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APRIL 1989

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APRIL 1989, VOLUME 6, NO. 4

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DEPARTMENTS

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Editorial

ARE HARD DISKS IN FOR HARD TIMES?

Remember when hard disks were referred to as Winchester drives? You can still be under 30 years of age, and go back to the beginnings of personal computers. It took time for hard disks to come down to a reasonable price level. And now that they are here in 20-, 30-, 40-megabyte, and larger capacities for home use, hard disks are facing obscurity!

Enter the erasable CD—*re-writeable* optical media. As 1988 came to an end, Sony announced a magneto-optical disk-drive system with a removable 5¼-inch disk capable of storing up to 650 megabytes. The new disks no longer require a micro-laser beam to wallop pulses of coherent light onto a polished surface, marring it permanently.

The magneto-optical process relies on the ability of a micro-laser to pinpoint a minute spot on a single magnetized disk. The disk contains magnetized crystals whose orientation can be altered when the crystal material is heated. The laser warms to the spot to its "Curie point," the point at which the disk's magnetic field is reversed. Each field reversal corresponds to a "0" or a "1," and each piece of data is packed closely together as only the micro-laser can do it.

Reading the stored data is practically a reverse effect—a low-level laser scans the rotating disk, the reflected light changes polarizations as it passes over magnetic islands (the physicists refer to that phenomenon as the Kerr effect), and the detected light is read as digital material. Read-back rates of 7 to 9-megabits per second are currently possible—admittedly, that's a bit slower than a magnetic disk.

Now the big question is, "Should I junk my hard disk and buy an erasable CD drive?" Not just yet; most of the newly developed units are aimed at the business user, who can afford to pay a price for the unit that will cover the cost, research and development, and profit. In other words, the price is high! Wait until the competition gets tight, production expands, and the market demands low-cost units.

That's when hard disks are in for hard times.

Julian Martin

Julian S. Martin, KA2GUN
Editor

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RESP489

Letters

BASIC ACNAP

I'd like to answer a question that I received about my article, "AC-Network Analysis Program," which appeared in the October 1987 issue of **Hands-on Electronics**. To convert ACNAP to run under Commodore BASIC, try eliminating the magnitude function (FNMAG) altogether. Replacing the original lines with the following ones should do the trick:

```
1040 REM
3010 B=SQR(A(I,I,0)^2+A(I,I,1)^2)
3030 T=SQR(A(K,I,0)^2+A(K,I,1)^2)
3035 IF T)B THEN B=T : HF=K
3440 MAG=SQR(A(I,N1,0)^2+A(I,N1,1)^2)
```

James E. Tarchinski

LOST AND FOUND

I would like to build the "Access Two Tone Dialer" that appeared in the June 1988 issue of **Hands-on Electronics**. However, I have not been able to locate a source for the TP53130 DTMF touch-tone generator IC.

The company listed in the article's Parts List doesn't seem to exist any more. Do you know where I can purchase that chip?

S.T.
Warren, VT

Companies come in all shapes and sizes. Some are multi-national, multi-billion-dollar-a-year concerns. Others are part-time operations whose place of business is the owner's garage. Most often, companies who put together kits of parts for magazine articles are closer to the latter, and many don't even have a business telephone listing (because there is no one around to answer it most of the time). Therefore, just because you can't find a listing in the phone book or through directory assistance, doesn't mean the company doesn't exist. It only means that all of your contact with that company must be through the mails.

That's the case here. The company you are looking for, Syntronics, is still around and supplying the IC. However, their address has changed: the new address is 2310 Sweetwood Rd, Nashville, TN 37214. In addition, the listed alternate, the MM53130, is available from Jameco (1355 Shoreway Rd., Belmont, CA 94002) and elsewhere.

PERSONAL POCKET PAGER

In reference to my article, "Personal Pocket Pager," (**Popular Electronics**, January 1989), please note the following corrections. In Fig. 6, resistor R16 (immediately below U2) is incorrectly labeled R6. In the Parts List for the RF Receiver, resistor R16 should be 130 ohms, and resistor R14 should be 10 megohms.

I'd also like to thank you for the excellent comments about Herb Friedman; he will be missed by all of us.

Dan Becker

JOIN THE CLUB

I'm 17-years old, and have been an electronics hobbyist and an avid reader of your magazine for many years. I am also the president of an electronics club that was recently formed at my high school. **Popular Electronics** has been an invaluable educational tool for the construction of projects.

My problem is that no one on the staff at school knows very much about electronics. As a result, I'm faced with the great task of answering every possible question on the subject that happens my way. I know a few people in the field, so outside help really isn't a problem—but that doesn't help much when an answer is expected immediately. Despite that little difficulty, the club is proving to be very successful. We recently mounted a light show for one of the school dances, and we plan to use lasers later on.

I would greatly appreciate any advice that any of my fellow readers could give regarding managing and teaching an electronics club. It might provide even better ways to help the club explore the fascinating world of electronics.

John Balderson
2243 Eglinton Ave. E., Apt. 513
Scarborough, Ontario
Canada, M1K 2N2

PAD PROBLEM

I have discovered a problem in the PC-board pattern in my article, "DTMF Field Phone," which appeared in the February, 1989 issue of **Popular Electronics**. Two pads that must be kept separate have bled together. Please alert your readers that the pad for R4 must not touch the group of pads that connect to the positive side of buzzer BZ1. If it does, the buzzer will not sound.

My goal is to always make my project articles as trouble-free as possible. I hope that this error hasn't discouraged anyone.

By the way, I grew up reading **Popular Electronics** and I am happy to see that you have revived the name. I am proud to have had my article published under such a distinguished banner.

Sam Allen

HAVES AND NEEDS

A friend of mine receives **Popular Electronics**; when I visited him recently I had the pleasure of reading a few issues. The "Haves and Needs" section prompted me to write this.

I have some old radios, including a mint-condition Detrola AM/FM/SW (model TS-125L), and a Stromberg-Carlson AM/FM/TV console (model 326). I need to find a schematic for the console, and any other information I can get my hands on so that I can start checking the unit out. As for the Detrola, although I have the original book that came with it, it doesn't contain a schematic. If someone has either of those schematics, I'd be very happy to receive a copy!

Joel Lautzenheiser
P.O. Box 8083
Toledo, OH 43605

I have a question for the readers of **Popular Electronics**. I recently purchased a used tube tester at a swap meet. It was made for the U.S. Army Signal Corps by the Daven Company of Newark, NJ; its model number is I-177-B. I tried to contact the manufacturer by mail and by phone, but they are no longer in business. I am looking for an owner's/operating manual for the unit. Can any readers help me out?

Bob Plante
1032 Oneida
El Paso, TX 79912

I'm looking for any information you or your readers might have on an oscilloscope. It's an EICO model 460 that was built from a kit. I've had it for two years, and I'd like to be able to use it. Thanks for printing my request.

Tom Boswell Jr.
38 Sharon Drive
West Pittsburg, CA 94565

A NEW DIMENSION

A small error appeared in my article "Sound Activated Kaleidoscope" (**Popular Electronics**, January 1989). On page 67, in the paragraph that describes the cylinder that holds the kaleidoscope to the speaker should read: "...to form a cylinder that's about 1/2-inch larger than the center of the speaker cone...".

Don Anderson

SEQUENTIAL LIGHT CIRCUIT

I have constructed the "Mini-Marque" circuit that appeared in the September 1988 issue. I like it, but I am now interested in a circuit that would have 24 or 32 LED's operating sequentially and continuously. Do you know where I can obtain such a schematic?

I also wanted to tell you how much I enjoy **Popular Electronics**. As soon as I receive it, I open it and don't put it down until I've read every interesting item. Please keep up the good work.

E.A.B.
North Hollywood, CA

Take a look at the "Dice-Roulette Game" story, which appears elsewhere in this issue. That circuit is designed to light 36 LED's in sequence; however, as explained in the article, it can be modified to work with any number of LED's. Perhaps that will do what you seek. ■

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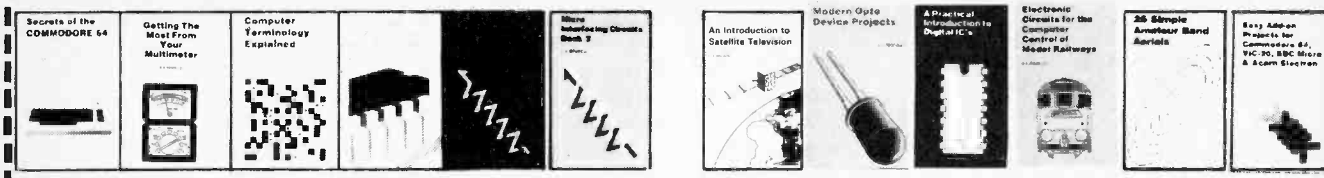

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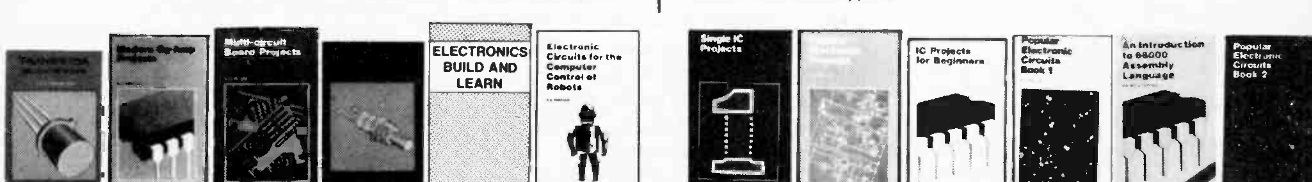

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50 CMOS IC PROJECTS

by Delton T. Horn

Written for the intermediate experimenter or hobbyist, this book provides practical projects designed to use CMOS IC's (complementary metal-oxide semiconductor integrated circuits). CMOS IC's are popular because they can function within a wide range of voltages, are inexpensive, and are readily available on the hobbyist market. In this book, Delton T. Horn prefaces the projects with a broad introduction to digital electronics and CMOS IC's.

The projects are all designed to be constructed in one or two evenings. Full schematics, including working diagrams and parts lists are provided, and construction hints and project variations are offered. A sampling of the projects includes timekeeping circuits, music-making projects, binary circuits, LED flashers, test equipment, control circuits, signal-generator projects, and game circuits.

50 CMOS IC Projects is available for $16.95 from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

ACOUSTICS SOURCE BOOK

edited by Sybil B. Parker

This book examines the science of sound, including its production, transmission, and detection. Significant applications, ranging from architectural acoustics to medical acoustics, are also discussed. The book is designed to provide quick, convenient access to reliable and up-to-date material for professionals, students, and educators.

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Acoustics Source Book is available in hardcover for $35.00 from McGraw-Hill Book Company, 11 West 19th Street, New York, NY 10011.

CIRCLE 96 ON FREE INFORMATION CARD

THE FROZEN KEYBOARD: Living With Bad Software

by Boris Beizer

With the idea that when things get bad enough, your best bet is to laugh, the author takes a tongue-in-cheek approach to a serious subject: coping with bad software. Aimed primarily at frustrated, novice PC users, the book strives to remove some of the obstacles they face. It tries to help the beginner to recognize the difference between his own errors and those that are caused by ill-conceived and poorly tested software. The book is unique in that it presents a great deal of concrete information in a non-technical, humorous manner.

The layout is different as well. The first chapter is an overview of the book; subsequent chapters deal with independent topics, and need not be read in order to be meaningful. A combination glossary/index does a good job of pointing the reader to precisely the right spot in the text, while providing brief explanations of each term. For those who require a more in-depth explanation, there is a tutorial section that covers such basic subjects as getting started, the various hardware components, installation, and "bugs" or "glitches." The glossary and tutorials keep the main text from getting bogged down with repetitive definitions and basic concepts. If the reader encounters an unfamiliar term, a quick check of the glossary should clear things up; further information will most likely be found in one of the tutorials.

With an insider's perspective of software, the book discusses how to rate the quality of various programs; how and why bugs exist, and what to do about them; why programs crash; menu-driven and command-driven software; and how to interpret user's manuals. The text is interspersed with charts, diagrams, illustrations of typical screens (showing commands and menus), and cartoons that novice users will surely relate to.

The Frozen Keyboard: Living With Bad Software is available for $17.95 from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

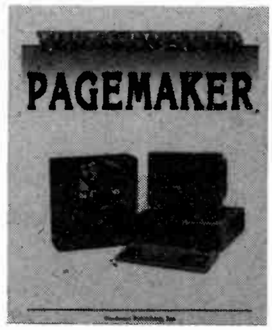
CIRCLE 98 ON FREE INFORMATION CARD

ILLUSTRATED PAGEMAKER

by Phyllis Moore

This book is intended to help readers master the skills needed to create typeset-quality books, brochures, and newsletters using PageMaker—a desktop publishing program that runs under Microsoft Windows on IBM PC's and compatibles. Detailed descriptions of all the PageMaker commands are included, along with examples and practical suggestions for applying those commands to real situations.

After a brief introduction and an explanation of how to get the program up and running, the topics discussed are arranged alphabetically, in "learning modules." Designed to be both a handy reference guide and a comprehensive user's manual, the alphabetic arrangement makes it easy for experienced users to find what they're looking for quickly. For beginners, there is a recommended learning sequence; by following that sequence, a beginning user is guided from the simplest, most-often used commands through the more advanced, less common commands.



Each module contains a description of the typical operations of the command, and learn-by-doing exercises. The self-contained modules (each begins with starting up PageMaker and ends with leaving it) can each be used as an isolated unit, although it is integrated into the recommended learning sequence.

Illustrated PageMaker is available for $19.95 from Wordware Publishing Inc., 1506 Capital Avenue, Plano, TX 75074.

CIRCLE 71 ON FREE INFORMATION CARD

MODERN RECORDING TECHNIQUES
Second Edition

by Robert E. Runstein
and David Miles Huber

The first edition of this book, which was written to bridge the information gap between sound engineers, record producers, and recording artists, has been used as a teaching and reference manual by thousands of professionals in the popular-music industry. It introduces readers to recording-studio equipment and controls, and to recording techniques and their role in creating a finished product.

The second edition has been updated to include information on the latest digital-recording and -processing techniques, including digital mastering to compact disc; new digital-effects devices; and the equipment, controls, and problems that are encountered in modern, multitrack recording studios. The major shift in studio acoustic design is discussed, along with the "marriage" of video and multitrack studios.

The central concept of a transducer and its place in the recording process is explored, as are amplifier basics, noise reduction, signal processing, microphone techniques, and the conversion of sound energy into electrical energy. The book explains the setup, operation techniques, and procedures used in the process of recording, overdubbing, and mixing, and the theory of disc recording, cassette duplication, and compact-disc production.

Modern Recording Techniques: Second 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

DIGITAL COMMUNICATIONS WITH AMATEUR RADIO:
The Complete Book of Packet Radio

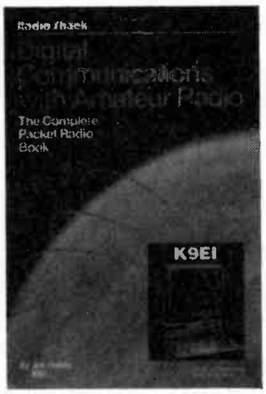
by Jim Grubbs, K9EI

If you're a computer enthusiast looking for new ways to communicate with other hackers, or a ham who wants to expand your amateur-radio network, packet radio could be just the ticket. Packet data communications can be used to exchange anything that can be digitized—text, images, music, and voice—at high data-transfer rates. Combining the freedom of radio with the power of the computer, packet has been likened to networking without wires, or to a modem that links computers by radio instead of by wires.

This comprehensive book presents the vital information needed to get into packet radio. For those who are familiar with computers, but not with amateur radio, there are explanations of amateur-radio links and

Electronics Library

interfaces, as well as packet-radio techniques, protocols, and licensing. For amateur-radio operators, there is a review of the basics of telephone-line digital communications, and how to interface digital equipment and ham gear. For all readers, the book presents a look at how to get everything connected and actually operating. The



book describes packet-radio accessories, innovations, and organizations, and explores packet satellite operation.

Digital Communications with Amateur Radio: The Complete Packet Radio Book is published by Master Publishing, Inc., 14 Canyon Creek Village MS 31, Richardson, TX 75080. It is available at local Radio Shack stores for $6.95.

CIRCLE 72 ON FREE INFORMATION CARD

WORDPERFECT 5 INSTANT REFERENCE

by Greg Harvey
and Kay Yarborough Nelson

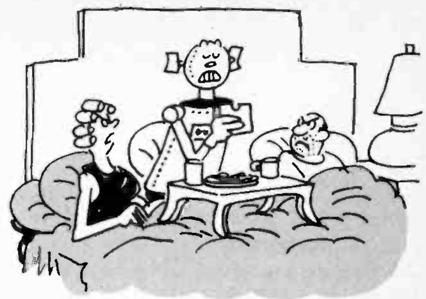
This book is designed to give WordPerfect users the essential information needed to get the most out of version 5, as quickly as possible. Intended for people who are familiar with WordPerfect 5's basic operations, it provides quick and easy access to both simple and complex information whether the user is "stuck" on a certain function, or just needs a refresher on a particular procedure.

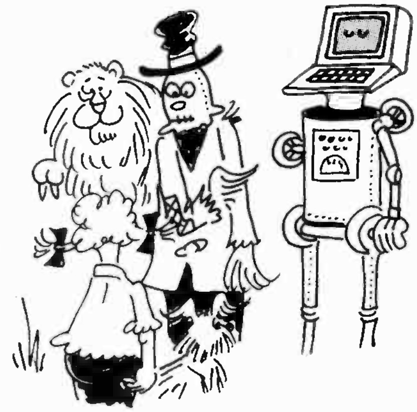
All WordPerfect commands are featured, arranged alphabetically. For each one, the book shows the exact keystroke sequence, how the command is used, a list of available options, additional notes, and a reference to any related functions. There is a brief discussion of the differences between version 5 and earlier versions, and appendices cover installation, hidden formatting codes, and WordPerfect's new macro command language. All desktop-publishing fea-
(Continued on page 12)

The coming generation...

FRIENDLY ROBOTS

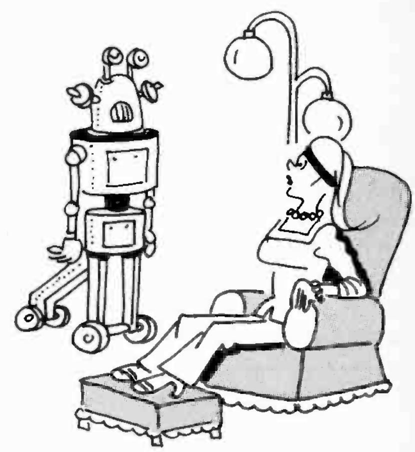
By Harry Nelson


"When I said, 'We'll have breakfast in bed,' I meant my husband and me!"

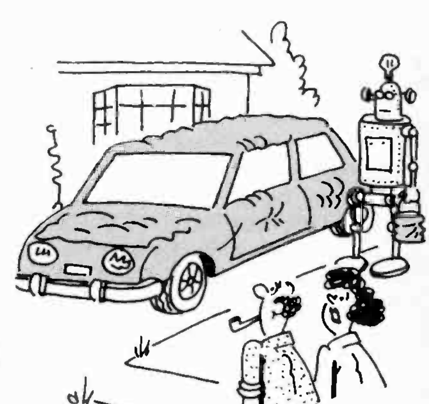

"You better ask the Tin Man, Dotty, He's the smart one!"


"Officer, Xyman is okay! It's my wife that's run amok."


"Here's Shelli. Her specialty is anything that's deep fried."


"Beep...I cannot answer the door, madam. It does not speak."


"Besides serving drinks, XDO-4 has an attachment to cut grass."


"It was you who told Robbo to wash the car and to use a bucket!"

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(Continued from page 8)

tures—including mixing graphics and tables with text, and how to work with columns, bullets, fonts, and other special effects to enhance finished documents—are included.

WordPerfect 5 Instant Reference is available for $12.95 from Sybex, Inc., 2021 Challenger Drive #100, Alameda, CA 94501.

CIRCLE 73 ON FREE INFORMATION CARD

UNDERSTANDING EXPERT SYSTEMS

by Louis E. Frenzel, Jr.

Lou Frenzel brings his down-to-earth teaching style and writing skills to the world of expert systems—problem-solving computer software that enables computers to reason like humans. The text is supported by ample illustrations and self-quizzes, and reinforced by a glossary, bibliography, and vendor list.

An overview of expert systems explains the basics of artificial intelligence (AI) and the broad field of problem-solving computing, and describes some well-known, pioneering expert systems. The book goes on to examine different types of expert systems, along with their applications in business, industry, government, and the military. It looks at how knowledge can be represented in an expert system's knowledge base, and at various search strategies, including breadth-first, depth-first, forward-changing, and backward-changing searches.

Frenzel describes how expert systems actually work, exploring their architecture

in detail. An examination of the tools used in programming expert systems includes the use of conventional programming languages and the special languages created to deal specifically with AI needs, such as LISP and Prolog. The ten steps to follow in creating an expert system are detailed; the reader is led through those steps to create a hypothetical system.

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

CIRCLE 95 ON FREE INFORMATION CARD

AMATEUR RADIO: Theory and Practice

by Robert L. Shrader

This book is aimed at anyone who wants to get an amateur-radio license, but has little or no previous experience in radio or electronics. It explains the basic theory that is necessary to pass all of the FCC's amateur-radio license exams—from the simplest subjects to the more advanced topics that the FCC will probably be using to develop new tests. The information needed to properly operate an amateur-radio station and its equipment is also included.

The book opens with a discussion of the scope of the Amateur Radio Service, the grades of amateur licenses, and some interesting aspects of amateur radio. Most of the other chapters present the basic electrical, electronic, and radio theory that is needed to pass the written license exams and that will give the reader a firm understanding of modern radio communications. Each chapter in the book ends with sample test questions that differ from the official questions only in wording.

A "how to" section outlines how to send and receive the required radio code needed for any of the amateur licenses, and briefly explains amateur communicating and message handling. There is also a condensed version—in non-technical language—of the FCC amateur-radio rules and regulations.

Amateur Radio: Theory and Practice is available for $28.95 from McGraw-Hill Book Company, 11 West 19th St., New York, NY 10011; 1-800-2-MCGRAW.

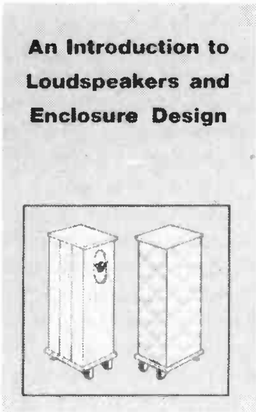
CIRCLE 96 ON FREE -FORMATION CARD

AN INTRODUCTION TO LOUDSPEAKERS AND ENCLOSURE DESIGN

by V. Capel

A loudspeaker cabinet is much more than just a box to hold speakers. There are many types of enclosures and drive units, and each has its own good points and drawbacks. This book explores those features and, in particular, examines what causes strengths and weaknesses in different enclosure designs. With an understanding of the principles involved, readers will be better able to make informed choices of loudspeaker design—or even design their own loudspeaker enclosures.

The book describes the moving-coil driver in detail, as well as alternative drivers. Crossover units are discussed, including the various types, how they work, the distortions they produce, and how to avoid them.



There are also step-by-step instructions on how to build a *Kapellmeister* loudspeaker enclosure. That design involves unique features that overcome many of the disadvantages of more conventional speakers. The Kapellmeister is a transmission-line speaker that offers remarkable stereo imaging and an uncolored musical sound. It takes up minimal floor space, and is inexpensive to build.

An Introduction to Loudspeakers and Enclosure Design (Order No. BP256) is available for $7.95, including shipping, from Electronics Technology Today, P.O. Box 240, Massapequa, NY 11762.

CIRCLE 97 ON FREE INFORMATION CARD

SUCCESSFUL ENGINEERING
A Guide to Achieving Your Career Goals

by Lawrence J. Kamm

Taking engineers a step beyond their technical classroom training, this book concentrates on the intangible, qualitative skills that are needed to excel in the field of engineering design. It provides solid advice on ways for design engineers—in such fields as mechanical, electrical, industrial, and

Electronics Library

chemical engineering—to capitalize on their natural abilities, adapt to on-the-job pressures, and plan rewarding career paths.

The book describes how to cultivate inventiveness while developing an eye for designs that combine quality, reduced cost, reliability and simplicity. It demonstrates how to design within the constraints imposed by budgets, legal contracts, specifications, and other practical considerations. Keeping up-to-date is essential; continuing formal studies, and using consultants, vendors, and libraries are examined as ways to broaden the engineer's knowledge base. There is also a strong focus on dealing with people—company politics, the art of persuasion, ethical dilemmas, efficient use of time, making smart career choices, and coping with corporate accountants are some of the human factors covered in the book.

The author considers "successful" engineers to be those who produce the best designs of which they are capable; get those designs accepted and used; are well rewarded in terms of money, position, and security; and enjoy their work. The advice he presents is based on his own long engineering career; the text is filled with real-life examples and anecdotes.

Successful Engineering: A Guide to Achieving Your Career Goals is available in hardcover for $39.95 from McGraw-Hill Book Company, 11 West 19th Street, New York, NY 10011; Tel. 1-800-2-MCGRAW.

CIRCLE 96 ON FREE INFORMATION CARD

ENHANCED SOUND: 22 Electronics Projects for the Audiophile

by Richard Kaufman

Here's a book for anyone who's looking to get better sound from his audio systems without spending a lot of money. But saving money isn't the only benefit—some of these projects simply aren't commercially available.

All of the projects presented are designed to boost the performance and capabilities of different types of audio systems. They include a practical infinite-slope crossover network using pole-zero cancellation, computer programs for designing speaker enclosures, indoor FM antennas, rhombic antennas, multiple-pole feedback filters, and stereo-image enhancers. Also included are a surround-sound decoder, an auxiliary input switch, tone controls, a shuffler, an amplifier-bridging circuit, and helical antennas.

While some previous kit-building experience might be helpful, those readers who are complete beginners will find all the information needed to build each project. Any printed circuit boards that are called for are available from Radio Shack, and tips are included on soldering, finding parts, and general construction techniques. The basics of theory, design, and application are explained, and readers are encouraged to adapt the circuits for their own specific needs.

Enhanced Sound: 22 Electronics Projects for the Audiophile is available for $9.95 from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

THE ILLUSTRATED DICTIONARY OF ELECTRONICS:Fourth Edition

by Rufus P. Turner and Stan Gibilisco

More than 27,000 terms used in today's electronics can be found in this reference book. The comprehensive dictionary includes all practical electronics and computer terms. The fourth edition has been updated to reflect the newest advances in the field.

The 650-page book includes over 450 detailed drawings and diagrams, along with the textual definitions. It also features tables and data on those subjects that are most often consulted for projects and experiments. There are Fahrenheit/Celsius temperature-conversion charts and English/metric and metric/English conversions for units of measure of energy, power, and volume. Illustrations of schematic symbols are included. Tables and data charts include resistor-color codes; mathematical signs, symbols, and operations; and electronic abbreviations.

The Illustrated Dictionary of Electronics: Fourth Edition is available for $23.95 from Tab Books Inc., Blue Ridge Summit PA 17294-0850; Tel. 1-800-233-1128. ■

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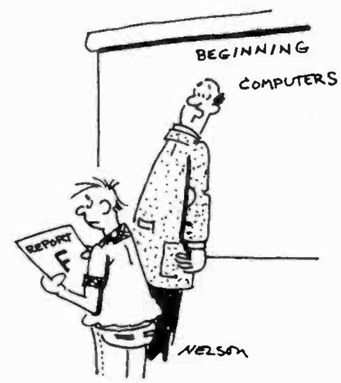
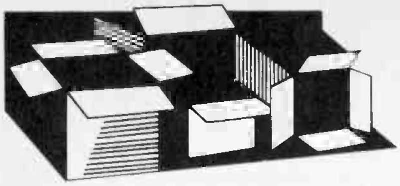


"The real computer error happened when it placed you in this class!"



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

EMERGENCY CB RADIO

Midland's Model 77-909 is a 40-channel, emergency CB radio. It is small enough to stow easily in a glove compartment or under a car seat, and a one-touch Channel-9 memory button provides instant access to the emergency-communications channel that can bring help quickly on the road.

The 77-909's has ETR frequency control for pinpoint channel-tuning accuracy,

fully variable squelch control, and a high-intensity green LED readout system. Separate up and down channel-selector buttons with two speeds provide fast tuning. The unit includes a built-in condenser microphone for improved audio transmissions, a pre-tuned telescopic antenna with magnetic-mount base, and a rugged vinyl carrying case.

The 77-909 emergency two-way radio has a suggested retail price of $149.00. For further information, contact Midland International, Consumer Products Division, 1690 North Topping, Kansas City, MO 64120.

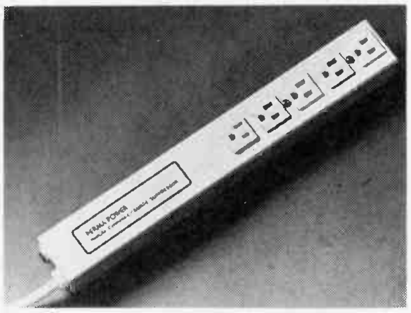
CIRCLE 75 ON FREE INFORMATION CARD

REMOTE SURGE SUPPRESSOR

The Model RW-500 remote surge suppressor from Perma Power Electronics protects a computer workstation from transient surges on the power line, and permits the entire system to be turned on or off from the computer monitor switch.

The surge suppressor has five outlets—a master and four auxiliaries. Its design incorporates a unique circuit that monitors the power flowing through the master outlet, so that when any equipment that is connected to the master outlet is switched on, the other four outlets are switched on simultaneously. That allows the monitor—or whatever peripheral is plugged into the master outlet—to serve as a convenient control point for the entire workstation, while the surge-suppressor strip and power cords are hidden neatly out of sight.

The RW-500 offers computer-grade protection in the normal mode (line-to-neutral), and in both common modes (line-to-ground and neutral-to-ground). It responds in one nanosecond, and has a maximum energy dissipation of 480 joules, 160 in each mode. The surge suppressor's clamping threshold is 225-volts peak, and it is rated for a



maximum transient voltage of greater than 6,000 volts.

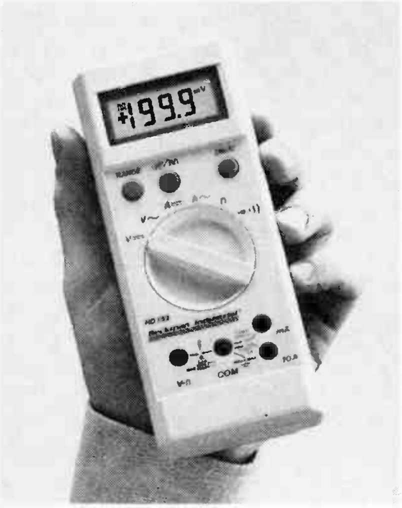
The UL-listed RW-500 remote surge suppressor has a suggested retail price of $99.90. For further information, contact Perma Power Electronics, 5601 West Howard Avenue, Chicago IL 60648.

CIRCLE 76 ON FREE INFORMATION CARD

HEAVY-DUTY DMM'S

Beckman Industrial's HD153 is one of their HD150 Series of $3^1/_2$-digit, auto-ranging digital multimeters. Offering hands-free usage and audible signaling, those heavy-duty meters are designed to go anywhere, under all conditions. Beckman claims that the DMM's are rugged enough to survive a 10-foot drop to concrete; they warranty the meters against outside contamination for five years and for two years against other damage (except in the case of abuse).

The meters are designed so that the user can keep his hands and eyes on the job. The HD153 features a "Skyhook" that can be flipped out from its back so that the meter can be hung up, as well as a tilt stand. With the auto-ranging feature, after function selection the proper range is set automatically by an internal microprocessor and readings are presented audibly. By listening to the continuous tone, which is proportional to the magnitude of the reading, the user does not have to look at the meter. The HD153 also points out intermittents by emitting a "crackling" sound as they are detected—faster than the information would appear on any DMM display. Using standard test leads, the HD153 detects the presence of most standard logic signals, and



alerts the user with a beep. The combination of those features is intended to make the HD 153 "attention-free." (On those occasions when hands-on usage is preferred, the unit is light, compact, and comfortable to hold.)

The DMM features DC-voltage ranges of 200mV, and 2, 20, 200, and 1500 volts, with resolution of 100µV and accuracy is 0.25% + 1 digit (4% + 1 digit for 1.5-KV range). AC voltage ranges are 200mV, and 2, 20, 200, and 1000 volts, with resolution of 100µV and accuracy of 75% + 3 digit + 300 µV (for the 45Hz-1kHz band) and 2.0% + 7 digit + 300µV (for the 1 kHz-2kHz band). AC- and DC-current ranges are 20mA, 200mA, and 10A with resolution of 10 µA.

The HD 153 digital multimeter—complete with battery and fuses installed, a spare 250mA/600V fuse, test leads, and operator's manual—has a suggested retail price of $199.99. For further information, contact Beckman Industrial Corporation, Instrumentation Products Division, 3883 Ruffin Road, San Diego, CA 92123-1989.

CIRCLE 77 ON FREE INFORMATION CARD

HIGH-END CAR SPEAKERS

The models *TS-U160* (pictured) and *TS-U130* represent the top of *Pioneer's* "Sound Series" line of car speakers. Aimed at high-end buyers, both speakers feature dual-strontium magnets, a carbon-fiber-blend polypropylene cone woofer, and a titanium dome tweeter, for a full range of audio response.

The TS-U160 is a 6½-inch, two-way, door-mount speaker that offers 100-watts maximum power and features a frequency response of 30 to 30,000 Hz and a sensitivity rating of 89 dB. The 5¼-inch door-mount TS-U130 is rated at 60 watts and has a measured frequency response of 37 to 30,000 Hz and 88-dB sensitivity.

All of the "Sound Series" speakers are built using an injection-molding process that aligns carbon-fiber particles and improves cone rigidity, resulting in smooth reproduction of both mid-range and high frequencies. A high-quality L/C crossover network insures proper frequency distribution. The tweeters use magnetic fluid in the voice

coil for improved linearity and reduced harmonic distortion, and a concealed lead wire to avoid interference with woofer movement. The speakers are styled to blend attractively with automobile interiors.

The TS-U160 and TS-U130 car speakers have suggested retail prices of $180.00 and $150.00, respectively. For further information, contact Pioneer Electronics (USA) Inc., 2265 E. 220th Street, P.O. Box 1720, Long Beach, CA 90801-1720.

CIRCLE 78 ON FREE INFORMATION CARD

HIGH-DEFINITION TUNER/AMPLIFIER

Nakamichi's Model TA-3A is a 75-watt, high-definition tuner/amplifier that is designed to be the focal point of a complete audio/video home-entertainment system. It allows existing Nakamichi customers to upgrade their systems without replacing their current components, and features STASIS output circuitry and unified system remote control. The unit provides remote control of a CD player and two cassette decks (including azimuth control on decks with an azimuth-control feature), as well as arm-chair control of power; volume; muting; and station, band, and source selection.

The TA-3A accesses three external audio/video sources (Video 1, Video 2, and Tape-2/VCR) and three audio-only sources (CD, Phono, and Tape 1) as well as its own AM/FM stereo tuner. Pre-Out/Main-In jacks allow the user to connect a surround-sound processor, a subwoofer, or other audio signal-processing equipment at the ideal point in the signal path. A video output is provided to drive a viewing monitor.

Independent selectors permit viewing and listening to one source while copying another; the "Record-Out" selector allows audio/video recording from either video source to the Tape-2/VCR output, and two-way audio dubbing between the Tape-1 and the Tape-2/VCR equipment. Both the video-monitor and the VCR-record outputs are buffered by discrete 3-stage wideband video amplifiers for optimum recording and viewing.

The tuner/amplifier features a quartz-synthesized AM/FM stereo tuner with 10 station presets and a choice of manual or

auto-seek tuning. The tone controls' effect is purposely limited to the extremes of the audio range so that substantial boost or cut can be applied there without altering the midrange response. Other features include audio mute and variable loudness contour that tracks the reduction in bass and treble hearing sensitivity as the listening level is reduced.

The TA-3A uses a STASIS output configuration; it neither requires nor uses "global" feedback to reduce distortion. That makes the amplifier inherently stable with every loudspeaker, and keeps its output impedance uniform with frequency-resulting in a louder and cleaner amplifier that can drive "difficult" speakers.

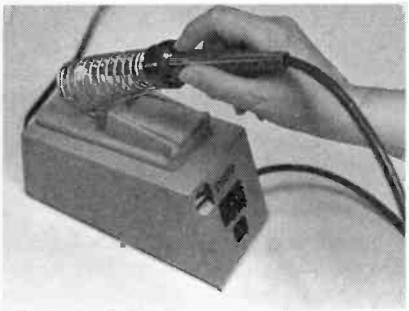
The TA-3A high-definition tuner/amplifier has a suggested retail price of $795.00. For additional information, contact Nakamichi America Corporation, 19701 South Vermont Avenue, Torrance, CA 90502; Tel. 800-421-2313; in California, 800-223-1521; in Canada, 800-663-6358.

CIRCLE 79 ON FREE INFORMATION CARD

SOLDERING STATION

Leads Metal Products' ENDECO Model 7100 is a temperature-controlled soldering station. Temperatures are set quickly and accurately with a push-button thumb-wheel control, and temperature control is maintained through a closed-loop thermocouple sensor.

The Model 7100 is designed to solder at 20W, which is 450°F to 700°F. However, due to its 20W/40W switching ability, the station has adequate thermal capacity to handle larger lugs and leads. It meets or exceeds Mil. Spec. WS 6536E para 3.2.3, with a 3-wire ground to prevent potential differences greater than 2 mV at the solder tip. Resistance reading from tip to ground is less than 20 ohms, and ±10° of preselected temperature at idle is guaranteed.



The unit is housed in a sturdy, industrial, nylon-coated steel case. Every unit is factory calibrated and tested, and carries a one-year warranty on the temperature-control unit.

The ENDECO Model 7100 temperature-controlled soldering station costs $265.00. For further information, contact Leads Metal Products, Inc., 5127 East 65th Street, Indianapolis, IN 46220.

CIRCLE 80 ON FREE INFORMATION CARD

CASSETTE DECK

Sansui's D-X301i cassette deck, featuring the company's exclusive Computerized Dual Function Control (CDFC), provides an impressive array of computerized functions including 20-song Automatic Music Program Search (AMPS), bi-directional music scan, and two repeat modes.

Designed to easily handle the dynamic range of compact discs, the D-X301i offers both Dolby B/C and HX-Pro for noise-free dubbing. Also featured are a fine-bias adjustment control to set the deck according to the type of tape being used, and a switchable multiplex filter.

Sansui's CDFC design concept allows the addition of extra features without adding separate controls for each. The result is a clean, uncluttered look. The front panel has a minimum number of controls; each performs multiple functions. Besides the 20-song AMPS, the unit offers other computerized functions, such as tape lead-in, auto record mute, bi-directional music scan, repeat of a single song or all songs, and memory stop. The D-X301i interfaces with other Sansui components for complete remote-control operation. Its frequency response is 30 to 20 kHz (±3 dB), and its signal-to-noise ratio is 75 dB (Dolby C).

The D-X301i cassette deck costs $339.95. For more information, contact Sansui Electronics Corporation, Home Audio Division, 1250 Valley Brook Avenue, Lyndhurst, NJ 07071.

CIRCLE 81 ON FREE INFORMATION CARD

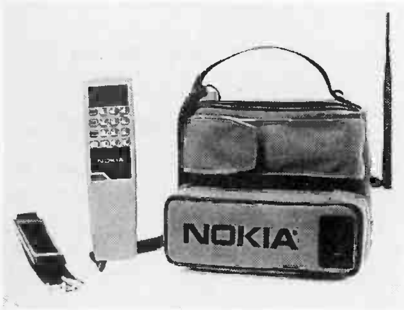
PORTABLE CELLULAR PHONE

With the addition of its optional battery and carrying-case system, the *Nokia M-10* cellular telephone becomes truly portable. The *Portable Kit* comes with a gray Cordura carrying case, a cigarette-lighter adapter, and a swivel antenna. The battery has a pouch that matches, and snaps onto, the carrying case. Together, with the M-10, it all adds up to a complete, modular portable system.

The Nokia M-10 includes 832-channel capacity, hands-free operation, and A/B system select. The handset's LCD display and 16-key pad are backlit for evening use. The

New Products

display indicates system select, electronic-lock status, roaming, no-service indication, alert, in use, and "select" (used prior to activating any of the phone's functions). The phone also features a call timer, single keystroke redial, unanswered-call indicator, and touch-tone compatibility (DTMF) to allow use of such special services as



voice mailboxes, answering machines, and an external speaker jack.

The battery provides up to four hours of standby or 20 minutes of talk time. A one-hour "quick charge" provides 80% of the power. The battery can be attached—in its pouch—for complete mobility, or removed for simple car-to-car transfers and operation (powered through the cigarette-lighter adapter).

The M-10 cellular telephone has a suggested retail price of $875.00. The complete Portable Kit and battery has a suggested retail price of $170.00. For more information, contact *Nokia-Mobira Inc.*, 2300 Tall Pines Drive, Suite 100, Largo, FL 34641.

CIRCLE 82 ON FREE INFORMATION CARD

DUST REMOVER

Chemtronics' E-Series Ultrajet gas duster offers high purity, low toxicity, and inertness in a non-flammable and environmentally safe formula that meets Environmental Protection Agency ozone-safety standards. It quickly and safely removes dust, lint, and oxide particles from electronic equipment, including computers and automated office equipment; optical surfaces; and precision mechanisms.

E-Series Ultrajet delivers powerful jet blasts for cleaning electronic systems. It offers a higher-gauge pressure (120 PSI) than conventional dusters. Ultrajet is non-abrasive; it won't contaminate or scratch surfaces, and leaves no residue.

It is packaged in 12-ounce cans that feature extra-wide, push-button valves for improved flow control, and an extension tube for precise application. For high-volume users, E-Series Ultrajet duster is also available as a complete, reusable system. The system includes a surgical-grade chrome trigger valve for precise flow control; a rigid, 4-inch stainless-steel nozzle; a final filtration disc for maximum contamination control; a flexible, 36-inch extension hose for hard-to-reach areas; and a refillable can.

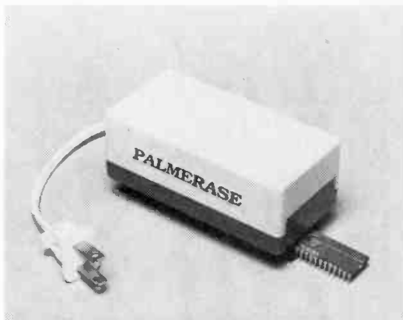
E-Series Ultrajet costs $5.45 in 12-ounce cans; the reusable system costs $24.50 (12-ounce refills are $5.00). For more information, contact Chemtronics, Inc., 681 Old Willets Path, Hauppauge, NY 11788; Tel. 800-645-5244.

CIRCLE 83 ON FREE INFORMATION CARD

EPROM ERASER

Contact East's Palmerase is an EPROM eraser that is designed for field-service and for engineering applications where space is at a premium. The compact unit measures 4- x 2- x 2-inches and weighs just 7 ounces.

The fast-acting Palmerase can erase a single EPROM in less than three minutes. It has a built-in tray that can accommodate



one 24- or 28-pin EPROM, with 600-mil pin spacing. The unit operates at 110-volts AC.

The Palmerase EPROM eraser costs $49.95. For more information, write to Contact East, 335 Willow Street South, P.O. Box 786, No. Andover, MA 01845. ■

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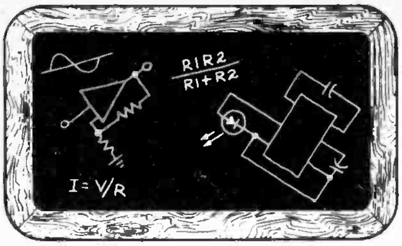


Think Tank

By Byron G. Wels

OP-AMP APPLICATIONS

The mail keeps pouring in, and the Fips Books keep going out. We even got a letter from one reader who became so entranced with the idea of the Fips Book that he wanted to know if he could buy a copy at his local newsstand. Well if you really want one, but don't want to submit a circuit to this column, we could probably sell you one if you wrote in asking for it and enclosing a check or money order for $7.50, plus $2.00 for postage and handling in US funds. (Sorry, no order will be shipped to locations outside of the U.S.A. and Canada.)

There's nothing wrong with that, of course. But the easier way is to submit an original schematic and write-up. So, just in case you're keeping score, chalk up one Fips book the hard way—paid for!

This month, we've got a nice assortment of projects all based on op-amps (short for operational amplifiers). You're going to find some good applications here, all for circuits you can easily build, and make good use of once you've assembled them. That's the important part of our game, too.

You not only get to occupy your time in a worthwhile hobby, but when friends see what you've put together and ask where you got it, you can honestly (and pridefully) tell them that you built it yourself. That has happened so often that I've learned to etch more than one circuit board at a time. Sure as shootin', somebody's going to ask me to build one for them too.

After building my own, I place the extra circuit boards into an envelope, mark them for what they are, and then when the need arises, I'm all set. But now, let's take a close look at what we have available for this month...

Scratch Filter. Byron, even with the coming of compact disc, there are still a lot of old-fashioned record players around, and we all know how they can decay records with each play. The first time you play one of the old-type discs, the stylus begins to knock the highs off. The smart listener tape records each brand-new disc on the first play. Still, in time, you start to get scratching, making the records almost annoying to listen to. Annoyance is *not* the reason that we listen to music!

This scratch filter not only removes some of the scratch noise, it also removes some of the annoyance. See Fig. 1. The circuit is built around an LM3900 quad op-amp (U1), which contains four Norton or current-difference amplifiers. The LM3900 differs from conventional op-amps, in that the output responds to relative input currents instead of input voltages.

The schematic shows only one channel for simplicity. The other is essentially the same; it simply uses the other two sections of the quad unit in an identical circuit. Op-amp U1-a is an inverting buffer stage with unity voltage gain, which establishes that the active filter is fed from a low source impedance and functions properly. In the inverting mode, resistors R1 and R3 set voltage gain at unity.

The non-inverting input is set with a bias current from the positive supply and via a series resistor (R2) has a value of about double the resistor connected between the output and the inverting input (R3). That value is not super critical, and the nearest standard-value resistor can be used for R2.

Op-amp U1-b serves as a unity voltage-gain buffer and is used as the basis for a conventional 12-dB-per-octave active filter. Resistors R6, R7, and R8 bias U1-b and set its input impedance and voltage gain to the required values. That's the same as the inverting mode. The ratio of R6 to R8 is what sets the amplifier's voltage gain. Any change in input voltage will change the current to the non-inverting input if R6 and R8 are of the same value.

By, it works and works well. I hope I can look forward to receiving one of the Fips books. I've heard from others that it's fun reading!

—*Marvin Rosen, Bronx, NY*

Marv, the only comment I'd like to make on your circuit, is that it will probably be noise-sensitive if there's noise on the supply lines to the non-inverting inputs from R2 and R7. I'd suggest that any readers who elect to build this circuit make sure they power it from a low-noise power supply. The only alternative is to take the bias currents through decoupling networks rather than directly from the + supply. And yes, your Fips book is on the way. I know you're going to like it!

Central Image Canceler. "Sure she sounds better than me!" my daughter said while listening to a stereo recording of a famous singer. "She's got a 16-piece orchestra backing her up!" Well, no way am I about to hire a 16-piece orchestra to back up my daughter's singing!

Then I realized that the soloist is center stage, and by eliminating the center, I also eliminate the singer's voice.

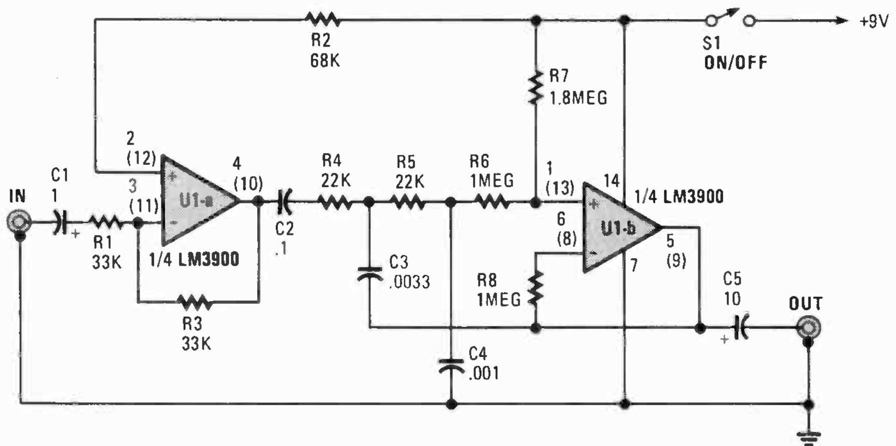


Fig. 1. The Scratch Filter is built around a LM3900 quad op-amp (U1).

The following circuit works, and now my daughter can sing along with the band, without hearing the soloist!

Look at Fig. 2. The circuit has to mix the two channels which have to be 180° out of phase so the signals that form the center-stereo image is canceled out. Those signals usually appear in phase. Resistor R3 biases the non-inverting input of U1 from a center tap formed by resistors R1 and R4, and capacitor C3. Resistor R4 and capacitor C3 along with potentiometer R6 form a negative-feedback circuit that establishes the closed-loop voltage gain of U1 at unity. The signal is inverted between the input and output.

Signals applied to the right input are coupled to the non-inverting input of U1 through C4 and attenuating resistor R5. Resistors R3 and R5 make up a 6-dB attenuator so once again there is unity voltage gain between the input and the output. However, the right input signal is not inverted.

Therfore, a signal appearing at both inputs is phased out by the circuit and will not appear at the output. Even if the two input signals are at slightly different levels due to different source impedances, you can still adjust for full cancellation by carefully tweaking R6.

Anyway, with this unit, my daughter puts on a record or tape, and plugs in her mike and sings along with the band. I suppose that this unit could just as well be used where any solo instrument is used, such as a clarinet, sax, or trumpet solo, just so the soloist is standing center stage. Got a Fips book handy?

—*George Frackson, New York, NY*

George, looking over your circuit, I'd venture to say that with a steady-state tone applied to the inputs, you'd probably get a lot of attenuation, but with a complex input signal, a lot of assorted frequencies, and the phase shift that occur in the circuit, you might not get quite as much. However, with the pot adjusted for optimum, you should get about 60 dB and that should be more than enough to keep your soloist happy. And yes, it's also enough to get you a copy of the Fips book. I know you'll enjoy it.

Simple Function Generator. This handy circuit can output sine, square, and triangular signals of from 15 Hz to 25 kHz in three ranges. The circuit is more than adequate for most hobbyist test benches. An output-level control lets you set voltages from zero to the maximum.

Look at Fig. 3. The circuit is built around an 8038 function generator that produces the triangular and squarewave outputs directly from an oscillator. The triangular output is then processed to develop the sinewave. While that method doesn't provide a sufficiently low level of distortion to let you make distortion measurements on audio gear, the degree of purity is high enough for frequency-response tests and a lot of other audio analysis.

Three switched capacitors, C2–C4, set the circuit's frequency range via switch S1. Variable resistor R9 and resistor R1 provide the voltage for controlling the charge and discharge rates of the timing capacitor selected. Resistors R4–R6 control the charge and discharge currents. Resistor R5 can be adjusted to provide a 1:1 mark/space ratio.

Byron, I can't say that this is the *handiest* tool on my own test bench, but since I've put it together, it seems to find a lot of use around the place. I sure hope it gets me a copy of the Fips book, since I've worked long and hard. Now I'm going to get away from the typewriter and back to my soldering iron, with which I'm a lot more comfortable!

—Ben Sable, Kean, NH

Okay Ben! I just feel we ought to add that circuits using the 8038 usually need a voltage of around 18 volts, but we found that this one works well with as little as nine volts. If you're going to put the circuit to a lot of use, it might be a good idea to use a heftier battery.

Battery Monitor. A friend of mine, many, many years ago, took the carbon rods out of three dry cells and sharpened them to a point at one end using a pencil sharpener. He then drilled ¼-inch breather holes in each of the three battery caps in his car, and stuck a rod into the enlarged hole so the pointed tip of the rod just touched the electrolyte.

Using the old grid clamps we had on radio tubes, he attached each rod to a panel on his dashboard fitted with small pilot lamps. He explained that this would tell him not only about the quality of each cell, but whether or not additional electrolyte was needed. It was, on the surface, a good idea. But in use, a wet cell gives off hydrogen gas. The first time he hit a bump, the electrolyte parted company with the rod, a small spark was generated, and he was parted from his battery. What a mess that was!

However, this circuit does the job right. It uses four LED's that switch on if the supply voltage falls below preset thresholds, which were set at about 10, 11, 12, or 13 volts. The circuit is built around an MC3302 quad comparator (see Fig. 4). One comparator from the MC3302 package is used to form each stage of the circuit. Each stage is almost identical to the others except for the value of the Zener diodes used.

The load for the output of U1-a is LED1, along with its series current-limiting resistor R4. There is no output current limiting in each stage's output. Discrete components are used to make sure the maximum allowable 20-mA output isn't exceeded.

The inverting input of U1-a is taken from the supply line through the voltage divider formed by resistors R1 and R2. The voltage to the inverting input changes with changes in the supply voltage and it probably will not exceed 0.1 volt. This bias voltage goes to the inverting input of each comparator.

Comparator U1-a's non-inverting input is provided by the supply lines through Zener diode D1 with load resistor R3. Usually, the supply voltage should be a few volts or more above the avalanche voltage of D1 and two volts should be present at the non-inverting input of U1-a. That means the output of U1-a is switched off and LED1 is not turned on.

If the supply falls below about 10 volts, D1 stops conducting and the voltage to the non-inverting input falls beneath the bias voltage of the inverting input. The output of U1-a switches on, lighting LED1. Incidently, any Zener diode with the proper voltage rating can be used for D1–D4 (which are rated for 10, 11, 12, and 13 volts, respectively). I happened to have had the ones shown on hand.

—Jerry Hathaway, Duluth, MN

Okay Jerry. I just wanted to point out to the readers that all four of the U1 comparator stages operate the same

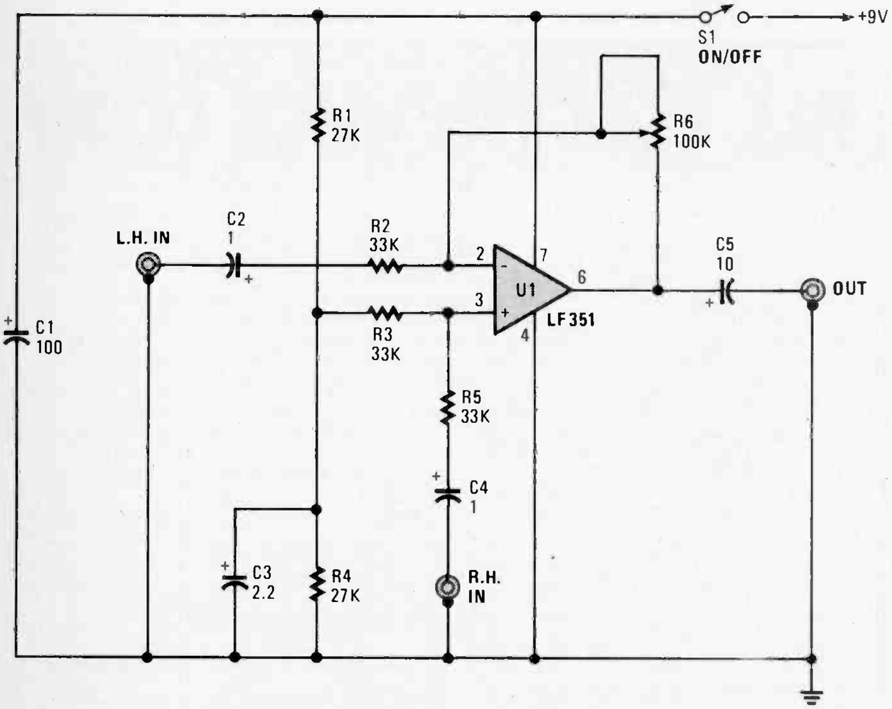


Fig. 2. The Central Image Canceler allows you to eliminate the vocal portion of an audio signal, while leaving the instrumental portion.

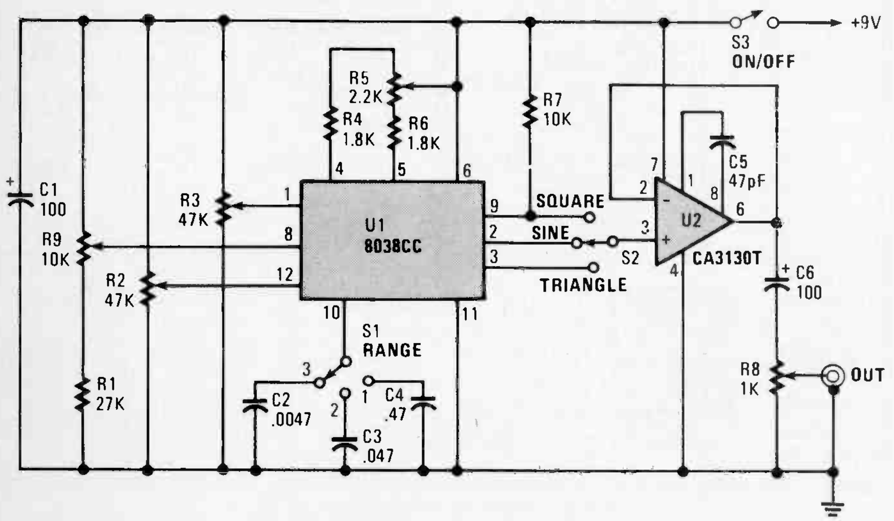


Fig. 3. Built around an ICM8038 function generator, the circuit can produce triangle wave, squarewave, and sinewave output signals.

way, the only difference being in the rating of the Zener diodes they select. If you plan to mount this (for example) in your car, you only need to wire up a single stage. The car's battery voltage never changes! And by the way, score one Fips book!

Audio Millivolt Meter. If you're at all interested in hi-fi/stereo, sooner or later you're going to wish you had one of these, so you might as well build it now, and have it on hand when it's needed. Check out the circuit in Fig. 5. Op-amp U1 is used as a non-inverting, unity-gain buffer that gives the circuit a high-input impedance of about 1 megohm, which assures that circuit does not load down the unit you're testing.

Capacitor C4 couples the output of U1 to a simple attenuator, which is used to provide a loss of 0 dB, 20 dB, or 40 dB, depending on the setting of switch S1 (the range switch). The circuit's sensitivity is 10-volts rms for full-scale deflection, so the attenuator gives additional ranges of 100-mV and 1-volt rms. The attenuator output is connected through capacitor C5 to a common-emitter amplifier (Q1), which has a high-voltage gain of 40 dB.

To get linear scaling on the meter, we have to use an active-rectifier circuit built around U2. That IC is connected so that its non-inverting input is biased to the 0-volt bus via R7. Capacitor C6 couples the output of Q1 to the non-inverting input of U2; C7 is the compensation capacitor for U2.

The voltage gain of U2 is set by the difference in resistance between the output and the inverting input, and the resistance between the inverting input and the ground bus. One resistance is made up of the diode-bridge rectifier (D1 to D4), the other by resistor R8.

It may not seem necessary for a circuit such as this to have a high performance level, but it does have a frequency response that's almost flat to about 200 kHz and the least-sensitive range is 1-volt rms.

The circuit is powered by a dual 9-volt supply, and is forgiving of variations in supply voltages. You can actually use anything from ±6 volts to ±10 volts. Use a regulated supply to avoid small fluctuations that could affect changes in Q1's gain.

—Marvin Holt, Madison, WI

Thanks, Marv. However, I'd like to add that U2 doesn't have a particularly wide bandwidth at low signal levels, but when there are large signal levels at the output, it has a better frequency response than most other op-amps. That can be a great advantage in many applications, since it makes the unit less prone to instability from stray feedback than other op-amps.

Microphone Preamp. Most low-impedance microphones are cheap, and almost all produce low output levels—in the few-hundred microvolt range. Usually you can raise the output levels through amplification, but that always seems to introduce signal-to-noise ratio problems and distortion. In addition, such preamps usually don't offer treble cut or any equalization.

The circuit shown in Fig. 6 offers a voltage gain of up to 700 dB, bringing the output of almost any low-impedance dynamic microphone to 1-volt rms or better. The signal-to-noise ratio (SNR) is usually better than -60 dB. Op-amp U1 has a low noise level, and are used in the inverting mode. Op-amp U2 is used in the non-inverting mode.

Resistors R2 and R3, and capacitor C2 act as a center tap on the supply

THINK-TANK

and are used to bias the non-inverting input of U1. Resistors R1 and R4 are the negative-feedback network, which set the input impedance at about 1000 ohms and the closed-loop gain to about 40 dB.

Potentiometer R7 serves as a gain control and couples a DC-bias voltage to the non-inverting input of U2. Resistors R5 and R6 set the audio-voltage gain of U2 at about 27 dB, but C4 provides 100% negative feedback (and unity voltage gain at DC). The output of U2 is, therefore, biased to half the level of the supply voltage.

The device selected for U2 features a very low noise level and it should be realized that the noise performance of U2 isn't as important as the noise level produced by U1, since any noise produced in U1 will be amplified by U2.

—*Bob Small, Enid, OK*

Bob, this is an extremely interesting circuit, and will solve a lot of problems for people who plan to use teensy-weensy electret microphones! Nice job, and your Fips book is on the way!

Slide Show Timer. Sometimes, when you're doing a slide show for friends, you have to be more of a juggler than anything else! But this little circuit (see Fig. 7) takes some of the burden off you, by automatically changing the slides at pre-set intervals. You can set the interval from about five to 30 seconds. A relay operates the slide-change mechanism.

Op-amp U1 forms a sort of Schmitt trigger. Resistors R1 and R2 bias the non-inverting input (pin 3) of U1 to half

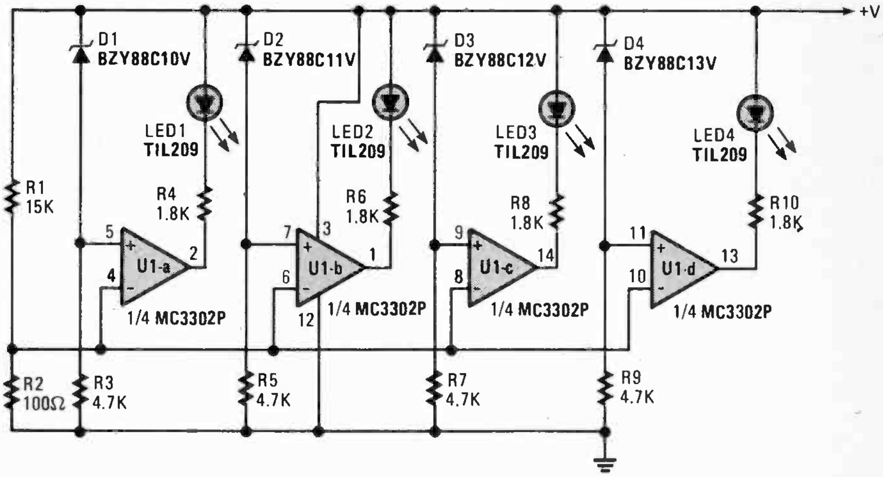


Fig. 4. This Battery Monitor contains four LED's that are set to switch on if the supply voltage falls below any of the preset thresholds, which were set at 10, 11, 12, and 13 volts by Zener diodes D1 through D4, respectively.

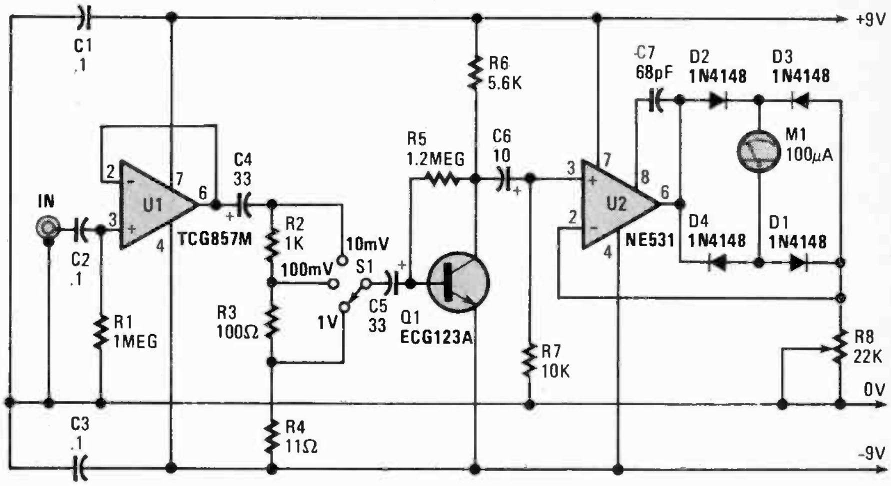


Fig. 5. In the Audio Millivolt Meter, integrated circuit U1 is used as a non-inverting, unity-gain buffer to provide a high input impedance, ensuring that circuit doesn't load down the unit under test, throwing off the reading.

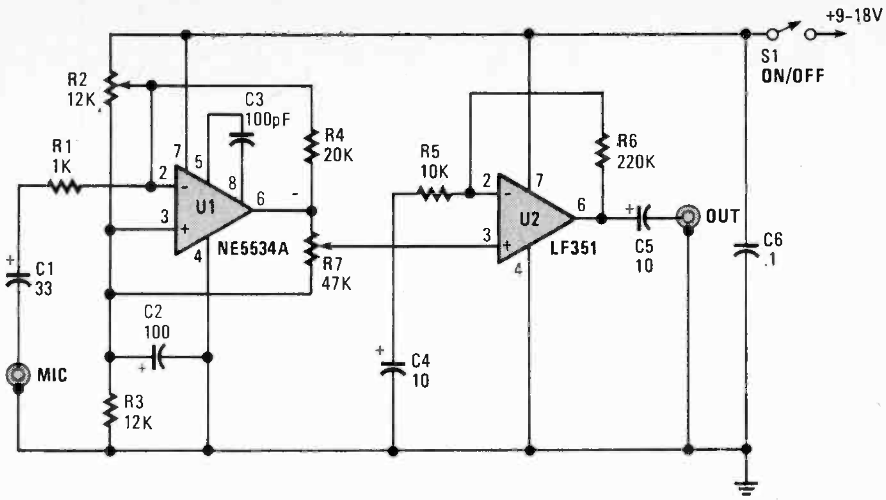


Fig. 6. This phono preamp offers a voltage gain of up to 700 dB, with a signal-to-noise ratio (SNR) of usually better than -60 dB.

the supply voltage. Feedback resistor R3 increases or reduces the bias to pin 3, depending on whether the output of U1 is high or low.

When power is first applied to the circuit, C2 has a zero charge and the inverting input of the op-amp is at a lower voltage than its non-inverting input. When the output of U1 is high, C2 begins to charge through R5 and D1. It takes about one second for the charge on C2 to reach the same voltage as that at the non-inverting input of U1. At that time, the output of U1 begins a negative swing.

Because of the positive feedback through R3, the voltage at the non-inverting input is reduced and the output goes more negative. The voltage at the non-inverting input is at about ¼ of the supply voltage and C2 begins to discharge through the resistor bank. The timing is controlled by R6.

The resulting pulses are fed to the base of Q1 (configured as an emitter-follower buffer stage), which is used to activate relay K1. Transistor Q1 is necessary because op-amps usually have an output current in the 20-mA range—which is too low to activate the relay.

—Barney Selwyn, Tulsa, OK

You know Barney, when I first saw your circuit, I wondered why you didn't just use a current-sensitive relay for the output and save the transistor. But you've explained that problem away very nicely. Nice job, and your Fips book is in the mail.

That's a "wrap" for this month (whew!), but I hope you guys will keep sending your pet circuits and descriptions to *Think Tank*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. Catch you on the rebound. ■

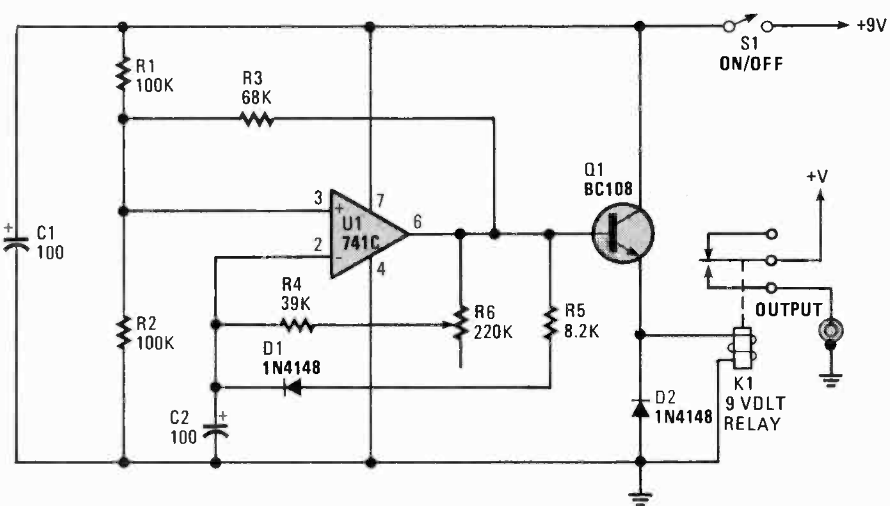


Fig. 7. The Slide Show Timer, built around a 741 op-amp, can be set to change frames at intervals that can be varied from about 5 to 30 seconds.

Popular Electronics®
APRIL 1989

LUCKY LOTTO SELECTOR

Do those lucky numbers keep eluding you. Build this lucky-number selector circuit and change your luck!

BY CHARLES D. RAKES

If you've run out of fingers, thumbs, toes, and birth dates trying to come up with a winning combination of numbers for your favorite lottery without much success, let our *Lucky Lotto Selector* do the picking for you. The circuit can be programmed by a simple wiring change to select numbers in three of your favorite lottery games by merely rotating a selector switch.

Naturally there's no guarantee that the *Lucky Lotto Selector* will pick the winning combination, but it will help take the drudgery out of coming up with the numbers every time a new game comes to town.

The circuit is designed around three low-cost IC's, and to keep it simple, the numbers are indicated by individual LED's instead of complicating the circuit with additional IC's and support components that would be needed to drive a seven-segment display. In fact, once you become accustomed to using the circuit, the readout scheme used in this project will seem like a natural path to follow in the numbers game.

A three-pole, three-position switch allows up to three different lottery systems to be hard-wired into the circuit. As shown, in the schematic diagram of Fig. 1, ours is programmed so switch position "1" allows numbers 1 to 33 to be selected; in position "2" numbers 1 to 40; and in the third position, numbers 1 to 47.

And because the circuit draws very little current, it can be powered by a standard 9-volt, transistor-radio battery.

How It Works. The schematic diagram for the *Lucky Lotto Selector* is shown in Fig. 1. Two gates (half of a 4001 quad, 2-input NOR gate), U1-a and U1-b, are configured as a simple oscillator circuit. Switch S2 (a normally-open pushbutton switch) is connected across the two inputs of U1-a, making it function as an inverter.

When S1 is depressed, a positive voltage is applied to pins 1 and 2 of U1-a, causing it to output a low. That low is then applied to both inputs of U1-b (which is also configured as an inverter), causing it to output a high.

The output of U1-b then travels along two paths. In one path, a portion of the output signal is fed back through C1, after which the signal again splits, with a portion of the feedback signal going to the input of U1-b and the rest to U1-a, causing the circuit to oscillate at about 18 kHz.

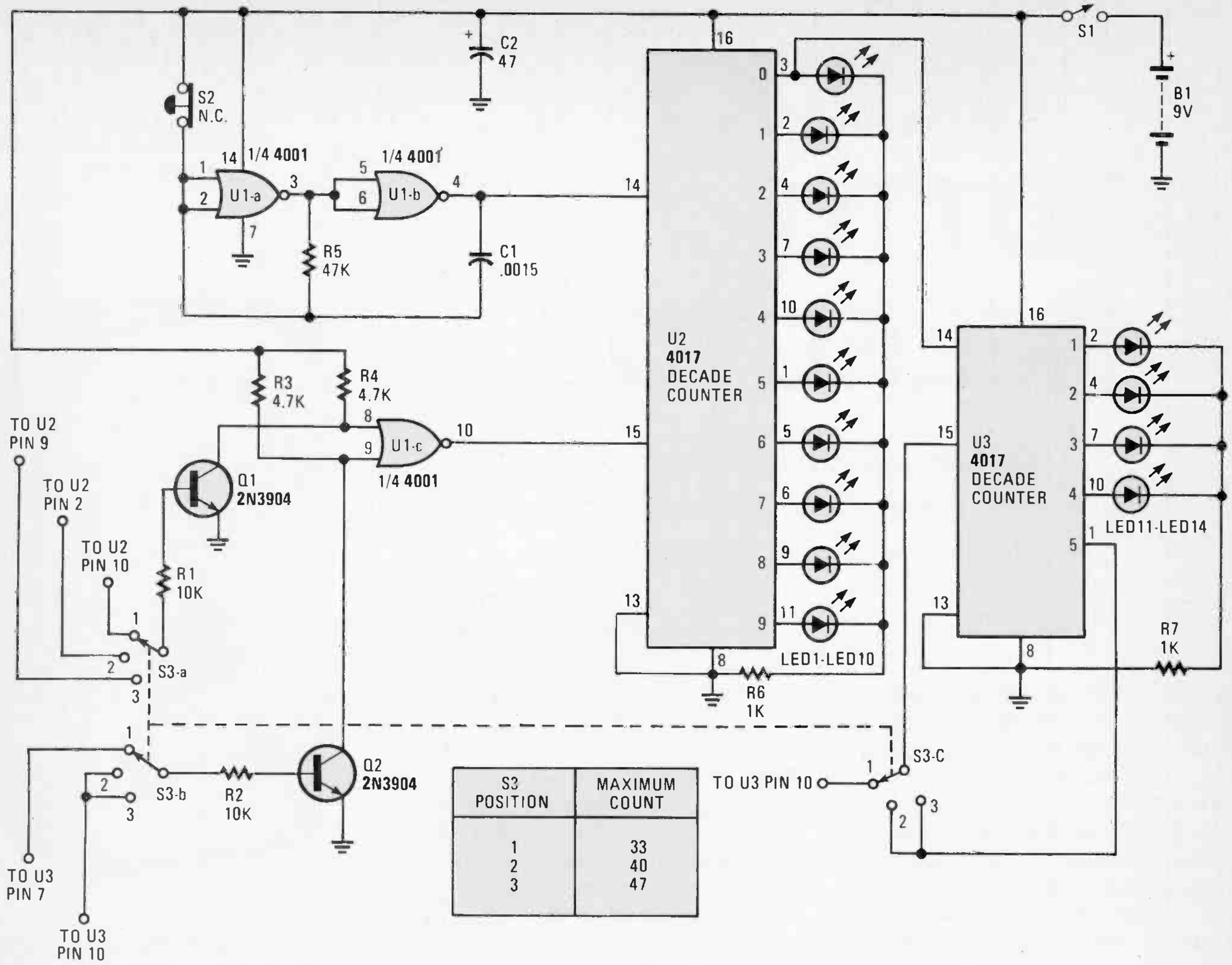
In the other path, the output of U1-b is fed to the clock input of U2 (a 4017 decade counter) at pin 14. Integrated circuit U2 counts each pulse and lights up an LED to indicate its position as it goes on its merry way. After counting ten pulses, U2 pin 3 goes high, causing LED1 (which represents the numeral 0) to light.

The output of U2 at pin 3 is also fed to the clock input of a second 4017 decade counter, U3, causing it to advance one count. That causes U3 pin 2 to go high, lighting LED11, which represents a 1. Together, the two lighted LED's represent the number "10."

Transistors Q1 and Q2, along with U1-c determine the maximum number indicated for a given position of S3. When the bases of both Q1 and Q2 go high, grounding pins 8 and 9 of U1-c, a high is applied to U2 at pin 15, causing it to reset to zero. With S3 in position 1, the circuit counts to a maximum of 33; in position 2, the maximum count is 40; and in position 3, the maximum count is 47.

The base of Q1 is connected through S3 to pin 10 of U2, which goes high only when the number 4 digit is lit. The base of Q2 is connected to pin 7 of U3, which only goes high when the number 3 lights.

At the count of 33, pin 7 of U3 goes high, turning on transistor Q2, which then pulls pin 8 of U1-c low. Transistor Q1 remains off until the count tries to go to 34, when pin 10 of U2 goes high. At that point, both transistors are turned on, grounding both inputs to U1-c. With both inputs to U1-c tied low, its output goes high, resetting U2 and the counting process is repeated. The transition time is so very fast that the number 34 never shows up on the display.



S3 POSITION	MAXIMUM COUNT
1	33
2	40
3	47

Fig. 1. The Lucky Lotto Selector is built around three readily available CMOS IC's and uses a rather simple switching arrangement to force the circuit to reset after the maximum count is reached.

Switch S3-c is configured to reset U3 at the proper count. With S3 in position 1, the reset input of U3 is connected to pin 10 of U3. That allows numbers below 40 to be counted and displayed. When U3 tries to count to 4, a reset pulse is applied through S3 to the reset input of U3 at pin 15, causing the count to start over.

Programming S3 for any lottery system with a maximum number of less than 50 is easy. Lets take, for example, a lottery that uses the numbers 1 to 47. Starting with S3-a, connect the position-1 terminal to the output pin of U2 that is one digit higher than the digit you want to count to.

In other words, we want the count to reset at 48. So S3-a position 1 connects to pin 9 (output 8) of U2. Switch S3-b, position 1, connects to pin 10 (output 4) of U3. Switch S3-c position 1 also connects to pin 10 of U3. Sounds complicated? Not really if you follow the scheme outlined and study the three systems shown in the schematic diagram of Fig. 1.

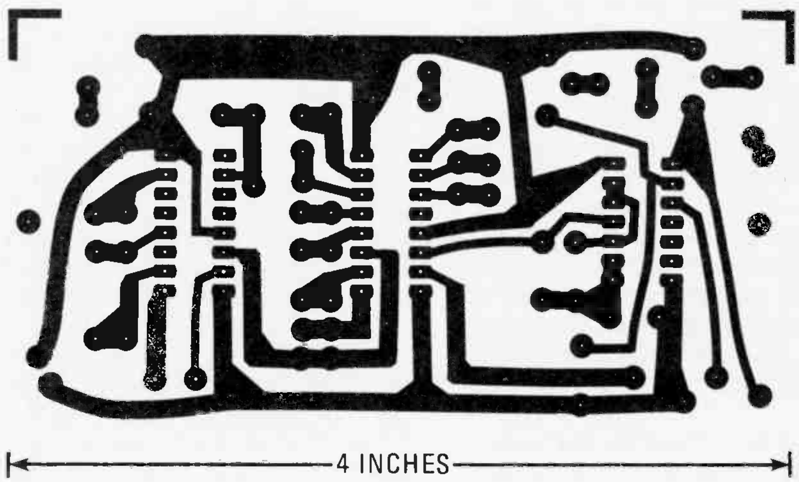


Fig. 2. Here is a full-scale template of the printed-circuit pattern used by the author. Printed-circuit construction makes assembly of the project simple and also helps to cut down on wiring errors.

The circuit can also be expanded to accommodate Lotto 54 (New York's bi-weekly, multi-million dollar lottery game) by connecting a fifteenth LED to output 5 (pin 1) of U3. Of course, you'll also have to figure out which switch contacts go where.

Let's take a look at how that's ac-

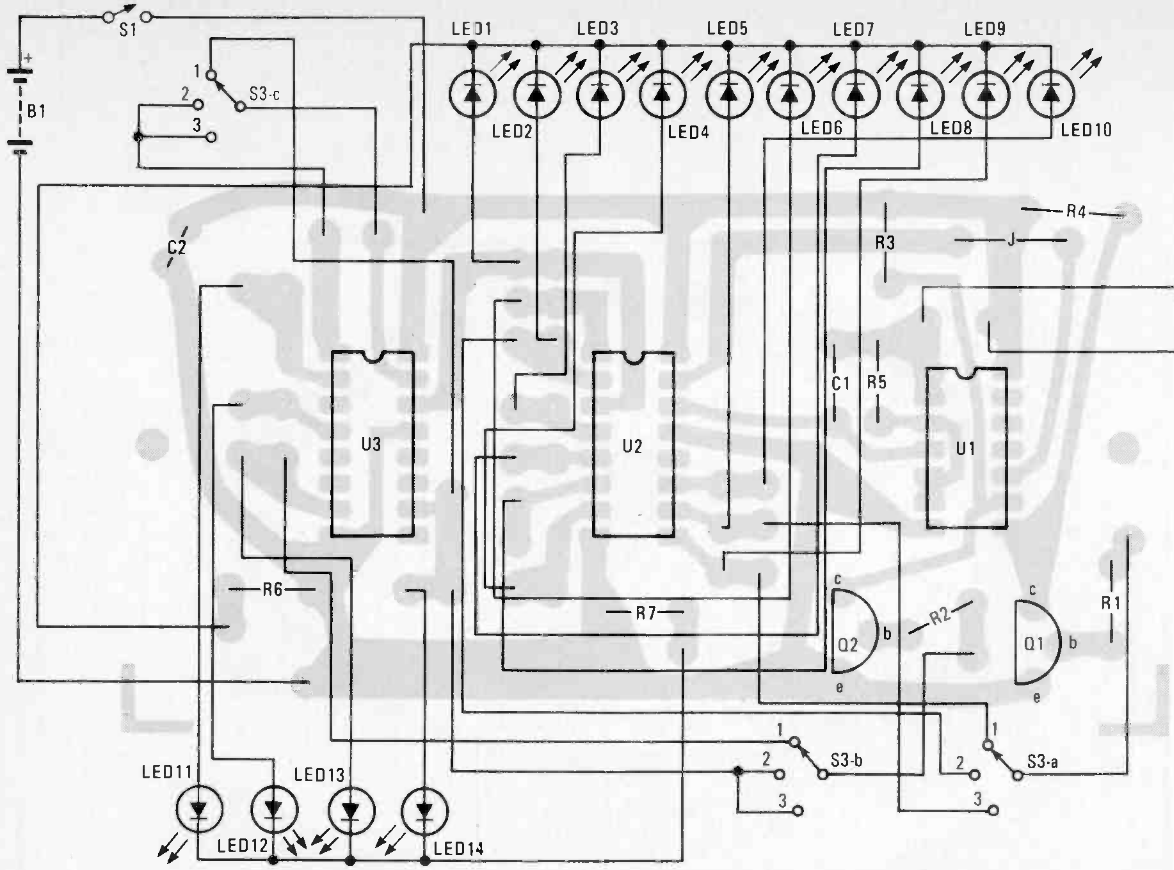


Fig. 3. Once you've etched your own printed-circuit board (or obtained one from the supplier given in the Parts List), install the components using this diagram as a guide.

PARTS LIST FOR THE LUCKY LOTTO SELECTOR

SEMICONDUCTORS
U1—4001 quad two-input nor gate
U2, U3—4017 decade counter/divider
Q1, Q2—2N3904 general-purpose NPN silicon transistor
LED1-LED14—Jumbo light-emitting diode (any color)

RESISTORS
(All resistors are ¼-watt, 5% units, unless otherwise noted.)
R1, R2—10,000-ohm
R3, R4—4700-ohm
R5—47,000-ohm
R6, R7—1000-ohm

CAPACITORS
C1—0.0015-µF, 100-WVDC, mylar or similar
C2—47-µF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS
B1—9-volt transistor-radio battery
S1—SPST miniature toggle switch
S2—Normally closed pushbutton switch
S3—3P3T rotary switch
Printed-circuit or perfboard materials, enclosure, IC sockets, battery and snap connector, wire, solder, hardware, etc.

A complete kit of parts (excluding the enclosure) is available for $29.95 (postage paid); printed-circuit board only for $9.95 (postage paid) from Krystal Kits, PO Box 445, Bentonville, AR 72712. All Arkansas residents please add appropriate sales tax. Please allow 6 to 8 weeks for delivery.

complished, using the number 54 as an example. Starting with S3-a, connect switch position 1 to U2 pin 5. Switch position 1 of S3-b should be connected to pin 1 of U3, and wire pin 15 of U3 through S3-c to pin 5 (output 6). That's all there is to it—and it doesn't take a genius to figure it out.

Building Your Own. Since the circuit is as uncomplicated as you can get and the component count is low, almost any construction scheme will do, although using a printed-circuit board will certainly make the project easier to put together. However, if you choose to use the perfboard approach, IC sockets would be a worthwhile addition. In any case, study the schematic diagram, photos, and the parts layout before starting construction.

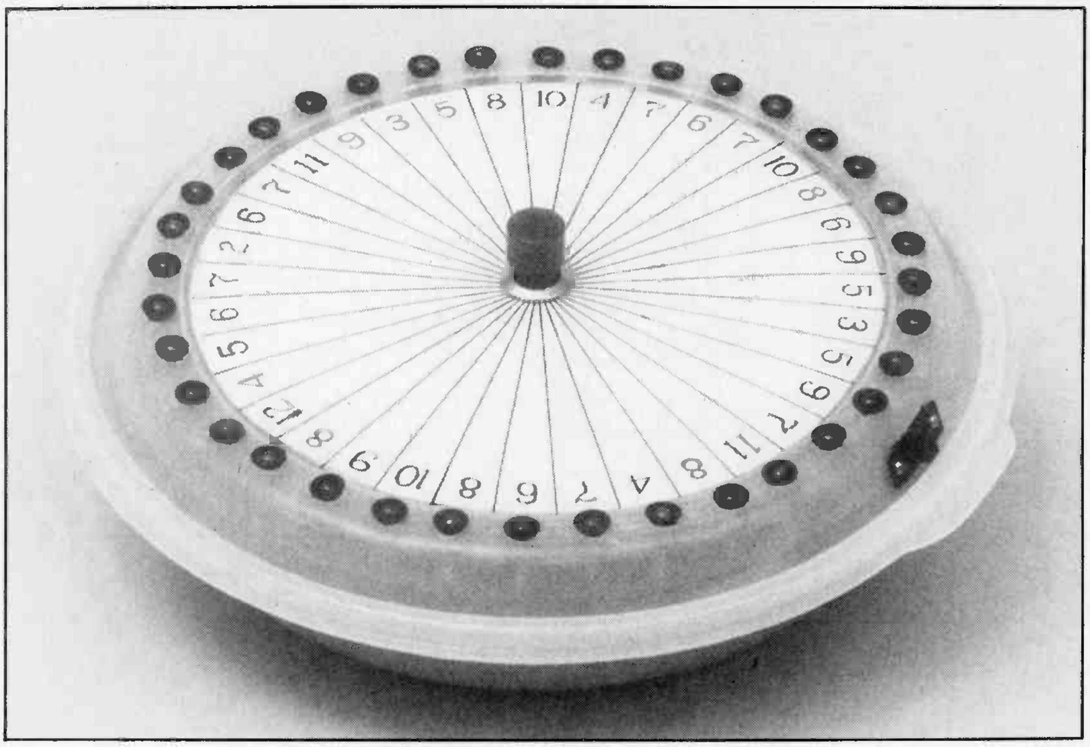
The author's prototype unit was built on a printed-circuit board; see Fig. 2 for details. If you opt to go the printed-circuit route, follow the parts-placement diagram shown in Fig. 3 for component positioning and orientation. Be particularly careful when installing the transistors (Q1 and Q2). If those components are misoriented, the circuit will give some strange results: For instance, incorrectly installing Q1 or Q2 would result in U2 not resetting at the proper time, if at all.

The off-board wire connections appear a little confusing (and they are). Your best bet here is to take your time and (perhaps) use some sort of color-coding scheme—the use of multi-colored insulated hook-up wire is recommended.

The author's prototype was housed in a plastic cabinet, measuring about 6 × 3 × 1¾ inches, but any similar size cabinet will do. The 14 LED's, and the three switches may be arranged in any pattern desired. Just remember

(Continued on page 100)

Dice-Roulette



Game

Build an exciting game that combines the thrill of roulette with the odds of a crap shoot!

BY JAN AXELSON & JIM HUGHES

Electronic dice and roulette wheels have long been popular projects for electronics experimenters. The *Dice-Roulette Game* presented here combines the two projects into one; because its a roulette wheel that gives the same odds as a pair of traditional six-sided dice.

Thirty-six LED's are arranged around the wheel, each labeled with a number from 2 to 12. Pressing the spin switch starts the wheel spinning—actually, the wheel stands still and the LED's light in rapid sequence to simulate spinning. Release the spin switch, and the spin slowly comes to a stop, leaving just one randomly chosen LED lit.

The spin and suspenseful spin-down are generated by a CMOS voltage-controlled oscillator. High-speed CMOS outputs directly drive the LED's at 20 milliamps, giving a bright display. And the circuit can easily be customized for any number of LED's, spin frequency, or spin-down time you'd like.

Inside Dice-Roulette. A complete schematic of the Dice-Roulette Game is shown in Fig. 1. In the circuit, U1 clocks a series of decade counters (U3–U7). Integrated circuit U1 is a 4046 phase-locked loop (PLL), here used for its VCO (voltage-controlled oscillator). The output at pin 4 of U1 is a square wave whose frequency is determined by R2, C2, and the voltage at pin 9. Resistor R2 and capacitor C2 determine the spin frequency, or the frequency of the signal at pin 4 when S2 is pressed. With the components shown, the spin frequency is around 350 Hz.

Switch S2 ties pin 9 of U1 to V+ to initiate spinning. Pin 9 provides the control voltage for the VCO. When S2 is released, the voltage at pin 9 decreases slowly as C1 discharges through R1. As the voltage at pin 9 falls, the frequency at pin 4 also decreases. Figure 2 illustrates that effect. When pin 9 has dropped to about 1 volt, the VCO stops oscillating. With the component values shown in Fig. 1, the circuit takes about five seconds to come to a stop.

The PLL provides clocking pulses for a 36-step counter made from five 74HC4017 decade counters. Figure 3 shows the operation of one 74HC4017. When enabled and clocked, the outputs go high in sequence for one clock period each. A high on pin 13 of any counter stops it, freezing all outputs in their current states A high on pin 15 resets the counter, causing pin 3 to go high and the other 9 outputs to go low. (There's also a carry output, though it isn't used by the Dice-Roulette Game.)

The five 74HC4017's really make up one counter with 36 outputs. The wheel may be at any position—with any of

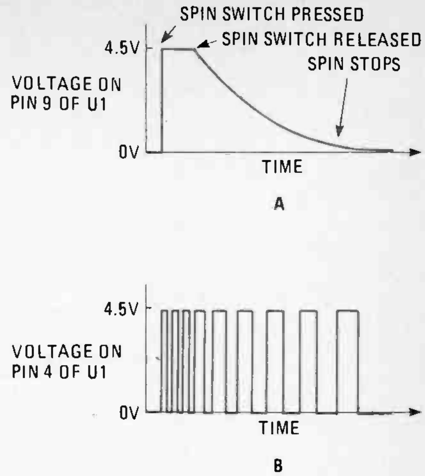


Fig. 2. The output frequency at pin 4 of the the 4046 depends on the voltage at pin 9 as shown in A. As the voltage drops, so does the frequency, causing the oscillations to slow to a stop (B).

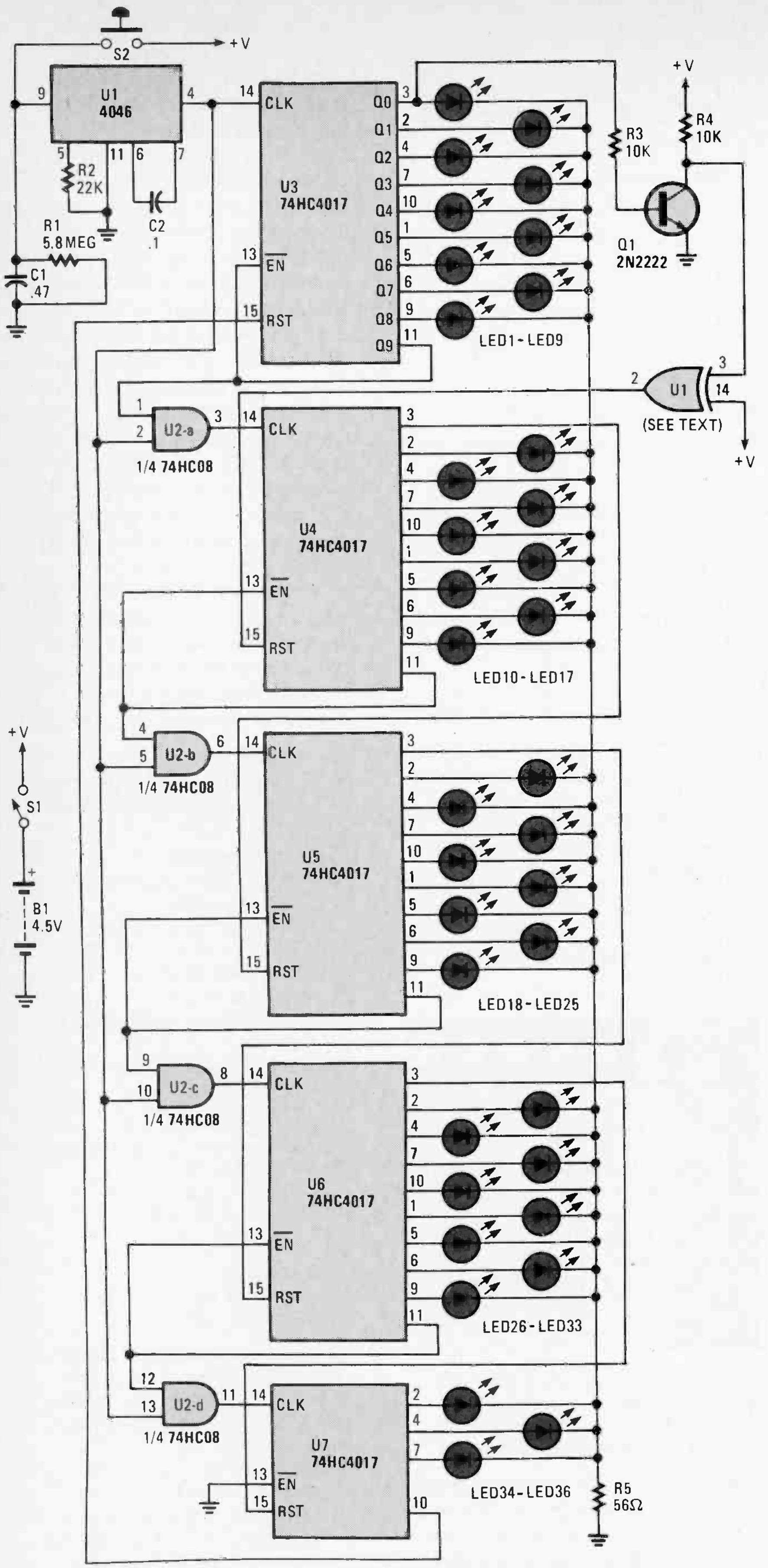


Fig. 1. The Dice-Roulette's clocking is performed by the voltage-controlled oscillator of a 4046 phase-locked loop. Five 74HC4017 decade counters control the game's 36 LED's.

the LED's lit—when the spin switch is pressed. For simplicity, assume that the wheel starts with LED1 on, and all the other LED's off. On the first clock pulse at pin 14 of U3, pin 3 goes low, turning LED1 off, and pin 2 goes high, lighting LED2.

Succeeding clock pulses light LED's 3–9 in sequence, then pin 11 of U3 goes high. That disables U3, But at the same time, U2-a now allows U4 to be clocked. Light-emmiting diodes 10–17 light in sequence, then LED's 18–25, 26–33, and 34–36, as U5, U6, and U7 are clocked in sequence.

Resetting the Counters. After LED 36 lights, the next clock pulse resets U3 and the count starts again at LED1. To get the circuit ready to count again, U4–U7 are also reset at this time. The high on pin 3 of U3 causes transistor Q1 to saturate, bringing pin 3 of the XOR gate in U1 low. Pin 2 of U1 then goes high, resetting U4. Pin 3 of U4 in turn resets U5, U5 resets U6, U6 resets U7, and U7 resets U3.

Note that the XOR gate used in resetting is actually part of U1. The gate is normally used as a phase comparator for the IC's phase-locked loop. Since we don't need the phase comparator to use only the VCO in U1, we can press the gate into service elsewhere. (By tying one input high, we're actually using the gate as an inverter.)

Why not connect pin 3 of U3 directly to U4's reset? Pin 3 has two jobs—resetting the counters and turning on LED1. The 20 milliamps of current used by LED1 pulls pin 3 down to about 3 volts, which isn't high enough to provide a

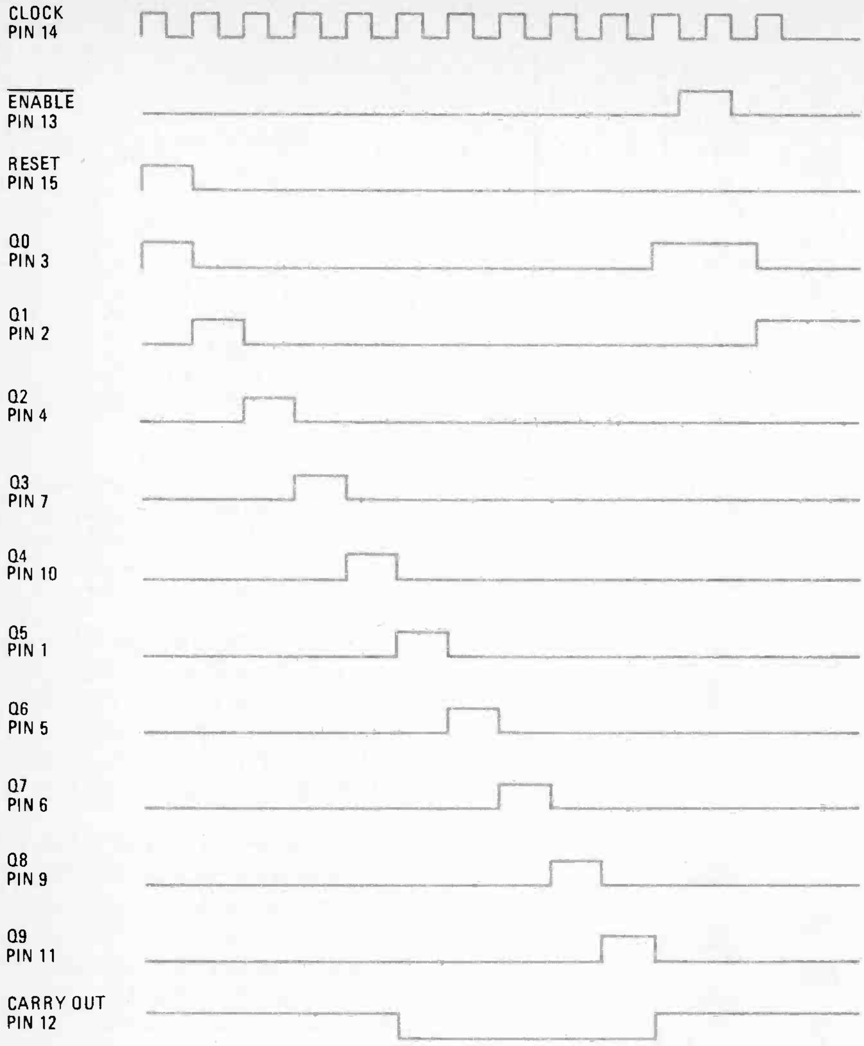


Fig. 3. When the counter is enabled, each of the ten counter outputs in the 74HC4017 go high for one clock period simulating rotation-like chaser lights.

reliable reset signal. But it will turn on Q1, bringing Q1's collector low. That low is then inverted by U1 to provide the reset.

Integrated circuits U3–U7 are HC (*H*igh-speed *C*MOS) versions of the 4017 CMOS counter. That version was chosen for its high output-current capability, enabling a bright LED display with a minimum of components.

The Dice-Roulette Game is powered by three 1.5-volt AA batteries in series. A 56-ohm resistor in series with the LED's limits the LED current to around 20 milliamps, safely below the 25-milliamp maximum rating limit for the IC's.

Since the entire circuit draws only around 20 milliamps, the batteries should run the wheel for many hours before needing replacement.

Crafting the Dice-Roulette Game. There's nothing critical about the construction of the project. The instructions that follow are for a wire-wrapped project, but you could also use point-to-point soldering or a printed-circuit board of your own design. Sockets for U1–U7 are recommended. A round microwave cooking and serving dish works well as an enclosure.

	⚀	⚁	⚂	⚃	⚄	⚅
⚀	2	3	4	5	6	7
⚁	3	4	5	6	7	8
⚂	4	5	6	7	8	9
⚃	5	6	7	8	9	10
⚄	6	7	8	9	10	11
⚅	7	8	9	10	11	12

Fig. 4. Rolling a pair of six-sided dice offers 36 possible throws. They are all noted on the template, with one LED assigned to each possibility.

To build the circuit, insert the IC sockets, R1 through R5, C1, C2, and Q1, and wire the connections among these components. Don't worry about any off-board connections yet.

You may substitute a 4081 quad AND gate for the 74HC08, but if you do, the schematic and wiring must be altered to reflect the 4081's different pinout. Do not try to substitute metal-gate 4017's for the high-speed CMOS 74HC4017's. The output current of a metal-gate 4017 powered at 4.5 volts is too low to light the LED's properly. (The letters 74HC in the device number indicate that you have the correct, high-speed CMOS version. The pinouts of the 4017 and 74HC4017 are identical.)

For best results, capacitors C1 and C2 should be polystyrene, polypropylene, or any other type suitable for timing applications.

Prepare the enclosure by marking and drilling 36 holes for the LED's. Space them evenly around the edge of the top of the enclosure. Also make a hole for mounting the spin switch in the center of the top, and a hole for the

PARTS LIST FOR THE DICE-ROULETTE GAME

SEMICONDUCTORS

U1—4046 CMOS phase-locked loop, integrated circuit
U2—74HC08 quad AND gate, integrated circuit
U3–U7—74HC4017 decade counter, integrated circuit
Q1—2N2222 general-purpose NPN transistor
LED1–LED36—light-emitting diode, any color

RESISTORS

(All resistors are ¼-watt, 10% units.)
R1—5.8-megohm
R2—22,000-ohm
R3, R4—10,000-ohm
R5—56-ohm

CAPACITORS

C1—0.47-µF polyester
C2—0.1-µF ceramic disc

ADDITIONAL PARTS AND MATERIALS

B1—Three 1.5-volt AA batteries
S1—SPST slide or toggle switch
S2—SPST momentary pushbutton switch
Perfboard, wire-wrapping materials, enclosure, wire-wrap IC sockets (one 14-pin, six 16-pin), 36 LED holders, battery holder, heat shrink tubing, etc.
All the electronic components are available from JDR Microdevices, 110 Knowles Drive, Los Gatos, CA 95030; Tel. 800/538-5000.

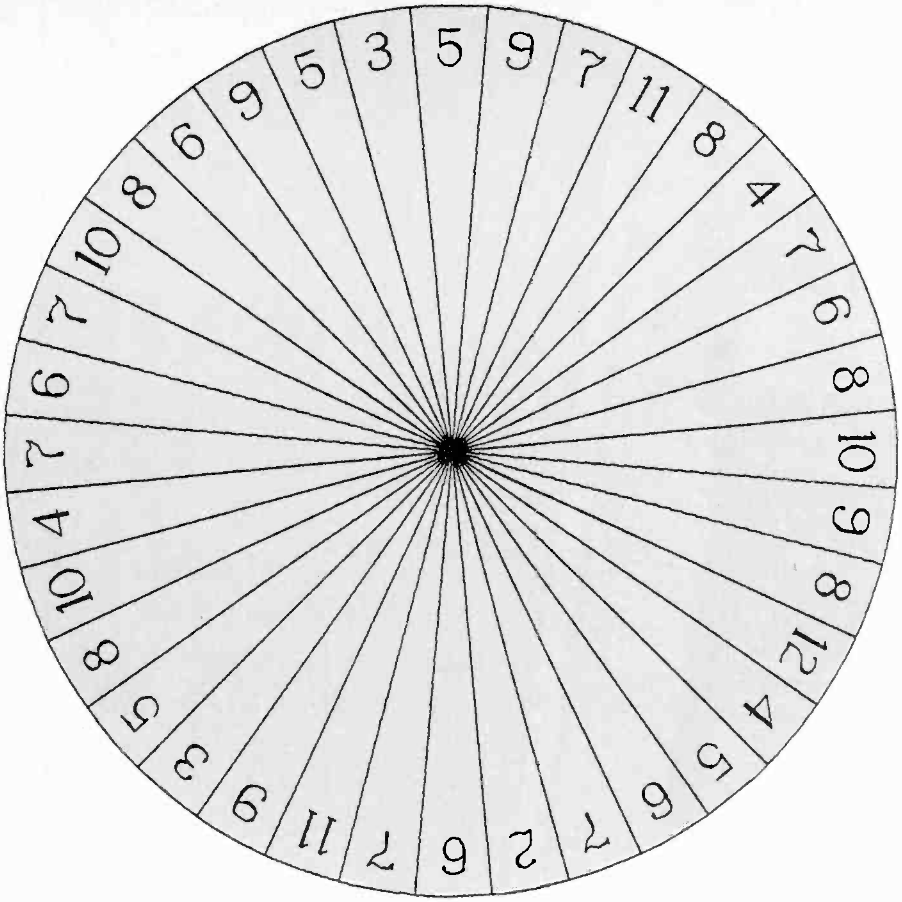


Fig. 5. This Dice-Roulette Game template, or one of your own design, can be copied to transparency film and glued to the top of the game for a well-finished look.

on/off switch, in any convenient spot.

Figure 4 shows the values of the 36 possible throws of a pair of six-sided dice. The top-most row shows the possible values of one die and the left-most column shows the values for the other die. The intersection between a row and column contains the sum of the two dice in that row and column. Note that the chances of throwing different numbers vary—there are six ways to throw a 7, but only one way to throw a 2. So the LED's must be labeled to present the odds correctly, with six number 7 LED's, but only one 2 LED, etc. Figure 5 is a template for the top of the Dice-Roulette Game, with the 36 possibilities arranged in random order but the right frequency around the wheel.

A copy shop can copy the template, or a template of your own design, onto a sheet of transparent film (such as that used for overhead projections) for mounting on the Dice-Roulette Game. The copy shop can also enlarge or shrink the template to the size you desire. When your template is ready, cut it out and cut a hole in the center for the spin switch.

A piece of solid-color adhesive-backed vinyl can be cut to size and mounted on the top of the enclosure to give an opaque surface to the wheel, if necessary. When you position the template, be sure the holes in the cover are alligned properly with the template's 36 wedges. Use spray-on transparent cement to attach the transparency to the vinyl or top of the enclosure. A final coat of spray-on clear acrylic will protect the lettering on the wheel.

When the template is mounted and dry, make holes in it that coincide with the holes on the cover. Insert an LED holder and LED in each hole. For a colorful display, alternate red, green, and yellow LED's. Align them so the cathodes face the outside edge of the top, and wire the cathodes of all of the LED's together. You're now ready to wire the LED's to the main circuit.

Cut and strip the ends of forty-one 15-inch lengths of wire. Using Fig. 1 as a guide, wire the LED's in sequence to their counter outputs. (You can begin anywhere on the wheel, but then continue in one direction.) Use another wire to connect the LED's cathode bus to R5. Next, wire and install S1 and S2 according to Fig. 1, using the remaining four lengths of prepared wire.

A four-battery holder such as Radio Shack's 270-391 can be modified for use with three batteries. Normally the batteries in the holder connect in series in the order 3-2-1-4. Cut the connecting wire between batteries 3 and 4, then use the wire at the + terminal of battery 3 as as the + power-supply lead. You can also use three single-battery holders wired in series. Connect the battery holder(s) to the circuit and cover any bare solder connections to the wires with electrical tape.

Carefully inspect your work, then mount the battery holder and circuit board in the enclosure. Insert the IC's, observing proper pin-1 orientation, and install the batteries. Pop on the cover and you're ready to go.

Testing and Customizing. If your Dice-Roulette Game isn't working correctly at first, don't despair. Troubleshooting is easier than with most circuits, simply because all those LED's offer valuable clues to what's wrong. No LED's light up? Check for V+ at each chip, and check with a logic probe or oscilloscope to see that pin 4 of U1 oscillates when S1 is pushed.

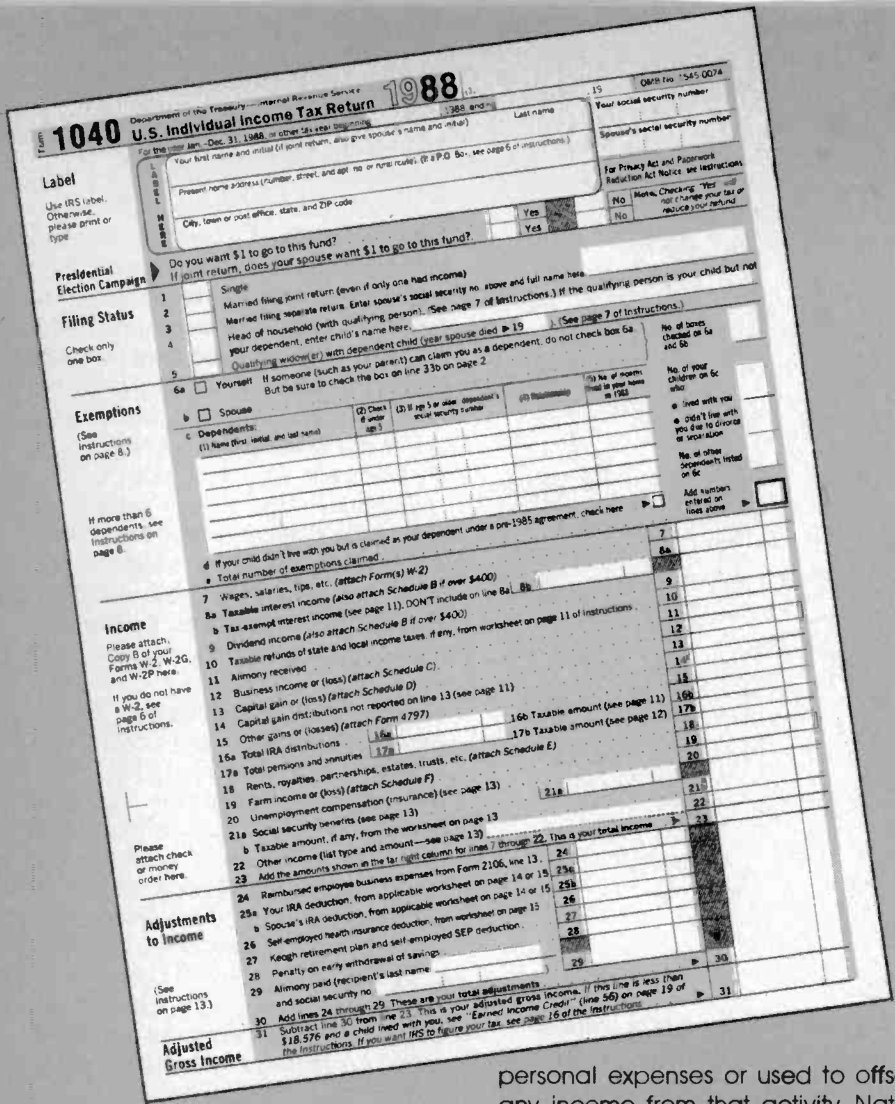
If only some LED's light, the problem can usually be traced to the part of the circuit controlling the first non-lighting LED's.

What about customizing the circuit according to your own preferences? You can easily change the number of LED's on the wheel by lengthening or shortening the counter chain. For instance, in a wheel with just 12 LED's, pin 10 of U4 connects to pin 15 of U3, pin 13 of U4 is grounded, and U5, U6, and U7 aren't needed.

By the same token, you can make a larger roulette wheel with as many LED's as you want, by cascading more counters. You can also design your own template for any type of wheel you'd like, perhaps your very own "Wheel-of-Fortune." You might also experiment with more creative LED patterns than the traditional wheel—a spiral or star shape, perhaps.

The spin and spin-down speeds are also easily adjustable. For a faster spin, decrease the value of R2 or C2. To slow it down, increase their values. Similarly, the amount of time the wheel takes to slow to a stop can be adjusted with R1 and C1.

You'll find the Dice-Roulette Game is an entertaining project all around (pun intended)—in the building as well as in the using. ■



YOUR HOBBY AND THE IRS

Who says having a hobby can't put money in your pocket? Would you belive it can be done with Uncle Sam's help?

BY MARK E. BATTERSBY*

Not too long ago, a couple that operated an Amway distributorship were denied a tax deduction for business expenses and depreciation because they failed to show the U. S. Tax Court that they had engaged in the activity with the objective of making a profit. But for that couple—and thousands of enthusiasts who might not be able to qualify their electronics-related activities as a "business" for tax purposes—all deductions are not lost.

Under our tax laws, special limitations are imposed on the deductibility of expenses incurred in an activity that is not engaged in for a profit. In other words, a "hobby." Often referred to as a "hobby-loss limitation," losses arising from a hobby generally cannot be deducted unless such loses are due to a casualty. The phrase "hobby-loss limitation" erroneously conveys the impression that any loss from a hobby cannot be deducted.

Fortunately, some of the expenses incurred in any electronics-related activity can be deducted, either as personal expenses or used to offset any income from that activity. Naturally, deciding which hobby expenses qualify as personal or which can or should be used to offset hobby income can be quite confusing—particularly since shifting those expenses between the two categories can have a noticeable impact on the bottom-line of an electronics enthusiast's annual income tax return.

The Expense Categories. In order to eliminate some of the potential confusion, as well as to ensure that all electronics-activity expenses are treated in the same manner, the IRS has established three general categories into which all hobby expenses fall:

Type One Expenses. Into this category fall all expenses for which a deduction would be allowable regardless of whether the activity was a hobby. For instance, items such as interest, and casualty losses are deductible.

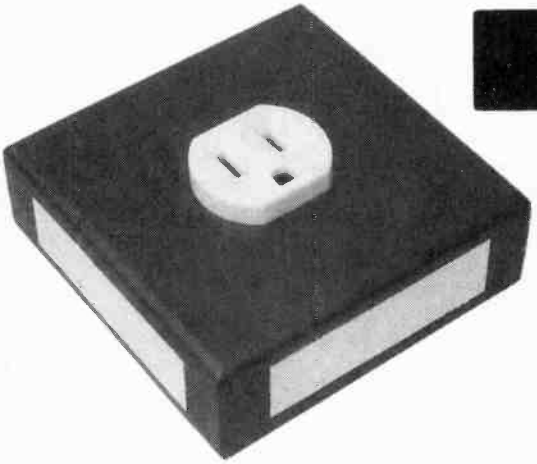
Type Two Expenses. These are expenses that, when deducted, do not require an adjustment to the book value of an item. Those include the cost of utilities, rent, or other expenses for the activity. Type two expenses are deductible to the full extent that the gross income from the activity exceeds the fully deductible expenses.

Type Three Expenses. These are the expenses that do result in a book value adjustment, such as depreciation, property losses, etc. Type three expenses are deductible to the extent that the income from the hobby exceeds the amounts deductible in the two other categories.

Thus, every enthusiast can deduct some of their electronics-related interest expenses (although that will be phased out), and casualty losses (subject to IRS rules) regardless of whether they receive any income. If the activity does produce income, that income may be offset by category two expenses, such as fees, rents, utilities, etc. If income from the activity still remains after deducting the expenses from those two categories, the remaining balance can be offset with depreciation deductions. Of course, as a hobby, deductions cannot exceed income, and no loss can be used to offset income from other sources. However, if you can satisfy the IRS that your electronics activity is performed for a profit, the potential for tax savings is much greater.

(continued on page 102)

*Financial and Tax Consultant
Ardmore, PA

Build a HT Socket

Here's a fun project that's bound to generate a shocking response!

BY WALTER W. SCHOPP

What would you think if you saw a small box that had an AC socket mounted on it, just laying on a desk? Your first impression might be "this can't be real so why is it here?" The next thing you'd do is pick it up for closer examination. About that time you'd be the recipient of a small jolt that will make you put it down in a hurry, most likely while mumbling a few choice words to yourself.

The circuit described in this article—the *Hot Socket*—is designed to deliver a mild shock to anyone inquisitive enough to pick it up. Shocks can be dangerous when they are received across a vital organ such as the heart. But with the Hot Socket, the startle factor is much greater than the actual danger.

In fact, the voltage and current generated (about 70 to 80 volts) by the Hot Socket is but a fraction of that produced by a stun gun or cattle prod. But, it is enough to establish in your mind that you just received a shock from an outlet that, from all appearances, has no power connected to it.

However, as safe as the unit may be, common sense should prevail when using the project. Don't leave it turned on and accessible to just about anyone who might happen along (such as a heart patient). Use it only under controlled circumstances.

Power for the circuit is turned on and off via a slide switch hidden on the bottom of the project's enclosure. When the switch is flipped to the on position, the circuit goes into sort of a semi-dormant condition until it is picked up and tilted slightly. The actual turn on is accomplished by way of four miniature-mercury switches oriented in four different directions.

When the Hot Socket is tilted, one of those switches closes, applying power to the circuit. At that point, a low-frequency oscillator is activated, which energizes a relay, causing its contacts to close momentarily. That produces a short pulse through the primary of a home-made transformer.

The secondary of the transformer is connected to the four aluminum-foil plates mounted on the sides of the enclosure. The opposing plates are connected across the secondary of the transformer.

How It Works. Figure 1 shows the schematic diagram of the Hot Socket. The circuit consist of two general-purpose transistors (Q1 and Q2) and a few support components, including a home-made transformer. When S1 is flipped to the on position and the circuit is not tilted in any direction, no power is delivered to the circuit. But when the circuit is tilted, power is applied through one of the mercury switches and a voltage divider network (consisting of R2 and R4) to the base of transistor Q1, turning it on. At the same time, a short-duration pulse is applied to the emitter of that transistor via capacitor C1.

With Q1 turned on, the base of transistor Q2 is pulled low. Normally that would turn on Q2, but the short pulse

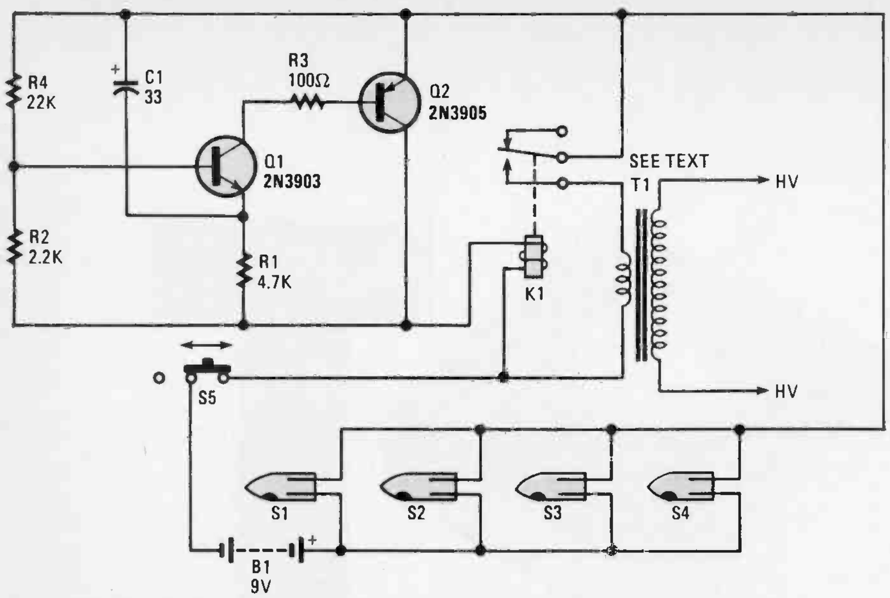


Fig. 1. The Hot Socket consist of nothing more than two general-purpose transistors (Q1 and Q2) and a few support components, including a home-made transformer.

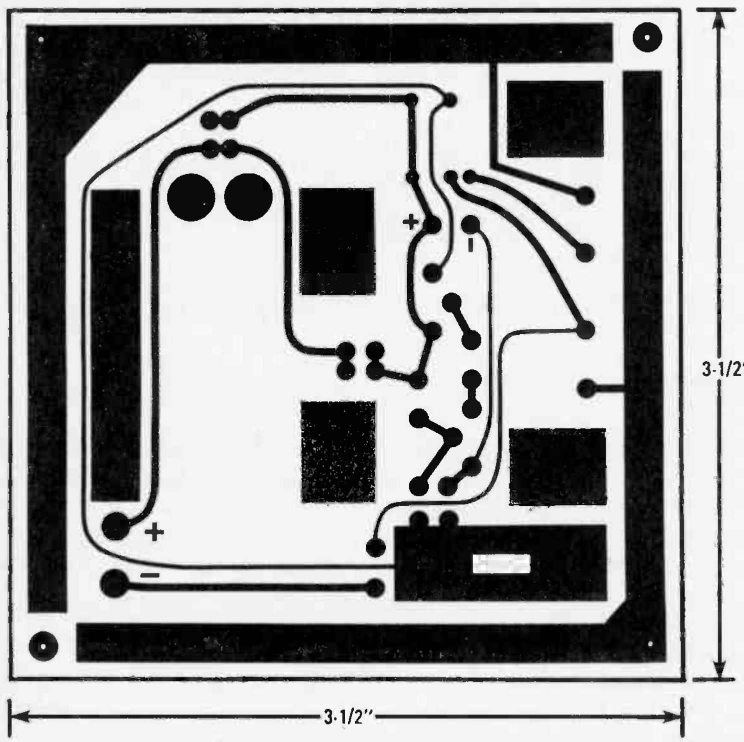


Fig. 2. Here is a template of the Hot Socket's printed-circuit board. The board has a dual role: it serves as the chassis on which the components are mounted, and as the bottom cover for the enclosure.

through capacitor C1 momentarily holds Q2 off. As C1 starts to charge toward the supply potential, Q2 turns on, delivering a pulse of energy to relay K1, energizing it. Relay K1, which is connected across the positive and negative supply rails, applies a short burst of energy across the primary of transformer T1. That causes a higher voltage to be induced in the secondary winding of the transformer. The output of T1 is then applied across the four aluminum-foil plates.

Construction. The author's prototype of the Hot Socket was built on printed-circuit board, measuring about 3½ square. All components were surface mounted to the foil side of the board. Figure 2 shows a template of the Hot Socket's printed-circuit board. The PC board has a dual role: it serves as the chassis on which the components are mounted, and as the bottom cover for the enclosure.

The parts-placement diagram for the Hot Socket's printed-circuit board is shown in Fig. 3. The 9-volt battery, B1, is held in place by two loops of No. 14 solid-copper wire formed around the battery and soldered to the board. A small loop is also soldered to the board at the bottom of the battery to keep the battery from sliding into the mercury switches located near the bottom end of the battery.

The leads of a snap-on battery connector are cut short and soldered to the terminals marked plus and minus on the PC board. The resistors were vertically mounted to the board to conserve space. The electrolytic capacitor, C1, can be of either radial- or axial-lead type. However, if an axial-lead unit is used, it will be necessary to mount it vertically.

The pins of the relay were bent outward and soldered to the pads on the board. A small slot was cut in the PC board to allow access to the slide switch handle and the slide switch was soldered to the pad provided. Small foot pads were mounted on the corners of the board to keep the project from resting on the slide switch handle when the project is completed.

The four miniature mercury switches are mounted with the lead ends elevated about 1⁄16 inch above the board with the tops pointing downward. That mounting scheme guarantees that no power is applied to the circuit when it is laying on a flat, level surface. The miniature mercury switches (S1 to S4) are not readily available from most electronic-parts suppliers, but are available in sets of four from the supplier given in the Parts List.

The miniature mercury switches are encased in metal and the metal cover is not insulated from the circuit. In order to prevent the cover from shorting against other board components or circuit-board traces, slip a small piece of heat-shrinkable tubing over each unit before mounting. When the switches are mounted and adjusted, secure them to the board with a drop of epoxy cement.

The transformer is not available from any supplier and must be made by the experimenter. Figure 4 gives details for the construction of the home-made transformer used in the Hot Socket. Start by cutting two small pieces of single-sided printed-circuit board material to a half inch square. Drill a hole, using a No. 35 bit, in the center of each square.

Next, heat a 3-inch No. 10D finishing nail over the burner of a kitchen stove

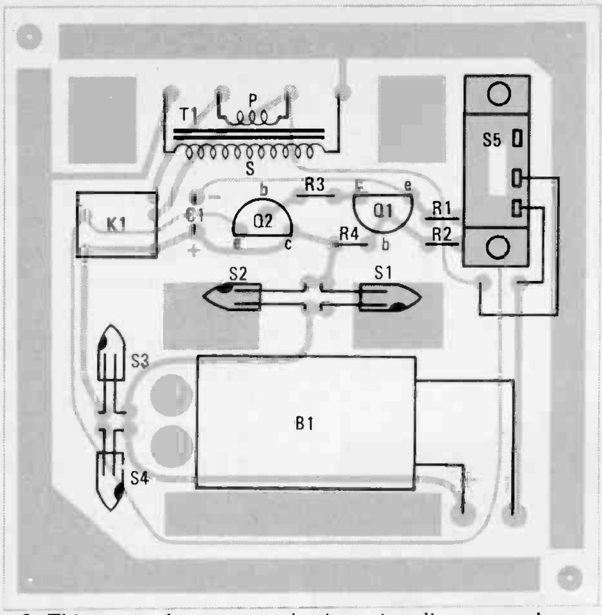
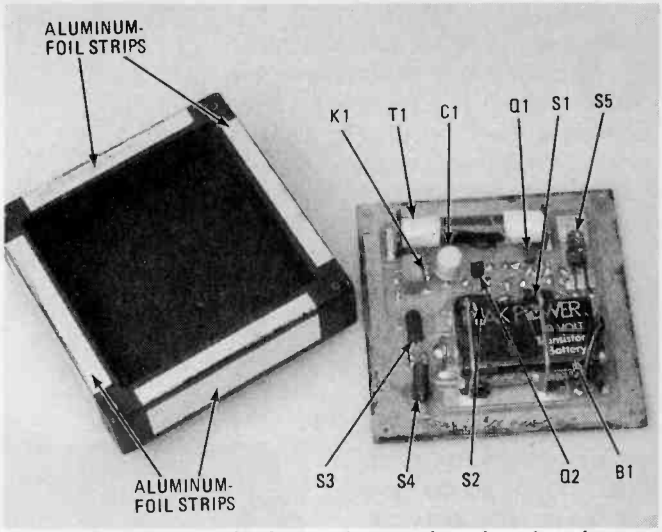


Fig. 3. This parts-placement and orientation diagram makes assembly of the Hot Socket a snap. Just be careful when installing the transformer; incorrect installation of that component will result in step-down operation, instead of step-up operation.



Here is the fully assembled printed-circuit board ready to be joined with its wooden enclosure. The white strips on the enclosure are actually the aluminum foil. When the project is fully assembled, the foil contacts the L-shaped circuit traces on the board, which are connected to the secondary of the transformer. When the project is tilted in any direction, a mild shock is delivered through the strips.

PARTS LIST FOR THE HOT SOCKET

Q1—2N3903 general-purpose NPN silicon transistor
Q2—2N3905 general-purpose PNP silicon transistor
R1—4700-ohm, ¼ watt, 5% resistor
R2—2200-ohm, ¼ watt, 5% resistor
R3—100-ohm, ¼ watt, 5% resistor
R4—22,000-ohm, ¼ watt, 5% resistor
C1—33-µF, 16-WVDC, electrolytic capacitor
K1—12-volt micro-miniature relay (Radio Shack 275-241)
S1-S4—Miniature mercury switch, see text
S5—SPST or SPDT miniature slide switch
T1—see text
Printed-circuit materials, wood, hard board, nail, battery, No. 36 AWG magnet wire, No. 14 wire, snap-on battery connector, etc.

Note: A set of four miniature mercury switches (part No. 3004) is a available at $10.00 (postage paid) from Electronic Enterprises, 3305 Pestana Way, Livermore, CA 94550. California residents please add appropriate sales tax. Please allow 6 to 8 weeks for delivery.

until it is cherry red, and let it cool slowly without quenching. That annealing process improves the ferromagnetic properties of the nail. After it has cooled, remove any scale by the placing it in an electric power drill and sanding it.

Once that's done, push the nail into one of the small circuit-board squares

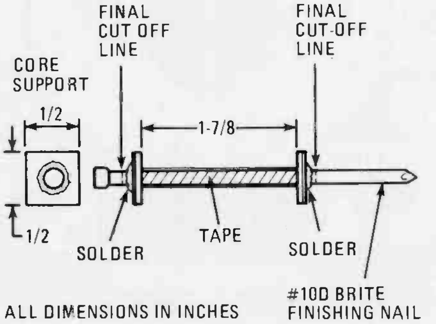


Fig. 4. The form on which T1 is wound must be fabricated by the builder. This illustration shows construction details for fabricating the form.

from the foil side until the head is about a quarter-inch above the copper surface. Solder the nail to the copper surface of the board. Next, drive the nail into the other square from the fiberglass side until the two squares are about two inches apart, as measured from the outside edges of the square end pieces.

Set the form on a flat surface and align the second square with the first so that it can be mounted on two flat edges. Solder the nail to the square to complete the coil form. Do not cut the excess nail length off at this time.

Cover the nail between the two ends with a single layer of scotch tape to keep the wire from shorting to the nail during winding. Wind a single layer of No. 36 AWG magnet wire the full length of the form (about 325 turns) between the end squares. That winding will serve as the primary of the transformer.

Next, place the pointed end of the nail into an electric drill and wind about 100 feet of No. 36 wire over the full length of the form. Lightly sand the insulating varnish from the ends of the four transformer leads and solder them to short pieces of light-gauge stranded wire and tape them to the coil with masking tape. That allows for easier handling without the fear of breaking off the fine magnet wires.

The ends of the nail can now be cut off almost flush to the printed circuit squares. The primary of the transformer is soldered to their pads on the printed-circuit board. The secondary wires are soldered to the pads and also connected to the L-shaped, printed-circuit traces. Those traces, when the board is fitted into its enclosure, contact the aluminum strips that are glued to the project's enclosure.

Building the Enclosure. The enclosure itself can be made from scraps of wood that you may have laying around. Start by making a frame about 3½-inches square, and ⅞-inch high (see Fig. 5) from a ⅜-inch thick piece of wood. The author's enclosure was made from molding strips of the type that is readily found at most lumber yards.

Cover the top of the frame with a ⅛- or ¼-inch thick square piece of hardwood. Sand smooth and paint the enclosure. The side plates—which are made from aluminum foil—are glued

(Continued on page 106)

Test Equipment on the Cheap

You can feed your champagne tastes in test equipment, even if you only have beer pockets!

BY JOSEPH J. CARR

One major reason why most electronic hobbyists don't own more test equipment is that such equipment is costly. Flip through any test-equipment catalog if you thrill over heart-thumping shocks. There are two ways to obtain test equipment (legally that is): First, you can save your pennies and then go buy it new. Today we have available a selection of not-too-unreasonably priced models that perform better than similarly priced models of yesteryear. Over time, you should be able to build up a decent workbench full of test gear. Second, you can buy used test equipment and refurbish it yourself.

"Used gear? Me? Refurbish it myself? Only dinosaurs are available; right?"

First of all, no; that's not correct. Second: So what if the equipment's been used? If I have to pay $400 for a modern service-shop grade RF-signal generator, or $25 for an "oldie but goodie" dinosaur from another era, then I'll save the bucks and sacrifice a little extra benchtop space for the ol' dinosaur.

In this article we are going to talk about sprucing up a signal generator, but keep in mind that the remarks and methods discussed can be applied equally well to most other types of old test equipment.

Making the Purchase. There are several ways to obtain used but usable test equipment. There are a number of dealers around the country who specialize in used test equipment, both "as is" and refurbished. Another source is TV-repair and other service shops that may have surplus equipment on hand. Pick a shop that has been in business a long, long time. Such shops are most likely to have old equipment gathering dust under the workbench, immediately beneath the glitzy new solid-state instruments that replaced them.

Still other sources of old equipment are events such as hamfests, computerfests, swap meets (and not necessarily only electronic swap meets), estate sales, and yard sales. I once saw a venerable Hewlett-Packard Model 608 signal generator on sale for about $25 in a yard sale (and I was broke at the time). There was also an estate sale that listed "miscellaneous electronic equipment" in the advertised list. The gear turned out to be a complete Collins S-line amateur-radio set and a benchfull of high-grade military-surplus test equipment, all of which went for a song to a friend of mine who was starting a repair shop business. It seems that most of the bidders were more interested in the antiques, furniture, and collectibles.

You will also find hams and other electronics enthusiasts offering used equipment for sale. Check any local ham-club newsletters, club bulletins, and the bulletin board at the local parts and equipment dealer for ads.

I obtained two RF-signal generators in recent years. One is a 1947 Measurements, Inc. Model 65 (that covers 2 to 400-MHz AM/CW), and the other is a Precision Instruments, Inc. Model E-200-C (which covers 100-KHz to 30-MHz on fundamentals, and into the VHF region on harmonics).

A Case History. The Precision E-200-C RF signal generator was purchased for ten bucks at the annual Gaithersburg (MD) Hamfest. When selecting a purchase, make a few visual, aural, tactile, and *olfactory* checks. First, eyeball the piece to see if it is complete. Make sure that the power cord, the knobs, the cabinet screws, and anything else that should be present, is present.

Next, give the knobs and controls a twirl (gently—you don't own it yet!). Do a tactile test: make sure that the controls operate without binding. Perhaps the most important controls are the rotary switches. If those are broken, then it is unlikely that a replacement can be easily obtained. Specifically in the case of a signal generator, check the tuning capacitor also. In other words, tune the main frequency selector dial. An "aural" test should be made while shaking the equipment (if practical). Listen for any large pieces clunking around, or a large amount of small debris. Now for the olfactory test: smell the equipment to detect the acrid odor of a burned-out power transformer. Again, the transformer is one of those parts that is hard to find (not impossible, but difficult).

Don't overlook the most obvious test. If power is available, then turn the equipment on and see if it works. Before plugging in, however, visually inspect the AC power-line cord to make sure that it is not frayed or in bad shape. Only plug it in if the power cord seems in good safe shape.

After you get the gem-in-the-rough home you will want to take it out of its cabinet and give it a look-see. Again, you are looking for obviously missing pieces. In the case of my Precision E-200-C, everything seemed to be present. A bench test showed that the unit could output unmodulated RF, but not modulated RF (the MOD RF position on the selector switch produced only unmodulated RF).

Cleaning. After many years of service, or unforgiving storage under a workbench or in a garage, the controls and switches are likely to be filthy. Oxide coating will cause intermittent operation, or prevent it all together. It may be necessary to remove shields to access some of the controls and switches. Use a good quality switch-contact and control cleaner. Aerosol cans of the stuff can be bought at electronics-parts outlets that cater to TV-service shops. Spray the control or switch and then vigorously work it through its entire range.

The main tuning capacitor, if any, may also need cleaning. Two problems present themselves at this point: First, you might find debris between the capacitor plates causing short circuits. A blast of dry air will clean out the

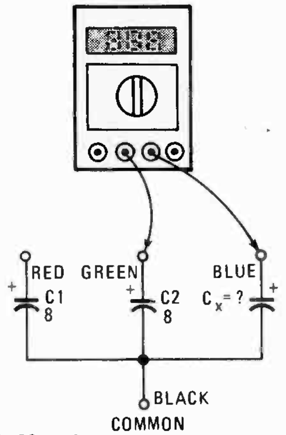


Fig. 1. If you're smart you can overcome the limited range of your test equipment. Shown is a method for measuring the capacitance of a large section in a multi-section capacitor.

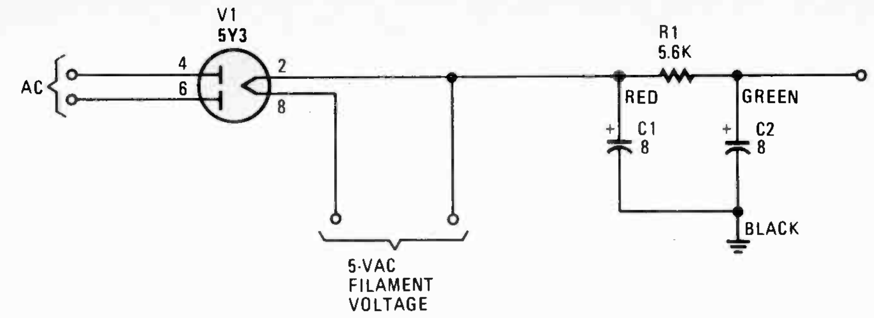


Fig. 2. Here are the two sections of the large capacitor connected to V1. From the specifications of V1, it was determined they should be 450-WVDC units.

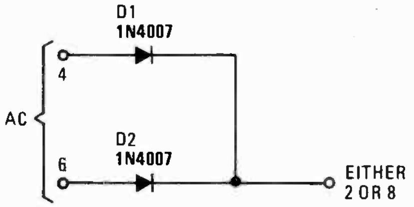


Fig. 3. A rectifier tube can easily be replaced with two diodes as shown.

capacitor plates in most cases. Dry air or nitrogen is available from the same stores that sell control cleaner. Alternatively, boat- and bicycle-supply outlets often sell canned air as well. It is used to power portable air horns. Alternatively, do what I did with one piece of equipment: take it to the gas station where you do business and use their air hose (provided they like you). If an air blast doesn't work, then clean between the plates with a relay-contact burnishing tool or an auto mechanic's feeler gauge.

The second common fault with tuning capacitors is poor grounding of the rotor. In receiver and signal generators alike, that will cause *microphonic oscillation* that is sensitive to light tapping. There are two ends to the rotor. Under one end there is a spring clip that grounds the rotor to the frame. Using a relay-burnishing tool, carefully (without bending it) lift the ground spring and clean underneath it. Very carefully spray some contact cleaner into the ball bearings at the front end, being careful to not spray too wildly. A little blast of dry air will clean it out. After the bearings are cleaned, re-lubricate them with a dab of Lubriplate or some similar servicer's white grease. I generally use a toothpick to apply the lubricant.

It may also be necessary to clean any tube pins and sockets you find. A little piece of No. 600 emery cloth or sandpaper will clean the crud off the vacuum-tube pins. Remove the tube from its socket, and clean the pins. Next, spray the pins with a little contact or switch cleaner, and reinsert the tube into its socket. Pull the tube out of its socket and reinsert several times to clean the tube socket well. If, when you test the equipment, you find that it is intermittent, then use a pair of long-nose pliers (with **the power off** and **the AC plug removed from the socket**!) to gently re-tension the pin receptacles on the tube sockets.

Other Problems. The signal generator worked (almost) when I bought it, but there were still some things that needed replacement. The audio modulation was regained simply by replacing the modulator tube (a 6C5). The price of tubes will utterly shock you if you go to a regular distributor. That 6C5 "lists" for $27 when you can find it at a retail outlet, and $15 is not an "unreasonable" wholesale price. However, check the small display ads and the classified ads in magazines like **Popular Electronics** and *Radio-Electronics*. Mail-order dealers sell new and used "classic" tubes for a whole lot less. I paid $4.50 for a new 6C5 by mail order.

The power supply and audio section of the E-200-C, contains the 6C5 tube and a large capacitor. That capacitor is a multi-section electrolytic capacitor used as a ripple filter in the high-voltage DC power supply. Although there did not appear to be any hum modulating the RF output, the paper body of the capacitor was discolored. I decided that was a good enough reason to replace it, but there were no ratings on the outside. What to do?

My portable digital multimeter (DMM) is capable of measuring capacitance up to 20 µF. Two sections read 8 µF, and I knew from past experience to expect some value in the 4- to 16-µF range for the DC power supply. The other section, however, overranged the meter. I used an interesting scheme to indirectly "read" the value of that section (see Fig. 1): Mathe-

(Continued on page 100)

CORD BUSTER

Now you can eliminate the need for headphone umbilical cords that keep you tethered to your stereo system.

BY CHARLES D. RAKES

If you have ever tripped over a dangling headphone cord, or had one tangle around something valuable and wipe it out, you'll be forever grateful for our *Cord Buster*. The Cord Buster can make a cord-free person out of you, all for an investment of a few bucks and a couple of hours work. Simply plug the Cord Buster into any headphone-output jack, mount an FM headphone receiver on the "old bean," and presto! No more umbilical cord to tie you down or tangle you up.

The Cord buster might be connected to your TV, letting you listen to the program without bothering others in the same room, or being tethered to the set via an umbilical cord. In like manner, the Cord Buster could be connected to a scanner so that you can listen in without being tied down. And how about plugging the Cord Buster into the *Listening Tube* (an electronic listening device presented in the January, 1988 issue of this magazine), or some similar device.

There is also a stand-alone version—which we'll call the *Ear Extender*—that can be used to transmit audio that's picked up by a built-in electret condenser microphone to a nearby FM receiver. For instance, you might place the Ear Extender next to junior's bed so that you can monitor from another room.

The two circuits are very similar. So much so that both can be built using the same printed-circuit layout. Both versions have a range of 50- to 100-feet, and can be used in conjunction with just about any signal source designed to drive a speaker or headphones. The actual operating range depends more on the quality of the receiver than on the RF output of the circuit.

How It Works. The schematic diagram for the Cord Buster is shown in Fig. 1. The circuit is built around two transistors (Q1 and Q2) and a handful of support components. Transistor Q1 (a 2N3904 NPN unit), configured as a buffer, isolates the audio-input circuit from the oscillator circuit (Q2) and sets the modulation level.

Resistors R1 and R2 form an impedance-matching network, which is set to match the impedance of most of today's modern headphone-driver circuits. Such a network is necessary to prevent overdriving the audio source. A voltage-divider network, consisting of R3 and R4, provides base-bias voltage for Q1. With the values shown, a bias of about half the supply voltage is applied to the base of Q1.

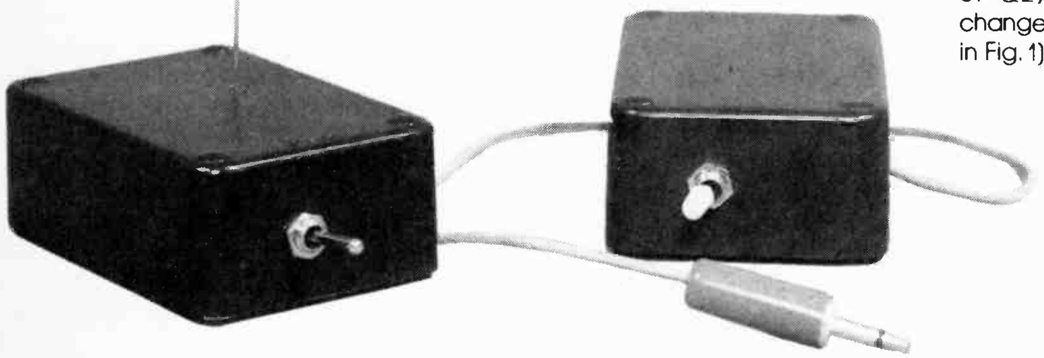
The input signal is fed through R1 and coupling capacitor C1 to the base of Q1. The output of Q1 (at its emitter) is fed through R6 and C2 to the base of Q2. Transistor Q2, along with components L1 (a home-made coil), C5, and C6 form an RF-oscillator circuit that operates within the FM-broadcast band. Bias for Q2 is provided by a second voltage-divider network, consisting of R7 and R8.

Resistors R7 and R8, together with R9, determine the RF output level of the circuit. Capacitor C4 supplies an RF bypass path for the base of Q2, while allowing the audio modulation signal to pass through.

Ear Extender. The Ear Extender circuit (see fig. 2) is simply a modified version of the original Cord Buster circuit. Note that only the front end of the circuit is shown in that illustration. That's because that is the only portion of the circuit that differs from the one in Fig. 1.

Actually, only two components have been changed or eliminated. In Fig. 2, instead of the audio input signal being fed through R1 and C1 to the base of Q1, the signal is input to the circuit via a small electret microphone element (MIC1). The microphone element, MIC1, connected in series with R1, is used to bias Q1. As was the case in Fig. 1, the output of Q1 (at its emitter) is then fed to through R6 and C2 to the base of Q2, whose function has not changed. And R5 (which was present in Fig. 1) has been eliminated.

Construction. There is nothing critical about the construction of the circuit. In fact, the author's prototype was built on perfboard and later transferred to printed-circuit board. Printed-circuit



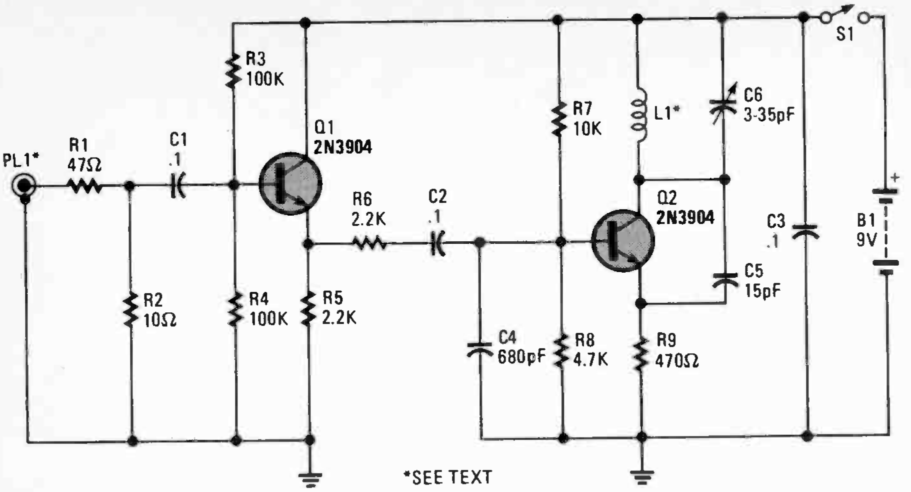


Fig. 1. This schematic diagram of the Cord Buster demonstrates the simplicity of the circuit. The circuit is built around two general-purpose NPN transistors, and a handful of support components, including a hand-wound coil, L1.

PARTS LIST FOR THE CORD BUSTER

SEMICONDUCTORS

Q1, Q2—2N3904 NPN transistor.

RESISTORS

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

R1—47-ohm
R2—10-ohm
R3, R4—100,000-ohm
R5,R6—2200-ohm
R7—10,000-ohm
R8—4700-ohm
R9—470-ohm

CAPACITORS

C1, C2, C3—0.1-µF, 100-WVDC, ceramic disc
C4—680-pF, 100-WVDC, ceramic disc
C5—15-pF, 100-WVDC, ceramic disc
C6—3-35-pF, trimmer

ADDITIONAL PARTS AND MATERIALS

B1—9-volt transistor-radio battery
L1—See text
S1—SPST miniature toggle switch
PL1—Phono plug, see text
Printed circuit or perfboard materials, enclosure, IC sockets, battery connector, wire, solder, hardware, etc.

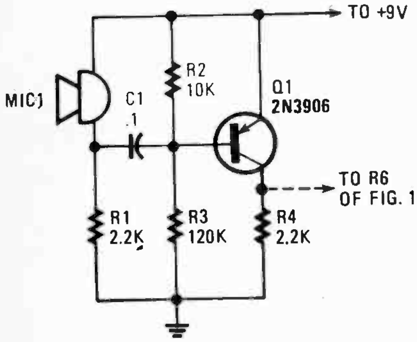
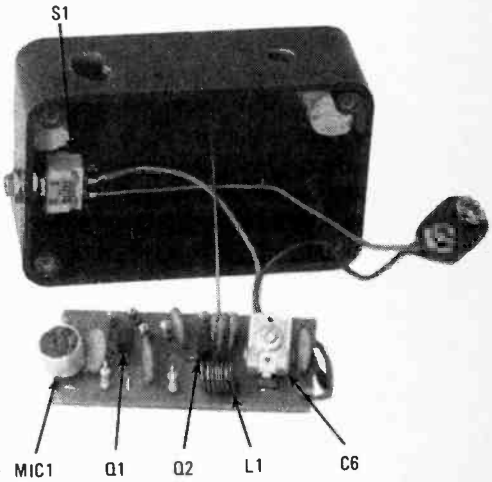


Fig. 2. Only the front-end of the Ear Extender circuit is shown here because that's the only part of the Cord Buster circuit that has to be modified.

Fig. 3. This printed-circuit template can be used to build both versions of the circuit. Refer to the layout pattern that pertains to the version of the circuit that you want to build.



The Ear Extender is identical to the Cord Buster, except that the input jack was replaced by MIC1, R5 has been eliminated, and transistor Q1—an NPN unit in the Cord Buster—has been replaced by a PNP unit in this circuit.

construction simplifies assembly and reduces the chance of a wiring error.

Figure 3 shows a template of the foil pattern used by the author to build the final versions of this two-in-one project; as mententioned, that pattern may be used to build both the Cord Buster and the Ear Extender versions of the circuit. Figure 4 shows the parts-placement diagram for the Cord Buster.

Figure 5 shows the parts-placement diagram for the Ear Extender circuit. When installing the microphone for the Ear Extender, be sure to observe proper polarity. After etching the circuit board(s), install the components using the proper layout pattern for the version desired.

Inductor L1 can be made by winding a 6½-inch length of number 19 or 20 enamel-covered copper wire around a ¼-inch diameter form. Before winding the coil, remove about ¼-inch of the enamel coating from each end of the wire and tin the ends. When completed, the coil should be close to ¼-inch in length.

Since the circuit is somewhat compact, all components are mounted in an upright position. Start by soldering L1 in place, then the trimmer capacitor, and transistors (Q1 and Q2). When installing the components be mindful of the proper orientation for the transistors. Improper installation of the transistors will render the circuit inoperative, or possibly even damage those units.

Next install the remaining resistors and capacitors. Don't overlook the jumper from the collector of Q1 to +V. The prototype was housed in a plastic cabinet—measuring 3¼ × 2⅛ × 1⅛ inches—with an aluminum lid, but almost any similar enclosure will do. The circuit boards were held in place with two grooved ¾-inch lengths of ⅝-inch dowel rods mounted with contact cement to the bottom of the cabinet.

Switch S1 is mounted at one end of the cabinet. A ¼-inch hole is drilled in the cabinet's side opposite the tuning capacitor, C6. If you are building a Cord Buster, a 12-inch length of shielded mike cord, with a suitable plug attached to one end, is used to connect the unit to some audio source. Either an ⅛-inch or ¼-inch input plug may be used, but if the ⅛-inch size is selected, an adapter can be used to go to the larger ¼-inch size plug if necessary. If you are building the Ear Extender, be sure to drill a hole in the side

(Continued on page 103)

Popular HANDS-ON REPORT Electronics

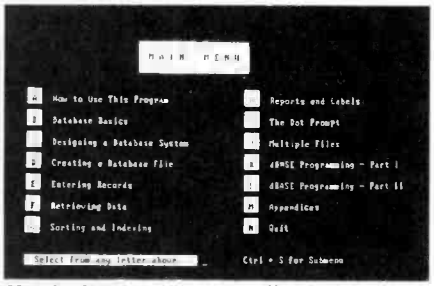
CIRCLE 69 ON FREE INFORMATION CARD

dBASE III PLUS TRAINING AIDS FOR BEGINNERS AND PROS

Two inexpensive training aids from Individual Software, Inc. make mastering dBase III Plus an easier and enjoyable task.

Everyone should become familiar with Ashton-Tate's dBase III Plus because it is one of the most common programs used by hackers and professionals for collecting and managing data. That can be a problem because dBase III Plus, like so many other *humungus* programs, is so extensive, the casual user who doesn't use the program frequently is sure to forget much about running the program. Every dBase session becomes a refresher course. Additionally, the two-inch thick *Learning and Using dBase III Plus* manual requires extensive reading time and is complex. It is not the ideal text for discovering dBase Plus III and learning dBase from scratch.

Individual Training. Ashton-Tate filled most of dBase user's initial learning gap with *The Assistant*, a collection of menus to perform your day-to-day data-management tasks. The Assistant does the job of prompting the user with choices that are familiar if you have some previous training, thus giving the users memory a rest. *Individual Training for dBase III Plus* by Individual Software, Inc. (ISI) offers simulated dBase Assistant menus in a carefully assembled training program. The user will believe that he is in dBase, because the menus are identical in appearance.

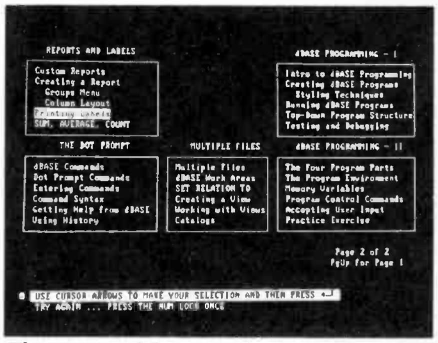


Here's the main menu. It allows you to access a submenu that contains a list of helpful texts you can call up.

The manual consists of 11 pages, and that is a credit to ISI's training-program philosophy. After the brief program description, license agreement, and copyright protection are discussed, the user is informed of how to either run the program from two copied floppy disks, or from a subdirectory from the system's hard disk. Once the program is running, the user need only refer to page 8 in the manual for specific control-key inputs—seven control keys to be exact—that make the program totally flexible. If you are a fast reader, just tap the space bar when you finish a screen's worth of information, and the program advances to the next screen. You learn at your own pace.

The program introduces the user to database concepts and terminology. Then follows with in-depth coverage of The Assistant's menus and *Dot-Mode* commands. The course offers informative lessons on creating, modifying, retrieving, editing, and sorting databases. There's much more, but we'll leave that as a bonus for the first-time user.

A few screens are presented in this article to show the reader what the user sees. There is a help function that is at first very useful, but is made obsolete by the acquired knowledge of the user.



This is one of the two submenus. There are several topics to choose from for each main-menu selection. A choice is made by positioning the highlighted area.

Unlike many other programs, ISI's dBase III Plus Training Program can be stopped in the middle and returned to later. If you have some knowledge of dBase's Assistant operation you know that if you want to jump to a particular portion of the course, say *label making*, it is possible.

101 dBase Programs, The real power in dBase III Plus is in the Command or Dot Mode, in which a programmer can shape and form the database information into reports that are useful. Help is needed here for the casual user. There are many utilities available that will help a user of dBase

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GIZMO®

A CHRONICLE OF CONSUMER ELECTRONICS

APRIL 1989

VOLUME 2, NUMBER 4

Get Physical

NINTENDO ENTERTAINMENT SYSTEM POWER SET. Manufactured by: Nintendo of America, Inc., P.O. Box 957, Redmond, WA 98052. Price: $149.95.

The progress of video games, regardless of the ups and downs of the marketplace has been from the arcades to the living room. Players, naturally, have followed, which means that they have progressed from standing to reclining. The flabbing of America, some observers maintain, has been accompanied by the electronic beeps and flashes of video games as youngsters (and others) retreat to the couch for yet another round of "Super Mario Brothers."

With the introduction of its *Entertainment System Power Set*, featuring a new *Power Pad*, *Nintendo* apparently intends to get players out of their chairs and back into the action without having to leave the vicinity of the television set, or of any of the company's electronic games.

The idea seems to be that users will be able to get back into shape without donning exercise togs, going to a gym, or even straying very far from a favorite chair or couch. Introduced with a new game, "World Class Track Meet," the Nintendo Power Pad appears to have been designed with the consumer's cardiovascular system in mind.

The Nintendo Entertainment System Power Set is described as the brand's "top of the line system" and it justifies its position (and its slightly higher price than the Nintendo "Action Set") with the Power Pad accessory and inclusion of the *Zapper Light Gun* (see **GIZMO**, August, 1988).

Connected to the control deck via controller socket number two (a standard controller is plugged into number one), the power pad is fabricated of some sort of plastic material and measures about 3 feet, 3 inches by 3 feet 2 inches. Divided into two halves, the top surface is marked with a series of red and blue circles numbered 1 through 12. One line of circles represents the "super speed positions." The next are advanced speed, and the bottom row (9 through 12) are the normal-speed positions. Instead of moving a controller stick or trigger, with the power pad the players move themselves. Pressing or standing on "one or more of the circles" activates the pad and the game. The top speed of each runner on the screen (in the power pad's "World Class Track Meet" game) varies depending upon which row of circles the player uses, making it easy to adjust for players of uneven ability or different ages.

Users are warned not to use the pad while wearing shoes or on any "thickly padded surface." Rugs and carpeting are okay, but the instructions caution to be sure that the control deck is off when changing game cartridges. Static electricity build-up in the pad circuitry could, under some conditions, damage the Nintendo Entertainment System.

Using the "World Class Track Meet" to introduce us to this new controller, we watched as the TV screen displayed an Olympic-style torch and the titles of six athletic events. The standard hand control is used to select one of the competitions—100-meter dash, long jump, 110 hurdles, triple jump, a tournament contest, and the final "World Class Track Meet."

After selecting an event, the user enters the number of players (up to six) and the competitors' names. The controller "start" button begins the game. The screen displays the information entered before play, as well as each runner's number, color, and position. Time is displayed on the right side of the screen, along with an indicator that appears when there's a false start or incomplete jump by one of the athletes. A display on the left shows each runner in relation to the start and finish lines.

If a player lifts a foot before the starting signal (a whistle and gun), that counts as a "false start." Players must begin running in place on the Power Pad as soon as the starting gun is fired. Two false starts and the player loses a turn. On screen, each player's representative runner increases speed gradually as the participants run in place on the power pad. Played solo, competition is against a runner projected by the Nintendo system.

In the "Track Meet" jumping events, the Power Pad proved to be an easy-to-abuse competitive device. It didn't take

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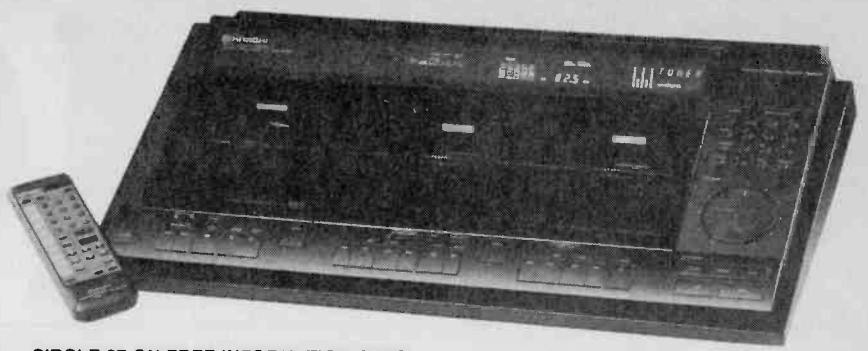
TURN PAGE FOR CONTENTS

This Month In GIZMO

Gizmo is published by Gernsback Publications, Inc., 500-B Bi-County Blvd., Farmingdale, NY 11735. Senior Writer: George Arthur. Contributors to this issue: Marilyn Ciafone, Rick Hammer, Bruce R. Olson.



CIRCLE 37 ON FREE INFORMATION CARD

Audio Visual

HITACHI STEREO CASSETTE RECEIVER/COMPACT DISC PLAYER (MX-W50). Manufactured by: Hitachi Sales Corp. of America, 401 W. Artesia Blvd., Compton, CA 90220. Price: $899.

Cosmetically speaking, most home-audio and -video equipment comes down to a box with a series of knobs, controls, and indicators concentrated on the front panel. Handy enough for stacking, storage, and shipping, but visually a little monotonous. The same thought apparently occurred to the design (or marketing) department of *Hitachi* and the result is something between a space-ship control panel and the DJ booth at a high-tech disco.

Either way, there's no mistaking the *MX-W50 Stereo Cassette Receiver/CD Player* for the standard home-audio oblong of entertainment. Three-inches high at the rear, the unit (25¼-inches long and 15-inches deep) contains a CD player, dual-cassette decks (both beneath their own plastic pop-up covers), an AM/FM receiver, and a 50-watt amplifier under its sleek, futuristic exterior. Assisting the user in controlling all that home-audio power is an infrared remote unit and what can only be described as a colorful array of unit-mounted controls—red, white, green, and amber signal lamps and indicator panels.

The CD player features direct, manual, skip, and random-memory search (of up to 15 tracks), as well as repeat and programmable play of up to 32 disc selections. An illuminated display (the "CD music table") above and behind the top surface panel indicates the tracks that are being entered into memory (programming can only be done via the remote control) or that are being heard during play. The main CD display furnishes track and disc-duration information. The CD player is also equipped with a pause/standby function.

Programming is per play, which is to say that once the system is switched off, or to another function, the memorized tracks are erased.

With its close proximity to a tape deck, this CD player's memory proves its practicality in duplicating selections from a disc. With just two controls, the user can put together cassette selections—which, for anyone still using the antique vinyl-LP medium, would mean laborious cuing and platter flipping. (The unit does include a turntable input, which may seem to future audio generations as archaic as the old 78- and 16-RPM turntable settings appear to current users.)

The MX-W50, in another combination of CD and tape functions, offers what the instructions call "Long Play," allowing the user to listen to a CD, followed by cassettes one and two. With the decks' cassette-reverse capabilities, that can add up to very long play indeed. In the "one-way" tape mode, the CD plays, followed by sides A or B of tapes one and two, followed again by the CD, which "is played repeatedly." In "endless mode," the CD plays, both sides of each tape are played through, and then the entire CD-tape sequence is "performed repeatedly."

Concealed under the cassette covers are controls for a graphic equalizer, audio balance, Dolby noise reduction, and "feather touch double-reverse deck" controls. Hitachi's nomenclature is almost as colorful as the unit's multi-hued lighting.

The dual-cassette component is of the master/slave variety; only tape two is a recording unit, although tape one can be used in tandem as the audio source in tape-dubbing operations, at either regular or high speed. There's the usual recording mute for eliminating unwanted material from a tape being recorded or to create a pause (of approximately 4 seconds) between music selections.

The AM/FM receiver features 20 station presets, signal lock, and a "phase-locked loop digital synthesizer." It comes equipped with an AM loop antenna, and the MX-W50 includes a 75-ohm FM-antenna terminal. As usual, we found ourselves slightly confused by the unit's elaborate pre-set, signal-lock, and auto-scanning features, but with time the combinations of indicators and buttons mesh-

(Continued on page 7)

Slim Sound

JAMO ART SPEAKERS. Manufactured by: Jamo Hi-Fi U.S.A., Inc., 425 Huehl Road, Northbrook IL 60062. Price (per pair): $398.

If there's one thing consumers seem to know about loudspeaker systems it's that bulk equals bass. Although the development of various bass-boost features and tiny portable-speaker systems of surprising fidelity is undermining this conviction, a couple of generations of home-music buffs have grown up believing the bigger the box the boomier the bass.

But not all home listeners subscribe to that audiophile creed. Introduced at last year's Summer Consumer Electronics Show, the *Jamo Art Speaker* reconfigured the standard home speaker in a relatively flat, rectangular form, suitable for wall mounting or floor use (the units include a folding bracket attached to the back). Developed in Europe, where the Danish firm Jamo (pronounced "Yamo") is a leading consumer-audio brand, these two-way speakers are described as "the same size and shape as a modern 20-inch color TV set." The design allows a speaker just over 3¼ inches from the middle of its slightly curved grill to the mounting-hole-equipped back. Hanging on the wall, an Art speaker takes up a space of 15¾ by 13¾ inches, remarkably unobtrusive as full-size home speakers.

Jamo's explanation of how the Art speaker works is suitably general: "The cabinet volume is surprisingly large." Hung on the wall, "the acoustic amplification from the wall plane is utilized to produce the deepest possible bass from the compact enclosure." The design and fabrication of the unit is said to "eliminate cabinet resonances" with a front baffle "cast in one piece from a synthetic material...furnished with a computer calculated grid of stiffening ribs." To "enhance the deepest bass, the Jamo Art cabinet incorporates a balanced bass reflex system," with an "internal canal replacing the traditional bass reflex tube," with ports located on the speaker's "heavy steel rear panel." At least informally, we were able to confirm some of that with our own ears.

In **GIZMO's** use of a pair of Art Speakers, reproduction was easily within our internalized standards of fidelity. Which is to say that listening to music through them for a month was neither more nor less pleasurable than listening to more conventional speakers. We mounted them rather high on the wall. As happens in real life, our placement was dictated in part by available-space considerations. Jamo provides the usual paragraphs on speaker placement, but suggests the "trial and error" method.

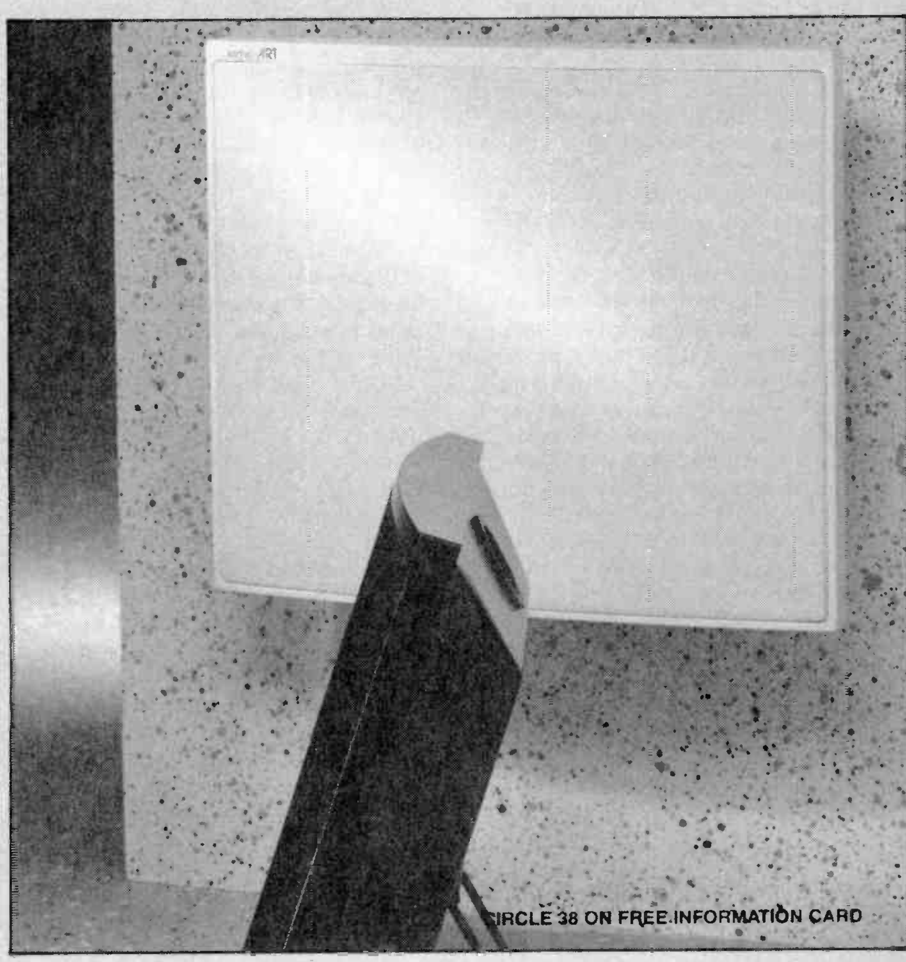
We found one drawback in everyday listening with these Jamo products. One of the tuners we connected them to was equipped with a bass-extender feature, a capability available under a variety of designations on numerous brands and models of tuner and amplifier units. Used in conjunction with the Jamo Art speakers, the effect was to discernibly muddy the sound, giving it an unpleasant, hollow quality.

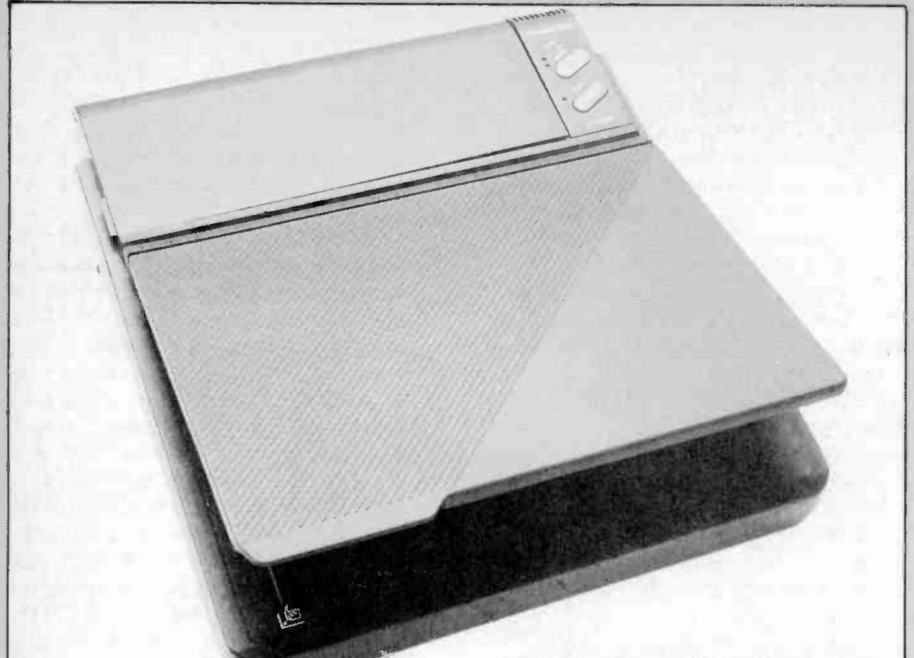
Devotees of really massive bass reproduction are probably not going to be satisfied with the Art Speaker's performance. Bass is heard, but it is its own version of the thump and pow of contemporary big bass. One audiophile suggested that the speakers depend on "psycho-acoustics," using bass and low-note overtones to which listeners add the expected underlying deep bass, processing the sound in their own heads. It's an intriguing idea, but not one that we're equipped to evaluate (if anyone really can).

But we have logged many hours of listening to amplified music, and nothing in the Jamo Art performance made us wince. Although we did notice a slight metallic tendency in the bass sound (or was this only after we found out that the speakers were housed in steel plate?), for all sorts of music, these speakers did their job well enough, and certainly unobtrusively.

These strike us as excellent speakers for TV or video connection, and only marginally less so for some music installations. As to appearance, some will clearly love these TV-tube speakers while others won't care for them in the slightest. **GIZMO's** test pair were in white; for those who don't like that color, and they're also available in black.

Designer item or audio-design innovation, Jamo says its Art Speakers have met with consumer acceptance since their introduction last summer. While we'll leave it to the technicians to test these speakers under laboratory conditions, we will quote **GIZMO's** audio consultant: "What it all comes down to is what sounds good to you." A sentiment right in line with Jamo's own test methods, described in its catalog as a "real life test method." Besides the usual factory and lab tests, "most of the measurements upon which the technical specifications are based are made in a normally designed living room." For those with a taste for the technical, Jamo gives the following specs for the Art Speaker: 60 watts of power (90 for music), a frequency range of 40 to 20,000 Hz, a cross-over frequency of 3,000 Hz, and 8-ohm impedance. Beyond the objective data, consumers will have to make up their own minds (or ears) regarding the speakers' sound quality, and their rather unusual appearance. ■





CIRCLE 39 ON FREE INFORMATION CARD

Screen Stealer

APOGEE/1 DIGITAL COPIER (FN-P300). Manufactured by: Panasonic Industrial Co., Two Panasonic Way, Secaucus, NJ 07094. Price: $799. VIDEO INTERFACE (FN-PA10). Manufactured by: Panasonic Industrial Co. Price: Not Available.

In the sense that the description is ordinarily used, *Panasonic Industrial's Apogee/1 Digital Copier* is a "plain paper copier." But the paper it uses appears to be just about the only thing plain about this unusual duplicating unit.

Priced competitively with other brands of "personal copiers," the Apogee/1 offers some capabilities unavailable with more conventional systems. Although the unit duplicates images directly, some rather sophisticated editing techniques are within its range of functions. Its color-cartridge system also allows relatively simple multi-color copying, a feature further enhanced by its digital capabilities.

With a fixed platen, the Apogee/1 requires no more space than the 14⅓ by 16 inches it takes up on a surface. A lift-up panel (the "platen cover") protects the glass copying surface, with blank paper fed via a slot in the rear of the machine that is also concealed when not in use. On the left of the unit is the power switch. On the right, next to the paper feed, are the "print" and "edit" controls, with an exposure-adjustment wheel just below at the side.

Copier color cartridges are installed in a compartment in front of the paper feed. To access it, a cover (the "roller cover") is raised and the cartridge is slipped into its cradle. Although the original is placed length-wise on the glass platen, the blank sheet is fed in vertically.

As with other small copiers, the Apogee/1 will copy only sheets measuring 8½ by 11 inches and smaller. The instruction specifications call for "plain paper, colored paper, transparency film, mailing labels, thermal transfer paper, and type-set paper." The unit can also handle card stock. "Continuous copies" can be made by this single-sheet-feed copier by feeding blank paper into the feed slot "within 12 seconds after the previous copy was completed."

In its editing capabilities, the Apogee/1 begins to show its sophisticated stuff. To delete, or to copy only a particular area on an original, the user takes a blank sheet of paper, places it over the image to be duplicated, and diagonally marks off an area with two black dots, "3mm or larger." That guide sheet is then placed, with the dots on the underside, onto the glass platen. A single depression of the "edit' button will mark the indicated area as the only one to be copied. A push of the "print" control activates the unit's memory. The indicator light designated "copy" blinks as the Apogee/1 notes the marked area in memory. When the light stops flashing, the user removes the dotted guide sheet and puts the original onto the platen. When paper is fed into the rear slot and the print button is depressed, the duplicate copy will roll out with just the indicated area copied.

To delete an area (telling the machine *not* to copy it), the same guide sheet is prepared, but the "edit" control is pushed twice, activating a green signal light marked "delete." After the delete process, when the copied image exits the machine the area marked on the original will be blank. In combination with the unit's various color cartridges (available in red, blue, green, brown, gold, silver, and black), that capability allows for a relatively easy approach to multi-color copies and complex layouts and designs.

Further expanding the Apogee/1's capabilities in an interesting direction is the *FN-PA10 Video Interface*. The accessory, only slightly larger than a personal-cassette player, connects to a VCR video-out jack, a TV or monitor video-in jack, and the Apogee/1 copier. It draws power from a standard outlet with a transformer. On its top surface are three controls—a contrast adjustment, a "video/scanner," and "memory." The user, after turning on the interface's power switch, engages "video/scanner" and then presses the "memory" key. The memory-indicator light comes on for about two seconds while the video image is being read.

When the memory-key light goes off, the user slips a sheet into the copier feed, presses "print," and makes a black-and-white (or whatever-color-and-white) "copy" of the video image.

The quality of the image is reminiscent of old-style wire-transmitted photographs, just a little less detailed than a contemporary facsimile-transmission picture. The still-video image doesn't fill a standard-sheet of paper, measuring instead 6 by 4¾ inches. Cross-hatchings are faintly visible and, occasionally, details from the video original will drop out. Image quality can be adjusted by using the interface's and copier's contrast adjustments and with the TV's or monitor's contrast control.

Despite its limitations, this screen-to-paper copying seems a remarkable capability—or at least it would have been not so long ago. While applications may be limited, the FN-PA10 connected to the copier makes a video-still copy of acceptable quality. Devices costing much more perform in a more sophisticated manner, producing an image of greater detail, and even in color. But this simple video interface is both smaller and more economical. Although Panasonic Industrial doesn't furnish a suggested list price for the Apogee/1's video interface, it is said to usually retail for a few hundred dollars.

In general, the Apogee/1's standard duplications were only very slightly less detailed than those produced by a more conventional copier. The difference was barely visible to the eye. Photos, although not as finely duplicated, can be copied with the FN-P300, as well as all manner of typed and written material. As an intriguing piece of video-age equipment, the Apogee/1's video-still capabilities make it a fascinating harbinger of technology waiting in the wings. What only a few years ago would have seemed a science-fiction invention has become consumer-technology fact. ■

CIRCLE 40 ON FREE INFORMATION CARD

No Frills Fax

SHARP FACSIMILE TRANSCEIVER (UF-50). Manufactured by: Sharp Electronics Corp., Sharp Plaza, Mahwah, NJ 07430. Price: $1399.

The *Sharp UX-50 Facsimile Transceiver* is described by the company as "a new compact...plain vanilla fax designed to meet user demand for low-cost machines...". It's not as fast as others, and it doesn't offer a lot of special features—just a few extras and no frills. But it's easy to operate, it's lightweight (just under 10 pounds), it fits on any desk, and it's useful for tasks like instantly transmitting a resume across town, to another city, or to another country.

Fax machines work slowly or quickly depending primarily on the operation and transmission times. Operation time is how long the unit needs to read the document being transmitted. Transmission time is how long the document takes, via phone lines, to reach its intended receiver. In our experience, operation is one kind of problem and transmission another.

Our first experience with fax machines was some months ago. The technology of the machine we used was cruder, and operation was tedious. Facsimile transmission appears to have advanced remarkably in a short time. Our second fax encounter was away from the job and entailed finding a copy shop that offered facsimile-transmission service and waiting while the clerk operated the machine. That alone added about half an hour to operation time. Then the transmitted document itself wasn't received after six attempts.

Our third experience was using the Sharp UX-50 on our own. We first used it at home, after a half hour spent with the instructions, and then needed about 20 further minutes of fiddling to operate the unit correctly and transmit successfully for the first time.

After that initial run-through, operation was reduced to three to five minutes. Most of that was spent waiting as the document feeder slowly drew the original sheet through and fed it out toward us. That process seemed to take as long as our old office model did, and took about twice as long as the new fax machines—which, incidentally, are also twice as expensive and nearly twice as big.

Transmission itself took about 45 seconds per standard-size page, as stated in the instruction manual's specifications. Transmission was accomplished on the first try. We reduced transmission time by calling ahead and arranging to send after regular office hours, assuring an open receiver line. That and other tricks of fax transmission deserve to be collected into an electronic etiquette guide of fax do's and don't's.

Our first transmission test was a **Popular Electronics** cover. The result was excellent for headline type, but the photos on the cover became sketchy and unrecognizable, inadequately representing the differences in the depth of perspective. Print transmission, of course, was better than photo, while black-and-white pictures were superior to color.

When we transmitted the first page of a **GIZMO** section, the black and white was more subtly shaded and looked more three-dimensional than the transmitted color cover had. But in the text, some clarity was lost in the fine print. The letters were pixilated—broken down into dots that didn't always align perfectly, but fell apart like slats unstacking. They were legible, but demanded some persistent eyeballing to make them out. It took twice as long to read the fax transmission as it took to read the original page.

Magazine type printed on glossy paper transmitted the best of all the test pages we sent. It arrived as clear and readable as the typical weekly newspaper. The glossy black-and-white of the original page was reduced in shade by about 50 percent, but that created no legibility problems. The photos were muddy, though, and one line of text was completely lost. Alas, it appears that such inexplicable glitches are one price that must be paid for consumer-electronics progress.

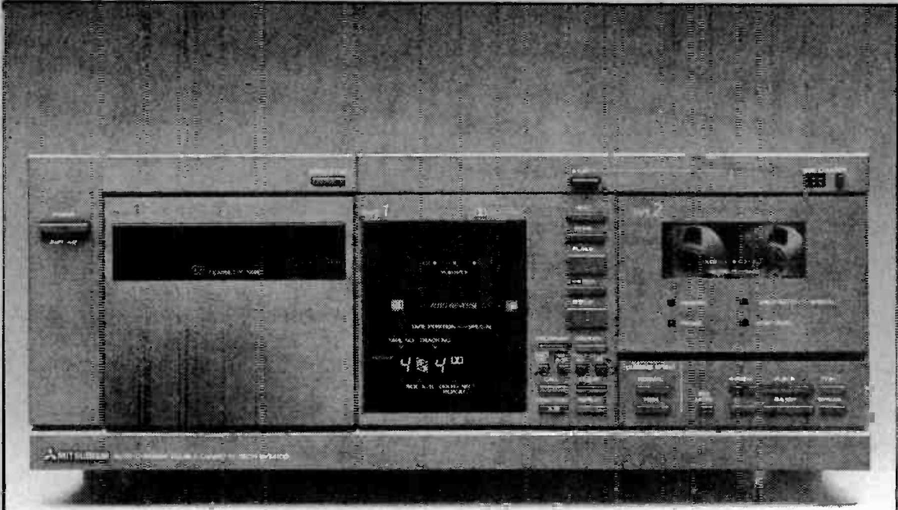
In our experience, the UX-50 suffers from one design flaw: Closing the operation panel is difficult, awkward, and confusing. When we first unwrapped the unit, we thought the machine was broken because the panel flipped up and we couldn't figure out how to close it. The necessary instruction was buried on page 13 of the manual: "Close the operation panel...by pressing down hard the center of the operation panel (at the power indicator light) until a click is heard." This is slam-bang consumer electronics in the most literal sense: The user has to slam down the operation panel in just the right spot to get it to stay closed. It took us three to six (gentle) slams to get a click.

Our other difficulty with the UX-50 was actually the result of a mental block on our part. We expected to be told where to find the unit's power switch. We had to make minor leaps of logic to to follow the instructions in the operation manual; and eventually we had to read the description of the operation panel itself to locate the on/off button on the unit.

The UX-50 comes in the currently standard black finish, which looks very serious. It would actually look forbidding, but for a green start button and pink stop control, which brighten its high-tech dourness a little. Black surfaces are practical, though, for sending messages via fax, since hands soiled by newsprint would soon leave unsightly smudges on brighter surfaces.

The Sharp UX-50 measures a relatively small 13½ by 9¾ inches and is just 3¾-inches high. Power is supplied to the unit through a three-prong, 120-volt outlet. The unit is a basic model, but it does offer a few extras. It can send a reduced image of an original. The handset offers on-hook dial and redial. There's both manual and automatic receiving, and the unit works with any G3-designated receiving facsimile.

At least in casual use, its limitations weren't terribly noticeable. As an introduction to the growing world of facsimile transmission and reception, the UX-50 would do just fine. Sharp even maintains a toll-free number on weekdays for user assistance if it should prove necessary; it was busy when we called. Fortunately, we didn't really have a problem—we just wanted to ask if the "Sharp Technical Action Center" would fax information to UX-50 users. ■



CIRCLE 41 ON FREE INFORMATION CARD

The Music Goes Round and Round

AUTO-CHANGER DOUBLE-CASSETTE DECK (M-T4100). Manufactured by: Mitsubishi Electric Sales America, Inc., 5757 Plaza Dr., P.O. Box 6007, Cypress, CA 90630-0007. Price: $349.

A few months ago, syndicated columnist Bob Greene was lamenting the passage of the jukebox, that once ubiquitous public source of colored lights, enjoyment, and endless music. After using the *Mitsubishi Auto-Changer Double-Cassette Deck*, we think the spirit of the jukebox lives on—embodied in this contemporary, double audio-cassette deck's ingenious seven-cassette auto-changer mechanism.

Slightly bulky, this deck lacks the high-tech gloss of other dual-deck machines. It's downright utilitarian in appearance. The job it does is to allow the user to program and listen to both sides of seven audio cassettes in a row. With the proper tapes it can be programmed to play selected sections of each tape. With its recording, second-cassette unit, the *M-T4100* can dub tapes at double or normal speed and offers synchronized recording from deck one (which carries the changer mechanism) to deck two. Missing is relay play, which would bring the machine's total capacity up to eight full cassettes—a trick we're surprised Mitsubishi missed.

The changer door is at the left of the front panel. A push of what would normally be the "eject" button brings the seven-slot drawer sliding out. Although the magazine door is made to resemble deck one's cassette door, the actual deck one is at the center of the front panel, behind a plastic transparent cover, backlit in green. Once cassettes one through seven are loaded, the "play" button puts the M-T4100's micro-computer-controlled changer into gear. The drawer slides out slightly to position the cassette so that it can be moved into the tape deck.

With a slight click, the cassette to be played is transferred to the deck and play begins. In its back-and-forth drawer action and with cassettes sliding into playing position, the auto changer seems a descendant of the mechanics of the jukebox. Which is fine by us, as that was a technology brought to a high degree of perfection over the decades.

Electronics rears its sometimes confusing head in the programming of cassette and selection play. Although not equipped with a remote control, the M-T4100 can be harnessed to the remote furnished with Mitsubishi receivers.

The primary controls used in programming the unit (program, memory, call, clear, tape number, side, track, and Dolby NR) are arrayed beneath the vertically arranged controls for deck one. A display helps guide the user through the program sequence: "program;" then the "tape number;" "side A/B," to select either double- or single-side play; "track number," to select specific tape sections; followed by "memory."

Track selection is possible only if the cassette's various sections are separated by silent intervals, creating the necessary reference points for programmed track play. Intervals, as we interpret the rather vague directions, need to be at least 12 seconds in duration.

Deck two, the recording unit, has the standard tape player/recorder controls (for some reason, deck one has no "pause" button) and a set of indicator lights. A "peak level" light stands in for the more elaborate level meters of other decks, while a "tape position—special" indicator lights if a chrome tape is being used. There is no tape-reverse mechanism except for rewind, so the cassette has to be flipped manually for play on both sides. On the rear of the unit is a small knob labeled "rec. volume." The instructions explain, "adjustment of the recording level may be necessary when using this unit with other components," which doesn't explain too much.

In using the M-T4100 with other components, we noticed a drop in volume level during playback. The same cassette played in both this and another tape deck required a higher volume setting with the Mitsubishi.

But in its speciality, uninterrupted tape play of luxurious length, the M-T4100 is unsurpassed. Seven 90-minutes cassettes could produce up to 10½ hours of music, while a full magazine of 120 minute tapes would bring the musical count up to 14 hours. The unit may well be descended from a model aimed at the commercial market, stores and other businesses wanting uninterrupted background sounds. Both its strictly-business appearance and its rather opaque instruction manual suggest a non-consumer-oriented product. Still, consumers interested in hours of music at a stretch will be interested in this unique dual deck. And jukebox *aficionados*, we can guarantee, will find its changer mechanism fascinating. ■

NINTENDO POWER SET

(Continued from page 1)

our testers (aged 6 and 14) long to figure out that if they simply jumped off the mat and then stepped back onto the circle, the jump's distance was easily increased. Fun, however, is the point—not the racking up of points. After discovering that easy-score system, the two went back to playing the game the proper way.

Rambunctious fun was characteristic of sessions with the power pad, and it is certainly more physically involving than the usual round of zaps and bleeps via an ordinary stick control or even a Nintendo "zapper." Although not likely to convert a generation of couch potatoes into Olympian athletes, it's a sign that designers are finally taking their eyes off the screen and looking at the humans playing the games. Imagination should extend beyond programming and the power pad is a simple but welcome innovation.

Also intended for use with the Pad are two Nintendo games announced last fall; "Dance Aerobics" is aimed at kids aged 6 through 12, and "Super Team Games" is described by the company as allowing "up to six players to compete in summer-camp-type games and obstacle events such as a long run, wall jump, crab walk, tug-of-war and skateboard race." Sold separately, those games retail for around $30. The Power Pad, with "World Class Track Meet," is scheduled for stand-alone sales, retailing for $79.95. ■

Bar Exam

HQ VIDEO CASSETTE RECORDER (PV-4862). Manufactured by: Panasonic Co., One Panasonic Way, Secaucus, NJ 07094. Price: $660.

We hunted around for quite a while before deciding to purchase the *Panasonic HQ Video Cassette Recorder (PV-4862).* As happy owners of various Sony Beta units, we believed their image quality to beat anything offered by VHS.

Eventually we were forced to concede the defeat of the Beta system, as hardly any local rental shops carry pre-recorded Beta cassettes; and if the outlet does, it's a pitiful selection. As Beta partisans, we've been pleasantly surprised in the months since we purchased the PV-4862. We could have bought a cheaper model, but splurged because decks with Hi-Fi stereo sound had been highly touted. This, our first VHS, stereo, HQ VCR has proved to be a fantastic home-entertainment investment.

If you watch a lot of rental movies, hearing the sound via stereo will double your viewing pleasure. It's comparable to theater sound in its quality. Another advantage is that the deck is equipped with MTS broadcast stereo. When watching "Late Night with David Letterman" for instance, you can hear Paul Schaffer's studio band in stereo, even if you're still using a monaural television. Just send the TV signal through the VCR and turn on your stereo system. For those who don't own a stereo-TV receiver, it adds up to a bonus upgrade of the television set.

By the way, the hook-up is extremely easy—even for the non-electronically inclined consumer. It's important to remember that an extra length of patching cable will probably be necessary if the audio system is any distance from the TV.

We've talked a lot about the deck's Hi-Fi audio capabilities because that's what finally sold us on the PV-4862. Rental cassettes of *Full Metal Jacket* or *Top Gun* haven't really been fully seen and heard unless the soundtrack booms and jets have blasted in stereo through the viewer's living room. In our household we've even been fooled by the ringing of the phone in a movie, rushing to answer our own when nobody was calling.

The deck can also be used to tape music from your stereo system. A friend has been duplicating his CD's onto VHS cassettes, claiming the sound quality reaches DAT-like fidelity. Of course, that gives the consumer the option of using the VCR as yet another audio source.

Because this Panasonic unit is a four-head model, it's got the usual special effects—fast search with minimal image distortion, and single-frame advance and "pause" that both provide a picture without any screen static. On this deck, however, there are two features that stand out, besides the excellent Hi-Fi/MTS sound—on-screen and bar-code programming.

CIRCLE 42 ON FREE INFORMATION CARD

We found the system's on-screen programming to be extremely user-friendly and even useful. After pushing a "prog/clock" button, a menu appears that guides the user along with simple, logical instructions. With some VCR's, it can take half an hour to figure out the time shift procedure. With this one, we never even bothered to crack open the instruction manual (an equally well-designed guide to VCR usage). On-screen programming, of course, is hardly an innovation at this point, but even skeptics will be surprised to find that this "gimmick" is actually a shortcut to viewing pleasure.

This particular model makes use of Panasonic's bar-code programming. The deck arrives with a separate scanner, about the size of a pocket flashlight (with four "AAA" batteries), and with two sheets of bar-code labels. The VCR can be programmed to record eight different unattended events over a one-month period. All the user does is spend a few minutes tracing those codes with the scanner and entering time and channel information in the usual way.

The bar-code system is supposed to make programming the VCR as easy "as drawing a line." It works this way: the scanner, grasped pencil-like, is traced over data represented in bar coding on a sheet provided with the unit—date, start time, stop time, and channel. The scanner then is pointed toward the VCR from, in our case, the couch, about ten feet away. A "scanner transmit" control sends the encoded information stored in the unit to the VCR, which then answers with a series of confirmation beeps. That's all there is to it.

Frankly, we prefer using the remote control for programming instead of running the scanner over the provided bar codes like a supermarket clerk. Programming can only be carried out via the remote control or scanner; there are no controls on the VCR itself for those functions. On-screen information also means that the TV must be turned on for such tasks as setting the VCR's clock. While we have our doubts about remote-control dependency, it appears to be the wave of the future.

Bar coding can be used to program the PV-4862 to record every day, every week, or at whatever intervals are desired. The scanner includes a timer-activation button. It can also be used to program the recording of movies shown on the pay channels, if the local cable guide includes bar codes printed for selected movies and specials (as an increasing number do). Where we live, this comes down to three or four pay-channel movies each month.

Although the bar code is a great gimmick, we don't use it that much. Perhaps video viewers who are masters of pre-planned viewing will get more out of this single-step programming system. ■

AUDIO VISUAL

(Continued from page 2)

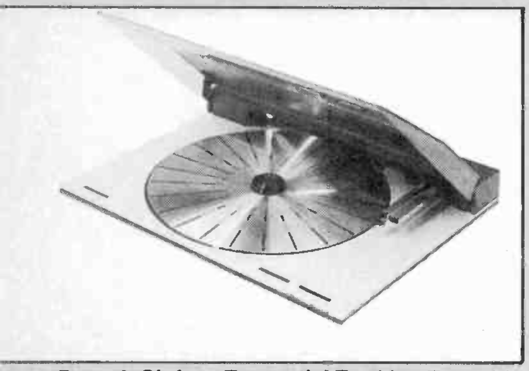
ed into a more-or-less logical whole. Our confusion would have been even shorter in duration if this otherwise cutting-edge product came equipped with an instruction booklet that wasn't such a chore to consult. Unit diagrams are separated from instructional text by the main body of the 20-page booklet, requiring extensive thumbing back and forth (at least in our case) before the numerical identities of various controls were fixed in our mind.

Perhaps our major disappointment in the MX-W50 was the discovery that it's equipped only for a single pair of speakers—a shortcoming for a good many audio consumers. Although (as it's dubbed by Hitachi) a "CD slimline system," this home-entertainment powerhouse is anything but compact. Its very different exterior makes it an unusually long component.

Hitachi offers an optional stand (*LX-MXW50*, $199) for the unit. It's also sold with its own floor-standing speakers, as the *MX-W51* ($1,299). As an alternative design incorporating four components, the Hitachi Stereo Cassette Receiver/CD Player offers consumers another shape for their home-audio experience. It may not fit everyone's home-audio needs, either in terms of power (although 50 watts is more than ample for most everyday listening situations) or cosmetics. But as a break from the endless boxes of home-audio and -video components, it's a welcome departure from the norm. ■

ELECTRONICS WISH LIST

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



Bang & Olufsen Tangential Tracking Turntable

Tangential Tracking Turntable

To hear the recorded-music industry tell it, the LP is just about due for retirement. Time will tell, but for those still using vinyl, the *Beosystem 3300 Tangential-Tracking Turntable* from *Bang & Olufsen of America* (1150 Feehanville Dr., Mount Prospect, IL 60056) would seem the ultimate in turntable performance. All functions can be operated by infrared remote control. For ease of cuing, the tone arm can be moved in ⅛-inch increments and there's a built-in light to automatically illuminate the disc. The unit also offers repeat play, and stop/start with a single button. Tangential tracking offers the advantage of tracking records the way they're cut—in a straight line, eliminating potential distortion and stereo imbalance. The servo drive on the tone arm is isolated from the stylus to prevent any vibrations from affecting the music. Using B&O's proprietary technology, *Datalink*, the Beogram 3300 turntable can be linked with other audio components. Price: $439.

CIRCLE 43 ON FREE INFORMATION CARD

Maxon Weather Receiver

Weather Receiver

It may not be the *Old Farmer's Almanac*, but the *Weather Receiver/Alert (WX-3)* from *Maxon* (10828 NW Airworld Drive, Dept. 777, Kansas City, MO 64153) can keep the user up-to-date on climactic conditions on a minute-by-minute basis. The unit receives the latest weather-information broadcasts on 162.550-, 162.475-, or 162.400-MHz U.S. Weather Service bands. If a severe-weather bulletin is issued, the monitor blasts a loud warning tone and illuminates an "Alert" indicator. A telescopic antenna provides drift-free reception within 50 miles of an N.O.A.A. (weather-information) broadcast transmitter and a second terminal allows the use of an external antenna. The WX-3 is marine-tested to resist moisture and draws power from 120-volts AC, backed up by a 9-volt battery in case of a power failure. Price: $49.95.

CIRCLE 44 ON FREE INFORMATION CARD

Plantronics Headset Cordless Telephone

Cordless Headset Telephone

Cordless telephones have been criticized for a variety of shortcomings, among them not offering all the features of their less mobile counterparts. But, according to *Plantronics, Inc.* (345 Encinal St., Santa Cruz CA 95060), the *SP 4 Cordless Headset Telephone* is an instrument that can "completely replace the standard telephone." It's described as a full-feature telephone (including automatic last-number redial, tone/pulse, mute, and hold functions, and adjustable volume) with a lightweight headset for completely "hands free" telephone use. Easily user-installable, Plantronics calls the SP 4 "ideal for phone-intensive professionals in home-office and small-business environments, as well as for personal use at home." Price: $89.95.

CIRCLE 45 ON FREE INFORMATION CARD

Haverhills Electronic Scrabble Game

Electronic Scrabble Game

Scrabble, the decades-old word game, also comes in an electronic version that can be played solo. *Monty Scrabble*, available from *Haverhills* (131 Townsend St., San Francisco, CA 94107), is a hand-held game that gives the user an opportunity to play against three other human players—or against the game computer itself, which is programmed to play at four different skill levels, and has a Scrabble vocabulary of 12,000 words. Monty keeps track of the tiles, keeps score, challenges incorrect words, and runs on 4 "C" batteries. The unit doesn't hide tiles or make up nonexistent words, which puts it at least a couple of steps ahead of some human Scrabble players we have known. Price: $99.95.

CIRCLE 46 ON FREE INFORMATION CARD

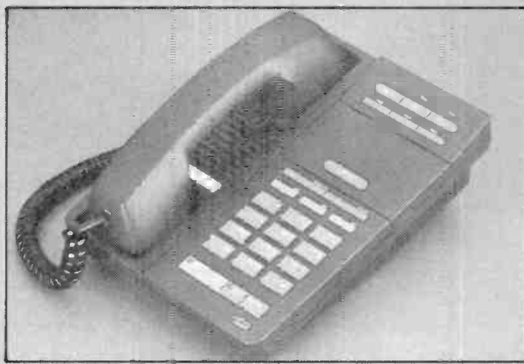
For more information on any product in this section, circle the appropriate number on the Free Information Card.

ELECTRONICS WISH LIST

Telephone Answering System

Not so many years ago, telephone answering systems were often bulky devices. Today's compact versions, like the *Telephone Answering System (GTE 7520)* from *GTE Consumer Products Corp.* (One Stamford Forum, Stamford, CT 06904) do much more in much less space. The GTE 7520 uses a digital voice-recording system for outgoing messages, eliminating the outgoing-message cassette. Instead, a tiny computer chip carries the user message. The answering machine allows remote playback of messages from any tone phone, one-step playback, call monitor, and message interrupt. There is also a remote turn-on feature and non-telephone messages can be left by members of the household. The GTE 7520 has a speaker phone, a 13-number memory, last-number redial, a hold button, and switchable pulse/tone dialing. Price: $189.95.

CIRCLE 48 ON FREE INFORMATION CARD

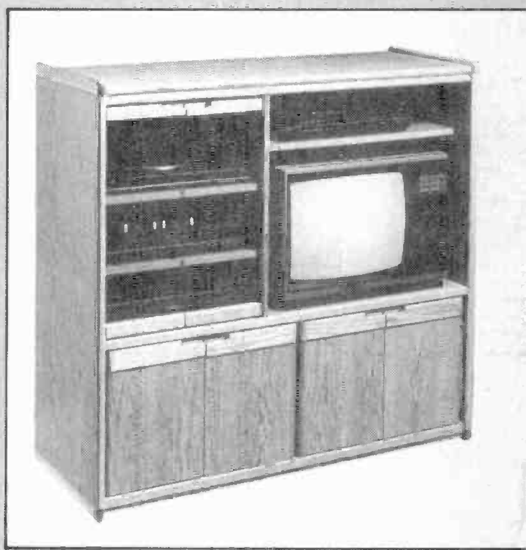


GTE Telephone Answering System

Entertainment Console

Using a combination of solid oak and fine oak veneers and laminates, the *Oak Classic Entertainment Center (AV1810)* from *Bush Industries* (One Mason Drive, Jamestown, NY 14702) gives an "upscale appearance" through its "generous proportions." The unit has plenty of room for a 26-inch television set, a complete sound system, and a variety of records, tapes, and accessories. Solid oak is highlighted on the doors, rails, caps, and frames. The system measures 49¼-inches wide by 48-inches high by 19½-inches deep. Tempered-glass doors feature solid-oak door pulls in front of the storage area. Price: $499.95.

CIRCLE 50 ON FREE INFORMATION CARD

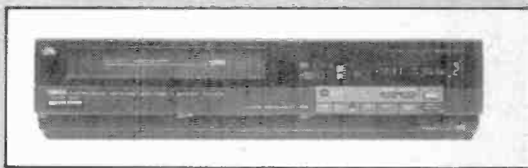


Bush Industries Entertainment Console

Four-Head VCR

Super VHS circuitry, Hi-Fi sound, and a four-head design are among the features of the "flagship model"*VCR (YV-1110-S* introduced by *Yamaha Electronics Corp. USA* (6660 Orangethorpe Ave., Buena Park, CA 90620) as part of the roll-out of three new video recorders. The YV-1110-S includes a picture-in-picture that can be moved, enlarged, and switched with the TV screen's main picture. Besides S-VHS, other special circuitry includes index coding and search, allowing the user to single-touch search from the unit's remote control. A real-time counter displays hours, minutes, and seconds and can operate with the search function to automatically find a program on the cassette. Price: $899.

CIRCLE 51 ON FREE INFORMATION CARD



Yamaha Four-Head VCR

Tape Deck Care Kit

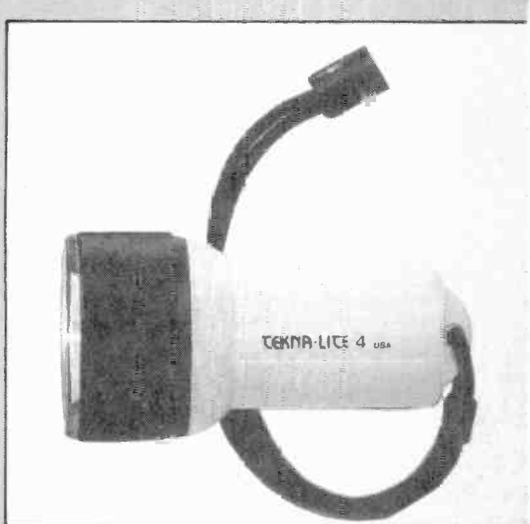
It's important to keep tape decks clean, especially in the car, but that is precisely the location consumers often overlook when taking care of electronic gear. The *Tape Deck Care Set* from *Discwasher, Inc.* (4310 Transworld Rd., Schiller Park, IL 60176) is designed to make maintenance of a car or truck tape deck easy. The kit includes Discwasher's "Perfect Path" tape-deck cleaner, the capstan and pinch roller cleaner, cleaning fluid, and a case to hold everything that is "no bigger than a paperback book." It can easily be stashed in a car glove compartment or door-side pocket. Price: $12.95.

CIRCLE 52 ON FREE INFORMATION CARD

Compact Flashlight

Any camper or hiker knows that space is at a premium when planning an outing into the woods, be it for an afternoon or for a month. Lighter is just about always better, and the manufacturers of the *Tekna-Lite 4 Flashlight* have found a way to "provide the same voltage as one that uses 4 D-size batteries but is only a fourth the size." The Tekna-Lite uses 4 AA-size batteries, is only 4½-inches long, and is waterproof. It is available through the *New York Museum of Modern Art's Museum Store* (Mail Order Dept., 11 W. 53rd St., New York, NY 10019). Price: $30.

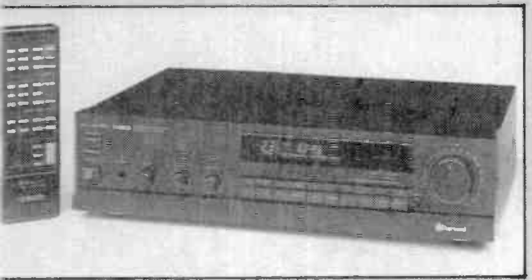
CIRCLE 53 ON FREE INFORMATION CARD



Tekna-Lite Compact Flashlight

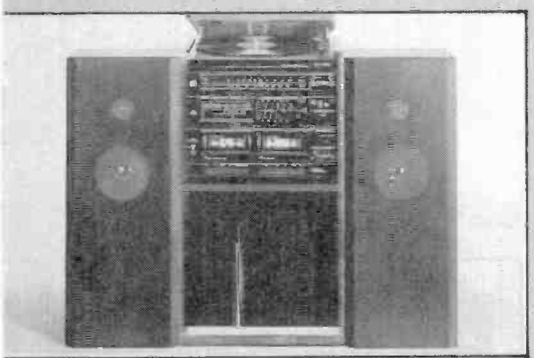
ELECTRONICS WISH LIST

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

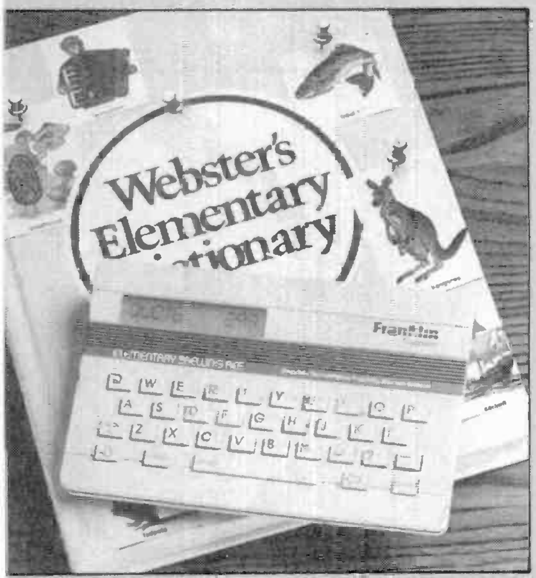


Sherwood Remote Control Stereo Receiver

Bose Car Music System



Ssangyong Stereo Rack System



Franklin Computer Elementary Spelling Ace

Remote-Control Stereo Receiver

A full range of features are available in the 50-Watt *Remote-Control Stereo Receiver (RA-1145R)* from *Sherwood* (13845 Artesia Blvd., Cerritos, CA 90701). Full remote control, quartz-locked computerized tuning, 30 station presets, and surround sound are among the more-or-less deluxe features of the unit. The Sherwood component also uses "a motorized pure-analog volume control with an LED pointer." Equipped with inputs for video, a loudness control, tape monitor, and a headphone jack, the amplifier has a frequency response of 8 Hz to 40 kHz. The FM tuner has a usable sensitivity of 11.2 dB, stereo separation at 1 kHz of 45 dB, and (mono) THD of 0.2 percent. The RA-1145R's midrange price is a definite plus. Price: $299.

CIRCLE 54 ON FREE INFORMATION CARD

Automotive Music System

Readers considering the purchase of a 1989 Cadillac De Ville, Seville, or Eldorado will be offered the option of an amplifier that puts out up to 200 watts, with the *Delco/Bose Gold Series Automotive Music System* from *Bose* (The Mountain, Framingham, MA 01701). The system includes loudspeakers, amplifier/equalizer modules, and standard ETR/cassette. It also comes with an optional digital compact-disc player. Designed to match the car, it also includes 4½-inch full-range drivers in the front door panels, 6- × 9-inch full-range drivers in the rear shelf, and new equalization circuitry for smoother acoustic frequency response. Price: Not Available.

CIRCLE 55 ON FREE INFORMATION CARD

Stereo Rack System

Billed by its makers as "big on sound and big on value," the *Stereo Rack System (TCM-501M)* is the first such component ensemble from *Ssangyong USA* (601 16th St., Carlstadt, NJ 07072). It features a semi-automatic turntable, an AM/FM stereo tuner, an amplifier with a five-band graphic equalizer, a dual-cassette deck, and twin two-way speakers. The speakers handle up to 10 watts of power, and the cassette deck offers continuous play from tape 2 to tape 1. The radio and turntable offer "additional options." Price: $169.95.

CIRCLE 56 ON FREE INFORMATION CARD

27-Inch Television

Television sets continue to get bigger and bigger, and in that spirit, *Sharp Electronics Corp.* (Sharp Plaza, Mahwah, NJ 07430), has introduced its first 27-inch televisions, including the *27RV79*. This model features circuitry to receive stereo broadcasts and an audio-out jack for connection to a complete audio-video system. The set offers 600 lines of resolution and a comb filter for bright, detailed images. It also has auto channel memory, sleep timer, a 209-channel direct-cable tuner, TV/VCR remote control, and on-screen display of channel information. Price: $899.95.

CIRCLE 57 ON FREE INFORMATION CARD

Elementary Spelling Ace

There's no doubt that this is the age of the computer, and both manufacturers and consumers are interested in ways to introduce kids to the wonders of the PC. The *Elementary Spelling Ace (ES-90)* from *Franklin Computer* (122 Burrs Road, Mt. Holly, NJ 08060), can be a gentle, and useful, introduction to computer skills. The device comes equipped with *Merriam-Webster's Elementary School Dictionary* and, like Franklin's grown-up spelling computers, phonetically corrects misspelled words and then refers the child to the page number in the dictionary where the word is listed. The computer contains an exclusive phonetic spelling algorithm designed for children 6 to 12. The child can keep a self-generated special word list and can play, with other children, a series of games such as Hangman, Anagrams, and Jumble—all designed to improve spelling and help the young user become familiar with an elementary computer. Price: $99.

CIRCLE 58 ON FREE INFORMATION CARD

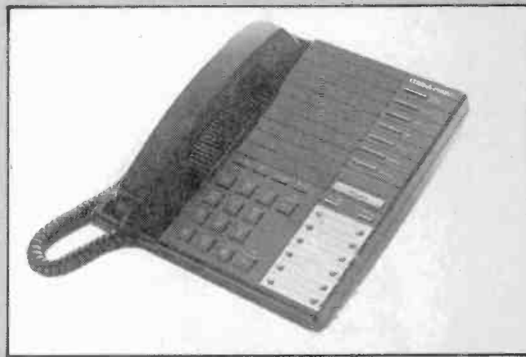
For more information on any product in this section, circle the appropriate number on the Free Information Card.

ELECTRONICS WISH LIST

Home/Office Answering System

The home-office market is one of the fastest growing in the electronics field and *Code-a-Phone Corp.* (16261 SE 130th, Clackamas, OR 97015) is aiming its new *Home/Office Answering System (5890)* at that expanding market. The system includes a dual-recording answering system, a "unique" private-message function, a message-forwarding feature for the professional who is frequently away from home, and a time/day voice stamp with which the system itself tells the user when the call came in. There are a total of 20 beeperless-remote features, a 24-number autodialer, a speakerphone, and a "hook flash" feature that lets the user take advantage of call waiting. Price: $269.95.

CIRCLE 59 ON FREE INFORMATION CARD



Code-a-Phone Home/Office Answering System

Blood Pressure Monitor

It's a good idea to keep track of blood pressure and pulse, especially in today's fast-paced and sometimes stressful world. With the *Cuffless Blood Pressure Monitor*, available from the *Synchronics Catalog* (Hanover, PA 17333), the user can determine pulse and blood pressure with the touch of a finger. Just slip the finger in the unit's convenient ring, flip a switch, and receive accurate readings on an easy-to-read digital display. The device is portable enough to fit in a briefcase and meets Association for Advancement of Medical Instrumentation proposed accuracy standards for electronic "sphygmomanometers." Synchronics offers a one-year warranty. Price: $85.

CIRCLE 60 ON FREE INFORMATION CARD

Synchronics Blood Pressure Monitor

35mm Camera with Zoom Lens

There are plenty of fully automatic autofocus cameras available to the photography buff who doesn't want to sacrifice image control and quality for convenience. But *Konica USA, Inc.* (440 Sylvan Ave., Englewood Cliffs, NJ 07632) calls its new *35mm Compact Camera (Z-UP80)* "the world's first compact 35mm camera to feature a built-in 40mm-wide-angle/80mm-telephoto, power-zoom lens that allows the user to focus in as close as 2 feet macro." The camera also has ultra-high-precision stepless autofocus, high-intensity zoom auto-flash, auto load/wind/rewind, and programmable auto-exposure features. Price: $472.

CIRCLE 61 ON FREE INFORMATION CARD

Konica 35mm Camera with Zoom Lens

Rechargeable Portable CD Player

The portable CD player has probably been at least as important in the sky-rocketing popularity of the laser-music medium as home units. The newest *Rechargeable Portable CD Player (SL-XP6)* from *Technics* (One Panasonic Way, Secaucus, NJ 07094) is a good example of why. The aluminum-diecast unit weighs 13.4 ounces (without its rechargeable batteries or the alternative pair of "AA" batteries). It offers a "quadruple oversampling digital filter" and a trio of play modes—normal, resume, and random. In addition to the two battery-power sources, the SL-XP6 can use a supplied AC adapter or a car electrical system. An LCD display indicates total number of disc tracks, playing time, track in play, elapsed playing time, repeat, program, play mode (resume/random), and battery level. Auto power off engages after the player has spent five minutes in the stop mode (to conserve batteries); there's also a headphone-level control; repeat, skip, and search keys; and a line-out terminal. Price: $349.

CIRCLE 62 ON FREE INFORMATION CARD

Technics Portable Rechargeable CD Player

ELECTRONICS WISH LIST

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

CBM America Hand-held LCD Color TV

Sharper Image Holographic Calculator

Photo Systems Compact Video Light

Hand-held Color TV

The march of electronic miniaturization continues, and with the hand-held *Color LCD-TV (TC-53-OA)* from *CBM America Corp.* (2999 Overland Ave., Los Angeles CA 90064), *Citizen* returns to the tiny TV market it helped establish. The company says that the TC-53-OA features "unsurpassed picture clarity, contrast and color vibrancy — even in broad daylight," thanks to a built-in backlight. The unit weighs under a pound and the screen measures 2½-inches diagonally. Other features include a 23-inch rod antenna; earphone; black, hooded, soft carry case; and four sample batteries. Optional accessories are an AC adapter, a car adapter, and a connector for use with an external antenna. Price: $299.95.

CIRCLE 63 ON FREE INFORMATION CARD

Financial Calculator

For the person on the go who needs fast fiscal calculations, the traditional calculator sometimes takes too long to solve complex, multi-step problems. The *Financial Consultant Calculator (FC-100)* from *Casio, Inc.* (570 Mt. Pleasant Ave., Dover, NJ 07801) has a 10-digit display that shows a 7-digit mantissa plus a two-digit exponent. It can calculate mark-up, margin, internal rate of return, net present value, percentage rate, and effective rate. It can also perform statistical and finance register calculations, linear regressions, and discounted cash flow. Price: $34.95.

CIRCLE 64 ON FREE INFORMATION CARD

Holographic Calculator

Here's an unusual calculator that should help users visualize the underlying reality of their financial calculations, and keep their attention on the glittering prize even as the sometimes monotonous work of calculation goes forward. Available from the *Sharper Image* (650 Davis St., San Francisco, CA 94111), the *Holographic Calculator* features a three-dimensional apparition of "stacks of coins from around the world." As the product description puts it, "this impressive collection lies forever beyond your touch, in the realm of perfect illusion created by holography." The calculator keys seem to float in space above the coins, through a high-quality dichromate reflection hologram of 27,000 lines per inch—500 times finer than conventional printing. A four-function calculator with eight-digit display, square root and percent keys, and three-key memory. The device is solar-powered, so batteries aren't required. The Holographic Calculator is sold with a stand and one-year warranty. Price: $59.

CIRCLE 65 ON FREE INFORMATION CARD

AM/FM Stereo Tuner

The combination of "low-profile design" and "audiophile quality performance" is an attractive one. Those, anyway, are the characteristics claimed for the new *AM/FM Stereo Tuner (T-2000E)* from *Audio Dynamics Corp.* (851 Traeger Ave., San Bruno, CA 94066). Features include 20-station preset, divided between AM and FM signals; Schotz noise reduction; and "efficient interference rejection" because of a "low 1.5 dB caption ratio over the entire signal strength range of 25-65 dB." The T-2000E can be used with Audio Dynamics' *CD-2000E* CD player and *CA-2000E* integrated amplifier, making for a component system with "armchair operation" capabilities, using the remote control supplied with the amp. Price: $349.

CIRCLE 66 ON FREE INFORMATION CARD

Compact Video Light

In the world of portable video-camera lights, weight is everything, and the *DC Camcorder Video Light (LT-3)* from *Photo Systems, Inc.* (7200 W. Huron River Dr., Dexter MI 48130), weighs in at a feathery 11 ounces. According to Photo Systems, the light is "extremely versatile" and "completely portable." It has a 50-watt DC lamp with computer-matched bulb and reflector. The unit attaches via a "hot shoe" mount directly onto the camcorder. The light is powered by a rechargeable lead-acid battery. The cigarette plug connects to an optional 12-volt battery pack, which allows 45 minutes of continuous operation. Price: $79.95.

CIRCLE 67 ON FREE INFORMATION CARD

RADIOSTROLOGY

BY CARL KOHLER

Understand your radio's personality and you'll both live in astral harmony!

Unnervingly esoteric as it sounds, shortwave radios and other radio gear have the same astrological characteristics that we humans do. That obscure theory has been suppressed by sundry radio designers, probably as an understandable favor to retail dealers. Depending entirely upon the exact moment of final assembly, each piece of radio gear qualifies for a built-sign corresponding to one of the twelve segments of the traditional zodiac.

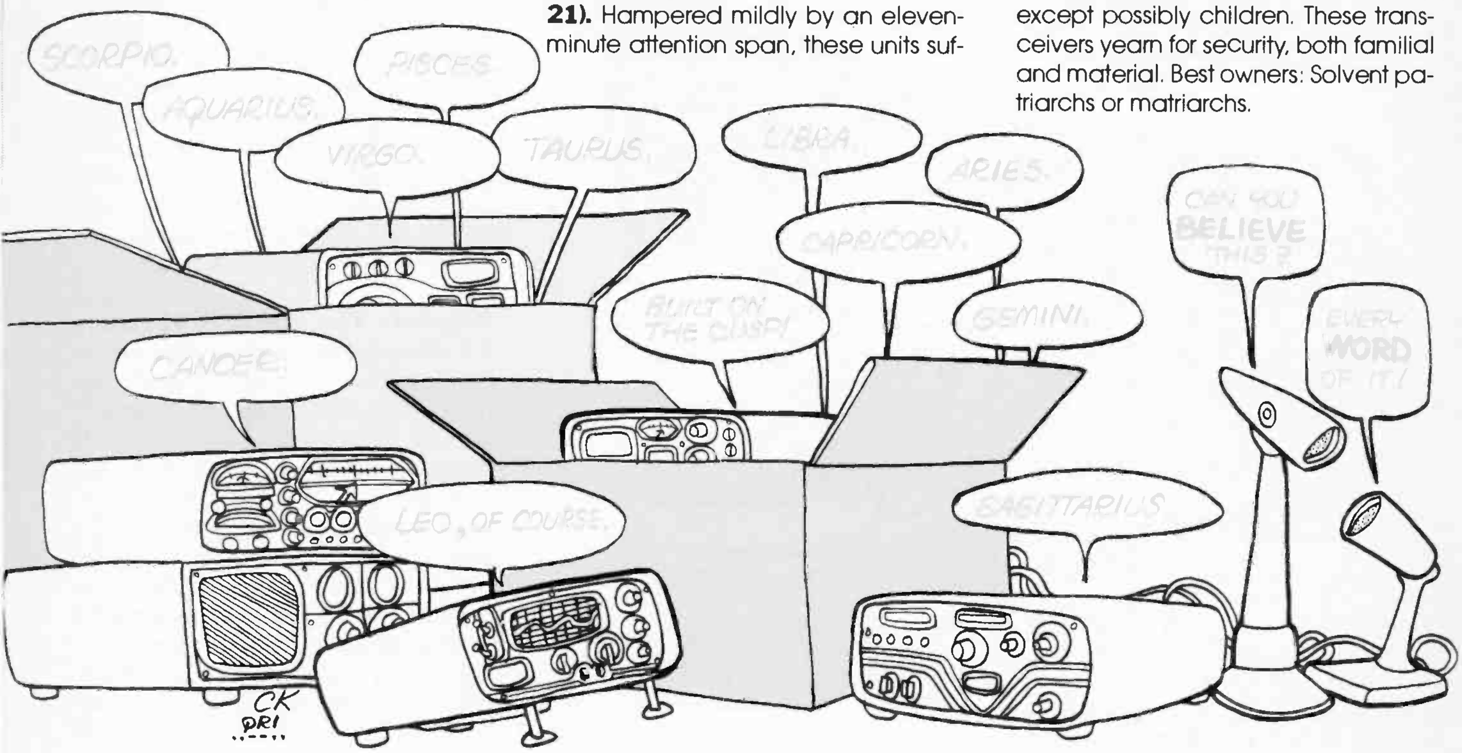
Overload thinking? Read on!

Aries, The Ram (March 21—April 21). Exhibiting testy confidence in their aggressive hopes and high-level performance, this grouping of transceivers would reach beyond the planet if they could. Somewhat rashly impulsive (and defensive about it), they crave advanced experimentation, and innovative usage and impatiently await important progress technically and humanly in the amateur radio field. Utterly contemptuous of all known limitations and disdaining timid operators, these demand pioneering attitudes. Best owners: Malcontents possessing only several QSL cards.

Taurus, The Bull (April 22—May 20). Deploring haste, these transceivers should never be used hurriedly. A laid-back pace nourishes their cautious temperament, increasing the reliability of their performance, every day of the week (and thrice on Sundays or holidays). They regard loyalty as just another 2-way transmission. Practical to their last inner component, they expect good maintenance and careful *re*-adjustments when needed. Profit-talk is their language. Best owners: Bank executives, stockbrokers, mint managers, and salvagers of buried treasure.

Gemini, The Twins (May 21—June 21). Hampered mildly by an eleven-minute attention span, these units suffer (read: are static-afflicted) when lengthy human conversation is imposed upon them. So change subjects and frequencies often for them. Addicted to all aspects of communication, they need juicier gossip than other radios: even if it must be transmitted via *dits* and *dahs*. Essentially sociable instrumentry, they appreciate crowds of bystanders and onlookers—at both ends of the broadcast. Best owners: Speed talkers with a million things on their minds.

Cancer, The Crab (June 22—July 22). Although this breed appears to be just like all the other shortwave radios, they're much more sensitive and moody than even the most neurotic microphone. Never discuss their *foibles* in the presence of strangers. For that matter, avoid allowing those who are unrelated to the operator (blood, marriage, creed, or license status) to even watch these rigs being used—except possibly children. These transceivers yearn for security, both familial and material. Best owners: Solvent patriarchs or matriarchs.



Leo, The Lion (July 23—August 22). Hungering for human attention, these *two-ways* perform superbly if accorded constant admiration and whispered praise. Ignored too long, they protest (read: emit only outraged key-clicks immune to all filters). Also, they demonstrate a subtle tendency to supervise transmission and reception unless monitored closely, which is more due to their innate regality than the operator's errors. Since nobody really ever owns these royal radios—because they, somehow, claim ownership of their operators—ownership is moot here.

Virgo, The Virgin (August 23—September 22). Three words adequately describe this segment: *picky, picky, picky*. That comment applies to their operators, selected transmissions, receptions, frequencies, explorations, and the interior decor of their owners' shacks. These simply refuse to cooperate with shoddy code adherence, slovenly transmitting techniques, or shabby surroundings, whether their operators like it or not. Also, they insist upon being sited at slight distances from lesser electronic equipment, due to their intrinsically aloof nature. Best owners: Accredited perfectionists and editors.

Libra, The Scales (September 23—October 23). Undeniably prima donna-ish and rabidly devoted to their creed of total balance, these radios function a tad more artistically than such instrumentry ever had any right to perform. Moreover, they're a little snobbish about this transmitted achievement than they're ever likely to admit—even if the most talented operators could get it out of them, which none have yet. Not that they're morally superior to occasional human ribaldry or fail to enjoy uncouth reception (if timed right). Best owners: Worldly amateurs with a flair for finding their own ilk and mobile phones with unlisted numbers.

Scorpio, The Scorpion (October 24—November 22). These transceivers require particularly good treatment and very careful handling. Like everything scorpion-ish, they don't get mad: They get even. (Read: short circuit and burn relentlessly). Used properly with utter respect, they out-transmit and out-receive any other radio in existence. Unfortunately, they despise blabbermouths. Operators would be wise to refrain from quoting their cost and/or full-performance ranges. These cannot be faulted for their manufactured secretiveness. Best owners: Taciturn humans.

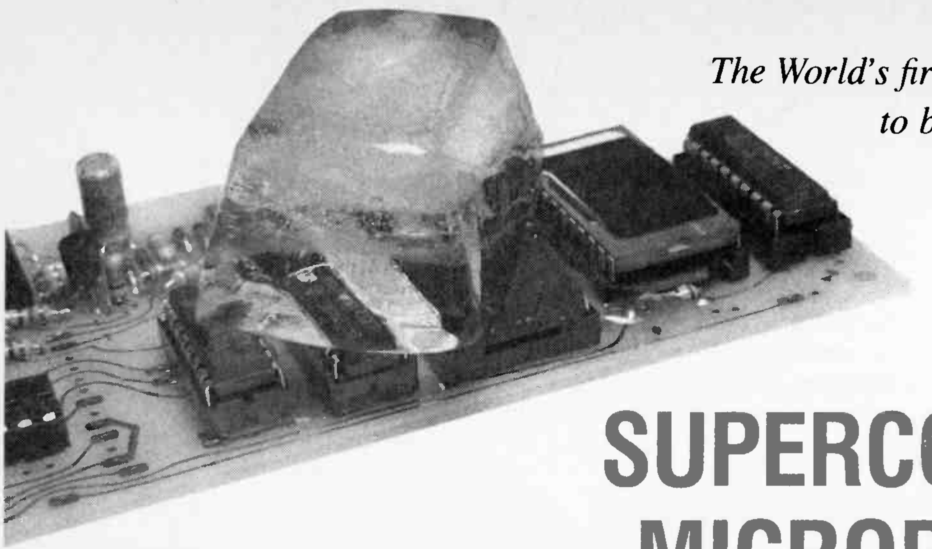
Aquarius radios hope to be operated by unusual, off-beat, and distinctive owners.

Sagittarius, The Archer (November 23—December 21). No more genial, cheerfully operating shortwave radios have yet been designed or assembled than these. Imbued with a maniacal love for travel, they simply hope to be kept in constant motion—making them perfect for mobile usage. Neither traffic, inclement weather, impossible routes, difficult transmission areas, nor downright foul human behavior tarnish their fondness for incessant wandering. Best owners: Gabby vagabonds and not-so-swift CBers.

Capricorn, The Goat (December 22—January 19). Striving for human respect, these rigs regard working for operators twenty-five hours daily, eight days weekly as nothing more than job insurance. They invented the word *communiholic*. Marconi likely unwittingly built one of them and it promptly helped him toward eventual fame because these radios contain the ambition of ultimately basking in the reflected glory of famous operators. To that end they exist and labor. Best owners: Bonafide celebrities and royalty.

Aquarius, The Water Bearer (January 20—February 18). Invisibly functioning upon an overwhelming curiosity about usual people, places, and unexplored frequencies—these radios are the eccentrics of radiodom. Usage that's too routine makes them ill (read: defective tickler coil). What keeps them healthy are transmissions to the unknown, the unvisited, and the unexpected. If any radios will put operators in touch with UFOs and/or other dimensions—these radios will, assuming that necessary conditions are conducive. Best owners: Rebels interested in contacting Mars and abandoned ETs.

Pisces, The Fish (February 19—March 20). Finally, shortwave radios whose major need is a need to be needed. These fairly radiate compassion for mere humanity. Their forte is natural disasters and all lesser human emergencies. They perform with efficiency during such stressful situations and have a long history of saving lives (thanks to their operator's alertness and skilled dispatch). For reasons still being researched, they function better near bodies of water. Ham shack aquariums are minor aids here. Best owners: Humane amateurs. ■



The World's first superconductive processor, to be announced this April First, promises to revolutionize the computer industry!

SUPERCONDUCTING MICROPROCESSOR

BY PAUL YORLEGG

It was just over two years ago that the world's most prestigious research facilities announced significant new breakthroughs in superconductivity—the ability of materials at very low temperatures to conduct electricity without resistance and without shivering. At that time, designers at Intelski International, a major eastern European semiconductor firm, began working on the first microprocessor to utilize those new research developments.

After spending $500 million on research and development—nearly half of the company's total assets—Intelski is expected to formally announce their new microprocessor, the PI-4U28, on the first of April.

The PI-4U28 is an ultra-high-speed, 1-bit microprocessor. It is a PMOS (*Peat-MOS*) device fabricated using Intelski's patented Duel Inline Package Superconductive Technology Integrated Carbon Kaolin (DIP-STICK) process. When the unit is eventually marketed, hopefully by late in the second quarter, it is expected to be available in a 39-pin DIP package, a 144-pin flat-pack, and a six-chip snack-pack.

The maximum clock frequency for the PI-4U28 is 20,000 GHz, about a million times faster than today's typical microprocessor. To obtain that extremely high internal clock frequency, however, designers had to make some compromises in the device's instruction set—it doesn't have one. That complete lack of instructions also gives the chip another notable distinction: it is the ultimate machine in the area of Reduced Instruction Set Computer (RISC) technology.

The Controversy. Many industry observers have stated that the lack of instructions is the chip's third- (possibly even it's second-) most serious drawback. In actuality, the lack of an instruction set is not really that bad considering the fact that a 1-bit processor only has two possible op-codes anyway.

A company insider, requesting that his identity be kept secret, has indicated that future versions of the PI device may have an expanded instruction set. The uncertainty is due to a great deal of internal bickering at Intelski about how many and what type of instructions should be added.

Engineers would like to add accumulator-load and -store commands, while management only wants to add a NOP instruction. By adding only one instruction, management hopes to keep from wasting the hundreds of hours it took to design an illegal op-code trap for a microprocessor. The trap causes the microprocessor to jump to a known address whenever an unassigned op-code is encountered, as might happen whenever the processor erroneously jumps into the middle of a data table. If there are no illegal op-codes, then the illegal op-code trap is completely useless; it's that simple.

Two Bits Adds Up. There is also a small faction at Intelski (specifically the mail-room employees) who tend to disagree with both management and the engineers on the matter. In their opinion, one of the op-codes should definitely be an AND instruction. Because the PI-4U28 is a one bit machine, the AND instruction could also be used as a 1-bit multiply instruction. That way engineers could get two instructions for the price of one. Along a similar line of reasoning, the second possible command should be an exclusive-OR (XOR) instruction, which could double as a 1-bit ADD instruction (without a carry, of course).

While there are some limitations due to the lack of instructions, there are also some important benefits. For one, there is no need to memorize a lot of complex commands in order to program the processor. Another advantage is the fact that an assembler for the micro is very easy to write.

Listing 1 contains a printout of one such assembler. The assembler is written in BS-BASIC, but is easily modifiable to run under any BASIC language with at least 1K of RAM.

Clouding the Issue. Not only is its instruction set (or rather, its complete lack of an instruction set) a problem, taking advantage of the PI-4U28's superconductive capabilities are a source of concern for computer companies wishing to integrate the microprocessor into their products. The

(Continued on page 102)

LISTING 1

```
1000 CLEAR : CLS : ER=O
1010 PRINT "***** PI-4U28 ASSEMBLER *****"
1020 PRINT "(c) 1988 - All Rights Reserved"
1030 PRINT
1040 INPUT "File name: ",N$
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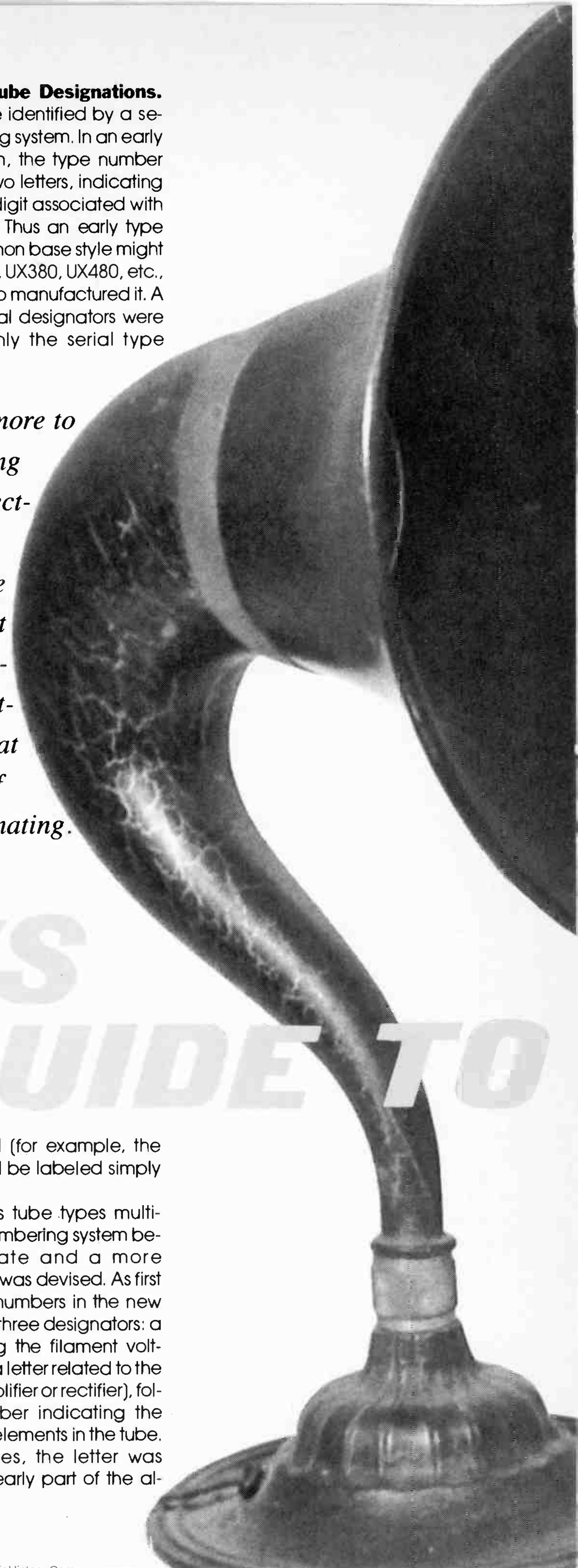
BUYER'S GUIDE TO

There's a lot more to radio collecting than just collecting radios! Here's a guide to the different types of radio-related collectibles, and what makes each of them so fascinating.

BY MARC ELLIS



Most people who enter the fascinating hobby of antique-radio collecting begin by acquiring the radio sets themselves. But it isn't possible to continue that activity very long without also becoming a collector of related items. For example, those who are interested in repairing their radios and keeping them running (and most of us fall into that category) must also collect tubes, parts, and servicing information. And what radio collector can resist picking up old magazines and catalogues containing all the related promotional material?

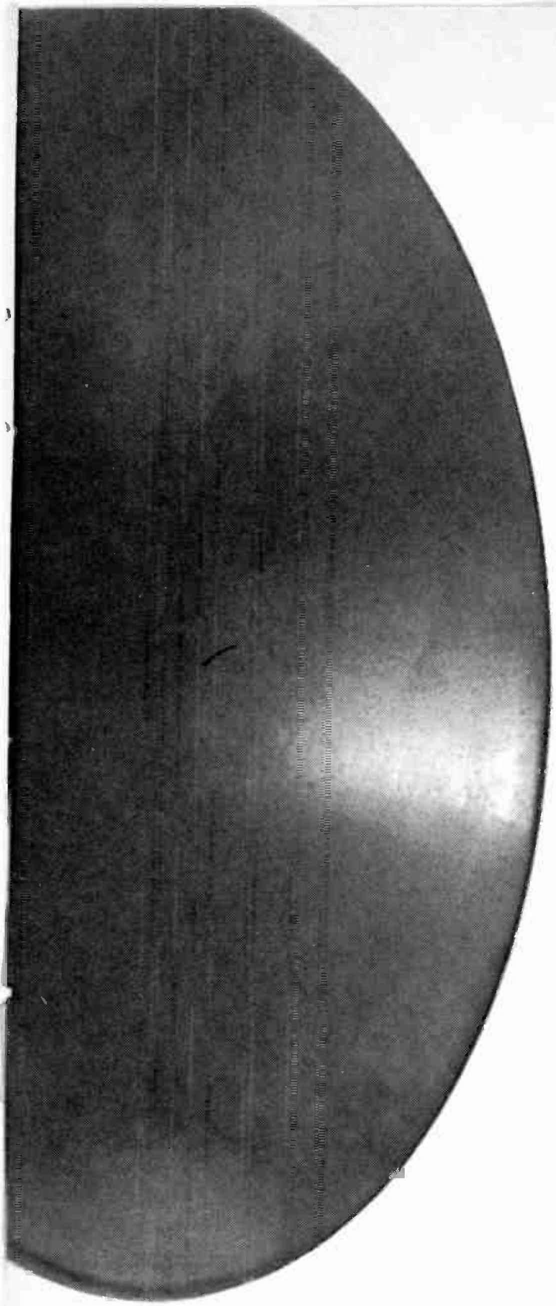
For some, the radio-related collectibles become as important as the sets themselves—or perhaps more so. Others tend to pick up only what they need for practical purposes and, perhaps, to add a little color to the radio room. If you're new to the hobby, you probably don't yet know where you stand, but this article will give an orientation that will help you make up your mind and add more spice and good fortune to your house-sale and flea-market forays by giving you more items to look for!

Collecting Radio Tubes. No matter how little you might care about radio-related collectibles, you won't be able to avoid an involvement with radio tubes. The evolution of radio receivers was very much tied to the evolution of new tube types. Once you gain an understanding of the latter, you'll be in a much better position to understand—and date—the radios you already own, and those you'll find in the future.

Tubes also make extremely interesting collectibles in their own right. While tubes dating from the earliest days of radio (such as the DeForest audion) are rare, and seldom seen outside of museums, those dating from the beginnings of radio broadcasting (early 1920's) are easier to find because they were mass produced.

Understanding Tube Designations. At first, tubes were identified by a serial-type numbering system. In an early form of the system, the type number was prefixed by two letters, indicating base style and a digit associated with the manufacturer. Thus an early type 80 having a common base style might be labeled UX280, UX380, UX480, etc., depending on who manufactured it. A little later, the initial designators were dropped and only the serial type number was used (for example, the above tube would be labeled simply "80").

In the 1930's, as tube types multiplied, the serial-numbering system became inadequate and a more sophisticated one was devised. As first introduced, type numbers in the new system contained three designators: a number identifying the filament voltage, followed by a letter related to the tube function (amplifier or rectifier), followed by a number indicating the number of active elements in the tube. For amplifier tubes, the letter was chosen from the early part of the al-



phabet; for rectifiers, from the latter part of the alphabet.

For example, the 6C6 has a 6-volt filament; is an amplifier; and contains 6 active elements (a filament, a cathode, three grids and a plate). On the other hand, a 5Z3 has a 5-volt filament; is a rectifier; and contains three active elements (a filament and two plates). The 6D6 and 5Y3 (an amplifier and a rectifier, respectively) perform functions similar to the tubes just discussed, but have different operating characteristics. That is reflected by the differences in identifying letters.

Physical Changes in Radio Tubes. The evolution of *physical* tube characteristics is also of interest to the collector. The glass envelopes of the earliest tubes were like those of contemporary light bulbs; pear shaped with a pointed seal at the top. Later, following trends in light-bulb design, the seal was moved to the bottom of the tube so that it could be hidden in (and protected by) the base.

Still later, in the 1930's, pear-shaped envelopes gave way to the "double-dome" or "ST" style. And a little later in the same decade, more compact tube designs made it possible to release new types (and some older ones) in the "bantam" or "GT" style. That envelope was much shorter than previous ones, straight sided, and had a rounded top. Some manufacturers released the same types in metal-enclosed glass envelopes, having roughly the same outer dimensions as the "GT" style.

Tube bases also changed over the years. Brass gave way to bakelite as a base material, and the original short-pin, bayonet-lock style was changed to the longer-pin type that engaged with friction contacts in the tube socket. Some transition-period tube bases had the longer, friction-contact pins, but could also bayonet-lock into the older sockets.

Tube cartons can be as interesting to collectors as the tubes they contained. From the plain generic-looking styles of the early 1920's to the colorfully lithographed ones of later years, they can make a very interesting display.

A detailed discussion of radio-tube history is beyond the scope of this article. But for more information on tubes from the early years of broadcasting through the early 1930's, check your back issues of **Hands-on Electronics**. You'll find the *Ellis On Antique Radio* columns of February, March, and April 1987, as well as May, 1988, to be very helpful.

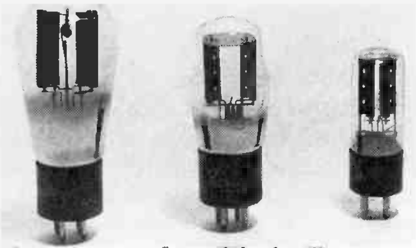
John Rider's® Mighty Manuals. As mentioned a little earlier, your preoccupation with printed radio literature will begin almost immediately after acquiring your first few sets. Because once you start working on the radios, you'll want to acquire schematics and other servicing information.

There are individuals and organizations who will look up information and photocopy it for you for a nominal fee. But if you have the space and the inclination, you can build your own personal library of original service data.

In my opinion, the best way to do that is to begin acquiring volumes of John Rider's *Perpetual Trouble Shooter's Manual*. Rider began publishing the manual some time in the late 1920's or early 1930's, and added a new volume to it approximately every year (with some breaks during World War II).

Each new book provided schematics and service information for virtually every radio released since publication of the prior one. The complete set contains 23 hefty tomes covering radios from the early 1920's through the early 1950's.

RADIO COLLECTIBLES



These three versions of the familiar type-80 tube show the evolution of bulb styles. At far left is an original pear-shaped bulb; in the center is an "ST" (double-dome) style; and at the right is a "GT" (straight-sided) bulb.

Rider volumes still turn up regularly at antique-radio swap meets and hamfest flea markets, and they're easy to spot. Look for a distinctive dark-blue binder with a quaint cover illustration of an antenna strung between two towers. A separate Rider series, similarly bound, covered television sets—but they are plainly marked as such, and you can avoid them (unless, of course, you are into early TV's).

The Rider manuals of most practical interest to collectors are probably volumes 1 through 13. (The latter bears a 1942 copyright, and covers the last of the pre-war radios). However, if you look at the Rider set as a collectible in its own right, you'll obviously want to acquire as many of the volumes as possible.

Price and Availability. The earliest volumes in the set (1 thru 4 or so) don't seem to turn up very often, and are expensive. The volumes towards the end of the series are also hard to come by. I suspect that the manuals declined in popularity towards the end of the run, and not as many were printed. Asking prices for the more common volumes seem to be from six to fifteen dollars each, depending on the mood of the owner.

Rider also published an abridged version of volumes one though five, complete in one book that is bound uniformly with the rest of the set. It was probably intended for repairmen who got into the business some years after the series was instituted and didn't have as much need for the earliest data. The abridged version is much more common than the individual volumes, and would be a good alternative for those who can't find the latter. I've seen it priced at about $40.00.

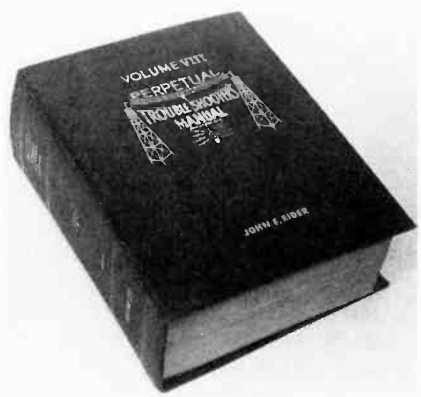
Though I didn't realize what I was buying at the time, I was lucky enough to purchase the complete volumes 1-3 bound in one book. It was originally offered by RCA as part of a tube deal, and the binder is the same physical size and type as that used in the standard Rider manuals. However, the cover is red instead of blue and shows a vacuum tube instead of the traditional antenna and towers. I've never seen another one like it.

Finding Your Way Through Rider's. Without an index, locating sets in Rider's is something of a pain in the neck. You're pretty much reduced to *guestimating* the year that your set was manufactured, then looking it up, trial and error fashion, in the volumes that most closely correspond. Since the books tend to be big, heavy and clumsy, doing so can be an unpleasant task.

Every few years, Rider published an index for the books that had been released up to that time; they were in softbound pamphlet form. The indexes don't seem to turn up as often as the manuals, but some have been made available in reprint form by *Antique Electronic Supply* (688 W. First St., Tempe, AZ). Current prices are $17.95 for the index to Volumes 1-15 (205 pages, spiral bound) and $7.95 for the index to volumes 16-22 (48 pages, spiral bound).

An interesting alternative to the Rider indexes is offered by *The P.R. Mallory Radio Service Encyclopaedia*—a radio-receiver index compiled for the purpose of recommending the correct Mallory controls, capacitors, or vibrator for every model. But each entry also includes the correct Rider's reference!

Colorfully lithographed radio-tube cartons can be as interesting as the tubes they once contained.



Rider's "Perpetual Trouble Shooter's Manual" series is not only the most exhaustive reference source available to collectors today, but is also a collectible item in its own right.

My *Sixth Edition* was copyrighted 1948 and, I suspect, is based on the Rider index to Volumes 1-15, which appeared in 1947. If you can find one of them, you may be able to get it for very little money since its value is not generally known (mine cost two bucks!). Some time after purchasing it, I bought a serviceman's assortment of Mallory controls in a metal storage cabinet. The cabinet had a compartment obviously intended to accept the manual—which must have been included with the deal.

The Supreme Series. Another source of schematics and service information was the "Most-Often Needed" series offered by Supreme Publications. Like Rider, Supreme released a new compilation each year. But while Rider published huge binders covering virtually every set ever produced, Supreme published relatively slim soft-cover books containing an

P.R. Mallory Radio Service Encyclopaedia (Sixth Edition) stores behind compartment containing assortment of Mallory controls. The manual contains an index to Rider's through about volume 15.

edited assortment of material on the most popular models.

To my mind, the Supreme manuals are more valuable as practical references than as collectibles. The first volume, which bears a 1941 copyright date, covers 1926 to 1938 sets. From then on, they came out every year with a gap during World War II. The manuals were published at least into the late 1960's.

The 1926-1938 volume was reprinted by Supreme more than once over the years, and copies turn up quite often at hamfests and antique-radio meets. It's a good starter book for the beginning antique-radio collector, providing information on the more common sets. But keep in mind that its approximately half-inch thickness covers a time span that would be represented by three feet or more of Rider volumes.

It's worth noting that most of the Supreme manuals are available, in reprint form, from ARS Enterprises, P.O. Box 997, Mercer Island, WA 98040. When last I looked, the 1926-1938 volume—and the subsequent individual-year volumes through 1959—were priced at $17.00 each. Later volumes were $5.00, and a master index was available at $8.00. Write them for current information.

The first "Supreme" manual covers common sets from 1926 to 1938, and has been reprinted many times over the years. It is a great "starter" reference book for beginning collectors.

Generic Servicing Books. Although we've covered collections of service information for specific sets, there are some generic books on servicing that are not only useful, but collectibles in their own right. And since they were very popular volumes when originally published, there are still a number around to be discovered today.

For example, watch for the radio books published by McGraw-Hill during the 1920's, 1930's, and 1940's. They have easy-to-spot, drab-green bindings with gold-lettered titles on the spines. The volumes by Moyer and Wostrel (including *Practical Radio* and *Radio Construction and Repairing*) are interesting relics of the 1920's.

For insights into radios of a later period, keep an eye open for *Principles and Practice of Radio Servicing* by Hicks. Editions of that book were published in 1939 and 1943.

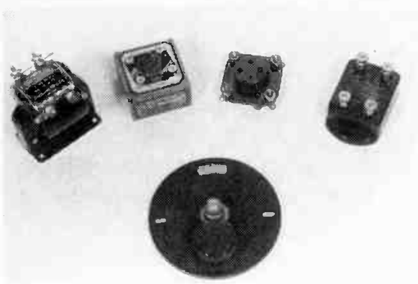
Two classics of the 1930's, both by Alfred A. Ghirardi, should be on every collector's shelf. *Modern Radio Servicing*, published by Murray Hill Books, is packed with practical information on troubleshooting 1930's-era sets. The edition on my own shelf bears a 1935 copyright, but there may have been subsequent revisions and expansions. *Radio Physics Course*, published by Radio Technical Publishing Co., has a more theoretical slant and will help you understand the "why" of vintage radio circuitry. My copy, a second edition revised in 1933, was printed in 1937.

No discussion of vintage servicing books would be complete without mentioning the many contributions by John F. Rider of *Perpetual Trouble Shooter's Manual* fame. Most of those are relatively short books focused on specific aspects of servicing, and were published by Rider himself. Look for such titles as *Servicing Superheterodynes*, *Practical Testing Systems*, *The Oscillator at Work*, and various titles in the *An Hour a Day With Rider* series.

Other Printed Materials. Vintage trade and hobby periodicals contain articles and advertising that will help you to understand the equipment that you're collecting and the context in which it was used. A list of the well-known and little-known titles in that area would be endless, but watch for publications such as *Radio News* and Gernsback's own *Radio Craft* and *Short Wave Craft*. Also interesting are private or "house" publications produced for dealers and servicemen by the manufacturers of radios and radio components.

Be sure not to neglect non-electronics magazines, either. The ones targeted for middle-class or carriage-trade readers contain elaborate display advertising for expensive consumer goods such as radios, automobiles and cameras. Old issues of

Vintage trade and hobby periodicals help you better understand your early equipment and the context in which it was used.



These interesting parts from the early 1920's include a Rauland audio transformer (far left); a Dubilier RF transformer (far right); a CLE-RA-TONE tube socket with original box (top center); and a vernier dial (bottom center).

The National Geographic are still fairly easy to find, and are a very rich source of such advertising. I've found a lot of fascinating information on the sets in my collection in old issues of that publication.

Anything like a complete discussion of collectible printed materials relating to antique radio would be impossible in an article of this scope. The volume of books, periodicals, catalogues, instruction manuals, promotion pieces, and other types of advertising—aimed at both the general public and the electronics professional—is huge.

My advice is keep your eyes open at the book stores and swap meets. If a piece interests you and you can afford it, make the purchase. I continue to enjoy all of the printed items I've picked up over the years.

Parts: Collectible and Otherwise. Most of the collectibles covered so far have a definite dual purpose. They're not only interesting in themselves, but also useful—or even necessary—for radio maintenance and repair. Oddly enough, that isn't always the case with radio parts. The collectible ones tend not to be the ones most needed for practical radio service, while the ones needed to keep the radios running tend not to be collectibles. Admittedly, I've made something of a forced distinction here, and there'll be plenty of exceptions, but let me explain what I mean.

I associate collectible parts and accessories with the radios of the 1920's period. During that era, many people built their own sets from plans published in books and magazines. The parts, much larger in size than the comparable electronic components of today, were individually packaged, advertised, and sold.

There were many competing manufacturers, and they vied with each other in the extravagance of their performance claims and the colorfulness of their advertising and packaging. The parts themselves, crafted of bakelite, glass, silk- or cotton-covered wire, and polished or brightly painted metal, were definitely made to be looked at. Among the parts of interest to collectors are knobs, dials, tuning capacitors, audio- and radio-frequency transformers, tube sockets, rheostats, resistors, plugs, and jacks.

1920's-era radio-parts advertising sometimes resembles today's advertising for high-performance auto parts.

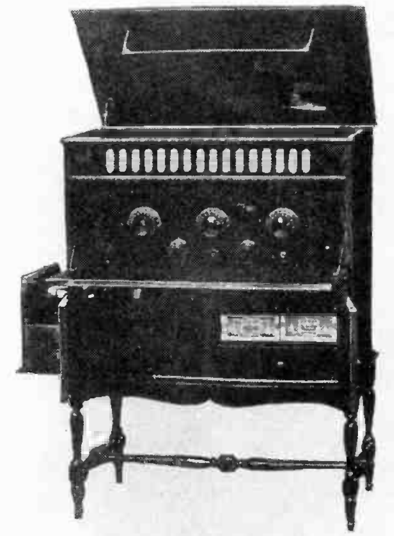
People bought parts not only to build new sets, but to improve the performance or convenience of existing sets. Parts in the latter category included not only straightforward components such as vernier-dial drives and "high-fidelity" audio transformers, but also a colorful assortment of more fringe apparatus, such as antenna substitutes, variable grid leaks, self-adjusting filament rheostats, and multiple-headphone adapters.

The radio sets of that era were so simple, and the parts so basic and generally well-made, that breakdowns due to component failure were relatively uncommon. It's true that restorers of 1920's radios sometimes have to deal with such problems as burned-out audio transformers and grid-leaks whose resistance has escalated over the years. But most performance difficulties can be traced to poor contacts caused by dirt and corrosion, not a part failure. Therefore, parts that have been acquired as collectibles can generally stay on the display shelf.

The Changes of the 1930's. I've always thought that the marketing of radio parts in the 1920's had a lot in common with the marketing of certain kinds of auto parts today; particularly the ones intended to improve performance or convenience and simple enough to be installed by the "backyard mechanic" set. But by the 1930's, radio receivers had become much more complex. Most sets were factory built, rather than home made—and the average radio listener was less apt to be in the market for parts to improve performance.

As you might expect, then, radio parts became more functional in physical design. They were being made to do their jobs, and not especially to be looked at. But with increased circuit complexity and higher component operating voltages, parts failures were, and are, much more common in the more-modern sets.

It's certainly true that proper resistors, capacitors, transformers, speakers, and other components suitable for use in repairing vintage radios are becoming harder and harder to come by. So most radio collectors acquire them as they can. But parts for repairing 1930's-and-later sets could hardly be called collectibles. They're usually not displayed, but stored in drawers and cabinets until needed.



Special radio furniture was designed to provide storage for the early battery set, its power sources and the other accesories required for its operation. Such furniture can be used to display the most prized items in your collection.

Battery eliminators and chargers were heavily marketed prior to the introduction of AC-powered sets. There are many still around to be discovered today.

Batteries, Chargers, and Eliminators. Vintage accessories can add yet another colorful and fascinating dimension to your collection of radio items. This is another category so rich in collecting potential that even a partial list of possibilities would be difficult to compile. But, just as in the case of parts, your most interesting "finds" are apt to date from the 1920's.

One important group of accessories is associated with the batteries used to power most radios of that period. First of all, there are the batteries themselves although—because of the corrosive chemicals they contained—not many of them survive today. The lead-acid storage "A" batteries used to light the filaments were generally 6-volt automobile types. However, I've seen special versions designed for radio use; some had beautiful teakwood outer cases incorporating handles for easy carrying.

The "B" and "C" batteries that provided plate and grid-bias power were generally of the non-rechargeable dry-battery type. Today, they are probably harder to find than the filament batteries because they were thrown away when exhausted. Those that were kept were generally quickly rendered unsightly after the chemicals inside ate their way through the outer casing. Yet, for some unaccountable reason, some of those dry batteries have survived (though quite dead, of course) in good cosmetic condition. Most have colorful, lithographed wrappers, and certainly look interesting when displayed along with examples of the radios they once powered.

Battery chargers and eliminators also make interesting collectibles. Both of those types of units plugged into normal, commercial, AC-power lines. The former—scaled-down versions of the commercial types then in use—made it possible for radio enthusiasts to replenish their "A" batteries at home—thereby, avoiding the discomfort and the danger of lugging them to the neighborhood gas station. The latter actually took the place of "A" and/or "B" and "C" batteries.

A word to the wise: avoid the temptation of trying to operate one of your prized battery sets from a vintage battery eliminator. The regulation of the old units was generally far from ideal even when new. Today, after many years of aging, the values of the carbon resistors and controls used to establish the correct voltages may be nowhere near original specification. The result could be dangerously high voltages that might well pop tube filaments and/or burn out AF-transformer windings.

Modern battery eliminators, using semiconductor regulators, are available from several sources. They provide stable, well-filtered DC power that is not only safer for your set, but will make it perform better.

Before leaving the subject of battery-radio accessories, I'd like to touch on a couple of other collectible categories that you might find of interest. With battery condition so crucial to proper set operation, most radio owners equipped themselves with some kind of a battery tester. The typical tester was a "watchcase" style meter housed in a highly chromed, round case a few inches in diameter. Some models tested for voltage; some for current; and some for both. They came in a variety of brands and styles, and an assortment of them makes a fine addition to any collection of sets from that period.

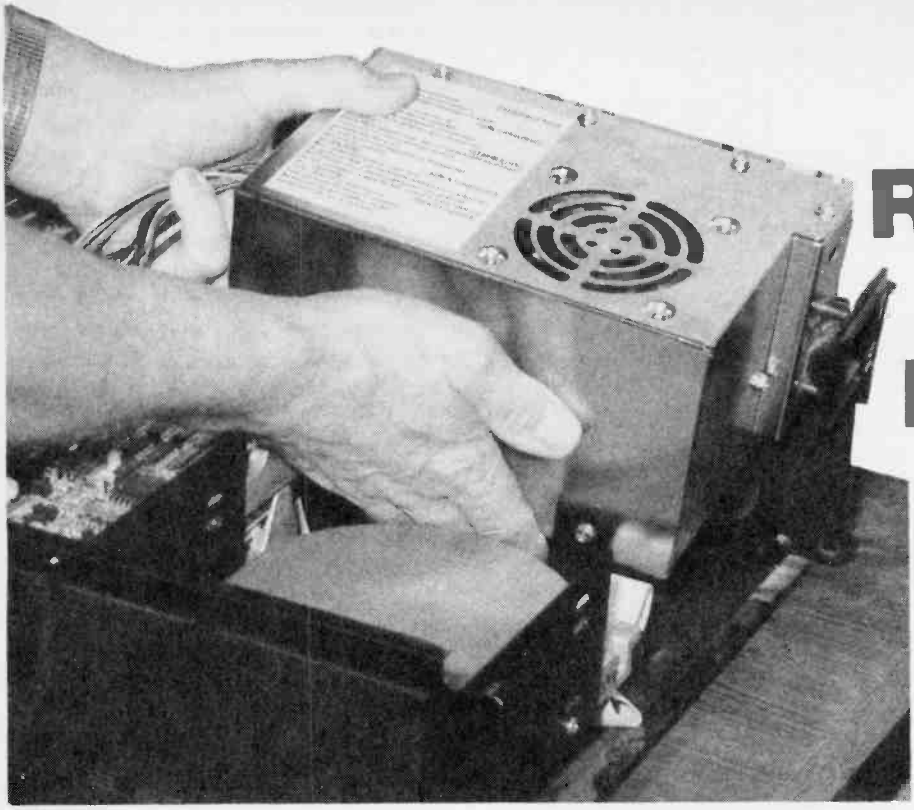
Finally, you might like to look for special radio furniture. Back in the 1920's, a typical radio installation consisted of the radio unit itself, plus a separate speaker, an array of batteries, possibly a charger, and/or eliminator. The natural setting for that novel, and very important, collection of apparatus was the family living room. But some housewives understandably felt it to be an eyesore. The answer, for many families, was a cabinet that would house all that stuff much like the hi-fi system organizers on the market today.

The typical unit contained compartments for storing (and concealing) radio, batteries, speaker, charger, etc. Many took the form of a drop-leaf desk, with the drop leaf serving as the radio operating table when open. If you can find one of those, and have the space to show it off properly, it can be a focal point for your collection—providing display space for some of your most prized pieces.

Reproducing Equipment. This could easily be one of the largest and most important categories in your collection of radio accessories. But why do I consider such things as headsets and speakers to be accessories? Because, back in the 1920's, such items were generally not packaged with the radio, but sold separately, much as hi-fi components are today. If the radio manufacturer offered them for sale, they might be purchased along with the set, or they might not. There were many makers competing for the set-buyer's dollar, and the buyer might well be tempted by a better price, a style more to his or her liking, or claims of improved performance.

The earliest speakers in common use with broadcast sets were of the horn type. The sound-reproducing unit within the base of most horns was essentially an overgrown earphone. The sounds were produced by vibrations induced in a metal diaphragm by the action of a pair of electromagnets. The horn then acted as an acoustical amplifier, very much in the manner of a megaphone.

(Continued on page 96)



Replacing your PC's Fan

It's easy to do because an exact replacement for your fan is available everywhere!

BY MARTY KNIGHT

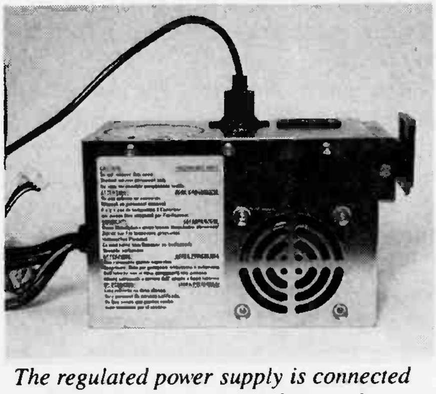
I sensed that there was something wrong with my computer, but I just couldn't put my finger on what it was. It powered-up very well, the memory check was always faultless, and the programs ran to perfection. So what was wrong?

One day I sat planning a BASIC program with the computer powered-up. I heard nothing, or almost nothing. The ventilating fan was too quiet, almost as though it wasn't there. I placed my hand behind the computer where the regulated power-supply vents to the room and felt nothing. No draft was felt. Remembering an old Boy Scout wind test, I wet my finger and felt the slightest of breezes from the vent on the rear apron of the computer chassis. Obviously, something was wrong.

Getting Inside. Immediately I powered-down the computer and unplugged the AC power cord. (Those readers who have a hard-disk drive should park the hard disk's heads first, and then power down.) I removed a few screws from the rear panel and removed the top cover of the computer by sliding it forward. You will probably need to follow a similar procedure for your computer, although some computer cabinets will obviously be somewhat different.

The regulated power supply used in IBM and clone computers is easy to spot. The unit is usually in a chrome-finished metal box about 8-½-in. long, 5-¾-in. wide and 5-½-in. high. The fan's circular vent is near the ON/OFF switch on the top surface of the regulated power supply.

On one side, there is a bunch of cables that connect it to the computer via plastic plugs. Not all of those cables may be connected and used in your computer. It makes sense to identify each used plug and jack there. My computer has two cables connecting it to the mother board. I numbered them cable 1 and 2 by writing on masking tape that I attached to the cables and to the motherboard. I have two floppy-disk drives and one hard-disk drive that are also connected to the power supply. The cables are identical, however, so I numbered them also. It would be silly to have to unbutton the computer's cabinet unnecessarily to reconnect a cable when one of the disk drives failed to operate.



The regulated power supply is connected to the AC power cord and the switch is set to the on position. The ventilating fan will suck air through the circular grille at lower right and exhaust it through louvers at top in photo.

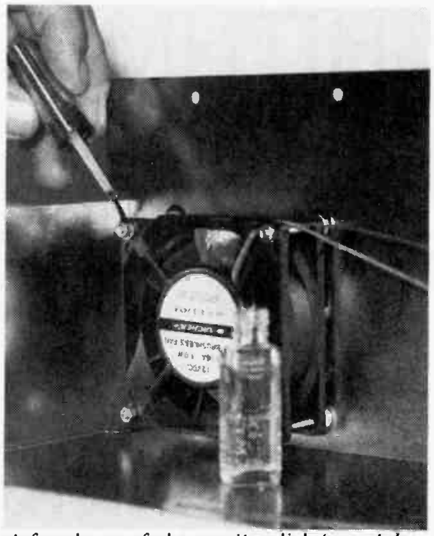
Inspect the computer for screws that secure the regulated power supply in place. Usually, removing four screws from the rear panel will release the power supply so that it can be lifted from the interior chassis. Remove the screws and carefully take out the supply. First-time computer repairers are advised that everything you have done so far can be performed in reverse order to restore the computer to its original condition.

Recheck. With the regulated power supply removed, connect the AC-power cord and turn the power-supply switch to the "on" position. The ventilating fan should come on immediately and create a breeze you can detect at the vent louvers. Mine was defective, as evidenced by the weak breeze and slow motion. A voltmeter told me that the regulated power supply was still good because the power to the floppy- and hard-disk drives measured exactly +5- and +12-volts DC. If the voltages were off, I would have replaced the entire regulated power supply. That would've been easy enough to do since the regulated power supply is a common model. Check the voltages on your own power supply and then unplug the unit before proceeding.

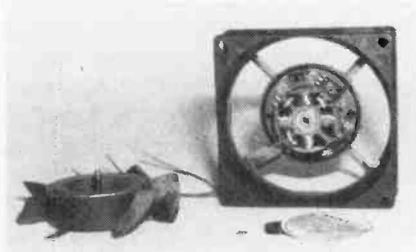
About ten or fewer screws need to be removed to open the supply casement. The ventilating fan will be on the removed cover, and the rest of the parts and the circuit board will be on the chassis. Plug the supply back in and measure the voltage supplied to the fan. The reading should be almost exactly 12-volts DC—it's regulated. Mark the positive lead with some masking tape; it should be color-coded, but don't trust your memory by just memorizing which wire is which. Now, power-down the supply again and remove the power cord.

Remove the ventilating fan and be sure to save the mounting hardware. I took the fan to a local Radio Shack store and purchased an exact replacement from a peg-board display. I didn't know how exact the replacement was until I compared the plastic casing of the old and new—they were from the same mold, and both were made in Taiwan. I compared the two fan's air-flow by powering up the supply and applying voltage to each, carefully observing polarity. The Radio Shack replacement fan really pushed air. Check the direction of air flow for the replacement unit and see if there is an arrow on the plastic frame that points in the same direction. If not, pencil an arrow on the plastic frame to indicate the direction of flow as a reminder.

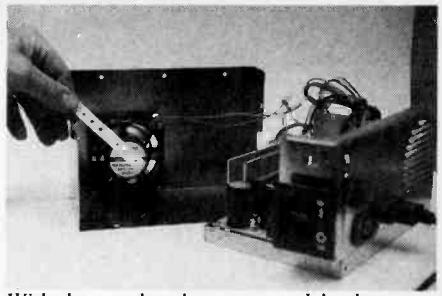
The rear panel has four mounting screws to secure the regulated power supply to the chassis. There are no mounting screws on the bottom surface of the chassis. The cables to the printer, modem, and monitor need not be disconnected.



A few drops of clear nail polish (one dab per nut) on the mounting hardware will prevent them from working loose.



The ventilating fan is shown with the fan rotor removed and the electronics revealed. Embedded magnets in the rotor are repelled by magnetic fields generated by four coils in the stator, causing the fan blade to rotate.



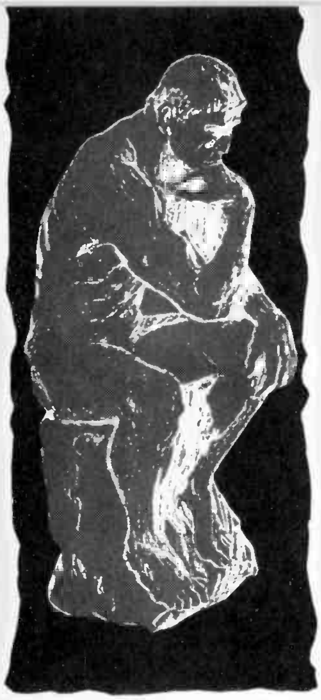
With the regulated power supply's chrome cover removed, the strip of paper will be bent toward you by the ventilating fan's air flow if it operates at all.

Reassembly. Mount the replacement ventilating fan to the cover using the saved hardware being sure that its orientation is correct. The air flow should be from outside the case to inside. Do not over-tighten the nuts—you might warp the plastic frame. Connect the wires for the power-supply and power-up the unit for a moment to check the air flow. If everything checks out okay, shut everything off and unplug the power cord. Use a drop of clear nail polish on each mounting nut to prevent them from working loose. Replace the cover of the power supply, insert it into the computer, and mount it as it was when you began. That completes the mechanical part of the reconstruction.

Reconnect all plugs using the labels as a guide. The computer can be operated safely now. Reconnect the AC power cord and turn the power switch on. Since you did not have to disconnect the monitor or printer, everything should operate as it did before except that a slight breeze will be felt coming from the louvers at the rear panel, indicating that the ventilating fan is operating. When the cover is installed, the fan will remove air from inside the cabinet, pass it through the power supply, and push it into the room through the rear panel. Cooler room air will seep in through the various ports in the chassis, thus providing a degree of cooling for the electronics outside the power-supply encasement.

Having Some Fun. You may be curious about the innards of a DC ventilating fan. You can start to take the old one apart by peeling off the manufacturer's label in the center of the unit's body. Underneath the label is a shaft with a retaining clip that you must remove. The fan-blade pops out to reveal components on a circuit board. The circuit energizes a series of coils in sequence so that the coils will repulse/attract permanent magnets located on the rotor, causing the blade to rotate. Without the power on, spin the fan by hand; it will skip from magnet position to magnet position coming to an abrupt stop each time. If you can determine what's wrong with your fan, you may end up with a replacement fan in your junk box for some other task. If not, throw it away.

Besides saving me the expense of a costly regulated power supply, replacing my PC's fan taught me a valuable lesson, to wit: With just a reasonable degree of care, you can open up your computer, perform simple repairs, and save lots of money. ■



E-Z MATH

BINARY NUMBERS AND ARITHMETIC

BY LOUIS E. FRENZEL, JR.

Become an expert of the three number systems you'll have under your belt after reading this easy-to-follow lesson.

Practically every piece of electronic equipment in use today uses digital techniques. Digital circuits such as logic gates and flip-flops work with binary signals and numbers. To understand the operation, application, and troubleshooting of digital equipment, you need a basic working knowledge of the binary-number system and binary arithmetic. 1You won't get too far working on computer equipment without such essential knowledge.

Binary numbers are those made up of just two digits, 0 and 1. Because they are seemingly so simple, you would think that everyone would be familiar with them. But while the concepts of binary numbers are indeed simple, they are a bit tricky to handle at first. In this article I will introduce you to the binary-number system and show you how to work with binary numbers. It is not all that difficult, and once you learn a few tricks, you will be able to keep up with the experts.

First I will talk about what binary numbers are and how to make conversions between binary numbers and the more familiar decimal-number system. Then I will show you how to perform basic arithmetic operations with binary numbers. Finally, I will conclude with information on the octal and hexadecimal-number systems, both of which are closely related to the binary-number system. Octal and hex notations are widely used in computers and you will find them a useful shorthand when programming and debugging computers.

The Decimal Number System. Before we talk about the binary-number system, let's review the number system you are most familiar with: the decimal-number system. It is the one we use every day to represent quantities. As you know, the decimal-number system uses the ten digits 0 through 9. They are combined in various ways to represent any numerical value. Because the decimal-number system uses ten digits to represent quantities, we say that its "base" or "radix" is 10. Other number systems use a different base. The binary-number system has a base of 2 because it uses two digits (0 and 1) to represent any value.

The decimal-number system is also what we call a positional or weighted number system. All that means is that each digit's position in a number has a specific weight or significance. In the decimal-number system, the positional weights increase from right to left: units, tens, hundreds, thousands, and so on.

Take a look at the decimal number 19052. You can see the meaning of the position weights if we break the number down into its component parts. That is done as follows:

$$2 \times 1 = 2 \text{ (units)}$$
$$5 \times 10 = 50 \text{ (tens)}$$
$$0 \times 100 = 0 \text{ (hundreds)}$$
$$9 \times 1000 = 9000 \text{ (thousands)}$$
$$1 \times 10000 = 10000 \text{ (tens of thousands)}$$

As you can see, the right-most or units position has a weight of 1. In that position, we have the digit 2. To get the total value of that position, we multiply the weight by the figure giving, in that case, 2.

The next digit is 5 and is in the tens position. Therefore, that position has a total value of $5 \times 10 = 50$. Once each position has been evaluated, all of them are added together to give the final value.

One way to express the above in a more mathematical form is to show the calculations like this:

$$(1 \times 10000) + (9 \times 1000) + (0 \times 100) + (5 \times 10) + (2 \times 1) = 19052$$

We can also use powers of ten to replace the units, tens, hundreds, and other weights giving the expression:

$$(1 \times 10^4) + (9 \times 10^3) + (0 \times 10^2) + (5 \times 10^1) + (2 \times 10^0) = 19052$$

Note we are using scientific notation with powers of 10 to represent the weight of each position. Ten, of course, is the base of the decimal-number system. Also, remember that $10^0 = 1$. Binary numbers can be expressed in a similar format, as you will see.

The binary-number system is also a weighted or positional system. The position weights, as in the decimal system, are some power of the base of the number system. In binary, the weights are powers of 2. The position weights in binary from right to left are $2^0 = 1$, $2^1 = 2$, $2^2 = 4$, $2^3 = 8$, $2^4 = 16$, and so on. As you can see, the weight of each position is two times the weight of the previous position to the right.

The binary-number system has a base or radix of 2 and uses the two symbols 0 and 1 to represent quantities. Each position in a binary number is referred to as a binary digit or a bit. An example is the binary number 10011011. Although you may not be able to tell by just looking at that number what value it represents, its equivalent is the decimal quantity 155.

You can use the technique described here earlier for decimal numbers to break down and analyze the binary number given above. The breakdown is:

$$(1 \times 2^7) + (0 \times 2^6) + (0 \times 2^5) + (1 \times 2^4) + 1 \times 2^3) + (0 \times 2^2) + (1 \times 2^1) + (1 \times 2^0) = 155$$

As in the decimal-number system, you simply multiply the bit value in each position by its position weight, then add all of the resulting numbers to get the decimal equivalent.

One last thing of importance. The first and last digits in a number have special names. In the decimal number 7526, the right-most number (the 6) is in the one's position so it has the least weight in determining the total value. We call it the least-significant digit (denoted LSD). On the other hand, the left-most number (7) is in the thousands position. It has the most weight so we refer to it as the most-significant digit (denoted MSD). That idea also applies to binary numbers. In the binary number 101010, the right-most bit (the last 0) is called the least-significant bit (abbreviated LSB). The left-most bit (a 1) is called the most-significant bit (abbreviated MSB). The terminology lets us conveniently refer to those key positions in a number.

Fractional Binary Numbers. The procedures outlined earlier are fine for dealing with whole numbers, but what about fractional values? In the binary-number system, as in the decimal system, there is a method of expressing fractional quantities by using binary fractions. One or more positions to the right of a *binary point*—the same as a decimal point in decimal numbers—in a binary number are used to express the fractional part of the number. Each position to the right of the binary point has a specific weight. In the decimal-number system, those weights are again powers of 10, but the exponents are negative. That gives positional weights of tenths, hundredths, thousandths, and so on. We can express the weights as powers of ten, or $1/10 = 10^{-1}$, $1/100 = 10^{-2}$, $1/1000 = 10^{-3}$, etc.

Consider the decimal fraction 0.6743. It can be expanded using the technique described earlier:

$$(6 \times 10^{-1}) + (7 \times 10^{-2}) + (4 \times 10^{-3}) + (3 \times 10^{-4}) = .6 + .07 + .004 + .0003 = .6743$$

Fractional values can also be expressed in the binary-number system using the same method. Bits to the right of the binary point in a number designate the fractional portion of the number. The weights of those positions have negative exponents with a base of 2. The positional weights from left to right are ½, ¼, ⅛, 1/16, and so on. Expressed as powers of 2, those are $1/2 = 2^{-1}$, $1/4 = 2^{-2}$, $1/8 = 2^{-3}$, $1/16 = 2^{-4}$, etc.

To evaluate a fractional binary number, you express it as you would a whole number. Simply multiply the bit in each position by its weight expressed as a negative power of 2, then add up all of the resulting figures. The sum will be the decimal equivalent. Let's try that with the number 0.1011:

$$(1 \times 2^{-1}) + (0 \times 2^{-2}) + (1 \times 2^{-3}) + (1 \times 2^{-4}) = .5 + 0 + .125 + .0625 = .6875$$

Binary/Decimal Number Conversions. You have already seen how it is possible to evaluate a binary number to determine its decimal value. The process is simple. All you do is multiply the bit value in each position by its position weight, then add all the results together. Because the value in each position is either 0 or 1, you will simply be adding the values of the position weights in those positions where a binary 1 occurs. All you have to do is remember the position weights. That is pretty easy since the weight of each position is simply twice that of the position to the right of it. The position weights starting at the binary point and moving left are 1, 2, 4, 8, 16, etc. That sequence is pretty easy to remember.

As an example, consider the binary number 11010. The position weights from right to left are 1, 2, 4, 8, and 16. As you can see, there are binary 1's in the 2, 8 and 16 positions. To get the value of the number then, all you have to do is add those weights. The resulting decimal number is:

$$2 + 8 + 16 = 26$$

Converting a decimal number into its binary equivalent is a little trickier. However, the procedure is generally straight-forward, so with a little practice it should give you little difficulty. The basic procedure is to divide the decimal number by 2 repeatedly making note of any remainder. When you divide any number by 2, the remainder will always be either a 0 or 1. The series of remainders written in reverse order *is* the equivalent binary number.

Below we show how to convert the decimal number 209 into its binary equivalent:

		Remainder
209/2 =	104	1 (LSB)
104/2 =	52	0
52/2 =	26	0
26/2 =	13	0
13/2 =	6	1
6/2 =	3	0
3/2 =	1	1
1/2 =	0	1 (MSB)

The resulting binary equivalent is 11010001.

Practice Problems. The best way to learn number conversion is to try it yourself.

1. Convert 101101 to decimal.
2. Convert 110101101010 to decimal.
3. Convert .0101 to decimal.
4. Convert 119 to binary.

Why Binary Numbers? A question you may be asking is why is the binary-number system used in electronic equipment rather than the decimal-number system, which we are all so familiar with. The answer lies in the hardware. It is difficult, complex, and expensive to implement the decimal-number system with electronic hardware. There would have to be some means of generating ten discrete states, each to represent one of the digits 0 through 9. One way to do that would be to use waveforms that can assume one of 10 voltage levels. Window-comparator circuits would be required to recognize which value the waveform represents. Other ten-state electronic circuits would also have to be developed.

When we use the binary-number system, the electronic circuits become extremely simple. Since only two states have to be represented, on/off switching circuits can be used. That's because in binary circuits, only two voltage levels are needed; one to represent a 1 and another to represent a 0.

Any signal switches between those two levels. Circuits for processing such signals are easy to implement and are extremely less complex. Another major benefit is that their speed of operation is significantly greater than circuits with ten states. Binary circuits can be implemented with switch or relay contacts, but in most cases transistors are used to switch between the on and off or 0 and 1 states.

So, while the conversion between binary and decimal is a nuisance, there are real benefits to using the binary system. As you will see later, some special binary codes have been created to simplify the binary-to-decimal interface.

Quantity vs. Bit Length. In the decimal-number system, the total number of digits in a number determines the maximum quantity that can be represented. For example, with five digits, numbers between 00000 and 99999 can be represented. Higher values obviously require more digits. The same is true of binary numbers. The total number of bits in a binary number determines the maximum value that can be represented. The greater the number of bits in a binary number, the higher the value you can represent.

You can determine the total number of states that can be represented for a given number of digits by using the simple formula given below:

$$M = 10^N$$

For instance, with 5 digits, N = 5. We can represent a maximum number of states (M) of:

$$M = 10^5 = 100{,}000$$

As we stated earlier, those 100,000 states are 00000 through 99999.

You can do exactly the same thing with binary numbers. The maximum number of states (M) for a given number of bits (N) is:

$$M = 2^N$$

For example, with four bits you can represent a maximum of 16 states:

$$M = 2^N = 2^4$$
$$= 2 \times 2 \times 2 \times 2 = 16$$

Table 1 shows those 16 states. Each 4-bit binary number and its decimal equivalent is given. Note that the numbers 0 through 15 can be represented. That is a total of 16 states: the values 1 through 15, and the value 0.

By modifying the basic formula above, you can calculate the maximum decimal value you can represent with a given number of bits. That formula is:

$$M = 2^N - 1$$

The maximum decimal value you can represent is simply one less than the total number of states that can be represented with a given number of bits. With 4 bits, the maximum number of states is 16 as you saw above. The maximum value is one less or:

$$16 - 1 = 15$$

That is 1111 as Table 1 shows. With 8 bits, you can represent numbers up to 255:

$$M = 2^8 - 1 = 256 - 1 = 255$$

Sometimes you would like to know how many bits it will take to represent a specific binary number. You can use the formula given here to do that:

$$B = 3.32 \mathrm{Log}_{10} N$$

You can find the base-ten or common logarithm from a set of log tables or with a scientific calculator.

To see how the formula works, assume we wish to determine how many bits it takes to represent the decimal number 395. All you do is punch in 395 on your scientific calculator and press the LOG key. The result is then multiplied by 3.32:

$$B = 3.32 \mathrm{Log}_{10}(395)$$
$$B = 3.32(2.5966)$$
$$B = 8.62$$

According to the result, it takes 8.62 bits to represent 395. Obviously we can't have fractional parts of a bit, so we simply round off to the next highest integer value. Thus we can represent the number 395 with 9 bits.

TABLE 1—BINARY EQUIVALENTS

Decimal	Binary
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111

Practice Problems.

5. How many states can you represent with 6 bits?

6. What is the maximum value that can be represented with 12 bits?

7. How many bits does it take to represent the number 10,000?

Number Designations. When you are working with more than one type of number, it is necessary to have some means of identifying the base of that number. For example, consider the number 1010. In decimal, of course, it is the value one thousand and ten; in binary, it represents the decimal equivalent of ten. The question is, what value is it? If you happen to be working with all decimal or all binary numbers, then there is no confusion. But if you happen to be working with both, it is necessary to indicate the base of the number to avoid confusion.

That is usually done by adding a small subscript to the number that identifies the base. For example, $1010_2 = 10_{10}$. Also, $1010_{10} = 1111110010_2$. Verify the equivalence for yourself using the conversion procedures described earlier.

Binary-Coded Decimal. Binary-coded decimal (abbreviated BCD) is an attempt to combine the binary and decimal-number systems. The BCD system was developed in an effort to simplify the human/machine interface. Humans are familiar with decimal, but machines work best in binary. By using BCD, the benefits of binary are obtained, but a human can more easily understand the code.

The binary numbers we discussed previously are generally known as pure binary numbers. Each quantity is represented by a single multi-bit number. In BCD, *each* decimal digit is represented by a 4-bit group.

To represent any decimal digit, 0 through 9, a maximum of four bits are needed. Those four-bit codes for the decimal digits are shown in Table 2. The codes in the table are known as BCD codes. Using the procedure described earlier, you can easily convert each 4-bit binary number into its decimal equivalent. Those 4-bit codes are used to represent each digit in a larger decimal number. For example, the decimal number 5029 is represented in BCD as follows:

5	0	2	9
0101	0000	0010	1001

You simply replace each decimal digit with its 4-bit equivalent. Note that you do not run all of the bits together. The result would appear to be a single 16-bit binary number which could be mistaken for a pure binary number whose value is 20521 rather than 5029. Each 4-bit group is separated by a space to distinguish the number from pure binary numbers.

To translate a BCD number into its decimal equivalent, all you do is substitute the decimal digit for each 4-bit code group. The 4-bit codes in Table 2 are easy to remember and should be committed to memory. Here's an example of converting a BCD number into its decimal equivalent:

1000	0100	0111	0001
8	4	7	1

The BCD system is widely used in electronic equipment because it does simplify the man-machine interface. But you should recognize the fact that it is less efficient than the pure binary code. What that means is that it simply takes more bits to represent a given decimal number when you use BCD than if you use a pure binary number.

TABLE 2—BCD NUMBERS

Decimal	BCD
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001

For example, the number 94 in pure binary form is 1011110. As you can see, only 7 bits are required to represent the number in binary form. In BCD, the number 94 is 1001 0100. It takes eight bits to represent the number in BCD form. That inefficiency leads to more hardware and more-complex processing, but sometimes the extra circuitry and cost is offset by the benefit of the ease in translating between binary and decimal.

Almost any piece of electronic equipment that has a decimal display uses BCD's. Digital clocks and watches, and test instruments like digital multimeters and frequency counters are examples. Many special forms of BCD's are also widely used. Perhaps the most common is the ASCII code—a 7-bit code scheme used in computers to represent not only numbers, but also upper and lower case letters, punctuation marks, and other special symbols.

Practice Problems. Test your understanding of BCD with these exercises:
8. Convert 10927 to BCD.
9. Convert 001 10110 0100 0101 1000 to decimal.

Addition of Binary Numbers. Two of the most common operations carried out in computers and other digital equipment is addition and subtraction. Those mathematical calculations show up in many programs and in many microprocessor-controlled devices. Of course, the computer performs those operations on binary numbers. It is helpful for you to understand the process.

The rules for adding binary numbers are similar to those for adding decimal numbers. In fact, the process is made simpler by the fact that only two numbers, 0 and 1, are used in the process. Listed here are the basic rules for binary addition:

$$\begin{array}{r}0\\+0\\\hline 0\end{array}\qquad\begin{array}{r}0\\+1\\\hline 1\end{array}\qquad\begin{array}{r}1\\+0\\\hline 1\end{array}\qquad\begin{array}{r}1\\+1\\\hline 10\end{array}$$

The first three cases are pretty obvious. Zero plus 0 is simply 0, while 0 plus 1 is 1. The fourth case is the most important one to understand. Adding 1 and 1 gives you 0 with a carry of a 1. The way to look at that is that you are adding two numbers, 1 and 1. The 1's also represent decimal 1's. You know adding 1 and 1 will give you 2. If you look at the result in the fourth case above, you will see that 1 and 1 produces a sum of 10, which is the binary representation for the decimal number 2. Just keep in mind that adding 1 and 1 gives you 0 with a carry of 1.

Now using the rules, let's try out the binary addition process on a longer number:

$$\begin{array}{rl}1111 & \leftarrow\text{Carries}\\ 01101 & \\ +10111 & \\ \hline 100100 & \end{array}$$

To check that in decimal form:

$$\begin{array}{r}13\\+23\\\hline 36\end{array}$$

As you can see, the addition process is really very simple. The only tricky part about it is keeping track of the multiple carries when they occur. The most complex situation is when you are adding 1 and 1 but also must add in a carried 1. The way to deal with that is simply to make the additions two at a time, keeping track of the carries to the column to the left.

Adding binary decimals is similar. Before you can add binary numbers, you must first align their binary points. Then add as usual. Any carrying you need to do takes place with no regard paid to the decimal point. So, if the addition just to the right of the binary point generates a 1 that must be carried into the column just to the left of the binary point, then do so ignoring the decimal point. An example will help to illustrate the process:

$$\begin{array}{rl}11111\ 11 & \leftarrow\text{Carries}\\ 1101.101 & \\ +110.011 & \\ \hline 10100.000 & \end{array}$$

Just remember, you can always check your work by converting the binary numbers into their decimal form, then performing the addition and translating the sum back into a binary number. That is an awful lot of work, especially if you have to do a number of such calculations, but it's a good check while you are still learning. Once you are confident with the process, you should be able to add any two binary numbers together and obtain the correct result without error.

Practice Problems. Here are two binary addition problems for you to practice on:
10. 11101011 + 10110010
11. 10001.11 + 1110.01

Adder Circuits. Binary addition is carried out in computer and other digital circuits by a binary-adder circuit. It is nothing more than logic gates that perform the addition process. In fact, a truth table defining the desired operation can be constructed by simply looking at the basic rules for binary addition given earlier. A truth table for those rules is shown in Table 3.

TABLE 3—ADDER-CIRCUIT LOGIC

A	B	Sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

If the two bits to be added are called A and B, you can see that the output sum has the same value the basic rules showed earlier. The carry output is derived from those rules also and is given under the last column. Notice that a carry occurs only when both inputs are binary 1.

By examining the truth table, you'll quickly discover that the sum column is nothing more than the output of an exclusive-OR (XOR) circuit with inputs A and B. The carry column is nothing more than an AND-gate output. As a result, we can construct a simple binary adder as shown in Fig. 1. That is known as a single-bit half-adder circuit. C_O means carry output. Multiple adder circuits are then combined so

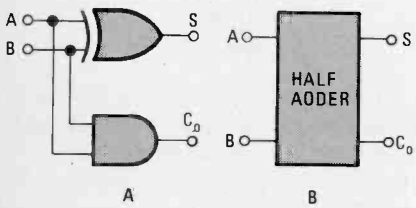


Fig. 1. Two bits can be added together by this simple half-adder circuit.

that all the bits of two binary numbers can be added simultaneously. To do that, we must use a full-adder circuit. The full-adder circuit not only adds each pair of bits, but also adds in any carry from a previous stage. That is done with a full-adder circuit as shown in Fig. 2A.

The two bits to be added, A and B, are summed in XOR1. The sum is then added to any carry input C_i from a previous stage. The final sum, S, is produced by XOR2. Both of the AND gates produce the carries associated with XOR1 and XOR2. Those carries are ORed together in OR1 to produce the carry output, C_O, which will be sent to the next stage. We can represent the entire full-adder circuit with the single block shown in Fig. 2B.

Figure 3 shows a complete 4-bit binary adder made up of full-adder circuits. The bits of the two numbers to be added are A1–A4 and B1–B4. Note that the least-significant bits of the binary

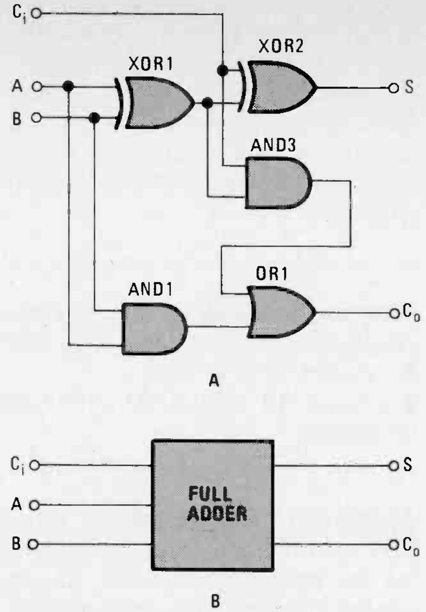


Fig. 2. A full-adder circuit not only supplies a carry bit for the next stage, but it accepts a carry bit from the previous stage as well.

numbers (A1 and B1) are added in a half adder as no carry input is present. The remaining circuits are full adders that accommodate the carry process. Any number of additional full-adder stages can be cascaded to build an adder capable of summing binary numbers of any size.

Subtracting Binary Numbers. The subtraction process is just as easy as addition. It is similar to subtraction with decimal numbers. The basic rules for subtraction are outlined as follows:

$$\begin{array}{r}0\\-0\\\hline 0\end{array}\qquad\begin{array}{r}1\\-0\\\hline 1\end{array}\qquad\begin{array}{r}1\\-1\\\hline 0\end{array}\qquad\begin{array}{r}10\\-1\\\hline 1\end{array}$$

The first three rules are obvious and self-explanatory. It is the fourth rule that bears further discussion. When you attempt to subtract 1 from 0, you must borrow from the next higher position. You cannot subtract 1 from 0. But by borrowing a 1 from the position to the left, you create 10, or the decimal number 2. Now you can subtract 1 from 2 to get 1.

An example will illustrate the use of the rules. Work through the problem below to be sure you understand how it is solved:

$$\begin{array}{r}1010\\-0111\\\hline 0011\end{array}$$

In decimal that's:

$$\begin{array}{r}10\\-7\\\hline 3\end{array}$$

The only tricky part of binary subtraction is keeping track of the borrows. In some numbers, you may have to repeatedly borrow from bit to bit. It is important to keep track of what was borrowed so that the correct answer will result. The process is similar to keeping track of borrows in decimal subtraction.

The same rules for whole numbers also apply to binary fractions. You can subtract one binary fraction from another using the same rules. The example below illustrates the process that must be followed:

$$\begin{array}{r}11010.101\\-1001.010\\\hline 10001.011\end{array}$$

In decimal that would be:

$$\begin{array}{r}26.625\\-9.25\\\hline 17.375\end{array}$$

Practice Problems. Try your hand at these two practice problems.

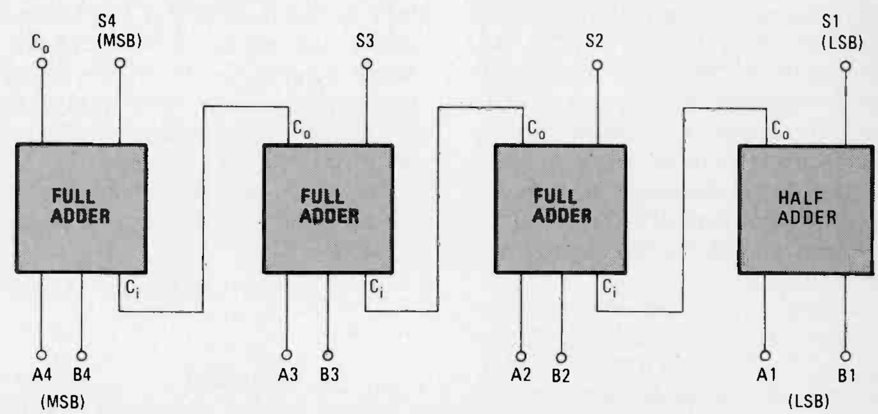


Fig. 3. By cascading adder circuits you may add binary numbers of any size.

$$\begin{array}{r} \textbf{12.}\ 11000101 \\ -1001110 \\ \hline \end{array} \qquad \begin{array}{r} \textbf{13.}\ 101111.100 \\ -10101.001 \\ \hline \end{array}$$

Subtracting By Adding. A binary subtractor circuit may be made out of logic gates just like an adder. In practice, however, you will find that binary subtractor circuits are just not used. Any computer would have to have separate circuits for subtraction and addition. That is not really necessary, as special techniques permit subtraction to be performed with a binary adder. That is done by using number complements. Remember that in binary terminology complement means the opposite. The complement of 0 is 1, and the complement of 1 is 0. You can perform binary subtraction by simply complementing the number to be subtracted, and then adding. You complement the subtrahend (the number being subtracted), add it to the minuend (the number you're subtracting from), and the result is their difference. Remember, the subtrahend is the number you take away from the minuend to get the difference.

There are two types of binary complements, 1's complement and 2's complement. To create the 1's complement of a binary number, you simply change each 1 to a 0 and each 0 to a 1. Note the binary number below and its complement:

11001010 (Number)
00110101 (1's complement)

The 2's complement is simply the 1's complement of a binary number to which 1 has been added. The 2's complement of the binary number is:

$$\begin{array}{rl} 00110101 & \text{(1's complement)} \\ +1 & \text{(add 1)} \\ \hline 00110110 & \text{(2's complement)} \end{array}$$

It is the 2's complement of the subtrahend that is added to the minuend to get the difference. Listed here are the basic rules of subtracting by adding complements:

1. If the subtrahend has fewer bits than the minuend, add leading 0's to the subtrahend so that it has the same number of places as the minuend.
2. Find the 2's complement of the subtrahend.
3. Add the minuend and the 2's complement of the subtrahend.
4. Discard any carry bit out of the most significant bit position.
5. The result is the correct difference expressed in binary form.

An example will illustrate the process. Let's subtract 10110 from 11101011:

$$\begin{array}{r} 11101011 \\ -00010110 \\ \hline \end{array}$$

Note that three lead zero's were added to the subtrahend. Find the 1's complement of the subtrahend:

$$\overline{00010110} = 11101001$$

Adding 1 to get the 2's complement of the subtrahend:

$$\begin{array}{r} 11101001 \\ +1 \\ \hline 11101010 \end{array}$$

Perform the addition:

$$\begin{array}{rl} 11101010 & \text{(Subtractend)} \\ +11101011 & \text{(Minuend)} \\ \hline 111010101 & \end{array}$$

And if we ignore the most significant bit, we get the result 1 1010101, which is correct.

You can always verify the correct result by converting to decimal. In the above example, we subtracted 22 from 235 to get 213.

Subtracting by adding complements greatly simplifies the computer hardware needed for subtraction. Separate subtractor circuits are not required. However, you do have to generate the complement. The complement, of course, can be generated simply by inversion. In some cases, the complement of a binary number may already be available at the output of flip-flops at which the number is stored. Otherwise, the 1's complement can be generated with inverters or by an exclusive-OR circuit as shown in Fig. 4. The circuit will pass a binary number A if

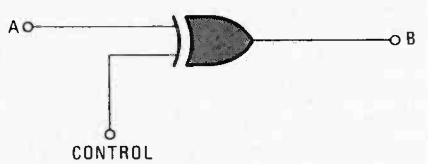


Fig. 4. A control signal determines whether or not this gate inverts the incoming signal or leaves it alone.

the control input is 0. If the control input is 1, the output will be the complement of the input.

Figure 5 shows a 4-bit adder/subtractor circuit that uses the 2's complement method. When the SUB control line is 0, the XOR circuits do not invert the bits B1–B4, so the circuit adds. The sum appears at S1–S4. If SUB is 1, the XOR circuits invert the B1–B4 bits producing the 1's complement that is added to the A1–A4 bits. The carry input to the LSB from SUB, which is 1, is added in to produce the 2's complement. The outputs, D1–D4, are the difference.

Multiplying Binary Numbers. Occasionally you will also need to multiply binary numbers. The rules are the same as those for decimal numbers. They are summarized as follows:

$$\begin{array}{r} 0 \\ \times 0 \\ \hline 0 \end{array} \qquad \begin{array}{r} 1 \\ \times 0 \\ \hline 0 \end{array} \qquad \begin{array}{r} 0 \\ \times 1 \\ \hline 0 \end{array} \qquad \begin{array}{r} 1 \\ \times 1 \\ \hline 1 \end{array}$$

The process of multiplying in binary is exactly the same as that used for decimal numbers. Each multiplication by one of the bits in the multiplier produces a partial product. The partial products are shifted from one another one bit to the left by padding zeroes to the right. As soon as all of the partial products have been written, they are added to produce the final product. This example shows the process:

$$\begin{array}{rl} 10101 & \\ \times 1101 & \\ \hline 10101 & \\ 00000 & \text{(Partial products)} \\ 10101 & \\ 10101 & \\ \hline 100010001 & \text{(Final product)} \end{array}$$

As you can see, when you multiply by 0, the partial product will be a series of 0's. Of course, you can simply omit that partial product as it adds nothing to the final result. Just be sure that if you omit the 0 partial products, that you correctly line up the remaining partial products, otherwise the final product will not be correct.

The multiplication of fractional binary numbers is similar. The multiplication process is the same, and the rules for placing the binary point is similar to the rule for placing the decimal point with decimal fractions. This example shows that:

$$\begin{array}{r} 0.1011 \\ 0.0010 \\ \hline 0000 \\ 1011 \\ 0000 \\ 0000 \\ \hline 0.00010110 \end{array}$$

For the example above, you determine the position of the binary point by

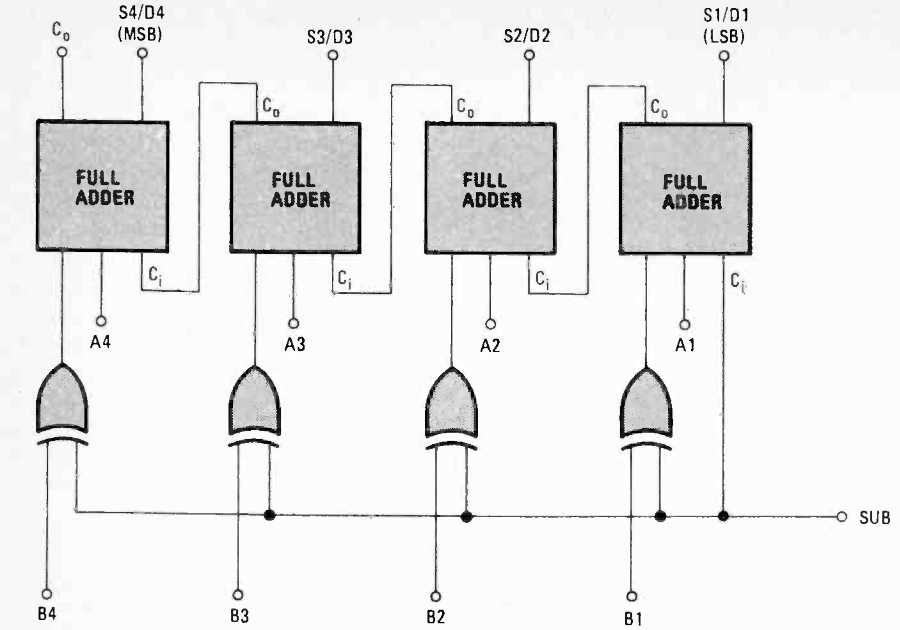


Fig. 5. When the XOR gates receive a 1 signal on the SUB line they take the ones complement of B. A 1 is sent to the first bits "carry" input to turn the 1's compliment into the 2's complement, so B is ready to be subtracted.

adding the number of binary places in the multiplier and the multiplicand. In the example, there are four places to the right of the binary point in both numbers giving a total of eight. You count off that many places from the right of the least significant digit, and that's where the binary point belongs. You can check the result by converting to decimal:

$$0.6375 \times 0.125 = 0.0859375$$

Practice Problems. Here are a couple of binary multiplication problems to test your newly gained knowledge:

14. 1100011 × 10110 = __________

15. 0.101 × 0.01 = __________

Dividing Binary Numbers. It is not too often that you will be called upon to do binary division. As with the other math functions, binary division is similar to decimal division. The process is a little trickier when using 1's and 0's. If you remember the procedure for long division with decimal numbers, you should have no trouble with binary division. Just keep in mind that the process also involves binary multiplication and subtraction along the way.

An example is to divide 45 by 4. Using a calculator or standard decimal long division, we discover that 45 divided by 4 is 11.25. Now let's do it in binary. The entire process is as follows:

```
        1011.01
   100)101101.00
       100
        110
        100
         101
         100
           100
           100
             0
```

First note that the divisor (100) is composed of three bits. You want to attempt to divide it into the first three bits of the dividend, so you are dividing 100 into 101. Of course, 4 (100) will go into 5 (101) one time. Therefore, you record the first bit of the quotient. Next you write the divisor under the first three digits of the dividend and subtract. The result is 1.

Now you bring down the next digit from the dividend producing 11. That is only two bits and the divisor 100 will not go into 11. For that reason you record a 0 in the quotient. Then you bring down the next bit from the dividend, a 0. That creates the number 110. The divisor, 100, will go into 110 one time. Again you must record a 1 in the quotient. Then put the divisor under 110 and subtract as before. The result is 10. You bring down the remaining 1 in the dividend to form 101.

Again the divisor goes into 101. Therefore you can record another 1 in the quotient. Subtracting 100 from 101 produces 1. Then, you bring down a zero from the dividend producing 10. The divisor 100 will not go into it so you record a 0 in the quotient. Bringing down the next 0 produces 100. The divisor goes into it evenly one time, therefore, you add the final 1 to the quotient. The quotient is 1011.01. If you convert that into decimal form, you will find that it is 11.25.

Practice Problem. Even though you won't be doing binary division that much, try your hand at the practice problem below.

16. 100011/101

Octal and Hexadecimal Numbers. One of the main problems in working with binary numbers is that it is so easy to make a mistake. It is easy to miss a bit when copying a number or performing some arithmetic operation. All those 1's and 0's can make you go crazy.

One way to overcome the problem is simply to convert all of the binary numbers into decimal form and perform whatever operations must be done in decimal. Of course, a lot of translating back and forth between binary and decimal will be necessary, but it may make you a little more comfortable and hopefully fewer errors will occur.

A better solution for the problem is simply to use octal and hexadecimal numbers. The octal-number system has a base or radix of 8. That means that eight different symbols are used to represent quantities. The octal-number system uses the digits 0 through 7. Like the binary and the decimal systems, the octal system is a weighted positional system, and all of the rules described earlier apply to octal digits and numbers.

The hexadecimal-number system uses the base 16. Sixteen symbols are used to represent quantities. In hexadecimal, the decimal digits 0 through 9 and the letters A through F are used to represent *hex* values. The hexadecimal system is also a weighted positional system, so all of those previous rules also apply.

However, you should understand that the octal- and hexadecimal-number systems are useful because they are related to the binary-number system. The bases of the octal and hexadecimal systems are powers of 2. Eight is the third power of 2, while 16 is

TABLE 4—OCTAL/BINARY EQUIVALENTS

Octal	Binary
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111

the fourth power of 2. Without going into all of the mathematical mumbo-jumbo, we can easily show how the octal and hex systems are related to binary. Let's start with the octal-number system.

To convert a binary number into its octal equivalent, all you have to do is mark off the binary number in groups of three bits beginning with the binary point on the right. Then, replace each 3-bit binary group with its octal equivalent. The octal numbers and their 3-bit binary equivalents are given in Table 4.

Let's take an example to show the conversion of a binary number into its octal equivalent; To convert 110101010 to octal, all we do is group the bits in threes and substitute:

110	101	010
6	5	2

So in octal that's 652.

Changing a number from octal to binary is just as easy. Simply replace each octal digit with its 3-bit binary equivalent as this example shows:

TABLE 5—HEX/BINARY EQUIVALENTS

Hex	Binary
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
A	1010
B	1011
C	1100
D	1101
E	1110
F	1111

4	0	5
100	000	010

The conversion process between binary and hex numbers is also easy. To convert binary into hex, you separate the bits beginning with the binary point into 4-bit groups. Then you replace each 4-bit group with its hex equivalent. Table 5 shows the binary and hexadecimal equivalents. The numbers 0 through 9 have the same binary equivalents as decimal numbers. The letters A through F have decimal equivalents of 11 through 15.

As an example of how a binary number is converted to hex, let's convert 10001110101 to hex:

0100	0111	0101
4	7	5

Note that a leading zero was added to complete a group of four.

Going the other way, from hexadecimal to binary is just as easy. Take the hex number and replace each of its digits with the 4-bit binary group from the table. For example, let's convert 7A4E to binary:

7	A	4	E
0111	1010	0100	1110

= 111101001001110

Converting to octal or hexadecimal is a very easy process. The result is a much shorter and easier to remember number. Just keep in mind that it is not a decimal number and you certainly cannot use it as such in any kind of calculation. But fewer digits allow you to work with the same information in a slightly easier-to-handle form.

While both octal and hexadecimal numbers are widely used, hex is by far the more popular. That is because most binary word sizes in computers and other digital equipment are some multiple of 4. Typical word sizes are 8, 16, and 32 bits. That makes hexadecimal the predominant method of expressing numbers stored in memory registers.

Whenever an octal or hexadecimal number is used, typically a subscript will be applied to it indicating the correct base. Octal numbers have a subscript of 8, while hexadecimal numbers have a subscript of 16. That prevents confusion if you are dealing with numbers in more than one number system. Sometimes you may see a hex number followed by an H instead of a subscript as shown:

$$5B8_{16} = 5B8H$$

The capital H is often used because the subscript is difficult for most computer printers to produce.

Octal and Hex Arithmetic. Yes, you can perform the basic mathematical operations on octal and hex numbers. Luckily you won't have to do it too often, so I will not show that here.

On the other hand, many programmers and field service technicians often need to perform additions and subtractions on hex numbers in debugging a program or troubleshooting some computer fault. Hex numbers are widely used for both data and addresses in a computer. Many times in calculating a result of an arithmetic operation or determining an address as part of an indexing or relative-addressing scheme, hex addition and subtraction must be done. Of course, you can always convert your hex numbers to binary and perform the addition or subtraction, but that is messy. You are probably thinking that it is also messy to add or subtract hex numbers. You are right. How in the world do you do addition and subtraction with letters of the alphabet? Just don't ask, as I don't plan to explain it here. Instead, I offer you the table shown in Table 6. With that simple table, you can perform one digit additions and subtractions with hex numbers. A couple of examples will illustrate the use of the table.

Let's suppose you want to add the hex digits B and 6. The addend, B, will be found in the vertical left hand column while the augend, 6, will be found in the top horizontal row. Locating B on the vertical axis and 6 on the horizontal axis follow each row and column until they intersect at the correct sum, 11. (Remember, 11 is a hex number.)

To use the table for subtraction, you use the top horizontal row for the subtrahend and you locate the minuend in the same vertical column in which the subtrahend occurs. For example, if you wish to subtract 6 from 9, the minuend is 9 and the subtrahend is 6. Locate the subtrahend, 6, on the top horizontal row. Then locate the minuend, 9, in that same vertical column. Then follow the row in which 9 appears over to the left until you come to the difference column. The difference is, of course, 3. Six minus nine is the same in hexadecimal as it is in decimal.

Take another example just to be sure. Let's subtract E from 1A. Locate E in

(Continued on page 94)

Antique Radio

By Marc Ellis

THE MYSTERY IS SOLVED

Back in the November, 1988 column, I described a mysterious-looking Philco gadget owned by reader Larry Lovell. Larry wanted some information about the device. But beyond observing that it looked like some kind of a wireless remote-control unit, I wasn't able to be of much help. So I appealed to the readers for assistance, and your letters have been coming in a steady stream ever since!

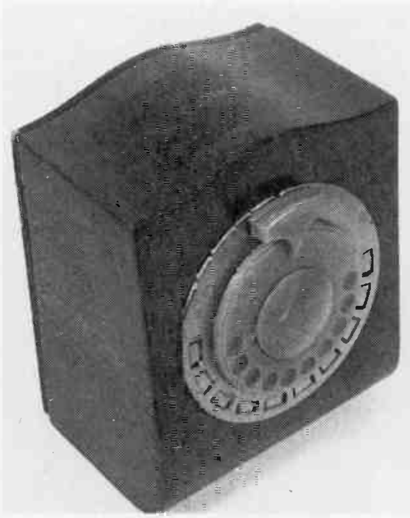
Starting with the bottom line, the little Philco unit really *is* a wireless remote-control unit for a radio receiver. Dubbed the "Mystery Control," the gadget contains a one-tube radio transmitter that sends out pulses from a built-in telephone-style dial. When picked up by a special receiver within the radio, the transmitted pulses control the station-selection and volume of the receiver.

But I don't want to get too far ahead of our story. Thanks to Larry, who graciously loaned me the device for a while so I could take detailed photos; and thanks to the many readers who sent schematics, service notes, and other information, I have enough material to devote this entire column to the Philco Mystery Control.

The story you are about to read was pieced together from all of the material I've received from readers so far. But each individual contribution will be recognized at the end of the article.

System Overview. The Philco Mystery Control system was introduced with two top-of-the-line 1939 sets: Models 39-55 (standard broadcast) and 39-116 (broadcast and shortwave). Those two console sets appear to be very similar in design, except that the "116" included a stage of RF amplification, accompanied by slightly more sophisticated audio circuitry.

Operating on a self-contained battery pack, and with no electrical connection to the radio, the Mystery



The Mystery Control as received from reader Larry Lovell.

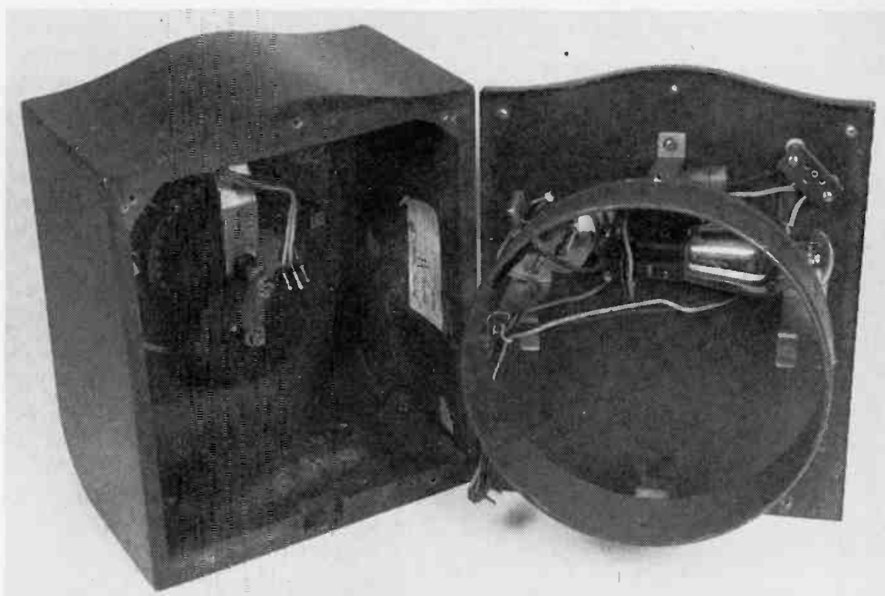
Control generated a pulsed radio signal. Depending on the number of pulses sent (as determined by the telephone-style rotary dial), the control could be used to select any of eight pre-tuned stations in the standard broadcast band.

The Mystery Control could also make volume adjustments and—when a listening session came to an end—shut off the set's power. However, for reasons that will be explained later, the set had to be turned *on* manually.

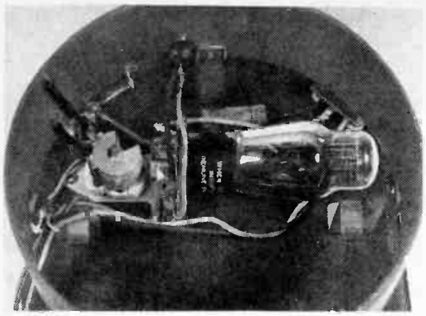
The signals from the Mystery Control unit operated the radio via a special "control amplifier" built into the set. That amplifier received the radio-frequency signal pulses from the control unit and converted them into DC pulses strong enough to operate an on-board stepping relay (similar to the ones used in a pre-electronic dial telephone exchange). That relay, in turn, controlled both an eight-position station-selector switch and a reversible motor that drove the volume control and power switch.

The nominal range of the control system was 25 feet. However, the receiver stage of the control amplifier had a sensitivity control that could be adjusted to shorten the unit's range if electrical interference was causing false triggering. The sensitivity could also be increased if conditions (such as the presence of large metal objects) were attenuating the control signal.

The control unit and control amplifier could be adjusted to work on any frequency between 350 and 400 kHz. In that way, according to the manufacturer, two Mystery Control radios operating in the same home, or apartment building, could be set up on different frequencies. Otherwise, signals from your neighbor's control box might retune your set to *Blondie and Dagwood* while you were trying to listen to the philharmonic.



Opening the cabinet reveals the oscillator circuitry mounted on the rear cover (right). The batteries were housed within the cabinet, below the dial mechanism.



A type-30 tube is mounted within the large oscillator coil. A trimmer capacitor, visible at the left of the tube socket, controls the oscillator frequency.

That last feature strikes me as mostly wishful thinking on the part of the manufacturer. I don't happen to have a price reference for the Mystery Control receivers, but they were top of the line to begin with, and the additional cost of the remote-control circuitry would make purchasing one of those sets quite a large investment indeed. The likelihood of the same family owning a couple of them—or even of two sets being located within 25 feet of each other in the same apartment building—seems very small indeed!

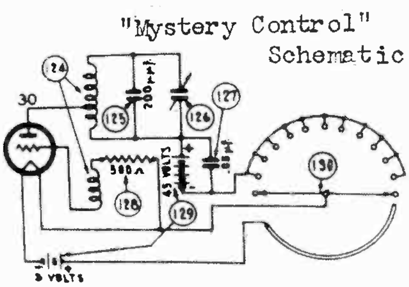
Inside the Box. The Mystery Control is housed in a nicely finished, wooden cabinet bearing the Philco logo. To get inside, one takes out the four wood screws holding the rear cover in place. Removing the cover separates the control box into its two basic sub-assemblies: the telephone dial, which is built into the cabinet, and the RF oscillator (or transmitter), which is mounted on the back cover. The batteries were housed under the dial, with short plug-in cables providing the necessary electrical connections between units.

The operation of the dial is conventional. Rotating the dial plate counter-clockwise winds a spring that returns the plate to the resting position when released. As the plate turns, it drives a gear train that actuates electrical switching and pulsing mechanisms. A small rotating governor regulates the pulse rate at about 12 per second.

The oscillator uses a type-30 tube in a simple tuned-plate, untuned-grid circuit. All of the parts are secured to the back cover, with the tube and associated components mounted within the large coil assembly. The battery pack inside the cabinet provided 45 volts for plate power and 3 volts to light the tube. In a moment, you'll see why it was necessary to feed 3 volts to what was normally a 2-volt filament.

Control-Box Operation. The control box has no on/off switch because power is controlled through the movement of the dial. With the dial in its "resting" position, both batteries are disconnected from the circuit. But as soon as the dial is rotated towards the finger stop, an internal switch closes, completing the circuit from the filament to its battery and lighting the tube. The overvoltage on the filament is necessary so that the tube will heat instantly and be ready for operation as soon as the dial is released.

With the release of the dial, the filament switch remains closed, but an additional "pulsing" switch goes into operation as the dial returns to resting position. That switch alternately completes and breaks the tube's grid-return circuit, turning the oscillator on and off. The number of on/off cycles, or pulses, completed by the switch depends—of course—on how far the dial was rotated counter-clockwise prior to release.



This is the schematic diagram of the Mystery Control as found in Rider Manual Volume 9.

The molded-plastic dial plate has ten finger positions. Rotating the dial by means of the position closest to the finger stop causes two pulses to be generated, the next closest position creates three pulses, and so on to a maximum of eleven pulses.

Once the dial has returned to rest, both switches return to the "open" position, cutting off all power to the circuit. The action is completed so quickly that the tube filament is in no danger of burnout from overvoltage. And, in fact, so little power is used that the manufacturer claimed that the service life of the batteries was essentially the same as its shelf life.

Inside the Radio. The "control amplifier," located inside the radio cabinet, contains two RF tubes (types 78 and 6J7) to receive and amplify the pulsed signal from the control box and an AVC (automatic volume control) tube (type 6ZY5) to detect the signal and smooth out signal-strength variations.

Finally, a *thyratron* rectifier (2A4) converts the relatively weak signal pulses into DC pulses that are strong enough to operate the coil of the stepping relay. No wire antennas are used at the control box or control amplifier; the large coils forming the tuned circuits act as a loop antenna, radiating and receiving enough signal energy to maintain communications.

The operation of the thyratron rectifier tube is analogous to that of the silicon-controlled rectifier in common use today. Think of it as an electronically actuated relay, triggered by a small electric current and capable of switching a much larger one. Thus, the weak pulses impressed on the thyratron grid from the AVC tube make and break the current flowing through the thyratron's plate circuit and the stepping-relay coil.

On the dial, the two finger positions closest to the stop (generating two and three pulses, respectively) control (via the stepping relay) an electric motor coupled to the volume control. Dialing the first position increases volume; dialing the second position reduces it. In both cases, the spring-loaded finger stop must be depressed before the dial is released.

That prevents the final pulse in the series from cutting off, thereby keeping the motor running. When the desired volume level is reached, the listener lets go of the finger stop, the pulse is completed, and the motor stops.

In order to shut off the radio, the listener dials for reduced volume and keeps the finger stop depressed so that the control rotates past the minimum volume setting. That actuates a switch, mounted on the volume control, that cuts off all power to the radio and control amplifier. Since the control amplifier is now unpowered, no further remote control of the radio is possible; power must be turned on manually to begin another listening session.

The remaining eight finger locations on the dial are used to select from eight pre-tuned stations. When any of those locations are dialed, the stepping relay drives a three-pole switch, picking out one of eight positions. One pole of the switch selects the correct

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Circuit Circus

By Charles D. Rakes

FUN AND GAMES!

Who said that life must always be taken seriously? Certainly not I, and to prove that point this month's collection of circuits deals only with fun and games. It's my hope that some of the circuit ideas presented this month might just tickle your funny bone, or at the very least (if you're the serious sort), prove to be valuable in some future project.

Hide and seek, treasure hunt, Easter egg hunts: All of those, and other similar games, can be played with the first three fun circuits. We have replaced the kid, the treasure, and the egg with an electronic IR transmitter that outputs invisible "find me signals" that can only be detected and pinpointed with our special IR "seeker" circuit.

Digital IR Transmitter. The first circuit, the Digital IR Transmitter, is powered from a standard 9-volt, transistor-radio battery. The circuit draws only a few milliamps, and can maintain its output signal for days, or until located and deactivated by a lucky hunter. The circuit sends out an invisible "SOS" signal that can be detected from a distance of over 20 feet.

Figure 1 shows the schematic diagram for the Digital IR Transmitter, which is built around a 4011 CMOS quad 2-input NAND gate and a 2N3904 general-purpose transistor. Together, those semiconductors (along with a few support components) provide sufficient drive for an infrared (IR) light-emitting diode. Gates U1-a and U1-b are configured as a low-frequency oscillator. The output waveform (at pin 11) is non-symmetrical with the positive portion of the signal making up only 20 percent of the time period.

Diode D1 (a 1N914 general-purpose unit) together with C1, R1, and R2 determine the on time for the positive portion of the output waveform. The off, or negative portion of the output waveform, depends mainly on the values of R1 and C1. The operating frequency of that oscillator is about 11 Hz.

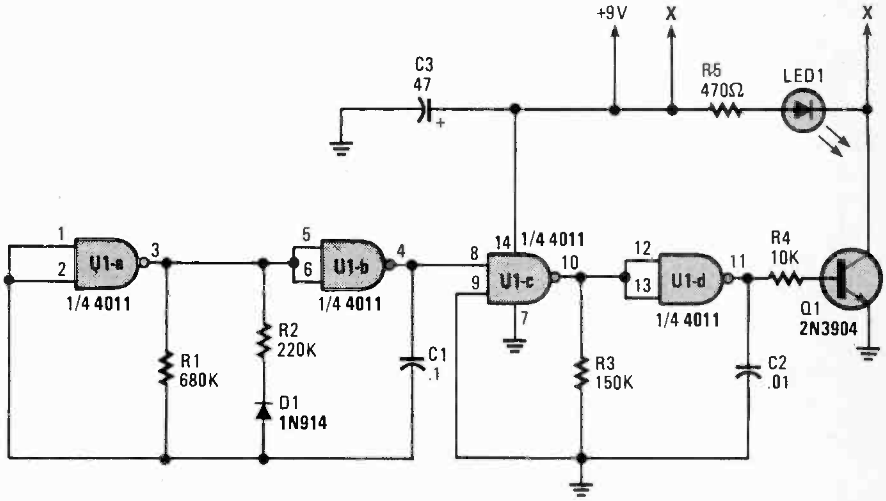


Fig. 1. The Digital IR Transmitter consists of two oscillators (U1-a/U1-b and U1-c/U1-d), with the output of the first oscillator controlling the output of the second. The output of the second oscillator is fed to the base of a general-purpose transistor that, in turn, drives an IR LED.

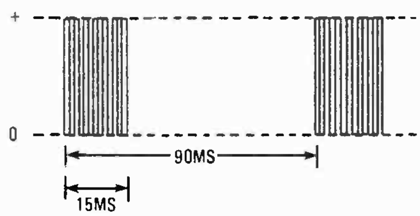


Fig. 2. Here's the output waveform of the second oscillator in the Digital IR Transmitter, which was created by using one oscillator to control another.

There is a second oscillator, consisting of U1-c and U1-d, which outputs an almost symmetrical waveform at a frequency of about 400 Hz. The output of the first oscillator (U1-a/U1-b) is fed to pin 8 of U1-c to key the second oscillator (U1-c/U1-d) on and off at about 11 Hz, with the on time limited to about 20 percent of the time period (about 15 milliseconds).

The output waveform of the second oscillator is shown in Fig. 2. That signal is fed to the base of Q1, which is used to drive an IR diode (LED1) in short bursts. Pulsing LED1 helps to save battery power, and also allows each circuit to be given its own special sound footprint that can be recognized by a sharp hunter.

By changing any of the values of R1, R2, R3, C1, or C2, the sound foot-print can be varied. As the component values are made larger, the oscillator's frequency goes down, and as the values are made smaller, the frequency goes up.

The IR transmitter can be assembled on perfboard, or for a really compact unit, the components can be wired directly to the IC socket. Since the circuit

PARTS LIST FOR THE DIGITAL IR TRANSMITTER

SEMICONDUCTORS

U1—4011 CMOS quad two-input nand gate, integrated circuit
Q1—2N3904 NPN general purpose transistor
D1—1N914 silicon diode
LED1—Infrared light-emitting diode (part of Radio Shack 276-142 emitter/detector pair, or similar)

RESISTORS

(All resistors are ¼-watt, 5% units.)
R1—680,000-ohm
R2—220,000-ohm
R3—150,000-ohm
R4—10,000-ohm
R5—470-ohm

CAPACITORS

C1—0.1-µF, 100-WVDC, ceramic disc
C2—.01-µF, 100-WVDC, ceramic disc
C3—47-µF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

Printed-circuit or perfboard materials, enclosure, IC sockets, 9-volt transistor-radio battery, battery connector, wire, solder, hardware, etc.

is non-critical, just about any construction scheme should suffice. The completed circuit can be housed in a small plastic cabinet with the IR diode mounted facing outward. Or for a really clever arrangement, you might conceal the transmitter circuit in some nondescript item that's found around the house and let its obvious location be its best hiding place.

If a greater range and/or a multi-directional output is desired from the transmitter, additional IR diodes can be added to the circuit. For each added output just duplicate the R5/LED1 portion of the circuit and connect the additional emitter circuit to the points labelled "X" and "Y" in Fig. 1.

To keep the battery and Q1 cool, no more than four IR diodes should be connected to the circuit. But if more outputs are desired, a different driver transistor (Q1) and a larger current-capacity battery should be used.

Simple IR Transmitter. Our next IR transmitter circuit, shown in Fig. 3, is

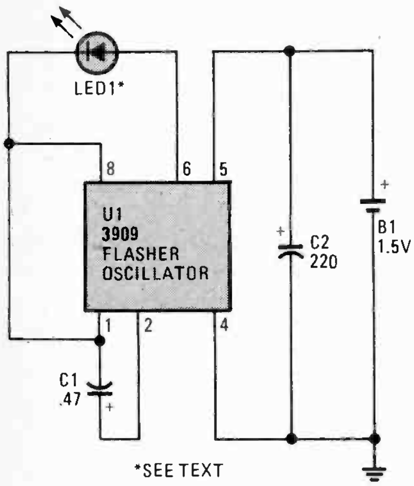


Fig. 3. This IR transmitter is built around a 3909 LED flasher/oscillator—an IC most often used to drive LED's in a variety of light-sequencing circuits.

PARTS LIST FOR THE SIMPLE IR TRANSMITTER

SEMICONDUCTORS

U1—3909N LED flasher/oscillator, integrated circuit
LED1—Infrared light-emitting diode (part of Radio Shack 276-142 emitter/detector pair, or similar)
C1—0.47-µF to 47-µF, 10-WVDC, electrolytic capacitor (see text)
C2—220-µF, 10-WVDC, electrolytic capacitor
B1—1.5-volt Alkaline "C" cell
Printed-circuit or perfboard materials, enclosure, IC sockets, battery, holder, wire, solder, hardware, etc.

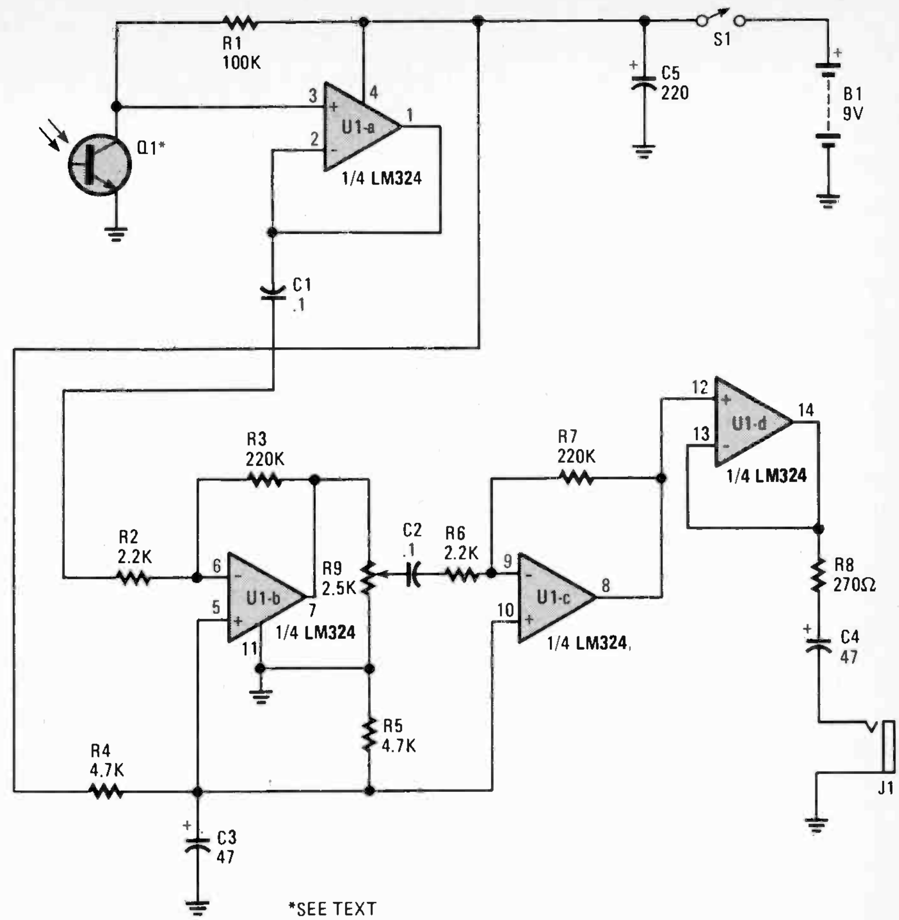


Fig. 4. The IR Interceptor, built around a phototransistor and a quad op-amp, is a key player in the electronic hide-and-seek game.

built around a 3909 LED flasher/oscillator—an IC most often used to drive visible LED's in an array of projects. All that's necessary to turn that simple integrated LED flasher into an IR transmitter is to replace the standard LED with an IR light-emitting diode.

The IR diode's flash rate is determined by the value of C1, a 220-µF capacitor that sets the rate of oscillation at better than 1-Hz per second. Reducing the value of C1 will increase the frequency of the circuit, while larger values will decrease the frequency.

Since the circuit only sends out single, narrow pulses of invisible light, the IR receiver only responds with a click for every output pulse. That, along with the relatively low output power, makes the circuit more difficult to find with its limited pickup range of less than 15 feet.

The few components that comprise the circuit can be wired directly to an IC socket and the single 1.5-volt cell can be permanently connected to the transmitter circuit. There's no need for a switch here because the battery will operate the unit for close to its normal shelf life.

IR Interceptor. The heart of the hide and seek electronic game is the detector. The circuit in Fig. 4—dubbed the IR Interceptor—uses a phototransistor, Q1, to detect IR emissions. The circuit is built around an LM324 quad op-amp that's supported by a handful of passive components. Op-amp U1-a is configured as a voltage-follower circuit, and it is specifically used to match the high output impedance of the phototransistor to the low input impedance of U1-b.

Infrared emissions detected by Q1 are fed through U1-a to U1-b, which amplifies the signal by a factor of 100. The amplified output of U1-b is fed to U1-c through R9, C2, and R6. Potentiometer R9 serves as a volume control. With R9 set to pass the maximum signal, U1-c provides a gain of 100, for a total system gain of 10,000.

The output of U1-c is connected to another voltage follower circuit (U1-d) to better match and drive headphones that can be plugged into J1.

For a slick IR Interceptor, the circuit can be assembled on perfboard and housed in a two- or three-cell flashlight

(Continued on page 94)

Computer Bits

COMPUTER VIDEO FORMATS

By Jeff Holtzman

Last month I promised a discussion of buying a hard disk for your first PC. Unfortunately, my research has taken me a little deeper than I expected; consequently, I have to delay the write-up until next month. So for now, let's talk about video standards.

Video Formats. Video systems for IBM-compatible PC's come in four basic flavors: Hercules, CGA, EGA, and VGA. Hercules provides text and medium-resolution graphics (720 × 348) on monochrome monitors; the others provide text and graphics in varying degrees of resolution on color monitors. In order of increasing resolution: CGA (640 × 200 in 2 colors), EGA (640 × 350 in 16 colors), and VGA (640 × 480 in 16 colors).

In addition, the latest generation of "extended" VGA cards have modes that extend to 600 × 800 and beyond. The extended modes provide the most economical means of doing CAD (computer-aided design) and desktop publishing on a professional basis.

Each video standard requires its own type of monitor. You can buy an acceptable Hercules-compatible monitor for about $100; color monitors start at about $250 and keep on going. However, a $250 color monitor gets you only CGA resolution and, practically speaking, that's so low that it's impossible to do serious work on it.

Moving up, EGA monitors start at about $350, VGA monitors at about $450, and multi-frequency monitors at about $550. (A multi-frequency monitor can display everything from CGA to extended VGA.)

One intriguing option is a monochrome VGA monitor. Models are available from IBM, NEC, Magnavox, and others starting at about $150. Unlike a traditional Hercules-style monitor, which has only three intensities, colors are displayed on a monochrome VGA monitor as sixteen different intensities.

Whichever monitor you choose, you will need a video adapter to drive it. Adapters start at $50 (for Hercules-only models), to $150 for EGA, to $250 and up for VGA and extended VGA models.

Until recently, most video cards interacted with the PC via an 8-bit bus. Recently, however, the market has been flooded with 16-bit video cards that in theory promise twice the performance of 8-bit cards. In reality, they cost about 50% more, and typically provide a speed increase of only about 15% in graphics modes.

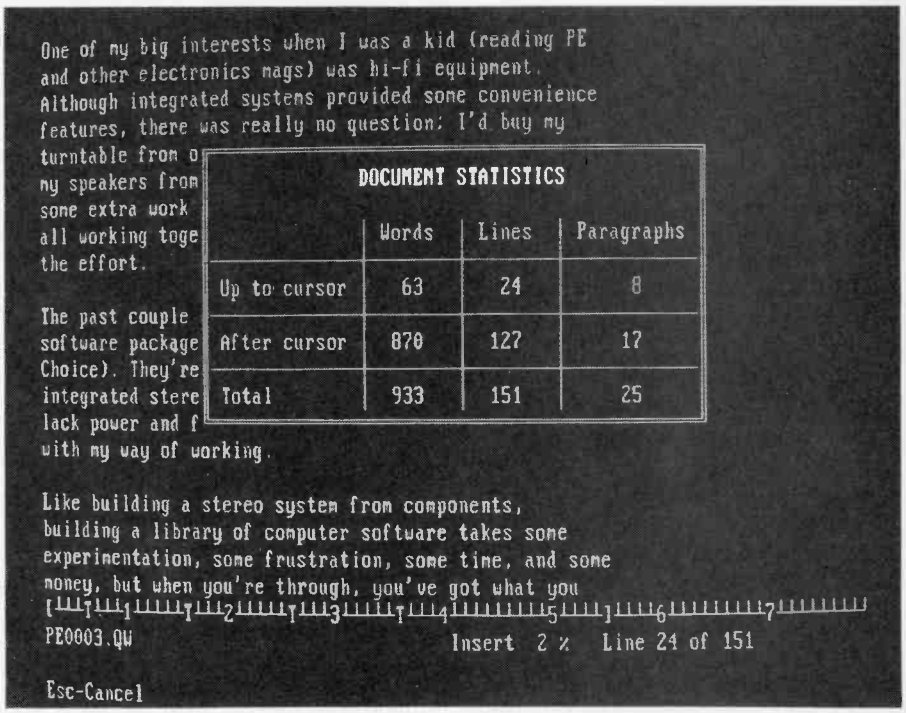
What to Buy? If you're on a tight budget, there's no choice: get a Hercules compatible system. If your budget is more robust, you can choose either a monochrome VGA system or a color EGA system for about $500. I'd go with VGA, because it provides 40% more resolution, and because most VGA cards (except those from IBM and Compaq) can display all standard video modes on a VGA monitor. In addition, if your needs change (and your budget increases), you can upgrade to a color monitor later without wasting your video-card investment.

If you've got money to burn and are serious about graphics, an NEC *MultiSync* monitor and a card with a 600 × 800 mode is the best buy. To go beyond 600 × 800, you've got to spend much more for a monitor. In addition, screen updates beyond 600 × 800 take so long that an adapter with its own on-board processor is required to avoid slowing the system.

Specifically, a good buy is the Paradise *VGA Plus*, which is widely available for about $250. It's an 8-bit card that's compatible with all previous video standards (Hercules, CGA, EGA, VGA) and that also has a 600 × 800 mode that works well on a MultiSync. You'll have to spend about $850 for the NEC/Paradise combination, but your eyes will thank you if you spend much time doing graphics.

I've looked at most of the 16-bit cards on the market, and if you've got your heart set on one, the Paradise *VGA Plus 16* and Video Seven's *FastWrite* are quality boards. Expect to pay about $350 by mail order.

Q&A Write. One of my big interests when I was a kid (reading **Popular**



Q&A Write is an easy-to-use word processor with surprising power and low cost. Among the software's highlights are fast editing, macros, extensive printer support, a spelling checker, and a special line- and box-drawing mode.

Electronics and other electronics magazines) was hi-fi equipment. Although integrated systems provided some convenience features, there was really no question; I'd buy my turntable from one company, my amplifier from another, my speakers from another, and so on. It might take some extra work to figure out what I wanted and get it all working together, but the results would justify the effort.

The past couple of months I've discussed integrated software packages (Microsoft Works and PFS: First Choice). They're better than the poorly designed integrated stereo systems of my youth, but they still lack power and flexibility, and simply don't fit in with my way of working.

Like building a stereo system from components, building a library of computer software takes some experimentation, some frustration, some time, and some money, but when you're through, you've got a system that really fits you.

Choosing a word processor is a good example. Do you go for power? Ease of use? Do you really need all the features that the big (and expensive) packages provide?

Up until recently, my answer to that last question was a resounding yes. At different points in my life, I really did need many of those features. However, when I looked at my present needs, I realized that I no longer needed the features I needed as a student (bibliography, foreign language support), as a writer of technical manuals (table of contents and index generators), etc.

I realized that what I wanted was a fast, clean way of creating and editing files; formatting and document-management features were unimportant because I seldom used the word processor to produce final copy. Other than business letters, most of my copy is either uploaded by modem for typesetting and publication elsewhere, or else it is imported into *PageMaker* for production locally.

I'd gladly give up page preview (a highly touted feature of the latest generation of word processors, page preview shows a graphical image of how each page will appear) for an editor that worked fast and reliably.

I also realized that some chores I was doing manually (typing envelopes and converting files between ASCII and my word processor's own format) were wasting lots of time. In addition, the latest edition of the word processor I was using was full of bugs (some of which I had reported while beta-testing the product!), slow in operation, and poorly supported by the company.

In short, I was ready to trade in my banged up old Cadillac for a sleek new Porsche. In fact, I was literally at the point of writing my own word processor when someone recommended Symantec's *Q&A Write*. It was a case of love at first sight. I glanced at the manual one night after dinner, and ended up reading it cover to cover that same night.

Q&A Write is an upgraded version of the word-processor from another Symantec product, *Q&A*, a database manager that allows you to create databases and reports using English-like phrases rather than arcane programming verbs.

Primarily what I like about Q&A Write is that it's fast and simple. It doesn't have half a dozen menus filed with commands; instead, a single menu provides necessary capabilities: load, save, edit, and print files, set up the editor, and edit a card file (a miniature database).

That's not to say that Q&A Write lacks features; rather, it manages to pack them in without cluttering up the program. Here's a partial list: spelling checker, macros, powerful search and replace, row/column math, word/line/paragraph count, optional thesaurus ($50) and document conversion utilities ($30), ASCII input and output for program editing and modem transfer, and more.

Print features include: mail merge (from the card file or an external ASCII database), multi-column printing, support for about 150 printers (including laser printers), 1-2-3-compatible spreadsheet and graph merging, enhanced text (bold, italic, etc.), automatic envelope printing, and more.

In operation, the program displays your text unjustified, but it does (optionally) show margins, page breaks, and headers and footers. The bottom line of the screen shows the most important function-key options (print, page set-up, etc.); you can also press <F1> to display a screen summarizing the major options. A status line shows the current file name, percentage of memory used, and line and page numbers. Above it is a ruler line that you can edit directly to set tabs (regular and decimal).

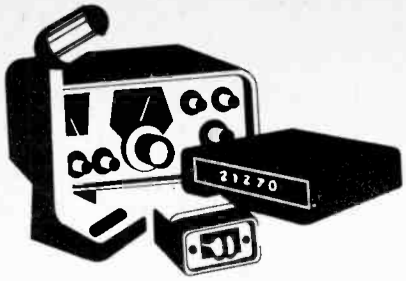
A nice range of cursor-movement functions is provided. The *WordStar* cursor-control diamond provides movement by character, word, and screen; a unique set of commands allow other types of movement. For example, press the <HOME> key once and the cursor moves to the left side of the screen, a second time to the top of the screen, a third time to the top of the page, and a fourth time to the beginning of the file. The <END> key works in the opposite direction. Movement is fast too; you can move from top to bottom and bottom to top of a 70-page document instantly. In addition, you can use any and all cursor-movement keys in block operations: moving, copying, and deleting.

A nice touch is that you can customize the program's main menu so that you can run your own programs and Q&A Write macros from it. A rather neat trick is the program's ability to convert an ASCII file (with a carrage-return/line feed ending every line) to word-processing format (with carrage-return/line feed's present only at paragraph ends). Q&A Write can also export text in either line- or paragraph-delimited ASCII form, and it can read files in WordStar, *PFS*, and several other formats. (Naturally, the extra-cost file-conversion program extends your import/export options.)

Q&A Write's search and replace is quite powerful; in addition to the usual features, you can use it to search for patterns composed of text, numbers, non-text, etc. For example, you could search for social security numbers (123-44-5678), telephone numbers (123-456-7890), etc. However you can't search for (or replace) control characters, which is the program's single major limitation.

The card file allows you to create a database with a maximum size of 1000 records, each of which may contain a maximum of 2000 characters. That's a rather small database, but if you need anything larger, you'd probably want to use the full version of Q&A anyway.

The program lists for $199 and can be had for about $120. It requires 384K and two floppy drives, but 512K and a hard disk are recommended. If you're in the market for a fast, clean editor without a lot of useless bells and whistles, Q&A Write is probably what you're looking for. For more information on Q&A Write, contact Symantec, 10201 Torre Ave., Copertino, CA 95014 (408/253-9600), or circle no. 68 on the Free Information Card. ■



Ham Radio

By Joseph J. Carr, K4IPV

HOW LONG IS A LONG-WIRE?

For many years, the long wire has been a popular form of antenna. It's cheap, easy to build, and—although reports vary—it has the potential to perform well. Properly set up, it has a lot of utility. But what is a "real" long-wire antenna?

In past columns I have used the term to mean an antenna like that shown in Fig. 1, which is popularly called a "long-wire" if it is more than a quarter wavelength (λ/4). I and other authors have used the term "long-wire" to mean such an antenna...but that's not rigorously correct.

A "true" long-wire antenna is one that is many wavelengths long, or to be a little more precise, an antenna that is more than two wavelengths long. While I'll still use the term "long-wire" for both forms of wire antenna, even though proper rigor requires Fig. 1 to be called a "random-length antenna."

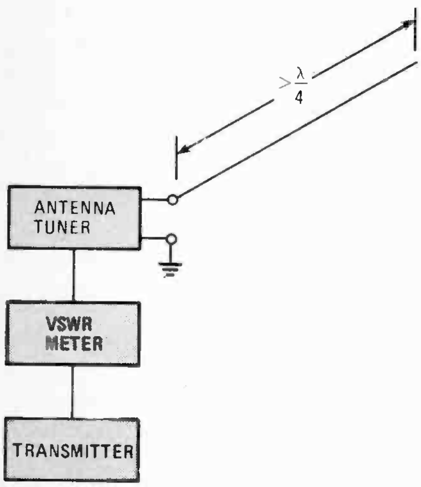


Fig. 1. While the form of antenna illustrated here is popularly called a "long-wire," a more accurate name for it is "random-length antenna."

True to Form. Figure 2 shows the true long-wire antenna. It is a horizontal antenna that, if properly installed, is not simply attached to a convenient support (as is true with the random-length antenna). Rather, the long-wire is installed horizontally like a dipole. The ends are supported (dipole-like) from standard end insulators and rope.

The feedpoint of the long-wire is one end, so we expect to see a voltage anti-node where the feeder is attached. For that reason we do not use coaxial cable, but instead use either parallel transmission line (also sometimes called "open-air" line or some such name) or 450-ohm twin-lead. The transmission line can be excited from any of several types of balanced antenna-tuning units.

Alternatively, a standard antenna-tuning unit designed for coaxial cable can be used if a 4:1 balun transformer is used between the output of the tuner and the input of the feedline.

What does "many wavelengths" mean? That depends upon just what you want the antenna to do. Figure 3 illustrates a fact about long-wire antennas that excites many of its users: it has gain relative to a dipole! Although a two wavelength antenna only has a slight gain over a dipole, the longer the antenna the greater the gain.

In fact, it is possible to obtain gain figures greater than a three-element beam using a long-wire antenna of only nine or ten wavelengths long. What does that mean? One wavelength in feet is $984/f_{MHz}$; so at 10 meters (29 MHz), one wavelength is about 34 feet; at 75-meters (3.8 MHz) one wavelength is 259 feet long.

In order to meet the "two wavelengths" criterion, a 10-meter antenna would need to be only 68 feet long, and a 75-meter antenna would be 518 feet long! For a 10-wavelength antenna, we would need 340 feet for 10 meters; for 75-meters, the antenna is nearly 2,600 feet long. Now you see why the long-wire isn't more popular!

Of course, there are always people like my buddy (now deceased) John Thorne, K4NFU. He lived near Austin, TX on a multi-acre farm that has a 1,400-foot property line along one side. John installed a 1,300-foot long-wire antenna and found it worked exceedingly well. He fed the thing with home-brew, 450-ohm, parallel ("open-air") line and a Matchbox antenna tuner.

John's long-wire antenna had an extremely low angle of radiation, allowing him to regularly work ZL, VK, and other southeast Asia and Pacific-basin DX with only 100 watts of output power from a Kenwood transceiver.

Oddly enough, John also found a little problem with the long-wire antenna that textbooks and articles rarely, if ever, mention: electrostatic fields build up a high-voltage DC charge on long-wire antennas! Thunder storms as much as 20 miles away produce serious levels of electrostatic, and those fields can cause a build-up of electrostatic charge on the antenna conductor.

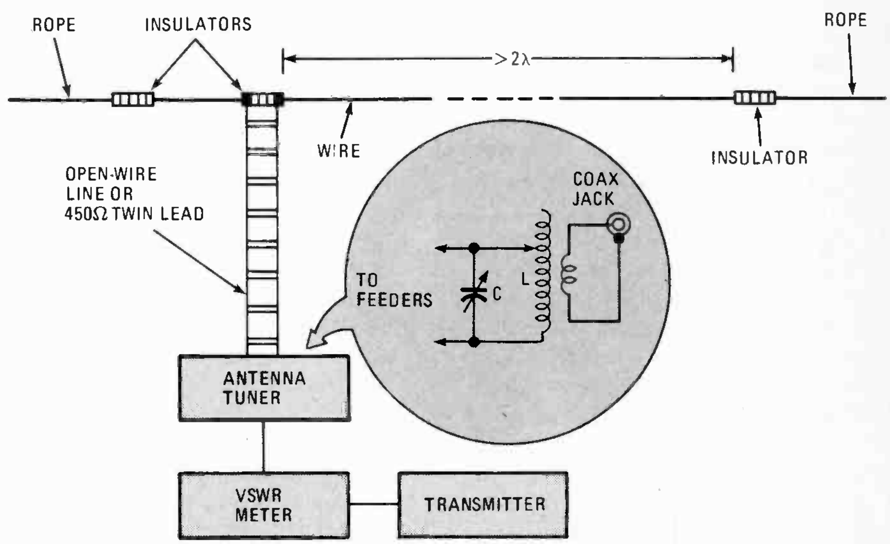


Fig. 2. The true long-wire antenna is installed horizontally like a dipole, with the ends supported (dipole-like) from standard end insulators and rope.

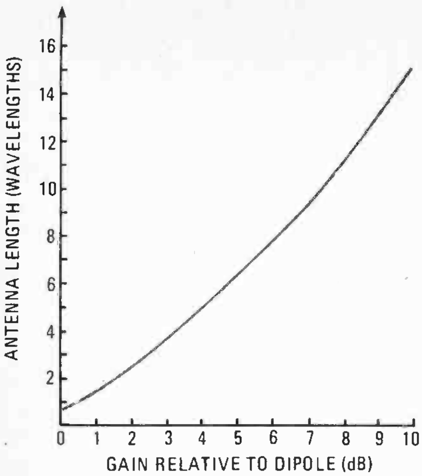


Fig. 3. The long-wire antenna has gain relative to a dipole! Although a two-wavelength long-wire antenna has only a slight gain over a dipole, the longer the antenna the greater the gain.

The electrostatic charge can cause damage to the receiver. John solved the problem by connecting one end of the antenna through a resistor—actually a multi-resistor network—to ground. The resistor network was composed of ten to twenty 10-megohm, 2-watt resistors. That network bled off the charge, thereby preventing damage to the receiver.

There is a common misconception about long-wire antennas that relates to their normal radiation pattern. I have heard amateurs on the air claim that maximum radiation for a long-wire antenna is broadside (*i.e.*, 90-degrees) with respect to the wire run. On other occasions, I've heard it said that the maximum radiation is in-line with the wire run. Neither is correct, although ordinary intuition would seem to indicate one or the other.

Figure 4 shows the approximate radiation pattern of a long-wire antenna when viewed from above. There are four main lobes of radiation from the long-wire (A, B, C, and D). There are also two or more, and in some cases many, minor lobes (E and F) in the antenna pattern. The radiation angle with respect to the wire run (G-H) is a function of the number of wavelengths found along the wire. Also, the number and extent of the minor lobes is also a function of the length of the wire.

Antenna Gain? In this article, other articles, and most textbooks on antennas (including my forthcoming TAB book, *Practical Antenna Handbook*), the term "gain" is used. What does that term mean? Unfortunately, antenna gain is an area where unscrupulous salespeople can distribute a little salt-water taffee! "Gain" and "directivity" with respect to antennas are basically the same thing. The term "gain" must always raise two questions:

1. Gain relative to what?
2. How and where was gain measured?

Gain is always a function of the specific direction of comparison. For example, measuring a low angle of

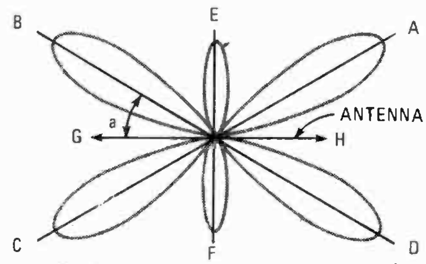


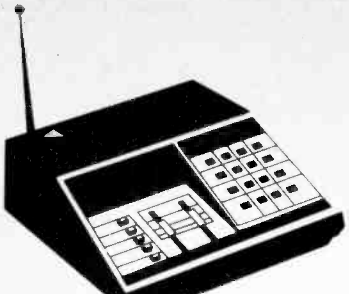
Fig. 4. This is a close approximation of the radiation pattern of a long-wire antenna when viewed from above.

radiation antenna at a high angle would give poor results...and the comparison with the super antenna being touted made invalid. Always compare two antennas at the same angle—both horizontally and vertically. (An antenna radiates in three dimensions, not two, as normally shown in plots like Fig. 4.)

The best gain figure is that above an isotropic radiator. The isotropic radiator is a hypothetical spherical source of radiation. When the spherical wavefront propagates outwards from the center point, it expands to become a giant sphere in space. A spherical surface contains about 41,253 "square degrees." A "gain antenna" does not create new power; it focuses the available power into a limited direction.

If you can calculate the surface area of the wave front from an antenna, then you can calculate the gain in that direction *only*! For example, in *The Amateur Radio Vertical Antenna Handbook*, Capt. Paul Lee, USN, gives an example of a beam antenna that has a beamwidth of 60-degrees horizontal and 30-degrees vertical. That means a wave front of $30 \times 60 = 1800$ degrees. The "gain" is $41{,}253/1{,}800 =$ 22.9 times, or 10 LOG 22.9 = 13.6 dB.

Well that does it for this month. Until next time, if you have any comments and suggestions for this column, write to Ham Radio, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■



Scanner Scene

By Marc Saxon

CONVERTER EXTENDS SCANNER RANGE

A letter from Vincent Venezia of Elverta, CA touches upon several questions that we are regularly asked. Vince says he heard about scanner accessories that act as converters, and can apparently extend a scanner's frequency coverage into regions not previously covered, such as 600 to 420 MHz, 72 to 76 MHz, 806 to 894 MHz, etc.

Yes, they're called converters and several companies produce them. They work just fine and do not require any internal connections to the scanner in order to make them function. Those devices simply plug into the antenna-input connector of the scanner. You then attach your antenna lead-in to the converter instead of directly to the scanner.

A switch on the converter activates the unit, or else returns your scanner to normal operation. When activated, the converter might (for instance) bring in 806 to 894 MHz signals, while your scanner was operating between 424 and 512 MHz.

Vince then poses the question that while some scanners cover virtually all frequencies between 30 and 1200 MHz, others have large gaps in their frequency coverage. For instance, he can't understand why his scanner was designed not to receive between 54 and 108 MHz, or 174 to 380 MHz, as well as several other groups of frequencies.

The majority of scanners are designed to pick up the basic two-way communications bands. Between 54 and 72 MHz, there are TV Channels 2 through 4; from 72 to 76 MHz, there are fixed and aeronautical marker beacons; between 76 and 88 MHz, there are TV Channels 5 and 6; and from 88 to 108 MHz, there is the FM-broadcast band.

Those are just a few examples of the frequency ranges that are omitted from many scanners. They are deleted because most people have little reason to want to pick up such services on a scanner. The only real loss to scanner owners is the exciting military UHF-aeronautical band that goes from 225 to 400 MHz, and the federal-agency band that extends between 406 and 420 MHz.

Only certain scanners include all or some of those bands, which (in my opinion) are worthy of being included in all scanners.

The AR-160 miniature mobile scanner from AOR, Ltd. features frequency-synthesized keyboard control, a fused DC-power cable, telescoping whip antenna, mobile mounting bracket, and an AC-power supply.

Where to Tune? Don Hawkins wants to know something about the General Mobile Radio Service (GMRS) and where to tune it in. That service grew out of what they used to call the Class-A CB service, and is used by business users as well as REACT teams and other emergency groups.

Although the GMRS appears to be in the process of undergoing some changes in the way it is structured on the FCC's books, basically it is a service with repeaters in the 462 MHz band. To check out GMRS activity, monitor between 462.55 and 462.725 MHz. There are eight channels there and you never know what you might find. They're at 25-kHz intervals.

In a postcard from Van Nuys, CA, Marc Barbani inquires about railroad frequencies used by Amtrak in his area. We'd suggest taking a listen on 452.90 MHz for Amtrak's Car Department, and on 161.055 MHz for Amtrak's police activities.

Car Thieves Beware. Bob Becker of Pensacola, FL reports that his state's Department of Motor Vehicles is experimenting with a new stolen-vehicle recovery system that uses radio. Bob saw it demonstrated on TV and now he wonders what frequency that system uses. He called the DMV and got no answers. Either they don't know, or won't tell.

We know, however, and will tell. Park your scanner on 173.075 MHz. If any of those signals are in your general area, you'll probably hear them. On the other hand, we suspect that they'll sound more like coded tones rather than a voice screaming out, "Help! Help! I'm a yellow 300-ZX and someone just ripped me off!"

What is It? Washington, DC reader E.P.J. reports that he has noted a federal-agency frequency referred to as Channel 5 on 173.125 MHz. He says that frequency appears to be active primarily at night and sounds like it's being used for surveillance or undercover operations of some kind by an unidentified agency. They talk of switching to other channels, but he doesn't know what any of the other channels are. In all, E.P. hopes that we can fill in the blanks.

(Continued on page 101)

DX Listening

By Don Jensen

BEING BIG DOESEN'T MAKE IT WELL KNOWN

If Trans World Radio is looking for a symbol that illustrates its broadcasting philosophy, something to replace its present globe and cross logo. It might consider one of those "smiley-face" stickers that youngsters love to paste on their school books.

For the past 35 years, putting on a happy face has been the aim of TWR. As one station staffer puts it, "We allow negativism, but only against sin." That policy has seen TWR—one of the world's major broadcasting operations, but surely not the best known—grow from a single shortwave station in Tangier, Morocco, in 1954, to a worldwide network of international broadcasting.

The man behind TWR is 70-year-old Dr. Paul E. Freed, an evangelist with a Ph.D in mass communications. When the Moroccan government threatened to nationalize his station, Freed, in 1960, moved it from Tangier to Monaco, the small southern European principality better known for roulette than religion.

TWR remains in Monaco today, leasing two tremendously powerful medium-wave outlets from the commercial *Radio Monte Carlo* (RMC). And with its two 100-kilowatt (kW) and single 500-kilowatt shortwave transmitters, it can drop its signal all the way from northern Europe to the far reaches of the Soviet Union.

In 1964, Trans World Radio opened its second station on Bonaire, a boomerang-shaped Dutch island off the northern coast of South America. Freed's network was expanded with other stations in Swaziland in southern Africa and, in more recent years, with outlets on Guam in the Pacific, and on Sri Lanka, the south Asian nation once known as Ceylon. In addition, TWR leases time on a station on Cyprus in the eastern Mediterranean, and in Montevideo, Uruguay.

Trans World Radio's broadcasting budget in 1987 totaled $18 million. Sixty percent of those costs were met by leasing air time to broadcasting evangelists like Billy Graham and organizations such as the Christian Missionary Alliance (CMA).

The rest of the financial support comes in direct contributions to the TWR shortwave network and to the individual missionaries who staff the stations and raise their own personal funding from supporters back home.

It is the Bonaire operation that is best heard by listeners in North America, who can tune to its powerful shortwave signals from their 50- and 250-kilowatt transmitters. A 500-kW, medium-wave, AM station, operating on 800 kHz, covers an area from the southern Amazon jungles to the southeastern U.S., when conditions and levels of interference are right.

Each station has a certain amount of programming leeway, and of course, the languages and schedules vary. The goals, however, remain the same; to spread the Christian Gospel.

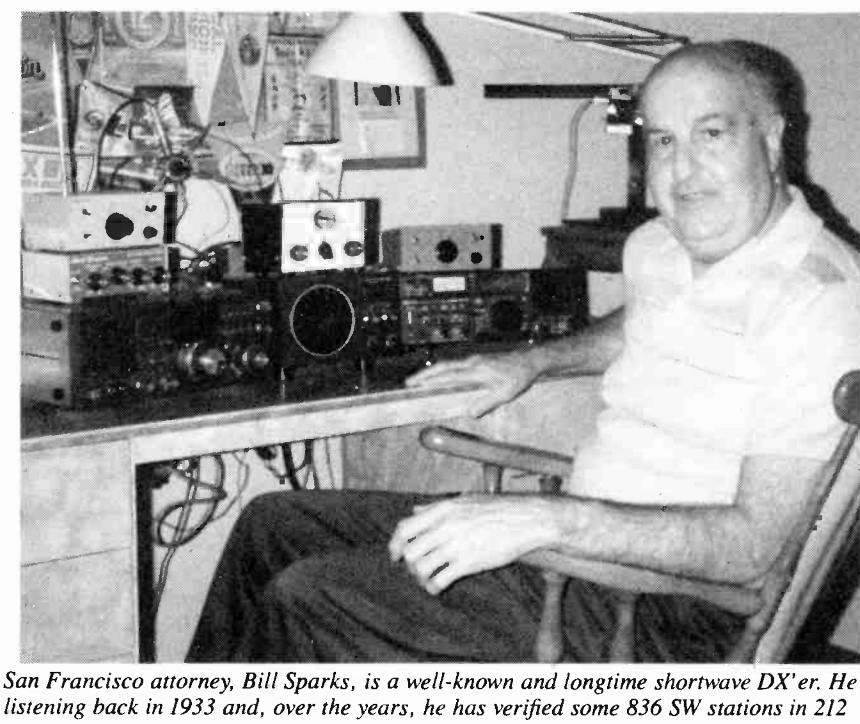
About half of the broadcasting time at the Bonaire TWR station consists of Bible-oriented religious programming. The rest of the schedule focuses on the application of beliefs in daily living, with programs stressing moral principles that are universal, particularly those that emphasize the family structure.

The TWR network broadcasts programs in 80 languages and its stations have a transmission coverage powerful enough to reach 80 percent of the world's population. Interestingly, the multilingual operations mean that with the exception of the Bonaire operation, none of the stations broadcast news.

Jeffrey Towers, a TWR executive at its worldwide headquarters in Chatham, NJ, notes that at a station like the one in Monte Carlo—which airs 36 different languages from Albanian to Ukrainian—translating news into all those tongues is simply too much for its limited staff.

TWR Bonaire, which broadcasts only in Spanish, Portuguese, and English, with some German, does not face that difficulty. Music, the vocal variety anyway, is limited to Christian lyrics, although popular, secular instrumentals are permitted.

Bonaire, with its neighbors Aruba



San Francisco attorney, Bill Sparks, is a well-known and longtime shortwave DX'er. He began listening back in 1933 and, over the years, he has verified some 836 SW stations in 212 countries! His main receiver these days is a modified ICOM R70.

*Credits: Richard D'Angelo, PA; Rowland Archer, NC; John Tuchscherer, WI; Kevin Albertson, WA; Bryan Price, KY; North American SW Association, 45 Wildflower Road, Levittown, PA 19057.

and Curacao, form the A-B-C islands of the Netherlands Antilles. It is a pearl of an island, surrounded by clear waters and coral reefs, with a population of just 10,000. It's a 21-by-7-mile isle where it's always summer, but a bit dull, except for the tourists who come to scuba dive or view the famed flamingo breeding grounds.

Tuning in the shortwave signals from TWR Bonaire is easy for listeners anywhere in the U.S. and Canada. Chuck Roswell, the station's frequency coordinator, offers SWL's some times and frequencies to tune for TWR Bonaire's English programming to North America.

Try 9,535 kHz from 0300 to 0430 UTC (until 0530 UTC Sundays and Mondays) or 2300 until 0030 UTC (until 0130 UTC Sundays and Mondays). Or you can tune 11,815 or 15,345 kHz from 1110 to 1257 UTC and 0710 to 0857 UTC (running Sundays until 1332 and 0932 UTC, respectively).

TWR Bonaire is happy to send QSL-card replies in response to SWL reception reports, provided that they cover a period of at least 15 minutes of listening and indicate in some detail the programming heard and the conditions of reception, Roswell notes. Listeners' letters may be sent to Trans World Radio, Bonaire, Netherlands Antilles.

Feedback. Our first letter this month comes from Alex Wiecek of Mississauga, Ontario, Canada. "In the shortwave spectrum," Alex writes, "I have encountered many interesting transmissions, but the ones I can't understand the purpose of are those *numbers* stations.

For instance, last year I picked up a numbers station on 5,090 kHz at 2300 UTC with a woman reading a series of numbers in English. Now that station is gone, but I have also heard another one on 4,050 kHz at around 0200 UTC. But that one reads numbers in German. And most recently, I received a transmission on 5,815 kHz at 0500 UTC with numbers in Spanish.

"Do you have any idea as to what the purpose of such transmissions are? I have heard that they are intended for espionage agents or smugglers. Is that true?"

Those are questions that have puzzled shortwave listeners for at least 25 years, for that's how long the so-called numbers stations have been around. Little is known for sure, but there is some evidence that numbers

ABBREVIATIONS

AM	amplitude modulation (modulated)
CMA	Christian Missionary Alliance
CST	UTC + 6 hours
DX	long distance (over 1000 miles)
DX'ing	listening to shortwave broadcasts
EST	UTC + 5 hours
kHz	kilohertz (1000 hertz or cycles)
kW	kilowatt (1000 watts)
MST	UTC + 7 hours
MW	Medium wave
PST	UTC + 8 hours
QSL	verification reply from broadcaster
RHC	Radio Havana Cuba
RMC	Radio Monte Carlo
RTVS	Radiodifusion TV Senegal
SRI	Swiss Radio International
SW	Shortwave
TWR	Trans World Radio
US	United States
USSR	Russia (Union of Soviet Socialist Republics)
UTC/GMT	Universal Time Code/ Greenwich Mean Time
VON	Voice of Nicaragua

read at dictation speed were used, at least several decades ago, to communicate coded espionage messages. At least one American convicted of spying for the USSR in the 1960's so testified.

Without any great change in format over the years, they continue today—in an era of more sophisticated equipment and almost instantaneous, difficult-to-monitor "burst" transmissions. Apparently they still have a purpose.

Direction finding and other research indicates that some transmissions have originated in East Germany and Cuba. But many of those numbers transmissions appear to be from U.S. government or military facilities, especially in the Washington, D.C. area and in Florida.

Extensive analysis of the numbers patterns by enthusiastic SWL's has shown that often the same "messages" are repeated again and again over long periods of time. That could suggest that many of them are just dummy transmissions with no communications purposes.

Why? It's a great mystery. Maybe some day we'll find out what they are all about. But I wouldn't count on it!

Down the Dial. What are you hearing? Do you have any questions or comments? This is a two-way street—a forum for the exchange of information

(Continued on page 106)

EZ-MATH

(Continued from page 79)

the top horizontal row of the table and follow it on down until you locate the minuend 1A in the same vertical column. Then follow that row over to the left until you locate the difference in the left-hand column. The result is C.

Practice Problems. Here are a few practice problems to ensure that you understand the use of octal and hexadecimal numbers.

17. Convert 101100011010 to octal and hex.

18. Convert 7053_8 to binary.

19. Convert $2C8D_{16}$ to binary.

Answers to Practice Problems.

1. 1 + 4 + 8 + 32 = 45

2. 2 + 8 + 32 + 64 + 256 + 1024 + 2048 = 3434

3. 0.25 + 0.0625 = 0.3125

4. Starting with the number to convert:

	Remainder
119/2 = 59	1 (LSB)
59/2 = 29	1
29/2 = 14	1
14/2 = 7	0
7/2 = 3	1
3/2 = 1	1
1/2 = 0	1 (MSB)

$119_{10} = 1110111_2$

5. The answer is 64, because $2^6 = 64$

6. The answer is 4095, because $2^{12} - 1 = 4096 - 1 = 4095$

7. 14 bits B = 3.32Log10,000
B = 3.32(4) = 13.28
And the next highest integer is 14.

8. 0001 0000 1001 0010 01kc011

9. 36458

10. 110011101

11. 100000.00

12. 10001111

13. 11010.101

14. 100110110110

15. 0.00101

16. 111

17. 5432_8, B1AH

18. 111000101011

19. 0010110010001101 ■

TABLE 6—HEX ADDITION/SUBTRACTION

0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	10
2	3	4	5	6	7	8	9	A	B	C	D	E	F	10	11
3	4	5	6	7	8	9	A	B	C	D	E	F	10	11	12
4	5	6	7	8	9	A	B	C	D	E	F	10	11	12	13
5	6	7	8	9	A	B	C	D	E	F	10	11	12	13	14
6	7	8	9	A	B	C	D	E	F	10	11	12	13	14	15
7	8	9	A	B	C	D	E	F	10	11	12	13	14	15	16
8	9	A	B	C	D	E	F	10	11	12	13	14	15	16	17
9	A	B	C	D	E	F	10	11	12	13	14	15	16	17	18
A	B	C	D	E	F	10	11	12	13	14	15	16	17	18	19
B	C	D	E	F	10	11	12	13	14	15	16	17	18	19	1A
C	D	E	F	10	11	12	13	14	15	16	17	18	19	1A	1B
D	E	F	10	11	12	13	14	15	16	17	18	19	1A	1B	1C
E	F	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D
F	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E

CIRCUIT CIRCUS

(Continued from page 83)

PARTS LIST FOR THE IR INTERCEPTOR

SEMICONDUCTORS

U1—LM324 quad op-amp, integrated circuit
Q1—Infrared phototransistor (part of Radio Shack 276-142 emitter/detector pair, or similar)

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1—100,000-ohm
R2, R6—2200-ohm
R3, R7—220,000-ohm
R4, R5—4700-ohm
R8—270-ohm
R9—2500-ohm potentiometer

CAPACITORS

C1, C2—0.1-µF, 100-WVDC, ceramic disc
C3, C4—47-µF, 16-WVDC, electrolytic
C5—220-µF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

B1—9-volt transistor-radio battery
J1—Headphone jack
S1—SPST toggle switch
Printed-circuit or perfboard materials, enclosure, IC sockets, battery clips, knob, wire, solder, hardware, etc.

case with the phototransistor (Q1) centered at the focal point of the flashlight's bulb location. No matter what scheme is used in building the circuit, the phototransistor must be shielded from ambient light.

Another way to accomplish that end is to mount the phototransistor in one end of a small opaque tube with the cell facing outward—giving Q1 a tunnel-vision view of the outside world. That arrangement works somewhat like a rifle scope in aiming at and selecting the incoming light that's directly in front of the tube.

To play electronic hide-and-seek, conceal the IR transmitter so that IR radiation is unrestricted in a direction that can be seen with the hunter's Interceptor. Keep the location of the IR transmitter away from brightly lit areas. If possible, place it in a dark or shadowy area. Not only will the location be oblivious to the hunter, its operating range will be at its greatest due to the differential in IR and the ambient-light levels.

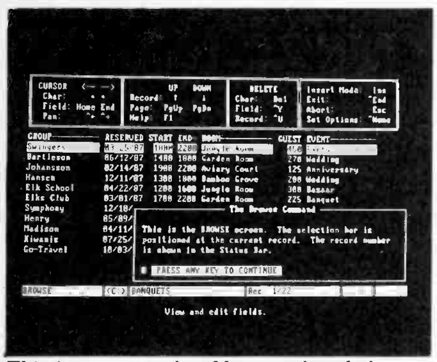
Alas, we've filled our perfboard for this month, but be sure to tune in next month when we'll have another batch of fun and educational circuits for you to examine. Until then have fun. ■

TRAINING AIDS

(Continued from page 46)

III achieve improved performance. A large selection is offered by ISI in their *101 Utilities for dBase III Plus.* Those programs will save keystrokes, time, and menu steps; and eliminate repetitive operations by automating frequently used dBase III Plus commands. Those routines have a variety of uses. They can save the user the trouble of remembering the syntax of dBase commands, add math functions to dBase, provide a menu-driven approach to manipulating database files, add useful utilities to deal with text files, and offer additional facilities not thought to be available from dBase III Plus.

The 101 utilities are provided on two non-copy-protected floppy disks, which should be copied onto back-up floppy disks, and installed on a hard-



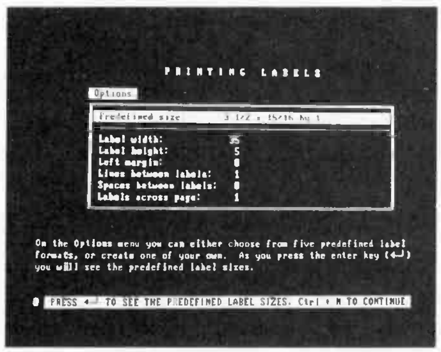
This is an example of how on-line help screens pop up to provide information on any screen (the Browse Screen).

disk drive should you have one in your computer.

The concise, compact manual is invaluable. It introduces the newcomer to database program work. In it, a simple program is illustrated that places a small, double-rule box on the screen with the time indicated. The manual instructs the user in a step-by-step fashion as he writes the program in a dBase edit mode—it's a real confidence builder.

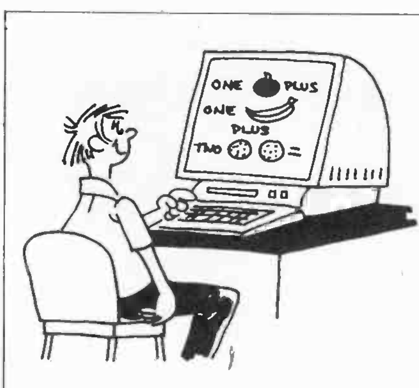
The utilities are broken down into seven categorical groups and a miscellaneous group of 34 utilities. No one user can fully expect to make full use of all 101 utilities, but a good number will find practical application. This reviewer used the RATING.PRG program (in dBase the .PRG extension indicates dBase programs) to rate his computer. (Interesting; he needs a new motherboard, but he knew that anyway.)

Other interesting programs that got used almost immediately upon review were: ROLDXPRN.PRG which prints Rolodex cards, LOAN.PRG an internal selectable options lets you compare two loans or analyze a loan, N!.PRG to compute factorals up to N = 34, ROOT.PRG which calculates the Nth root of a number, and ALARM.PRG an all-purpose reminder capable of working with dates and memos. You can triple the power of dBase by letting it draw bar and X vs. Y graphs, adding math functions such as sine, cosine, and tangent, and adding utilities to manipulate text files. Considering that there are 101 programs, this paragraph best end here.



Here's one of the help screens. You request them from one of the submenus.

Where They're At! *Individual Training for dBase III Plus* and *101 Utilities for dBase III Plus* are both available from Individual Software, Inc., 125 Shoreway Drive, Suite 100, San Carlos, CA 94070-2704 for $69.95 each. Telephone orders can be placed by calling 800/331-3313; in California call 415/598-8855. For more information on the packages, contact the company directly, or circle 69 on the Free Information Card. By the time this article is in print the training course for dBase IV will be available. The training course for dBase III Plus and the 101 utilities are compatible with the advanced form of dBase. ■



"Fruit Salad"

RADIO COLLECTIBLES

(Continued from page 67)

Though they all worked the same way, the physical appearances of horns varied quite a bit. Some were made of wood; some of metal; some of what appears to be a paper-based composition material. The neck of the horn might be straight, curved, or of the familiar goose-neck shape that has become the *cliche* of what an antique radio horn should look like.

By the mid 1920's, a more sophisticated form of radio speaker had begun to appear. In that type, the electromagnets acted not on a diaphragm, but on a rod-like metal armature. The rod was attached to the apex of a paper cone, much like that of the cone speakers with which we are familiar today. Because of the direct transfer of sound vibrations to the cone, the new speakers had improved fidelity and power.

With some speakers of that type, such as the Crosley *Musicone*, the paper cone (mounted within a protective frame) was exposed, decorated, and intended to be looked at. With others (the RCA Models 100 and 103 are good examples), the cone was concealed within a decorative enclosure.

I also once owned a 1920's-era speaker (made by Sonora) mounted within a box containing a wooden horn-like structure. Unfortunately, though, I never looked inside—so I can't make a definite statement about what the sound-producing unit was like. But I strongly suspect that it was "earphone style."

You're obviously going to need a few of those speakers if you intend to play the larger battery sets in your collection. But you'll also find that a display featuring horn and cone speakers will be a sure-fire attention-getter. The different sizes, shapes and styles lend themselves to interesting and attractive groupings.

No discussion of early reproducing equipment would be complete without touching on the subject of headsets (otherwise known as earphones). The collector who gets involved with the said items can certainly have lot of fun acquiring examples produced by famous manufacturers such as Baldwin, Brandes, Murdock, Western Electric, and Dictaphone. Headsets are still fairly easy to find at radio swap meets and, as antique equipment goes, tend to be reasonably priced.

I've found that headsets without a head inside are really difficult to display (my best success so far has been to suspend them by cup hooks from the bottoms of shelves). And, since the differences from model to model are fairly subtle to the non initiated, collections of those units almost always seem to have a "ho-hum" appearance. If you like headsets, though, don't let me discourage you!

Though they don't turn up very often, phonograph-conversion units should also be mentioned. Those devices are similar to the earphone-type devices that drive horn speakers. However, they're made to fit on the arm of an acoustical phonograph in place of the normal needle unit, making it possible to use the "acoustical labyrinth" within the phonograph cabinet as a kind of a radio horn gone to heaven.

Horn-type speakers of the 1920's took many shapes and forms; two typical horn speakers are the ones made by Music Master (left) and Dictagraph (center). Cone-type speakers, like the Crosley unit (right), began to appear by the middle 1920's.

Vintage Test Equipment. As you've seen, many of the pieces we've discussed so far have an obvious dual purpose. They're useful for repairing and operating vintage radios, and they're also valuable collectibles in themselves. But, odd as it may seem, I don't consider most antique test equipment to be in that category.

Such apparatus can really be wonderful to look at with its Bakelite panels, hardwood cases, engraved dials, and quaint meter styles. However, by today's standards, much of it isn't worth a darn as test equipment. First of all, design concepts have improved by quantum leaps since the vintage equipment was made. Secondly, test equipment that has been used and stored (under unknown conditions) for over half a century isn't exactly equipment you'd want to rely on. Component values may well have changed and user abuse taken its toll.

Diehard radio buffs who feel that old radios should be fixed with old equipment have a legitimate position, and I can see how they might derive quite a bit of enjoyment from the practice. In fact, I can think of a couple of situations (to be discussed) where the old equipment might be quite valuable. But I'd strongly suggest checking calibration and accuracy against reliable modern equipment (borrowing it, if necessary) before relying on the relic instruments.

Most types of antique test equipment that you're apt to find have counterparts familiar to any electronic experimenter of today. Electronic technicians of the 1920's, 1930's, and 1940's used multimeters, tube testers, and RF and audio oscillators similar in function, if not in design, to the ones used now. You'll even come across vintage oscilloscopes, although the units will not generally predate the late 1930's.

One type of commonly seen vintage test equipment, the set tester, really has no modern equivalent. It was used to expedite the diagnostic process back in the days when radio chassis could be large and heavy monsters indeed. The set tester made it possible to measure voltages and currents at the tube socket connections—while the set was running and without removing it from the cabinet.

To use the tester, the tube in question

Early multimeters are visually interesting, and also useful when checking set voltages against manufacturers original specs (see text).

was removed from the set, a special adapter (having a cable running to the tester) was plugged into the tube socket, and the tube was plugged into a socket on the adapter. Now, at the touch of a lever or button, measurements could be made on any desired tube pin using the meters built into the tester.

Most such testers were also set up to be used as normal multimeters, receiving input from standard test probes instead of the special adapters. The set tester often made it possible for a serviceman to arrive at an accurate diagnosis, and sometimes even effect a repair, without removing the radio from the customer's home.

Equipment You Can Use. Which kinds of early test equipment do I feel could be useful for repairing antique radios today? I'd recommend a late 1930's or early 1940's multimeter having 1000-ohm-per-volt sensitivity for DC measurements and an RF oscillator that will hit frequencies as low as 100 kHz or so.

The multimeter will hardly take the place of your modern one, but it will come in handy when you're checking voltage readings in a set against values published in a manufacturer's chart. The reason: all voltmeters load down the circuits they are measuring, making the measured voltage lower than the voltage present without the tester in the circuit. Less sensitive meters (having a lower ohms-per-volt figure) load down the circuit more, and reduce the voltage more than do meters of greater sensitivity.

That's why the ohms-per-volt rating of the meter used to do the original testing is generally specified on the "normal" voltage charts. Use a meter of the same sensitivity specified by the manufacturer and you'll have a better chance of matching his readings. Since many of the early charts specified a 1000 ohms-per-volt meter, it's a nice idea to have one on hand.

The least expensive pocket multimeter in the Radio Shack catalogue today has a 2000 ohms-per-volt rating, and more serious multimeters of even average quality are rated at least 20,000 ohms-per volt. So the best way to get a 1000 ohms-per-volt unit would be to look for a vintage model.

The RF oscillator with the low-frequency range will be helpful in aligning IF transformers of early superheterodyne receivers. They were often tuned to much lower frequencies than the modern "standard" of 455 kHz. That's why modern units often don't go low enough!

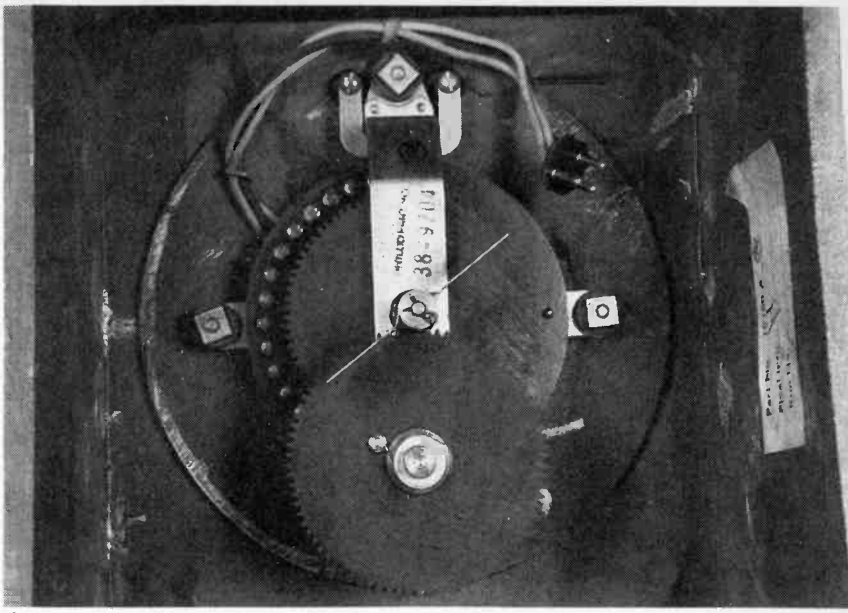
In Conclusion. I'd like to stress one more time that a relatively short article such as this one can't even begin to cover all possible radio-related collectibles. What I've tried to do is orient those who might be new to the field by touching most of the important bases. To find out more, my advice is get involved and start collecting! ■

ANTIQUE RADIO

(Continued from page 81)

oscillator coil; another selects the matching antenna-padding capacitor; and the third lights an indicator lamp on the front panel corresponding to the selected station.

And that about sums up what I've been able to learn about Larry Lovell's "Mystery Control." At some future time, maybe I'll have an opportunity to discuss the associated radios, but now I'd like to recognize the many readers who contributed information to this column!



This rear view of the dial assembly shows the gear train, governor, and some of the pulsing contacts.

Our Contributors. W.J. Brown (Thomaston, ME) sent schematic diagrams and offered some personal memories of a "Mystery Control" radio that his family purchased in 1939. He kept the set going until about five years ago, when a tragedy occurred: the chassis was accidentally dropped while the electrolytic capacitors and dial cord were being replaced.

Robert E. Chapman (Ventura, CA), who was an active service technician (Minneapolis-St. Paul area) in the late 1930's, worked on several of those radios. He considered the design of the Philco set to be very advanced for its time, and contributed several interesting technical details to the story you've just read.

Frank Krantz, who retired after 54 years as a radio repairman, now repairs old sets as a hobby. After identifying the control unit for us, he included some interesting information on Philco model and part numbers. For one thing, Frank confirmed an earlier remark of mine about the model numbers. He agrees that prefixes were used to indicate year of manufacture (for example, a model 37-620 was made in 1937), but says that the system was only used from 1937-1942.

Warren Baker (Albany, NY) tells us that the telephone-type dial on the control unit may have evolved from a similar station-selector dial on an earlier model. The earlier dial was mounted directly on the cabinet, and was *not* part of a remote-control system.

Ray Shetrone (Fort Myers, FL) also remembers the control unit well. His interest in radio dates from the early 1930's, when his dad was operating a radio and appliance repair shop in Baltimore, Ohio (the shop is still operating today under the family name). Ray speaks ruefully of the many "golden oldies" he and his dad dismantled for parts over 50 years ago!

J. Beck (Zion, IL) sent along an informative article on the Mystery Control system (from a 1939 *Lincoln Engineering School* publication). He also identified some of the Philco radio models that used that control unit and says that he picked up one of them (a Model 39-55) at a flea market, intending to strip it for parts. When he realized what he had, however, he canceled the tear-down and located a control unit for the radio. Restoration is now proceeding.

I'm also indebted to the following people for technical literature on the Philco Mystery Control system: Alfonso E. Patron sent Philco service notes covering the Models 39-55 and 39-116 all the way from Mazatlan, Mexico.

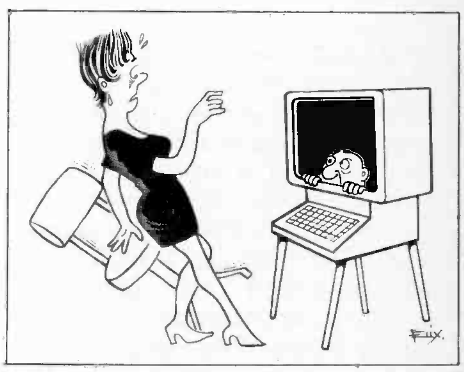
Larry Kenan (Westlake Village, CA) contributed a very informative article he wrote in 1984 for *Radio News*, the journal of the Arizona Antique Radio Club. Larry credits Rider *Perpetual Troubleshooter's Manual* Volume 9 (Philco Models 39-55 and 39-116) for much of his information.

And Scott Holderman (Sherman Oaks, CA) sent along a write up on the Mystery Control taken from a special supplement to Rider Volume 9.

Finally, I'd like to credit the unsung heros of this article: the people who wrote Larry Lovell directly with information about the mystery control. Larry mentioned that he had received letters from several retired radio servicemen, and other antique-radio enthusiasts. Just as I sat down to write this, I realized that I should have contacted him to get their names. But my deadline looms and I have to get the column in the mail. Many thanks, guys, and sorry, but you'll have to be anonymous for now!

Good-bye until next month, when we'll open more mail and discuss, among other things, the many reader answers to my other Philco mystery (the highly chromed device, resembling a miniature speaker, shown in the December 1988 column). And be sure to keep your comments and questions coming. As you can see, the input I get from readers is a real enhancement to this column.

Almost everything I receive is eventually credited, or discussed, in print. Regrettably, however, it's almost impossible for me to respond to letters personally. Time just doesn't permit it! Send your letters to *Antique Radio*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■



TEST EQUIPMENT ON THE CHEAP

(Continued from page 43)

matically speaking, capacitors in series combine similar to resistors in parallel, so when the capacitance meter is connected across the hot leads of two sections it effectively sees a total capacitance of:

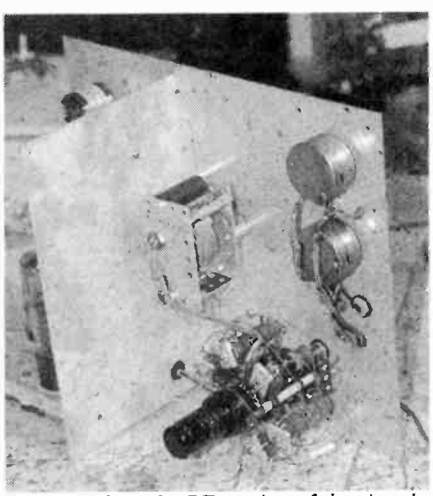
$$C_{total} = C1C2/(C1 + C2)$$

or, since one section was known to be 8 μF:

$$C_{total} = (8)C_X/(8 + C_X)$$

The reading was 6.8 μF for C_{total}, so when the equation was solved for C_X, it showed that the unknown section was 47 μF.

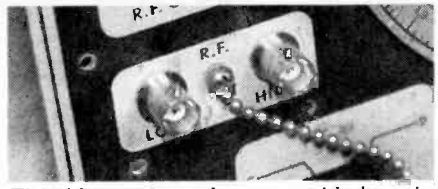
By circuit tracing, I found that the two 8-μF sections were connected to the high-voltage DC power-supply circuit (Fig. 2), while the 47-μF section was connected across the 0- to 50-volt DC AGC BIAS output terminals. Obviously, then the two 8-μF sections were high-voltage capacitors, and the 47-μF section was a low-voltage unit (the WVDC would be less than 50 volts).



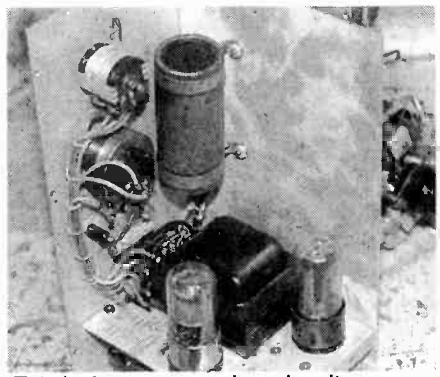
Here we show the RF section of the signal generator. Visible are the main selector switch, oscillator tube, tuning capacitor, and the RF-output section with the shield removed. The tuning inductors, trimmer capacitors, and the 6SJ7 oscillator tube are mounted directly to the switch assembly.

Finding the maximum ratings of a 5Y3 rectifier tube from an old tube manual, I figured 450-WVDC would be a safe voltage rating for the high-voltage sections. I could've also checked the back of old *Radio Amateur's Handbook* volumes for such information.

Multi-section capacitors are relatively easy to obtain, but I used tubular capacitors to replace the big filter capacitor instead. Those capacitors are of modern design, and so are very small. They fit nicely into the power-supply circuitry beneath the chassis. Selected were two 16-μF/450-WVDC units (you can always use more capacitance in power supply filters), and a single 50-μF/160-WVDC unit.



The old connectors that came with the unit are not very popular any more, so they were replaced with BNC connectors.



This is the power supply and audio section of the E-200-C, including the 6C5 tube. Note the large multi-section electrolytic capacitor used as a ripple filter in the high-voltage power supply.

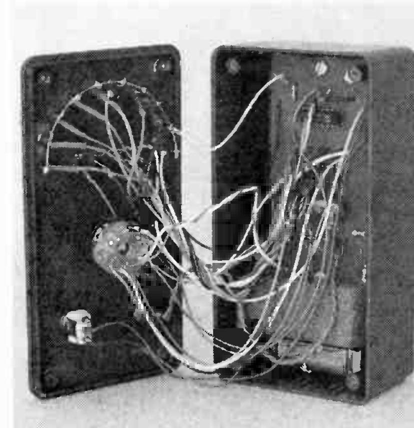
If the rectifier tube (in my case a 5Y3) is bad, then either replace it, or use a pair of silicon-rectifier diodes connected as shown in Fig. 3. Some mail order suppliers offer solid-state replacements for rectifiers such as 5Y3, 5U4, and 5R4. Those replacements are either a circuit like the one in Fig. 3, or a variant in which each rectifier diode is shunted with a 470k-ohm, half-watt resistor and a 0.001-μF/1000-WVDC ceramic-disc capacitor.

Finally, the RF OUTPUT connectors needed replacements. Not because they were bad, but rather because they were an older type that is not extensively used any more. I replaced the two AUDIO MICROPHONE connectors used for RF output on the E-200-C with a pair of BNC chassis-mounted connectors. The type of BNC connectors that use a single-point mounting thread, rather than four small screws, fit directly into the holes vacated by the former connectors.

Obtaining test equipment is easy and cheap if you buy used units. And refurbishing the equipment is not all that difficult in most cases. ■

LOTTO SELECTOR

(Continued from page 31)

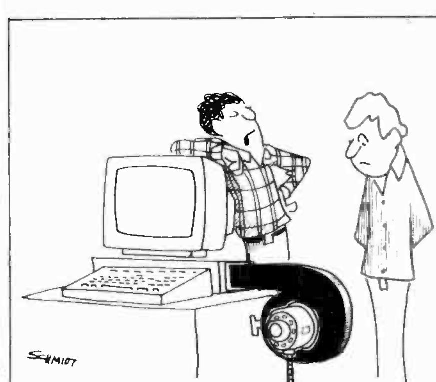


Here's an inside view of the Lucky Lotto Selector. The cathodes of the LED's were connected to a bus that's connected, in turn, to the circuit board.

that the number indicated by this display scheme relies heavily on the values indicated on the front panel and how they are interpreted by the user.

Note that the front-panel of the author's prototype is set up so that the LED's representing "one's" are arced around the upper portion of the display section. The LED's representing "ten's" are lined up at the base of the display section.

Checking It Out. With battery in place, set S3 to the desired number range and press S2. When S2 is released, the LED's that remain on will indicate the electronically selected number. Just repeat the procedure as many times as is needed for the lottery system to complete the series of numbers. To keep the circuit flexible and less complicated, the digit "0" is not suppressed, so if it appears alone just press S2 again and go on selecting numbers until the selection is completed. ■



"It was overheating."

SCANNER SCENE

(Continued from page 88)

We don't have any definite information, but the *Registry of U.S. Government Radio Frequencies* does show that the U.S. Treasury Department is a user of that particular frequency at its training center in Georgia. They may well be using it elsewhere, too. Monitors in various areas might wish to check it out to see what it might have to offer. Let us know what you find and we'll pass the information along.

Several issues ago we mentioned that several programmable VHF-FM marine transceivers could be set up to operate on many frequencies unauthorized for maritime purposes. We also noted that sometimes doing so caused interference to stations in other radio services who happened to be licensed to operate on those frequencies. Well, it looks as though the FCC has decided to prohibit the manufacture, sale, and use of VHF-FM marine transceivers that are capable of being programmed outside of the authorized band.

We are always looking to hear from our readers with questions, loggings, news clippings, and other scanner-related material that might be of interest. Write to *Scanner Scene*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735.

Scanner Report. AOR, Ltd. has come up with yet another of their interesting and unusual scanners. This time, it's a miniature mobile unit—the *AR-160*—that features frequency-synthesized keyboard control.

This is a case where the word "miniature" really applies. The AR-160 is *very* small; an inch and a half high, less than five inches wide, just over six inches deep. Weighing in at just over 26 ounces, the unit can be mounted in almost any vehicle, even those with the smallest available area to devote to scanner placement.

Yet, thanks to the latest in electronic hybridization and integration techniques, AOR has fit lots of good things inside—such as frequency coverage of 29 to 52 MHz, 136 to 174 MHz, and 436 to 512 MHz.

The most often used operating controls are on the front panel of the AR-160, but space is saved by placing the twenty programming keys that access the on-board microcomputer on top of the case. A row of sixteen LED's provide a bright notification of which channel the unit is monitoring. And a battery retains memory so the AR-160 doesn't develop instant programming "amnesia" in the event of a momentary power loss.

The AR-160, despite its tiny size, offers specs that match or clobber those of other mobile scanners of larger girth and carrying a heftier price tag. For $189 (suggested retail price), you get the scanner, a fused DC-power cable, telescoping whip antenna, mobile mounting bracket, and an AC-power supply.

For more information on the AOR Model AR-160, write to Ace Communications (Monitor Division), 10707 East 106th Street, Indianapolis, IN 46256; or call toll-free (outside of Indiana) 800/445-7717, or (in Indiana) 317/842-7115. ■

IRS

(Continued from page 36)

What's a Business? The married couple that operated the Amway distributorship were denied a deduction for business expenses and the depreciation of cars and household furnishings because they were unable to show that they had operated the distributorship to produce a profit. In fact, according to the U.S. Tax Court, the most-significant part of the case was the singularly un-businesslike manner in which they operated the "business."

That leads to the question of whether your own electronics-related activity is operated in a businesslike manner and with an intent to make a profit? If those conditions exist, the expenses that exceed income may be used to offset income from other sources. In other words, the losses may be carried over to the personal income tax return of the enthusiast.

When determining whether an electronics activity is actually operated for profit, the IRS uses certain objective standards, usually taking into account special facts and circumstances in each case. Technically speaking, although the expectation of a *reasonable* profit is not required, the enthusiast must have entered into the activity, or continued in it, with the objective of making a profit in order for it to be considered as a "business" for tax purposes. In fact, the chance of making a profit may be small, as long as the anticipated profit is large.

Proof of Intent. The nine factors that the IRS maintains are relevant are:

1) The manner in which the taxpayer carries on the activity. Maintaining complete and accurate books and records indicates, at least to the IRS, that the activity is being carried on for profit. Even better, a change in the method of operation in order to improve profitability is more acceptable.

2) The expertise of the taxpayer—or his advisers. Preparation for the activity by learning about accepted business practices and procuring expert advice also indicate a profit objective, unless, of course, the enthusiast fails to follow such advice.

3) Time and effort expended. An electronics enthusiast who devotes a substantial amount of time and effort to carrying on an activity, particularly if the activity does not have significant personal or recreational aspects, or if the taxpayer has withdrawn from another occupation, evidences an intent to derive a profit. Although a taxpayer may personally devote only a limited amount of time to an endeavor, he may nevertheless still have a profit objective when he employs qualified persons to carry on the activity.

4) Expectation that assets used in the activity may appreciate in value.

5) Success in carrying on other activities. A situation where a taxpayer has engaged in other activities—similar or dissimilar—in the past and converted them from unprofitable to profitable enterprises also demonstrates to the IRS a profit objective.

6) Income history. Losses during the start-up of any electronics activity are not necessarily an indication that the activity is a hobby. However, continued losses beyond the period customarily necessary to show a profit are an indication of a hobby. Of course, losses due to unforeseen circumstances such as fire, theft, or even depressed market conditions, do not indicate a hobby.

7) Amount of occasional profit. An occasional small profit for an activity generating large losses, or in which the enthusiast has a large investment, is not sufficient to establish a for-profit objective. Naturally, an occasional, but substantial, profit generally indicates the necessary profit objective.

8) The taxpayer's financial status. Lack of any other source of income indicates, even to the IRS, that an activity is engaged in for profit.

9) Elements of personal pleasure or recreation. Although the fact that an electronics enthusiast enjoys or derives personal satisfaction from an activity does not mean that there isn't a profit objective—but it does suggest that the activity might be a hobby.

Let the IRS Work. The limitations imposed on hobbies and the burden of proving a profit objective can be avoided if an activity is profitable in three out of five consecutive tax years. Although the presumption that an activity is for profit can be rebutted by the IRS, the effect of the "profit presumption" is to shift to the Internal Revenue Service the burden of proving that the electronics activity is a hobby. That shift can enhance an enthusiast's chance of escaping hobby-deduction limitations.

Finally, any electronics enthusiast can choose to delay a determination of whether the profit presumption applies until the close of the fourth tax year after the year the individual first engages in the activity. Unfortunately, the enthusiast must also execute a waiver extending the statute of limitations for those years. By doing so, a taxpayer also gives a general consent to an extension of the assessment rather than a limited one. In other words, the statute of limitations is extended on the entire return, not just the hobby portion of it. So at anytime within the extended period, the IRS can legally send you a "notice of deficiency" arising from tax matters that are unrelated to the activity for which the extension was requested.

Tax deductions should not be ignored merely because profits do not exist or proving a profit objective is impossible. While the deductions for a hobby may be limited, they can provide a welcome relief for every electronic enthusiast. ■

SUPERCONDUCTING

(Continued from page 61)

problems stem from the fact that in order to operate the PI-4U28 properly, it must be kept at a temperature of −70°C (−94°F).

Until a few years ago, the highest temperatures at which superconductivity took place were very near absolute zero (−273°C). Those temperatures could easily be obtained in the laboratory by submersing the material under study in a bath of liquid oxygen. Obtaining those levels of cold inside an integrated circuit, on the other hand, were considered to be impractical if not impossible.

Because the PI-4U28 only needs to be cooled to −70°C, however, it can be adequately chilled by being bathed in a small bath of liquid smog. Board developers wishing to use the superconductive processor will have to develop small, economical devices capable of converting atmospheric smog into the liquid state. The smog must then be applied to the microprocessor and *presto*!, instant superconductive computing.

If superconductive microprocessors are the wave of the future, and if the computer companies can develop smog liquefiers, then one thing is a sure bet: Los Angeles is destined to become the computer capital of the world. ■

BUILD THE CORD BUSTER

(Continued from page 45)

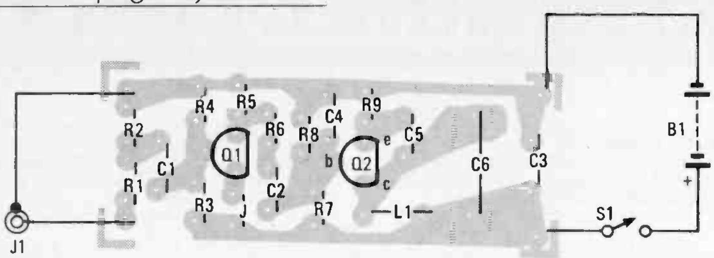


Fig. 4. Here is the parts-placement diagram for the Cord Buster. The coil, L1, was made by winding about 6 inches of No. 19 or 20 enamel-coated wire on a quarter-inch form.

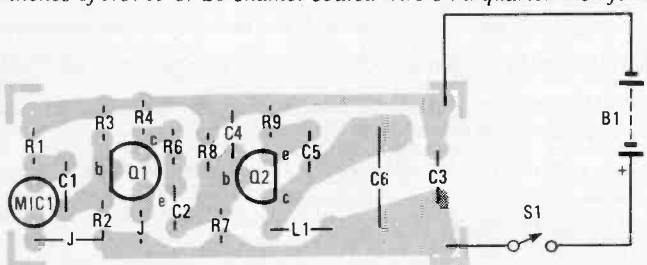


Fig. 5. If you compare this layout with the one shown in Fig. 4, you'll notice very little difference between the two. That's because the Ear Extender is simply a modified version of the Cord Buster.

PARTS LIST FOR THE EAR EXTENDER

SEMICONDUCTORS

Q1—2N3906 general-purpose PNP silicon transistor
Q2—2N3904 general-purpose NPN silicon transistor

RESISTORS

(All resistors are ¼-watt, 5% units, unless otherwise noted.)
R1, R4, R6—2200-ohm
R2, R7—10,000-ohm
R3—120,000-ohm
R5—not used
R8—4700-ohm
R9—470-ohm

CAPACITORS

C1, C2, C3—0.1-µF, 100-WVDC, ceramic disc
C4—680-pF, 100-WVDC, ceramic disc
C5—15-pF, 100-WVDC, ceramic disc
C6—3-35-pF, trimmer

ADDITIONAL PARTS AND MATERIALS

MIC1—Electret condenser microphone
S1—SPST miniature toggle switch
B1—9-volt transistor-radio battery
Printed circuit or perfboard materials, enclosure, battery connector, wire, solder, hardware, etc.

Note: The following items are available postage paid from Krystal Kits, PO Box 445, Bentonville, AR 72712: A complete kit of parts for the Cord Buster priced at $9.95; complete kit of parts for the Ear Extender priced at $11.50; printed-circuit board *only* $5.25. Please allow 6 to 8 weeks for delivery. Arkansas residents, please add sales tax.

of the enclosure to allow sound to reach MIC1.

A standard 9-volt transistor-radio battery and snap connector is used to supply power for the circuit. The red lead of the connector is soldered to one solder lug of switch S1, and the black lead is soldered directly to the board at the negative or ground position. Another lead is then brought from S1 to the positive supply input on the board. When the battery is installed, a small piece of foam rubber is used to keep it away from the circuit board.

The circuit's effective operating range can be increased somewhat by adding a 6- to 8-inch wire antenna to the emitter of Q2. But, with or without the short antenna, the best bet for good steady reception is to use a quality FM receiver.

Check Out. Turn on an FM receiver and set the dial to any vacant spot between 88 and 94 MHz. Power up the circuit and tune C6 with a nonmetallic screw driver, until a quieting signal is heard in the receiver. If the upper end of the FM band is preferred, carefully separate each turn of L1 by about 1/32-inch, or more if necessary, to extend the oscillator's operating range.

Plug the Cord Buster's PL1 into a suitable audio source or place the Ear Extender's MIC1 near a source and adjust the circuit's output level using C6 for a non-distorted signal on the FM receiver. That's all there is to it. ■

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BUILD THE HOT SOCKET

(Continued from page 41)

to the sides of the enclosure with contact cement. The foil pieces are folded around the bottom edge of the enclosure and extend about ¼ inch inward from the outside edge.

Contact is made between the foil and the secondary of the transformer when the printed-circuit board is installed. The aluminum foil at the bottom edge of the enclosure is painted the same color as the enclosure itself to hide the fact that it goes around the bottom and into the enclosure. When completed, the aluminum plates

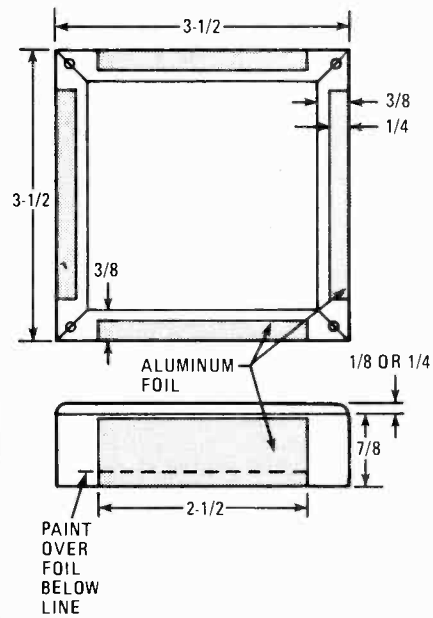

Fig. 5. When making the enclosure for your Hot Socket, start forming a frame (about 3½-inches square, and ⅞-inch high) from a ⅜-inch thick piece of wood. All dimensions here are in inches.

should appear as though they were applied for decoration only.

The AC socket was salvaged from an old 117-volt AC double socket. It was sawed in half to get a single socket and then the top of the socket was cut off with a hack saw. The back surface was sanded down until the face of the plug was about 3⁄16-inch thick. That part must be made thin enough so that it is difficult to pick up the box by the socket. The socket is then fastened to the top of the box with epoxy.

Once the enclosure is completed, the board can be screwed to the bottom of the enclosure with four No. 2 wood screws about ¼-inch long. Predrill the pilot holes to keep from splitting the glue joint at the corners of the enclosure. ■

DX LISTENING

(Continued from page 81)

and views on this interesting hobby. Send your letters to *DX Listening*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735.

Here's what some of your fellow SWL's have been hearing on the shortwave frequencies. All frequencies are in kHz (kilohertz), and all times are give in UTC (Universal Coordinated Time), which is the same as EST + 5 hours, CST + 6 hours, MST + 7 hours, or PST + 8 hours.

Brazil—17,815 kHz. *Radio Cultura* is a Brazilian shortwaver noted around midnight UTC (2400) with jazz and a talk program in Portuguese.

Cuba—5,965 kHz. *Radio Habana Cuba* (RHC) heard on a Thursday evening, or Friday UTC, from 0400 to 0410 with news at the top of the hour.

Nicaragua—6,120 kHz. *Radio Zinica* on Nicaragua's Atlantic Coast is a tough station to hear, compared to the *Voice of Nicaragua*, which operates on 6,100 kHz, just 20 kHz away. But it has been logged tentatively with Spanish news at 1100 UTC.

Pakistan—15,115 kHz. *Radio Pakistan* is noted with programming in both Urdu and English from 0200 until sign off at 0246 UTC.

South Africa—4,760 kHz. *Trans World Radio*, Swaziland. This TWR station in southern Africa has been logged around 0420 UTC in German with a sermon, followed by English programming.

Switzerland—12,035 kHz. *Swiss Radio International* (SRI) noted at 0410 UTC with a current affairs program on Angola.

West Africa—4,890 kHz. *Radiodifusion TV Senegal* (RTVS) is a west African station reported here with French programming, including news, around 0650 to 0725 UTC. ■

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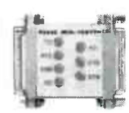
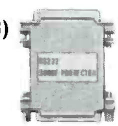
RS-232 Plugs and Accessories

(1)  (2)  (3) 

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9	Hood	276-1539	1.19
25	Male	276-1547	1.99
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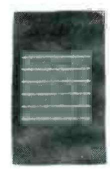
(3) Inline RS-232 Spike Protector. Guard computer, peripherals. #276-1402 . . **16.95**

(1) Solar Cell and Project Kit



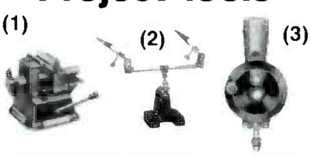
Put Your Sun to Work

(2)

(1) Flexible Solar Cell. This 3¼ × 1⅞" cell produces about 1.2VDC, 65 mA. #276-138 .... **5.95**

(2) Solar Project Kit. Mini panel, motor, propeller, educational booklet. #277-1201 .... **9.95**

Project Tools



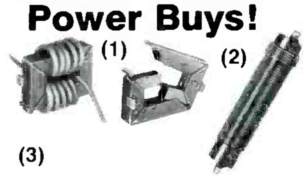
(1) (2) (3)

(1) Mini Vise. #64-2094 ..... **3.99**

(2) Adjustable Project Holder. For easier soldering, gluing, painting and assembly. #64-2093 .... **7.99**

(3) Mini Drill. #64-2097 ..... **3.49**

Power Buys!



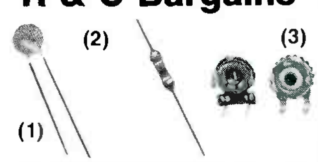
(1) (2) (3)

(1) RFI-Busting Toroid Choke Cores. Easy to install on AC power cords, coax, phone lines. #273-104, **Pkg. of 2/6.95**

(2) 0.1 mH RF Choke. #273-102, **99¢**

(3) Heavy-Duty MOV. #276-568, **1.99**

R & C Bargains



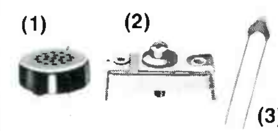
(1) (2) (3)

(1) Pkg. of 50 Low-pF Capacitors. 50 WVDC. 2 to 33 pF. #272-806 ... **2.99**

(2) Pkg. of 500 ¼-W, 5% Resistors. 54 popular values. #271-312 .... **7.95**

(3) 12 Trimmer Pots. #271-1605, **1.98**

Unusual Items



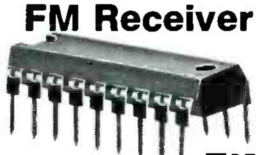
(1) (2) (3)

(1) PC-Mount Mini Speaker. 29/32" diameter! 8 ohms. #273-090 . . **4.99**

(2) Trimmer Capacitor. 95-420 pF. Compression type. #272-1336, **1.69**

(3) Thermistor. #271-110 .... **1.99**

FM Receiver



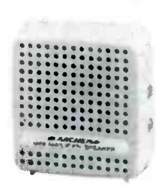
5.95

TDA7000. RF amplifier, mixer, IF and demod stages on one 18-pin DIP. Perfect for a small FM broadcast or public-service band receiver—requires a minimum of support parts. 70 kHz IF eliminates IF transformers. With circuit data. #276-1304

Mini Audio Amp

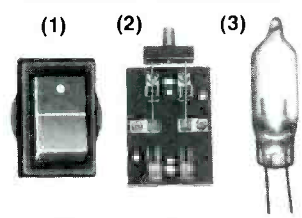
11.95

- **Built-In Speaker**
- **High-Gain IC Design**



Ideal test amplifier, it's also great for computer voice and music synthesis, circuit tracing, and line testing. Has ⅛" headphone jack, ⅛" input jack and volume control. Battery extra. #277-1008

Switch Values



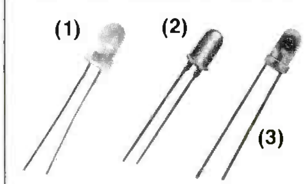
(1) (2) (3)

(1) SPST Rocker Switch. Rated 6 amps at 125VAC. #275-690 ..... **1.99**
DPDT Rocker. #275-691 .... **2.59**

(2) DPDT Knife. #275-1537 .... **1.29**

(3) Mercury Bulb. #275-027 ... **1.29**

LED Indicators



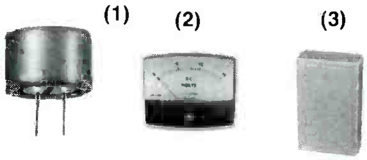
(1) (2) (3)

(1) Super-Bright Red LED. 2000 mcd output! #276-087 .... **1.69**

(2) Blinking Red LED. Built-in flasher IC. #276-036 .... **1.29**

(3) Blinking Green LED. Flash rate: 1 Hz. #276-030 .... **1.29**

More Project Parts



(1) (2) (3)

(1) PC-Mount Electret Mike Element. Hi-fi response. 2-10VDC. #270-090 .... **1.49**
Element With Leads. #270-092 .... **2.99**

(2) 0-15 VDC Voltmeter. #270-1754 .... **7.95**

(3) Transmitter Case. Perfect for a pocket-size IR or RF controller. #270-293 .... **3.99**

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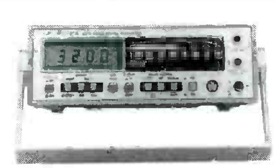
Our Best Breadboard

Universal Breadboard. Molded socket accepts DIPs, discretes and 22-gauge wires. Mounted on a heavy metal base with rubber feet. #276-169 .... **19.95**

Getting Started in Electronics. By Forrest Mims III. The perfect introduction to electronics project building. 128 pages. #276-5003 . . . **2.49**

Bench Instrument



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Precise LCD digital display plus 31-segment analog bargraph. Displays transistor gain directly. Diode-check, memory and continuity functions. Measures to 1000VDC, 750VAC, 10 amps AC as well as DC, and resistance. With leads and manual. #22-195 . . **99.95**

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