" is useless.

What does work, however, is a lot of listening. And don't just listen to the weak stations with a load of echo. Many times we dig for the weaker guy, only to find out that he or she is a W/K in the next call zone...out of our skip zone. On the other hand, when the DX is good (like it is right now), the European station will sound like gang busters. I've heard many a 58 or 59 (or 598/599 on CW) station from South America and Europe.

Listen a lot on the standard "net" frequencies. A lot of people use those frequencies as "calling" frequencies even when the network they like is not in service. Good bets are 21.39 MHz on 15 meters, and around 14.290 to 14.320 MHz on 20 meters. Several international nets use those frequencies. **But do not interrupt net business for DXCC contacts!** It's darn bad manners and more likely to earn you the enmity of the other stations. Instead, when a pair of stations goes up or down band to pass traffic, follow them and wait for the contact to end. When it's polite to do so, break in and ask for a quick QSO (communication).

Don't just listen for "CQ" calls from the

(Continued on page 98)

Scanner Scene

By Marc Saxon

TURBO-CHARGED SCANNER

In your Porsche or Saab, the word "turbo" relates to a blower that helps the vehicle to go faster. In an aircraft, a turbo-prop engine is one that lets the plane fly faster than a standard prop-engine aircraft. In the world of scanners, the word has come to mean a set that scans at a rate of speed far faster than usual. So it is with the *Uniden BC-1 Super Turbo Scanner.*

Many scanners scan at a rate of 8 to 16 channels-per-second (cps), and some can be modified up to 20 cps. While many folks feel that going from 16 to 20 cps is going from a trot to a gallop, compared to the BC-1 Super Turbo Scanner, that all seems slower than molasses going uphill in winter. That's because the BC-1 scans at 60 to 100 cps.

There are other things that are also quite different about this scanner. For one thing, you can't program any frequencies into the BC-1. It's been factory programmed with all CB channels; the NOAA weather channels; and the VHF-low/high-, UHF-, and UHF-T-band police frequencies used in each individual state. You merely punch up the state you're driving through and the BC-1 scans all of the police frequencies used in that state. You can hold a transmission or skip over it. If you touch the WX key, the BC-1 instantly finds you an active weather channel. If you hit the CB button, you can monitor any one CB channel, or scan them all. You can lock out up to 32 channels to be skipped while in scan mode, and there's a button to insert a 3-second scanning delay on any channel.

The set is quite small (it weighs less than 2 pounds) and is obviously intended for the driver who likes to have his ears on while traveling along the Interstate. It comes with a telescopic antenna, but certainly any mobile installation would be improved with an antenna mounted on the exterior of the vehicle.

The Bearcat BC-1 comes from the Uniden Corporation of America, 4700 Amon Carter Boulevard, Fort Worth, TX 76155, and carries a suggested list price of $219.00.

You Wrote To Say. Justin LeBlanc of Haughton, LA, wrote to tell us that last year he was in Memphis, TN, and made it a point to visit Graceland, the Elvis Presley estate now open to the public. He advised that the trip was enhanced by carrying along his handheld scanner and monitoring the two channels used there for various purposes. Those are 151.625 and 151.925 MHz. The next stop after Memphis was Nashville, where he found that the Grand Old Opry Tours run their communications on 464.75 MHz. Justin asked that we pass those frequencies along to our readers, as both cities attract many visitors each year and being able to monitor what's going on behind the scenes enhances the experience.

From Clearwater, FL, we heard from George Schmitt. He reported that he was speaking to a sheriff about purchasing a new scanner that picked up the 800-MHz band, so that he could monitor the communications of that officer's agency, which had recently moved to that band. The deputy told him that it might not be possible for him to hear the communications even with those frequencies covered because the agency is using a "trunked system." George asked us to shed some light on that as it's one he hadn't heard before.

Well, George, such systems do exist, and while they're not impossible to monitor, they do make it a bit more of a task than systems you're probably used to monitoring. Trunked systems all operate with the licensees assigned maybe a dozen or more channels. During any series of exchanges of communications between a dispatcher and a mobile unit, the conversation might very well jump in a seemingly random pattern through several or all of those channels. If you programmed each frequency into your scanner you'd probably be able to follow the conversation without missing much. However, that's not the biggest problem.

The whole thing gets hairy when the licensee has two or more dispatchers operating simultaneously on the same shared set of trunked channels. A city might, for instance, have a license for a single trunked system using twenty channel pairs. Those could all be in use by police and fire agencies, plus EMS, street-repair crews, building inspectors, and the dog catcher. Attempting to single out and follow one conversation from the barrage of babble is extremely difficult.

Trunked systems are becoming rather popular of late. Although it may seem that their primary intent is to confound scanner owners, they are used primarily to make a two-way system more versatile. Whereas the hypothetical city just described once may have had to maintain numerous different one- or two-channel communications systems (perhaps in different bands), with their new trunked commu-

High-speed scanning, factory presets, and pushbutton convenience are the hallmarks of Uniden's BC-1 Super Turbo Scanner.

nications, only one municipal system need be purchased and maintained. Moreover, each agency has potential access to every channel pair in the system.

The individual dispatchers sharing one of those systems don't have any control over frequencies used; they are picked, sorted, kept track of, and changed by a computer at the base station, which also sends out data that permits the mobile-unit transceivers to follow their lead. Nevertheless, many scanner owners report having gotten the knack of dealing with a trunked system in their midst—nuisance though it may be.

Scanner Skip-To-My-Lou. Al Kerner, Registered Monitor KNV7RW, of Nevada, wrote to remind scanner owners that there are excellent DX possibilities these days for picking up the audio portions of European TV broadcasts. He suggested occasional checking of 51.75- and 53.75-MHz on FM, now and in the coming months. There are many other channels, too, but they are subject to interference from North American TV signals. Those two frequencies lie below the North American TV band. I've punched them into my scanner (wide FM mode) and I'm just letting them perk along in the hope that maybe the sunspots will produce some of that DX. The overseas skip has been spectacular of late during daylight hours in the 30- to 50-MHz "low band," and we can thank the sunspots for those conditions. Enjoy some of the DX while you can!

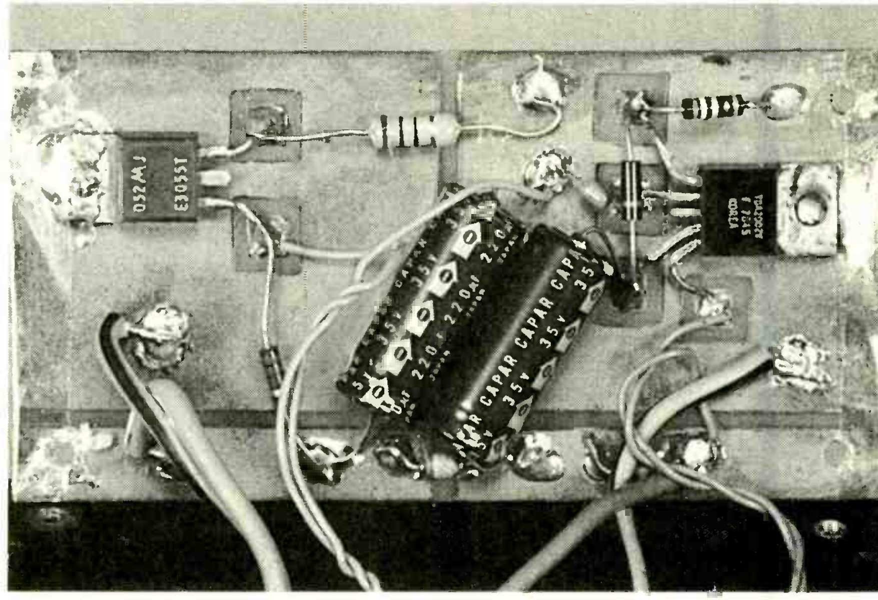
We are always pleased to hear from you with your thoughts, frequencies, questions, and suggestions. Our address is: *Scanner Scene*, **Popular Electronics**, 500-B Bi-County Boulevard, Farmingdale, NY 11735. ■


"A hacker just broke into our computer."

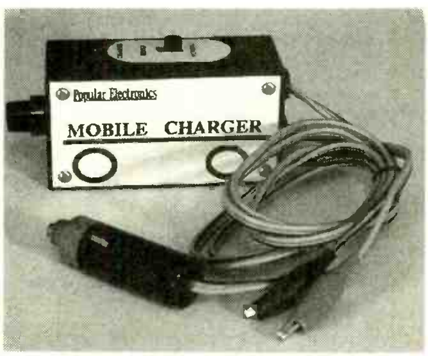
MOBILE CHARGER

(Continued from page 38)

Caution!: Under no circumstance should the Mobile Charger be left plugged in while the engine is turned off. Many automotive electrical systems do not disengage the cigarette-lighter socket when the engine is turned off, hence leaving the Mobile Charger plugged in could (and probably will) deplete the car's battery. As an alternative to unplugging the charger circuit between uses, you might consider placing a single-pole single-throw switch in series with cigarette-lighter's line cord to serve as an on/off switch.



No foil-etching pattern is required for the assembly of the Mobile Charger. The author simply etched isolated copper areas into a printed-circuit blank, and surface-mounted the components to the copper side of the board. Point-to-point wiring was then used to interconnect the components.



In the final assembly of the Mobile Charger, the fuse holder, LED1, and S1 were mounted to the project's enclosure. A couple of holes were also drilled in the enclosure for the cigarette-lighter plug's line cord and a pair of clip leads for connecting the battery to be charged to the circuit.

The original intention of the Mobile Charger was to refresh 12-volt Camcorder batteries while traveling. However, the mobile Charger is not limited to that application. For instance, tradesmen can recharge cordless power tools while traveling between job sites. Public-safety workers can keep their flashlights fully-charged, and ready for use while driving.

And that's not the end to the possibilities of this project. While the Mobile Charger is not the answer to all your battery needs, it does provide a convenient way to charge depleted batteries whenever an AC power source is unavailable. ■

CIRCUIT CIRCUS

(Continued from page 85)

One unusual signal often received between 10 and 14 kHz, in our location (lower Midwest), is a slow two-tone, *dit-dah* signal that's strong enough to be received on a relatively short antenna. Electrical storms, with heavy lightning, can be received on those frequencies as crunching, crackling, and whistling sounds, long before the approaching storm strikes.

PARTS LIST FOR THE VLF CONVERTER

Q1—MPF102, general-purpose, N-channel FET
Q2, Q3—2N3904, general-purpose, NPN silicon transistor
R1—1.5-megohm, ¼-watt, 5% resistor
R2—330-ohm, ¼-watt, 5% resistor
R3, R5, R6—1000-ohm, ¼-watt, 5% resistor
R4—220,000-ohm ¼-watt, 5% resistor
C1—0.05-µF, ceramic-disc capacitor
C2, C3—680-pF, ceramic-disc capacitor
C4, C6, C7—0.1-µF, ceramic-disc capacitor
C5—15-pF, ceramic-disc capacitor
C8—470-µF, 16-WVDC, electrolytic capacitor
S1—SPST toggle switch
L1—1.5-mH choke
L2—2.5-mH choke
L3—See text
XTAL1—3.5-MHz (80-meter band) crystal
Perfboard, crystal socket, metal cabinet, antenna terminals, etc.

On frequencies above 15 kHz, you can expect to receive several of the following signals; Loran, Military, some foreign broadcasts, various CW signals, and in some areas a number of beacon and CW signals between 160 kHz and 190 kHz sent out by experimenters using 1-watt transmitters. Many of those legally operated transmitters have spanned the airways for several hundred miles to be received by other VLF'ers.

With the component values given in the Parts List, the circuit will cover all of the VLF frequencies from below 10 kHz to over 260 kHz. For the circuit to operate from 200 kHz to 500 kHz, a couple of input-filter component values will need to be changed. Remove C2 and C3, and replace C3 with a 150-pf, 100-WVDC ceramic-disc capacitor. Remove L2 and connect L1 to Q1's gate, or, if you are going to make only a temporary change, just place a jumper across L2. If you wanted a dual-band converter, a simple switching circuit could be added to do the above component swapping.

Even though the circuit's frequency range is on the low side, care should be taken in the circuit's construction. The components can be neatly mounted on a 2- × 3-inch piece of perfboard (as I did) or a circuit board can be used for an even more compact unit. Whatever scheme you use, keep the component and interconnecting leads short, and locate the crystal-oscillator circuit away from the front-end circuitry.

If you want to convert to a different frequency, use a socket for XTAL1. The converter will operate best when housed in a metal cabinet and since the circuit only draws a few milliamps of current, battery operation is suggested.

To use the VLF converter, connect the converter's RF output to the shortwave receiver's antenna input through a shielded cable or coax. Connect a good ground to the converter and receiver. Connect a long-wire antenna to the converter, tune the receiver to 3.5 MHz, and set the receiver's mode switch to CW.

The receiver should produce a loud audio tone. That audio tone is produced by the receiver's BFO (beat-frequency oscillator) heterodyning with the converter's 3.5-MHz crystal oscillator—that's normal. As the receiver is tuned beyond 3.5 MHz toward 4.0 MHz, the dial reading, starting at 3.5 MHz can be used to read out the converted frequency: 3.5 MHz = 0 Hz; 3.6 kHz = 100 kHz; and 4.0 MHz = 500 kHz.

Inductor L3 was made by winding 30-turns of 26-gauge wire on a ¼-inch diameter ferrite core removed from an old AM-radio, loopstick antenna coil. The VLF converter can be used on other bands by changing the crystal's frequency and L1's inductance. To change from the 80-meter band (3.5 MHz) to the 40-meter band (7 MHz), both the crystal and L3 will need to be changed. Inductor L3 can be modified to operate in the 40-meter band by removing about 10 turns.

That's all the time and space allotted to us for this month, but be sure to tune in again next month, when we'll present another group of useful and fun circuits designed to entertain and educate you in the ways of electronics. Until then, enjoy experimenting with these RF circuits, and good luck in your signal hunting endeavors. ■

OLD TIME CIRCUITS

(Continued from page 45)

predecessor or competing crystal sets, but it did supply greater volume because of the amplifying action of the tube. Unlike the circuit in Fig. 7, the signal input is shown at the left; output at the right, a circuit arrangement that was used from that time on.

The antenna transformer had a primary winding that was tuned by a slider and a secondary tuned by a variable capacitor, C1. Earlier sets had just a slider-tuned secondary, but the variable capacitor supplied more precise tuning.

As in the last circuit, multiple batteries were used. The "A" battery was a 6-volt storage battery of the type found in some vehicles of that era. The "A" battery had a rheostat (R1) in series with the tube's filament, but there was no way of knowing the exact filament voltage to use. The operator would set the resistance of R1 to its maximum, connect the battery, and slowly reduce the resistance of R1 until the filament glowed a warm orange-yellow light. (The filaments of the first tubes were tungsten and were quite bright.) The rheostat was used as a volume control and as the program material became loud, the rheostat was adjusted to allow less filament current. Turning the current down also extended the tube's life.

The "C" battery had a double function: It biased the tube, V1, to its cutoff point, permitting signal detection. It also prevented a condition known as a blocked grid in which electrons captured by the control grid finally made the grid so negatively charged that current flow from filament (cathode) to the plate ceased.

The "B" battery was often a single 45-volt pre-packed block with just two terminals. In some instances a pair of them were used in series to supply 90 volts.

Some of the early tubes were quite "microphonic" and would start howling with the smallest amount of vibration. Various cushioning arrangements were used for the tube socket and sometimes a lead weight was mounted on the tube, with the weight shaped so as to fit the tube's curvature.

Still another problem was "hand-capacity." The circuit's tuning was affected by the physical proximity of the user's fingers. That was overcome in two ways: one was to mount the capacitor several inches away from the front panel with its shaft connected to the tuning knob by a length of some tubular insulating material, such as a bakelite rod. The other technique was to use a metallic front panel with a ground lead connected to it.

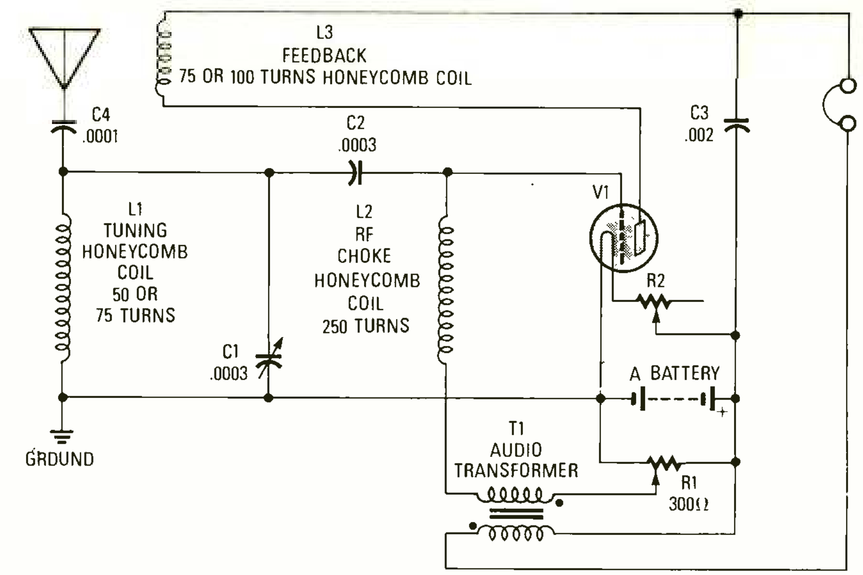


Fig. 10. The Cowper circuit used one triode and only one battery for detection and audio amplification of radio signals.

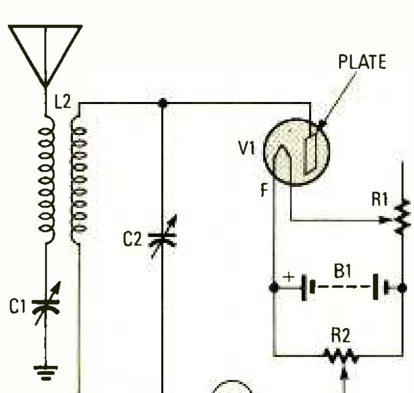


Fig. 9. This is An early radio receiver using a diode signal rectifier in place of the popular galena crystal. Note that it is a one-battery circuit.

From Whisker to Vacuum. Early radio receivers had two primary goals: detection of the radio signal and amplification. In its formative years, radio depended on semiconductor diodes, notably the galena crystal—a bluish-gray mineral known also as lead sulfide. The crystal had much to recommend it: it was small and inexpensive but required patience to find its most sensitive spot.

Following the crystal detector came the tube diode. Invented in England in 1904 by Professor J.A. Fleming, it was that invention that determined the course of radio for the following four decades. The crystal detector could have been developed into the transistor; but the "Fleming valve," as the tube was called, led to the growth of vacuum-tube technology instead.

The Fleming tube consisted of a filament made from carbon, tungsten, or tantalum, surrounded by a metal cylinder, with the assembly sealed in an evacuated glass tube.

Figure 9 shows one of the early tube-diode radio circuits. The single battery, "A," not only heated the filament to incandescence, permitting the escape of electrons from its surface, but also supplied a small amount of plate voltage. That voltage was governed by variable-resistor R2. The setting of variable-resistor R1 set the amount of filament voltage and was also used as a volume control.

Since the tube supplied signal rectification but not amplification, it may seem surprising that the plate required some potential. The potential was supplied to overcome the effects of space charge due to electrons remaining in the vicinity of the filament, an effect that impeded the movement of electrons to the plate after the tube was operated for a time.

The problem with Fleming-valve receivers, as with other early signal rectifiers, was that they did not supply signal gain. Further, it was not as efficient as a good crystal detector.

Amplification at Last. The arrival of the triode vacuum tube paved the way for amplification, but the tube needed three batteries for operation: an "A" battery to supply filament power; a "B" battery for plate (anode) voltage, and a "C" battery for bias. Interestingly, in Dr. Lee De Forest's drawing for his receiver patent he did not include either a "C" battery or a grid leak/capacitor combination!

The development of De Forest's *Audion*, the name he gave to his triode vacuum-tube circuit, led to a substantial amount of experimentation despite the fact that early tubes were "gassy," leading to erratic operation.

No sooner had batteries supplied DC voltage for tube operation than some efforts were made to eliminate them. One attempt resulted in an odd-ball circuit called the "Cowper" (see the circuit in Fig. 10).

A single battery was used to supply filament voltage, which was controlled by a rheostat. Acting as a voltage divider, a potentiometer shunted across the filament battery furnished a negative bias voltage for the control grid. The plate also received some battery voltage via a winding on the audio transformer and the headphones.

Since the battery was usually a 6-volt lead-acid storage type, the amount of plate voltage was small, but some gain was supplied by the use of a "feedback honeycomb" coil. The amount of feedback was determined by the position of the feedback coil, L3, with respect to another coil (in this case the antenna coil, L1) used in the tuning circuit. Inductor L1 would be fixed in position and L3 would be mounted on a pivot so it could be rotated to vary the coupling of the coils.

The triode vacuum tube, V1, worked as a detector with the filament and control grid functioning as a diode, and all three elements operating as an audio amplifier. The purpose of the RF choke, L2, was to help keep the carrier out of the audio transformer. Capacitor C3 worked as an RF bypass to keep the carrier from reaching the headphones. Capacitor C4 and honeycomb-coil L1 form a wide-bandwidth series tuned circuit.

But despite the low parts count and the very clever use of the components, the receiver never gained much popularity. Its output wasn't strong enough to drive a speaker and that was soon to become a feature of merit to consumers. It was rapidly replaced by more-appealing three-tube circuits consisting of a grid-leak detector followed by two stages of audio amplification to provide enough output for speaker operation. ■

STEPPER MOTORS

(Continued from page 74)

circuits use 50-volt supplies? The answer has to do with speed.

Try this simple experiment: leave the pushbuttons open, and turn the motor shaft briskly using the attached lever. At around 60 RPM, you will feel a distinct drag and the ammeter will show around half an amp being fed back into the battery. The speed at which the current just starts to flow backwards is the speed it would run at when driven as a motor.

To go faster, you need a higher voltage. Of course, you will also need some means of preventing the motor from burning out when it is standing still, because when the motor first starts from rest, a greater amount of current flows through the windings than normal. That "stalled current," as it is called, is usually limited by two resistors (R1 and R2) as shown in Fig. 3.

Figure 3 is the most commonly used drive circuit for low to medium power motors. The V_{CE} rating of the NPN transistors should be greater than twice the motor-supply voltage.

High-power motors require a different approach. Dropping resistors would waste too much power, so the driver transistors are used as switching current regulators instead.

Shaft Torque. There are numerous applications for stepper motors. In models, for example, they can often make a gearbox unnecessary because of their high shaft torque. They also have great braking ability. Try this experiment: Remove the 1.5-volt cell from its holder and depress all four pushbuttons. Now try to turn the motor shaft. The damping effect with all windings shorted is amazing. The braking torque saturates at only a few RPM. A constant-current circuit would enable the stepper motor to be used as an adjustable brake on reel-to-reel tape hubs.

Put the 1.5-volt cell back in its holder and try turning the motor really fast. You will notice that it feels like a slipping clutch. That is because the generated AC current is limited by the winding inductance as the frequency increases.

This constant-current generating characteristic is very useful for bicycle-lighting systems—just choose the total bulb wattage to suit the saturation current of the "alternator," and the bulb brightness remains constant above a certain threshold speed. ■

HAM RADIO

(Continued from page 91)

other stations, but rather for QSO's in progress. It is then possible to break in and ask for a quick QSO at the end of the present QSO. In fact, many DX stations will ask for additional contacts before moving on.

Also, don't assume that an American accent means a stateside station. There are scores upon scores of thousands of U.S. citizen's living and operating abroad under their own or foreign call signs. They are military, civilian U.S.-Government employees, corporate employees, academics on sabbatical, missionaries, and scores of other "Yanks" on foreign soil.

The sunspot activity has not been higher than it is this year since the DX "Golden Era" in the late 1950's. It's eleven-year cycle is very favorable to hams right now. Even with low power and a non-premium antenna system, you can earn both DXCC and WAC with relative ease...something that won't be true in a few years. ■

EIA

(Continued from page 77)

earlier that C1 can range from .001 to 100 μF and R1 can be any value between 1000 ohms (1k) and 10 megohms.

First change the value of R1 to 500k by placing a second 1-megohm resistor in parallel with the resistor currently used as R1. Now calculate the timing interval and record that value. Then initiate a timing cycle as before, taking note of its length. How does the measured time compare to the calculated value.

Now change R1 to 2 megohms by placing two 1-megohm units in series. As before, calculate the time and record that value. Initiate a timing cycle by bringing pin 2 low momentarily and take note of the length of that cycle. Compare that to your previous calculations and readings. What conclusion can be drawn from the collected data? Repeat the previous experiments, this time substituting various values of capacitors for C1.

Experiment with the other circuits and see what untold mysteries you can discover. Try using one or two in your own applications. A few applications for a couple of the circuits should immediately come to mind. ■

The Electronic Industries Association/Consumer Electronics Group has recently completed the first in a series of videocassette training tapes.

EIA/CEG ANNOUNCES COMPLETION OF NEW "BASIC CAR AUDIO INSTALLATION" VIDEO TAPE

If you are thinking of "cashing in" on the profits in the ever growing car audio service business, the troubleshooting–service–installation–and removal of car audio products is a large, non-competitive profit center for your service facility. This thirty minute video introduces you to the ever increasing complex world of car stereo installation. It guides the new installer or owner in the correct layout and design of a car stereo installation facility, covering basic as well as specialized tools needed for the installation business.

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KEY TOPICS COVERED IN THIS VIDEO

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RECEIVER CIRCUITS
(Continued from page 48)

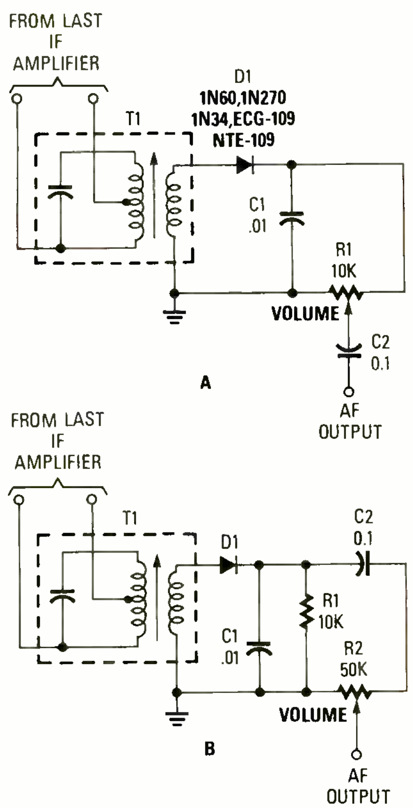

Fig. 6. Diagram A shows a conventional diode detector, while the circuit in B is a modified diode detector.

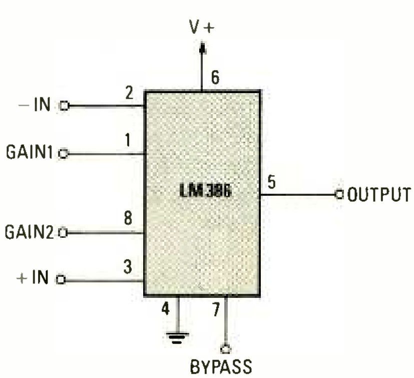

Fig. 7. These are the standard pinouts on the LM386 audio-amplifier chip.

ohms in order to properly match the input impedance of the MC1350P. The output of the MC1350P is also tuned by a similar IF transformer.

Gain in the MC1350P device is controlled by the voltage applied to pin 5 of that IC. That voltage may be varied between +3- and +9-volts DC in order to set the overall gain of the stage. The gain-control voltage supplied to pin 5 can be derived either from a manual gain control (*i.e.* a potentiometer voltage divider), from an automatic gain control (AGC) circuit, or from a combination of both.

Figure 5 shows a sample manual gain-control circuit based on a 10k potentiometer and a 5.1k fixed resistor. If a fixed gain is desired, then a fixed-ratio voltage-divider chain can be used instead. Also, it is not strictly necessary to use the same gain control for all stages in the combined IF amplifier. One can, for example, make one stage a variable-gain circuit, and set the other(s) for a fixed gain.

Detector and Audio Circuits. Once the IF amplifier builds the signal up to a point where it can be successfully demodulated with good volume, we will want a detector circuit to recover the modulated audio. The simplest AM detector is the envelope detector shown in Fig. 6. The envelope detector is a signal-diode rectifier at the output of the last IF transformer. The diode should be a germanium type such as the 1N34, 1N60, 1N270, ECG-109, or NTE-109 devices. A volume-control potentiometer serves as the load for the diode, and a 0.01-µF capacitor serves to filter out any residual IF signal that remains in the circuit following demodulation.

The detector stage must be capacitively coupled to protect the following stage because the demodulation process produces a small DC offset. The capacitor strips off the DC and makes the signal AC once again.

In some cases the audio stage following the detector contains a volume control, so an alternative circuit, such as the one in Fig. 6B is used at the detector.

The basis for our audio-output stage is the easily obtained LM386 audio-amplifier IC (see Fig. 7). The chip is available from Radio Shack and a number of mailorder sources. While the low power level leaves something to be desired, the LM386 is both better behaved and more available than certain higher powered audio chips.

Figure 8 shows the basic circuit for the LM386 chip when used as an audio stage for a receiver project. Notice that the circuit is extremely simple in that it basically has just input, output, ground, and V+ connections. The circuit is able to provide two levels of gain. If capacitor C2 is used, then the gain is 200×; and if the capacitor is deleted, the gain is 20×. Normally, the gain will be set to 20× in receiver projects unless the design provides a little gain ahead of the detector (which might be the case in the simplest superhets or in direct-conversion designs).

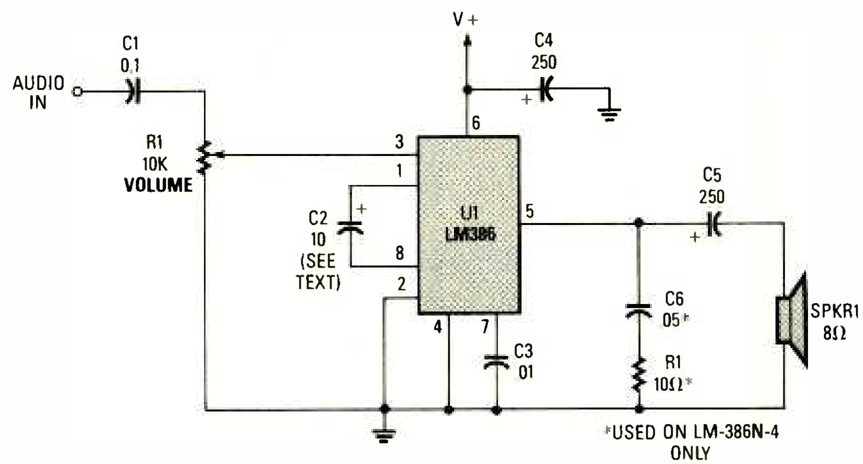

Fig. 8. Here's an LM386 connected as a receiver's audio-output stage. The bypass capacitor, C4, should not be overlooked.

The LM386 is relatively well-behaved in projects, which means that it takes only ordinary care in layout to achieve good results. It is possible, however, that because of the high gain, the IC will oscillate mercilessly if a poor layout is created. Be sure to keep the inputs and outputs physically separated, and don't allow the ground to wind its way all over the board. Use a centrally located ground and make all your ground connections to it. Also, make sure that the V+-bypass capacitor, C4, is used and is placed very close to the amplifier pins.

Conclusion. It was not the intention of this article to design a radio receiver for you, but rather to empower you to design your own radio receivers in the VLF, AM, and shortwave bands. The circuits are well-behaved and easily built using readily available components. ■

THINK TANK

(Continued from page 28)

available voltage at the transistor decreases, and with it the volume at the speaker. Then the striker signal goes low and C5 discharges quickly through D1, leaving it ready for the next cycle. That process gives the sound effect of a bell or chime repeatedly being struck.

You can tinker with the values of the resistors to change the type of effect. For instance, R3 and R4 control the pitch and R2 the spacing of the striker. Just about any general-purpose transistor or diode should work without any trouble.

—*James Parvey, Portland, OR*

I wanted to tell everybody that Jim also sent in his solution to the water problem we had, and he got it right. But Jim, we're out of the Fips Books, and are sending you a Think Tank book instead.

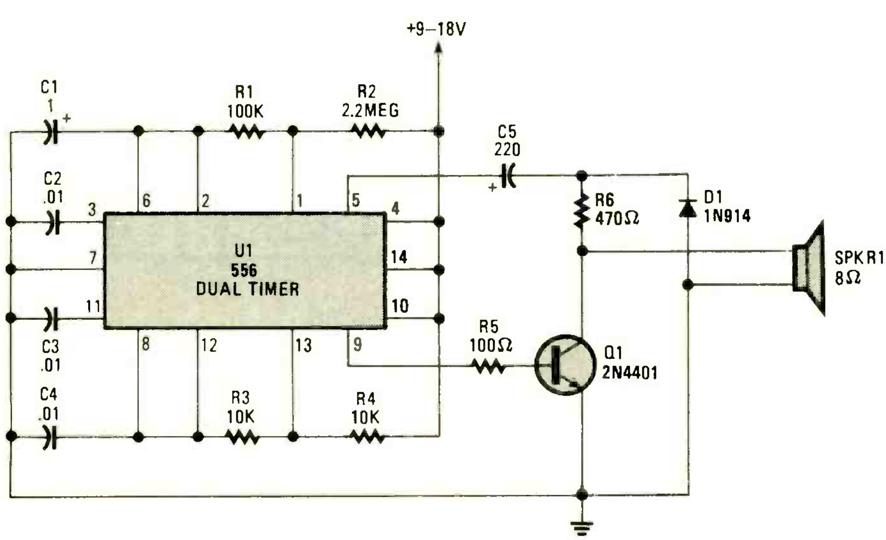

Fig. 9. The Electronic Chime is built around a 556 dual oscillator/timer, which is wired to generate two separate square waves. The first is an audio tone which sets the pitch of the bell, while the second square wave provides the "striker."

Bipolar Relay Driver. As a hobby, I build and install computer equipment for the totally disabled. With this equipment, they can dial and answer a telephone, control room lights, lock and unlock doors, operate a TV and radio, write letters on a printer, and play 30 and more games.

I could not locate a pulse-on, pulse-off bipolar relay to use as a hook switch at any of our local suppliers, and since this was an on-going problem, designed and built this relay driver. My first attempts, using flip-flops failed due to blips or other electrical disturbances turning on the telephone amplifier at some ungodly hour, like 3:00 AM.

After several tries, I came up with a rock-steady driver that hangs on like a bulldog. See Figure 10.

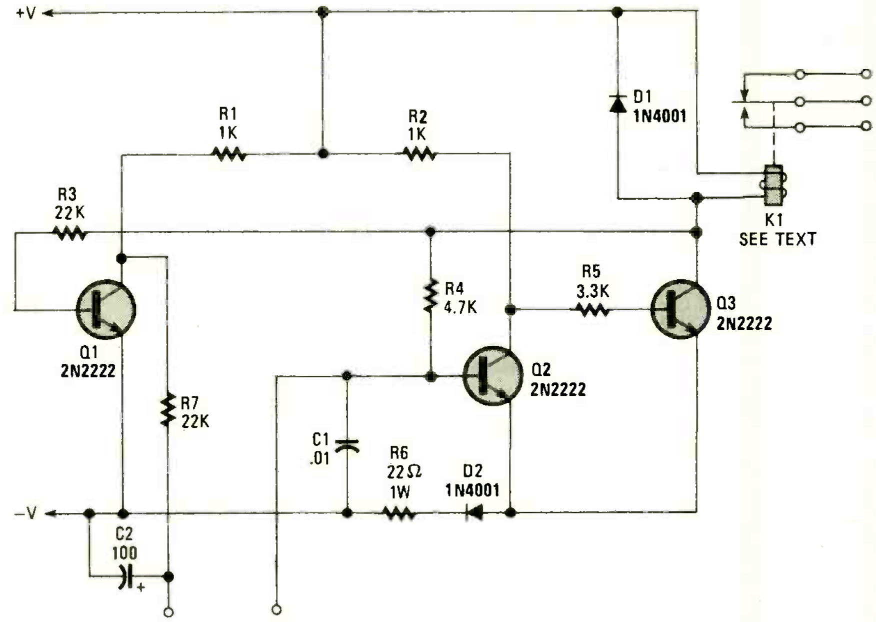

Fig. 10. The Bipolar Relay Driver circuit, consisting of three transistors and a handful of support components, is used to complete the relay's coil circuit, which then energizes the device connected across its contacts.

When power is applied to the circuit, capacitor C2 begins to charge through R1 and R7; at the same time, transistor Q3 is biased on via R2 and R5, pulling the collector of Q3 (which is connected to the base of Q1) low. When terminals T1 and T2 are bridged (via a switch or some similar device), the charge stored in capacitor C2 is fed to the base of Q2, causing it to turn on, pulling the base of Q3 low. That causes Q3 to turn off, deactivating the relay. The bias at the base of Q2 is also fed back to the base of Q1 through R4 and R3, causing it to turn on. That pulls the base of Q2 low, causing Q2 to turn off, which again turns on Q3.

—*Joe F. Sobieski, Johnstown, PA*

Good idea, Joe. It's certainly a well-thought out circuit with many additional applications. I hope our readers will file this one away, as you never know when you're going to need something like this.

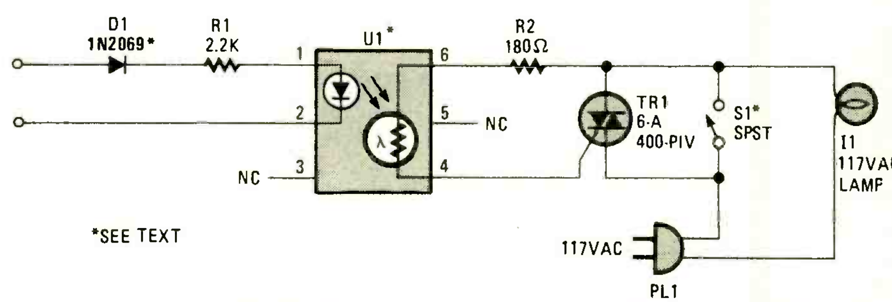

Fig. 11. At the heart of the Telephone Light is a home-made optocoupler, consisting of a light-dependent resistor (R3) and a light-emitting diode (LED1), encased in an opaque container to keep out ambient light.

Telephone Light. I had a problem at night when the telephone rang. It would wake up everyone in the house. I wanted to replace the bell with a light, but needed an optoisolator to separate the telephone from the light circuit. I decided to make my own. That was done by taking two black caps from a nose-drop bottle. I threw away the plastic nose end, leaving a rubber bulb in each cap. I then cut off the tops of the bulbs, leaving their rubber parts in the cap. I bought a cadmium sulfide light-dependent-resistor (R3) and a super-bright LED (LED1) and assembled those components as shown in Fig. 11.

To make the optoisolator, glue the two caps together and apply a layer of black electrical tape over the seam. You can touch up the ends where the leads come out with a bit of black paint. The unit works very well. Mount it in a small experiment's box and add an AC receptacle for convenience's sake.

Now when the telephone rings, the external light flashes, and you don't hear the raucous sound of the bell. Of course, the light will only come on while the phone is ringing, so add the SPST switch shown across the line, and when the phone rings, you can close that switch to keep the light on until you're ready to go back to bed.

—*Lloyd F. Thomas, Oxnard, CA*

Cute idea, Lloyd. But I'd suggest that instead of cutting off the rubber bulb, simply cut a slit in them. That way, you won't have to retouch with paint. You might also want to fill the bulb with some silicon cement which will also provide a measure of strain relief.

Well, as we say in the publishing business, "that's a wrap for this month!" We'll see you again next month, so keep the soldering irons hot and get those pet ideas of yours in right away. Do so and you might win yourself a wonderful prize, a copy of the Think Tank book. Send your ideas to "Think Tank," **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

"Social security number?"

ANTIQUE RADIO

(Continued from page 83)

the same neighborhood—but you had to be lucky to be heard more than a mile or so away. To exchange signals with an amateur-radio operator in the next town, you needed to make your equipment a little more sophisticated. And most people began by adding a home-made "condenser" (we call them capacitors now).

The condenser was made by sandwiching sections of tinfoil (usually about a foot square) between sections of plate glass (perhaps 14-inches square). There might be as many as 20 of those alternating glass-and-foil sections, and the whole shebang was held together in a wood rack. Electrical contact with the condenser was made via a pair of binding posts or other terminals. One terminal would be connected to the top foil in the stack and every other foil on down; the other terminal would be connected to the second-from-the-top foil and every other one on down. The result was that the set of foils connected to one terminal was interleaved with the set connected to the other one.

Your home-made capacitor was connected directly across the spark gap and, by storing energy between sparks, it definitely gave your sparks more power and your signal more range. But that, in itself, probably wouldn't improve your signal to the point where it would reach the next town.

Creating a Tuned Circuit. Your next logical improvement would be to add a coil in series with the capacitor and spark gap. Properly sized, the coil and capacitor would form a tuned circuit causing the transmitter to radiate most of its power at a specific, desired wavelength (as opposed to whatever the natural wavelength of the antenna system happened to be).

If you were like most folks who were ready to take that step, you added an *oscillation transformer* instead of merely a coil. The primary of that transformer acted as the tuning coil, and was wired in series with the condenser and the spark gap. The secondary (whose position with respect to the primary was adjustable) was connected in series with the antenna and ground—which were now *inductively coupled* to the spark-gap circuit instead of direct-connected as before.

Inductive coupling resulted in better power transfer to the antenna than the direct-connection scheme—and, if a *hot-wire ammeter* (which was a device for indicating the current flowing in the antenna circuit) was added to the system, the distance between the primary and secondary of the oscillation transformer could be adjusted for maximum radiated power. The oscillation transformer was also sometimes called a *helix* because of the distinctive spiral configuration of its windings.

Transformer-Powered Stations. Once all of those improvements were made, your signal might sometimes be heard at a distance of five miles or so instead of just in the next block. But if you wanted to be heard 50 or 100 miles away, you had to take a still more drastic step—one that was not for those faint of heart or light of purse.

A spark coil connected to a few dry-cell batteries could only provide a limited amount of power. But if your home was wired for electric lighting (and if the electricity supplied was the usual alternating current), you could get rid of the coil and switch over to transformer power.

Buying a high-tension transformer was a fairly large financial investment. And—if you were a teenager, as many radio experimenters were—you might also have to do quite a selling job on your parents concerning the *safety* aspects of the proposed purchase. The transformers routinely used for radio work stepped up the 117-volt house current to about 15,000 volts. But once you got one, there was no more need to fool with cranky interrupters or coax inch-long sparks out of dying batteries. Your station was now in a power class occupied by many small commercial stations of the day.

Converting to transformer power didn't change the operating principles of your station. You still needed a condenser, oscillation transformer, gap, etc. But the higher voltage and higher power required better-insulated filler and heavier duty components. So when you made that move, most of your original station would have to be replaced with much more expensive stuff.

Even your Morse key, which probably was the same light-weight model used in land-line telegraph circuits, would now have to go. Transformer rigs were keyed right in the 117-volt transformer primary circuit, where the current averaged 20 or 30 amps. So the keys required heavy-duty contacts—which were often made of silver (though platinum was considered better).

The Rotary Gap. Probably the most changed component in your new transformer rig would be the spark gap itself. The signal produced by your old interrupter-and-coil was fairly high pitched and easy to read. But a transformer operating at the normal 60-cycle household-power frequency would produce a low-pitched buzzing signal when mated with an ordinary "straight" spark gap. The sound was unpleasant and hard to distinguish through static crashes and other types of interference.

The answer was to use a "rotary" gap. A typical amateur rotary gap contained several pairs of fixed electrodes mounted in a circle on a fixed support. A motor-driven metal bar, carrying an electrode at each end, rotated within that circle. The electrodes on the bar were arranged so that they came close to, but did not touch, the fixed electrodes.

At different points in the rotation, the electrodes on the bar were positioned opposite different pairs of fixed electrodes. And each time the bar was positioned in that way, the spark would jump across that particular pair of fixed electrodes. The result was that your signal would now be an easy-to-read musical note (whose pitch depended on motor speed) instead of a buzz. The sharp operator learned to cut power to the motor when completing a transmission—producing a jaunty-sounding drop in pitch that signalled he was listening for a reply from the other station.

See You Next Month! By that time I hope to be able to complete my power supply so that I can give you an operating report on the A.C. Super-Wasp. After that, maybe we'll return to the wireless days for a while and talk about old-time receiving techniques. In the meantime, send your comments and questions to *Antique Radio*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

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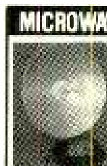

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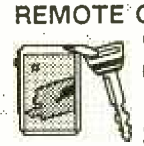

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MODEL CONTROLLER

(Continued from page 71)

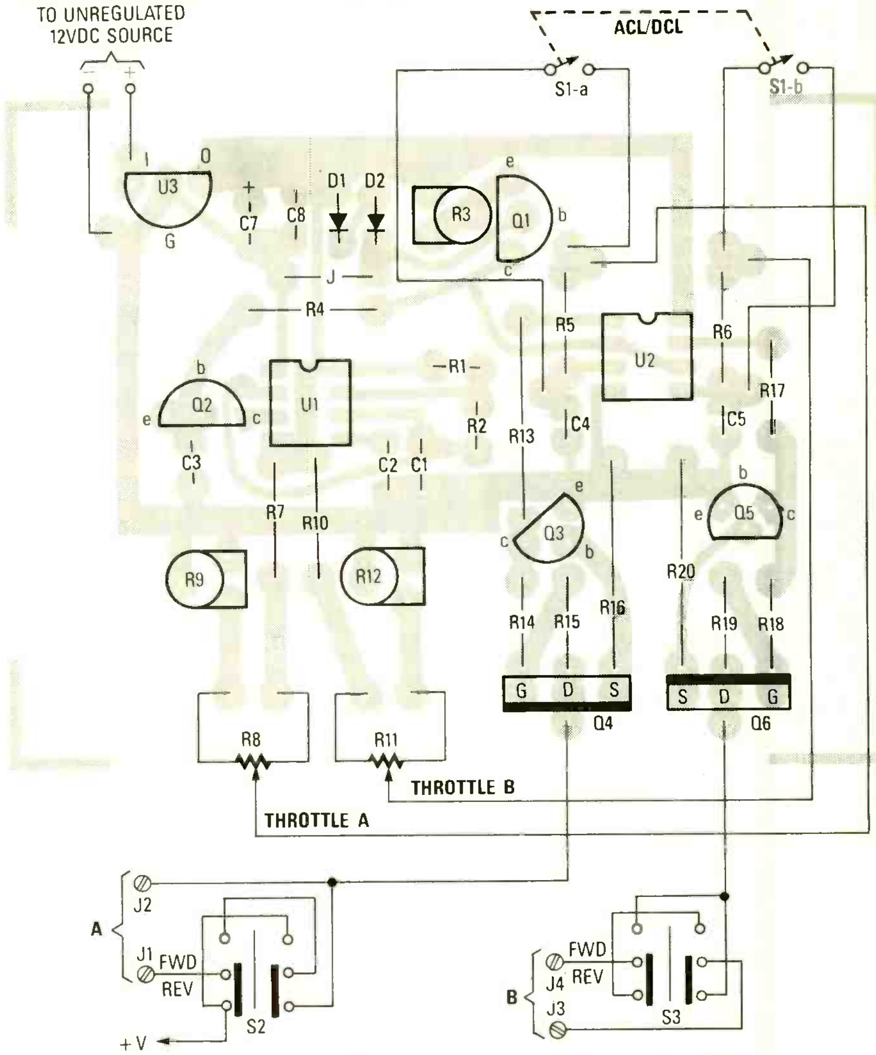
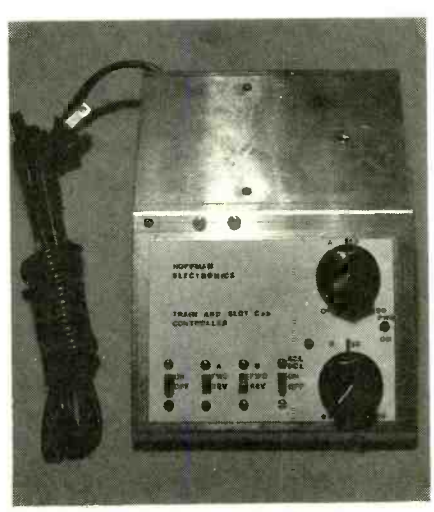


Fig. 3. Install the printed-circuit mounted components, and wire the off-board components to the board guided by this illustration. It is recommended that IC sockets be used for U1 and U2. Note that Q4 and Q6 are shown as being mounted to the printed-circuit board: they are actually mounted off-board to the project's metal enclosure.



Here's the author's completed prototype. The controller adds real-life characteristics to your model setups.

joints, solder bridges, misoriented components (particularly the polarized capacitors, transistors, and diodes). Make sure that the IC's are properly seated in their sockets (no pins bent under or outward).

If all seems correct, apply power to the circuit. LED1 should light. If not check the orientation of the power supply components (the most likely trouble spot is a misoriented bridge rectifier). If all is okay there, check the output of U1 with an oscilloscope (if one is handy). Check to make sure that the outputs of U2-a and U2-b are oscillating at about the same rate as the output of U1, and that those signals are being reproduced at the outputs of Q4 and Q6. If all goes well, close up the enclosure. Your project is now ready for use. ■

uniden®

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Uniden Corporation of America has purchased the consumer products line of Regency Electronics Inc. for $12,000,000. To celebrate this purchase, we're having our largest scanner sale in history! Use the coupon in this ad for big savings. Hurry...offer ends March 31, 1990.

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Frequency range: 29-54, 118-174, 406-512, 806-956 MHz. Excludes 823.9875-849.0125 and 868.9875-894.0125 MHz.
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Bearcat® 800XLT-T

List price $549.95/**CE price $239.95/SPECIAL**
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Bands: 29-54, 118-174, 406-512, 806-912 MHz. Excludes 823.9875-849.0125 and 868.9875-894.0125 MHz.
The Uniden 800XLT receives 40 channels in two banks. Scans 15 channels per second. Size 9¼" x 4½" x 12½." If you do not need the 800 MHz. band, a similar model called the **BC 210XLT-T** is available for $178.95.

Bearcat® 145XL-T

List price $189.95/**CE price $94.95/SPECIAL**
10-Band, 16 Channel • No-crystal scanner Priority control • Weather search • AC/DC
Bands: 29-54, 136-174, 406-512 MHz.
The *Bearcat* 145XL is a 16 channel, programmable scanner covering ten frequency bands. The unit features a built-in delay function that adds a three second delay on all channels to prevent missed transmissions. A mobile version called the **BC560XLT-T** featuring priority, weather search, channel lockout and more is available for $94.95. CEI's package price includes mobile mounting bracket and mobile power cord.

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List price $499.95/**CE price $239.95/SPECIAL**
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NEW! President® HR2600-T

List price $599.95/**CE price $299.95/SPECIAL**
10 Meter Mobile Transceiver • New Features
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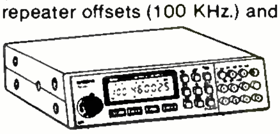

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