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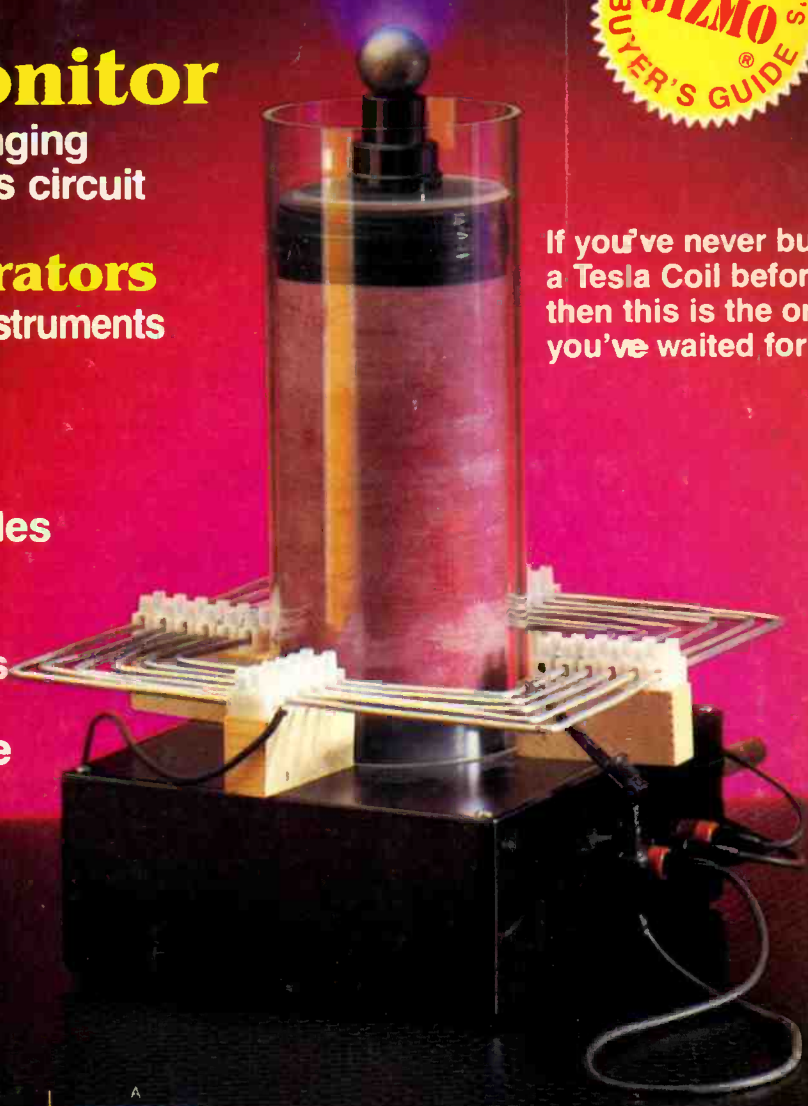

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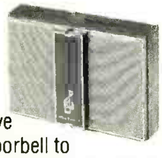

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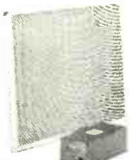

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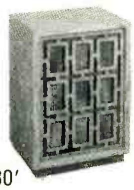

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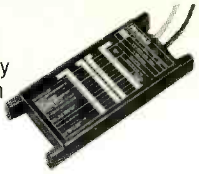

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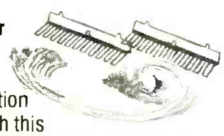

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Editorial

DAH-DI-DAH-DIT DAH-DI-DAH-DAH

Calling all hams! The call is out for a new amateur-radio license that would not require Morse code qualification. That's right, a new *code-free* amateur-radio license.

Immediately, the indignation of many key operators rises, and the loyal opposition takes root again. Others, from the ranks of licensed Novice- and Technician-class licensees, and even responsible CB'ers, are excited by the possibility of such a license. Is there a middle ground?

Yes, there is! I envision a code-free class of license that would be categorized by grades (Grade 1, Grade 2, etc.), with Grade 1 at or about the level of the current Technician-class license. The higher grades would encourage amateur operators in the code-free license groups to pass stiffer and stiffer theory requirements so that they may gain access to additional operating privileges and bands.

Currently, the American Radio Relay League and other such organizations around the world are considering recommending such code-free licenses to their respective federal governments. I leave the exact details to those knowledgeable groups and wish them success.

The advantage of the code-free license is that the ranks of the amateur-radio operator will be swelled with technically trained and motivated operators of the highest order. We should not stifle those individuals and thereby seriously limit and hamper the growth of the international fraternity of licensed amateurs.

What is your opinion? I'd like to know. Till then, listen for my Dah-di-dah-dit Dah-di-dah-dah.

Julian Martin

Julian S. Martin, KA2GUN
Editor

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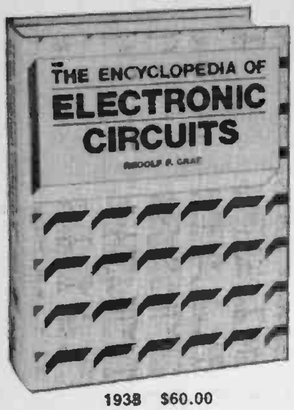

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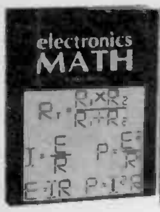

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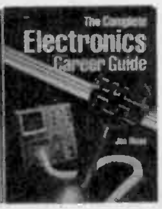

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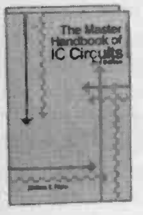

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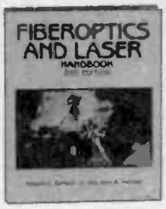

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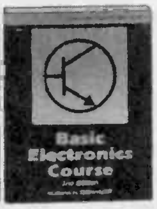

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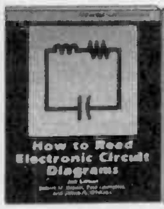

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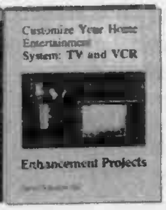

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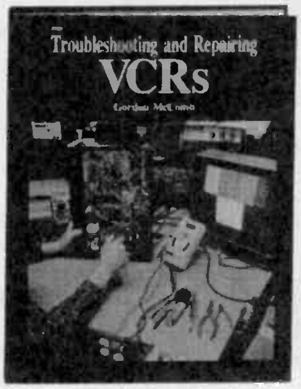

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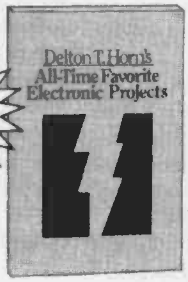

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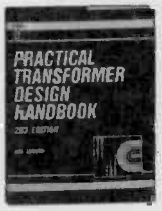

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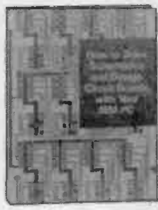

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Letters

READING IS FUNDAMENTAL

I read John Balderson's letter (**Popular Electronics**, April 1989) with great interest. John wrote that he is faced with the problem of answering all sorts of questions on the subject of electronics.

Well, I understand, and it *can* be a problem. It does seem that when people find out you know something about science and technology, they quickly come to believe that you know everything!

No one can possibly be familiar with such an enormous amount of information. But it's always possible to look things up. That means reference books—and I think John's electronics club needs a library.

I've been writing articles for **Popular Electronics** for a little over one year, and the following are some of the books I've consulted again and again:

The Art of Electronics, by Paul Horowitz and Winfield Hill (1980)

Modern Dictionary of Electronics, by Rudolf E. Graf (6th edition, 1984)

The Solid State, by H.M. Rosenberg (3rd edition, 1988)

Getting Started in Electronics, by Forrest M. Mims (1983)

Nature's Electricity, by Charles K. Adams

Forrest Mims' book is available at Radio Shack; the others can be ordered at almost any large bookstore.

Finally, there is a mail-order company by the name of Lindsay Publications (P.O. Box 12, Bradley, IL 60915-0012) that sells a wide variety of extremely interesting books on the science and history of electricity, including several on the technology of Nikola Tesla. Some of these books have been out of print and difficult to get for a long time. The Lindsay catalog costs $1.00.

Good luck with your club, John!

Stan Czarnik
Chicago, IL

MAXIMUM MINIMIZATION

I read with interest the article entitled "Boolean Laws and Reduction" by Louis Frenzel (**Popular Electronics**, February 1989). The laws of Boolean algebra are presented in good order and reasonable manner. Unfortunately, Mr. Frenzel got a little confused when it came to applying the minimization techniques to a "real" problem.

The minimum logic for the die's LED display, presented toward the end of the article, is far from minimum. What seems to have caused the confusion was the "don't care" conditions for what would be die states 7 and 8 if the numbers in the first column of the table in Fig. 17 were to be continued. Mr. Frenzel states in the text that we don't care what the outputs are for those input states since they will never occur, although including the "don't cares" in logic equations allows for better minimization. That simply is not true. The "don't care" conditions help minimize logic precisely because they can be included or not, whichever results in minimum logic. In the truth table, Mr. Frenzel carefully makes the value for the output of each "don't care" equal to 1. The minimization is carried out including those terms and forcing the output of each LED driver to be ON for those "don't care" states.

He should have marked the logic combination for those states and included them if they made a simplification possible, or else excluded them. Looking at Fig. 17, it is clear that LED4 must be ON for all odd counts. The 1's in the truth table for LED4 correspond exactly to the 0's in the "C" column for the counter. Therefore, the only necessary condition for LED4 is NOT C. Note that LED4 would light for the "don't care" condition 7. Similarly, LED1 and LED7 only need the condition $A+BC$ to be on in die counts 4 and 5. They don't have to be on in the "don't care" states. LED2 and LED6 can be turned on by AC. They only need to be on for die count 6. LED3 is the only one that Mr. Frenzel got correct. $A+B+C$ is the minimum.

If looking at truth tables of correspondences strikes some readers as unscientific, they should look into the subject of Karnaugh maps, which make logic minimization a matter of "inspection" rather than tedious applications of the laws of Boolean algebra. Actually, using a Karnaugh map amounts to the same thing as Boolean algebra manipulations. It is basically a method of combining terms like $AB\overline{C} + ABC$ to form the single term AB, by looking at the map and combining adjacent squares. "Don't cares" are included or not depending only on which results in the maximum minimization.

R.W.A.
Ann Arbor, MI

LIGHTNING BULB SUPPLIER

Due to extremely high liability-insurance rates, Eudonics Inc. has informed us that they are unable to supply the kits for "Build The Lightning Bulb" (**Popular Electronics**, *February 1989). We're sorry for any inconvinience that this has caused.—Editor*

A dB IS A dB

I believe that Joe Carr got tangled up in his explanation of decibels in his "Ham Radio" column in the January issue of **Popular Electronics**. A dB is a dB. There is no such thing as a power dB and a voltage dB! An S unit is usually called a 6-dB change, which is 2:1 in voltage, and $P = E^2/R$ or $2^2 = 4{:}1$ in power. The subject is already confusing, without a prestigious magazine and writer mixing up the public more.

We all make mistakes, in dB's, etc. Good luck with a most-interesting column.

V.W.R.
Fort Myers, FL

IN THE DARK

Two errors crept into the illustrations that accompanied the "Lights-on Warning System" article that appeared in the May issue. In the schematic (Fig. 1), capacitor C2 should be connected only between U1 pins 4 and 1 and not to pin 3 as shown; delete the connecting dot at the intersection of C2 and pin 3 of U1. Also, in Fig. 3, the parts-placement diagram, R3 (20,000-ohm, PC-mount, trimmer potentiometer) was mislabeled as R2.—Editor

A "NEW" SUBSCRIBER

I just started getting my new subscription to **Popular Electronics**, and all I can say is "Wow!" I was one of the many electronic hobbyists lost in the computer shuffle, and this is like a reunion with a long-lost friend—especially reading Marc Ellis' reminiscences in "Antique Radio" (March 1989).

The back issues on the shelf above my desk are reminders of many years of fun, relaxation, and education. At the far left is good old Volume 1, Number 1—October 1954. Well-thumbed, pages brown and brittle, I can tell you without taking it down from the shelf that John Frye's "Carl and Jerry" decided to form a new company called something like Electronics Experimenters Inc. Ham-receiver kits were advertised, probably for about $15.00, and crystal-controlled transmitter kits cost about $30.00.

Later on, during my SWL period, **Popular Electronics** decided to make us feel special with our own "SWL call letters." WPE0CUQ preceded my novice ticket by more than a year. Carl and Jerry went to school and then to college, and so did I. They never ceased their enjoyment of learning electronics, and neither have I.

Although I would like to say that most of my projects were completed in a Carl-and-Jerry style, unfortunately, most of mine were more in line with Carl Kohler. He was another of my favorites. Our senses of humor were resonated to the same tuning fork. I could tell him stories of acrid smoke, blown fuses, and blown inventions. (Sit around a group of true electronic hobbyists, and the funniest stories that are told detail our failures.) Carl helped us live with, and laugh at, our catastrophes.

My real reason for writing is to say that the device submitted by Richard Spratley (pictured on page 89 of the May issue) is a "Stolen Power Radio." If I took the time tonight, I could find the issue of **Popular Electron-**

ics in which the circuit was first described. In that **Popular Electronics** circuit, a crystal receiver was tuned to a strong local station. The rectified and filtered audio was enough to drive a second receiver that, I believe, used two transistors for improved reception. The second radio could be tuned to any station on the band, using power from the crystal set. Looking at Dick Spratley's project, I would guess that he was measuring the current produced and then either powering the 15-transistor radio or the calculator shown in the picture.

Over the years I have seen many people lay claim to ideas that I first learned from **Popular Electronics**. A good example is the "Lemon Battery." I believe it was in the "After Class" section on batteries that I learned to make a battery from a strip of zinc, a copper rod, and a lemon. A few years ago, some guy was on television talking as if it were something he'd just discovered. And the other day at work, someone had a digital clock that used Coke for the electrolyte. "Gee," he said, "what will they invent next?"

Thanks for listening, and keep up the good work!

D.A.
Uvalde, TX

ZIP-CODE SLIP-UP

*In "Hands-On Reports: Megamate 3.5-Inch Disk Drive System" (**Popular Electronics**, May 1989) the address for the software's distributor, MicroSolutions, contained the wrong zip code. The corect zip code is 60115.—Editor*

OVERSEAS GREETING

Hello from arctic Scandinavia. Since **Popular Electronics** is also available here, I decided to drop you a line.

I read "Antique Radio" in the March issue, about the old "optimistic" days that so many people seem to think are gone. I must say that I've had the same feeling, and so has a friend who is much older than I. Nowadays, he often recalls the good old days and laments, "When I was young I had ideas but no money. Now I'm old and have money but no ideas!."

K.L.
Finland

BRAKE-LIGHT FOLLOW UP

I spotted what I believe is an error in the article "Flashing Break Light" (March, 1989). It appears that the orientation of SCR1 and C4 differs between the schematic and the parts-placement diagram. Am I correct, and which diagram is the right one?

H.D.F., Jr.
Katonah, NY

You are correct. On the parts-placement diagram, the cathode and anode connections of SCR1 were reversed, as was the polarity of C4. The schematic diagram is correct.—Editor ■

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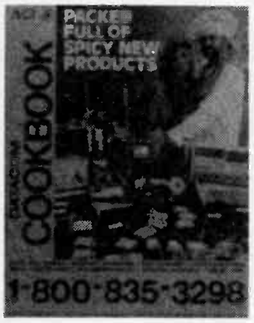
DATACOM COOKBOOK NO. 5

Telebyte Technology, Inc.

The latest *Cookbook* contains more products to help people tackle connectivity problems. Solutions presented in this catalog range from simple wiring alternatives using modular products, to interface converters for connecting systems with different electrical interfaces. Telebyte has added PC,



modular, and 3270 product lines to its collections of short-haul modems, interface converters, Datacom test equipment, local-area multiplexers, and lightning-protection devices.

Datacom Cookbook No. 5 is available free of charge from Telebyte Technology Inc., 270 East Pulaski Road, Greenlawn, NY 11740; 1-800-TELEBYT.

CIRCLE 85 ON FREE INFORMATION CARD

THE MODEM REFERENCE: Complete Guide to Selection, Installation, and Applications

by Michael A. Banks

This book shows readers how to put telecommunications to work for them, by providing all the information needed to choose the right modem and communications software, evaluate online services, and work out solutions to specific telecommunications problems. Written for those who are thinking of buying a modem, and those who want to make the most of the telecommunications equipment they already own, it explains data-transmission and communications protocols, installation, and troubleshooting, in an easy-to-read style.

The fundamentals of telecomputing—what it is, what equipment is needed, and how it works—are clearly explained at the beginning of the book, followed by some simple suggestions for getting online without a hitch, whether you're transferring files, ringing up a BBS, using information-retrieval services, or linking up to a full-service consumer network. The applications of telecommunications systems are fully examined, including a look at new and future technology. The book also presents a comprehensive reference section, including a "modem telephone directory," an "online phone and address book," information on cables and connectors, a shopper's guide, and troubleshooting tips.

The Modem Reference: Complete Guide to Selection, Installation, and Applications is available for $19.95 from Brady Books, Division of Simon & Schuster Inc., Gulf + Western Building, One Gulf + Western Plaza, New York, NY 10023.

CIRCLE 84 ON FREE INFORMATION CARD

TROUBLESHOOTING AND REPAIRING YOUR COMMODORE 128

by Art Margolis

Filled with hundreds of do-it-yourself repairs, troubleshooting tips, and secrets for keeping the Commodore 128 up and running, this book shows how to save time, money, and computer down time. The combination technical reference, programming guide, and service manual provides a complete set of diagnostic programs that advanced hardware enthusiasts and technicians can use to test their own C-128's. A master schematic of the Commodore 128 is included, and effective service procedures for pinpointing problems are described. The book explains how to take the machine apart and reassemble it safely and correctly, including IC-replacement procedures.

Each of the computer's IC's is detailed in a chart that shows its logic, pinouts, voltage, and scope readings; the book's "Chip Location Guide," is a layout diagram of all 63 IC's. Electronic and manual techniques for IC replacement are also detailed. Timing diagrams are included, and the use of PEEK and POKE commands to signal trace circuits is described.

Troubleshooting and Repairing Your Commodore 128 is available for $18.95 from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

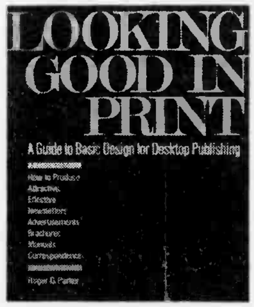
CIRCLE 98 ON FREE INFORMATION CARD

LOOKING GOOD IN PRINT: A Guide to Basic Design for Desktop Publishing

by Roger C. Parker

Desktop publishing has brought graphics design out of the realm of professionally trained art directors and designers, and into the office and home. This book aims to teach those who lack formal graphics-art training how to achieve professional-looking results from whatever desktop-publishing program they use. This isn't a supplemental software manual; it assumes that the reader knows the ins and outs of his particular system. Instead, it concentrates on how to create attractive and persuasive documents.

The book provides easy-to-read instructions on choosing the right typeface, han-



dling white space, putting illustrations and photographs to work, and enhancing documents by using bullets, boxes, rules, and screens. A time-saving section describes 10 common "design pitfalls" and explains how to avoid them. Actual examples of design make-overs illustrate the dramatic improvements that can be achieved by practicing simple good-design techniques. Tips and tricks are offered for specific desktop-publishing projects, including newsletters, tabloids, ads, brochures, correspondence, and manuals.

Looking Good in Print: A Guide to Basic Design for Desktop Publishing is available for $23.95 from Ventana Press, P.O. Box 2468, Chapel Hill, NC 27515.

CIRCLE 83 ON FREE INFORMATION CARD

USING dBASE IV

by Edward Jones

Designed for dBASE III users who are upgrading, as well as newcomers to database programming who are learning dBASE IV from scratch, this book covers all the features of that powerful program. After a brief introduction to database design and to dBASE IV, the book concentrates on how to use the program's non-procedural interface—a series of pull-down menus that allows users to create, display, and change databases without dot-prompt commands.

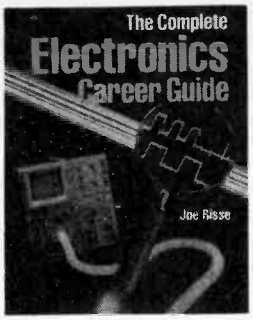
The book also explains how to manage data efficiently by using the program's query-by-example features. dBASE IV's report generator, macros, SQL support, and an improved application generator (which allows users to create menu-driven custom applications) are all covered in detail. Sample database programs are also included, and an appendix listing defines all dBASE commands.

Using dBASE IV is available for $22.95 from Osborne McGraw-Hill, 2600 Tenth Street, Berkeley, CA 94710.

CIRCLE 93 ON FREE INFORMATION CARD

THE COMPLETE ELECTRONICS CAREER GUIDE

by Joe Risse



The field of electronics is growing ever more diverse, and there are plenty of electronics jobs for those who know where to look—and exactly what they want to do. This book is written for anyone who wants to get into electronics professionally, or who is already working in electronics, but wants to make a career move. It describes more than 30 possible job paths, and provides a clear overview of basic electronics to help readers decide which field is really for them.

Career options are explored in the fields of consumer electronics, industry, broadcasting and communications, technical writing, telecommunications, engineering, aerospace and aviation, computer servicing, the military, and education. Specific jobs are described, including the required training and all the possible ways of obtaining it—colleges, trade and vocational schools, apprenticeships, correspondence courses, and on-the-job training. The book gives an accurate picture of each position's respontsibilities, average pay scales, and advancement potential. It offers advice on how to advance in the field, and includes extensive listings of professional associations and electronics manufacturers, publishers, and educational organizations.

The Complete Electronics Career Guide is available in paperback for $12.60, or in hardcover for $19.95 from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

McGRAW-HILL CONCISE ENCYCLOPEDIA OF SCIENCE & TECHNOLOGY
Second Edition

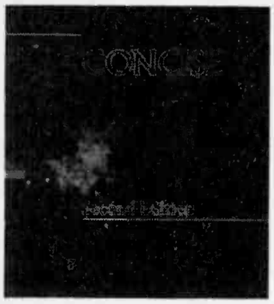
edited by Sybil P. Parker

Packing more data than you'd imagine possible into one large (2,298-page) volume, this reference features current, accurate information on the key concepts and issues in more than 75 major areas of science and engineering—including computer science and data processing, life sciences, electronics, physics, geology, chemistry, ocean and atmospheric sciences, acoustics, optics, and meteorology. The material was extracted from the sixth edition of McGraw-Hill's 20-volume set, and carefully

CIRCLE 12 ON FREE INFORMATION CARD

condensed to ensure full, clear coverage of each topic.

This second edition presents new information on many recent scientific and technical developments, including such timely and diverse topics as expert systems, supergravity, medical imaging, high-energy astrophysics, and AIDS. Four hundred of the volume's 7,700 articles are new to this edition. More than 1700 photographs and line



drawings, plus hundreds of charts, diagrams, graphs, and tables, supplement the text. A 30,000-entry index makes each topic easily accessible. Complete bibliographies are included, listing additional reference sources. Appendices provide such basic information as units of measurement, mathematical notation, the chemical elements, and electronic circuitry.

The McGraw-Hill Concise Encyclopedia of Science and Technology is available for $110.00 from McGraw-Hill Book Company, 11 West 19th Street, New York, NY 10011; Tel. 1-800-2-MCGRAW.

CIRCLE 96 ON FREE INFORMATION CARD

AN INTRODUCTION TO MICROPROCESSORS: Volume 0, The Beginner's Book (Third Edition)

by Adam Osborne and David Bunnell

This newly revised edition of the first book in a popular introductory series provides novices with the basic concepts needed for a thorough understanding of microcomputers. It presents a complete overview of how they work, starting with a description of microprocessors and peripherals that is detailed enough to help the reader make smart purchasing decisions when setting up his own system. The inner workings of computers and the technical principles upon which they work are briefly discussed. (Those subjects are more thoroughly examined in *Volume 1*.)

The book's introduction includes an historical overview of microcomputers, from the *Altair 8800*, the first generally available microcomputer kit (which was featured on the cover of the January 1975 issue of **Popular Electronics**) to the wide variety of today's computer marketplace. The text is fully illustrated, and important concepts are presented in boldface for quick summarizing.

An Introduction to Microcomputers: Volume 0, The Beginner's Book is available for $16.95 from Osborne McGraw-Hill, 2600 Tenth Street, Berkeley, CA 94710.

CIRCLE 93 ON FREE INFORMATION CARD

THE CD ROM HANDBOOK

edited by Chris Sherman

This book presents an in-depth introduction to CD-ROM (Compact Disc Read-Only Memory) technology, investigating the enormous capabilities of discs that can store more than 660 megabytes each. More than 20 authorities in the field have contributed material on their areas of expertise, bringing together timely information on CD-ROM hardware, software, and manufacturing.

The fully-illustrated handbook includes chapters on CD-ROM and local area networks, Digital Video Interactive (DVI) and Compact Disc Interactive (CDI), designing a CD-ROM information structure, and CD-ROM device integration. An historical perspective is included, along with a selected bibliography that shows Search CD-450 in action, and a discography of published CD-ROM titles.

The CD ROM Handbook is available in hardcover for $59.95 from McGraw-Hill Book Company, 11 West 19th Street, New York, NY 10011; Tel. 1-800-2-MCGRAW.

CIRCLE 96 ON FREE INFORMATION CARD

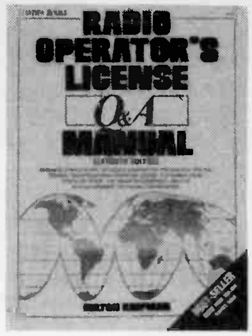
RADIO OPERATOR'S LICENSE Q&A MANUAL: Eleventh Edition

Milton Kaufman

The latest edition of this perennial best seller contains information on all the current FCC regulations in a question-and-answer format. New topics covered include the phase-locked loop, frequency synthesis, digital-logic circuits, op-amps, FET's, mobile-radio equipment, microprocessors, RF interference, and active filters. It's a valuable study guide for anyone trying to pass the FCC General Radiotelephone License Exam, the Marine Radio Permit Exam, or private-industry electronics-certification exams.

With an emphasis on solid-state circuitry and state-of-the-art radio communications, the book presents a strong foundation for the radio enthusiast. FCC-style questions are followed by clear answers, and most subjects also include in-depth explanations of the topic. Each section ends with a practice exam.

Appendices include a completely new,



FCC-type exam, with answers; a troubleshooting section that provides practice in solving the type of problems that appear on the actual exams; and a listing of certification programs for technicians. Revised extracts from FCC Rules and Regulations and extracts from the Communications Act of 1934 are also presented.

The Radio Operator's License Q&A Manual, Eleventh Edition is available for $19.95 from Hayden Books, Division of Howard W. Sams & Company, 4300 West 62nd St., Indianapolis, IN 46268; Tel. 800-428-SAMS.

CIRCLE 95 ON FREE INFORMATION CARD

IBM DESKTOP PUBLISHING

by Gabriel Lanyi and Jon Barrett

The broad field of desktop publishing is growing at a rate that makes it hard to keep up with the latest advances, and harder still to make informed purchasing decisions. Aimed at anyone who would like to configure a cost-effective, IBM-based desktop publishing system, this book strives to narrow the choices between all the available word processors, graphics programs, and laser printers—and to answer some of the questions that are sure to arise.

Readers who are putting together complete systems, or simply upgrading, will find help in matching a system to their needs, budgets, existing equipment, and technical abilities. Separate chapters present in-depth coverage of the different components, available products are reviewed, and the authors offer recommendations for meeting specific needs.

Basic desktop publishing concepts—such as resolution, page layout, and fonts—are explained. Page-composition software programs (Ventura Publisher, PageMaker, Byline, etc.) are examined, along with word-processing software (WordStar, WordPerfect, Word, etc.), both with an eye toward choosing the right one for specific needs. Hardware options are also examined, in terms of XT's, AT's, and 386's; color and

(Continued on page 12)

Electronics Library
(Continued from page 8)

monochrome displays; graphics cards; and scanners. The book also includes an analysis of desktop-publishing trends, and a glossary of terms.

IBM Desktop Publishing is available for $19.95 from Windcrest, Division of Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

SHORTWAVE DIRECTORY
Fifth Edition, 1989

by Bob Grove

This latest edition of the *Shortwave Directory* provides a guided tour of the radio spectrum. It can help shortwave listeners identify transmissions from around the world, and make amateur radio less confusing for beginners and experienced listeners alike. While concentrating on the busy shortwave portion of the spectrum, listings (10,000 of them!) are provided from 10 kHz through 30 MHz. The major emphasis is on 2-way communications, but hundreds of world broadcasters' frequencies are also listed.

Major listings include Air Force, Navy, Army, Coast Guard, Federal Government, Aircraft, Space, Maritime, Public Safety, Business and Scientific, Common Carrier, Broadcasting, and Longwave. Listings are sorted by agency and cross-referenced by frequency, and over 150 subtitles make identifications quick and easy. A comprehensive glossary explains communications terms, call-sign prefixes, procedural signals, and common abbreviations.

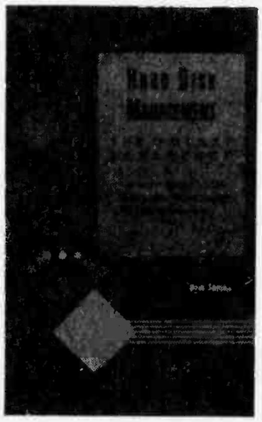
The Shortwave Directory, Fifth Edition, is available from Grove dealers for $14.95, or can be ordered directly (add $2.00 for shipping) from Grove Enterprises, P.O. Box 98, Brasstown, NC 28902; Tel. 1-800-438-8155 for credit-card orders.

CIRCLE 81 ON FREE INFORMATION CARD

HARD DISK MANAGEMENT
The Pocket Reference

by Kris Jamsa

Osborne/McGraw-Hill's "Pocket Reference Series" are pocket-sized and designed to provide quick answers to common software and hardware problems and questions. This book is a handy reference on procedures for getting maximum speed, capacity, and



performance from a hard-disk drive. It explains how to back up files for extra protection, how to organize the disk for best performance, and how to upgrade with a new version of DOS. Tips for saving time and keystrokes, and pointers for maintaining your system are included. The book also describes how to determine the most appropriate hard disk for your individual needs.

Hard Disk Management: The Pocket Reference is available for $5.95 from Osborne McGraw-Hill, 2600 Tenth Street, Berkeley, CA 94710.

CIRCLE 93 ON FREE INFORMATION CARD

BUILD YOUR OWN UNIVERSAL COMPUTER INTERFACE

by Bruce Chubb

The author has isolated the unique characteristics and idiosyncrasies of 105 of the most popular computer models from IBM, Apple, Tandy, Commodore, and other manufacturers, and designed an interfacing system that works with all of them. In this book, he provides step-by-step instructions for building his versatile interfacing system, and then explains how it can be used to control anything from model trains and home-security systems to robotic and industrial control operations.

Some theory is included, but the basis of the book is the construction and testing of the actual interfacing system. Each step is explained in plain English, with accompanying illustrations and photographs. The book shows how to connect all kinds of external hardware—switches, LED's, lamps, relays, solenoids, digital circuits, and motors—to any personal computer with any BASIC software. BASIC subroutines, which allow readers to perform some simple functions, are included. The book also provides source lists for obtaining circuit cards and electronic parts.

Build Your Own Universal Computer Interface is available for $19.95 from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

ILLUSTRATED MS/PC-DOS 4.0
Sixth Edition

by Russell A. Stultz

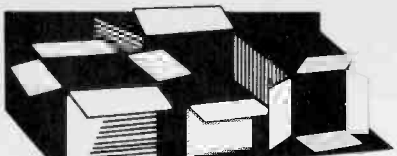
Containing all the significant updates to the popular disk-operating system, this time-saving reference leads users through a sequence of hands-on exercises. It includes the additional features introduced in Version 4.0—the ability to address more than 32 megabytes of disk space, the new DOSSHELL utility (a menu-driven program and file manager), and the ability to make more efficient use of expanded memory.

The book is arranged in alphabetized, modular entries, each of which provides a description, applications, and step-by-step examples. Novices can follow the "Recommended Learning Sequence" to learn DOS from scratch, and experienced Dos users can use individual modules as references for solutions to specific problems or questions. Appendices include a glossary of terms and definitions, and DOS practice exercises.

Illustrated MS/PC-DOS 4.0, Sixth Edition is available for $21.95 from Wordware Publishing Inc., 1506 Capital Avenue, Plano, TX 75074. ■

CIRCLE 82 ON FREE INFORMATION CARD

"He's just mad because I won't give him a belly button"



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

WORD PROCESSOR

AT&T's Word Processor 7700 includes an electronic typewriter and a monitor with 24-line display. Users can create, edit, and store up to 300 pages, and then print them out at up to 90 characters per second, in 16 type styles and sizes.

The word processor also features a 77,000-word dictionary, a built-in calculator; and dedicated keys for such functions as center, search, print, indent, and insert.

A help key and a menu make those functions easy to use. For basic typing jobs, the 7700 can be used as a standard electronic typewriter.

The Word Processor 7700 has a suggested retail price of under $1000. For more information, contact AT&T, 5 Wood Hollow Road, Parsippany, NJ 07054.

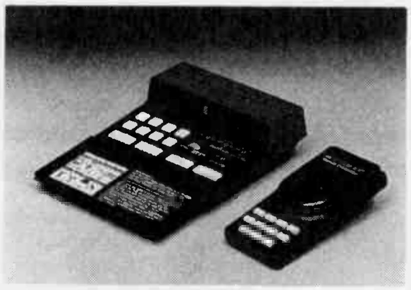
CIRCLE 101 ON FREE INFORMATION CARD

TELEPHONE RESPONDER SET

The *X-10 Powerhouse TR2700* telephone responder/controller set consists of the *TR270* responder and the *TR274* remote transmitter. Used with *X-10* Powerhouse Modules or any X-10-compatible modules—including those sold by Radio Shack, Sears, Heath/Zenith, and Leviton—it allows you to control as many as eight household lights and appliances from any phone, anywhere in the world. With the *HD243/HD245* 220-volt heavy-duty appliance modules, you can control water heaters and window air conditioners; with the *TH2807*, thermostats can be controlled.

When you're on vacation, lights can be turned on and off to make it look as if someone's home, and you can turn the heat up before driving home from the airport. Or you can use it on a daily basis, to set the temperature at home before leaving the office. The TR2700 set also works as a remote control when you're at home, to turn off radios or TV's in other rooms. The ALL LIGHTS ON button can light the whole house if you hear a noise at night, and the ALL UNITS OFF button shuts everything down to save energy.

The telephone responder/controller is in-



stalled by simply plugging it into an AC outlet and its phone cord into a standard phone jack. Signals are sent over existing house wiring to control those lights and appliances that are connected to X-10 modules.

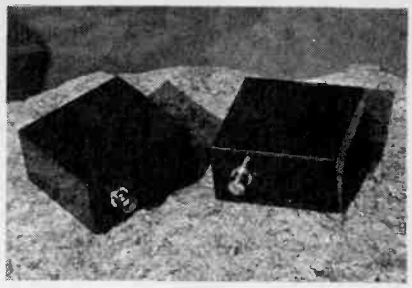
The TR2700 telephone responder set has a suggested retail price of $39.99, and the X-10 Powerhouse Modules cost $14.99 each. For additional information, contact X-10 (U.S.A.) Inc., 185A LeGrand Avenue, Northvale, NJ 07647.

CIRCLE 102 ON FREE INFORMATION CARD

ANTENNA COUPLER

Electron Processing's WPO Window Coupler lets you connect your outside antenna to your inside TV, scanner, or VHF/UHF transceiver without drilling holes in the window frame to route the antenna line. The WPO Window Coupler consists of two weatherproof boxes that mount on either side of the window with double-sided tape. Each box contains either a BNC, a UHF (PL-259 mate), or a type-F connector, and links to either the antenna or to the receiver.

Three models are available. Both the *WPO-VHF* (for use in the 140 – 160-MHz range) and the *WPO-UHF* (for the 440 – 460-MHz range) are rated for 25 watts and provide a 1.5:1 VSWR across a 10-MHz section of their bands. Loss is 2-dB or less on most windows. The *WPO-TV*, which is used only to receive (TV, FM, and scanners), covers the entire 60 – 800-MHz band with only 8-dB loss.

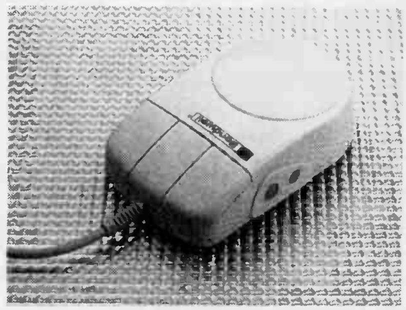


The suggested retail prices are $59.95 for the WPO-VHF or WPO-UHF and $49.95 for the WPO-TV. An optional suction-cup mounting bracket (*SC-4*) costs $20.00. For further information, contact Electron Processing Inc., Sales Department, P.O. Box 708, Medford, NY 11763.

CIRCLE 103 ON FREE INFORMATION CARD

COMPUTER MOUSE

The *B125 Bondwell Mouse* is a high-speed (250-mm/second) and high resolution (200-dots-per-inch) opto-mechanical controller for IBM PC-compatible computers. The mouse has three command buttons and two additional buttons that accommo-



date a turbo function and a sensitivity control for cursor movement.

The B125 mouse has both DB25 and DB9 pin connectors. Bundled with *Dr. Halo III* software and its own Microsoft-compatible driver program, the mouse is compatible with *Mouse System PC Mouse* and *Microsoft Serial* mouse-mode selections.

The B125 mouse controller has a suggested retail price of $69.95. For more information, contact Bondwell Industrial Co., Inc., Quick Shot Division, 47485 Seabridge Drive, Fremont, CA 94538.

CIRCLE 104 ON FREE INFORMATION CARD

GPIB INTERFACE CARD

The *Philips PM 2202* GPIB interface card from *John Fluke* turns an IBM PS/2 computer into a versatile controller for GPIB/IEEE-448 instrumentation and measurement systems. No hardware setup is required. The card is inserted into one of the PS/2's Micro Channel plug-in slots; initialization is done automatically upon power-up by the computer's "Programmable Option Select" facility.

The interface card comes with a set of software routines and drivers, which simplify GPIB programming and can be included in applications written in BASICA/GBASIC, Microsoft C, and Pascal. The routines include all commonly used functions—bus commands, sending and receiving messages, remote and local instrument setting, serial polling, time-out setting, etc. The routines also include error checking. The PM 2202 supports several Philips GPIB software packages.

The PM 2202 GPIB interface card has a U.S. list price of $695.00. For further information, contact John Fluke Mfg. Co., Inc., P.O. Box C-9090, Everett, WA 98206; Tel. 800-443-5853, ext. 77.

CIRCLE 105 ON FREE INFORMATION CARD

MOBILE HAM RADIOS

Contacts in North and South America, Europe, Africa, Asia, and Australia are not uncommon with either of *Uniden's* two styles of *President* 10-meter mobile transceivers. The *HR 2510* and the *HR 2600* are full-featured, all-mode (SSB/CW/AM/FM) amateur transceivers that have 25-watts PEP output for SSB and CW, and 10 watts for AM and FM. Both cover the entire amateur 10-meter band (28.000 to 29.6999 MHz) and feature noise blankers, scanning, microprocessor-controlled operation, digital VFO, and analog RIT.

The *HR 2600* features selectable 100-kHz offset and encoding of any of the 38 EIA CTCSS tones in the FM mode, which makes working 10-meter repeaters a snap. It also provides 4 watts of audio output for good performance in high-noise environments. It has high-speed semi-QSK operation, a built-in 800-Hz offset for easy CW operation, a disable switch for the RIT, and continuous tuning (with a choice of 10-kHz, 1-kHz, and 100-Hz step sizes) from pushbuttons on the microphone.

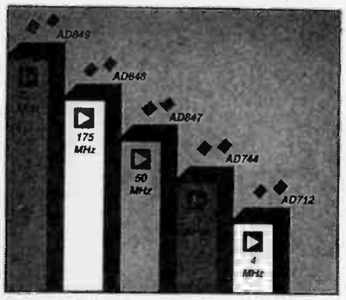
The HR 2510 and the HR 2600 10-meter mobile transceivers have suggested retail prices of $399.95 and $489.95, respectively. For further information, contact Uniden Corporation of America, 4700 Amon Carter Blvd., Ft. Worth, TX 76155.

CIRCLE 106 ON FREE INFORMATION CARD

SMT OP-AMPS

Five of *Analog Devices'* small-outline integrated-circuit (SOIC) op amps provide high-speed, 4- to 725-MHz range of gain bandwidths and precise AC and DC performance for demanding surface-mount technology applications. The 8-pin SOIC package has lower internal inductance and capacitance than—and is only one-third as high and half as long as—its DIP counterpart, ensuring faster, more reliable operation while saving board space.

The designer has a choice of bandwidths. The *AD712* is a 4-MHz dual-channel BiFET for high-resolution applications. The 13-MHz *AD744* guarantees settling of 10-volt steps to within 0.01% in a maximum of 750 ns. The *AD847*, which was designed for



various buffer, driver, and video applications, features 50-MHz unity-gain bandwidth and 300-volt/µs slew rate, yet requires less than 5-mA of quiescent current. The 50-mW *AD848* and *AD849* have respective gain widths of 175 MHz and 725 MHz, and both are suited for video and line-driver applications. All five op-amps offer high precision, offset voltages guaranteed less than 2 mV, and total harmonic distortion below ±120 dB at 1 kHz.

Prices in 100's for the AD712 and AD744 begin at $0.95 and $2.48 each, respectively, and $2.95 each for the AD847, AD848, and AD849. For more information, contact Analog Devices Literature Center, 70 Shawmut Road, Canton, MA 02021.

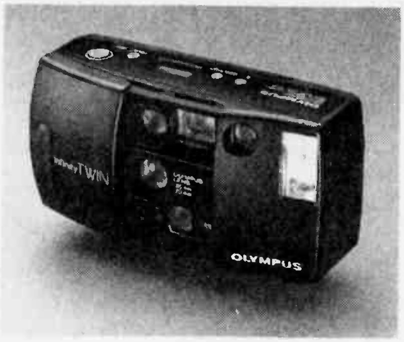
CIRCLE 115 ON FREE INFORMATION CARD

35mm CAMERA

The *Olympus Infinity Twin* has a twin-lens system that completely eliminates noisy and time-consuming lens extension and retraction, and fits into a more compact body (about 5 × 2½ × 2 inches) than other tele-wide lens-shutter cameras. A 35mm autofocus lens is positioned in the middle of the camera, with the 70mm lens above it. In the "Tele" mode, a specially designed mirror reflects the image from the 70mm autofocus lens down onto the film plane, without using a teleconverter. The 35mm lens provides wide-angle coverage for group photos and outdoor shots; the 70mm lens offers 2× telephoto power for close-ups.

The weather-resistant, 9-ounce Infinity Twin has a programmed auto-exposure system that selects both the aperture and shutter speed, and film speed is set automatically. It also has a twin-shot self timer and a "Continuous" mode that shoots up to 4 frames in row, using 1.5-frame-per-second motorized film advance. An LCD panel on the top keeps the photographer informed of the camera's operation status.

The built-in flash fires automatically when needed, and "Fill-in Flash" compensates for backlighting. "Slow-Synchro Flash" with



1/15-second shutter speed lets even the background be exposed, for balanced sunsets and twilight portraits. The flash can be turned off completely when not wanted.

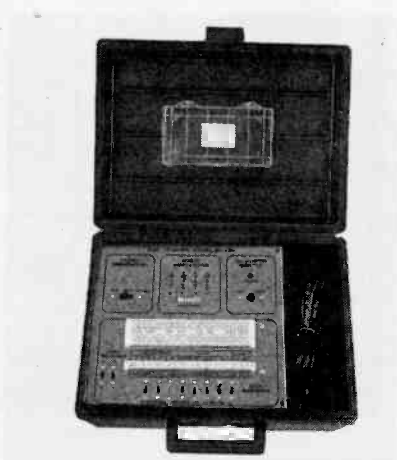
The Infinity Twin has a suggested list price of $325.00. For more information, contact Olympus Corporation, Crossways Park, Woodbury, NY 11797.

CIRCLE 128 ON FREE INFORMATION CARD

DIGITAL TRAINER

The *Elenco XK-220* digital trainer provides students and hobbyists with hands-on training in how digital theory actually works. Available fully assembled or in kit form, the trainer has 3 power supplies, 8 data switches, 2 logic switches, and 8 logic indicators. Circuits can be easily assembled on the 590-pin breadblock and 100-pin breadstix. The unit comes in a sturdy carrying case with a parts box attached inside the lid to keep everything in one place. Instructions, circuit descriptions, and a troubleshooting guide are also included.

The assembled XK-220 costs $150.00;



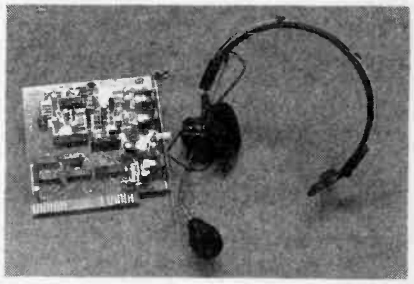
the kit costs $110.00. For additional information, contact Elenco Electronics, Inc., 150 West Carpenter Avenue, Wheeling, IL 60090.

CIRCLE 107 ON FREE INFORMATION CARD

PC VOICE-RECOGNITION SYSTEM

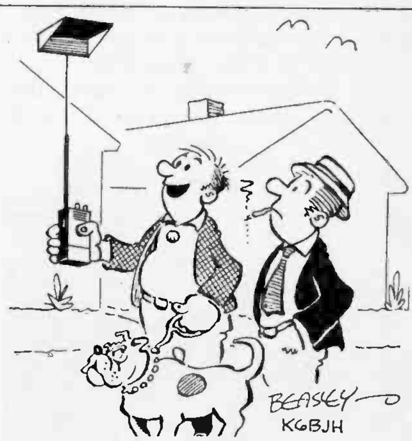
The *Voice Master Key System (PCKS-PO-200)*, a complete hardware/software package from *Covox*, lets the user add voice commands and digitized speech to IBM PC's and compatibles running under MS-DOS. The speaker dependent, isolated word recognizer simplifies CAD, desktop publishing, word processing, and game-playing. The system is also useful for software developers who want to incorporate speech or sound into their programs.

Voice Master Key includes a half-sized hardware card that can be inserted in any available expansion slot, a quality headset, an instruction manual, and recognition software (a 64K RAM-resident utility). As many as 256 vocal inputs can be used to



replace dozens of keystrokes or mouse point-and-clicks. Voice commands and their associated keyboard macros are easy to assign.

The system also contains developer software for speech and sound recording and editing. Graphics-based editing lets the user cut and paste the sound waveform, and the results can be saved to disk and linked



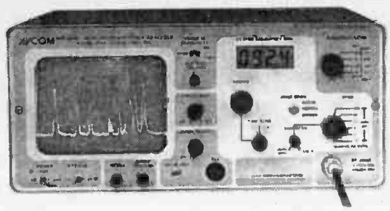
"It's my own idea, a 5/8-wave with a top-hat—upside down it's a pooper-scooper!"

to form digital sound files. Digitized voice memos can be recorded and sent over networks.

The Voice Master Key System costs $149.95. A software-only package for the Tandy 1000SL/TL costs $89.95 and requires a Tandy/Radio Shack electret condenser microphone. For more information, contact Covox Inc., 675 Conger St., Eugene, OR 97402.

CIRCLE 108 ON FREE INFORMATION CARD

PORTABLE SPECTRUM ANALYZER



AVCOM's PSA-65A spectrum analyzer is designed for 2-way radio, cellular, cable, LAN, surveillance, production, and research and development work. It covers frequencies from 2 MHz through 1000 MHz in one sweep, with sensitivity greater than ±90 dBm at narrow spans. Its ZERO SPAN switch allows instant monitoring of transmissions as soon as the "spike" is tuned to the center of the display.

The 18-pound, battery- or line-operated portable spectrum analyzer measures 11½ × 5½ × 13½ inches. Optional frequency extenders allow the PSA-65A to be used at Satcom and higher frequencies. Other options include an audio demodulator for monitoring, log-periodic antennas, and a carrying case.

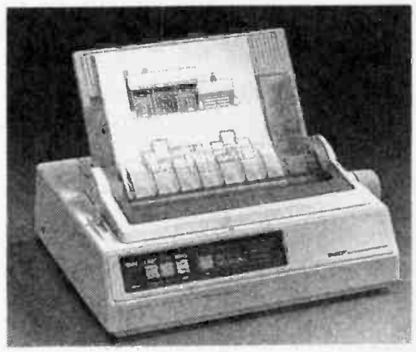
The PSA-65A portable spectrum analyzer costs $2,675.00. For brochure and spec sheet, contact AVCOM of VA, Inc., 500 Southlake Blvd., Richmond, VA 23236.

CIRCLE 109 ON FREE INFORMATION CARD

DOT-MATRIX PRINTER

Radio Shack's Tandy DMP 300 is a 10-inch carriage printer that features full 24-wire graphics and prints as fast as 270 characters per second. Designed for home or business offices that generate high-quality text and graphics, its word-processing and data-processing modes print 10, 12, and 17.1 characters per inch, in proportional, elongated, boldface, or italics fonts. The printer can also handle subscript, superscript, double-height, and microfont type.

The printer emulates both the Tandy character set and the IBM Proprinter X24 printer, providing high-resolution graphics of 360 × 180 dots per inch. Its IBM Alternate Graphics Mode provides greater compatibility with graphics-based software. It can store up to 12,000 characters in memory with an additional 32,000-character memory available for download fonts.



The DMP 300 can handle paper up to 10-inches wide, and has a semi-automatic sheet feeder. A built-in push tractor with automatic paper advance puts the paper

New Products

in the right position for tearing with no waste, and single-touch PAPER PARK allows fan-fold paper or forms to remain in the printer while cut-sheet paper or envelopes are printed.

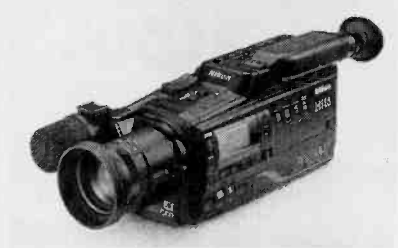
The DMP 300 printer (Catalog #26-2818) is available at local Radio Shack stores for a suggested retail price of $649.00. An optional one-bin cut-paper feeder, the *CSF 300* (Catalog #26-2816) has a suggested price of $299.95. For further information, contact Radio Shack, 1700 One Tandy Center, Fort Worth, TX 76102.

CIRCLE 110 ON FREE INFORMATION CARD

8mm CAMCORDER

Nikon's versatile *VN-950* Action-8 camcorder lets the user choose the standard 8mm recording mode or the "Hi-Band," also called "Hi8," recording system. The conventional 8mm range is 4.2 – 5.4 MHz; the Hi8 range is 5.7 – 7.7 MHz—resulting in horizontal resolution that is improved to more than 400 lines. While Hi8 recording and playback must be done on Hi8 tapes using a camera with a Hi8 system, Hi8 tape can be recorded and played back in the normal 8mm mode. The VN-950 accepts Hi8 tapes or conventional 8mm tapes for recording and playback in normal mode.

The camcorder has an 8× power-zoom lens with macro focusing for close-ups. Its



variable seven-speed electronic shutter has speeds up to 1/10,000-second. In the AUTO-LOCK mode, focusing, exposure, and white balance are all adjusted automatically. By switching off AUTO-LOCK, the entire system can be operated manually or the photographer can choose to control some features manually and others automatically.

Built-in special effects include freeze-frame, slow motion, and frame-by-frame advance. A 2-page digital superimposer allows prerecorded pictures, illustrations, or titles to be superimposed while recording a scene. A FADER mode creates smooth transitions by letting the picture and sound gradually fade in or out.

For editing, a flying erase head provides noise-free picture transitions and smooth inserts. The camcorder can also be connected to other video equipment for editing and dubbing through its S-VIDEO and video/audio inputs and outputs. The S-VIDEO connector transmits and receives luminance and chrominance (the two components in a composite video signal) separately, which minimizes flickering and blurring, enhances sharpness, and assures minimum picture loss during editing.

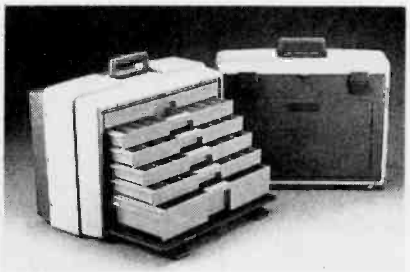
The VN-950 comes with an AC adaptor and a rechargeable battery pack, which provides about 50 minutes of continuous camera recording when fully charged. Its RFU adaptor kit (also included) provides compatibility with TV's and VCR's that aren't equipped with video/audio inputs, an AV connecting cord, and a connecting cord with "S" connectors.

Prices and availability for the VN-950 Action-8 camcorder have yet to be announced. For additional information, contact Nikon, Inc., 623 Stewart Avenue, Garden City, NY 11530.

CIRCLE 111 ON FREE INFORMATION CARD

SMALL-PARTS CABINET

Contact East's portable *Small-Parts Storage Cabinets* help keep easy-to-lose components and compact tools organized. Available in three styles, the cabinets have rust-proof removable drawers in different configurations. A "self-storing" front door slides



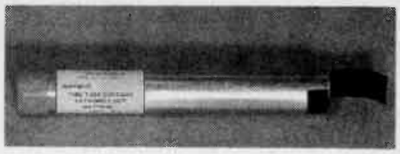
open into the bottom of the cabinet for free access to the drawers, and double latches shut to prevent drawers from accidentally sliding open. A padlock tab will accept a #10, a #7, or a #3 lock (not included).

The Small-Parts Storage Cabinet costs $77.95. For additional information, write to Contact East, 335 Willow Street South, P.O. Box 786, North Andover, MA 01845.

CIRCLE 112 ON FREE INFORMATION CARD

SOLDERING-IRON SLEEVE

The *Iron Sleeve* from *Electron Processing* saves time for the technician by allowing him to place a hot soldering iron back into his toolkit without having to wait for it to cool down. The Iron Sleeve is an 11-inch long, 5-inch diameter tube that contains a proprietary heat-absorbing mass. The soldering iron is held in place by a Velcro strap. Besides absorbing heat, the sleeve pro-



tects the sheathed iron from tip damage caused by other tools in the kit. Most 50-watt or less irons fit the Iron Sleeve.

Prices for the Iron Sleeve start at $19.95, with quantity discounts available. For additional information, contact Electron Processing, Inc., Sales Department, P.O. Box 708, Medford, NY 11763.

CIRCLE 113 ON FREE INFORMATION CARD

VOICE-OPERATED COMPUTER

Advanced Products & Technologies' VOICE is a totally voice-operated computer. The hand-held, cordless unit has graphics, video, voice synthesis, serial-port outputs, two software capsule slots, and CPU access—but no traditional keyboard. The Voice computer can be trained to recognize spoken commands, and responds in a synthesized voice.

The unit has a base voice-recognition vocabulary of more than 500 words and phrases, which results in tens of thousands of sentence inputs and outputs. It is available in two models.

Conversational Computing, using *Nativeguide* software, is a data-processing system that will translate 35,000 sentences spo-

ken in your voice into a computer-synthesized Spanish voice. (French and other languages will be available later this year.) The Explorer could also be used to manage the data on your PC, eliminating the need to program macros.

The Voice Conversational Computing package has a suggested price of under $2300.00. For further information, contact Advanced Products & Technologies, 15444 N.E. 95th St., Redmond, WA 98052. ■

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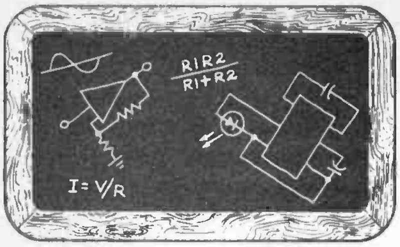

Think Tank

By Byron G. Wels

DANGER!—1,000,000 OHMS!

Back when I was a mere stripling in electronics, the IRE (*I*nstitute of *R*adio *E*ngineers) used to have a colossal show at New York's Colliseum. We had a sense of humor about electronics in those days; in fact at almost any resistor-manufacturer's booth, you could pick up a bright red card with the legend *DANGER!—1,000,000-ohms* printed on it.

I can remember tacking one up over my home work bench, and my dad becoming quite upset about it. I had tried to explain the humor, but how do you explain to a non-electronics type that there really wasn't any danger? Dad just didn't want me playing around with anything that had to be labelled "danger." I tried to explain about Ohm's law, but to no avail. I finally solved the problem by the simple expedient of removing the sign.

One resistor manufacturer sold 10- and 20-watt resistors that were colored green with a ceramic coating over them and a solder tab at each end. They were familiar to everybody, and at the show, they gave away "1,000,000,000-ohm" resistors that looked exactly like the real thing.

The one difference was that the resistance was actually infinite, as there was no connection at all between the solder lugs. Those who worked in electronics loved such things, because you could always drop a handful into another technician's supply bin and drive him nuts. And if you were the first to arrive at work in the morning, there were all sorts of cute little things you could do!

Before the power was turned on in the place, you could stick ½-watt, 10-ohm resistors into all the AC outlets. When the next guy came in and turned the power on, it sounded like a machine gun! Those resistors would pop all over the place. Another cute trick was to roll up a small ball of rubber tape, remove the tip from another fellow's soldering iron, drop the ball in and then replace the tip. When he came in and plugged in his iron, the stench would empty the place!

Naturally, I take a lot of good-natured ribbing (I *hope* its good natured!) about the era of electronics I grew up in. I try to keep up-to-date, and my favorite come back is to ask how many of these Johnny-come-latelys can name the grids in a pentagrid converter tube! My own consolation is that I know more about integrated circuits than Fleming, Maxwell, Oersted, and Volta knew!

Burglar Alarm. When you price a commercial burglar alarm, you're going to find that they're too expensive, and it's going to be a two- to four-weeks wait for installation. This project will protect your wallet and your impatience.

Look at Fig. 1. The schematic may look a little complicated, but it's not. And it all fits on an 8- by 2-½-inch printed-circuit board.

The heart of the circuit is a 555 oscillator/timer (U1), configured for monostable operation. The output of U1 at pin 3 is tied to the gate of SCR1. As long as S1–S5 (which are connected to the trigger input of U1) are open, the circuit remains in the ready state, and does not trigger SCR1 into conduction. Because the relay is not energized, battery current is routed through the relay's normally-closed terminal and current limiting resistor R3 to LED2, causing it to light.

However, when one of the switches (S1–S5) is closed, grounding U1 pin 2, the output of U1 at pin 3 goes high, activating SCR1. That energizes the relay, pulling the wiper of K1 to the normally-open terminal, causing LED1 to light and BZ1 to sound.

The duration of the output is determined by the R/C time-constant circuit, formed by R1 and C1. Resistor R2 regulates the output of U1 to a safe value for the gate of SCR1. Switches S1–S5 are to doors, windows, etc. A switch can be connected in series with B1 to activate and deactivate the alarm circuit when it's not needed.

—M. J. Kazar, Bowling Green, KY.

Love it, M.J., and since your unit draws as much as 45 mA, I'd suggest using an AC power supply for it. Keep an eye open for your copy of the Fips book!

Easy Does It. Here's another lights-on reminder, and it's probably the easiest way to go that I've seen yet! (Refer to Fig. 2.) With both the ignition and the car lights on, the piezo transducer (BZ1) draws no current and remains silent. With only the ignition on, diode D1 is reverse biased and so prevents current flow through BZ1.

However, when the lights are on and

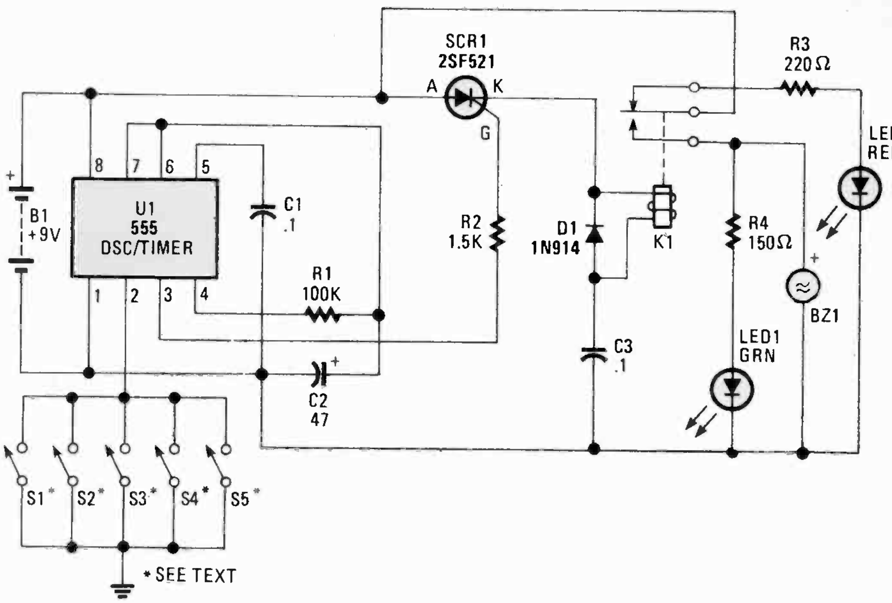

Fig. 1. This burglar alarm circuit is built around a 555 oscillator/timer (U1), configured for monostable operation.

the ignition is off, the transducer becomes energized and sounds to alert you to turn the lights off. With the ignition off and the lights on, D2 is reverse biased, preventing current from flowing to the ignition.

Resistor R1 prevents a short circuit when the ignition is on. If the circuit is connected to the lights through the

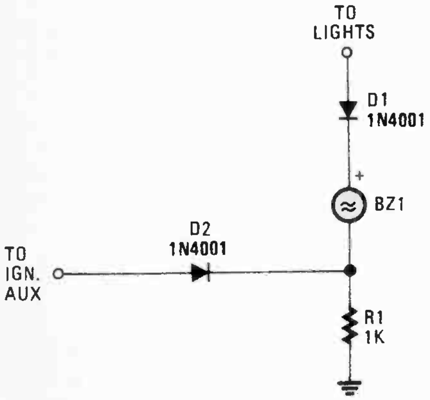

Fig. 2. This lights-on reminder is probably the simplest one yet, consisting of only four extremely non-critical, commonly available components!

dashboard light circuit, then the piezo transducer can be easily turned off using the dash light-dimmer control. That is handy when you want to have the headlights on and the ignition off. That way you don't have to listen to the sometimes-grating sound of the transducer.

—Charles Eubank, Julich, West Germany

Thanks, Charley. Hope you enjoy the Fips book!

Light Dimmer. This simple circuit (See Fig. 3) has proven quite useful in my home. I built it into the base of a bedroom lamp. When entering a room, I like to have the lights bright. But after watching television for awhile, a lower intensity is more desirable.

When the wiper of S1 set so that AC line voltage is fed through D1, the lamp (I1) connected to the circuit lights at about half its brightness, because D1 acts as a half-wave rectifier, delivering only about half of the supply voltage (as pulsating DC) to the lamp. What's more, since in the dim position the lamp gets a good-deal less voltage, the bulbs seem to last a lot longer!

Drill a ⅜- inch hole in the lamp's base to accommodate a small single-pole, three-position rotary switch. In the first position of the switch, no connection is made, and the lamp is off. In the next

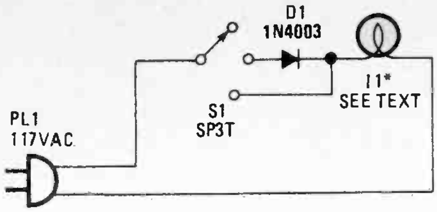

Fig. 3. Looking at this light dimmer circuit one might wonder how something so simple accomplishes its task—the answer is half-wave rectification.

position, current is applied to the lamp through the diode. In the last position, the current is applied to the lamp directly, providing full brightness.

Diodes aren't all that expensive, so use a pretty-hefty type. I've used 600-PIV diodes rated 400 to 600 amps. Also, don't go nuts in selecting a suitable lamp. High-wattage lamps aren't the best choice for a circuit like this. And also, make certain that everything is well-insulated. Now is *that* worth a Fips Book?

—George Benjamin, Pompano Beach, FL.

(Continued on page 24)

THINK TANK

George, that circuit is so small, I nearly misplaced it on the desk! But simple as it is, it surely qualifies, as it is indeed electronic! You've earned yourself a Fips Book.

Auto Alarm. Here's an unusual alarm circuit (see Fig. 4) with a variable exit delay, an LED indicator, and an auto reset function.

The circuit is operated by an external SPST key switch (S1), and by two easy-to-get IC's. In operation, the alarm circuit allows a 0–47 second time delay (as determined by the R1/C1 combination) after the switch is armed to allow the vehicle's motion sensor to settle down, or allow you time to get a bag of groceries out of the trunk, and not have the hassle of juggling the groceries and the key switch all at once.

During the time delay, half of LED1 (which is actually a single, bi-colored, three-legged common cathode device) lights green. At the same time, pins 8 and 4 of U2 (a 555 oscillator/timer) are held low by U1 (a 3905 precision timer), causing the alarm to remain silent. Once the delay is over, LED1 turns red, indicating that the circuit is armed.

At that point, a ground at pin 2 of U2 forces pin 3 of U2 high, closing the contacts of K1 and sounding the siren for a time duration determined by R4 and C2. Once time has elapsed, pin 3 is pulled low, K1 opens, and the circuit is again ready to go. The circuit can be manually reset by the simple expedient of opening and closing the key switch. Potentiometer R3 controls the LED's illumination intensity. Diode D1 ensures that the green segment of LED1 is fully extinguished when Q1 is turned on (which turns the LED to red). Resistors R4 and R5 must be connected to the +V bus, not to pin 7 of U1, otherwise U2 will mysteriously trigger itself each time the initial delay ends.

—J.J. Richard, Gretna, LA.

Thanks, J.J. Your copy of the Fips Book is on the way. To set reader's minds to rest, the current drain is so slight that you won't be sacrificing batteries on the altar of security!

Transistor Tester. Have you ever breadboarded a circuit, or even worse hard-wired it together, only to find that it didn't work? Of course you have. We *all* have! You start checking, circuit tracing, and testing only to find that the problem is a faulty component.

One of the biggest bug-a-boos is problems with a faulty transistor. To sidestep that problem, my friend and I designed a simple, effective means of testing transistors. This circuit will also help identify whether a transistor is a PNP or NPN type.

The circuit is simple (See Fig. 5). My prototype is built on a piece of per-

(Continued on page 26)

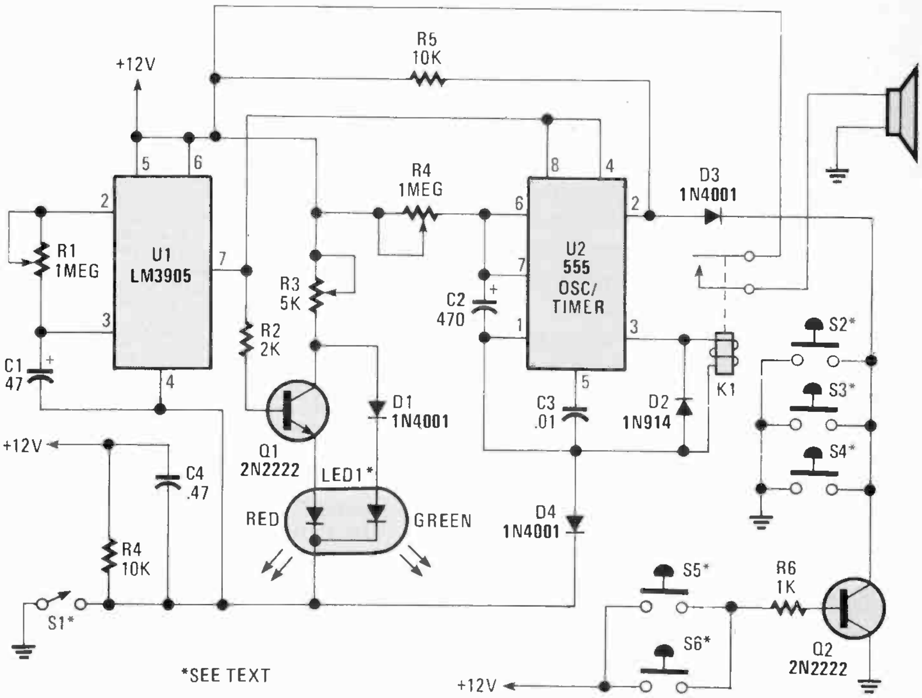

Fig. 4. This auto-alarm circuit has a variable exit delay, an LED indicator, and an auto-reset function—some of the same features touted for commercially available units.

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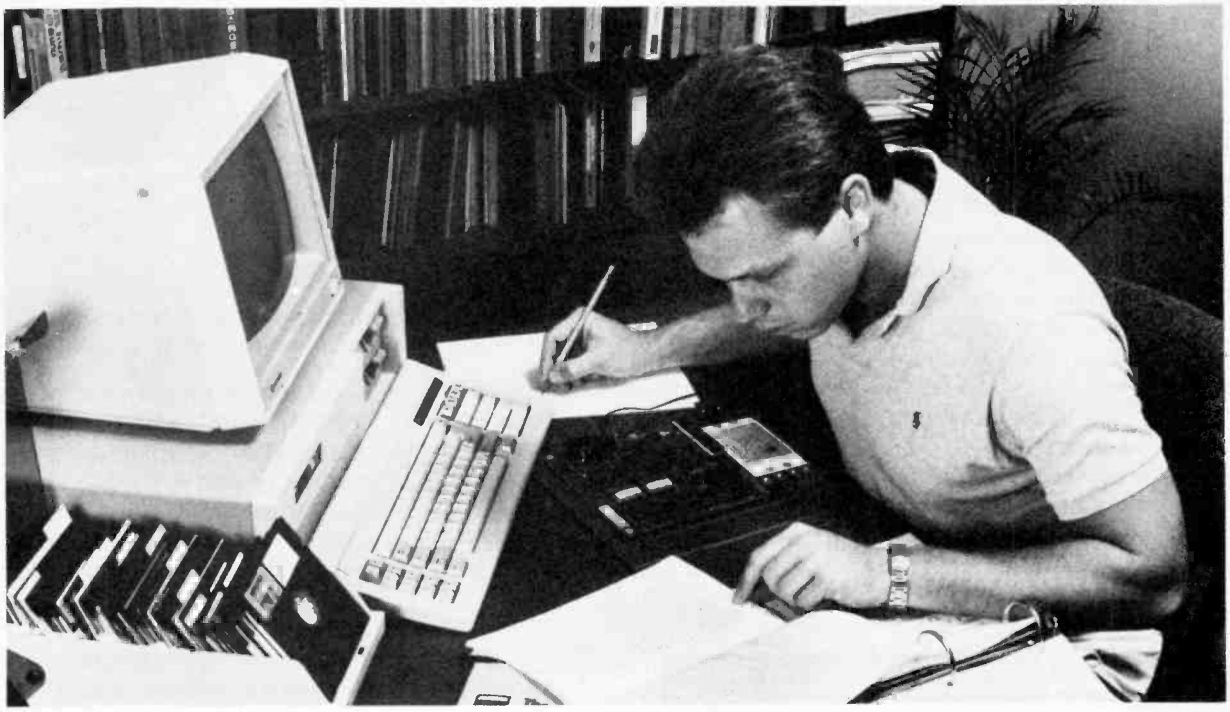

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P-889

THINK TANK

(Continued from page 24)

fboard about the size of a 9-volt transistor-radio battery. The 555 timer is set up as an astable multivibrator. This gives the transistor the opportunity to conduct at either a logic 1 or logic 0 state, making the determination easy.

The transistor network is basically a driver system for the LED's and the transistor under test. When an NPN unit is connected to the test terminals (E, B, and C) LED1 lights, and LED2 lights to indicate a PNP unit. If all LED's are equally bright, the transistor is good. However, different transistor faults provide different indications. A collector-to-emitter short is hardest to detect as the only symptoms will be that LED3 and LED4 will be brighter than the others. When in doubt, check further with a multimeter.

That circuit has saved us lots of time and frustration and I'm sure it will do the same for you.

—FC2 Christopher M. Strickland and ET1 Derstine, U.S.S. Thorn.

Nice job Chris. Your Fips book is on the way. Let Derstine read over your shoulder! By the way guys, this circuit was designed to test and identify low current, general-purpose transistors. It might not operate with the higher-power units.

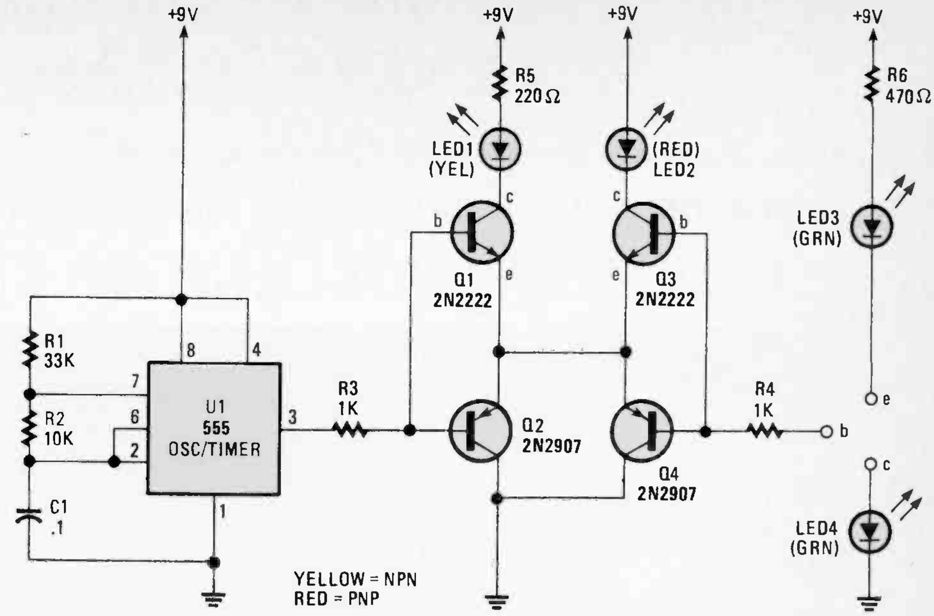

Fig. 5. The transistor tester, aside from giving a visual indication as to the fitness of the unit under test, can also help identify whether a transistor is a PNP or NPN type.

Capacitor Tester/Analyzer. My face is red with embarrassment for submitting this circuit (See Fig. 6) but as simple as it is, it's also extremely accurate and useful! The circuit is built around an LM3909 oscillator/flasher (U1), in fact, you might say that U1 is the whole thing. Just attach the capacitor under test, read the frequency on an oscilloscope or frequency counter and then convert the capacity from a simple calibration chart. It's a great aid in determining the capacity of those cryptically-coded ceramic jobs. Testing is also easy. If the unit matches the rated capacitance, it passes, and if it doesn't, it doesn't! It also has an LED (LED1) to manually time those really-fat capacitors. The 3909's frequency is totally dependent on the capacitor's value only. Some typical results are:

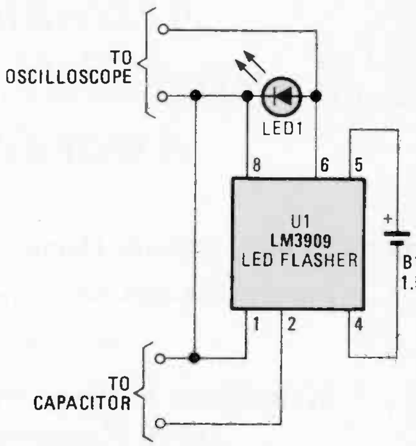

Fig. 6. The capacitor tester/analyzer is built around an LM3909 oscillator/flasher (U1), in fact, you might say that the LM3909 is the whole thing.

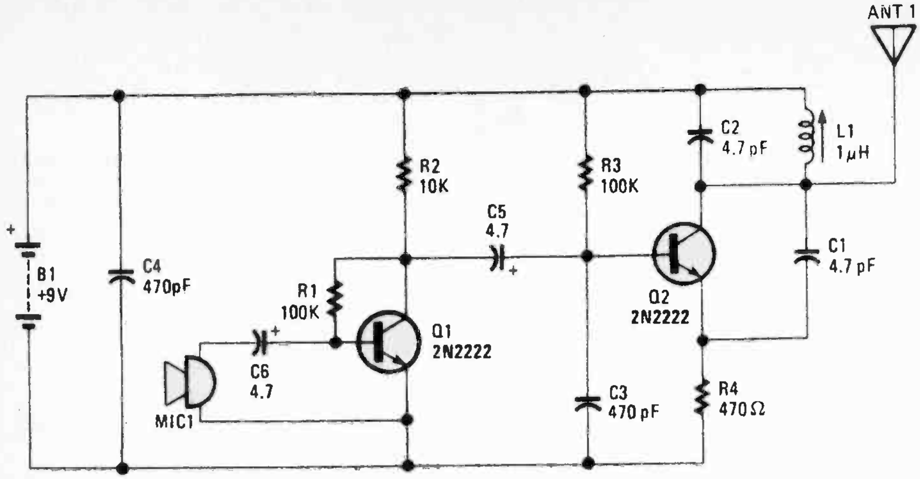

Fig. 7. The wireless mike is really an electret-microphone element feeding its output signal to a miniature transmitter, operating somewhere in the range of 88 to 95 MHz.

4700 µF......0.04 Hz
470 µF.......0.4 Hz
4.7 µF.......57 Hz
0.047 µF.....4.1 kHz
0.0047 µF....25 kHz
47 pF..........660 kHz

It's sweet and simple.

—Nick Cinquino, Norridge, IL.

Okay, Nick. It sure is, and it definitely rates a Fips Book, which went out to you today. I'd urge readers to use standard capacitors and work out trial frequencies just to check Nick out.

Wireless Mike. This circuit is useful and certainly easy to put together. You can assemble the transmitter on perfboard, or use any other method that you're comfortable with. And you'll probably be able to find most of the parts in your junkbox, as well.

While we powered ours with a nine-volt transistor-radio battery, you could opt for the more-expensive 12-volt types. The transistors aren't critical either. You could select a 2N2222 or 2N3904, or any of a handful of other general-purpose, NPN types.

See Fig. 7. Transistor Q1 acts as an amplifier for the condenser microphone (MIC1). The output of Q1 is applied to the base of transistor Q2 through a 4.7-µF capacitor. The combination of C2 and L1 form an L/C tank circuit, which is used to set the frequency at which the transmitter operates. Coil L1 is a variable inductor centered a bit below 1 µH and is used to adjust the modulating frequency of the circuit. Capacitors C1 and C2 are 4.7-pF units, but if required, a lower value can be used to raise the circuit's operating frequency.

The microphone and Q1 provide a varying voltage at the base of Q2, with the output of Q2 being applied to the L/C tank circuit. That causes a modulating action in the tank circuit that, when applied to the antenna (a short piece of wire 6- to 8-inches long) will provide a good, clear FM signal (somewhere in the range of 88 to 95 MHz) with a range of about 100 feet.

Once you've got the unit operational, select a quiet place on the dial within that range, and use a non-metallic screwdriver to adjust the circuit's output frequency by rotating L1 in either direction. I had a lot of fun with it, and I'm sure many other readers will enjoy it as well.

—Richard Hart, Spring, TX

Thanks Dick. It sure looks like a winner. I might add however, that you can usually increase the range of such units by adding more wire to the antenna.

It Can Happen! This morning, Larry Steckler, our Publisher, was sitting in my office, when a package arrived from Mike Giamportone, of Yale, MI. I opened it, and we started to play with his test circuit. Julian Martin, our Editor came in, and the next thing you know, I had the unit taken from me. Mike, we're sending you a Fips Book as promised, but you won't be seeing your idea in the Think Tank. Instead, we're sending you a special author's contract. You'll be getting a contract and a check. We're planning to make a short article for the magazine out of it! How do you like *them* apples?

Before we sign off for this month, I must inform you that we're always in need of circuits for this column. Send 'em to: *Think Tank*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. We look forward to hearing from *you!* ■

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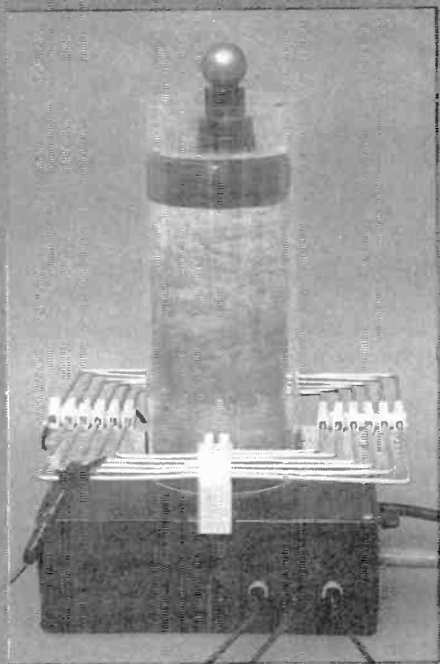
Popular Electronics®
AUGUST 1989

By VINCENT VOLLANO

THE SQUARE SQUARE SQUARE SQUARE TESLA COIL



Build this unusual version of Nikola Tesla's most famous experiment!

Nikola Tesla, considered by some to be the greatest inventor of the electrical age, is today best remembered for his fascinating power-transmission experiments, using his famous Tesla Coil. In his original experiment, he was able to transmit electrical energy without wires to light incandescent lamps located over 25 miles way.

Today, most similar circuits—like the *Tesla Coil* described in this article—are used for educational and experimental purposes. Unlike many of the modern versions, our circuit feeds AC to a power transformer capable of outputting about 3-kV AC at 20 milliamps. The output of the transformer is sent to a primary coil, and is magnetically coupled to a secondary coil with a top capacitance. And if the primary coil is properly tuned, a spectacular high-frequency, high-voltage output is produced at the secondary coil.

Circuit Description. Figure 1 shows the schematic diagram of the Tesla Coil circuit. The circuit consists of little more than a few coils, a step-up power transformer, and a capacitor. Power from an AC wall socket is fed to transformer T1 (a small neon-sign transformer) which steps the voltage up to about 3000-volts AC.

The stepped-up output of T1 is fed through L1 and L2 across C1, causing it to charge until enough power is stored in the unit to produce an arc across the spark gap. The spark gap—which momentarily connects C1 and L3 in parallel—determines the amount of current transferred between C1 and L3.

The arcing across the spark gap sends a series of high voltage pulses through L3, giving a sort of oscillating effect. The energy fed through L3 is transferred to L4 via the magnetic coupling between the two coils. (Because of the turns ratio that exists between L3 and L4, an even higher voltage is produced across L4.) Coil L4 steps up the voltage, which collects on the top-capacitance sphere where it causes an avalanche breakdown of the surrounding air, giving off a luminous discharge.

In order to get maximum output from the Tesla Coil, certain conditions must be met. First of all, the primary and secondary resonant frequencies must be made equal by tuning the primary coil, L3. That's accomplished by tapping L3 at points along the coil with a clip lead.

In addition, the setting of the spark gap greatly effects the output of the Tesla Coil. Our Tesla Coil is designed to use either a stationary spark gap or an optional rotary spark gap; both of which must be adjusted for maximum output. (We'll discuss the rotary spark gap a little later.)

If L3 and L4 are coupled too close, coil efficiency is reduced; over-coupling prevents the circuit from resonating at maximum efficiency. That also causes a breakdown between L3 and L4, which can produce arcing between the two coils. By increasing the coupling between L3 and L4, the amount of energy increases in L4 until a "critical coupling" is reached.

In addition, the Q of the coils is very important (the Q of a coil is equal to its inductive reactance divided by its resistance). The lower the Q, the higher the efficiency of the coil. The primary coil was made from a few turns of aluminum grounding wire (so its resistance is very low). The secondary has many more turns of fine magnet wire, which by its very nature exhibits a higher resistance than does the wire used in the primary coil (L3).

Rotary Spark Gap. The rotary spark

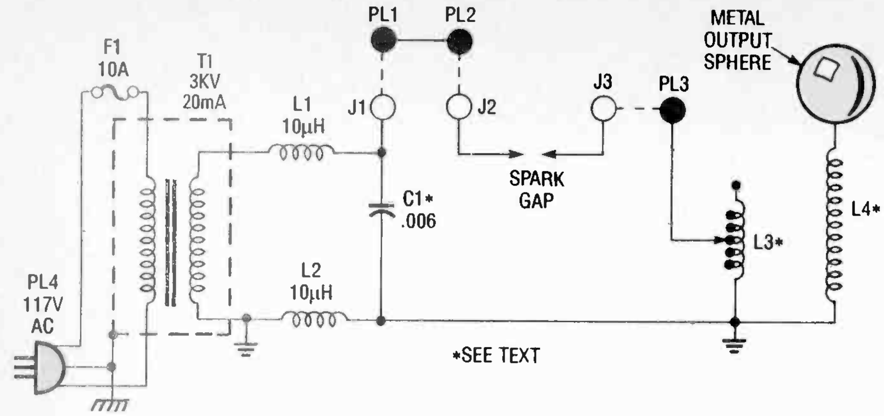


Fig. 1. The Tesla Coil circuit consists of little more than a few coils, a step-up power transformer, and a capacitor.

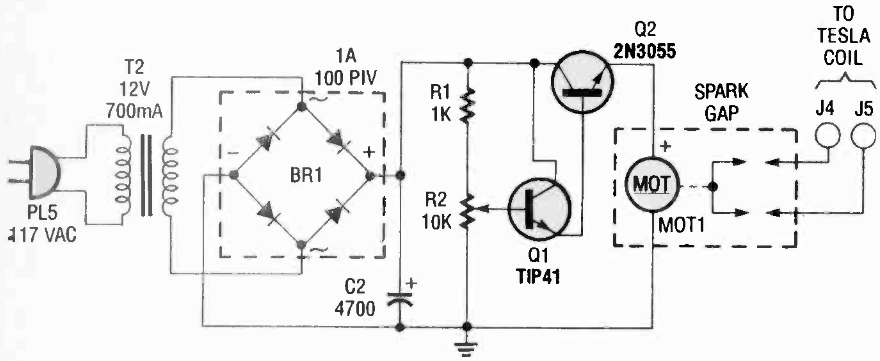


Fig. 2. Here's the schematic diagram for the optional rotary spark gap. The circuit is made up of a 12-volt power transformer, a bridge rectifier, a 4700-µF capacitor, and a 12-volt DC motor.

gap is a simple add-on circuit for the Tesla Coil, consisting of a variable DC power supply and a small, 5000 rpm, DC motor. The circuit allows you to vary the output of the Tesla Coil by adjusting the rotating speed of the motor. A rotary gap is far more efficient than the stationary gap because the stationary gap could cut out, requiring that the gap be readjusted.

Figure 2 shows the schematic diagram of the rotary spark gap, which is assembled as a separate unit. The circuit is made up of a 12-volt power transformer, a bridge rectifier, a 4700-µF capacitor, and a 12-volt DC motor. Power is delivered to the circuit via a 117-volt AC line cord, and fed to transformer T2 (a 12-volt, 700-mA unit), which provides a 12-volt AC output. The output of the transformer is fed to BR1 (a 1-amp, 100-PIV, full-wave bridge rectifier), which converts the AC input to provide 12-volts DC for the operation of the motor.

The output of the rectifier is fed to the base of transistor Q1, which along with Q2 forms a Darlington pair. The output of Q1, which controls the bias presented to the base of Q2, is controlled by potentiometer R2. Potentiometer R2 is used to adjust the base bias on Q1, thereby varying the current through Q2, which in turn varies the rotating speed of the motor.

The rotary spark gap has a stationary post (two screws) mounted on a small square of perfboard, which face a rotor (another perfboard square on which four screws are mounted and electrically connected together with bus wire). The stationary posts and the rotor posts are positioned as close as possible. The movement of the rotor makes and breaks the gap giving maximum impulse power, and will not cut out if the stationary and rotor posts are set properly.

The rotary spark gap is connected to the Tesla Coil through separate wires and banana jacks (J4 and J5). When the circuit is powered up, the current that normally travels through the stationary spark gap on the Tesla Coil is rerouted through the rotary gap via J4 and returned to the Tesla Coil via J5. To make the connections plug PL1 into J1, PL2 into J4, and PL3—which in Fig. 1 is used to connect the output of the stationary spark gap to L3—into J5.

Construction. The author's prototype of the Tesla Coil was built into a large plastic enclosure; because of the high voltages involved, it is imperative that you avoid metal enclosures. Because the circuit consists of very few parts, its components can easily be hard-wired together within the housing, using Fig 1 as a guide. There is nothing particularly critical about the layout of the circuit. Just be sure to maintain adequate spacing between the individual com-

PARTS LIST FOR THE TESLA COIL

L1, L2—10-µH, AC-line filter choke
L3—6 turns, #10 aluminum grounding wire, see text
L4—348 turns, #24 magnet wire, see text
T1—3-kV, 20-mA, neon-sign transformer
C1—.006-µF, 5000-WVDC ceramic capacitor (see text)
F1—10-amp fuse
J1–J3—Banana jack
PL1–PL3—Banana plug
PL4—3-conductor AC power plug with line cord
Metal output sphere, plastic or wooden enclosure, "L" brackets wire, solder, wood, hardware, etc.

PARTS LIST FOR THE ROTARY SPARK GAP

Q1—TIP41 NPN silicon power transistor
Q2—2N3055 NPN silicon power transistor
BR1—1-amp, 100-PIV, full-wave bridge rectifier
MOT1—12-volt, 5000-rpm, DC motor
T2—12-volt, 700-mA, step-down power transformer
R1—1000-ohm, ¼-watt, 5% resistor
R2—10,000-ohm potentiometer
J4, J5—Banana jack
PL5—2-conductor AC power plug with line cord
Perfboard materials, plastic or wooden enclosure, wood, wire, solder, hardware, etc.

Note: The following items are available from Star Electronics, PO Box 2233 Times Square Station, New York, NY 10036: the 3-kV, 20-mA neon-sign transformer, $45 (plus $4.50 shipping and handling; .012-µF capacitor, $9.50 each (plus $3.00 S/H); rotary spark gap motor with shaft lock, $16.95 (plus $3.00 S/H); component kit for the rotary gap's DC power supply (includes 12-volt transformer, transistors and heat sink, resistors, bridge rectifier, capacitor, and potentiometer), $22.95 (plus $4.50 S/H); half-pound spool of #24 magnet wire for secondary coil, 14.50 (plus $3.00 S/H). New York residents add 8.25% sales tax. Please allow 6 to 8 weeks for delivery.

ponents.

Start by drilling holes in the enclosure to pass wires through and for the panel-mounted components. In the author's prototype, three sides of the enclosure were outfitted with appropriate sized holes. A ⅛-inch hole was drill in one side of the enclosure, through which a ground wire connects to L3.

On another side of the enclosure, holes were drilled to accommodate a dowel rod (which is part of the stationary spark gap), a fuse holder, and the power cord. On the third side, three holes were drilled for banana jacks. It will also be necessary to drill holes in the bottom of the enclosure suitable for T1's mounting hardware.

Begin assembly by mounting the power transformer on the bottom of the enclosure. Next connect a 10-μH AC filter choke in series with each of T1's secondary leads, and then connect the free ends of each coil across C1 (see Fig. 1).

Note: In the author's prototype, C1 is really two .012-μF, 2500-volt AC capacitors that were wired in series to create C1 (giving the capacitor an effective rating of .006 μF at 5-kV AC). If you use the same scheme, keep the connecting leads between the capacitors as short as possible. After connecting the capacitors together, cover the gap between the two units with non-conductive tape, and connect the jerry-rigged unit in the circuit as shown.

Stationary Spark Gap. The stationary gap can be made from two 3/16-inch carriage bolts (see Fig. 3). One bolt is stationary and the other one is adjustable so that it can be used to vary the spark gap. A ½-inch wooden dowel is attached to the bolt that is to be adjustable, allowing adjustments to the gap to be made from outside the project's enclosure.

The wooden dowel is very important; one does not want to adjust the gap by touching metal (or any other conductive device), since the gap is adjusted with the Tesla Coil in operation.

The bolts that form the spark gap are supported by two "L" brackets mounted to spacers so that they face each other (see Fig. 3). The stationary post of the spark gap is connected to J3, and the movable bolt is connected to J2.

Primary Coil. The original primary coil (L3) was made from 6 turns of #16 aluminum grounding wire in a pancake style winding. However, to give the unit a somewhat unusual look, the original (more-or-less round) primary coil was replaced with a square version made from heavier #10 aluminum grounding wire. The Coil was formed on four 6-position, twin-turnscrew type barrier blocks, which were mounted on four blocks of wood.

The wood blocks (with barrier blocks attached) were mounted to the top of

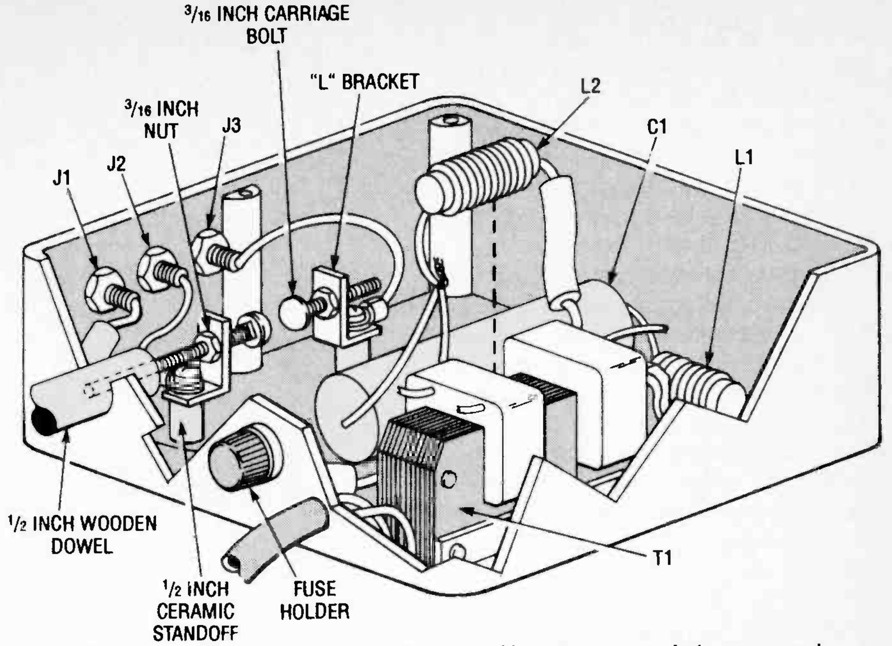


Fig. 3. The stationary spark gap is made from two 3/16-inch carriage bolts supported by "L" brackets mounted to spacers so that they face each other. One bolt is made stationary, while the other is made adjustable so as to vary the spark gap.

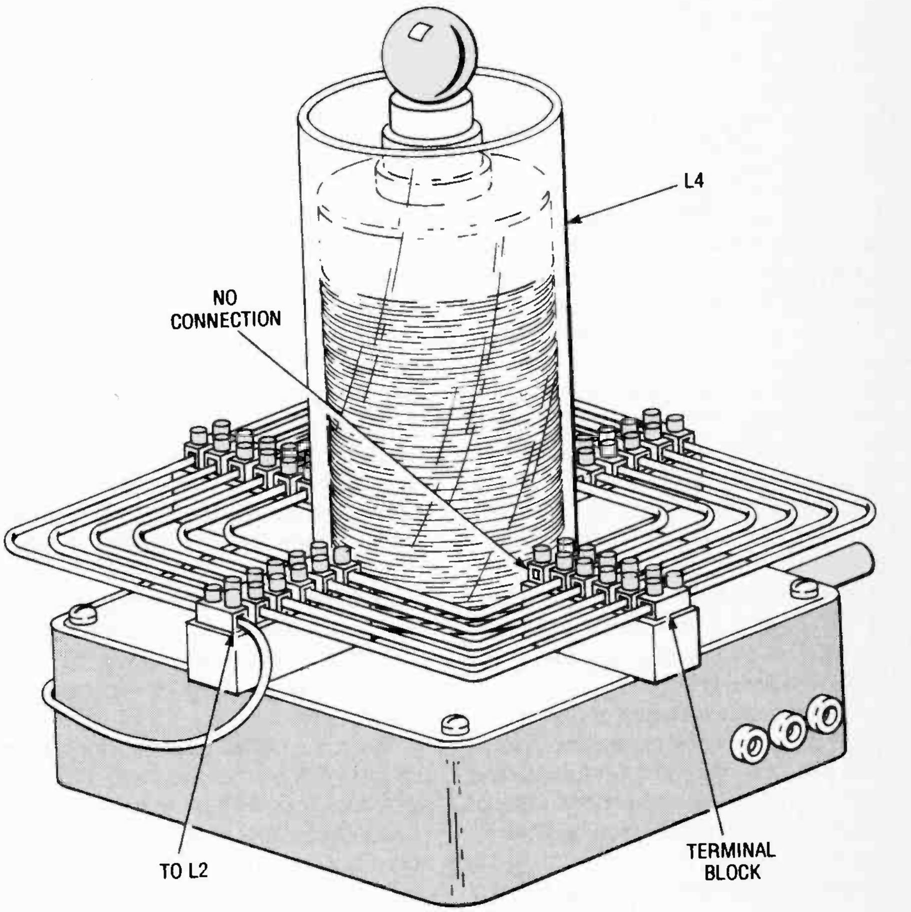


Fig. 4. The inner winding of L3 should have an area of about 6-inches square. When making the coil be careful that you do not form wire loops, instead of the continuous coil illustrated here.

the enclosure near the edges, and bus wire was then connected to the barrier blocks to form the coil. Note: The wires do not have to be fed through the barrier strips because of the twin-turnscrew arrangement. The wire can be cut to the proper size and screwed into the terminal strip to form the primary coil.

The inner dimensions of L3 should be about 6-inches square. When making the coil be careful that you do not form wire loops, instead of the continuous coil illustrated in Fig. 4. When you are finished with the coil, there should be one unoccupied screw terminal at the center and another at the outer rim of the coil. The unoccupied terminal at the outer rim of L3 is connected to ground via a wire that's brought out through a hole in the enclosure. The unoccupied terminal at the center of the coil is left floating.

The Secondary Coil. To fabricate the secondary coil (L4), the author wound about 348 turns of #24 magnet wire onto an 8½-inch length of 3½-inch diameter PVC tubing. That works out to be about 48 turns per inch, covering 7¼ inches on the PVC tubing.

The coil was wound by hand using a simple jig—which consists of little more than a stand for the wire and another for the coil form. When winding the secondary coil, try to keep the winding as even as possible without overlapping any turns.

After the coil has been wound, apply clear varnish or polystyrene (Q-DOPE) to hold the coil windings in place, and to help insulate the coil. Next drill a small hole in the center of the Tesla Coil enclosure lid, and thread the lower lead of L4 through the hole and connect it to the ground end of L3 (as shown in Fig. 1) and mount L4 in the center of L3 (see Fig. 4). The secondary coil is then secured in place with glue.

As an added measure of protection, you can also place clear plexiglass 4-inch OD (outside diameter) tubing over the secondary coil as a second layer of insulation. You might also seal the insulating tube and place mineral oil in it, thereby further increasing the tubing's insulating properties, but that's not necessary for this type of Tesla Coil.

The Output Sphere. The output sphere—a 1¼-inch steel ball on top of a plastic spacer—also serves as the top capacitance. An important point here is that the surface area represents the capacitance not the inner area of the

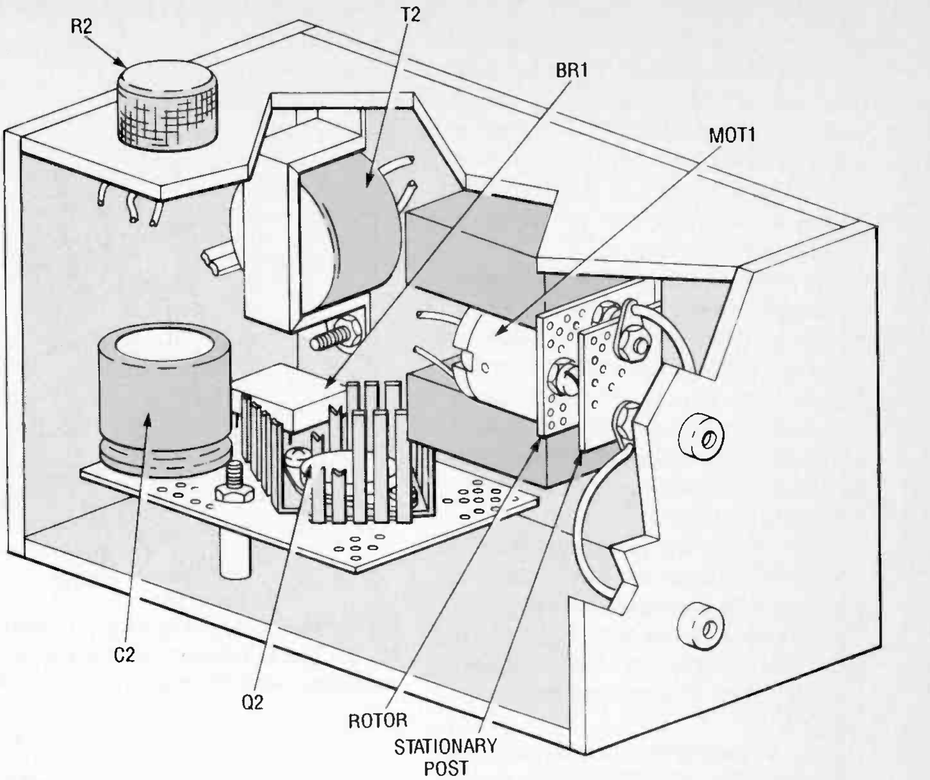


Fig. 5. The rotor of the rotary spark gap is made from a small perfboard square containing four #6 screws that are connected through bare bus wire. The stationary post consist of another perfboard square (of equal size), containing two #6 screws that are not tied together electrically.

ball. It matters not if you use a solid ball or a hollow ball; they will both work equally well as long as their surface areas are equal.

The size of the sphere effects the secondary's resonant frequency, so if you use a larger sphere, it will be necessary to retune the primary coil for maximum output. A bigger sphere collects more energy, causing it to give off a higher output. So experimenting with the top capacitance is highly recommended.

The Rotary Gap. The rotary spark gap is not necessary to the operation of the Tesla Coil. So, if you do not wish to build the optional rotary gap, skip this section.

The rotor of the rotary spark gap is made from a small perfboard square on which four #6 screws are mounted and electrically connected through bare bus wire. The stationary post consist of another perfboard square (of equal size), containing two #6 screws that are not tied together electrically. The screws of the stationary post are instead taken out to J4 and J5. Perfboard is specified because the holes in perfboard make it easy to align the screws on the rotor with those on the stationary post.

The first step in building the rotary gap is to build and mount the motor support. In the author's prototype (see Fig. 5), the motor mount was made from small blocks of wood assembled in a "U" shape. A wooden mount is also used to secure the stationary post in place.

The distance between the rotor screws and the stationary post screws must be as small as possible without touching in order for the unit to function properly. After mounting the motor mount in the enclosure, place the motor in the mount and secure it in position with epoxy.

Next assemble the motor controller circuitry on a piece of perfboard, using Fig. 2 as a guide. Note that T2, R2, J4, and J5 aren't mounted to the perfboard, but instead are mounted to the rotary-gap enclosure. Once the controller board is assembled check your work for wiring errors. If all checks out, solder wires to the appropriate points on the board for connection to the off-board components. Set the board to the side for now; it will be installed in a moment.

Mount the off-board components on some convenient spot on the enclosure. Mount R2 so that you'll have easy access to its wiper. Jacks J4 and J5 can be mounted in any desirable loca-

(Continued on page 95)

Build a SFERIC-Level Monitor

Enter the world of weather forecasting with this atmospheric-noise monitor

BY RALPH W. MYERHOLTZ, W9OMS

If you are interested in meteorology or perhaps are a radio amateur involved in providing emergency services, you should find monitoring the level of sferic activity during thunderstorms both interesting and helpful in tracking the progress of storms through your area.

The term "sferic" (or atmospheric) refers to electromagnetic radiation that appears as noise at radio frequencies, ranging from a few kHz to hundreds of MHz. Noted near the turn of the century, the association between lightning flashes and sferics was and has since been the subject of many scientific investigations and publications. (The static heard on an AM radio is an example of sferics.)

During World War II, for example, a network of sferic monitoring stations with large directional antennas set up on this continent and abroad were used to locate distant thunderstorms. More recently, sferic monitoring has been used to check lightning activity near power-transmission lines, in forest areas, and near some airports. Sferics rate of occurrence also have been the subject of extensive studies to determine their value in assessing storm intensity and detecting tornadoes.

Most of the techniques used by investigators exceed the capabilities or budgets of amateur weather observers. And they may involve some risk to equipment and personal safety because of the possibility of a lightning strike during local storms on one of the outdoor antennas required by the system.

However, for about thirty dollars, you can build the *Sferic-Level Monitor* described in this article, which, when used with a common transistor AM radio, can provide amateurs with a new approach to weather watching during the thunderstorm season. And it can be used indoors to minimize risk.

The Sferic-Level Monitor provides a relative measure of overall electrical activity in a thunderstorm related to both the rate of occurrence of sferics and the strength of the received signal. Providing actual calibrations for sferic rate and range would require a much more sophisticated circuit than the one presented here. Although our circuit is restricted to relative measurements, it can help the amateur to visualize storm-activity level changes and track the progress of storm systems as they move through the monitoring area.

The received signal strength depends upon the energy within the lightning flash and the distance from the stroke to the monitor. The maximum range of detection depends on the receiver's sensitivity. (The author has monitored storms as they approached from 50–75 miles away, based on radar reports.)

With experience, you should be able to make some judgments about the approximate distance of a storm and whether it's approaching, bypassing, or getting farther from the monitoring site. The results can often be correlated with other weather observations, making it possible to do simple storm tracking.

In the simplest version of the circuit, meter readings are taken at suitable intervals and then plotted against time to show changes in sferic activity. However, provision is easily made for unattended monitoring, using a chart recorder that has either 1-mA or 10-mV full-scale sensitivity.

Sample Results. An example of the results obtained with the Sferic-Level Monitor and a chart recorder are shown in Fig. 1. Note that there is a moderate increase in sferic level beginning near 1700 hours as the system approached. That observation was not matched by local weather activity other than gray skies and increasing wind speed.

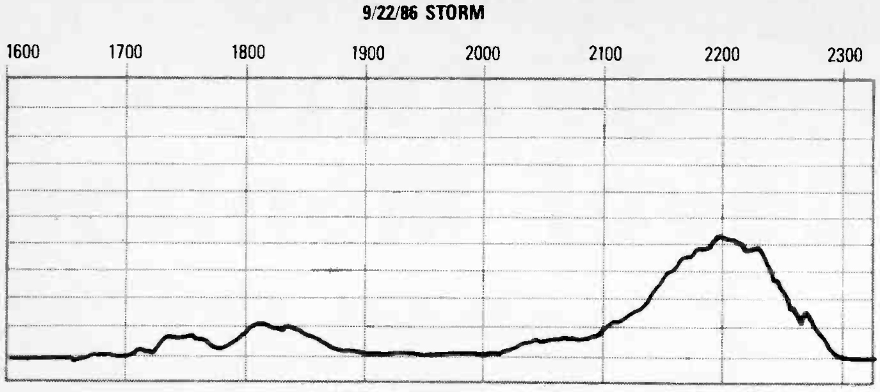


Fig. 1. Here is a chart recording showing sferic level vs. time, which was collected during the approach and passage of a storm.

However, during the subsequent larger increase in activity, temperature dropped rapidly, with both rain and local lightning activity beginning near 2145 hours when the sferic level was near its maximum. Rain continued until about 2230, when the sferic level had decreased significantly as the storm left the area.

Referring to Fig. 2, data collection was begun about an hour before rain started at 1807 hours. The plots show that the onset of rainfall and a marked temperature drop occurred near the first maximum in sferic level as the storm front approached. It's interesting to note that there were apparently three portions to the storm system (based on observations of sferic level) and that maximum rainfall rate coincided with the two major peaks in sferic activity. Thunderstorms frequently consist of a number of thunder-cloud "cells," which may account for the peaks in sferic-level noted.

Figure 3 shows a polar-coordinate plot for the trial tracking of a fairly active storm system approaching from the northwest, which passed about 30 miles north of the monitoring site and caused no local weather activity. Inverse signal strength (related to distance) is represented in arbitrary units by the distance from the graph origin, and the estimated bearing by the radiating lines labeled in degrees. The plot is consistent with radar reports indicating that the storm passed 30–40 miles from the monitor, while moving in a southeast to east by southeasterly direction.

The data was obtained by first orienting the receiver antenna coil for east-west reception, and then for north-south reception at 10 minute intervals and then applying simple trigonometry to the stabilized readings obtained in each direction. That approach to tracking has not been investigated in depth, but may be of interest to experimentally-inclined amateur observers. Cooperative monitoring by two or three observers some miles apart should be of benefit.

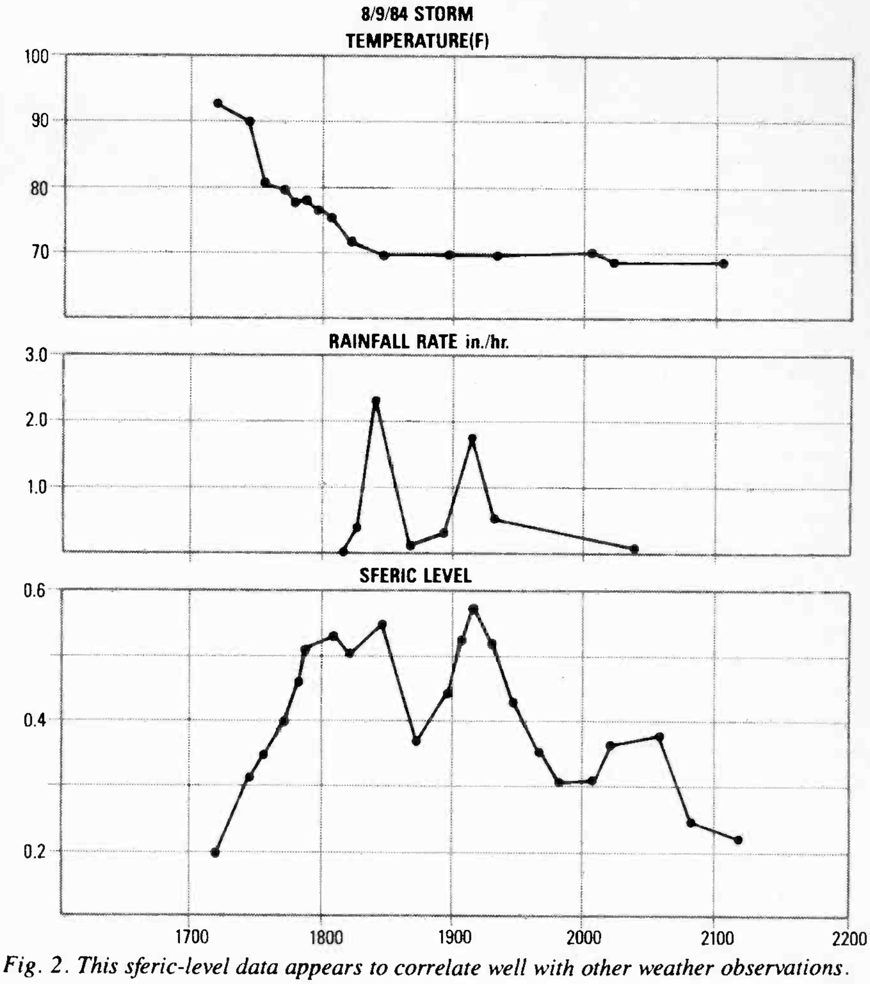


Fig. 2. This sferic-level data appears to correlate well with other weather observations.

The Monitor. Figure 4 shows the schematic diagram of the Sferic-Level Monitor. Tune an unmodified transistor radio to an unused frequency near 540 kHz that's free of broadcast-station interference; the receiver is used to pick up sferics. The received signal is fed from the receiver's earphone jack through a patch cord to the input jack (J1) of the circuit. The back-to-back audio transformers, T1 and T2, provide a suitable impedance-match and signal-level when the unit is used with various receivers.

Diode D1 rectifies the audio input from the receiver to pulsating DC, which is filtered by C1, R1, and C2 to provide a time constant of several minutes. That dampens out fluctuations in most cases, unless lightning flashes are very infrequent.

The voltage appearing at the output of the filter is a function of signal strength transferred by C1. Switch S1 is included to provide a convenient way to discharge the capacitors, should adjustments be required during a monitoring session.

Integrated circuit U1 (one section of an LM324 quad op-amp) is used as a high input-resistance voltmeter. Resistors R2 and R3 determine amplifier gain, while potentiometer R4 is used to adjust full-scale meter deflection for a

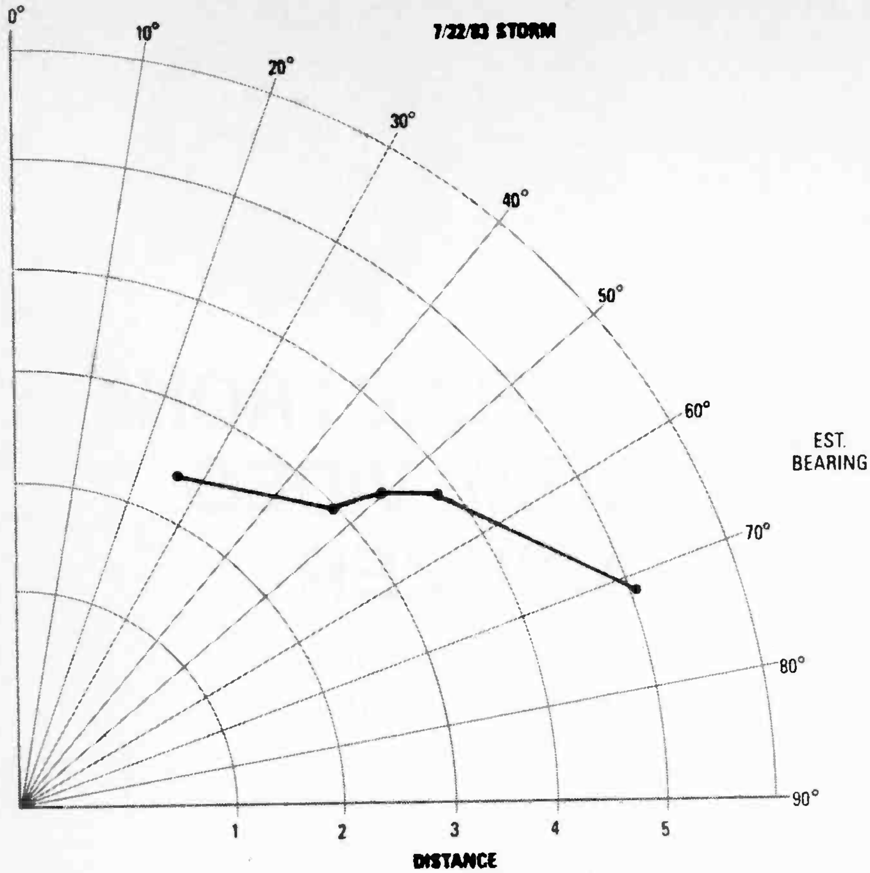


Fig. 3. Trial tracking of a storm system between 2000 and 2130 hours.

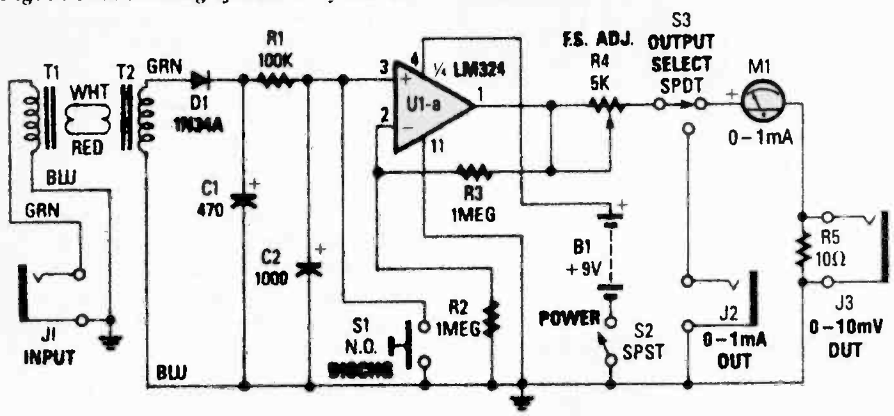


Fig. 4. Here is the schematic diagram for the Sferic-Level Monitor.

suitable voltage level at the input. A value of 1.5 volts has been satisfactory for use with several receivers tried, but can be changed if desired.

If the monitor is to be used only as a meter, the milliammeter may be connected directly between R4 and chassis ground, omitting R5, S3, J2, and J3. The latter components provide suitable output for use with a chart recorder having a full-scale range of either 10-mV or 1-mA. The circuit, when powered from a 9-volt battery, draws about 1 mA.

Construction. The author's prototype was assembled on a small section of perfboard. The physical layout of the perfboard-mounted components is not critical, however, we do suggest that an IC socket be used for U1. Once the socket is mounted on the board, it can serve as a point of reference for the placement of the other components. Do not install U1 in the socket until it's time to adjust the meter for full-scale sensitivity.

First complete the wiring for all components in the voltmeter circuit except the connection between the filter section of the circuit (C1, C2, and R1) and pin 3 of U1. Temporarily install the LM324 and the 9-volt battery and set R4 to mid-range. Connect a 1.5-volt battery to the circuit—with the negative end to ground and the positive terminal to pin 3 of U1, and apply power to the circuit.

PARTS LIST FOR THE SFERIC-LEVEL MONITOR

SEMICONDUCTORS

U1—LM324, quad op-amp, integrated circuit
D1—1N34A general-purpose germanium diode

RESISTORS

(All fixed resistors are ¼-watt, 5% units)
R1—100,000-ohm
R2, R3—1-megohm
R4—5000-ohm potentiometer
R5—10-ohm

CAPACITORS

C1—470-µF, 35-WVDC, electrolytic
C2—1000-µF, 35-WVDC, electrolytic

SWITCHES

S1—SPST normally-open, momentary-contact, pushbutton switch
S2—SPST toggle switch
S3—SPDT toggle or slide switch

ADDITIONAL PARTS AND MATERIALS

B1—9-volt, transistor-radio battery
MA—0- to 1-mA meter (see text)
T1, T2—1000 to 8-ohm audio-output transformer (Radio Shack 273-1380 or similar)
Perfboard material, enclosure, 14 pin IC socket, battery connector, battery holder, phono jacks, wire, solder, hardware, etc.

When the power switch is turned on, the meter should deflect up-scale. Adjust R4 for full scale deflection, disconnect the batteries and remove U1 until you've finished all the wiring.

When installing diode D1, use a heat sink. Connect the banded (cathode) end of the diode to the filter input. Also, be sure to observe the polarity of the electrolytic capacitors.

The author's prototype uses a discontinued Radio Shack meter, which can be replaced by their 9- to 15-volt DC meter (Cat. No. 270-1754). The replacement unit is basically a 0–1-mA meter normally supplied with a 15,000-ohm series resistor; it may be used in the Sferic-Level Monitor by omitting the series resistor. Suitable milliammeters are also available from Mouser Electronics and other suppliers.

Components J1–J3, S1 (DISCHG), S2 (POWER), R4 (F.S. ADJ.), and M1 are not mounted on the perfboard, but instead are mounted to the project's enclosure and connected to the on-board components by way of short lengths of hook-up wire. The input jack (J1) and momentary-contact switch (S1) were mounted on one end of the enclosure, while the OUTPUT SELECT switch (S3) and

(Continued on page 94)

CIRCLE 28 ON FREE INFORMATION CARD

Popular Electronics HANDS-ON REPORT

SCO ELECTRONICS DIGITAL VIDEO STABILIZER

Eliminate the annoying effects of video-tape guards by overcoming their copy-protection signals.

You're all set for a comfortable evening in front of the television. The rental tape of *Rocky 23* is in the VCR, the television is up and running, the synthetic potato chips and salted peanuts are within reach, and your favorite gal is beside you. You punch the remote to activate the VCR and fast-forward past to the opening credits of the film. Something is just not right; What's with the flickering? How come Rocky has green blood? What gives?

Movie moguls are so determined to protect their "flick fortunes" that they are willing to risk disturbing your viewing pleasure with copy protection schemes that can cause all kinds of video havoc. Copy-protected tapes may display color darkening, color shifts, unwanted lines, and jagged edges on the picture. While not all VCR's show those side effects, if yours does, you won't want to use it much. A few minutes of watching a protected copy of *Rocky 23* on a VCR that's susceptible will make even the salted peanuts seem stale.

Rather than trash your VCR, you can knock out the disturbing copy protection signals with the *Digital Video Stabilizer RXII*. Hook one into your video system and you'll see *Rocky 23* as if it were received on cable. The Digital Video Stabilizer eliminates the side effects of copy protection to let you watch a crystal-clear picture.

Hookup. There are two ways to install the unit; how you go about it depends on what your television receiver inputs are. Figure 1 details the hookup for one video-cassette recorder, the Digital Video Stabilizer, and a TV receiver or monitor that has VIDEO IN and AUDIO IN jacks. Connect the TV receiver to the recorder as you normally would, but insert the RX11 stabilizer in series between the units as shown.

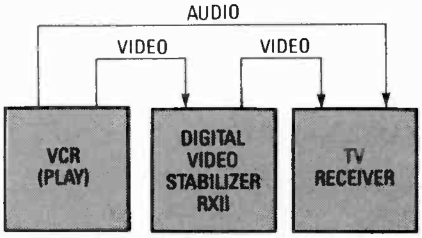


Fig. 1. The hookup for a TV receiver equipped with video *and* audio *input jacks is shown here. The RXII stabilizer is inserted in the video line.*

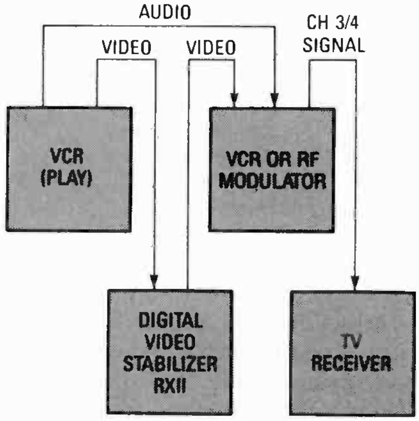


Fig. 2. Should your receiver not have video *and* audio *input jacks, two VCR's are required to process the signal.*

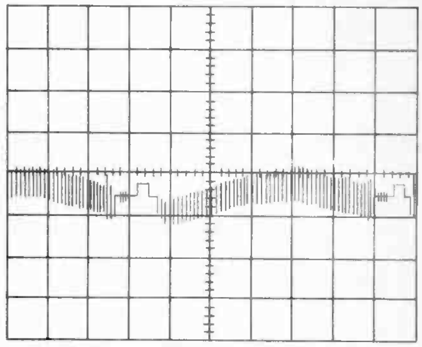


Fig. 3. Here's what your video signal would look like if the video signal is sinewave encoded. The coded sync pulse is below the level of the video signal and can be hidden from your TV set, causing it to run wild.

If your TV is not equipped with those jacks you must use two video-cassette recorders as shown in Fig. 2. If you haven't got a second VCR, you feed the audio and stabilized video into an RF modulator. The Radio Shack 15-1273 is a popular model. The first VCR provides the raw video signal with copy-guard included. That signal passes through the stabilizer and into the second VCR or RF modulator. The second unit modulates the video onto either channel 3 or 4 for the antenna input of the TV receiver. The audio line connects as shown.

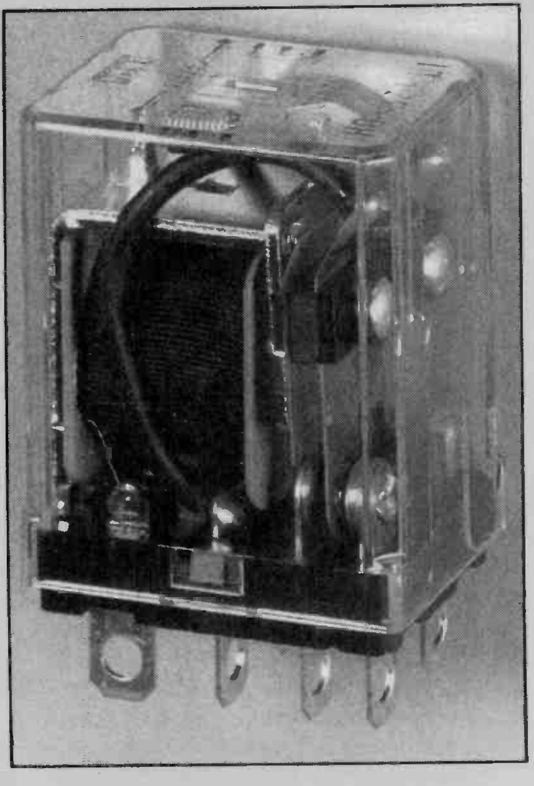
A note of caution: The Digital Video

(Continued on page 102)

Winning the Relay Race

Read how relays have evolved through the years to survive both the tube and transistor eras.

BY ALVIN G. SYDNOR



In 1836, Joseph Henry transmitted a small electrical current down a wire to energize a remote coil. The coil operated a set of contacts that completed a low-resistance circuit to ring a bell, and the relay was born.

Since that day, over 150 years ago, the relay has undergone steady evolution and the modern relay is far removed from the crude relays of Henry's day. Today, electronic circuits that generate control signals are used in place of mechanical switches; that means relay devices are needed to allow those small signal voltages to operate power-intensive devices. In this article we'll present the recent descendants of the long-present relay family of devices.

Armature Relays. Basically a relay is an electrically operated switch. The relay makes remote switching possible and allows a safe, low-level signal or control voltage to switch hazardously high load voltages. It also allows a single signal voltage to control many individual load voltages or currents.

Relays come in three main types: electromechanical, solid-state, and hybrids, which are a combination of the first two. There are some specialized relays that fall into neither category, but we will deal with them individually later.

Taking electromechanical relays first, they come in three main "flavors:" armature, plunger, and reed. Armature relays are the oldest of the group, so let's talk about them first.

The basic time-honored SPST armature-type relay is illustrated in Fig. 1. Many turns of very fine insulated wire are wound around an iron core to form an electromagnet. The movable metal armature has an electrical contact that is positioned over a fixed contact attached to the relay frame. A spring holds the armature up so that the movable and fixed contacts are normally separated (open). When the coil is energized, it attracts the pivoting armature and pulls it down, which closes (makes) the contacts and completes the power circuit.

If the fixed contact was placed so that it touched the moving contact only when the armature was in its unenergized position, the relay would be a normally closed device. Such a relay could be used to "break" a circuit instead of making one. With a contact at both positions, the relay can break one circuit while making another. As should be apparent, creating a variety of contact and armature schemes can make relays useful for a wide range of control applications.

Various Relay Armatures. There are many different types of armatures, most of which are very specialized and are of little use to the hobbyist. For that reason, we'll give you just a brief overview of a few armature types so you can get a feel for what's out there without being bogged down with the unusual.

Because of its spring action, the armature on the relay of Fig. 1 is often referred to as a "clapper-type" armature. The armature contact is usually mounted on a flexible strip attached to the rigid armature plate. The armature is allowed to over-travel a little, providing additional spring tension to compensate for wear, and creating a slight wiping action of the contacts for self-cleaning. That is the most popular armature type, so you're likely to deal with it most often.

Less popular, but more interesting, telephone-type relays use a multiple-spring flexure in which all the contacts are mounted on individual long spring arms stacked parallel to each other in a single bank. The armature carries no contacts itself, but has an extension that bends one or more spring arms in the "contact stack" to make and/or break circuits when the coil is energized.

There is another contact arrangement known as the "card lite-off" type in which a perforated plastic card placed at the end of the contact stack engages the ends of the movable-contact spring arms. When the relay is energized the card is lifted by the armature to actuate the contacts. That allows the relay to switch only the contacts selected by the card.

Plungers in Relays. Some relays have a plunger instead of a pivoting armature. The plunger design shown in Fig. 2 uses solenoid action to close the contacts. The electromagnetic core is hollow and a metal rod or plunger, P, extends halfway through it when the relay is not energized.

When energized, the coil draws the plunger in and a shorting bar, B, attached to the end of the plunger closes the circuit between contacts X and Y. When the coil is de-energized, the

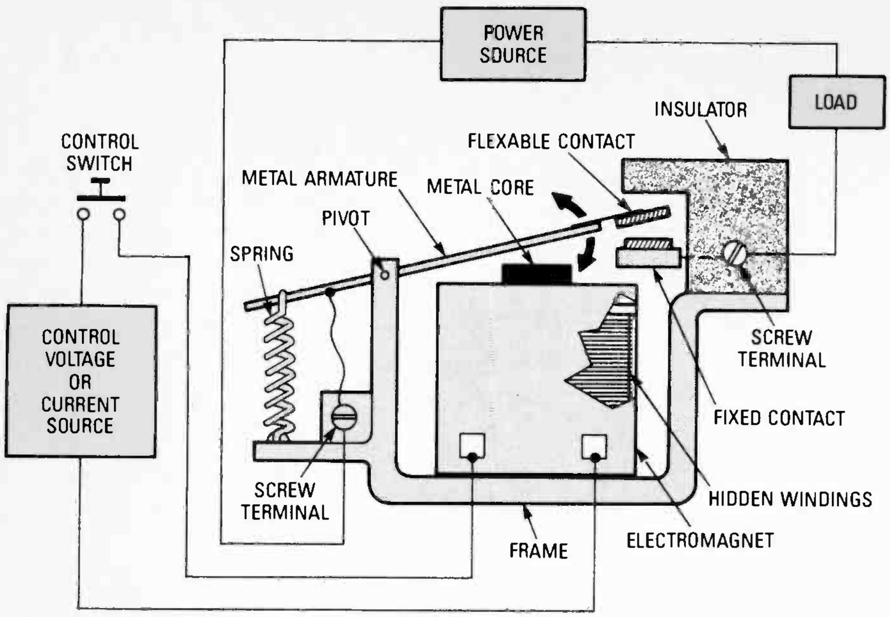


Fig. 1. The ever-enduring armature-type relay is an elegantly simple device. The electromagnet attracts the armature and pulls it down so the contacts touch.

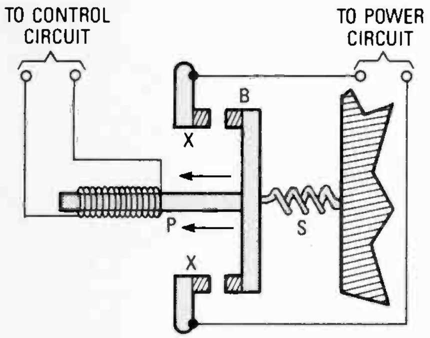


Fig. 2. The plunger relay is excellent for switching high voltages because of the large distance between the contacts.

spring, S, retracts the plunger/shorting-bar assembly to its original position, breaking the circuit.

The coil-plunger design allows much greater contact travel than the pivoting armature design, thus allowing wide contact separation. The increased separation allows plunger systems to be used with higher voltages than armatures. Also, the higher closure force of the solenoid permits the use of larger contacts and provides greater current-handling capability.

Reed Relays. Since their inception, electromagnetic relays have improved in sensitivity, switching complexity, current-handling capability, response time, and reliability. A big step in improving electromagnetic-relay technology was the creation of the reed relay. Being relatively small, reed relays fill the demand for miniaturization.

The use of flexible reeds and self-attraction distinguishes the reed relay (shown in Fig. 3) from other electromagnetic relays. The contacts are mounted on thin metal strips (reeds) sealed in an evacuated glass tube for protection. The tube is surrounded by a magnetic coil that, when activated, magenetizes the reeds, causing them to attract one another and close. When the coil is de-energized, the spring tension in the reeds causes them to separate again. The design has the advantages of high speed operation, long operating life, and very low price.

One of the great advantages reed relays share with other electromagnetic relays is the relative ease with which they can be fitted with multiple contacts. As in the coil-and-armature and coil-and-plunger types, the contact mechanisms can be stacked to provide multiple circuit-closures or openings, or combinations of both, all

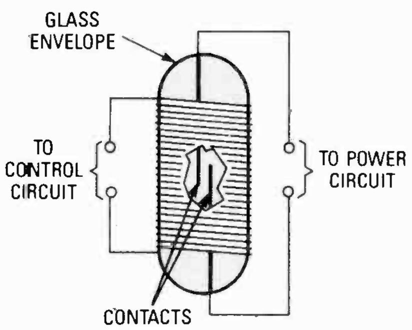


Fig. 3. The reed switch is an interesting electromagnetic relay in that the contacts are made to attract one another and close.

actuated by a single coil. In reed relays, multiple contact pairs, in their individual tubes, can be stacked and wound with a single actuating coil in a very small volume of space. That is not a feature of solid-state relays.

Solid-State Relays. Since solid-state relays (commonly denoted SSR's) are not ganged together in most cases, they usually must be mounted individually, with separate heat sinks and control-signal lines for each unit. But even so, they still have some unique advantages over their electromagnetic counterparts. For example, they have no moving parts; there are no contacts to wear-out, arc, or burn; and they have the capacity for high-speed bounceless and noiseless operation.

The reason for that is that solid-state switching devices take advantage of the on/off switching properties of transistors and silicon controlled rectifiers (or SCR's) for opening and closing DC circuits, and Triacs for switching AC circuits. When discussing solid-state relays, we will mostly use devices with Triac outputs as examples, which are usually used to control AC loads. However, keep in mind that DC versions of those relays (with the appropriate output devices) do exist.

Optical Coupling. Some SSR's are available with a unique feature called optical coupling. They are composed of a light-emitting diode (denoted LED) and a phototransistor or other light-sensitive semiconductor in a "light-tight" package. The LED, which is connected to the control circuit, shines on the light-sensitive component that serves as the actuating device for the power circuit. When the LED lights, it activates the light-sensitive semiconductor, completing the power circuit.

In some designs the photo-coupler housing has a slotted opening between the LED and the phototransistor and the LED is continuously lit. Control is provided by a moving arm, vane or other device that rides in the slot and interrupts the light beam in accordance with some external mechanical motion.

An optically-coupled relay is shown in Fig. 4. When the LED lights, its light falls on and energizes the phototransistor—a semiconductor whose collector-emitter current is controlled by the amount of light falling on its base region. It, in turn, activates the Triac-trigger circuit, which activates the Triac.

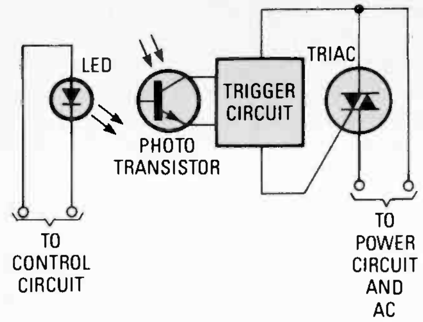


Fig. 4. The greatest isolation between power and control circuits is displayed by optical-coupling devices. They are also among the fastest-acting devices.

That arrangement is capable of providing the most isolation between the control and power-circuits.

Normally an LED requires about 1.5 volts for full emission of light, and will respond almost instantaneously when the control signal is applied, as would a phototransistor or Triac. Such relays have short turn-off times, making them capable of very fast activation and high speed, repetitive operation.

Other SSR's. There are other methods of isolation besides optical coupling. A transformer-coupled solid-state relay, shown in Fig. 5, is another such method. In that circuit, a DC control pulse is changed to AC in a converter circuit, the output of which is magnetically coupled to the Triac-trigger circuit by means of a transformer. Since there is no direct electrical connection between the primary and secondary of the transformer, control/power-circuit isolation is provided up to the voltage limit of the windings' insulation. The DC to AC conversion is necessary to take advantage of the transformer's ability to isolate the relay.

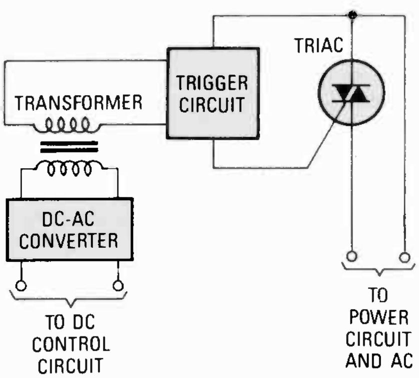


Fig. 5. The DC-AC converter in the circuit is not necessary for an AC control signal. However the transformer would still be useful as an isolating device.

That degree of isolation is usually unnecessary for most applications. The circuits complexity and bulk makes it an unattractive design. The circuits shown in Fig. 6 are the simplest alternatives. Note that there is no coupling device between the control and actuating circuits, so complete current isolation is not provided.

The device shown in Fig. 6A is known as a Darlington circuit and it provides a moderate amount of isolation. In it, there are two cascaded power transistors: one to receive the control signal, and the other to switch the power circuit on. The first transistor buffers the control signal to provide some isolation, although some control-signal current is used. Such SSR's are used in many DC

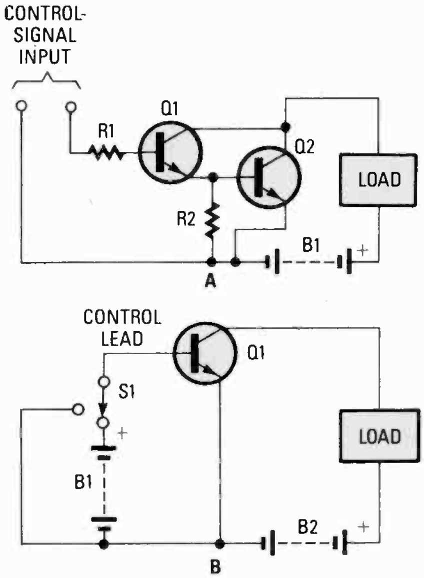


Fig. 6. Buffering the control signal from the power-switching component, as in A, provides some degree of isolation. Of course, some applications require little isolation, so the simple transistor switch in B will do for DC control signals.

circuits to achieve very high power gain—1000 to 10,000 and sometimes higher.

Electrically that unit is equivalent to the one shown in Fig. 6B, but with a very much higher power gain. The circuit in Fig. 6B can be used in a DC circuit the same way as the one in 6A, but provides less isolation because it has no buffer stage. Neither device is usable in AC-power circuits.

Hybrid Relays. As the name implies, hybrids are a combination of the reed and solid-state relays described earlier. Reed relays are often packaged in many low-cost, so-called "solid-state"

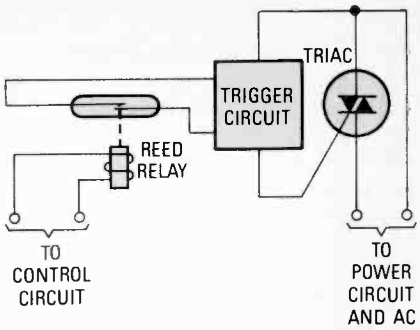


Fig. 7. The small size of reed relays makes them good isolation devices for solid-state relays.

relays because reed relays can readily serve as miniaturized coupling/isolation devices in such packages. The type of reed relay used operates with very low power-control signals. The reed-relay/solid-state combinations shown in Figs. 7 and 8 offer excellent isolation between their energizing coils and their reeds. Figure 7 is a configuration used for AC control, while Fig. 8 is used for DC control. Such circuits require DC control signals of around 5 volts at 8 mA, and they can be AC controled when a rectifier and filter capacitor are used, as shown in Fig. 9.

Hybrid relays can be made directly compatible with digital computers for use in circuits called controllers. Controllers must be able to work with a computer's logic-level outputs. The re-

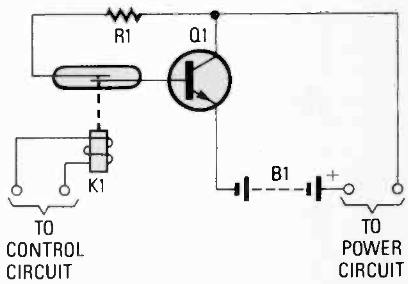


Fig. 8. For DC-power control, a reed-relay/transistor combination makes an effective switching device.

lay effectively acts as an interface between the digital-electronics world and the world of power systems.

However, as with any switching device, there are practical lower limits to the control-signal power necessary to drive the relay adequately and consistently. When the available control signal is below that limit (as it sometimes is in computer applications), a common expedient is to insert one or more stages of solid-state amplification. Such a circuit can help microwatts of control

A Reference Glossary of Relay Types

Add-subtract—See "bidirectional."
Annunciator—Triggers an indicator of the present or former state of one or more circuits.
Antenna-switching—See "RF."
Armature—See "electromagnetic."
Automatic-reset—See "homing," and "overload."
Auxiliary—See "slave."
Bidirectional—A stepping relay in which the rotating wiper may move in either direction.
Bi-metal—A thermal relay in which the free end of a bimetallic member deflects when heated to close one or more contacts.
Circuit-board—Miniature relay equipped with connecting pins for insertion into a printed-circuit board.
Clapper-type—Any electromagnetic relay in which the armature is hinged or pivoted on a fixed member.
Close-differential—A relay in which the pickup and dropout values are close together.
Coaxial—See "RF." So called because it was originally designed for use with coaxial cables or for switching the types of loads that coaxial cables usually carry.
Continuous duty—A heavy duty relay that may be energized indefinitely at maximum rated power, but remains within specified temperature limitations.
Crystal can—A microminiature relay packaged in a type of hermetically sealed enclosure originally used for housing a quartz crystal.
Current or current-sensing—An electromagnetic or thermal relay that operates at a specified current value.
Current-balance—Operates when the value of one current exceeds that of another by a specified amount.
Dashpot—A time-delay relay, employing the pressure of air, gas or liquid of selected viscosity to slow the motion of an activated plunger or piston and armature moving to close its contacts.
Delay—See "time-delay."
Differential—A relay with two or more windings that operate when the difference in voltage, current or power around windings reaches a specified value. The differential can be monostable, bistable, or center-off (three-position) polarized or non-polarized.
Double-arm—Relay with two pickups activated by separate armature arms.
Dry-circuit—See "low level."
Dry reed—See "reed." So called to distinguish it from a mercury-wetted type.
Dual coil—A relay with two coils, one on each leg of a U-shaped magnetic core.
Electrical interlock—See "interlock."
Electrical reset—On a latching relay, the use of an auxiliary coil, which, when momentarily energized, restores the relay to the unlatched state.
Electromagnetic (EMR)—Any relay employing an electromagnet to cause mechanical motion, thus effecting contact closure.
Electrostatic—A relay with adjacent electrodes which, when electrically charged, develop an attractive or opposing force between them (depending on the polarities of the charges) that is mechanically coupled to close relay contacts; in effect, a capacitor with moving plates that operates at high voltages.
Electrostrictive—A DC relay in which the dimensions of a dielectric body are changed by an electric field. The motion thus produced is mechanically coupled to operate the relay contacts, thereby giving the effect of a capacitor that makes contact when charged, and breaks contact when discharged. That type of relay is usually operated at very low voltages.
Fereed—See "reed."
Flasher—A self-interrupting relay usually a thermal type.
Frequency-sensitive—See "resonant reed," and "RF."
High-voltage—Senses and operates at a specified maximum voltage, or designed to handle high-voltage on coil, contacts, or both. See "vacuum."
Homing—A stepping relay that after each operational cycle is stepped around or back to the initial position.
Hot-wire—See "thermal," "linear expansion."
Hybrid—Combines electromechanical with electronic components to provide conversion or conditioning of the control signal's current or power.
Hybrid SSR—A reed-relay coupled SSR in which the control signal is applied to the coil, and closure of the relay switch activates circuitry that triggers a thyristor (a triggered semiconductor switch).
Impulse—A relay that alternately assumes one of two positions as the coil is pulsed (also called a flip-flop relay); or a relay that follows and repeats current pulses (e.g. from a telephone dial); or a a relay that discriminates between long (or strong) and short (or weak) pulses and operates only on one of the former.
Impulse-transmitting—Briefly actuates contacts during pickup or dropout.
Inertia—A relay modified to increase the moment of inertia of the moving parts and thus slow down operation or continue motion after the energizing signal is removed.
Instrument—See "meter type."
Integrating—Operates on energy stored from a long pulse or series of pulses.
Interlock—A relay with two or more armatures designed so that the position of one armature permits, causes, or prevents the motion of another. The linkage may be mechanical, electrical, or both (called a combination-interlock relay).
Intermittent-duty—A relay that must be left unoperated at intervals to avoid excessive temperature rises (as opposed to continuous duty), or one that operates at intervals, as in pulsing.
Latch-in—A relay that is locked in the on position by magnetic or mechanical means, after the coil has been energized. Either way, the latch reset may be mechanical or electrical.
Locking—See "latching," also "lock up."
Lock-out—An interlock relay in which the position of one armature prevents the motion of another.
Lock-up—A relay that remains locked in the operational position after its coil has been de-energized, by means of either permanent magnetism or auxiliary contacts that energize the coil electrically.
Low-level switching—A relay for switching dry circuits or low-level currents in the range of microamps or a few milliamps.
Magnetic contact—A relay with a contact spring operated by magnetic attraction when the coil is energized. A reed relay for example.
Magnetostrictive—A relay set in motion by dimensional changes of a magnetic material in a magnetic field.
Manual reset—A latching relay that must be manually returned to the inactive position.
Memory—A relay with two or more coils, each operating independently of contacts, and another set of contacts that remain in the state caused by the coil last energized.
Mercury contact—One of several types of relay in which the flow of mercury in a sealed capsule makes contact between stationary electrodes. For example, one in which the flow is caused when the capsule is tilted by an electromagnetic armature.
Mercury plunger—A relay in which a magnetic plunger is pulled down into or up out of

power to control kilowatts of output power.

A control-signal amplifier may contain a single transistor stage, a Darlington circuit, or even a complex combination of rectifiers, transistor amplifiers, level changers, filters, and other circuitry, depending on the characteristics of the available control signal and the demands of the relay. Some standard relays have built-in amplifiers designed specifically for various purposes.

For instance, some circuits incorporate op-amps for signal conditioning. The amplifier may merely amplify a small DC-voltage signal, or operate as a comparator, causing the relay to be on when the control signal is above a selected voltage level, and off when the signal is below that level.

A Reference Glossary of Relay Types (continued)

a pool of mercury by the magnetism of the surrounding actuating coil, thus raising or lowering the level of mercury to make or break contacts.

Mercury-wetted contact—An encapsulated reed relay in which the base of a single reed is fixed in a pool of mercury at the bottom of the capsule. The mercury flows up the reed by capillary action, wetting both the free end of the reed and the stationary contact it touches when activated.

Meter—A highly sensitive relay in which a D'Arsonval or similar meter movement actuates switching. A moving-contact arm replaces the pointer and a second adjustable arm carries a stationary contact. Also called an instrument relay.

Motor-driven—A relay in which a small electric motor drives a gear train and cam mechanism to give contact.

Multi-position—A relay with more than one pickup or non-pickup position, such as a stepping relay.

Neutral—A relay that operates on current of either polarity.

Overcurrent—A relay that activates an alarm or shuts off power when its coil current reaches a specified or dangerous value. See also "current-sensing."

Overvoltage—A protective relay that operates an alarm or shuts off power when its coil voltage reaches a specified or else a dangerous value.

Phase-sensitive—A relay actuated by a change in the phase relationship between two AC voltages or currents.

Photo-coupled or photo-isolated SSR—A solid-state relay in which the control signal activates the load circuit by a light source and photosensitive semiconductor.

Plunger—A relay in which the contacts are opened and closed by a movable solenoid-actuated plunger or core.

Polarized—A relay that operates on only one coil-current polarity. Opposite of a neutral relay.

Power—Any of several types of relay with heavy-duty contacts that are rated at 15 amperes or more, 28 VDC, or 115/230 volts AC or more.

Pulse repeating—See "impulse."

RF—Designed for switching radio-frequency currents with minimum loss. See "antenna" and "coaxial."

Reed—A relay in which two reeds (flat narrow, magnetic metal blades) are fixed at opposite ends of a sealed capsule with their contact-bearing free ends overlapping. When the coil around the capsule is energized, the free ends attract and meet to make contact, their spring tension separates them when the coil is de-energized. A "fereed" relay combines a dry-reed relay with one or more permanent-magnetic elements that latch the contacts together after a very short energizing pulse through the coil, until a release pulse, which changes the magnetic orientation arrives. See also "mercury-wetted contact."

Reed-relay-coupled SSR—See "hybrid SSR."

Resonant reed—A relay in which a vibrating reed with a contact at its free end responds only to a coil current of a specific frequency—See "vibrating reed."

Rotary—A relay in which the energized coil causes rotation of a shaft that carries the movable contacts.

Sensing—A relay responding to a specific condition or degree of excitation. See "current sensing," "overcurrent," "overvoltage," "resonant reed," "thermal," "undercurrent."

Sensitive—Any of the various types of relays requiring only small amounts of control-signal power to operate, commonly 100 ms or less in duration.

Sequential—A relay that operates two or more contacts in a specified sequence.

Series—See "current."

Slave—A relay of any type used to increase a circuit's power-switching capabilities or to operate secondary outputs such as alarms and indicators, etc.

Slow-operate—A relay designed for long operate time, but not necessarily long release time.

Snap-action contact—A relay in which the armature actuates a snap-action switch mechanism.

Solenoid—See "plunger."

Solid-state (SSR)—A relay in which the load current is conducted by one or more semiconductors such as a SCR, power transistor, or triac.

Stepping—A relay that commutates a movable contact through a series of fixed contacts in a semicircular array. Each energization of the drive coil advances the contact one step. Usually, the contact "homes" automatically to its beginning point after the last step. The relay usually comprises a number of such contact banks or "levels" driven simultaneously.

Telephone—A relay of the type originally developed for use in telephone-system switching equipment. It consists of a "pole" of contacts mounted on parallel, flexible, flat, metal fingers, some of which include extensions on which insulated tabs are installed. A level arm (part of the relay armature) engages the extensions, and produces contact closures and/or openings when the relay coil is energized.

Thermal—Any relay in which changes in the dimensions of a material, caused by a change in temperature, provide the mechanical motion to open or close a contact. In a half-wire relay, the expanding element is a heated wire. See "metal," and "linear expansion."

Thermal time delay—A thermal relay that employs the time that it takes to heat the expanding material as a delay interval between energizing of the heating element and the operation of the contacts.

Time delay—An electromagnetic or thermal relay that provides a specified time interval between energizing of the coil or heating element and actual contact closure. See "bimetal," "dashpot," "linear expansion," "mercury plunger," and "thermal time delay."

Timer—An early mechanical timing technique or clockwork mechanism. Energizing a winder solenoid in such a relay closes one set of contacts and winds a spring; a clockwork escapement then provides a timed unwinding interval, after which the contacts open or close.

Transformer-coupled SSR—A solid-state relay in which the control signal is applied to the primary signal of a low power transformer and the resulting secondary voltage triggers the thyristor switch in the load circuit.

Undercurrent, or ***undervoltage***—Protective relays that are designed to trigger an alarm or to cut power off when the energizing current (or voltage) declines below a specified value.

Vacuum—Any relay with contacts sealed in a vacuum; characteristically capable of handling high voltages and currents in a small configuration.

Vane-type—An AC relay in which current changes move a small vane or light metal disc.

Vibrating reed—A relay in which an AC or self-interrupting voltage applied to the coil creates a pulsating magnetic field that vibrates a reed to close contacts.

Wire spring—A relay in which round wire springs rather than flat leaf springs carry the contacts. ■

A form of hybrid frequently encountered is a relay designed to operate from a range of input voltages; that is, from a control source whose on-signal value may fluctuate appreciably. Such fluctuation could cause erratic relay operation. In that case, a simple constant-current source is interposed between the signal source and the relay, delivering a consistent energizing current to the relay coil, despite the variations in the applied signal. Theoretically, any control signal can be used to drive any relay properly and consistently, provided the right interface circuitry is used.

Time-Delay Relays. A time-delay relay interposes a known "waiting" interval between the application of the control signal and the actuation of the

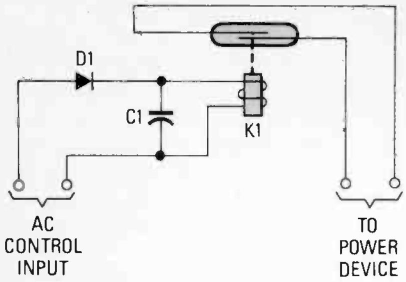


Fig. 9. By rectifying and filtering an AC control signal, it can be used to actuate a DC reed relay provided C1 can charge sufficiently on any given halfcycle.

relays contacts. The time interval of standard time-delay relays may be fixed or adjustable, and can range from a fraction of a second to 120 hours.

The function of a time-delay relay may be to open or close a circuit after a time interval, or a combination of the two by using multiple contacts. Time-delay relay's have three operating modes: slow operate/quick release, slow operate/slow release, and quick operate/slow release.

Various timing techniques are used to obtain delayed relay actuation. They include mechanical, hydraulic/pneumatic, thermal, electrical, and electronic. An early mechanical method is the clockwork mechanism, what most would call a timer. Energizing a solenoid in such a relay closes one set of contacts and winds a spring; a clockwork mechanism then provides a timed un-wind interval, after which the contacts open or close.

Hydraulic/Pneumatic. Some plunger relays are equipped with hydraulic or pneumatic "dashpots" to provide a delay in contact closure. In a dashpot, a piston forces a fluid through a small orifice in a cylinder at some known rate. When the solenoid of a hydraulic relay is energized, drawing its plunger into the coil, the plunger tip bears against the piston of a dashpot. The hydraulic fluid (or air) is slowly forced from the dashpot cylinder through the small orifice as the piston settles deeper until the relay contacts close at the end of the piston's travel.

Some armature relays come with dashpots for time-delay action, too. In them, the dashpot is actuated by a lever-arm extension mounted on the armature. Standard contact arrangements or lever-operated, snap-action switches are used to control the power circuit(s).

Normally, a check valve is included in the mechanism so that the contacts can release quickly when the relay is de-energized without waiting for the fluid (or air in pneumatic types) to be metered back through the same orifice. Some commercial models are position sensitive and require a particular orientation when installed for proper operation.

It is interesting to note that contact ratings for some members of this relay family may vary; the current decreasing as the delay interval is increased because the contacts make very slowly. If "make-slowly" action is undesirable, one can get time-delay relays with snap-action contact closure.

Interestingly, there are also mercury-type hydraulic relays in which the metal fluid serves as both the hydraulic-delay medium and the electrical contact-closure medium.

Thermal. There are several forms of thermal time-delay relays, but all make use of heat generated by an electric heating element mounted on their actuator mechanism. The most commonly encountered types contain a bimetallic element—a bonded "sandwich" made of two metal strips that have different thermal coefficients of expansion. One end of the strip is anchored and the other end carries the movable contact of the contact pair. A resistive-wire heater element is wound around the body of the strip, and is insulated from the strip by thin mica strips.

The heat from the element causes an expansion of the metallic strips; One strip will expand more than the other, so the element bends or warps toward the strip that's expanding the least (the one with the lower coefficient of expansion). After a short time, the warping will bring the movable contact to the adjacent fixed contact, completing the externally connected circuit. The time required for closure depends on the dimensions and composition of the bimetallic strip, the thermal output of the heater, and the applied heater current.

After the contacts close, they will remain closed as long as the heater is energized, and for an additional period after the heater power is removed since the bimetallic strip must cool sufficiently for it to return to its original form. The nominal accuracy of the time interval can be anywhere from ±10% to ±30% depending on the particular design and, more importantly, the ambient temperature.

Another type of thermal relay, called the "hot-wire" relay uses a single wire as the expansion element that causes contact closure. Current applied to the wire causes it to expand to provide the motion that opens or closes the power-circuit. The accuracy and ambient-temperature operating range is about the same as for the bimetallic-type relays.

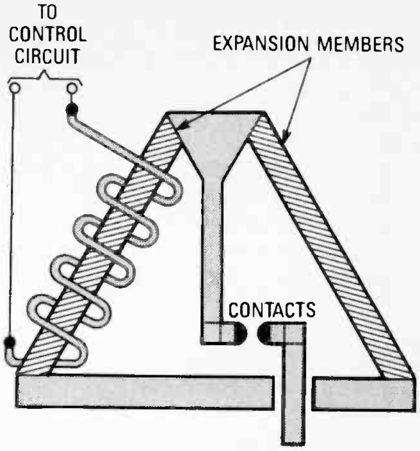


Fig. 10. By using two expansion members to hold the moving contact, the effect of ambient temperature is canceled out.

A linear-expansion type relay utilizes the change in dimensions of heating materials, but has an independent heater, as in the bimetallic relay. Unlike the bimetallic relay, it has a special mechanical design that balances out the effects of the ambient temperature, and is shown in Fig. 10. Two rigid members of identical material and size are mounted as a "thermal bridge" that supports a lever with a movable contact on its free end.

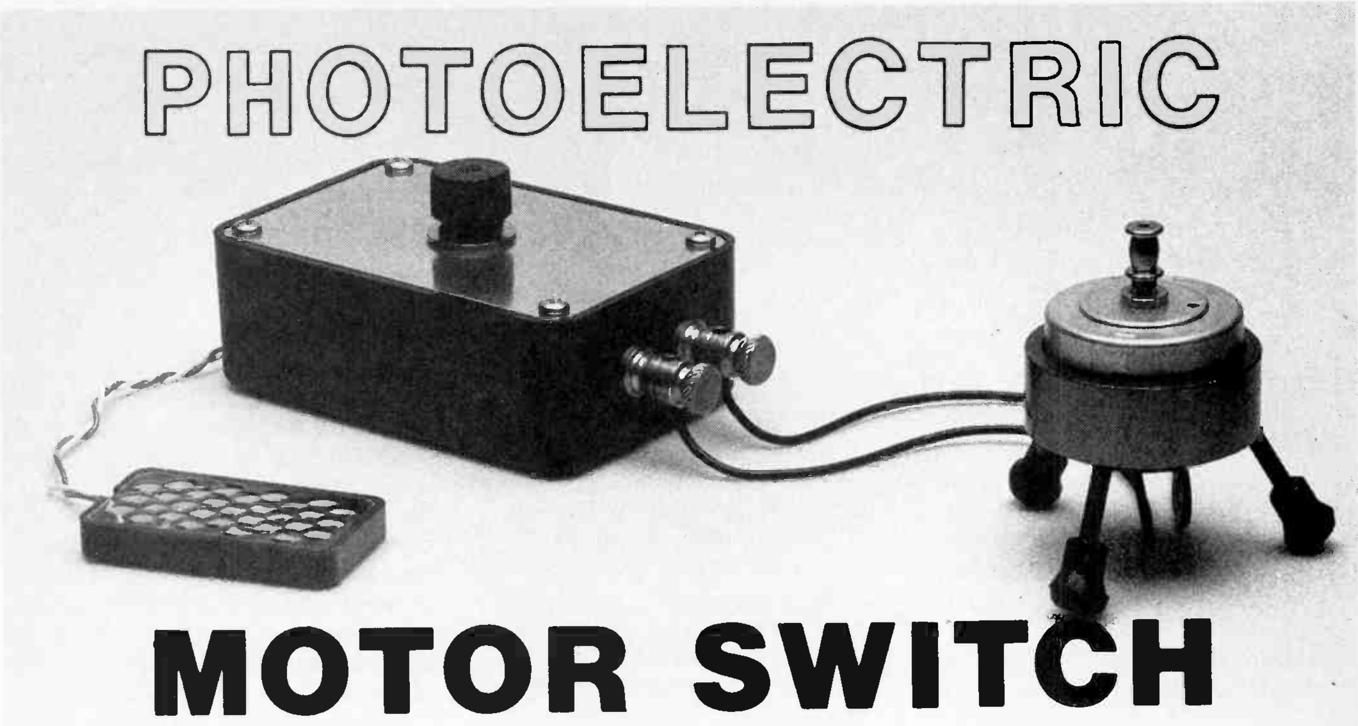
The heater winding is wound around one of the expansion members. When the member is heated, it tilts the contact lever in the direction that will produce closure with the fixed contact. Since ambient temperature changes cause equal expansion and contraction in both members of the bridge, the effect of the ambient temperature cancels out mechanically, and only the temperature of the heater influences lever deflection.

There is an appreciable time-lag after the heater current is removed before the thermally-deflected element resumes its original (cold) position (and can again offer a full time delay for the next operating cycle).

A thermal-delay relay is often used with an auxiliary relay that does the actual power-circuit switching. When the thermal-relay coil is energized, its con-

(Continued on page 100)

PHOTOELECTRIC MOTOR SWITCH



This simple photovoltaic switch project helps you to understand how photo cells can be used to your advantage.

BY STANLEY A. CZARNIK

Photoelectric devices, which are often regarded as an expression of twentieth-century high technology, have in fact a very long and complicated history.

In 1839, the French scientist Edmond Becquerel immersed two electrodes in an electrolytic solution. A small voltage was generated when one of the two electrodes was exposed to the light of the sun. In 1877, W. G. Adams and R. E. Day observed the same effect when light struck a sample of the element selenium.

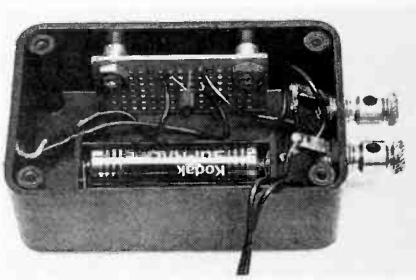
A related line of investigation originated in 1887 with the noted German experimenter, Heinrich Hertz. Hertz found that electric sparks pass more readily between electrodes illuminated by the ultraviolet light of another spark. A few years later, in 1890, Wilhelm Halwachs connected a polished zinc plate to a gold-leaf electroscope. Halwachs discovered that the zinc plate became electrostatically charged when irradiated by a strong electric light or the light from a burning magnesium ribbon.

Einstein's Contribution. A theoretical breakthrough was needed to unify those scattered observations. It was Albert Einstein who in 1905 first explained the photoelectric (or photovoltaic) effect in terms of the quantum character of light; namely, the photon.

Photoelectric emission is the liberation of electrons (from solids, liquids, or gases) due to the absorption of photonic energy. Einstein's theory was based only on the photon hypothesis and on the conservation of energy. For his theory of photoelectricity, Albert Einstein was awarded the Nobel Prize in 1921.

Solar-Cell Physics. The modern solar cell is, essentially, a semiconductor diode that takes in light and converts it to electrical energy. The conventional silicon solar cell consists of one layer of N-type silicon located under a very thin layer of P-type silicon (or vice-versa). The junction between the two is a typical PN junction. The area in the immediate neighborhood of the PN junction is called the *depletion layer* or *space-charge region*.

When light strikes the cell, electron-hole pairs are created in the depletion layer. That forces the electrons to migrate from the N side of the cell, and the holes (electron vacancies) to the P side. If the two sides of the PN junction are connected to a load through an external circuit, an electrical current flows in that circuit. Most single solar cells generate an output of about 0.5 volt.



A small project box provides just enough room for a 3-volt "AAA" battery pack and a piece of perfboard for the transistor.

The Switch. With one small solar cell, a 2N2222 NPN transistor, and a 3-volt battery pack (two 1.5-volt cells connected in series), it is possible to build a sensitive photoelectric motor controller. The circuit is so simple that you can actually put it together on a solderless breadboard in less than five minutes. Then, if you wish, you can build a per-

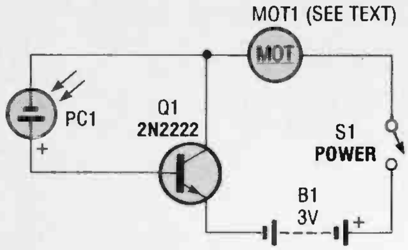


Fig. 1. When the solar cell is illuminated, a positive bias is placed on the base of Q1, causing the transistor to conduct, thereby applying power to the motor.

manent version. The switch makes an excellent introductory solar-energy project.

As can be seen from the schematic (see Fig. 1), power for the motor (MOT1) is provided by a 3-volt battery source, which is controlled by two switches—a transistor switch consisting of Q1 and a toggle switch S1. With little or no light striking the photo cell, PC1, no bias, or insufficient bias, is applied to the base of Q1. With insufficient bias delivered to its base, Q1 presents a high series resistance to the current from the battery pack—effectively an open circuit—so no current flows through the motor, and no work is performed.

However, as the light intensity striking the photo cell increases, so does its voltaic output. At some point, the bias applied to the Q1's base reaches sufficient magnitude to induce conduction, thereby completing the motor circuit. That allows battery power to pass through the motor, causing the motor to spin.

A very powerful source of light is not needed to get the circuit to function. A small desk lamp or even a flashlight should provide enough illumination to activate the switch. The stronger the illumination, the faster the motor will turn. Once the motor starts working, the solar cell may have to be deprived of light entirely before the motor will come to a complete stop.

Note: If you use components and/or a power supply other than those mentioned in the Parts List, your system may not operate exactly like the prototype. For example, different motors may begin to turn at different voltage levels. You can monitor the output of the circuit by connecting a voltmeter across the motor terminals.

Construction. The construction of the Photoelectric Switch is not critical. Your version of the Photoelectric Switch can be built on a small section of perfboard, or hard-wired to a barrier block. In the author's prototype, transistor Q1 was mounted to a piece of perfboard, and housed in a small project box. The photo cell and motor are then connected to the transistor switch via short lengths of hook-up wire, fed through holes in the enclosure.

You may choose some other arrangement, but be sure that the photo cell has direct access to light that will act as the trigger source. The circuit can be housed in almost any type of enclosure that has sufficient room for the battery pack that supplies the motor's operating power.

The solar cell and motor connections can be made either temporary or permanent. I chose to attach the solar cell permanently to Q1 and supply a couple of binding posts for the motor. For convenience, a small SPST switch may be added to the output part of the circuit. And as for the motor, nearly any low voltage (3-volt or less) DC hobby motor will work just fine. A suitable unit is available from the supplier mentioned in the Parts List.

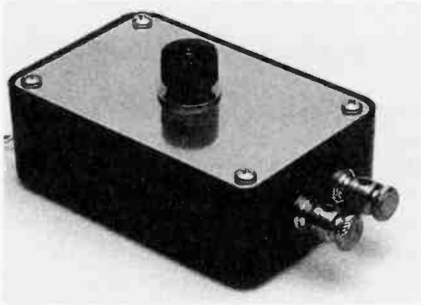
PARTS LIST FOR THE PHOTOELECTRIC SWITCH

Q1—2N2222 general-purpose NPN silicon transistor (Radio Shack 276-1617)
PC1—Solar Cell (JerryCo C-7104 or equivalent)
MOT1—Low-voltage DC, hobby motor (JerryCo C-10368 or equivalent)
B1—Two 1.5-volt "AAA" batteries (see text)
S1—Single-pole, single-throw toggle or rotary switch

ADDITIONAL PARTS AND MATERIALS

Printed-circuit or perfboard materials, enclosure (Radio Shack 270-230 or similar), battery holder (Radio Shack 270-398 or similar), binding posts, hook-up wire, solder, hardware, etc.

The following items are available from JerryCo, 601 Linden Place, Evanston, IL 60202: solar cell at $3.00; motor at $1.75. IL residents must add sales tax. Please note that the company now requires a minimum order of $12.50 and a flat $4.00 fee for shipping and handling. The JerryCo catalog is available at $0.50.



Under the knob on top of the unit is an old plastic single-pole, single-throw rotary switch. A small SPST toggle switch will work just as well.

Other Uses. While the motor used in our circuit is small, a similar arrangement can also be used to activate heftier motors. Of course, some modification to the basic circuit might be necessary. For instance, with only a slight modification, the circuit can be used to activate 117-volt AC motor, or another AC device. That can be accomplished by replacing the motor in Fig. 1 with a relay, with the relay contacts connected to the motor circuit (see Fig. 2) to control its operation much the same as transistor Q1 in Fig. 1 controls motor operation in that circuit.

The circuit in Fig. 2, like the one in Fig. 1, is activated when PC1's voltaic output (which is delivered to the base of transistor Q1) rises to a sufficient level. However, instead of transistor Q1 allowing the flow of current through the motor, current flow is now through the relay, K1. The relay (which, in this case, has a 12-volt coil) must have contacts that are rated for 117-volt AC operation. The relay contacts are wired in series with the motor (MOT1) and the 117-volt AC power source.

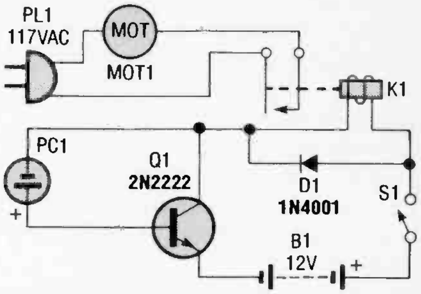


Fig. 2. With a simple modification to the basic photo switch of Fig. 1, the circuit can be used to activate of line-operated devices such as motors, lamps, etc.

A further modification to the circuit—the inclusion of a low-voltage power supply—would allow the battery to be eliminated from the circuit alltogether. The circuit in Fig. 2 is not limited to the operation of a simple motor; by replacing the motor with a 117-volt AC socket, lamps (as well as other line-operated devices) can be activated by the circuit. There is an endless array of modifications that can be made to the photo-switch circuit. ■

AUGUST 1989

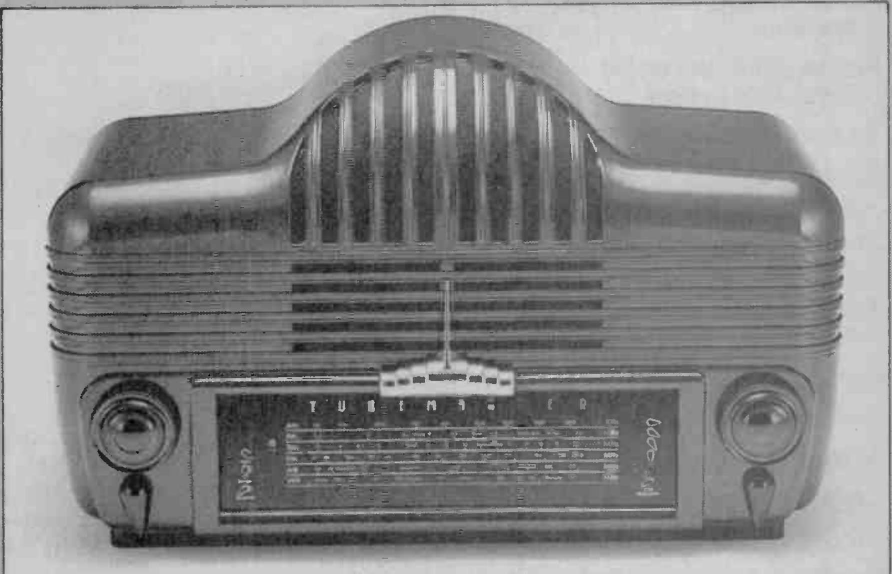
GIZMO®

VOLUME 2,
NUMBER 8

A CHRONICLE OF CONSUMER ELECTRONICS

Back to the Future

TUNEMASTER SIX-BAND CLASSIC RADIO REPLICA. Available from: The Sharper Image, 650 Davis St., San Francisco, CA 94111. Price: $199.



CIRCLE 51 ON FREE INFORMATION CARD

The growing interest in antique radios and a dramatic increase in shortwave broadcast listening have converged in a product unveiled in *The Sharper Image's* spring catalog: the *Tunemaster Six-Band Classic Radio Replica*. Externally, the Tunemaster is a reproduction of a pre-World War II, European-manufactured table radio, the *Sonora Excellence 301*. Inside, however, the replica has been outfitted with modern components to produce a six-band AM/FM/shortwave receiver. Further bands allow the listener to tune into VHF, which can include police, fire, ambulance and marine communications; as well as pagers and non-cellular mobile telephones; aviation transmissions; the National Weather Service 24-hour broadcasts; and single-sideband transmissions (with the assistance of a beat-frequency oscillator).

For the experienced radio hobbyist, the Tunemaster, despite its attractive exterior, may not seem like anything special. That is why **GIZMO** selected a tester with no experience in shortwave. We wanted to find out if the Tunemaster could serve as an introduction to the fascinating world of shortwave and whether it would perform well in the hands of a novice.

Equipped with a 15-foot antenna wire, our tester ran the line out of his fifth-floor apartment's window to the roof of the building. Despite its location—the middle of New York City, surrounded on three sides by apartment buildings—he was able to start picking up shortwave immediately. Some further adjustment of the wire improved reception, but he couldn't shake the notion that the human body was nearly as important to the receiver's performance as the supplied antenna. Seated next to the radio, shortwave reception was notably clearer than it was when trying to listen from across the room.

On the Tunemaster's front are two dials, one for volume and power and one for frequency tuning, and two teardrop-shaped knobs for band and broadcast selection. There's something about the radio's appearance that reminds us of the dashboard of a 1947 Plymouth; perhaps it's a combination of the type style used on the dial, the speaker cover's rounded crown rising above the radio, and the back-lit dial itself.

On the radio's rear panel are a headphone jack; speaker-out jack; BFO switch; antenna and ground terminals; 75-ohm antenna-jack; auxiliary input and output jacks; and fine-tuning, tone, and loudness-equalization knobs. While considerations of authenticity probably dictated their location, in using the Tunemaster we wished the fine-tuning control, in particular, had been placed in a handier location. Fine tuning proved to be a must for bringing in shortwave broadcasts.

One innovation we fully endorse is the inclusion of an "instruction tape" (besides the usual owner's manual) with the Tunemaster. Narrated in a classic announcer's voice, the tape gives the novice a sense of what to listen for, and what to expect from the radio's reception in audio terms. Samples of reception from each band are included on the cassette, as well as advice on antenna placement and tuning. In recognition of today's emphasis on the instant and effortless, the tape reminds users several times that it's necessary to "tune very slowly" and "with much patience" across the SW, sideband, weather, or aviation transmission bands. Even without the radio, the tape would serve as a concise introduction to non-AM/FM radio activity.

The receiver's 5-inch speaker is "mounted in an air-sealed internal exclosure, completely separate from the case." We have to say that we didn't find speaker performance to be outstanding, even when listening to AM/FM. (Perhaps our expectations had been unrealistically raised by the instruction tape's creamy spiel.)

In a month's worth of "listening in," our tester became rather proficient at tuning such shortwave services as Radio Moscow and the BBC's worldwide service. Reception of weather, sideband and VHF activity was, for the most part, defeated by the crowded urban ether and the limitations inherent in the antenna's location. (The more time he logged on the dials, however, the better reception became.)

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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: Rick Hammer, Erik Lacitis, Tom Ligamari, Rick Marx, Bruce R. Olson.

CIRCLE 52 ON FREE INFORMATION CARD

Speaker Esprit

PRECISE MONITOR FIVE SPEAKERS. Manufactured by: Precise Acoustic Laboratories, Suite B, 200 Williams Drive, Ramsey, NJ 07446. Price (per speaker): $180.

When it comes time to top off your home-stereo system, does speaker selection leave you feeling a little queasy? "At sea" when it comes to matching performance with preferences? Relax. That lack of listener self-confidence is widespread enough to have inspired a brand-new line of loudspeakers from *Precise Acoustic Laboratories*, an independent but wholly owned division of *Onkyo U.S.A. Corp.*

Designed by renowned audio engineer Keith Johnson, the *Monitor* speaker line promises "serious listeners," who are "more bewildered than ever about which loudspeaker to choose for their high fidelity system," "long-term listenability." Identified as one of Johnson's "many theories regarding loudspeaker design," long-term listenability would seem a goal that any lay listener might endorse, especially if the consumer doesn't have the luxury of replacing loudspeakers every couple of seasons.

GIZMO had the opportunity to listen to a pair of *Monitor 5's*, one of five models rolled out last year in Precise Acoustic's introductory line. Described by Precise as "a true bookshelf sized reference monitor," the unit stands 21⅙ inches high, 10⁵⁄₁₆ inches wide and 12⅛ inches deep, and weighs 32.1 pounds (making it somewhat of a large entry in the bookshelf category).

In reality, using it in a horizontal position (which is what we've always taken "bookshelf" to mean) compromises its performance. Perhaps it's a tribute to their precision engineering to say that these are the first speakers in which we've been able to detect a notable difference in their performance in the horizontal and vertical positions. (If we'd used speaker stands, that would probably have made a discernible difference as well.)

In our use of the Monitor 5's, we used a recently introduced *Audio Dynamics* integrated amplifier, tuner, and CD player, as well as a *Technics* tape deck that is positively antique in consumer-electronics terms. For our "control group," we connected a pair of *Acoustic Research TSW 105's* (GIZMO, March 1989) as the system's "B" speakers.

The speaker's manufacturer, Precise, in its advertising literature, makes the claim that "many of today's loudspeakers have not kept up with major advances in recent years among other audio components. Most contemporary loudspeakers are based on technology that was already showing its age years ago."

To our ears, it seemed clear that Precise's style of audio fidelity is very much in keeping with contemporary tastes, presumably a reflection of those "major advances" in other home-stereo technology. Much attention has been focused in recent years on bass reproduction and enhancement. The Monitor 5's certainly produce a beefy, even muscular bass response, that is solid without being earth shaking in its strength.

That was true even at low volume levels. Yet bass doesn't seem to be emphasized at the expense of the midrange and treble tones. Instead, a subtle balance is maintained—or at least that's what it sounded like to us. But we should say that not everyone who heard the speakers agreed with our assessment.

A **GIZMO** contributor who's done a fair amount of recording and audio engineering for live performances positively hated the Monitor 5's reproduction of high-end sounds. He maintained that in his opinion they sounded "processed" and artificial.

One listener's processed artificiality, however, to another set of ears is "bright and articulated" sound. To our way of listening, there is a spaciousness to the Precision speaker's handling of the entire range of musical sounds that we came to appreciate. Such controversy at least suggests that Precise Acoustics hasn't taken the middle-of-the-road route in trying to rethink loudspeaker design (which, at this point in audio-reproduction history, must resemble trying to reinvent the wheel).

Speaking of controversy, in its instruction manual Precise indicates a lack of enthusiasm for equalization: "We suggest you do not use equalization unless the sound quality of the source isn't to your liking." Further explaining that the speaker is designed to "reproduce music over a wide frequency range, with a smooth octave to octave balance that sounds natural and uncolored." Equalization, it's implied, can denaturalize and color the Monitor 5's sound.

Looking at the unit's specifications we read that it has a "rated input power" of 40 watts and a "maximum input power" of 80 watts. It is a speaker of the "two way, tuned port" type and has a frequency response of 32 Hz to 224 kHz. What we know is that we especially liked the way the guitars on Lou Reed's new album sounded through the Monitor 5, as well as Louis Armstrong's cornet and vocals on a new, digitally processed reissue of some of his recordings from the 1920's. The presence achieved by a CD of a Haydn string quartet as performed by the Endellion String Quartet was nearly enough to get us to reconsider our musical preferences, or at least to begin reacquainting ourselves with classical recordings.

Like the music that goes through them, the final choice of home audio-system loudspeakers is really a matter of individual listener preference and taste. *Consumer Reports* magazine has called loudspeakers, "the make or break component," suggesting that when buying speakers it's a good idea to "try to arrange for return privileges." And, in fact, regardless of what the guys in the white lab coats may report about a particular speaker, or what well-reasoned argument your local neighborhood audiophile uses to support his preferences, the important exchange is the one which takes place between your ears and the speaker. In our brief encounter, the Monitor 5's were well worth lending an ear to. ■

CIRCLE 53 ON FREE INFORMATION CARD

No Strings Attached

REALISTIC STEREO INFRARED WIRELESS TRANSCEIVER SYSTEM. Manufactured by: Tandy Corp., One Tandy Center, Fort Worth, TX 76102. Price: $89.95.

Perhaps your household has witnessed similar encounters: You want to watch *Full Metal Jacket* at top volume. Or maybe that Def Leppard video has just appeared on MTV, and you're trying to revive your adolescent interest in heavy metal. Your spouse, meanwhile, wants to quietly read a novel by the crackling fireplace.

There is a big argument. Your spouse indignantly exits to the bedroom to read. Or maybe you turn off the TV and glare at your loved one.

That's happened in our household—which is why we were so enthusiastic about trying the *Realistic Stereo Infrared Wireless Transceiver System*. Now that we've logged numerous listening hours, we're still enthusiastic, despite some undeniable drawbacks.

Most wireless headphones work by using infrared light waves to transmit sound signals. The user simply connects the infrared transmitter to the earphone or headphone jack of a TV set, VCR, or stereo amplifier, and then connects any standard pair of headphones to the infrared receiver. (The Realistic system isn't equipped with its own set; we used a $6 Radio Shack headphone that worked just fine.) The receiver looks like the kind of beeper that doctors carry, complete with a clip for fastening it to a shirt pocket or belt.

That's all there is to it. Now you can watch (and, more to the point, listen to) that high-decibel movie at top volume without incurring the wrath of others in the vicinity. You can even walk around the living room wearing the headphones without worrying about a cord, as the transmitter provides 40° coverage. In our case, that means 9 feet on either side of the transmitter.

As mentioned, the Realistic system has its drawbacks. A background hiss is a common accompaniment to most audio programs. Through trial and error, we learned how to keep that interference at a tolerable level.

It's important to remember that infrared light travels in a straight line. That means the transmitter should be placed at the same height as, or maybe a little higher than, the receiver. If the listener usually lies down on the sofa while using the transceiver, he should locate the transmitter accordingly. Also, intense sunlight and bright incandescent indoor lighting can interfere with operation, as those are also infrared light sources. If that happens the transmitter will have to be moved to a darker spot in the room.

We connected the transmitter to our VCR (a *Panasonic PV-4862 HQ*), which has stereo-reception capability. We were glad to have purchased the stereo version of the Realistic infrared system, instead of the companion monaural unit, as the listener can really "experience" stereo broadcasts. (Believe it or not, *The Tonight Show* is broadcast in fantastic stereo. When Ed chortles at one of Carson's quips, he's heard on the left side of the headset. And Doc answers Johnny's jibes on the right side.)

The transmitter is equipped with an AC adapter and features a volume control that is adjusted until a green indicator lamp begins glowing. The receiver uses a single 9-volt battery, which has given us many hours of service thus far. The receiver has a volume setting, along with an ON/OFF switch. (We often just covered the re-

(Continued on page 5)

CIRCLE 54 ON FREE INFORMATION CARD

Talking Tutor

VOYAGER. Manufactured by: Texas Instruments, Consumer Relations, P.O. Box 53, Lubbock, TX 79408. Price: $70.

Interactive voice technology has been a hot product category in consumer-electronics marketing, if only for the innate appeal of using the voice to direct a device or appliance. But in the marketplace, interactive voice products have compiled a mixed sales record.

Application has often been the sticking point, but the *Texas Instruments Voyager* educational toy would seem to be a potentially valuable use of interactive voice recognition. The product's headset computer asks questions about subjects like dinosaurs, U.S. presidents, or elementary biology and registers the child's response.

The youngster learns by reading a booklet and then conversing with the Voyager headset. "Software expansion packs" each contain two parts—software cartridges and a booklet with text and illustrations—at a suggested retail price of around $19.95. After reading the printed instructional material, the user feeds the software cartridge into a slot in the headset. Similar to a computer diskette but more user-friendly and child-sized, each Voyager cartridge is equipped with a tiny handle.

With the cartridge in place, the child enters into a conversation with the Voyager, answering the questions it asks about information in the booklet. The **GIZMO** test unit came with "Dinosaurs and Prehistoric Animals," 36 color-illustrated pages with a minimum of easy-to-read text. Other Voyager software packs are entitled "Journey to Exotic Animals," "Journey into Space," "Journey to Birds and Reptiles," and "Journey Across the United States." Texas Instruments recently introduced three new packs—"U.S. Presidents," "Journey to Human Anatomy," and "Journey to the Language Arts."

The Voyager system offers education with near infinite patience and makes learning fun. As Texas Instruments puts it, "This is an educational electronic toy that takes children 5 through 9 years old on learning journeys." Those journeys can be undertaken right at home, in a car, or just about anywhere, since the headset is light, comfortable and compact.

The booklet for "Journey to Dinosaurs" was developed with the assistance of Dr. Paul Cerno, Professor of Vertebrate Paleontology at the University of Chicago. Slipping a cartridge into the device, we put on the headset and turned it on: "The time machine is on and warming up ... hold tight, here we go, back, back, back in time. Do you want to explore dinosaurs?"

When we responded "yes," the Voyager gave us a choice of voices in which it would speak to us. We went with the normal voice, although different and unusual voices are aimed at keeping youngsters' attention and interest. The Voyager offered a true-and-false quiz on dinosaurs. The device asked and we answered. If we stopped and pondered, the question was asked again. When our response was correct, the electronic tutor was encouraging, "That's correct," "Outstanding," "You're doing very nicely!" and similar messages. In addition to the true-and-false test, kids can "design" their own dinosaur, bird, or reptile using the animal parts discussed in the software and accompanying booklet.

The real test, of course, is with its intended age group. So **GIZMO** recruited an 8-year-old and a ten-year old to try out this talking electronic tutor. The younger test subject said she liked "Journey to Dinosaurs" better than the same pack's "Journey to Prehistoric Animals." She then ran through some facts regarding the Brachiosaurus, adding that the Voyager "tells you what it likes to eat and stuff." Her response to the synthesized voice was unexpected. She liked the regular voice, but "hated" the synthesized, low-bass voice.

The ten-year-old sister of our first small-fry tester also used the Voyager, but didn't discuss it with her sibling. The Voyager was, apparently, a solitary activity, as homework often is.

According to a spokesman for Texas Instruments, the Voyager headset contains three small computers, one for the voice data synthesis, one to respond to the frequencies of the human voice—recognizing the "s" in "yes" and in "false," the "o" in "no," and the "u" in "true." The final onboard computer tells the other two what to do, such as changing the frequency of the synthesized voice. According to Texas Instruments, the Voyager is the first moderately priced consumer item that incorporates built-in "voice discrimination."

The headset design stands out as safe, comfortable, and attractive. A foam pad rests against the child's head and ear, and the headset itself is constructed of soft plastic in complementary yellow and purple. The Voyager unit requires four "AAA" alkaline batteries, which go in a compartment on the headset. After setting the headset aside, the Voyager continues for a time until it shuts itself off, saying, "So long, gang!" Leaving the headset near a television or radio immediately after using the product can cause the Voyager to continue talking.

Texas Instruments Consumer Division maintains a long-distance telephone number, which can answer questions about its products. The company provides a one-year limited warranty against defective material or workmanship and will repair a malfunctioning product or replace it with a reconditioned comparable model at the firm's expense.

The Voyager is part of what the company calls "Texas Instruments Learning Path," a system of electronic toys that addresses children's "learning phases"—the skill and knowledge acquisition characteristics of different age groups. Toys for early learning (ages 2 to 4) encourage use of the imagination, along with

(Continued on page 6)

Phone Ease

DUOFONE 202 SPEAKERPHONE WITH DIRECTORY AND AUTO DIALING. Manufactured by: Radio Shack, Tandy Corporation, One Tandy Center, Fort Worth, TX 76102. Price: $119.95.

CIRCLE 55 ON FREE INFORMATION CARD

Nowadays you can pick up any newspaper flyer and see ads for telephones with all kinds of features that in real life you likely won't use. The *Radio Shack Duofone-202* is a telephone loaded with electronic gimmicks, most of which we actually have found quite useful.

At first sight, the unit with all its buttons—besides the telephone keypad, it includes a second keypad with the entire alphabet—looks a little imposing. But after a few minutes of use, the design reveals itself as entirely user friendly.

One feature that sets this telephone apart is its 200-name-and-phone-number memory capacity. Each individually entered number can contain up to 32 digits; the name entries can hold up to 16 characters each.

To "program" the Duophone-202, you press the STORE key and the word "name" appears on the LCD located at the top of the base unit. You enter the name you wish to store via the alphabetic keyboard, and press the STORE key again. The LCD display then goes blank and you enter the corresponding phone number via the telephone keypad. By pressing STORE once more the name and number are memorized.

Names can be called up from the directory in several ways. You can press ENTER and type in the first three letters of the name of the person you're calling. The unit automatically goes into the speakerphone mode and dials the requested number. If, by chance, you've stored more than one name beginning with the same first three letters, the last letter blinks and the Duofone-202 requests the next letter of the name.

A name can be called up by pressing its first letter on the alphabetic keypad. For instance, by pressing "G," "George" might appear on the LCD. Press "G" a second time and the next name stored, let's say "Gordon," appears. A third press of "G" would call up the next alphabetic "G" entry. When the LCD displays the right name, all you do is press the DIAL/REDIAL button and the phone automatically dials the number.

You can also scroll through the directory by holding a letter key. Each name beginning with that letter is then displayed for a second. When the name you want appears, you release the letter button.

The phone has the capability of storing the last phone number you've dialed, and has three "priority" buttons—P_1, P_2, and P_3—for speed dialing important or frequently called numbers. There's also a code button through which a series of numbers can be stored, a useful feature for connecting with a computer and using security codes. Those stored numbers can be transferred in turn to a second memory as a coded single digit, leaving memory space for more efficient storage of the main directory.

The Duofone-202 automatically displays the time on its LCD screen, which seems a minor enough feature, but it's surprisingly handy to have the time displayed on your phone.

Other features are standard for many contemporary phones. It has a speakerphone (with good fidelity), it can redial a number up to ten times automatically, and it has a "privacy" feature for when you don't want the person you're talking with to hear what you're saying to someone present at your end of the conversation. The Duophone-202 also has an LDT button to communicate with the telephone system's tone-access services. It has the PAUSE and FLASH buttons required by some special, subscriber phone services (so special we've never used them).

The unit requires two "C" alkaline batteries to keep its memory up and running. The batteries in our unit have lasted for at least six months. There is a battery tester located on the bottom of the unit for quick determination of remaining battery life. A dimming of the LCD display indicates that the power source needs replacement.

All in all, we have been happy with the Duofone-202 in everyday use. It's undergone a real-life test—it was accidentally dropped from a height of five feet on a couple of occasions, and it took the beatings like a champ. Tough and hardworking—it's many automatic features make it something of a telephonic valet—the Duofone-202 doesn't require a technical re-education to access its many features and capabilities. While it won't be mistaken for the old-fashioned, featureless home telephone, it shares at least one important characteristic of its predecessors—unobtrusive dependability. ■

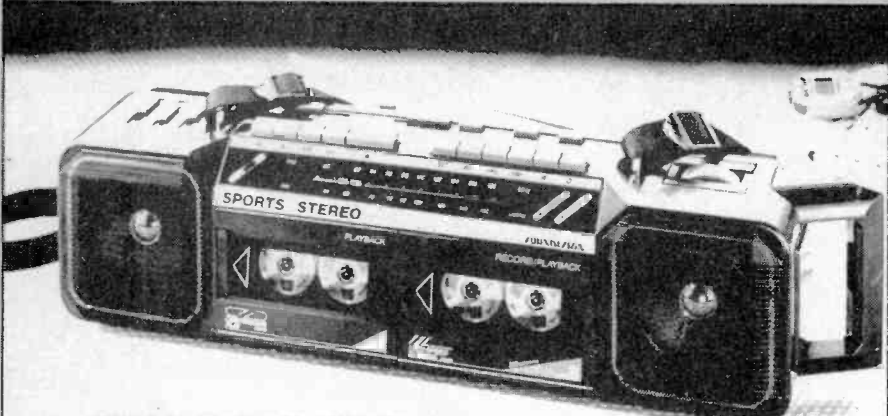
NO STRINGS

(Continued from page 3)

ceiver's sensor window, blocking out the infrared light signal, to cut the volume entirely.)

Although fastidious listeners might consider the system's background hiss to be more than a minor irritation, it usually is at such low levels that we have stopped hearing it. After all, this article is being typed on a computer with a fan cooling its innards. The noise from the fan has become an expected part of the room's audio ambiance.

A final note: Do not confuse the Realistic Stereo Infrared Wireless System with some mysterious systems widely advertised as having a "remarkable" effect which produces "monostereo simulation," whatever that might be. ■



CIRCLE 56 ON FREE INFORMATION CARD

Budget Box

SOUNDESIGN PORTABLE DUAL CASSETTE RECORDER WITH AM/FM STEREO (4752BLK). Manufactured by: Soundesign Corp., Harborside Financial Center, Jersey City, NJ 07311-3962. Price: $69.95.

Let's say you've decided to take a much-needed vacation and want to bring along some music. Or perhaps your kids are off to summer camp and after you've busted your budget paying fees and outfitting your junior campers, the offspring insist they need some portable audio to take with them. In such situations, there's no time to make a careful consumer search for the best possible system, and thanks to the miracle of mass electronic production, there's no need to.

Not every audio purchase is made with the audiophile's dedication to ultimate fidelity regardless of cost. In the real world, few of us have the bottomless bank accounts that audio magazines seem to assume consumers come equipped with. That's what drew **GIZMO**'s attention to the *Soundesign Portable Dual Cassette Recorder with AM/FM Stereo*. Its low suggested retail price puts it within reach of all kinds of consumers. If it simply performs adequately, it's a perfect answer for "emergency" audio requirements. And at less than $70, it doesn't cost much more than ordinary travel or vacation incidentals.

Sturdy and compact, the *4752BLK* (also available in yellow as the *4752YEL*) is a dual cassette recorder, equipped with an external microphone and a three-band graphic equalizer. Emphasizing its designation as a "sports" model, there's a folding built-in handle on the unit's right end, and it also comes equipped with a canvas strap for over-the-shoulder carrying. Power is supplied with either a detachable AC cord or from six "C" batteries.

In a month of use, the Soundesign system proved its sturdiness—it was knocked off tables at least twice in the course of our test—and performed well enough as a radio, tape recorder, and dubbing unit. While our tester wasn't astounded by its performance, as long as we recalled its price we found it lived up to its product description.

The only exception was what Soundesign calls its "high performance 3½ inch speakers." Our tester characterized the speakers as being about as good as most television loudspeakers. Technically, they might be "high performance," but to our ears they're "adequate performance" units.

There are some eccentric aspects to the 4752BLK's design, but none which seem to affect its overall performance. Cassettes are placed upside down and the transport system moves the tape to the left. Slightly confusing at first, but made more so by the instruction manual's odd wording in explaining cassette insertion: "insert cassette tape with tape facing up and the side you wish to play facing you [the assumption being the user is in front of the unit]." Its right-to-left tape transport might just appeal to the left-handed among us.

Music taped with the Soundesign 4752BLK isn't going to give CD reproduction a run for its money, but on the other hand it's not hard to listen to. If we wanted to carp, we'd say it was slightly muffled, as if recorded at the other end of a long tunnel. But compared to many car radios, other budget-priced portable receivers, and elevator-music systems, the 4752BLK does just fine. Dubbing at either high or normal speeds produces the same consistent dub. Tapes from the radio fall into the same acceptable range, and prerecorded music tapes play back at the same level of audio fidelity.

Appropriately enough, considering the brand name, we'd give Soundesign good marks in the design department. Controls and indicators are simple and clearly marked, although the three-position TAPE/DUBBING/RADIO switch label is a little less than obvious in indicating its triple settings. We also wish that the TAPE REWIND, FAST FORWARD, and PLAY/RECORD controls automatically popped up when cassette end is reached. The dubbing instructions, however, do say that tape units "A" and "B" ("A" is playback only) are equipped with "automatic stop."

Just for the sake of flexibility, it would be useful to equip the unit with audio input/output jacks. But in terms of day-to-day use, it's probably more practical to include a headphone jack, as the 4752BLK does. Without casting any aspersions, we also have to wonder about long-term durability in systems such as the tape transport and even in switches and controls. Costs, invisible or otherwise, have to be cut somewhere.

But as a quick solution to a lack of audio resources, or as a first system for a preteen, or just as a music source to take on vacation without worrying about losing the unit or having it stolen, the Soundesign 4752BLK seems to us to fill a valuable niche in the consumer-audio market. ■

TALKING TUTOR

(Continued from page 4)

color, shape, and picture recognition. In the pre-school phase (4 to 6), Texas Instruments education products are designed to support number, letter and word recognition; promote real-world skills; and encourage planning and other cognitive behavior. The school-age learning phase (ages 6 to 12) encourages logical thought, promotes good study habits and develops comprehension skills.

According to Texas Instruments, the goal is for the child to do better in school. The company's "learning phase" toys incorporate proven learning methods, to promote creativity, provide a challenge and to interest the kid long enough to provide lots of learning-related play. In our brief test of the Voyager, it seems to live up to those expectations. We may not be educational theorists, but we do know a lot more about dinosaurs. ■

BACK TO THE FUTURE

(Continued from page 1)

We've often wondered why interest in shortwave listening fell off so sharply among the general public over the past few decades. In the years before and after World War II, many (if not most) high-quality console radios were equipped with shortwave capabilities. Whatever the reason, the pendulum seems to be swinging back today; The Sharper Image reports that sales last year of world-band receivers increased by 25 percent. The introduction of the relatively simple-to-install-and-use Tunemaster (available in either "ivory" or "candy apple red") will likely help increase sales, especially among new shortwave listeners, even further. ■

Fully Armed

ROBOTARM (SV1-2000A). Manufactured by: Quick Shot Division, Bondwell Industrial Co., Inc., 47485 Seabridge Dr., Fremont, CA 94538. Price: $69.99.

The *Quick Shot Robotarm* is a "fun first encounter with robotics for the young" (age five and up), and once mastered, *Bondwell Industrial* promises, the device can be used to pick up objects, build miniature structures, or dig with human-like dexterity. The Robotarm is capable of picking up and manipulating an object as small as a paper clip or as large as a tennis ball

The Robotarm is set up on a flat surface, stabilized by legs equipped with rubber cups. It's powered by four "D" batteries, and controlled with a video-game-style

(Continued on page 8)

CIRCLE 57 ON FREE INFORMATION CARD

Robo-Dentist

INTERPLAK HOME PLAQUE REMOVAL INSTRUMENT (PB-2). Manufactured by: Bausch and Lomb Oral Care Division, 5243 Royal Woods Parkway No. 100, Tucker, GA 30084. Price: $99.

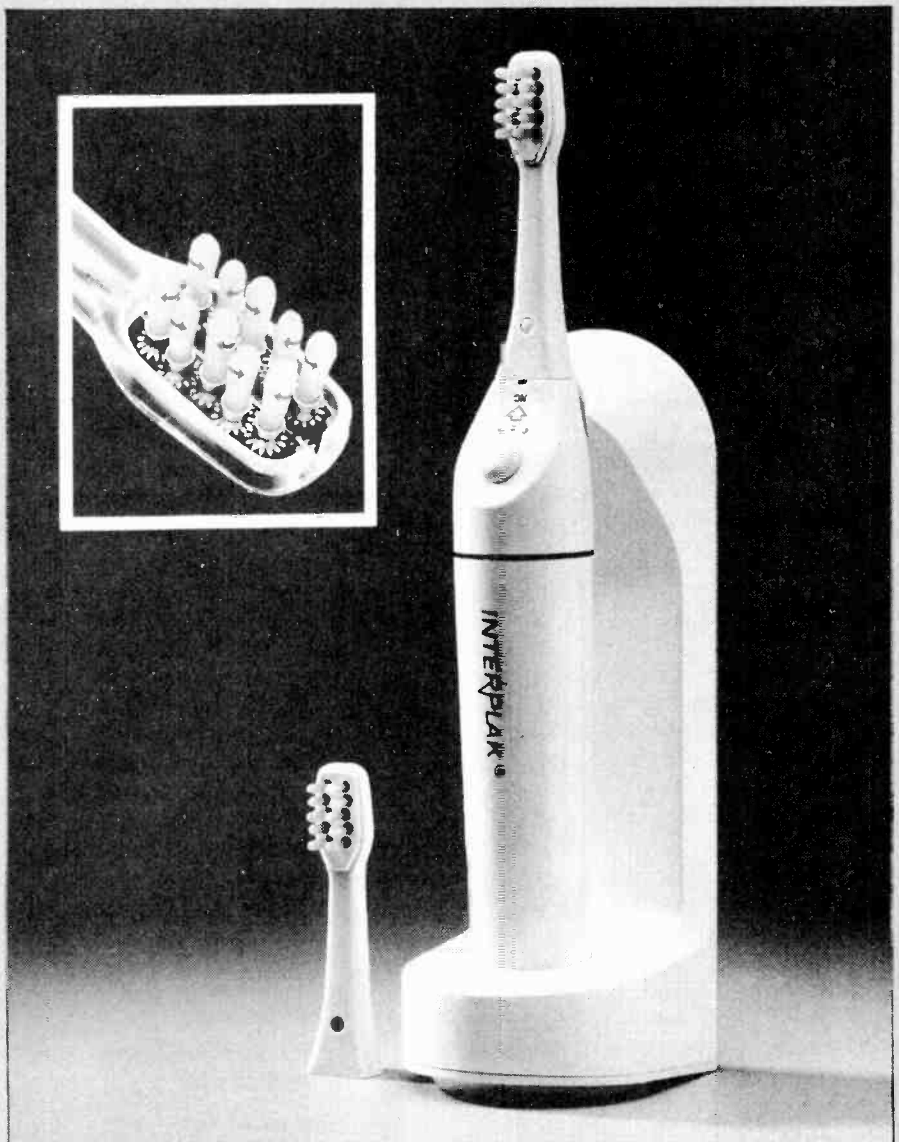
The *Interplak Home Plaque Removal Instrument* certainly looks hi-tech, and it is. Its precision electronic and mechanical engineering make it an amazingly effective dental tool when, to quote a phrase famous from years of repetition in toothpaste advertising, "used in a conscientiously applied program of dental hygiene."

Using snap-in brush heads, the unit turns each individual tuft of bristles 4200 times a minute. Each tuft—a brush head has ten tufts—also reverses direction 46 times a second, and revolves in a direction opposite that of the next set of bristles, creating a slight receding and extending of the tufts.

All that bristle maneuvering is supposed to remove plaque between teeth and along the gum line where periodontal disease often originates. If the user so desires, he can secure a copy of eight clinical studies from the manufacturer that show Interplak leaves tooth surfaces 98.2% plaque free.

Our own experience has been that Interplak can sometimes be more diligent in removing plaque than we desire, leaving our mouths feeling a tad sensitive. The instruction manual does carry this warning regarding possible gum irritation: "It is common to experience a small amount of bleeding during the first week of use." The unit features a trio of speed settings, and

(Continued on page 8)



CIRCLE 58 ON FREE INFORMATION CARD

ARMED

(Continued from page 7)

joystick. (Bondwell also makes other styles of controllers, but they must be purchased separately.)

The Quick Shot Robotarm comes with a choice of three different "fingers"—forceps, a shovel with stabilizer, or a magnetic arm with a thumb-like sheath. The device has five axes of arm movement: rotation clockwise or counter-clockwise at the base; wings down or up at the "knee;" lowering and lifting from the forearm; a rotating "wrist;" and opening and closing to grasp an object at the hand. Those arm movements are driven by five small motors with 180° vertical freedom and 270° horizontal freedom.

The robotic limb accurately simulates the performance of a full-scale industrial robot of the sort increasingly used in manufacturing and construction. With its spotlight on and its audio effects going, a youngster can enjoy the excitement of a tiny work site. Movement is satisfyingly fluid and practice pays off in increased robotic dexterity. Kids should respond to its challenge. As with a video game, there's a long arc of increasing skill and comprehension.

As the Robotarm operator learns to use the device, its potential continues to unfold. Even though you won't be juggling expensive crystal or scrambling eggs with the arm, it remains fun and challenging—fascinating in the way pre-electronic mechanical toys often were. As an exercise for developing eye-hand coordination, the Robotarm again can be compared with electronic games—with the added attraction of the action taking place in three dimensions.

We have found the Quick Shot Robotarm offered in two science catalogs, Edmund Scientific (101 E. Gloucester Pike, Barrington, NJ 08007) and Kelvin Electronics (7 Fairchild Ave., Plainview, NY 11803), the Robotarm has apparently found its main following among younger science and electronics buffs. (The Kelvin Electronics catalog offers the Robotarm with a computer interface for the Apple computers most often found in schools, allowing the user to program the Robotarm's sequence and combinations of movement, creating yet another level of challenge and mastery.)

But for just about any kid, the Quick Shot Robotarm would provide an involving introduction to the possibilities of robotics. Just as there's been attention paid to the importance of making the younger generations "computer compatible," maybe preparing youngsters for life in the robotic age might be a legitimate educational concern. If that's the case, Bondwell has devised an excellent learning tool. If not, the Robotarm is still a fascinating action toy. ■

DENTIST

(Continued from page 7)

it's recommended that users begin with the slowest speed.

Still, we like this newest tool in the dental-hygiene arsenal. We have always been somewhat lazy teeth-brushers (as several decades' worth of dentists have told us). The unit, which is simple to use and care for, leaves a very hygienic mouth in under two minutes. The brush is moistened with water; you don't even have to use toothpaste with the Interplak. Bristles are placed perpendicular to flat tooth surfaces, and the instrument is guided slowly along the outside, the inside, and then the biting surfaces of your teeth. After use, hot water should be run for a minute through its cleaning ports (a little hole in the brush head) while the instrument is still on. (Once a week the cleaning procedure should be repeated using mouthwash.)

The Interplak comes with a charging base which is plugged into any standard outlet. The power handle should be towel dried before it's returned to the base.

By the way, the instruction manual carries the "medical warning" that the unit is designed for "teeth cleaning only. Do NOT use the instrument for any other purpose." We pondered that warning for a while and concluded that technical writers assigned to instruction manuals must have vivid imaginations. ■

ELECTRONICS WISH LIST

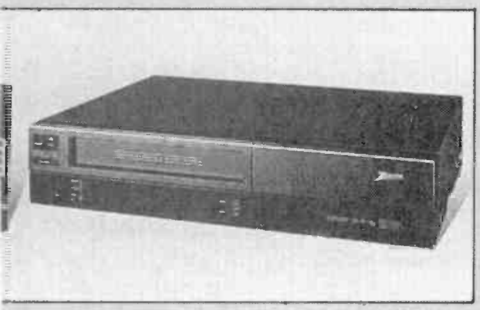
For more information on any product in this section, circle the appropriate number on the Free Information Card.

Minolta Compact 35mm Camera

Compact 35mm Camera

One of the drawbacks of many automatic cameras is the limited range of the lens. The *Freedom Zoom 90* from *Minolta Corp.* (101 Williams Drive, Ramsey, NJ 07446) is a 35mm camera that features the versatile 38mm–90mm (2.4 ×) power-zoom lens, a simple-to-use zoom-program mode, multi-beam focusing, and an optional zoom extender. The zoom mode is particularly useful for portraits, allowing a photographer to get a close-up shot without pushing the camera into the subject's face. The focusing is done through 5 infrared beams, which are projected onto the subject to correspond to what is seen in the viewfinder. The camera can detect more than one subject and focuses on the nearest, so the user can adjust the camera for those artistic shots with the subject off-center or near the edge of the frame. Price: $428.

CIRCLE 59 ON FREE INFORMATION CARD



Zenith Teletext-Compatible VCR

Teletext VCR

The industry's first video-cassette recorder that can record and play back teletext is available from *Zenith Electronics Corp.* (1000 Milwaukee Ave., Glenview, IL 60025). The *Super-VHS Video Cassette Recorder (VRE550HF)* allows recording of closed-captioned material for the hearing impaired as well as a variety of other printed data. That includes teletext program listings, news stories, stock quotations, and other information. The recorder must be used with a Zenith TV set that features built-in teletext decoding. The top-of-the-line unit also features standard- and extended-play recording, a flying erase head, and on-screen menus including items like timer, clock, and recording status. Price: $1,149.

CIRCLE 60 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

Heart-Rate Monitor

The fine art of exercising can be dangerous, and the jogger or walker is wise to know where he stands at all times. The *Pro/Trainer Watch (8733)* from *Computer Instruments Corp.* (100 Madison Ave., Hempstead, NY 11550) allows wary exercisers to keep on top of what their bodies are doing at all times. Using a chest-strap transmitter, the heart rate is sent wirelessly to the wristwatch. The watch displays the heart rate and also gives the time of day or stop-watch time. Its high and low alarms can be set based on exercise goals or limits, assuring maximum benefit from the activity without pushing too hard or under-performing. Price: $249.

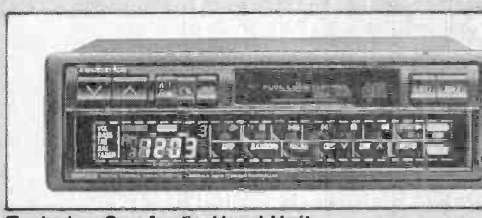
CIRCLE 61 ON FREE INFORMATION CARD

Pro/Trainer Heart Rate Monitor

Compact-Disc Changer

The *Compact Disc Changer (CDC-500)* from *Yamaha Electronics Corp. USA* (6722 Orangethorpe Ave., Buena Park, CA 90620) offers the convenience of single or multiple compact-disc operation and a wide program selection. A 10-key direct-access system provides instant selection of any track on any loaded disc. A supplementary set of 6 keys provides access to any disc in the unit's magazine. The memory can store 32 programmed selections to be played in any order selected. And the player can repeat a single disc or all the magazine-loaded discs for hours of uninterrupted music. Price: $499.

CIRCLE 62 ON FREE INFORMATION CARD

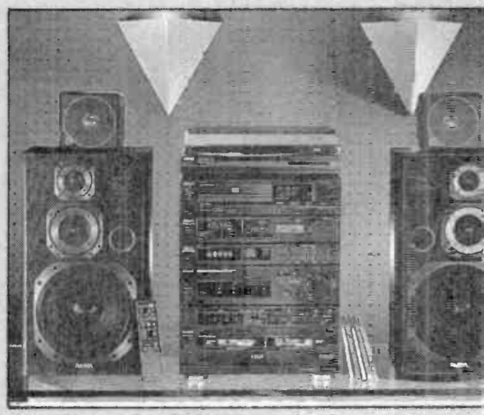


Technics Car Audio Head Unit

Car-Audio Head Unit

For ease of control in a vehicular sound system, the touch-sensitive LCD face of the *Audio Head Unit (CQ-R9550)* is hard to surpass. The face serves as a display and control panel simultaneously, so the driver/listener can manipulate the controls while concentrating on the road. This *Technics* (One Panasonic Way, Secaucus, NJ 07094) unit is equipped with a palm-sized remote control. Features include quartz digital "Alphatuner," a full-logic cassette deck, and an optional 12-disc CD changer. Price: $699.95.

CIRCLE 63 ON FREE INFORMATION CARD



Aiwa Home Audio System

Home-Audio System

Consumers with large rooms and an interest in concert-quality sound may want to have a look at (and listen to) the new *Home Audio System (X-88)* from *Aiwa* (35 Oxford Dr., Moonachie, NJ 07074). The system is powered by a 100-watt-per-channel amplifier and comes with a CD player, a tuner, a graphic equalizer, a double-cassette deck, a turntable, dual speakers, and a wireless remote control. Further features include surround-sound circuitry, and "dynamic super loudness" bass enhancement. The AM/FM tuner is equipped with digital-readout synthesizer; memory presets; and a system timer with clock, daily-event, single-event, and sleep functions for automatic audio recording from broadcasts. The CD player has 10-key direct music search, 20-selection random programmable memory, and a double over-sampling digital filter. Price: $1,100.

CIRCLE 64 ON FREE INFORMATION CARD

MB Quart Subwoofer

Subwoofer

The addition of a subwoofer to an audio system has clear advantages in the reproduction of sound, but often leaves something to be desired in terms of decor. The *1310 Subwoofer* from *MB Quart Electronics USA, Inc.* (25 Walpole Park S., Walpole, MA 02081) is one possible solution to that conflict. MB Quart says that the unit permits "smooth unobtrusive integration into a living space" as the "aesthetically pleasing" unit is available in "eleven striking finishes" and a "smoke glass top." The 1310 incorporates a 12-inch front-firing woofer in an aluminum cast-frame with crossover fixed at 100 Hz @ 18-dB per octave. Price: $899.

CIRCLE 65 ON FREE INFORMATION CARD

ELECTRONICS WISH LIST

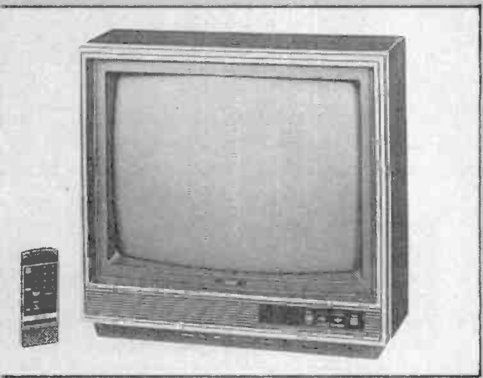
For more information on any product in this section, circle the appropriate number on the Free Information Card.

Casio Electronic Pedometer

Electronic Pedometer/Calorie Counter

The manufacturers of wrist timepieces have discovered that variety is the spice of life. One of the more interesting entries in the wrist-information explosion is the *Electronic Pedometer (EXW50)* from *Casio, Inc.* (570 Mt. Pleasant Ave., Dover, NJ 07801). This instrument gives its wearer an accurate reading of how many calories are being burned during exercise. By inputting age, weight, height, and gender, the EXW50 can be personalized to the physical-fitness profile of its user. The watch can also store some 30 sets of "exercise information patterns," so the user won't forget what to do next during a pound-shedding exercise session. Price: $79.95

CIRCLE 66 ON FREE INFORMATION CARD



Sanyo Ninteen-Inch TV

Ninteen-Inch Television

"Armchair convenience" in a reasonably priced 19-inch Television is the claim made by the *Sanyo-Fisher (USA) Corp.* (21350 Lassen St., Chatsworth, CA 91311-2329) on behalf of its new *91C624* tabletop model. The set is equipped with a 20-button infrared remote control with direct-access tuning for up to 119 channels; on-screen displays for time, channel, and volume; and a power-off timer. Last-channel memory flips back to the previous channel at the touch of a single button. Sanyo's "black matrix picture tube" is said to deliver crisp, clear colors, with automatic fine tuning and single-button color control assuring optimum reception and the proper hue balance. Price: $299.99.

CIRCLE 67 ON FREE INFORMATION CARD

Mini Stereo Radio-Cassette Player

For consumers less inclined to rugged outdoor adventure, *Samsung Electronics America* (301 Mayhill St., Saddle Brook, NJ 07662) has introduced a *Mini Stereo Radio-Cassette Player (MY-A1)*, which may not take much of a beating, but which won't bust a buyer's budget. Weighing a mere 9½ ounces, the mini-unit offers a three-band graphic equalizer, auto reverse, Dolby-B noise reduction and a "sensitive AM/FM tuner." Power is supplied by two "AA" batteries or via a 3-volt DC adapter. Price: $69.95.

CIRCLE 68 ON FREE INFORMATION CARD

Broderbund U-Force Game Controller

Hands-Off Video-Game Controller

If you've been waiting for "the world's first and much anticipated video game controller that eliminates all physical contact between player and machine," your patience has been rewarded. From *Broderbund Software, Inc.* (17 Paul Dr., San Rafael, CA 94903-2101) comes *U-Force* for use with the Nintendo system. Plugged into the joystick port, it requires no batteries or other power source. A set of switches allows the user to configure U-Force for use with specific Nintendo games. In "Mike Tyson's Punch-Out," for example, to throw a left jab, the U-Force-equipped player simply throws a left jab in mid-air, and the game receives the command. Within the "three-dimensional range" of the system, "a patent-protected series of electronic sensors and proprietary circuitry" detects a player's exact motion, velocity and relative position and translates that data into instant on-screen action. U-Force is equipped with a complete set of accessories, including "firing handles and T-bar." Whether it will solve the vexing physical condition dubbed "joystick elbow" remains to be seen. The U-Force controller is scheduled for a spring retail debut. Price: $69.95

CIRCLE 69 ON FREE INFORMATION CARD

Playskool Super Express Train Set

Super Express Train Set

Nobody says that the *Super Express Train Set* from *Playskool* (1027 Newport Ave., Pawtucket, RI 02861) is particularly high-tech, but as toys aimed at the preschool set goes, it is not without its charms. Four "D" batteries power the locomotive, which can pull up to 6 cars at 2 speeds in both forward and reverse along the 24 segments of smooth-edged track included with the set. Other kid-friendly features include the size of the rolling stock (slightly larger than standard train-set cars), colorful styling, and "rounded edges for little hands to easily grasp and hold." Further cars and accessories are offered separately by Playskool. Price: $95.

CIRCLE 70 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

Outdoor Cassette-Corder

Toughness and durability are the mark of an outdoor cassette/radio unit, and the *Outback AM/FM Radio Cassette-Corder (CFS-D960)* is ready to provide full-bodied sound "whether on African safari or at a ski slope in St. Moritz." Available from *Sony Corporation of America* (Sony Dr., Park Ridge, NJ 07656), the unit features a "Mega Bass" sound system for enhanced performance and two 4-inch speakers. Durability is built-in with elastomer coating over high-impact plastic. The water-resistant Outback has large, easy-to grasp controls. Other features include auto reverse, auto shut off, and automatic music sensor. Price: $219.95.

CIRCLE 71 ON FREE INFORMATION CARD

Sony Outdoor Cassette-Corder

Automotive Loudspeaker

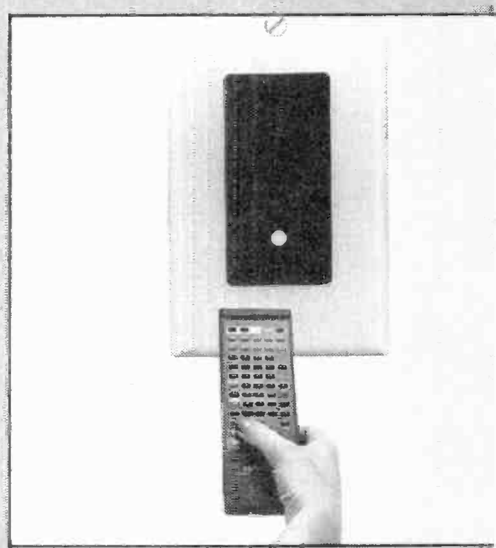
Dynamic sound and sleek design are the keynotes of the *Automotive Loudspeaker (JSM301)* from *International Jensen, Inc.* (4136 N. United Parkway, Schiller Park, IL 60176). The speaker is compact but still delivers 100 watts of peak power with 25 watts of continuous RMS capacity. It has a 4-inch woofer, 2½-inch midrange and a 1-inch solid-state tweeter. The versatile mounting rack can be used in vans and campers as well as cars. Price: $139.93.

CIRCLE 72 ON FREE INFORMATION CARD

Remote Control Extender

A user can control a sprawling home-entertainment system from anywhere in the house with the *Xtra Link Custom System (780)* from *Xantech/Video Link* (12950 Bradley Ave., Sylmar, CA 91342). The system consists of a series of receivers, senders, and connecting blocks tailored to the user's needs. The receiver mounts in a standard, single-gang, electrical J-box and is no more obtrusive than a light switch. The system can be built into as many rooms as needed and can control multiple audio and video sources from various remote locations. Price: $74.95.

CIRCLE 73 ON FREE INFORMATION CARD



Xtra-Link Wireless Remote Extender

MIDI Sequencer

This product helps program and synthesize sounds with the touch of a button. The *MIDI Sequencer (SY-MQ8)* from *Technics* (One Panasonic Way, Secaucus NJ 07094) has a memory capacity of 23,000 notes; another 90,000 notes can be stored on a double-sided 3½-inch floppy disk. By storing and playing back musical MIDI data signals (such as volume, velocity, note number, and program change), the unit allows auto-play of any MIDI instrument. There is also a large selection of play/edit functions, including in/out, repeat copy, delete, merge, medley play, and quantizing. MIDI channels can be programmed independently for each of eight tracks, and the musical technician can record a new part on a separate track while listening to the newly recorded section. Market introduction is scheduled for later this year. Price: Not available.

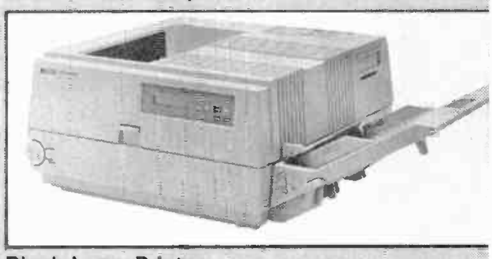
CIRCLE 74 ON FREE INFORMATION CARD

Technics MIDI Sequencer

Laser Printer

Specially designed for desktop publishing and heavy graphic-output applications, the new *Laser Printer (6000/PS)* from *Ricoh Corp.* (Five Dedrick Place, West Caldwell, NJ 07006) provides 6-page-per-minute printing in versatile formats. In its "PostScript" mode, the printer can produce newsletters, brochures, presentation material, computer-aided designs, and more with text in any of 35 typefaces contained in 11 fonts. The "HP LaserJet Series II" mode can be used for general office output, including business letters, database output, spreadsheets, charts, and reports. The unit interfaces easily with many computers, including IBM's and compatibles, and Apples and Macintoshes. Resolution is 300 dots per inch with 24 standard HP fonts resident on the printer. Price: $4,495.

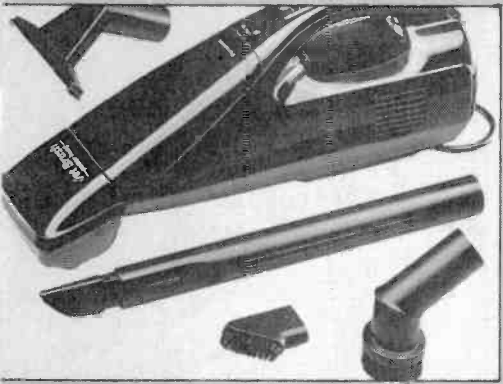
CIRCLE 75 ON FREE INFORMATION CARD



Ricoh Laser Printer

ELECTRONICS WISH LIST

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

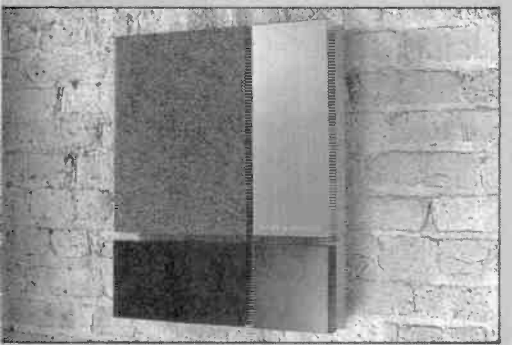


Panasonic Hand-Held Vacuum

Hand-held Vacuum/Duster

Dusty table tops, gritty workbench surfaces, and thick rugs are the enemies of the *Jet Brush Vacuum/Duster (HV-P750)* from *Panasonic Co.* (One Panasonic Way, Secaucus, NJ 07094). Its sophisticated twin-motor system and a variety of attachments allow the user to declare war on dirt everywhere in the home or workshop. One of the motors is located just below the handle, providing optimum suction, while the second is inside the power nozzle, rotating the agitation brush to loosen dirt and grit. Attachments—an upholstery tool, a swivel dusting brush, a crevice brush, and an extendible crevice tool—provide easy access to hard-to-reach places. Price: $99.95.

CIRCLE 76 ON FREE INFORMATION CARD

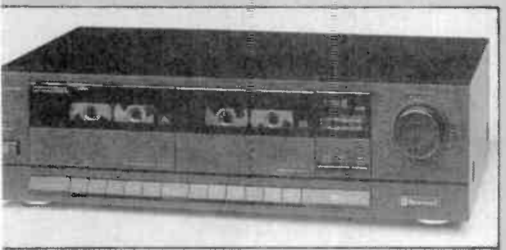


Bang & Olufsen Wall-Mount Speaker

Panel Speakers

If your home-entertainment area is already crowded and getting more so, the *Panel Loudspeakers (BEOLAB 3000)* from *Bang & Olufsen of America Inc.* (1150 Freehanville Dr., Mount Prospect, IL 60056) could help relieve the congestion. The speakers are only 3⅙-inch deep and require no floor or shelf space. The units simply attach to the wall and can be connected to any B&O audio/visual system. The amplifiers in the speakers automatically switch on and off and incorporate a "Dynamic Bass Equalizer" function that alters bass output at various volume levels. The speakers can also be placed in a separate room; a "Master Control Link" can provide complete listener control from the central system. Price: $1,695.

CIRCLE 77 ON FREE INFORMATION CARD



Sherwood Double Cassette Deck

Double Audio Cassette Deck

High-speed dubbing and Dolby-B noise reduction are available at an economy price in the *Double Cassette Deck (DD-1030)* from *Sherwood* (13845 Artesia Blvd., Cerritos, CA 90701). The front-loading unit also offers relay play and has settings for normal, chrome, and metal tape. It features adjustable record level; three-digit tape counter: LED record-level indicators; and air-damped, soft-eject cassette doors. The unit has a frequency response of 30 Hz to 16 kHz, and an S/N ratio (with Dolby B) of 65 dB. Price: $159.

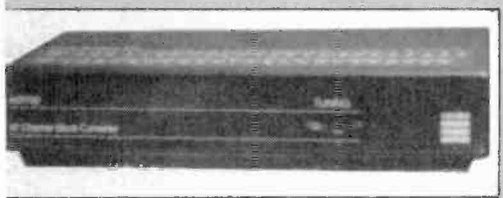
CIRCLE 78 ON FREE INFORMATION CARD

Toshiba S-VHS VCR

S-VHS Hi-Fi VCR

The march of technology continues to improve VCR capability. A new unit from *Toshiba America, Inc.* (82 Totowa Rd., Wayne, NJ 07470) offers what the company says are "sophisticated editing and digital effects previously available only on professional VCRs." The *Super VHS Hi-Fi VCR (SV-F990)* features three key editing components: automatic assemble, automatic insert, and pre-roll editing. Digital effects include wipe, fade, color correction, color fader, superimposition, and negative/positive inversion. The unit's flying erase head accurately deletes frame by frame and the model also has jog and shuttle rings for varying playback speed. Price: $1,800.

CIRCLE 79 ON FREE INFORMATION CARD



TV Block Converter

TV Block Converter

You can avoid extra cable-television bills and still get all the non-pay cable channels you want to see with *The TV Block Converter*, available through *Haverhills* (131 Townsend St., San Francisco, CA 94107). The 7- by 3-inch unit converts a television's VHF, midband, and superband channels to 47 UHF channels if it's already connected to regular pay cable. The Block Converter also features remote control and facilitates use of the VCR to record one channel while viewers watch another. Price: $34.95.

CIRCLE 80 ON FREE INFORMATION CARD

Stay on top of the action—even when you've gone to bed or out on the town—with this scanner-controlled recorder-activation unit!

Build the AUTO SCAN

BY TIM GOEBEL

It never seems to fail. You wake up in the morning, turn on the radio news, and there it is: A major fire across town, a drug bust in the local park, or an airliner forced to make an emergency landing along the highway. Such events always seem to happen just after you've turned off your scanner and gone to bed, or left the house.

Some of the hottest action to come over the airwaves for months, and you missed it...that is, until *Auto Scan*. With Auto-Scan connected between your scanner and a tape recorder (via the recorder's microphone or auxiliary input and its remote start jack), you'll never have to worry about missing any of the action.

Auto Scan is similar to several of the available commercial units, but offers greater flexibility. The Auto-Scan unit has a level control that allows it to be used successfully with any type of scanner—portable or base unit—regardless of its output-amplifier configuration. It also provides control over the length of time the recorder continues to run after the transmission ceases. Also included in the circuit is a switch that allows you to select either automatic or manual operation.

When Auto Scan is set to the auto mode, the recorder's motor operates only during transmissions. In the manual mode, the motor is activated whenever any of the recorder's functions (play, rewind, etc.) is selected. That allows all the interconnecting cables to remain in place when you decide to rewind and listen to the tape. A speaker in/out switch is provided to allow monitoring (via the circuit's built-in speaker) while recording. In addition, Auto-Scan provides both microphone and line-level outputs, so that even the least-sophisticated recorders can be used.

How It Works. Figure 1 is the schematic diagram of the Auto-Scan circuit. Audio from the scanner's earphone or speaker jack is fed to the circuit via J1. Jack J2, which is wired parallel with jack J1, provides a line-level output for input to the recorder via its auxiliary input jack. The signal is also fed through a voltage divider, consisting of resistors R1 and R2, which attenuates the signal for the MIC OUT jack J3.

Switch S1 is used to switch speaker SPKR1 in and out of the circuit. In the OUT position, a 10-ohm resistor, R3, is switched into the circuit in place of the speaker's 8-ohm impedance, providing a fairly constant load for the scanner's output. Capacitor C1 blocks any DC voltage that might be present. The signal is then fed to the inverting input of U1-a (½ of an LM1458 dual op-amp), the gain of which is set to about 150 by the R5/R4 combination.

The output of U1-a at pin 1 is rectified by diode D1. The peak voltage is fed across C2 to the non-inverting input of U1-b, which is configured as a voltage comparator. When the voltage at pin 5 is higher than that set by R6 (the LEVEL/SENSITIVITY control) at pin 6, the output of U1-b swings to near the positive supply rail, lighting the green half of LED1 (a bi-color light-emitting diode).

Resistor R7 limits current to LED1. The high at U1-b's output (pin 7) also turns on Q1 which, in turn, activates a reed relay, K1, causing its contacts to close. The contacts of the relay act as the tape-recorder motor's on/off switch. When the voltage at pin 5 of U1-b is lower than that at pin 6, its output swings close to the negative supply rail, illuminating the red half of LED1, and at the same time turning off Q1 and K1, as well as the tape recorder's motor.

The discharge rate of C2 combined with the setting of R6, determines the time the recorder runs after the last transmission. With an LM1458 op-amp,

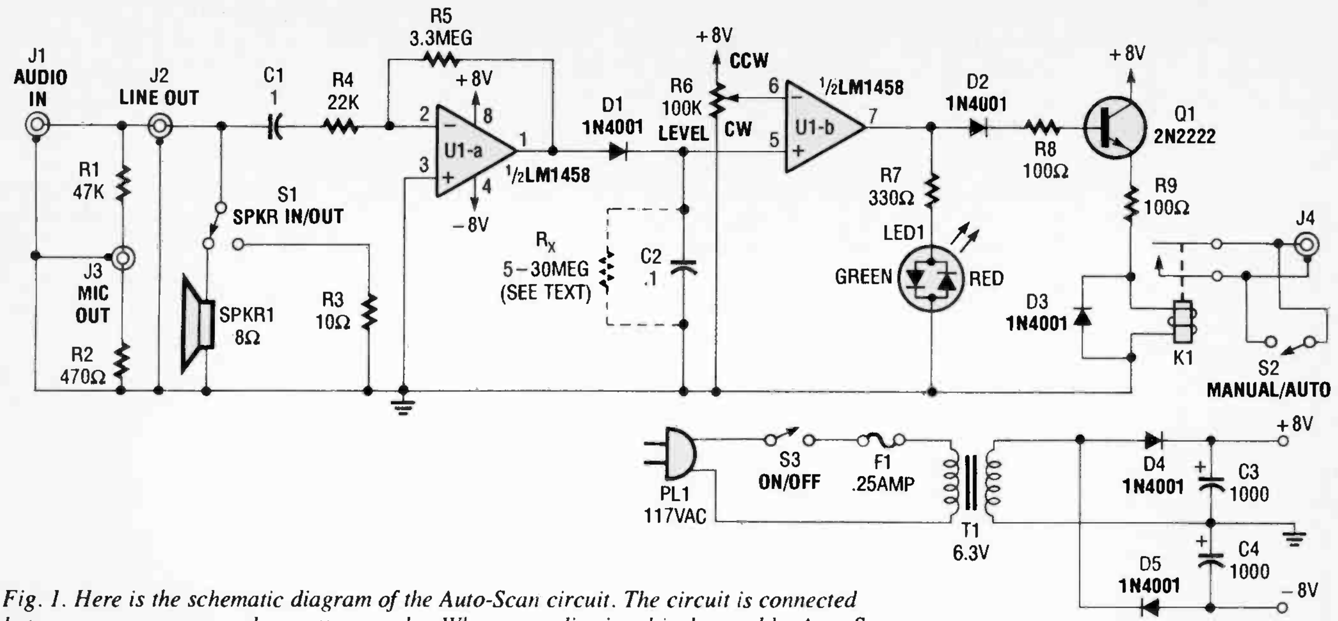


Fig. 1. Here is the schematic diagram of the Auto-Scan circuit. The circuit is connected between your scanner and cassette recorder. When an audio signal is detected by Auto-Scan, it activates the recorder, keeping you in touch with all the action.

and its relatively low input impedance, a C2 value of 0.1 µF provides an ideal discharge rate. However, if a high input-impedance op-amp is used, such as one with JFET inputs, C2's value should be increased to around 5 µF, and the value of R_X should be set near 10 megohms. Some experimentation with the value of R_X—whose value should fall somewhere between 5 to 30 megohms—may be necessary to achieve optimum performance.

Diode D3 is used to shunt any harmful spikes produced by the relay's coil away from Q1. Switch S2 is the MANUAL/AUTO select switch. When S2 is closed, it acts like the closed contacts of the relay, turning on the tape-recorder motor.

The circuit is powered from a dual 8-volt power supply, consisting of a handful of inexpensive components. The AC line voltage is fed through S3 (the ON/OFF switch) and F1 (a ¼-watt fuse) to power transformer T1, which reduces the 117-volt line to 6.3-volts. That voltage is then full-wave rectified by D4 and D5, and filtered by C3 and C4, to provide a suitable power source for the circuit.

Construction. There is nothing critical about the circuit's layout, but using the printed-circuit board pattern shown in Fig. 2 helps to simplify matters. Jacks J1 to J4 should be of whatever type matches the inputs to your scanner and tape machine. The author used ⅛-inch jacks for his Auto-Scan prototype.

Figure 3 is the parts-placement diagram for Auto-Scan's printed-circuit board. Note that several components for the circuit are mounted off-board on the front panel of the project enclosure. After positioning the off-board components, run short lengths of hook-up wire from the appropriate points on the board to those components.

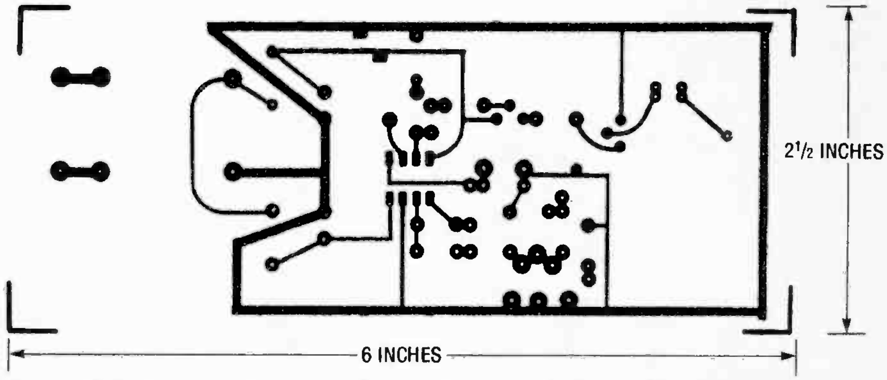


Fig. 2. While there is nothing critical about the layout of the circuit-board components to prevent you from devising your own design, using the printed-circuit foil pattern shown here will certainly make things go a bit easier.

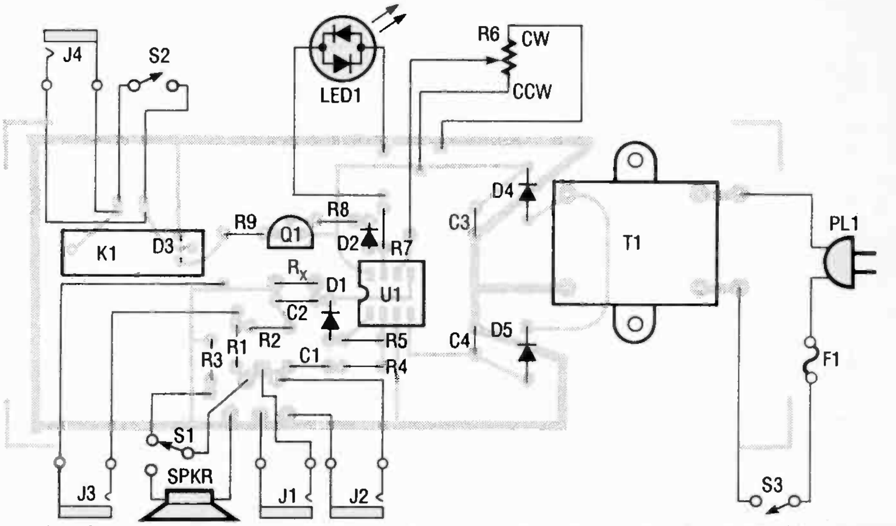


Fig. 3. After preparing your printed-circuit board, consult this parts-placement diagram for the location and orientation of Auto-Scan's board-mounted components. The components not shown on the board are mounted on the front and rear panels of the enclosure.

PARTS LIST FOR AUTO-SCAN

SEMICONDUCTORS

U1—LM1458 dual op-amp, integrated circuit
Q1—2N2222 or equivalent general-purpose silicon NPN transistor
D1–D5—1N4001 1-amp, 50-PIV, silicon rectifier diode
LED1—Bi-color light-emitting diode (see text)

RESISTORS

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

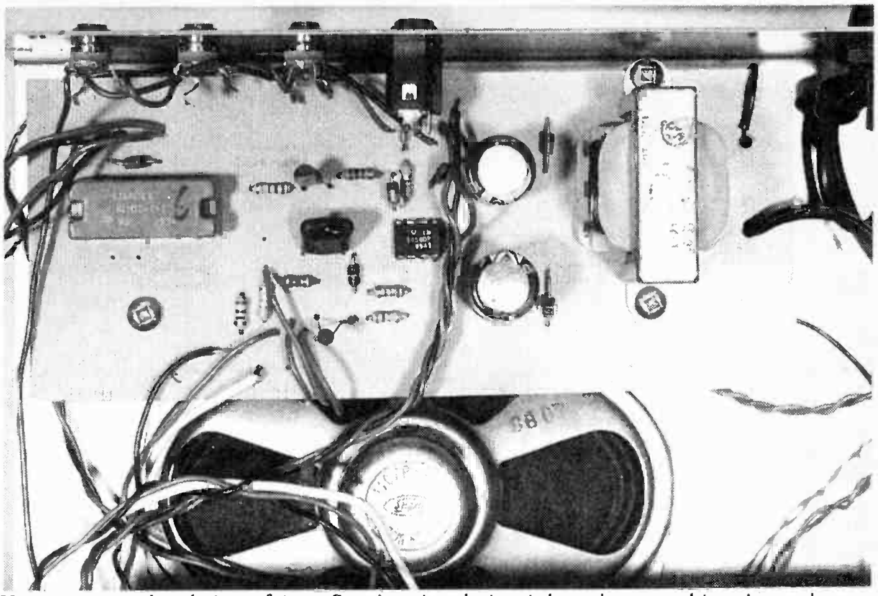
R1—47,000-ohm
R2—470-ohm
R3—10-ohm
R4—22,000-ohm
R5—3.3-megohm
R6—100,000-ohm linear potentiometer
R7—330-ohm
R8, R9—100-ohm
R_x—see text

CAPACITORS

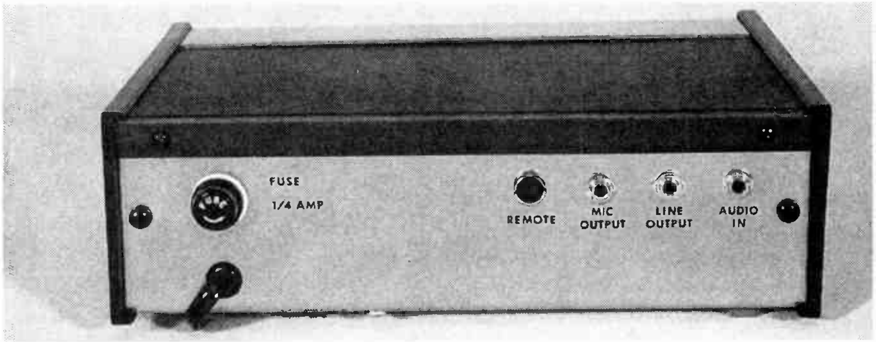
C1—1-µF, 35-WVDC, tantalum
C2—0.1-µF, ceramic-disc, see text
C3, C4—1000-µF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

T1—12.6-volt, 300-mA, center-tapped, PC-mount power transformer (Radio Shack 276-1384, see text)
K1—SPST 1-amp reed relay (Radio Shack 275-232, or similar)
SPKR1—8-ohm speaker
S1—SPDT micro-miniature toggle switch
S2, S3—SPST micro-miniature toggle switch
J1–J4—see text
F1—¼-watt fuse
Printed-circuit or perfboard materials, enclosure, IC socket, fuse holder, AC-line cord with plug, knob, hook up wire, solder, hardware, etc.



Here is an overhead view of Auto-Scan's printed-circuit board mounted into its enclosure. Note that the speaker is mounted on the bottom of the enclosure with the board hovering above it on stand-offs.



This is a view of Auto Scan's rear panel. The fuse, as well as the remote-input, mic-output, line-output, and audio-input jacks are located on the rear panel of the enclosure. All connections to and from the Auto-Scan unit are through those jacks.

Turning to the bi-colored LED used in the circuit; if a similar unit cannot be found, the two color unit can be replaced by two discrete LED's. Of course, it will be necessary to supply an appropriate dropping resistor for each unit; or if you decide to hook them up back-to-back (duplicating the unit's schematic symbol), you may have to play with the value of the dropping resistor.

The author used a Radio Shack 12.6-volt, center-tapped transformer in the power-supply of his prototype. The output of the transformer is taken from its center tap, thereby providing 6.3-volts AC for the rectifier circuit. If you have difficulty in locating a similar transformer, you might consider using a 12-volt transformer (with a sufficient current rating), along with a 7808 and 7908 (positive and negative, respectively), 8-volt, three-terminal regulator. If you choose to go that route, be sure not to overlook the filter capacitors.

As for the enclosure itself, there are a couple things to watch for should you decide to use a metal cabinet to house the project. Some tape machines with positive grounds or other unusual circuitry react violently to having either side of their remote start switches grounded. To prevent that problem, the contacts of the REMOTE jack (J4) should be covered with a non-conductive plastic sleeve to keep the contacts completely isolated from Auto-Scan's other circuitry.

In addition, because the circuit derives power from a 117-volt AC outlet, make certain that the board is mounted in its enclosure on standoffs to prevent the board from coming in contact with the cabinet.

Making a neat cutout for speakers is always a problem, but is easily solved by putting the opening at the bottom of the cabinet, where imperfections won't be noticed.

Using Auto-Scan. After connecting Auto-Scan, a scanner, and a tape recorder together, flip the speaker switch (S1) to the ON position and turn the LEVEL/SENSITIVITY control (R6) fully counter-clockwise. Next, find a busy channel on the scanner and put the tape unit into the record mode. LED1 should be red, meaning the tape is stopped. Slowly rotate the LEVEL/SENSITIVITY clockwise until LED1 turns green. At that point, your tape machine should be running, recording everything coming over the scanner.

Now switch to a silent channel and see how long it takes for Auto-Scan to shut off the recorder. If the time isn't right, turning R6 clockwise will increase the time before shut-off, turning it counterclockwise shortens the delay. ■

SWEEP FUNCTION GENERATORS

BY JOSEPH J. CARR

When testing most circuits, you have to provide them with a signal to process, but that's only the beginning of what a function generator can do for you.

Function generators are signal generators that output at least three different waveforms: sine waves, square waves, and triangle waves. Some models will also output sawtooth waves. Often the function generator is mistaken for an audio generator, and for many applications it can be used in place of one. They both can generate audio-range signals, and have a 600-ohm output impedance. However, the frequency of a typical audio generator is switch selectable, and a step attenuator, combined with a meter and a fine level control, can precisely set the output level; whereas a function generator tends to have a coarse output control instead, and can usually function over a broader frequency range.

Such instruments come in a wide range of qualities from modest to professional. The very professional Tektronix FG-507, shown in one of the photos, is capable of providing precise signals from sub-audio to well within the RF region (up to 2 MHz), but there are other function generators more modest in performance and cost, but more than sufficient for most hobbyist's needs. The author recently purchased a sweep frequency function generator for less than $150 that outputs the three basic waveforms over a range of 1 Hz to 100 kHz.

Basic Features. Figure 1 shows the front panel of a generic low cost function generator. A row of pushbutton switches selects the operating frequency, the waveform, and the wave's DC offset, if any. The frequency is set with the vernier dial, marked 0.1 to 1.0, and a multiplier switch. The actual output frequency is found by multiplying the vernier setting by the multiplier. For example, if the dial is set to 0.6 and the 10-Hz switch is pressed, the output frequency is 0.6 × 10 Hz, or 6 Hz. Similarly, if the 100-Hz switch is pressed the output is 60 Hz, and so on.

The waveform selector switches set the desired output waveform. Three are available from the instrument illustrated: sine, square, and triangle.

There are three output connectors on the instrument that provide the selected wave at different voltages. The HI -output yields voltage levels from 0.1- to 10-volts peak-to-peak without a load, and 0- to 5-volts peak-to-peak when driving a 600-ohm load.

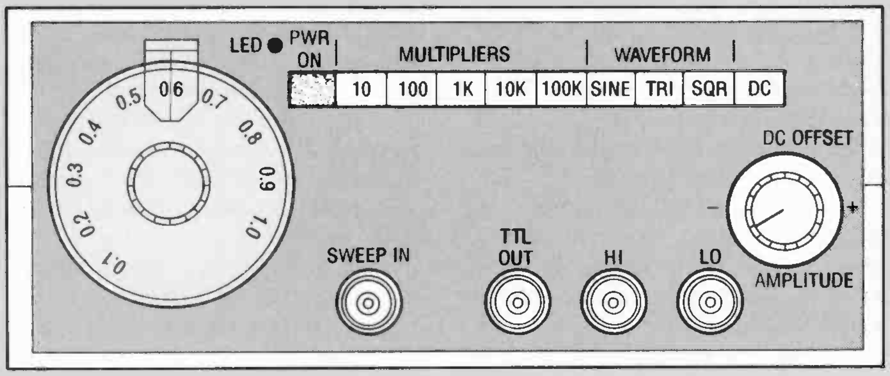


Fig. 1. This is the front panel of a generic low-cost function generator. A standard audio generator differs from the function generator in that it has a precise output control, and may generate only sine waves.

The LO output is at a level −40 dB below the HI output, so it can be used for small-signal applications. Preamplifiers and control amplifiers are used to boost small signal voltages from most sources to the 100 to 1000 mV required at the input of power amplifiers. For example, a tape head or dynamic phono cartridge will produce a signal of only a few millivolts, while a crystal microphone will produce around 100 mV. The function generator's LO output makes a good substitute for those transducers in testing preamplifier and control-amplifier circuits.

The TTL output is a square wave (regardless of the waveform selected) at the set frequency. The TTL output is a digital output in which a logic low is 0 to 800 mV, and a logic high is +2.4 to +5 volts (typically 4 volts).

The AMPLITUDE control sets the height of the output signal. Most function generators do not have a precision attenuator for amplitude control, so if accurate voltage levels are needed, one must be provided externally.

The DC OFFSET switch, and the vernier DC OFFSET control (behind the amplitude control), superimpose a DC level on the output waveform. Figure 2 shows three sine waves with different DC offsets: Fig. 2A shows a sine wave with a +3-VDC level, Fig. 2B shows a wave with no DC level applied, and Fig. 2C shows the same sine wave with a −3-VDC level superimposed. The DC OFFSET control allows a continuously variable offset from −3 to +3 VDC.

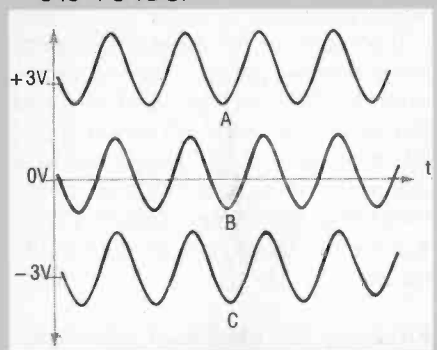


Fig. 2. This is the affect of applying DC offset to a sine wave. Shown are offsets of +3 VDC (A), 0 VDC (B), and −3 VDC (C) all affecting the same wave.

The sweep feature found on modern low-cost function generators is a powerful tool for testing certain kinds of circuits. Depending upon the design of the generator, applying a ±10-volt sawtooth or triangle waveform to the SWEEP IN input will cause the output frequency to sweep over a 10:1, 100:1, or 1000:1 range. In most cases, an increasing voltage forces the output frequency to increase, while a decreasing voltage forces the output frequency to decrease. Figure 3 shows the swept output for a sine wave.

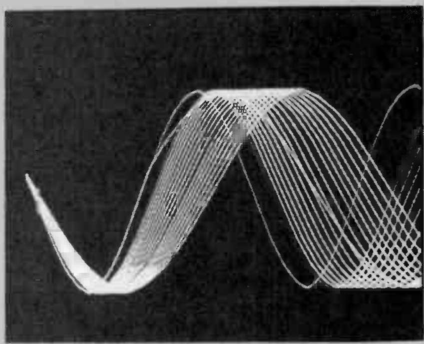


Fig. 3. A frequency-swept sine wave will draw many traces on an oscilloscope. Notice how they all start at the same point due to the oscilloscope's triggering mode, but they diverge because of their different frequencies.

If a DC level is applied to the sweep input instead of an AC wave, then the unit's precise output frequency can be voltage controlled. Two applications for voltage-controlled operation come immediately to mind: first, a precision voltage source can be used to increase the unit's frequency resolution, freeing you from relying on the sometimes inaccurate vernier control; second, if the control voltage is supplied from a digital-to-analog converter (DAC), then the sweep function generator can be used as a digitally controlled frequency source. The signal generator can thus be used in computer-controlled test systems at very low cost.

Amplifier Testing. Function generators can provide relatively low distortion audio signals, so they are useful for testing many audio amplifiers. Keep in mind a function generator's output is typically not as clean as an audio generator's, which is intended for high fidelity use, but it is good enough for less-rigorous applications.

To start testing an amplifier, you would connect a function generator to its inputs, just the same as you would an audio-signal generator, and either an oscilloscope or AC voltmeter (or both) is connected across the output load. For the best results, and to keep the volume down to a sane level, replace the loudspeaker with a non-inductive load resistor of whatever value the amplifier is rated for. The "non-inductive" requirement excludes the use of wirewound resistors. Non-inductive resistors are needed because any inductance would distort your measurements. In addition, some amplifiers will oscillate (possibly destructively) when inductive loads are used.

The power level of the resistor must be greater than the rated rms output power of the amplifier. Various catalogs list non-inductive resistors up to 100 watts. For higher power tests you'll have to construct a network of 100-watt resistors to provide the required power and impedance values.

The output power of the amplifier is found by applying a sine wave (see the upper trace of Fig. 4), and then advancing the volume control until the amplifier begins to clip (lower trace).

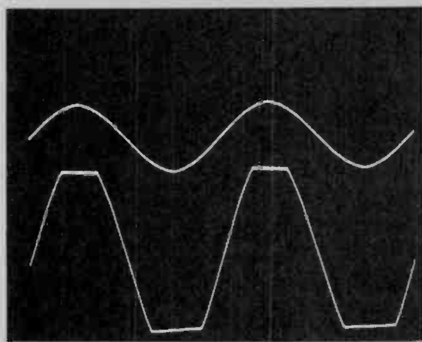


Fig. 4. When an input sine wave (top) is clipped by an amplifier, it develops plateaus, as the lower trace shows.

The volume is then backed off to eliminate the clipping. For high fidelity equipment, it is common to measure the output power at a specified level of total harmonic distortion (denoted THD). Unfortunately to measure the THD you would need an analyzer, so we'll just discuss how to measure an amplifier's output power. When the highest non-clipped signal voltage is found, then the output power is:

$$P = (V_{rms})^2/R_L \quad \text{(eq.1)}$$

Where: P is the power in watts, V_{rms} is the rms signal (in volts) measured across the load, and R_L is the value of the load resistor in ohms. If the signal voltage across the load was measured using an oscilloscope, then you will have the peak-to-peak voltage, not the rms voltage. To convert the peak-to-peak voltage to an rms value, divide it by 2.83. You can then plug that result into the equation to find the power.

To measure the gain, measure the input signal level (V_{in}) and the output signal (V_o) on an oscilloscope or AC voltmeter. It doesn't matter whether rms

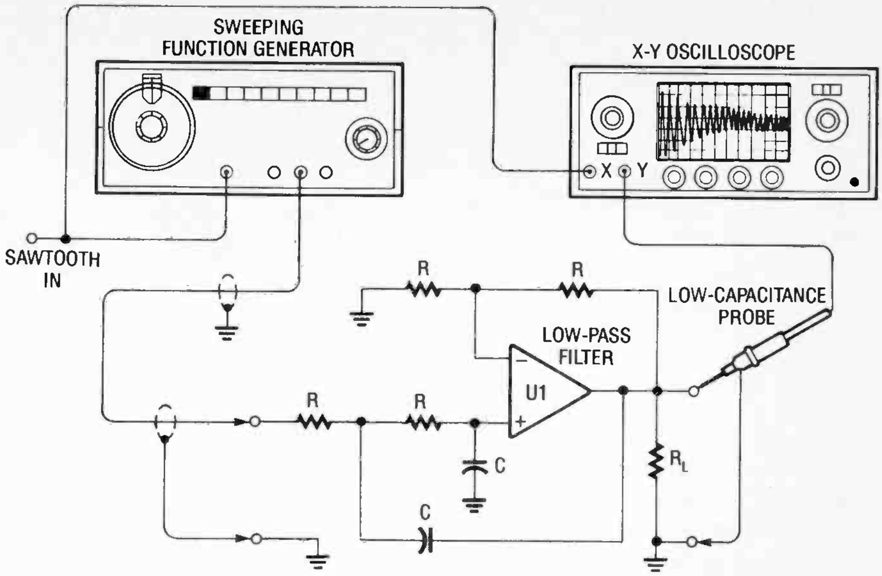


Fig. 5. This is the set-up you would use for testing a low-pass filter or other frequency-selective amplifier using a sweep frequency generator.

or peak-to-peak readings are used, so long as both V_{in} and V_o are measured the same way.

If the level of the signal generator's LO output is too low to easily measure on the test equipment that you own, then measure the level of the HI output and divide by the scale factor for your unit. In a function generator that I own, the scale factor is 1/100 (−40 dB), so I would divide the HI reading by 100 to find the LO-output voltage.

The voltage gain of any amplifier is simply the ratio of the output voltage to the input voltage:

$$A_v = V_o/V_{in}$$

Or, in the case where decibel notation is used:

$$A_v \text{ dB} = 20\text{Log}(V_o/V_{in}) \text{ (eq. 2)}$$

If the output voltage is greater than the input voltage (i.e. there is amplification) then the result of equation 2 is positive. But if the circuit is lossy, then the output voltage is less than the input voltage and the result is negative.

Sweep Testing. The greatest capability a sweep function generator has is it can automatically make an excursion through a band of frequencies. Low-cost sweep function generators are generally able to sweep through a 100:1 range of frequencies, while maintaining linearity through a 10:1 range. That capability offers us the ability to perform qualitative tests of any frequency-selective audio or near-audio circuit. In Fig. 5 you will find the normal test set-up for making those checks. The frequency-selective circuit under test is a low-pass filter, but it could just as easily be a tone-control amplifier, bandwidth-limited preamplifier (as in two-way radio sets), a graphic equalizer, etc.

The appropriate output (either HI or LO) of the sweep function generator is connected to the input of the circuit under test. The SWEEP IN jack on the function generator is connected to an external sawtooth source. The voltage at that input controls the output frequency, so as the voltage increases the frequency increases. Since the input is receiving a sawtooth wave, the output frequency will steadily rise until some maximum, drop to its initial value, and begin rising again.

An X-Y oscilloscope equipped with a low-capacitance probe (to prevent circuit loading) is used to monitor the output signal's voltage. The signal being monitored is applied to the Y-input. An X-Y oscilloscope (or a regular oscilloscope with X-Y capability) does not use internal horizontal sweep, but rather requires an external signal to control the horizontal deflection. So we connect its X (horizontal) input to the same sawtooth signal that's controlling the output frequency. That means that the oscilloscope beam is deflected as the frequency of the generated wave changes. Because the left-to-right sweep of the oscilloscope is controlled by the same sawtooth that sweeps the function generator, the oscilloscope display gives a plot of amplitude vs. frequency (with frequency along the horizontal axis).

The results of the sweep frequency test are shown in Fig. 6. The −3-dB frequency (f_c) of the filter was 5 kHz, and the generator was set to sweep from 1 kHz to 10 kHz (a 10:1 range called a decade). The result shown is for a first-order filter. That type of filter has a response that drops off −20 dB/decade above f_c.

Filtering Waveforms. Figure 7 will help illustrate the action of a low-pass filter, and point the way to an application or two for one, as you'll see. A square wave (Fig. 7A) is made up of a fundamental sine wave with frequency *f*, plus an extremely large number of odd-order harmonics (*i.e.* sine waves of frequencies 3*f*, 5*f*, 7*f*, etc.) all added together. The general wisdom is that an amplifier must be capable of a frequency response of 0.1*f* to 10*f* (100*f* is preferable) in order to pass a square

(Continued on page 93)

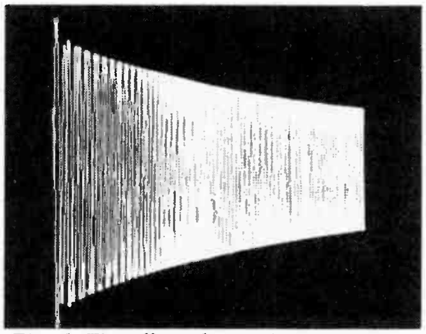


Fig. 6. The effect of sweeping across a filter's cut-off range looks like this. Using sweep in this way allows us to view the frequency response of a circuit.

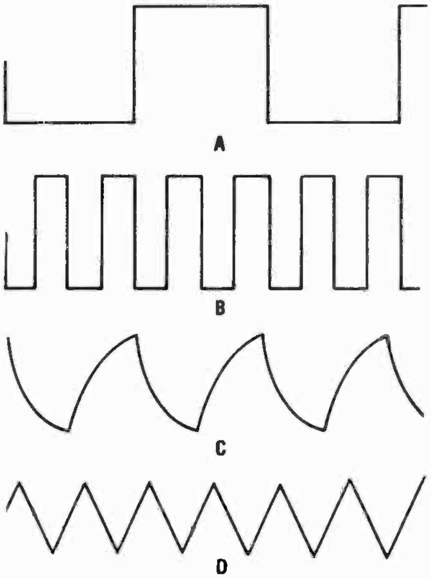


Fig. 7. As you pass square waves of various frequencies (shown here are 100 Hz (A), 1000 Hz (B), 5000 Hz (C), and 50 kHz (D)) through a 5-Hz low-pass filter it dampens some of the wave's harmonics, transforming the wave into a new shape (triangle).

The Amazing AMIGA

Here's the low-down on the Commodore Amiga—a popular, and powerful, alternative to the PC.

BY KARL T. THURBER, JR., W8FX

Commodore's fleet has a new flagship: the *Amiga 500*, arguably the most capable and powerful home computer introduced to date. Indeed, the A500, as it is often called, has the potential to become the "Volkscomputer" of the 1990's, replacing the aging 8-bit Commodore 64 and 128 workhorses. Optimistically referred to by Commodore as the "ultimate" home computer, the Amiga has formidable capabilities in areas such as computer graphics, video processing, telecommunications, desktop publishing, business applications, audio processing, music, and games.

Despite its awesome power, it's a surprisingly easy machine to use. Icon-activated windows and pull-down menus contribute to its performance and vaunted user-friendliness. Of course that enhances the machine's appeal to the uninitiated.

In this article, we'll take a quick tour of the Amiga 500 and what is supplied with it, check out its machine/world interfaces, look at pre-bundled and additional software, and talk about getting started and upgrading.

A500 Mind and Hardware. The A500's popular price (under $800) and good performance have combined to make it well-accepted by the public, with around 1 million A500's being sold so far. However, while the A500 may be Commodore's flagship, there are many older but still powerful Amiga 1000's in service today, and the memory-rich, expandable, and IBM-adaptable Amiga-2000 series is coming on strong with professional and business users. For the sake of brevity, let's discuss only the A500.

The computer uses an advanced GEM-like operating system, complete with windows, icons, menus, and a pointer operated by a mouse. Under that intuitive visual interface, the hardware has all of the features of the older Amiga 1000 with some frills: It contains the Motorola 68000 CPU and runs at a clock speed of 7.16 MHz. The A500 also comes with 512K of RAM, expandable up to 1 MB internally, or up to 8 MB externally. Microsoft BASIC is included, and other languages (including C, Pascal, Modula II, Lisp, Assembly, Fortran, and Forth) are available, which makes the machine attractive to programmers.

Another capability that makes the A500 stand out from other home computers is that it can multitask—apparently performing several jobs at the same time. For example, if you have enough memory you can run a word-processing program and a database program at the same time, or print out a report while you're playing a game.

Other items of note include direct text-to-speech conversion using the built-in (yes, that's "built-in") SAY speech synthesizer; the use of the standard *I*nterchange *F*ile *F*ormat (or IFF) that allows easy exchange of data between programs; and sophisticated sound support for standard computer languages such as C and BASIC.

The power supply is housed separately and the on-off switch is located on it.

Input/Output. The A500 is a one-piece machine with an excellent 94-key, integral keyboard, and—unlike the older A1000—the full-size numeric keypad includes all four arithmetic operators. For further interaction, there are two joystick/mouse ports, and there's an IBM-compatible parallel printer port that allows almost any industry-standard Centronics-interface printer to be used. There's also an RS-232 serial connector for a modem or other serial devices. Also included are four external-drive connectors, RGB-color and monochrome-monitor connectors, and stereo audio jacks.

However, unlike the Commodore 64 and 128, and the A1000, there's neither a composite color-video output for connection to a VCR, nor an RF output for connection to a television set, though external adapters are available.

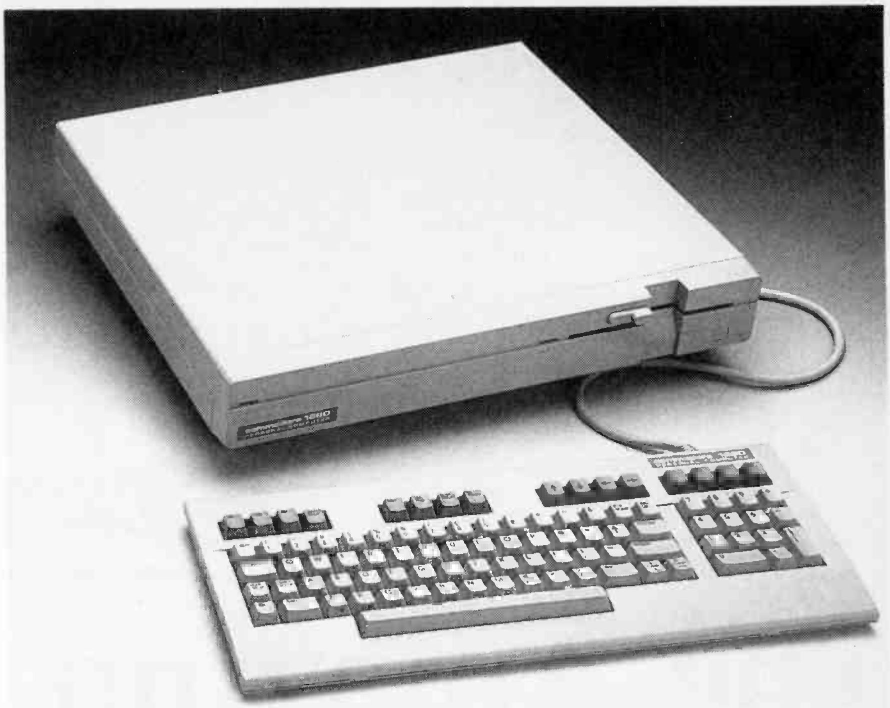
On the disk-drive front, the A500 comes with a single 3.5-inch internal disk drive with a storage capacity of 880K using *D*ouble-*S*ided *D*ouble-*D*ensity (DSDD) disks. It's a decent drive, though it makes little clicking noises even when the drive isn't being accessed.

Graphics. For the computer-graphics artist or video enthusiast, the A500, with its kaleidoscopic palette of 4,096 colors, is particularly worth looking into. Depending on the graphics mode, you can select 16 or 32 colors for display at a single time from the palette. Further, the A500 can produce its colorful screens with very high resolution in either static or animated modes. Several different resolutions are available: from 320 × 200 to 640 × 400 pixels in interlaced mode, and up to 768 × 442 pixels optimally.

There are three types of monitors that you can normally use with the Amiga: an analog RGB color monitor, such as the Commodore 1080, 1084S, and 2002, all of which can display the Amiga's 4,096 colors on a screen with up to 640 x 400 pixel resolution; a digital RGB color monitor, such as the 1902 and those used with the IBM PC (they aren't recommended as they can only display 16 colors); and a monochrome (composite-video) monitor, useful for business applications where maximum sharpness of text is required. Multisync monitors can also be used, and with some video hardware and software applications they are a must.

Many A500's are sold with the excellent 1084S stereo analog monitor (about $320), though Commodore has hinted that they will be selling an even better monitor than the 1084S sometime in 1989 that will reduce the characteristic screen flicker that occurs in the high-resolution 640 × 400 interlaced mode.

With an external adapter you can use a conventional television set as a display monitor, though results are likely to be disappointing, and you'll need an extra-cost TV modulator kit to do so. Commodore will sell you the Amiga 520 Video Adapter for $49 that lets you route your Amiga to a standard composite color monitor, VCR, or TV set.



First it was the venerable Commodore 64, then the 128, shown here, that were popularly dubbed the "flagship" of Commodore's fleet; now the Amiga carries the flag. The C-128 is an 8-bit C-64 upgrade that is 100% compatible with C-64 programs and also offers an 80-column screen and CP/M operation. (Photo courtesy CBI, Inc.)

Audio. The A500's MIDI (*M*usical *I*nstrument *D*igital *I*nterface) expandability makes it an ideal machine for the musician as well. It allows the user to connect synthesizer keyboards and sequencers to the computer to harness its sophisticated digitized stereo-music capabilities. Speaking of stereo, it even has four-voice stereo sound with the four voices output as two voices per channel. You can connect the A500's stereo outputs to your audio system, too, if you want to be acoustically overwhelmed.

However, you don't have to be a musician to appreciate the A500's formidable sound and music capabilities. Even if you don't own any music software, the computer's stereo-sound capability over nine octaves is productively used by game software, to make zapping aliens a sensoral delight.

Packaged Documentation and Software. The computer comes with a thick and reasonably well-written user's manual called "Introduction to the Commodore Amiga." There are distinct sections covering everything from setting up the A500, to using the DOS-like *C*ommand-*L*ine *I*nterface (or CLI). The manual is liberally illustrated, and it contains several appendices and an index. It's adequate for a simple hookup, though little technical information is provided. There's also a thick book on AmigaBASIC; it covers everything from getting started with BASIC to creating animated images. Two 3.5-inch disks are also supplied: the "Workbench" disk, which includes AmigaDOS, and the "Amiga Extras" disk that includes BASIC and several utilities, various device drivers, and demos.

Utilities and Games. Utilities are productivity enhancers that allow you to customize your system software, extend the capabilities of AmigaDos, and help applications programs run better. Which utilities you'll want depends on your particular needs, which you'll only discover after you've used your system for awhile and notice some drawbacks and inconveniences.

For instance, Grabbit, a popular utility by Discovery Software, lets you save screens from your application and print them out. CLImate from Progressive Peripherals and Software allows you to access AmigaDOS from the Workbench. FACC II by ASDG acts as a disk-performance enhancer to speed up operation. Disk Mechanic by Lake Forest Logic is a broad-based collection of utilities you may want to check out. Along similar lines is Project D, a multipurpose, integrated-disk utility by Fuller Computer Systems. For safety's sake, Quarterback, a hard disk backup utility, is available from Central Coast Software, and Marauder II by Discovery Software, is useful in backing-up protected disks.

To some game *mavens* the Amiga name is said to mean "*AMazIng GAme* machine." And so it is—it's not much of an exaggeration to say it's hard to find a truly poor Amiga game, considering the machine's inherently dazzling graphics and super sound.

Some of the more popular Amiga games include Roger Rabbit, who we all remember from the movie (Buena Vista); Battle Chess (Interplay), with its chess pieces engaging in mortal combat; Falcon, a thrilling and incredibly realistic F-16A fighter simulator (Spectrum HoloByte); Bard's Tale I (Electronic Arts), a fantasy role-playing adventure; Shanghai (Mediagenic), a fascinating *mah-jongg* derivative; Earl Weaver Baseball (Electronic Arts), a statistics-based simulation and arcade game in which you call the plays; Rocket Ranger and Three Stooges (Cineware), games that come on like interactive movies; and Firepower (MicroIllusions), a superb, low-cost arcade tank shoot-'em-up that rivals the best IBM PC and Apple games, and which can even be played over a modem—to name but a few.

Sight and Sound Software. With the quantity and diversity of graphics software that's presently available, you can create your own snappy high-resolution artwork using all 4,096 colors, and even animate your work. You can easily turn your Amiga into an "animation workstation."

The latest thing in Amiga video is a spate of new three-dimensional art and animation programs, some of which use sophisticated "ray-tracing" methodologies that allow at-home 3D sculpting and modeling. They use many of the techniques of professional animators.

Some of the best-seller graphics programs include Deluxe Paint II (Electronic Arts); Digi-Paint (NewTek); Fantavision (Broderbund); and Zoetrope (Antic). Some of the new 3D graphics programs include Turbo Silver 3.0 (Impulse); the Sculpt-Animate series (Byte-By-Byte); and Modeler 3D and Videoscape 3D 2.0 (Aegis).

Desktop video is expanding the Amiga's graphic horizons: superb color-video capabilities allow you to create highly professional images from a variety of video sources, making you the producer of your own home-movie videos. You can even use the Amiga to customize and add titles to your pre-recorded videocassettes, and make your own video presentations.

Many different types of video products, both software and hardware, are available for the Amiga. Some popular video-based programs include Digi-View 3.0 (NewTek), the software part of the Digi-View color-video capture system; InVision (Elan), a video-effects software package used with the LIVE! video digitizer to create real-time moving images and special effects; and the Photon video-animation and graphics programs from MicroIllusions.

To please the ears as well as the eyes, a bevy of excellent note-entry and musical-composition programs are available, including: Deluxe Music Construction Set and Instant Music (Electronic Arts); Sonix (Aegis); and the Music Studio (Mediagenic). Harnessing some of the more advanced Amiga sound capabilities requires the addition of extra hardware, such as MIDI interface and a sound digitizer. A large number of specialized MIDI-sequencer programs are available, including Dr. T's KCS; Mimetics' Sound-Scape Pro MIDI Studio; and Music-X from MicroIllusions.

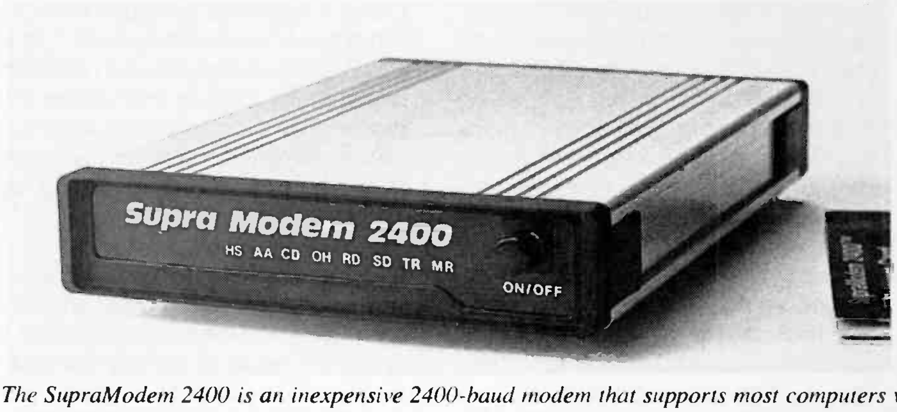
Word Processers. Word processing has become the only way to "type" anything for the many who have relegated their typewriters to backup use. The speed, flexibility, and logical organization of word-processing programs eliminates tedious retyping and leaves more time for creative composition. The recent entry of the best-selling and powerful WordPerfect program (WordPerfect Corp.) into the Amiga marketplace has helped legitimize the Amiga as a serious business and home-office productivity machine.

Some of the many capable Amiga word processors, most of which support a wide variety of Amiga type fonts using dot-matrix printers, include Excellence! and Scribble! by Micro-Systems Software; KindWords (The Disc Company); ProWrite (New Horizons); VizaWrite (Progressive Peripherals and Software); and Commodore's own Textcraft Plus. Many Amiga word processors are graphics-oriented, so that you can conveniently integrate graphics into your documents.

Record and Number Crunching. Database management programs let you organize and keep track of things without resorting to manual file folders and lists. For example, you can use a database manager to automate a club mailing list, organize your record or cassette collection, or keep track of a store's inventory.

Perhaps the premier database manager for the Amiga is the Superbase series by Precision, Inc. Several versions are available, ranging from the easy-to-use Superbase Personal, to the highly sophisticated Superbase Professional. Other Amiga-specific databases include Microfiche Filer (Software Visions); Organize! (Micro-Systems Software); and Flex File Amiga (Cardinal).

Spreadsheets are programs that help you keep track of numbers, not only simply recording them, but manipulating them and performing complicated mathematical operations on them in order to determine correlations and make futuristic "what-if" projections. They can also be programmed to balance your checkbook or maintain your business's books.



The SupraModem 2400 is an inexpensive 2400-baud modem that supports most computers w an RS-232C interface, including all Amiga models. (Photo courtesy Supra Corporation.)

Amiga Manufacturers and Distributors

Aegis Development
2210 Wilshire Boulevard
Suite 277
Santa Monica, CA 90403

Amicus Library
PO Box 869
Fall River, MA 02722

Antic Publishing
544 Second Street
San Francisco, CA 94107

ArborSoft, Inc.
5019 Highland Avenue
Downers Grove, IL 60515

ASDG
925 Stewart Street
Madison, WI 513713

Broderbund Software, Inc.
17 Paul Drive
San Rafael, CA 94903-2101

Buena Vista Software
500 S. Buena Vista Street
Burbank, CA 91521

Byte-By-Byte
Arboretum Plaza II
9442 Capitol of Texas Hwy. No.
Suite 150
Austin, TX 78759

California Access
780 Montague Expy. #403
San Jose, CA 95131

Cardinal Software
14840 Build America Drive
Woodbridge, VA 22191

Central Coast Software
268 Bowie Drive
Los Osos, CA 93402

Centsible Software
PO Box 930
St. Joseph, MI 49085

Cinemaware Corp.
4165 Thousand Oaks Boulevard
Westlake Village, CA 91362

Commodore Business Machines, Inc.
120 Wilson Drive
West Chester, PA 19380

Digital Creations
2865 Sunrise Blvd., Suite 103
Rancho Cordova, CA 95670

The Disc Company
3135 South State Street
Ann Arbor, MI 48108

Discovery Software International
163 Conduit Street
Annapolis, MD 21401

Dr. T's
220 Boylston Street, Suite 206
Chestnut Hill, MA 02167

Elan Design
PO Box 31725
San Francisco, CA 94131

Electronic Arts
1821 Gateway Drive
San Mateo, CA 94404

Fred Fish's Amiga Library
1346 West 10th Place
Tempe, AZ 85281

Future Systems, Inc.
21634 Lassen
Chatsworth, CA 91311

Fuller Computer Systems, Inc.
PO Box 9222
Mesa, AZ 85214

Go Amigo
508 Waverly Street
Palo Alto, CA 94301

The Gold Disk
2179 Dunwin Drive #6
Mississauga, ON
Canada L5L 1X2

Great Valley Products
225 Plank Avenue
Paoli, PA 19301

Haitex Resources
208 Carrollton Park, Suite 1207
Carrollton, TX 75006

Hilton Android Corp.
PO Box 7437
Huntington Beach, CA 92615

Impulse, Inc.
6860 Shingle Creek Parkway, #110
Minneapolis, MN 55430

Interplay Productions
Dist. By Mediagenic
3885 Bohannon Drive
Menlo Park, CA 94025

Infinity Software
1144 65th Street, Suite C
Emeryville, CA 94608

ISD Marketing
2651 Johns Street, Unit 3
Markham ON
Canada L3R 2W5

Several highly rated spreadsheets are available for the Amiga. Top contenders are Maxiplan 500 and Maxiplan Plus (Oxxi); Analyze! (Micro-Systems Software); Super Plan (Precision); and VIP Professional (ISD Marketing).

If you're determined to closely manage and budget household finances, several programs can assist you. A very complete home finance package is PHASAR (Antic), which lets you set up and monitor your budget and helps you to calculate your income taxes and net worth. Other home finance products include 2 + 2 Home Management System (ArborSoft) and Money Mentor (Sedona).

If you want to economically combine the features of a word processor, database manager, and spreadsheet into a single package, often with a common "look and feel" to the modules, an integrated software package is the key.

A best-selling Amiga integrated package is The Works! by Micro-Systems Software: it includes Scribble! (a word processor), Organize! (a database manager), and Analyze! (a spreadsheet). An even more sophisticated integrated product from the same firm is The Works! Platinum Edition, which also includes a built-in telecommunications module that allows files created by the program's word processor, database manager, and spreadsheet manager to be exchanged with others.

Communications Software. If you invest in a modem and a terminal program for your Amiga, you'll be able to enter the world of on-line computer *b*ulletin *b*oard *s*ervices (or BBS's.) You'll also be able to take advantage of the wealth of public-domain and shareware software that's available for downloading.

There are several good terminal-emulation packages for the Amiga. They include AmicTerm (Haitex); A-Talk III (Oxxi); Diga! (Aegis); and OnLine! (Micro-Systems Software). However, before purchasing one check to see if your modem comes complete with a suitable communications program, as many modem manufacturers toss in the software and sometimes even include a free starter kit for one or more on-line services.

Specialized Software. The Amiga's excellent graphics and its suitability for business applications make it a natural for the *d*esk*t*op *p*ublishing (or DTP) of newsletters, brochures, catalogs, flyers, and most anything else that requires more pizzazz than straight text. With the

Amiga Manufacturers and Distributors (continued)

Kinetic Designs
PO Box 1646
Orange Park, FL 32067-1646

Lake Forest Logic, Inc.
28101 East Ballard Road
Lake Forest, IL 60045

LRA Enterprises
35615 Avenue D
Yucaipa,CA 92399

Mediagenic
3885 Bohannon Drive
Menlo Park, CA 94025

Micro Ed, Inc.
PO Box 24750
Edina, MN 55424

MicroIllusions
1748 Chatsworth Street
Grenada Hills, CA 91344

MicroSearch Inc.
9896 SW FReeways
Houston, TX 77074

Micro-Systems Software, Inc.
12798 West Forest Hill Blvd.
Suite 202
West Palm Beach, FL 33414

Microway
PO Box 79
Kingston, MA 02364

Mimetics Corp.
PO Box 1560
Cupertino, CA 95015

New Horizons Software
PO Box 43167
Austin, TX 78745

NewTek
115 West Crane Street
Topeka, KS 66603

Northeast Software Group
Dist. by Brown-Wagh Publishing
16795 Lark Avenue, Suite 210
Los Gatos, CA 95030

Oceanic America
PO Box 70587
Eugene, OR 97401

Oxxi, Inc.
PO Box 90309
Long Beach, CA 90809

Phoenix Electronics, Inc.
PO Box 156
314 Court Street
Clay Center, KS 67432

Pioneer Computing
2469 East 7000 South
Salt Lake City, UT 84121

Practical Solutions
1930 East Grant Road
Tucson, AZ 85719

Precision, Inc.
8404 Sterling Street, Suite A
Irving, TX 75063

Progressive Peripherals and Software
464 Kalamath Street
Denver, CO 80204

Public Domain Software, International
PO Box 1191
Massillon, OH 44648

Sedona Software
11828 Rancho Bernardo Road
Suite 123-20
San Diego, CA 92128

Spectrum HoloByte
2061 Challenger Drive
Alameda, CA 94501

Soft-Logik Publishing Corp.
11131 Southern Towne Square
Suite F
St. Louis, MO 63123

Software Visions, Inc.
PO Box 3319
Framingham, MA 01701

Star Micronics
#3 Oldfield
Irvine, CA 92718

SunRize Industries
3801 Old College Road
Bryan, TX 77801

Supra Corp.
1133 Commercial Way
Albany, OR 97321

TNL Enterprises
Box 1326
North Massapequa, NY 11758

Trans-Com
PO Box 88566
Carol Stream, IL 60188

2.S.R. Hutchinson Co.,
110 West Arrowdale
Houston, TX 77037-3801

WordPerfect Corp.
1555 North Technology Way
Orem, UT 84057

Unicorn Software
2950 East Flamingo Road
Greenview Park, Suite B
Las Vegas, NV 89121

Amiga, you can compose professional-looking documents that rival typeset copy, especially if you invest in a good quality laser printer.

The premier DTP package for the Amiga is considered to be Professional Page by Gold Disk, a $395 package. Other popular desktop publishing packages include City Desk 2.0 (MicroSearch); Publisher Plus (Northeast Software Group); Publishing Partner Professional (Soft Logik); and Shakespeare (Infinity).

The A500 is also an excellent educational resource for grade schoolers and postgraduates alike. The wide array of educator-developed software, along with the computer's formidable capabilities in art, animation, video, music, and data management combine to make it an ideal teacher of the language arts, math, and social studies—or almost any other subject.

Just a few of the many available Amiga educational programs are Beginning Reading Skills and Early Math (Micro Ed); Mavis Beacon Teaches Typing (Electronic Arts); Galileo II (Infinity); All About America (Unicorn); and the Robot Readers series (Hilton Android Corp.)

Free and Almost-Free Sources. No mention of Amiga programs is complete without touching on public-domain and shareware (we'll call them PD and SW) software. Hundreds of such budget-accommodating programs have been written by Amiga enthusiasts. They include games, utilities, productivity applications, paint software, and programming languages.

With SW software, a nominal fee ($3–$6 typically) is charged to cover the cost of the disk, copying, and mailing. While PD software is free for the taking, if you like and use the program, you should send the author his requested fee. The quality of PD/SW software runs the gamut from simply terrible to absolutely superb.

With a modem and a terminal program, you can download PD/SW software from BBS's or from the commercial information services such as CompuServe, GEnie, and People Link. Or, you can order PD/SW disks from one of the Amiga library services.

Perhaps the largest Amiga library service is Fred Fish's Amiga Library, with its 150-plus disk archives. Another is maintained by the Amicus Library. Others I know of include Centsible $oftware, Kinetic Designs, and Public Domain Software, International.

PD/SW software is a great concept, but you should be aware of two things: Realize that many PD/SW programs are minimally documented, so wait until you're reasonably comfortable at operating your computer before sampling such wares. Also, some PD/SW software is "infected" with nasty computer viruses that irresponsible programmers have created and circulate to the unwary. Ranging from pesky to fatal, the viruses enter your computer's memory, corrupting your disks (usually in the critical "boot block") until you power down. They can even force your monitor to run at dangerous scan rates and ruin it.

To see if a disk is virus-free, you can use a virus-detection program such as the PD programs VirusX and VirusCheck. A commercial program, VIP, (standing for Virus Infection Protection) (Discovery) is also available.

Setting Up and Beyond. If you haven't already purchased your Amiga, consider looking for a package deal including the Amiga and the set of peripherals you'll likely need in the near future. Packages including the A500, a monitor, memory expansion, and an external disk drive represent practical systems, and they can save you money.

Despite its complexity, the Amiga isn't particularly difficult to set up. Chapter 2 of the user's manual is clear on installation instructions, and it's liberally illustrated with color photos. There are just three things to hook up: the power supply, the main unit, and the mouse. And, despite the number of connectors on the rear panel, they're all of different sizes and styles so it's difficult to incorrectly insert a plug and damage the computer.

Something you should consider getting for your computer is extra memory, especially if you'll use memory-hungry graphics packages and powerful productivity software. If so, expanding memory to 1MB should be a priority. Technically, the A500 can only address 512K of chip RAM; extra RAM is specially addressed as "fast" RAM. Despite that nuance, additional RAM speeds processing and allows more programs to run at the same time.

For the A500, Commodore's A501 Memory-Expansion Card (costing $150–$200, depending on the current price of memory chips) installs internally with little fuss—there's a little door underneath the computer where you pop in the expansion card. It also contains a battery-operated real-time clock that keeps time even when you power down.

A number of third-party manufacturers also offer internal and external memory-expansion units, but expanding beyond 1MB usually requires the addition of an external power supply for the memory card. I'd suggest staying away from internal memory expanders other than the A501, as installing them can be difficult and their installation may void your warranty.

SupraDrive hard-disk system is for the A500 and includes the hard-disk drive, SCSI expansion port, and an easy way to expand the Amiga's memory using a plug-in RAM module. The high-speed drive is available in capacities ranging from 20 to 250MB. (Photo courtesy Supra Corporation.)

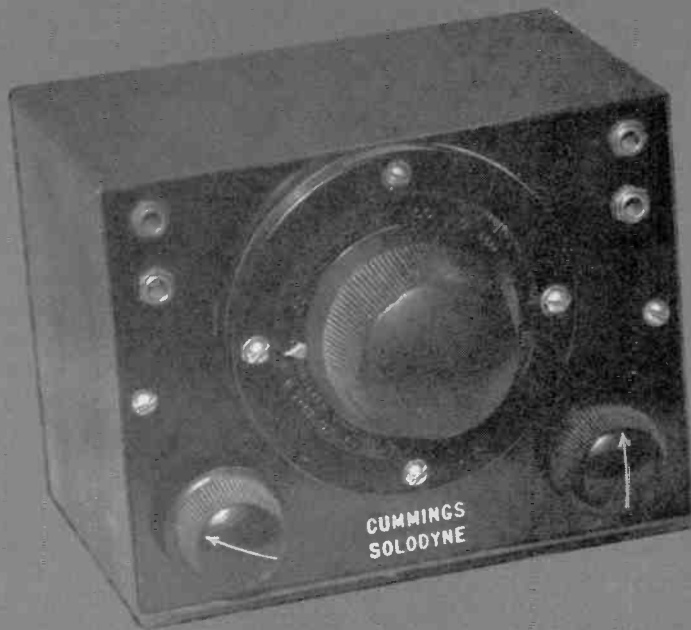
Printers. A printer is an important adjunct to the Amiga. Practically any dot matrix or daisy-wheel printer that works with the IBM PC will do—at least for black-and-white text—since the A500 has an industry-standard parallel printer connector.

If you're heavily into color graphics, you may want to look into a low-cost 9-pin color printer, such as the Star NX-1000 Rainbow. That inexpensive printer can accurately reproduce a wide range of colors, and it provides excellent graphics resolution. If you need top-quality output, you'll likely invest in a laser printer, especially if you're into desktop publishing.

Unfortunately, the version 1.2 Workbench disk contains only a limited number of printer drivers. If your printer isn't supported, you'll have to experiment with the drivers on the disk to come up with one that works acceptably with your printer, or search for a public-domain driver for it. The newest version of Workbench, 1.3—about a $25 upgrade—has a lot more (and much faster) printer drivers on it than did 1.2. The new Workbench disk also has an improved version of BASIC and comes with an excellent AmigaDOS reference manual.

Note that on the A500, a part of the operating system—the kernal routines—reside on the "Kickstart" ROM chip. To access all of the features of the recent Workbench upgrade, you should install that new ROM chip (about $45). However, if you just recently purchased your Amiga, it may already be equipped with the new Workbench disk and Kickstart ROM, which improve the Amiga's capabilities and enhance many software applications. While the 1.3 Kickstart ROM is a must for hard-drive

(Continued on page 101)



The Cummings Solodyne

Learn about the one-tube, one-battery circuit, no larger than today's transistor radios, that was made obscure before its time.

BY GLEN E. ZOOK

During the 1920's, radio manufacturers tried designing many different receivers in order to get around the patent restrictions set by their competitors. Some were very successful, while others failed for one reason or another.

One very interesting circuit tried by a handful of companies was the *solodyne*. The circuit, which used only one battery of 6-volts or less instead of the usual three, contained either a triode or a tetrode vacuum tube. All voltages—plate, filament, and grid—were supplied by the one battery.

Virtually all other battery receivers of the 1920's, had at least three batteries: an "A" battery to furnish filament current, a "B" battery for the plate (anode) circuit, and a "C" battery to furnish grid bias. Batteries were fairly expensive at the time, and, with the exception of a wet-cell "A" battery, were not rechargeable. Thus, whenever a battery became run-down, it had to be thrown away and a new one purchased. The elimination of two of the batteries is what makes the circuit so interesting, even today.

The Solodyne's Background. Basically a regenerative circuit, the best definition of a solodyne (also known as a unidyne) can be found in *Gernsback's Radio Encyclopedia for 1927*. It reads as follows:

"*Solodyne*—A radio circuit which dispenses with high-tension or B batteries and which utilizes a double-grid vacuum tube."

Saving on batteries is all well and good, but the additional circuitry required to build the set negated most of the advantages of the circuit. It's partly for that reason that very few solodyne sets were actually built for sale. However, there were probably many put together by hobbyists.

Frankly, little is known of the manufacturer of the unique receivers. Only a one-line entry appears in either *Ralph H. Langley's Set Catalog and index* or the *Expanded Radio Collector's Guide* by Morgan E. McMahon. However, enough were manufactured to be included in the guides.

During the late 1950's and early 1960's, there was renewed interest in solodynes and similar circuits, and there appeared a number of articles on "starved-circuit" amplifier designs, as they were called. The updated circuits usually had a 12AT7 tube, and operated using a 12-volt filament source and a "B" battery. But interest in those circuits was short lived because of the introduction of tubes designed to operate with only 12 VDC on the plate.

Even the 12-VDC plate-voltage tubes were short lived, because the transistor, which could operate on just a few volts, had been invented and was becoming more and more commercially attractive. The solodyne was at last relegated to obscurity.

How They Work. A typical solodyne circuit is shown in Fig. 1. In a solodyne, a small plate current (due to the electrons travelling from the lighted filament to the plate) passes through the tickler coil. The tickler feeds that current back to the main-grid circuit through the primary of a step-up transformer in series with the user's headphones. The current then flows back to the battery to complete the circuit.

The electron stream passing from the filament to the plate must pass two grids. The one closest to the plate, known as the *additional* (or *screen*) grid, is primarily made positive by the battery. That tends to assist the electron stream, which reduces the resistance of

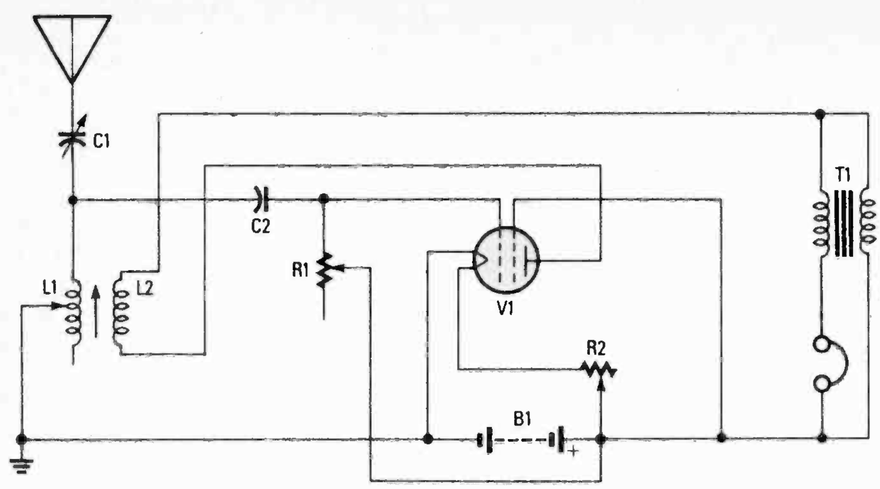


Fig. 1. The basic solodyne circuit used a single battery to power a two-grid tube. The same thing can be accomplished with a triode as well.

the vacuum in the tube. The additional-grid voltage is further enhanced by the stepped-up plate voltage from the transformer. The additional grid in turn assists electron flow to the plate, thus increasing audio output.

The main grid functions in the usual manner, except that it, too, is used to help the additional grid by giving it a strong positive bias. But enough about the general circuit itself; let's now take a look at an actual solodyne receiver: the Cummings Solodyne.

The Cummings Solodyne. Among the more successful attempts to eliminate multiple batteries was the Cummings Solodyne. However, "successful" is only a relative term, for the receiver actually doesn't work all that much better than the simple crystal sets of the same era.

The Cummings Solodyne, at 4 × 5 × 3.25-inches, is not much larger than many transistor radios of today. Considering that the receiver was manufactured in 1928, the internal construction is very compact. The receiver is largely self-contained, with only the antenna, ground, and headphones being external. Virtually everything is attached to the front panel by either the pin jacks or the screws that mount the variable capacitor. A metal bracket held by the screws holds both the tube socket and the audio transformer.

There are three tuning controls to be found on the front panel: the main tuning capacitor; a feedback control; and a filament-voltage control (a potentiometer) that is used as the volume control. The filament-voltage control also acts as an ON/OFF switch, because the wiper doesn't make contact at the beginning of the potentiometer's range. So, turning the VOLUME control all the way down shuts the receiver off.

The pin jacks for the external components can also be found on the front panel. Unfortunately, nothing is labeled except for the 0–180 scale embossed on the variable capacitor by the Dubilier Condenser and Radio Corporation and the name "Cummings Solodyne" engraved right on the front panel.

The schematic of the receiver appears in Fig. 2. As can be seen, it does differ from the classic solodyne circuit shown previously. It uses a triode tube so there's only one grid to bias the tube. What is not obvious is that the Cummings solodyne is picky about the triode it uses. With the case in place, only the Cunningham "CX" series (the CX99, CX199, CX299, or their equivalents) will work. However, if you remove the solodyne's case, it will operate with any one of a number of tubes.

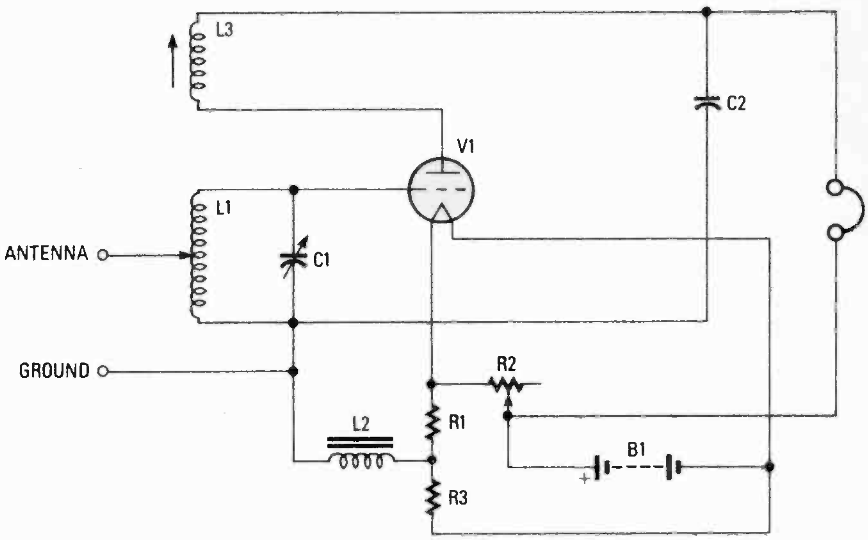
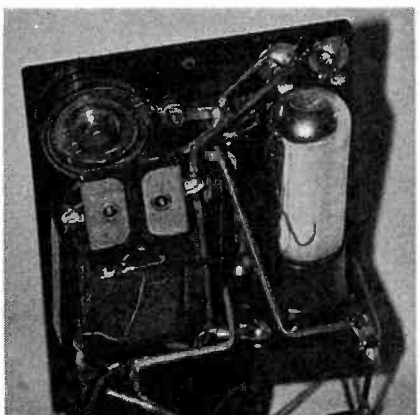
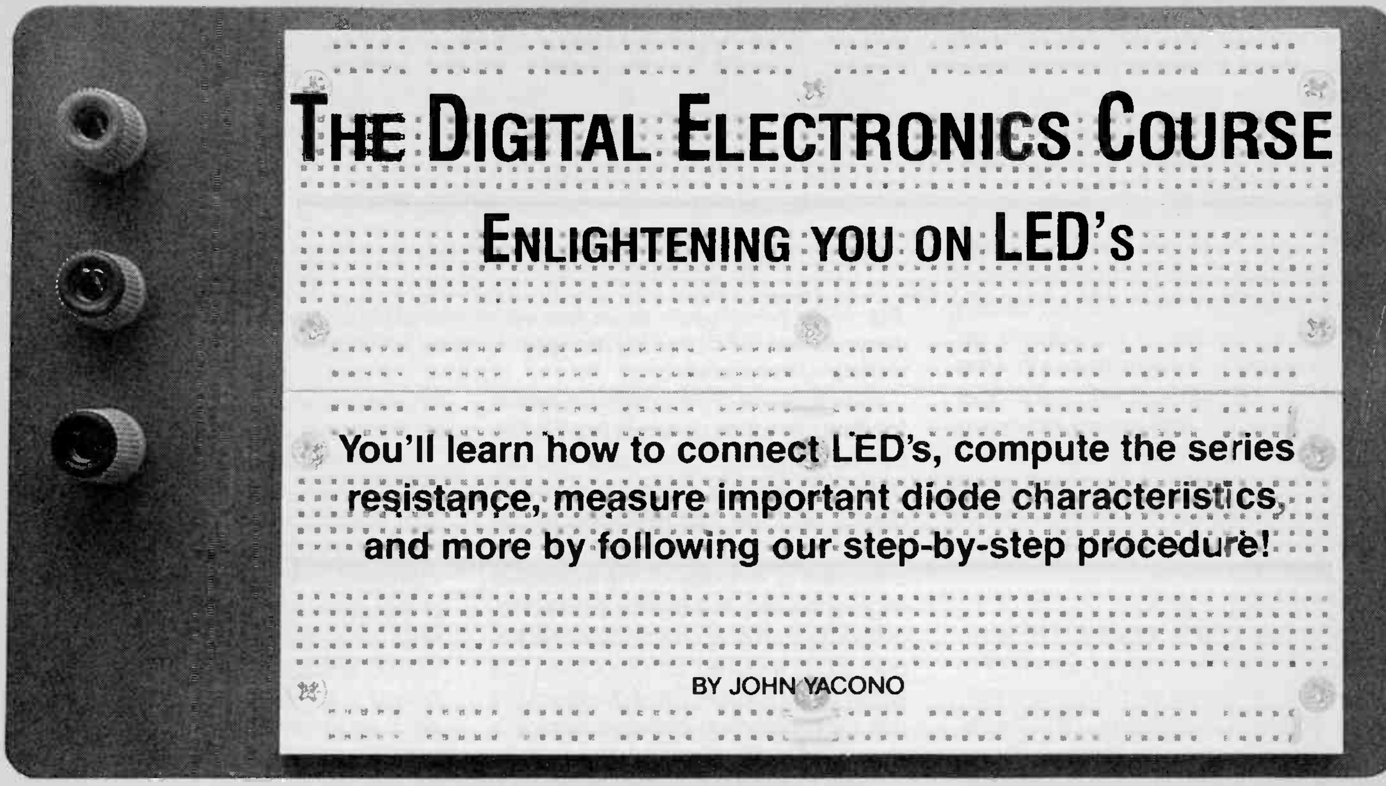


Fig. 2. The Cummings Solodyne was unusual in the fact that it only uses one battery instead of the usual three batteries as did most of the receivers of the era.



Although large by today's standards, the Cummings Solodyne was very compact for 1928. All components are mounted to the front panel by either the pin jacks or the screws holding the variable capacitor,

Although very crude in terms of today's miniature sets, the Cummings Solodyne was one of the first attempts to make broadcast receivers smaller and cheaper to operate. Unfortunately, the actual performance of the set was little better than that of a crystal set, and the much added expense was not worth the slight performance gain. Because of that and the rapid change in technology that was taking place at the time, the Cummings and other solodyne sets rapidly faded into obscurity. However, they do hold a unique place in the history of radio, and for that they should be remembered. ■



THE DIGITAL ELECTRONICS COURSE

ENLIGHTENING YOU ON LED'S

You'll learn how to connect LED's, compute the series resistance, measure important diode characteristics, and more by following our step-by-step procedure!

BY JOHN YACONO

Light-emitting diodes (or LED's) are small diodes that give off light. All diodes are composed of two different substrates sandwiched together. A terminal is connected to each substrate; one is called the anode and the other the cathode. When the anode is slightly more negative than the cathode, current will not flow through the diode. That is called *reverse biasing* the diode. If the diode leads are reversed, the diode would be *forward biased* and it will allow current to flow.

Like other diodes, LED's can be forward or reverse biased. When an LED is forward biased it releases energy in the form of photons (light). If the LED is reverse biased, it will not allow current to flow, and it will not light.

Measuring Diode Characteristics. Obviously, a diode's resistance depends on how the diode is biased. So if you apply a voltage to a diode without knowing its polarity, the diode may display either its forward- or reverse-bias resistance for that voltage. An ohmmeter can be used to measure an LED's low *forward resistance* and its high *reverse resistance*.

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

Since the internal battery of the ohmmeter biases the diode, one resistance measurement is taken and the test leads are reversed to measure the other resistance. The lower reading will, of course, be the forward-resistance reading. We know the positive meter lead will be connected to the anode during the forward-resistance reading (*i.e.*, during forward biasing), so we can determine the LED's polarity while taking resistance measurements.

You will find that for many LED's, the forward resistance is approximately 85 ohms and the reverse resistance is approximately 1.5 megohms.

Of course, you must know which test lead is positive on your ohmmeter. The easiest way to determine the lead's polarity is to use a voltmeter to measure its DC output voltage. If you don't have a voltmeter available, you can trace the circuit within the ohmmeter, starting at the positive terminal of the internal battery and ending up at the positive test lead.

If that is too difficult, try the negative terminal and follow its path through the switches to a test lead. If that fails, continue reading this article. When you understand how to identify the anode or cathode of an LED (or most diodes, for the matter), use that diode to determine which test lead is positive. Please note that such checks may produce invalid results on some digital VOM's that do not have a diode-test feature.

LED Applications. Obviously, light-emitting diodes are useful as indicators. They come packaged as individual units and as segments in character displays and bar graphs. In character displays, each LED makes up one line in the character (often a numeral) to be displayed. In bar graphs, each LED is like a step in a ladder. The number of LED's lit (the height of the ladder or bar) indicates the level of whatever you are trying to display.

Light-emitting diodes also have many opto-electronic uses, such as isolated switching and control. In such applications, an LED is packaged in a sealed plastic enclosure along with a light-sensitive device—a LASCR, light-sensitive Triac, light-sensitive transistor, etc. Any circuit driving the LED can then control any circuit connected to the light-sensitive device. The reason for using *optoisolator/couplers*, as they are called, is that they permit one circuit to control another without any electrical connection between them. That allows circuits that could be damaged by high voltage, high current, and/or power surges to safely control more powerful circuits.

There are also LED's that emit infrared light. They are useful for sending remote-control signals through the air or data through fiber-optic cables.

Yet other LED's can emit laser light for use in laser copiers, long-distance fiber-optic-communication systems, etc.

A lasing LED is little different than an ordinary LED. The major differences are that a lasing LED must have well-defined dimensions and mirrored surfaces. That sets up what is called a laser cavity within the LED material.

Within the cavity, the light bounces back and forth off the mirrored surfaces until it hits one surface that's only partially reflective. That surface allows some percentage of the light to escape, and reflects the rest back in. If the cavity is manufactured with the proper dimensions, the light waves bouncing around in the cavity will constructively and destructively interfere with each other until only light in a narrow bandwidth is left. All the waves will be roughly in phase, too.

Protecting LED's. Most LED's operate satisfactorily with a forward current of 10 to 20 milliamperes and a forward voltage drop of approximately 1.5 to 2 volts. So, if an LED is connected to a power supply of higher voltage, a current-limiting resistor must be connected in series with it to prevent damaging it.

Refer to Fig. 1. As shown, the LED is connected to the output of a 5-volt power supply. A resistor, R1 (known as a dropping resistor), is connected in series with the LED. The value of the dropping resistor is easily calculated using Ohm's law, assuming the following:

$$V_{CC} = 5 \text{ volts}$$

$$V_f = 2 \text{ volts}$$

$$I_f = 10 \text{ milliamperes}$$

where V_{CC} is the supply voltage, V_f is the forward-bias voltage drop, and I_f is the forward-bias current.

Using those values and Ohms law, you can calculate the value of the current-limiting resistor needed for the circuit:

$$R = V_{CC} - V_f/I_f$$

$$R = (5-2)/0.01 = 300 \text{ ohms}$$

If you cannot find a 300-ohm unit, a resistor value of 270 ohms (as is shown in Fig. 1) will suffice. (You could use a 330-ohm unit also, but that may not allow for satisfactory illumination.)

LED Displays. As mentioned earlier, the most useful application for LED's is in digital displays. A seven-segment LED display is designed to display a single digit. The display has 7 LED's used to form the numerals themselves, with an 8th LED for the decimal point.

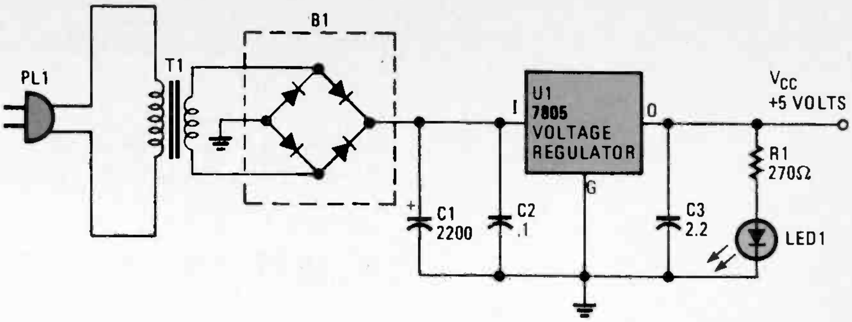


Fig. 1. The power supply shown here was developed in the previous article. The LED and series resistor (LED1 and R1) are additions to the power-supply circuit that was assembled in the previous exercise.

The segments are identified by letters "a" through "g" as shown in Fig. 2A. The two basic types of seven-segment displays include the common-cathode display and the common-anode display—common meaning that the cathodes or anodes of the individual segments within the display are tied together, so that only one anode or cathode pin is required for all of the LED's within the package. The equivalent circuit for a common-cathode display is shown in Fig. 2B.

Each of the LED's in the seven-segment display can be checked with an ohmmeter in the same manner that you would check a single LED. If a display is unidentified, one would first determine the common pin or pins (some displays have two common pins; one on each side of its package), and then determine if the unit is a common-anode or common-cathode type. That is often done by trial and error.

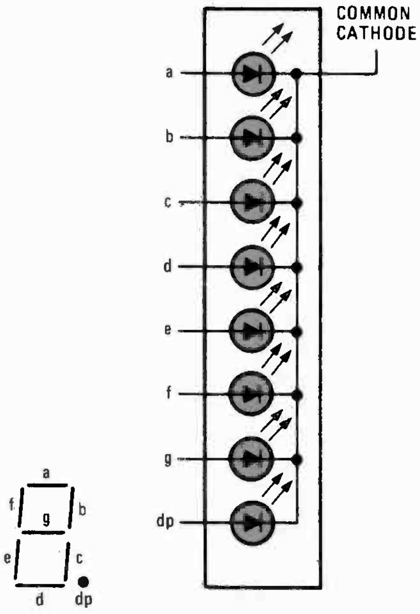


Fig. 2. There is a standard way of labeling the segments of a seven-segment display (A). Electrically speaking, a 7-segment display is nothing more than a group of light-emitting diodes (assembled) in a single package with one side of each connected together as shown in B.

Some ohmmeters will supply sufficient current so that the segment will light when forward biased, so the segment and its corresponding pin can be identified. In the event that an ohmmeter does not provide sufficient current, one may connect a current-limiting resistor of the proper value to a power supply or battery and check each segment by operating it as a single LED.

Procedure. Figure 1 shows the set-up for this month's experiment. Before you can proceed, you will have to construct the power supply used in last month's exercise (if you've dismantled it, that is). If you left the power supply circuit set-up on your breadboard, you need only add the two additional components to the circuit when you perform the exercise.

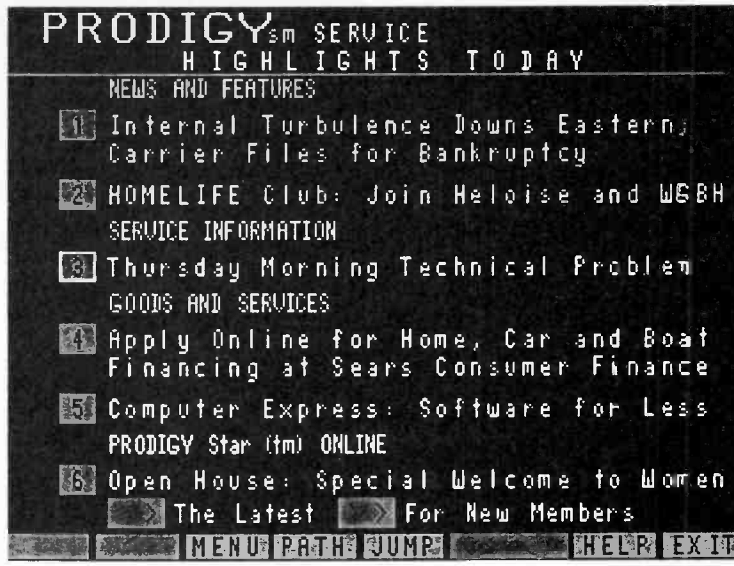
It is suggested that you not breakdown the breadboarded circuit after each exercise in anticipation that the breadboard will be used again and again in the exercises to come. Because you will be required to keep some of the circuits (particularly this one) on the solderless breadboard for the next experiment, it is important that good wiring practices are used to conserve space. For instance, keep leads and wires short and direct. Also, do not place wires *over* IC's. If the IC is bad and you must replace it, such wires would have to be removed. That wastes repair time and can cause you to make mistakes during reconnection.

Along with the parts in the Parts List, you will also need a multimeter to perform all the steps. If you do not have one, you can still get a lot out of the experiment by skipping the steps that require one.

Measuring Diode Resistances. Using an ohmmeter set to its high-resis-
(Continued on page 92)

By JEFF HOLTZMAN

EXPLORING



PRODIGY

Two of corporate America's giants have teamed up to create a new on-line database aimed at the masses. Is it a hit, or a miss?

Webster's defines a prodigy as a thing "so extraordinary as to inspire wonder." Take Sears (America's largest retailer) and IBM (the world's largest computer company), throw in a market of maybe 30-million PC users, and you've got some idea of just how extraordinary that is.

The "Big Two" understood that of those 30-million users, only a few percent have modems and use them regularly to connect to on-line information services. So IBM and Sears teamed up to develop a new on-line communications system called Prodigy. Prodigy is not yet a prodigy—but it's got potential, lots of it.

The reason so few PC owners go on-line is not that there isn't plenty of useful and interesting information—there is. Rather, it's the difficulty of navigating Byzantine menu structures or mastering complex and arcane command-line languages ("r xmodem myfile.typ"). So, foremost among the new system's ambitious goals is that it be easy to use.

In so doing, Prodigy's designers have jumped on the *G*raphics *U*ser *I*nterface (GUI, pronounced "gooey") bandwagon. When you're on-line with Prodigy, every screen is presented in CGA graphics mode: 320 × 200 pixels. With a CGA adapter, you get only two colors (black and white); with an EGA or VGA adapter, you get 16 colors. Hercules owners get monochrome screens in high-res graphics mode. The reproductions shown in this article are screen dumps made from a VGA system, with various colors shown as shades of gray. Unfortunately, the grey-scaling does not allow the full attractiveness of the Prodigy screens to show through.

The underlying structure of Prodigy is similar to that of other systems, but the graphics screens provide a "friendlier" facade; in addition, using Prodigy entails use of single-key commands: J (jump), H (help), E (exit), etc. As we'll see shortly, several other features contribute to Prodigy's ease of use.

The fact that all screens are presented in graphics mode might cause you to suspect that operation is slow. My tests, which were run on a 10-MHz AT clone with a 2400-bps Hayes internal modem, indicate that the more speed you have, the better. That's not to say that every screen is transmitted bit by bit; rather, screens are apparently sent in a compressed format that reduces transmission time but of course adds decompression time at the receiving end. What that means is that you'll want both a fast modem and a fast PC—or lots of patience.

Actually, that "local processing" is what gives Prodigy a leg up over most on-line services, which depend on heavy-duty (and expensive) mainframes to do most of their processing. The nationwide Prodigy network actually consists of several layers: a home-based mainframe that provides centralized services and hooks up to other mainframes (Dow Jones News/Retrieval, for example); smaller local computers that help route network traffic and that store frequently accessed information; the bottom layer consists of individual PC's.

That layered approach allows Prodigy to charge only about $10 per month; by contrast, many on-line services charge that much per hour as a minimum; many charge between $20 and $40 per hour; specialized databases can run much more than that.

Cost is also reduced in another less tasteful way: on-line sponsors. Approximately 20% of nearly every screen is devoted to a commercial message. The upper 75% of the screen is devoted to the current activity, whatever it happens to be. The bottom 5% contains a list of the current commands. The no-man's land in between is where the sponsors get to ply their wares.

To many current users of on-line services, that blatant commercialism may be distasteful. In a medium whose information-carrying capacity is already fairly low, devoting 20% of that medium to non-essential information may not seem to be a good trade-off.

On the other hand, even jaded cynics (including yours truly) may find themselves legitimately interested in some of the products and services offered. Considering the $10/month end-user cost of Prodigy, it's obvious that someone is picking up the tab. No newspaper, magazine, radio, or television station survives on subscriber dues alone, and no one forces you to read, watch, or listen to the ads.

Using Prodigy. To use Prodigy, you need an IBM compatible; the company hopes to offer a Maintosh version by the end of the year, but has no plans to support small machines including the Apple II, Commodore 64/128, etc.

You must have 512K of RAM after booting and loading DOS 2.0 or later; use of memory-resident programs is strongly discouraged while running Prodigy. You also need a 1200- or 2400-bps Hayes-compatible modem, a graphics adapter (CGA, EGA, VGA, or Hercules), and a suitable monitor. You can install the Prodigy software on a hard disk or on several floppies; obviously, a hard disk is more convenient. A mouse is neither necessary nor supported for navigating Prodigy's GUI interface.

Oddly enough, for a program that prides itself on ease of use, I found Prodigy's installation procedure clumsy. In its effort to be "friendly," the "Getting Started" booklet used non-standard terminology that confused me. But I did manage to install the software without calling for help.

Then, to log on, you enter your account ID and a password, and Prodigy dials a local telephone number for you automatically; it learned the correct number during installation. The fact that it's a local number means you incur no long-distance charges. Several members of the same family can share the same account (for billing purposes), each with his or her own password for privacy.

The first thing you see when you enter Prodigy is the Highlights screen; it generally lists half a dozen items including important news events, news about changes in Prodigy, specials offered by Prodigy sponsors, etc. You can use the <TAB> key or the arrow keys in the numeric pad to move from item to item, or you can simply type the corresponding number. When the cursor is on the desired item, just press <ENTER>.

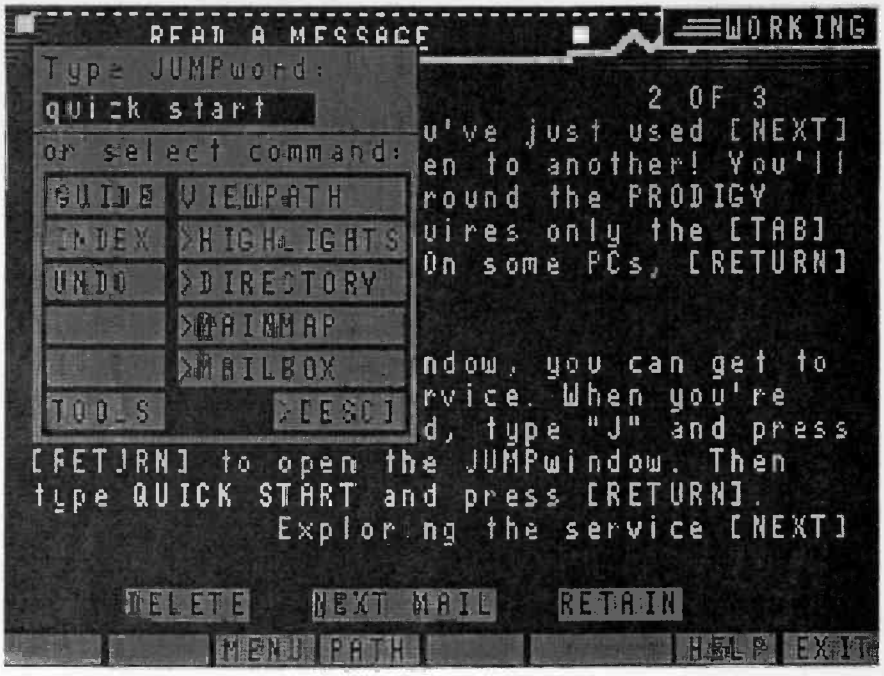
Actually, there's a well-defined structure hiding behind the Highlights screen. The company uses the following metaphor to describe it: Prodigy consists of a number of "buildings" (currently 6), each of which has a number of "floors," each of which has a number of "departments." The "buildings" consist of the following topics: Information, Living, Shopping I, Finance, Shopping II, and Traveling.

Using Prodigy's Guide command (by pressing G from most screens), you display a pop-up menu system that shows the current building, floor, and department you're in, and allows you to move among them using the cursor keys.

In addition, you can jump (using J, the jump command) directly to any department on any floor of any building from any other department on any floor of any other building—at any time.

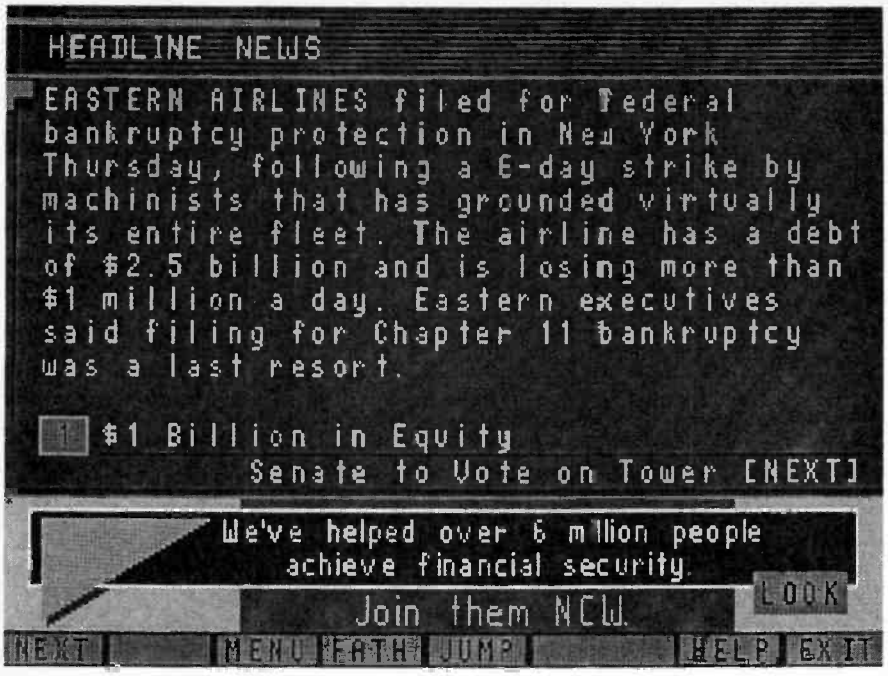
Further, after you get to know your way around the system, you can set up a list of your favorite jump words; the list is called a path. Then, using the Path command (always available on the bottom line of the screen), you can quickly visit your favorite departments one by one without a lot of typing.

So much for the structure; what do the departments actually consist of? Even though the service was only a few months old when I tested it, they contain quite a lot. You can view national and local weather maps and your cur-

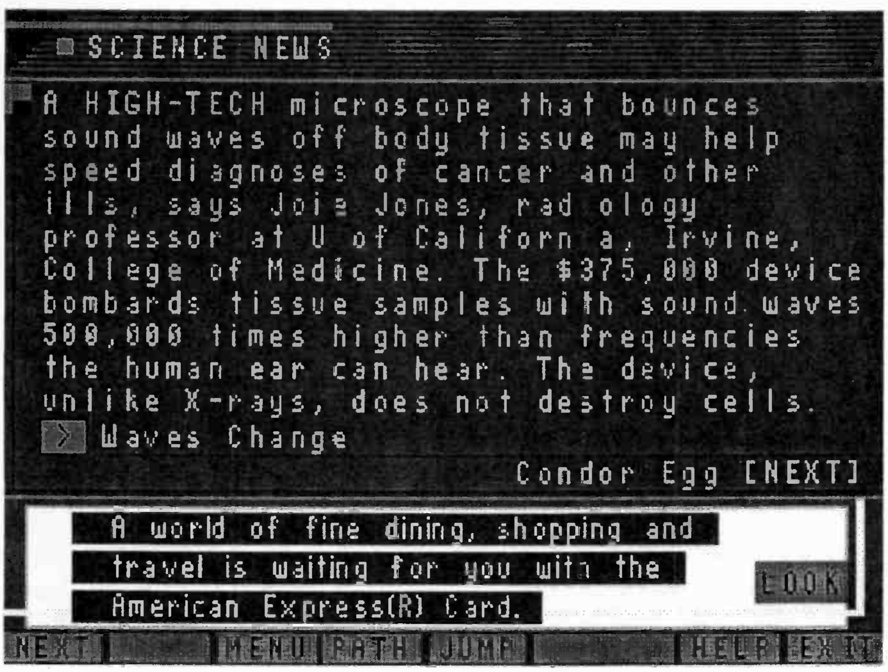


Press J from any screen to bring up the Jumpword menu. From here you can type the name of any desired jump word, or select one of the predefined jump words (Guide, Index, Mainmap,etc.). Press Enter and you're off!

Prodigy's "Mainmap" looks good, but doesn't provide much useful information. Instead, you'll probably want to use the Guide, a series of nested menus that show your position in the overall structure. Here, the "Building" is Living, the "Floor" is Computing, and the "Department" is Alsop, a noted computer-industry analyst.



The day these test shots were taken was the day Eastern Airlines filed for bankruptcy; here is Prodigy's report. Note the "commercial" for a financial institution.



The Science News jump word had a report on a new sonar-like microscope.

rent horoscope (courtesy of Jeanne Dixon). You can read a daily column about current films by noted critic Gene Siskel; Prodigy also has an on-line database of some 25,000 films that you can search, unfortunately, by title only. You can read product reviews by *Consumer Reports* and *Home Office Computing* magazine. You can read about current events, both daily news and more general feature stories. You can get information about and even book your own flights through American Airlines' Sabre system. Single persons can get advice on how to meet people; there are special sections for women and women's issues. You can send and receive private EMAIL (electronic mail) messages along with other Prodigy subscribers, and participate in a limited conferencing system. You can check current stock prices, and even set up a "portfolio" from which your favorite stock prices are instantly viewable.

And, of course, you can buy things. Every time Prodigy changes the main screen, a new "commercial" appears. If you're interested in the current one, press L (for Look), and you'll get full details. If you find you want to buy something, you need do little more than press <ENTER> a few times; Prodigy already has your name, address, and a credit-card number to charge your purchases to.

Some vendors have their own "departments" set up, so you can browse through on-line catalogs of computer supplies, general-interest books, and more; the list is growing all the time.

The Down Side. In spite of the attractive and easy-to-navigate screens, there are several problems with Prodigy. First is the building/floor/department metaphor. Actually, the metaphor itself is fine; it's the distribution of the actual topics that's suspect. Once you find out that a topic exists, you can always jump to it. But understanding both its place in the hierarchy and its possible relations to similar topics are difficult because the overall scheme is simply not intuitive.

In addition, a number of the tools supplied by the system are weak, compared with those provided by services like Compuserve and BIX, or are simply non-existent. For example, probably the most popular activity on all BBS's and commercial on-line services is downloading files; Prodigy currently has no provision for doing so.

Further, most of the information presented in the news and features sections is extremely abbreviated. Generally you get two or three paragraphs, each of which consists of eight or ten 40-character lines. How much information can one convey in 200 words? It's an insult to the intelligence. Granted, there shouldn't be a PhD thesis on every topic; even so, there should be details for those who want them.

The messaging system is weak because the system only stores messages for a few days, after which they are deleted. So Prodigy doesn't encourage the long message threads with multiple digressions and evolutions into new topics that make electronic conferencing a worthwhile activity.

On the positive side, Prodigy has squarely attacked two of the foremost issues keeping "Everyman" off the on-line service networks: cost and ease of use. However, the constant flow of commercials and the fact that two of the

(Continued on page 102)

Circuit Circus

By Charles D. Rakes

ELECTRONIC DRUM CIRCUITS

This month the Circus starts of by following the "beat" of an electronic drummer. There are a number of similar noise makers on the market. Some of the low-end drum simulators use a piezo disc as the sensor to detect the drum stick's tap.

The piezo disc is attached to the bottom of a thin plastic membrane that serves as the drum head. Normally when the plastic drum sticks are used, the piezo sensor performs as designed, but if a wood or similar hard object is substituted, it's likely the sensor will be shattered and the beat will cease.

Not only will our first circuit overcome the problem of the fragile piezo sensor, but it will also replace it with a 10-cent super tough pick-up that's kid proof. If you take a common garden variety ceramic disc capacitor and bang away on it, a small, but detectable output will be produced.

The circuit in Fig. 1 takes advantage of that uncommon fact. A 0.1-µF, 100-WVDC disc ceramic capacitor is connected, through a length of shielded mike cable, directly to the input of op-amp U1-a.

The minute signal developed from thumping on C1 is boosted several hundred times by U1-a and its output (at pin 1) is fed to the input of U1-b (which is configured as a voltage follower). A low voltage audio amp, U2, boosts the signal level sufficiently to produce a "bong" sound from the speaker for each tap on C1.

A number of various makes, shapes, sizes, and voltages of 0.1-µF ceramic-disc capacitors were tested for the sensor, and, like people, all were not alike. The capacitors that tested best for the task were the smaller (physical size) variety with a 100-volt or less voltage rating. Values greater than 0.1 µF will work too, but generally they're not as plentiful in most junkboxes as are the 0.1-µF or smaller units. The smaller capacitance values tested just didn't produce a sufficient output for the circuit. Although some 0.1-µF capacitors tested better than others, all worked fine as sensors.

The circuit in Fig. 1 makes a great test circuit because it lets you hear the results of each capacitor as it is being checked out. Some capacitors will produce a short "pinging" sound while others will actually produce a longer-lasting ringing sound.

Trigger Circuit. Our second circuit (see Fig. 2) uses the capacitor's amplified output pulse as a trigger signal to turn on a separate sound-generating circuit. The shape, duration, and level of the capacitor's output pulse is still important because it adds to the mix that determines the length and shape of the generated audio-output signal.

The circuitry surrounding U1-a is the same as in the previous circuit, but in this circuit U1-a's output is fed to a voltage-doubler/rectifier circuit, comprised of C2, D1, D2, and C7. The rectifier's output pulse supplies positive bias to the base of Q1.

Op-amp U1-b and its associated components make up a tone-generator circuit that remains inactive until triggered. The generator's output is fed to the input of U2 (an LM386 low power audio amplifier), which provides enough signal boost to drive the speaker, SPKR1.

Now here's how the circuit produces a drum-like sound. When C1 is tapped the signal is amplified by U1-a, and its output is converted to DC by the rectifier circuit. The DC output of the rectifier charges C7. At a given level, the charge on C7 is sufficient to turn on Q1 for a short time period. When Q1 turns on, it switches the junction of C4 and C5 to ground, causing the oscillator circuit to begin operation, producing a drum-like beat.

The timing of the output tone is controlled by the amplitude of the pulse coming from U1-a and the value of C7. Increase either or both and the "bong" lasts longer. Also the value of R7 can be decreased to shorten the tone time.

The generator's output frequency can be set to just about any audible tone by experimenting with the capacitor values of C4 and C5. Try 0.1 µF or larger values for the low end and 0.01 µF or smaller for the high end to produce just the right note.

For a different action and look, the sensor capacitor can be mounted inside a drum stick made out of a long plastic tube. Place the capacitor solidly against the inside edge of one end of the tubing and epoxy it in place. Connect the capacitor to the circuit through a length of shielded microphone cable and bang away on any hard surface.

Here's another sound application for the cheap sensor. If your home has one of those fancy, brass door knockers, epoxy one of the ceramic capacitor sensors to the inside area next to where the knocker makes contact. Connect the sensor to the circuit with a length of shielded cable and use an AC-operated power supply and you'll have a

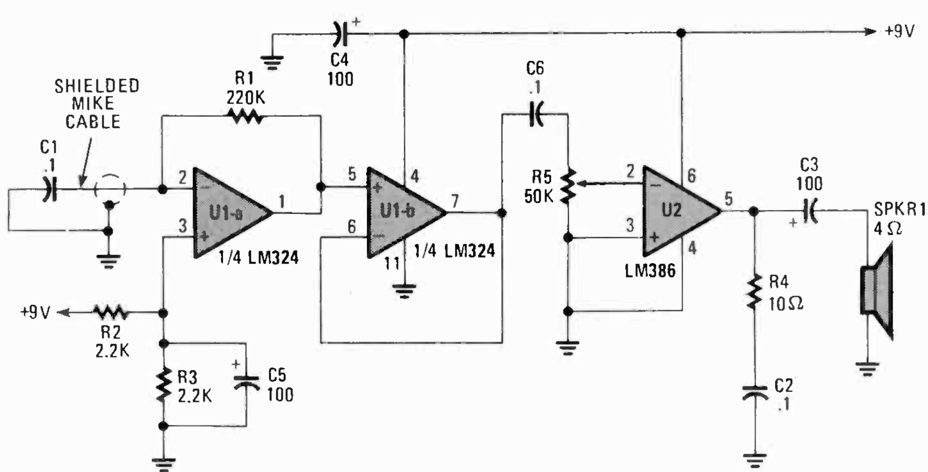


Fig. 1. Our drum simulator uses a capacitor to detect the tapping of the stick. The detected signal is then amplified, conditioned, and used to drive a 4-ohm speaker.

PARTS LIST FOR FIG. 1

U1—LM324 quad op-amp, integrated circuit
U2—LM386 low-power audio amplifier, integrated circuit
R1—220,000-ohm, ¼-watt, 5% resistor
R2, R3—2200-ohm, ¼-watt, 5% resistor
R4—10-ohm, ¼-watt, 5% resistor
R5—50,000-ohm, potentiometer
C1, C2, C6—0.1-µF, ceramic disc capacitor
C3–C5—100-µF, 16-WVDC electrolytic capacitor
SPKR1—4-ohm speaker
Printed-circuit or perfboard materials, enclosure, IC sockets, battery and battery holder, shielded microphone cable, hook-up wire, solder, hardware, etc.

PARTS LIST FOR FIG. 2

U1—LM324 quad op-amp, integrated circuit
U2—LM386 low-power audio amplifier, integrated circuit
Q1—2N3904 general-purpose NPN silicon transistor
D1, D2—1N914 general-purpose small signal silicon diode
R1–R4—150,000-ohm, ¼-watt, 5% resistor
R5–R7—10,000-ohm, ¼-watt, 5% resistor
R8—10-ohm, ¼-watt, 5% resistor
R9—25,000-ohm potentiometer
C1, C3, C10—0.1-µF, ceramic-disc capacitor
C2—0.47-µF, ceramic-disc capacitor
C4, C5—0.01-µF, ceramic-disc capacitor
C6, C8, C9—100-µF, 16-WVDC, electrolytic capacitor
C7—4.7-µF, 16-WVDC, electrolytic capacitor
SPKR1—4-ohm speaker
Printed circuit or perfboard materials, enclosure, IC sockets, battery and battery holder, shielded microphone cable, hook-up wire, solder, hardware, etc.

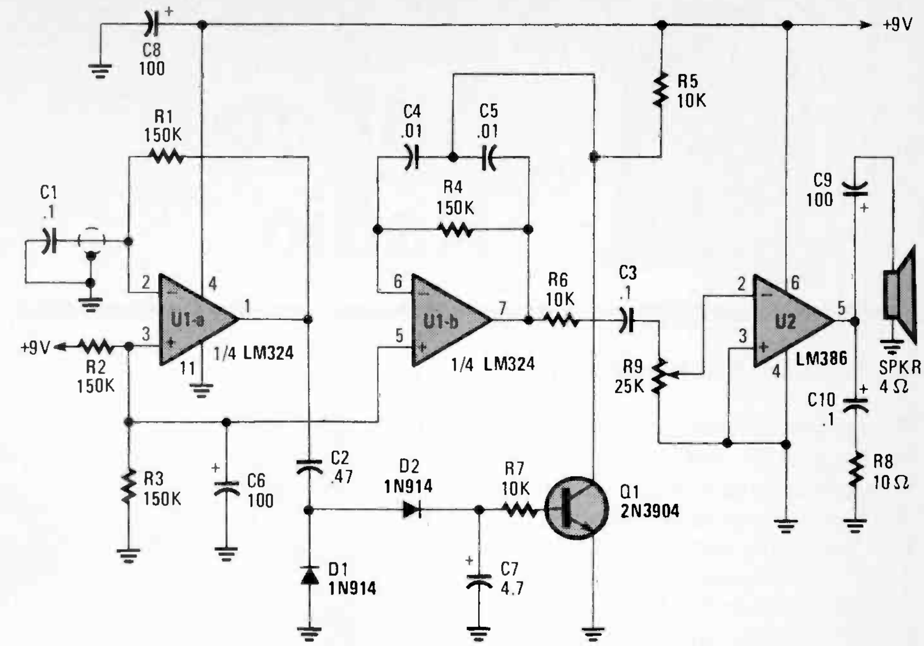


Fig. 2. This circuit is similar to the circuit in Fig. 1, except that the signal detected by the capacitor sensor is used to trigger the circuit.

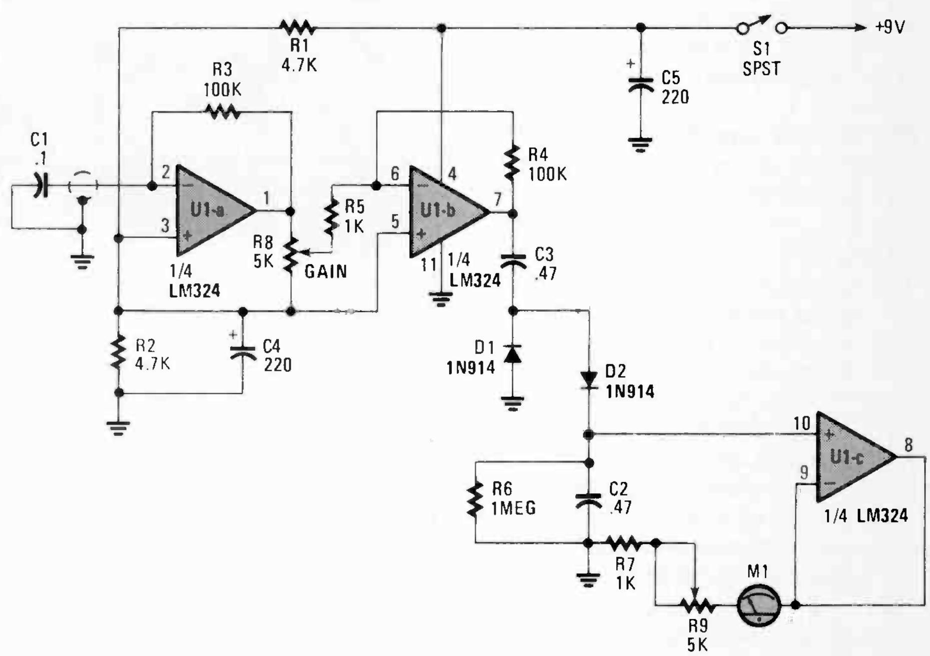


Fig. 3. Here is a circuit that should be of interest to car buffs and others involved with tracking down the source of strange knocking noises in electro-mechanical devices.

most unusual annunciator.

The third and last circuit using the ceramic sensor should find its way into every electronic detective's tool chest. If you have ever experienced the perplexing problem of tracking down the source of a knock or low frequency ping in a mechanical or electro-mechanical device, then by all means build and use the knock detector/locator.

Here's just a few area's where the circuit will certainly prove most valuable in locating and pinpointing an unusual sound problem: Locating the source of a knock or ping in an automobile or industrial internal-combustion engine; Detecting and locating the source of a similar noise in just about any mechanical or electro-mechanical manufacturing equipment, including robotic equipment, printing presses, office equipment, etc.

Knock Detector. Figure 3 shows the schematic diagram for the knock-detector circuit, in which capacitor C1 is used as a sensor. The sensor's output signal is amplified several thousand times by op-amps U1-a and U1-b. Potentiometer R8 serves as the sensitivity control. The amplified output of U1-b is rectified by the voltage-doubler circuit made up of C3, C2, D1, and D2. The doubler circuit's DC output is fed to the input of U1-c (which is configured as a voltage follower), and its output is fed to a 1-mA meter. Potentiometer, R9, sets the meter's maximum current level.

The value of R6 sets the discharge time for C2. If the value of R6 is made too large, the meter will require too

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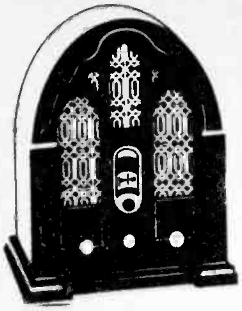


Antique Radio

By Marc Ellis

Exploring the A.C. Super Wasp

Last month, I introduced the *Pilot A.C. Super-Wasp*—the receiver we are now featuring in *Antique Radio*. For those of you who've just joined us, the Pilot A.C. Super-Wasp is a 4-tube, 5-band regenerative receiver designed for operation from the AC power line. It covers the frequency range of 500–14.2 meters (600 kilohertz to about 18.5 megahertz) using five sets of plug-in coils. The 1929-vintage set was sold only in kit form and has several interesting features. I'm sure you're going to enjoy exploring them as much as I am!

Pilot's Past and Future. The A.C. Super-Wasp was a product of the Pilot Electric Manufacturing Company of Brooklyn, New York, which had just changed its name to "The Pilot Radio and Tube Corp." Pilot's advertising of the period stressed that the firm had been founded in 1908 and operated "the world's largest radio parts plant."

I don't know much about Pilot's early history, except that the company seems to have been an old-line electrical-parts manufacturer. By the late 1920's, however, Pilot was wholly committed to the radio field and manufacturing a very diverse variety of electronic parts. They were also aggressively marketing Wasp receiver kits—which, as you might imagine, were constructed almost entirely of Pilot-brand components.

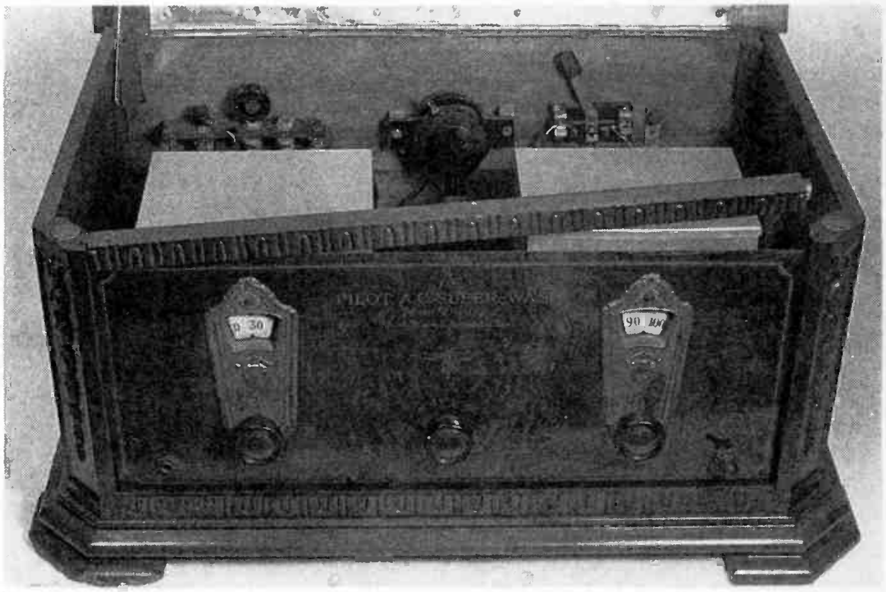
Older readers might remember seeing the famous Pilot "skipper and ship's wheel" logo on the little *Pilotuner* FM converters that were widely marketed in the 1950's. Those table-model, wood-cabinet FM tuners played through any available amplifier—or even the phono input of the living-room radio. They provided pioneer hi-fi nuts with an inexpensive introduction to the wonders of FM broadcasting.

My 1964 Lafayette Electronics catalog has a full page devoted to the Pilot line of component stereo—including tuners, amplifiers, and complete receivers. The distinctive Chinese-inspired lettering used on the company name at the head of the page would have been familiar to any reader of the firm's 1920's advertising. Why Chinese? I don't know. Perhaps it was originally meant to tie in with the nautical logo and suggest the far-away places that could be reached via shortwave radio.

At any rate, that was the last mention of Pilot that I saw. I couldn't find Pilot equipment in either the 1965 Newark Electronics or the 1966 Allied Electronics catalogues (I don't have the Lafayette catalogues for those years) and assume that the company went out of business around that time. Perhaps one of our readers can tell us a little more about Pilot's history and what happened to end more than half a century of successful operations.

The Charm of Transition. Why do I consider the A.C. Super-Wasp to be a radio of unique interest? It's because the set is so *transitional*. The design and construction represent a fascinating combination of the battery-set technology that preceded it and the plug-in radio technology that would follow.

To get an idea of the nature of the appeal, think of an early 1920's runabout-style car. With its cloth top and high, angular body, it was obviously only recently descended from the buggy. But those quaint exterior trappings concealed a reasonably powerful—if cranky—internal-combustion engine that gave the machine a speed and endurance its horse-drawn counterpart could never rival.

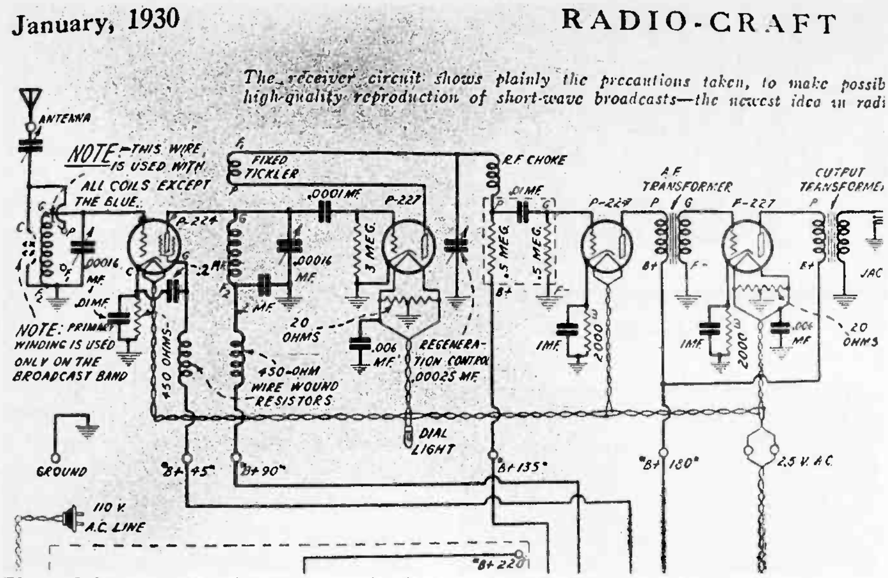


Here's the A.C. Super-Wasp just prior to disassembly for inspection. Locking rail at top of panel is partly removed (see text).

Now think of any horse-drawn buggy you may have seen in a museum—I don't care how elaborately crafted it may have been. Does it engage your sense of nostalgia the way a tin Lizzie might? I'll bet not.

Finally, compare our hypothetical tin Lizzie to a mid-1930's convertible-style car. The latter certainly has an appeal all its own. But the crank is gone; the body is low-slung and streamlined; the dependable, multi-horsepower engine has been smoothly integrated into the body and chassis. In your mind, does that kind of car have the unique ungainly charm of our tin Lizzie? Probably not.

Radios that straddled battery- and AC-powered technology in the way the tin Lizzie straddled horse- and gasoline-powered technology are rare. The A.C. Super-Wasp is one of the few for a couple of reasons. First, Pilot Radio had a very aggressive marketing strategy and was willing to introduce an improved



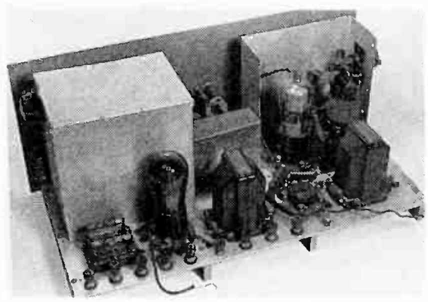
The A.C Super-Wasp schematic as published in a 1930 Radio-Craft article. My set matched it connection for connection.

model whenever any new technological development warranted it. Second, since the company was concentrating on kits rather than completed radios, design changes didn't require extensive reorganization of the production lines and were relatively easy to implement.

Last month's column provided some background on the evolution of the various Wasp models marketed by Pilot. Those models were released only months apart, and each one incorporated the latest developments in the exploding technology of the era. More conservative manufacturers, and those who were manufacturing completed sets, weren't as quick to redesign and retool. That's why the Pilot sets are so interesting to study, and why the A.C. Super-Wasp can provide us with such a vivid "snapshot" of the state of the art as plug-in radios were beginning to evolve from battery-powered ones.

Getting Ready to Explore. The particular A.C. Super-Wasp that we'll be working with in this series of articles came into my possession in quite good shape. We won't so much be restoring it as checking it over, cleaning it up, and correcting any defects that we may encounter.

And since this one—like all A.C. Super-Wasps—started out as a kit, it seemed like a wise idea to begin our exploration by checking the work of the original constructor. That could best be done by tracing the circuit of the receiver and comparing it, connection by connection, with the original schematic diagram. While looking for wiring



Rear view of Wasp's chassis. Shield can for screen-grid RF stage has been partially dismantled to gain access to wiring.

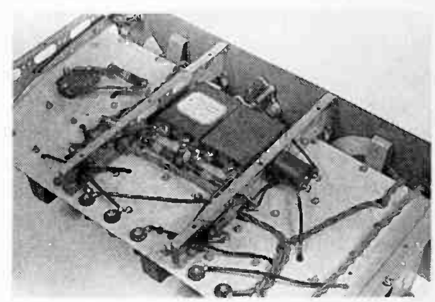
errors and/or modifications, I'd also be able to get a feel for the construction style and make some general checks on the condition of the components.

The schematic I used, and which is reproduced for you here, was originally published in the January, 1930 issue of *Radio-Craft* as part of an article by John Geloso, Pilot's Chief Engineer. As discussed in this column last month, the circuit is very similar to that of the *Super-Wasp*, a battery-operated predecessor. But to make power-line operation possible, the original battery-filament tubes were replaced with their just-introduced AC-heated equivalents: a type 24 screen-grid amplifier, a type 27 regenerative detector, and two type 27 audio amplifiers.

Like its predecessor, the new AC-powered Super-Wasp received its operating voltages via a string of binding posts located along the back of the chassis. Instead of coming from batteries, however, those voltages were provided by a power supply (to be covered in a later column) that operated from a 117-volt AC outlet. The power supply, sold as an accessory, was a separate unit from the radio proper. Pilot's engineering staff had not yet integrated the power supply and radio circuitry as they would with the following model—the *Universal Super-Wasp*—released in 1931.

Before I could begin checking out the Super-Wasp's circuitry, I had to figure out how to remove it from the cabinet. (That was apparently an accessory item purchased from another manufacturer, since it does not appear that Pilot offered a cabinet for the "Super-Wasp" models.) The set was held in place only by its front panel, which seemed to be securely and permanently framed into the woodwork. It took a moment before I realized that the top rail of the "frame" around the panel had to be removable. Exerting a slight upward pressure did the job, after which the chassis could be pulled up, sliding the front panel out of its retaining groove. A very neat system!

Though I had removed the set from the cabinet, I wasn't yet in a position to study all of the wiring. In the Super-Wasp models, the screen-grid RF-amplifier and regenerative-detector stages are housed in separate shield cans. That is done in order to minimize interaction between the stages and to prevent the operator's body capacitance from affecting tuning.



View of the set's underside. Cathode bias resistors for two of the stages, along with their associated bypass capacitors, are located in the center section.

The tops of those square shield cans slide off readily to facilitate coil changing. However, that wasn't good enough to expose the wiring for inspection. Noticing that each can was actually made up of two half-cans fastened together, I unscrewed and removed the back half of each enclosure. Now I had more than adequate access.

In the process of dismantling the enclosures, I saw that several of the screws and nuts holding the half-cans to each other and to the chassis were missing. I

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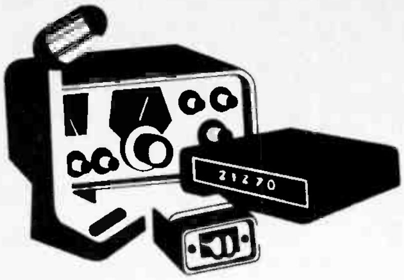

Ham Radio

By Joseph J. Carr, K4IPV

WANT TO GO FOX HUNTING?

Fox hunting? Are you out of your tree? This is a ham radio column! Yep, but fox hunting is an old and honorable amateur-radio activity. The term "fox hunting" refers to a hidden-transmitter hunt. The general scenario goes something like this: One amateur with a mobile or portable rig hides someplace within a general area, and is the fox; other amateurs with radio direction-finding antennas on their mobile or portable rigs try to find the hidden transmitter. It's great fun!

Although hidden-transmitter hunts were once very popular, they went into eclipse in most areas for a number of years. However, recent chatter on the local repeater, and the recent publication of a couple of books, indicates that amateurs are rediscovering the fox hunt.

At one time, the afternoon fox hunt was a staple of every hamfest, and it's likely that it will again be popular. I can still recall a lot of Saturday morning fox hunts with local ham clubs. It was common that the whole gang would meet at a local eatery after the hunt for breakfast, and to exchange "lies" about previous hunts (hidden-transmitter "fox hunters" lie as much as real fox hunters).

A friend of mine used to have a 1948 Plymouth that was painted fire-engine red and forest green, and the paint looked like it was put on with a stray broom instead of a brush or spray gun. He was an avid fox hunter in those days (now he's a police officer). He had a 75-meter receiver installed for transmitter hunting. The direction finding antenna was a square tuned loop mounted on the end of a long broom handle. Because the winner is the first guy or gal to touch the hidden-transmitter operator, the unfortunate tendency is to...errr...speed a little as one closes in.

One morning, my friend's enthusiasm got the best of him, as he sped toward the final triangulation point. Because his car looks so bizarre, and the antenna resembled a cross with a wire loop

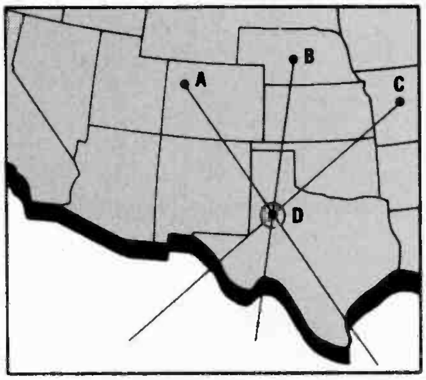

Fig. 1. Illustrated here is the method used in triangulation. Bearings on the hidden transmitter are taken from three or more directions, and plotted on a map. The point where the lines intersect is the location of the the hidden transmitter.

around it, I understand that the local police received a citizen report of "...a religious nut driving recklessly up and down the street waving a cross out the window!" Ah, the good ol' days. While I cannot condone reckless driving, the fox hunt will yield a lot of fun.

Reasons for Fox Hunting. One good reason for the fox hunt is to build radio direction-finding skills. Next month, this column will deal with tracking down interlopers and other sources of interference on our bands. Because such problems are on the increase, it may be important to develop RDF skills—through transmitter hunting—as a hobby-survival issue.

It is not merely the survival of our hobby (at least in the form that it presently takes) that makes RDF skills useful. There is also a public service application. Remember, the "amateur service" is like all other radio services; it exists as a public service. We can use our RDF skills in emergencies to augment our communications abilities. For example, I once read a story in the newspaper where amateur-radio operators were able to press their RDF skills into service to find a lost hiker.

The hiker was lost in the Appalachian Mountains of western Maryland, but carried a CB walkie-talkie. Amateurs who were used to fox hunting on 10 meters were not unfamiliar with the problem of locating the poor chap...and their skills aided the local police and rescue units in narrowing the range that needed to be searched.

There is even a persistent story of amateurs aiding in national defense during World War II. According to the (possibly apocryphal) story, immediately before the US entry into the war, German voices were heard on the then newly opening 10/11-meter band by East-coast hams. Through RDF'ing, they learned that the source was North Africa, and the signals were Rommel's tank forces talking to each other.

Because of skip problems, British-intelligence receiver sites would be unable to hear the signals, but US amateurs could! Even very low power signals will propagate over intercontinental distances on 10 meters (Note: With the sunspot cycle on the upswing, look for a lot of low power DX opportunities on 10 meters in the next couple of years).

The Basic Method: Triangulation. Figure 1 shows the basic method of locating a hidden transmitter. A hidden transmitter is located at point D, while receiver sites are located at points A, B and C. Each receiver uses a directional antenna to find the direction from which the signal is emanating. When those bearings are plotted on a map, they cross near point-D. Long distance RDF in the HF bands is less accurate because of propagation effects, so one must re-home-in on the transmitter locally.

In the local case, the bearings are taken from three or more locations, and plotted on a map. The bearings, when plotted on a map, cross in a small radius. The receiver can then be taken to that small area and re-triangulated to locate the specific spot from which the transmitter is operating.

To home in on a hidden transmitter (when the other operator is real clever), one must use a portable field-strength meter, or some other similar device, to home in on the last few yards. Of course, if the hidden transmitter is an illegally operated transmitter, then it is likely to be in a house with a big antenna on top...and that's easier to find.

A Word About Antennas. Fox-hunting antennas must, by necessity, be d rectional. In the VHF and UHF bands, especially 2-meters and up, it is possible to use a hand-held yagi antenna for that purpose. Wildlife scientists use that type of antenna to track radio beacons attached to animals. At lower frequencies, however, one version or another of a dipole or loop antenna is used. Those antennas sometimes pose a little problem for RDF'ers.

Figure 2 shows the polar pattern for a simple dipole antenna, and (more or less) also for smaller loop-stick antennas sometimes used in RDF'ing. Notice that the pattern is bidirectional. Also note that the peaks of the main lobes are quite broad. The implication of that second feature is that the exact peak is hard to see on a receiver's S-meter or by ear.

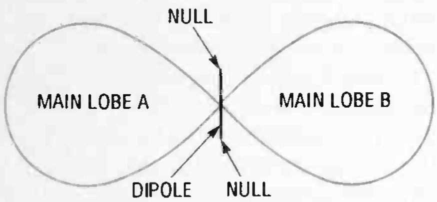

Fig. 2. The bidirectional "figure-8" pattern of a dipole is ambiguous: which of the two directions is right?

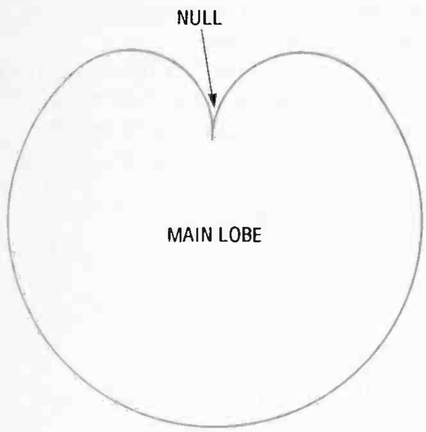

Fig. 3. The cardioid pattern of a proper RDF antenna is a lot less ambiguous than the bidirectional antenna.

For that reason it is common practice to use the null, not the peak, as an indication of the direction of the transmitter. The nulls are much sharper than the peak, and so are easier to accurately locate. Therefore, rotate the antenna until the minimum S-meter indication is found, and that is the direction of the hidden transmitter. Or is it?

There are two nulls in the pattern of Fig. 2. Those nulls are along a common axis, and the transmitter could be located in either direction along that axis. Properly designed RDF antennas use

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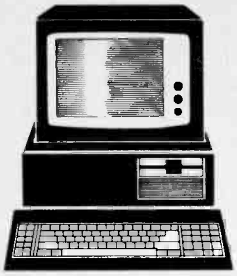


Computer Bits

By Jeff Holtzman

A PROGRAM WRITING CONTEST!

You've been bitten by the computer bug, or else you wouldn't be reading this. You're also a hands-on person—one who likes to lift up the hood and get your hands dirty. Well, here's your chance. To make it interesting, we're offering $650 worth of prizes, including a fast 286 motherboard (courtesy of JDR Microdevices), and a pile of great software (courtesy of TurboPower Software).

This is a software contest. The challenge: To write the best short utility program. How short? A maximum of 100 lines. The language? Turbo Pascal (version 4 or 5; however, version 5 is recommended).

Why not BASIC? Because BASIC is bad! Sure, it's easy to learn, and modern versions have evolved to the point where they're very Pascal-like, but even so, Pascal was designed from the ground up to promote good programming practices. In addition, the environment provided by Turbo Pascal allows you to write, test, and debug programs as fast as in BASIC.

To give you a start, I'll describe a short utility program that displays the free space and total space of a specified disk drive. (See Listing 1.) Note that when we discuss Pascal command, functions, statements, etc. in text they will appear like this.

Pascal Basics. Every Pascal program is built from procedures and functions, which are similar to BASIC subroutines. Procedures and functions are similar to one another, in that both perform a task and may be called by other procedures and functions. They differ in that a procedure simply does its thing without notifying whatever called it of the results of its actions.

A function, by contrast, does its thing and returns something to the calling routine. What it returns can be a numeric value, a string of ASCII characters, or a more-complex structure. An example of a procedure is Pascal's writeln statement, which is similar to BASIC's PRINT. Whereas in BASIC you might say:

PRINT "HELLO"

in Pascal you'd say:

writeln ('HELLO');

The semicolon is required at the end of every Pascal statement.

An example of a function in Pascal is sqrt, which returns the square root of the specified value:

x := sqrt (4);

Note that assigning a value to a variable is done with a colon plus an equal sign, not just with an equal sign as is done in BASIC.

Pascal comes with many built-in procedures and functions; writing a Pascal program is really the process of writing new procedures and functions that accomplish whatever it is you need to get done.

Variables and Types. In BASIC, when you call a subroutine, you often assign a variable(s) a value, and then call the subroutine. In Pascal, you can supply the values you want a procedure or function to act upon when you call the routine. For example, in a BASIC subroutine to multiply two numbers, you might say:

A = 10: B = 2: GOSUB 2000: REM NOW C = A*B

but Pascal is much more elegant:

c := MultiplyTwoNumbers (a, b);

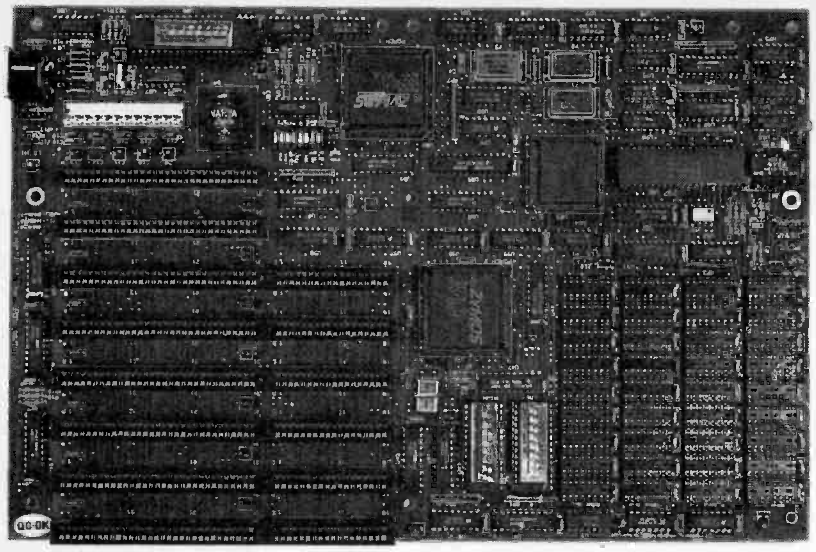
In Pascal, you can't just start using a variable whenever you need one. Rather, you must *declare* it. The necessity of being explicit in declaring all variables helps avoid common programming errors, such as using the same variable twice, or giving two different types of variables the same name.

Look at the example program. In line 9 is the keyword var, which tells the compiler that the following items are variables. Those variables (DriveString and Drive) are *global* variables; every function and procedure in the program could use or change their value. Although they're not used here, you can also declare *local* variables within any function or procedure.

A local value only has meaning inside the procedure or function that declared it. If two procedures or functions declare variables using the same

LISTING 1

```
1   program disk;                     {jkh  3/31/89}
2     {Demonstration program for Popular Electronics}
3
4   {$M 1024,0,0}
5   {$B-,D-,R-,S-,V-}
6
7   uses dos;
8
9   var
10    DriveString : string;                  {User-specified drive}
11    Drive : word;                          {0=current drive, 1=A, 2=B,
    ...}
12
13  function TotalSpace (drive : word) : word;
14    {Get total size of disk, convert to K}
15  begin
16    TotalSpace := DiskSize (drive) div 1024;
17  end;
18
19  function FreeSpace (drive : word) : word;
20    {Get free space on disk, convert to K}
21  begin
22    FreeSpace := DiskFree (drive) div 1024;
23  end;
24
25
26  begin                                    {The program starts running
    here}
27
28    Drive := 0;                            {Default is current drive}
29    if ParamCount > 0 then                 {Else get user specified dri
    ve}
30      begin
31        DriveString := ParamStr(1);        {Get specified drive}
32        Drive := ord (upcase(DriveString[1])) - 64; {Convert from ASC
    II}
33      end;
34
35      writeln ('Total space = ',TotalSpace(Drive),'K');
36      writeln (' Free space = ',FreeSpace(Drive),'K');
37  end.
```



This streamlined, MCT-M286-12, 12 MHz, mini 80286 motherboard (provided by JDR Microdevices) is offered as first prize in our program-writing contest.

name, the two variables are independent of one another—it's as though they had different names and are not treated as global variables.

Note also that DriveString and Drive are followed by a keyword that specifies their *type*, in this case, string (a sequence of ASCII characters), and word (an integral value ranging from 0–65,535). Pascal comes with a number of types; you can even define your own.

Program Structure. In BASIC, a program starts executing at the first line; in Pascal, that's not the case. Just as you must declare all variables before using them, you must also define all functions and procedures before using them. So the place where a Pascal program actually begins is near the bottom, in this case at line 26, at the keyword begin. (By the way, comments in a Pascal program are surrounded by curly brackets. Also, line numbers are shown for purposes of discussion only; Pascal programs do not use line numbers.)

The end of the program, line 37 is marked by the keyword end. (with a period). Procedures and functions also have their own statement blocks that start with begin and stop with end; (with the semicolon). See the example program if this is unclear.

The Example Program. You use the program simply by typing DISK. If you specify a drive (*e.g.*, DISK C), it reports the total amount of space and the free space on the specified drive. Otherwise it reports those values on the current drive.

Now let's see how the program works. First, in line 28, the variable Drive is set equal to zero; that tells the disk functions to operate on the current drive in case the user didn't specify otherwise.

Next (in line 29), the program checks whether the user entered anything on the command line. If so, we get the first character of the string (DriveString[1]), convert it to uppercase, get its numeric value, and then subtract 64 from that. For example, an ASCII "A" has a decimal value of 65, so the variable Drive would contain 1; for "B" it would be 2, etc.

Then the program writes the desired information to the screen. Note that the ASCII strings, such as "Total space = ", are enclosed in single quotes, and that several items separated by commas are specified in the same writeln statement. So after writing "Total space = ", the function TotalSpace is called for the drive we just calculated. The value returned by the function is printed next, followed simply by the letter K. Then the process is repeated to get the free disk space.

Note that when the two disk functions (TotalSpace and FreeSpace) are called, the global variable Drive is passed to them. The two functions work almost identically; let's talk about TotalSpace.

The variable that the function is supposed to use (and its type) are specified in the first line of the function, in parenthesis, following the name of the function. Then comes the type of value that the function will return. The incoming variable is called Drive; it could have been called anything. The variable drive doesn't refer to the global variable Drive, with which the function is called; the drive is a local variable that is only in effect while this routine is running; when it ends, the variable magically disappears.

The way the function works is actually quite simple. First it calls a built-in Turbo Pascal function (DiskSize), which returns the size of the specified disk in bytes. To obtain the value in kilobytes, the result is divided by 1024. The final result is then assigned to the name of the function, which is the mechanism by which the value is returned to whatever called it.

It's impossible to teach any language in so little space, however, I hope this discussion will inspire you to try Pascal. Pascal may be a little easier to learn than BASIC, but once you do learn it, it's much more efficient, in terms of both the work you have to put into it and program efficiency.

Where To Go From Here. If you're already fairly proficient in BASIC, a good way to get started with Pascal would be to convert a short program to Pascal. If you're starting from scratch, you'll need a good introductory text describing the language.

The Pascal "Bible" is *Pascal User Manual and Report* by Kathleen Jensen and Niklaus Wirth, published by Springer-Verlag (New York, 1974). Also, check your local bookstore for more modern titles, especially those dealing with Turbo Pascal.

If you're having trouble thinking of programs to write, here are a few suggestions. Don't take them literally; use your imagination!

- Calculate the amount of space that would be required to copy a group of files from one type of drive to another.
- PRINT ASCII text files with footers and headers optionally containing page numbers, current time and date, file-creation time and date, filename, etc.
- A memory-resident program to capture text screens to disk when a hotkey is pressed.
- A system-info program to display information about the number and type of disk drives, video display, amount and types of memory, etc.
- A memory-resident printer-setup program.
- A memory-resident program to change screen colors.
- Count words, lines, and characters in an ASCII text file.
- Count how many times each word appears in an ASCII text file.

(Continued on page 91)

DX Listening

By Don Jensen

BE A GOOD SCOUT!

Here's a chance for radio enthusiasts to do a good deed and help promote shortwave listening among young people at the same time. The Boy Scouts of America recently decided to award merit badges to Scouts demonstrating skill in SWL'ing. And they need the assistance of experienced listeners to carry out the program.

The Radio Merit Badge is not new, of course, but until just a few months ago, it was based exclusively on amateur radio—that is, "ham"—operating skills. But the National BSA leadership has decided to expand the range of activities, satisfying the badge requirements in an attempt to draw more Scouts into radio.

The Association of North American Radio Clubs (ANARC), the "umbrella" organization linking the hobby-radio clubs of this continent, is aiding the Boy Scouts in implementing the program, according to Robert Horvitz, ANARC executive secretary.

The requirements for the Radio badge will include logging shortwave broadcasts, conducting band surveys at different times of the day, compiling the schedules of major SW broadcasters and locating the sites of stations on a map.

The guidelines for the new Radio Merit Badge are contained in Pamphlet No. 3333, available in stores that sell Scouting products. Or you can order a copy by calling the Boy Scouts national toll-free line, 800/323-0732.

Where can you fit into this expanded Boy Scout merit badge program? Each of the 410 local Scout Councils in the United States needs a Radio Merit Badge counselor with shortwave-listening experience to advise troop leaders and scouts, and evaluate individual merit-badge efforts.

Local Scout Councils will select their own counselors from among volunteers. If you're interested in helping Scouts with their SWL'ing activities, call your local council. You can find the number in your hometown telephone directory under Boy Scouts of America.

Tell them you're willing to serve as a local counselor for the Radio Merit Badge's shortwave-listening option. If you're selected by your hometown Scouting headquarters, ANARC would appreciate it if you'd drop them a postcard too, telling of your appointment, so they can keep a record of the Radio Merit Badge counselors across the nation. ANARC's address is PO Box 143, Falls Church, VA 22046.

So be a good Scout, volunteer!

This decal, depicting the station's mythical namesake—half-man, half-horse centaur—was sent to SWL's reporting reception of Columbia's La Voz de los Centauros.

Feedback. Comments? Questions? Why not drop a line to *DX Listening*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. Your letter, like Aurel Dumitrescu's, could soon find its way into these pages.

"I'm a native of Romania," writes Aurel, "but I have been in Canada since 1986. I was surprised, in a good sense, to find *DX Listening* when I read **Popular Electronics**, the best electronic magazine for everybody who likes electronics.

"Because of the huge radio distance between Calgary (where I now live) and Bucharest, I've lost any connection with Romania. A friend of mine has bought a radio receiver with shortwave. He has tried many times to catch a Romanian speaking station, but has not been successful.

"I am in electronics as a service tech, but about shortwave, I know little. I would be very happy to hear my native language. Can you help?"

I hope so. Radio Bucharest isn't as easy to hear as, say, Czechoslovakia's Radio Prague. But still it operates as series of 120- and 250-kilowatt shortwave transmitters, so I don't think you should have too much difficulty in tuning in your homeland. Your best bet would be the programs beamed to North America. The frequencies to try are 5,990, 6,155, 9,510, and 9,570 kHz.

Programming in the Romanian language is aired from 0130 to 0200 UTC. That is followed by Radio Budapest's English programs to Canada and the U.S. until 0300 UTC. There's another English segment at 0400 UTC. As of this writing, Bucharest also has scheduled Romanian-language broadcasts to North America from 2300–2400 UTC on 11,830 and 11,940 kHz.

Aurel, you might also listen for broadcasts in your native tongue from the West German transmitters of *Radio Free Europe* (RFE)—or *Radio Europa Liberia* as it is announced in Romanian. The frequencies do vary, especially with the season, but some to try are: 7,255 and 9,595 kHz from 0300 to 0555 UTC, and 15,215 kHz from 1500 to 2255 UTC on weekdays, and 1300 to 2255 UTC on Saturdays.

The *Voice of America* (VOA) has Romanian broadcasts on a number of frequencies from relay transmitters in England, Morocco, and Greece at 0430 UTC. The British Broadcasting Corporations' Romanian broadcasts are also on a number of frequencies, including 7,210 and 9,750 kHz, at 0445 UTC.

Good luck in hearing Radio Bucharest's programs.

John Miller, Thomasville, GA, writes that he recently "picked up my first copy of **Popular Electronics** the other day and found it interesting! I especially enjoyed your *DX Listening* segment, but found it very short."

I, too, wish it could be longer, John, but **Popular Electronics** has only so much space between its covers to cover a wide range of electronics and communications subjects. But I do, each month, try to include a reason-

Credits: Dan Sheedy, CA; Richard Eckman, CA; Harold Sellers, ONT.; John Miller, GA; Kirt Allen, OK; David Snyder, NY; Edward Cichorek, NJ; John Figliozzi, NY; North American SW Association, 45 Wildflower Road, Levittown, PA 19057 able mix of information for beginner and veteran listeners alike, plus tips on when and where to tune for specific stations.

Speaking of listening tips, thanks to John for including information on your loggings of *Radio Baghdad* and *South Africa's Radio* (RSA), which you'll find among this month's "Down the Dial" listing.

To the rest of you readers, why not follow suit and send in information about your loggings. What are you hearing on shortwave? This is your column and your contributions certainly are always welcome.

Another way of getting more information about international stations, their schedules, and their frequencies is by joining one of the radio-hobby clubs affiliated with the Association of North American Radio Clubs.

That brings us to a letter from Barry A. Rader of Fostoria, OH, who says he has been an SWL since 1987, and has been a regular reader of this column. "Could you give me some input on which clubs to join?" Barry asks. "I belong to NASWA and SPEEDX. Could you tell me what other clubs to join?"

Sorry, Barry. Radio clubs differ in the way each covers the listening hobby. Their monthly bulletins differ because each club has its own editors, each with their own approaches and styles. Choosing a club, or clubs, is a personal matter; no one else can (nor should they be allowed to) make a choice for you. But the decision is made easier if after you take a look at a number of the club publications.

As I've noted before, the first step is to send a large stamped, self-addressed envelope to ANARC Publications (PO Box 462, Northfield, MN 55057) with a request for the Club List. It will give you all the information you need to send away for sample bulletin copies from any or all of ANARC's 18 affiliated radio clubs.

Down the Dial. Here's a sampling of what your fellow listeners have been hearing on shortwave recently. All times are given in Coordinated Universal Time (UTC). UTC is equivalent to EDT + 4 hours, CDT + 5 hours, MDT + 6 hours or PDT + 7 hours.

Burma—5,985 kHz. The *Burma Broadcasting Service* (BBS) has been noted with English news and identifications at 1500 UTC. The signal quickly faded, though.

England—9,334 kHz. Until last fall, when they were removed from shortwave, *American Forces Radio and Television Service* (AFRTS) programs were beamed to U.S. military personnel at sea or on remote overseas bases. It is still possible to hear AFRTS programs relayed in single sideband on SW thanks to a relay transmitter at Barford, England. Look for this one during the early evenings in North America.

Iraq—9,515 kHz. *Radio Baghdad* was heard at 0315 UTC with English Rock music. A press review was heard at 0320 UTC, followed by news, an identification, and a cultural review.

Nicaragua—6,100 kHz. The official station of the Managua government is the *Voice of Nicaragua*, which can be heard with English news at 0425 UTC, continuing with identification and pop music. There often is interference on this channel.

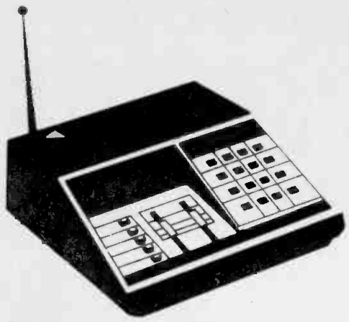
Peru—5,025 kHz. *Radio Quillabamba* has been heard here at about 0100 UTC with Spanish-language programming, giving the station identification, AM, FM, and shortwave frequencies. A program called *Panorama del Peru* follows.

South Africa—11,770 kHz. *Radio South Africa* was heard at 2230 UTC on this frequency and on 15,175 kHz.

Turkey—6,340 kHz. Not an easy logging is the Turkish Police Radio in Ankara, which sometimes is heard signing on at 0458 UTC with the Turkish anthem and Turkish-language announcements by a woman. ■

DX LISTENING ABBREVIATIONS

AFRTS	American Forces Radio and Television Service
ANARC	Association of North American Radio Clubs
BBC	British Broadcasting Corporation
BBS	Burma Broadcasting Service
CST	UTC + 6 hours
DX	long distance (over 1000 miles)
EST	UTC + 5 hours
kHz	kilohertz (1000 hertz or cycles)
kw	kilowatt (1000 watts)
MST	UTC +7 hours
PST	UTC +8 hours
RFE	Radio Free Europe
RSA	Radio South Africa
SW	Shortwave
SWL('s)	Shortwave listener('s)
SWL'ing	Shortwave listening
US	United States
UTC/GMT	Universal Coordinated Time/ Greenwich Mean Time
VOA	Voice of America
VON	Voice of Nicaragua



Scanner Scene

By Marc Saxon

A FEATURE-PACKED, MOBILE WIDEBAND SCANNER

Kenwood's RZ-1 packs a lot of features into one unit. With a range from 500 kHz to 905 MHz, you get AM/FM, SW, TV, and all the UHF/VHF bands. It stores 100 channels in memory, features band scan and memory-channel scan, and offers manual and automatic tuning.

Kenwood, whose ham and SWL equipment has rolled up a most respectable reputation, has announced their *RZ-1* mobile (can be used at your base station with a 110-volt power supply) wideband scanner. It covers from 50 kHz (below the AM medium-wave broadcast band) straight through to 905 MHz. So, you get an AM/FM (and TV-audio) broadcast receiver; a shortwave receiver; and a receiver that tunes all of the VHF/UHF public-safety, federal, maritime, aero, industrial, and other bands from 30 to 905 MHz.

There are 100 memory channels, direct keyboard or VFO frequency entry, memory-channel scan, band scan, four types of scan stops, channel lockouts, memory backup battery, beeper on/off switch, line outputs for stereo, a display that reads out to four decimal places, and a "clear" button.

The sensitivity is less than 5 μV in AM mode (10 μV in the medium-wave band) at 10-dB S+N/N. In FM (narrow) the sensitivity (12-dB SINAD) is rated at less than 6 μV below 60 MHz, and less than 3 μV at higher frequencies. In FM (wide) mode, it is less than 1 μV (checked at 83 MHz). Selectivity at points −6 dB on AM is 7 kHz, FM/N is 20 kHz, and FM/W is 250 kHz. Note that the RZ-1 does *not* receive SSB. Perhaps an optional accessory will become available to enable it to do so, although nothing in the literature we saw made any mention of SSB mode.

The manual tuning operates in increments of 5, 12.5, 20, and 25 kHz. In auto mode, tuning is in 10-kHz and 100-kHz steps.

The manufacturer's suggested retail price of the Kenwood RZ-1 is $599.95. For more information, contact Kenwood U.S.A. Corp., P.O. Box 22745, Long Beach, CA 90801-5745. Or give it the eyeball at any of Kenwood's many ham-equipment dealers.

You Wrote To Us... In a postcard from Owings Mills, MD, Marty Sharrow indicates an interest in picking up any weather transmissions other than the 162-MHz band NOAA broadcasts. He hopes that we can come through with suggestions for additional frequencies to monitor.

The best bets we can think of include 122.0 MHz, which is where private pilots exchange weather information with FAA ground stations. Pilots of military aircraft do about the same thing on 239.8, 342.5, 344.6, and 375.2 MHz, although only one or two of the military channels might be active in a given area. Lastly, you might wish to check out 410.075, 410.10, 410.575, 415.90, and 416.375 MHz, which appear to be UHF link frequencies used in some areas by the NOAA in conjunction with their 162-MHz broadcasts.

We recently offered to send our readers some worthwhile modifications for the Realistic *PRO-34* and *PRO-2004* scanners upon receipt of a request accompanied by a self-addressed, stamped envelope. Plenty came in, along with people asking us to send various modifications for Realistic *PRO-2010* and a host of Uniden Bearcat Scanners. Sorry, but we don't have any modifications available other than those specific ones that we mentioned.

Several readers also wrote to point out that the Realistic PRO-2004 has a "strange" tuning coverage gap between 520 and 760 MHz. They wanted to know what services used those frequencies, why they weren't included in the scanner, and how to restore them.

That's not too strange, really. Roughly, that covers UHF-TV channels 22 through 62. No communications services are known to use those frequencies and that's probably why they were omitted. We don't know of any way to retrieve them in the PRO-2004.

A letter from Steve Fenner of Halifax, Nova Scotia, observes that he substantially enhanced the signals entering his scanner by the addition of a Radio Shack *115-117* in-line amplifier placed in the antenna cable, near the entry point at the rear of his scanner. He comments that inasmuch as this amp was designed for TV use, it was made with "F"-type connectors. Therefore, it will probably have to be used with adapters in order to interface with the connectors used in most scanner installations.

A question from Mike Pawlukiewicz, Farmington Hills, MI, asks for a simple explanation of what +3-dB gain really means to the listener in terms of an antenna system, or how much damage is done by a loss factor of 6-dB/100 feet of coaxial cable.

A 3-dB gain (+3 dB) is equivalent to doubling the effective strength of a received signal. An attenuation (loss) of 6 dB per 100 feet means that incoming signals will be substantially diminished after having traveled 100 feet from the antenna to the scanner. A signal from, say, a 15-watt transmitter would reach your scanner as if it came from a transmitter running less than 4 watts.

Fredrick Hunt has two questions. First, he asks, "Do you know of a source of frequencies other than *Police Call*?" Next, he asks if any of our readers can advise him about the type of scrambling presently in use by his local police department in North Little Rock, AR.

There are many sources of frequency information available to scanner owners. We think the recently released series of *Regency Regional Frequency Directories* are especially well done and useful. As for the specific type of scrambling technique used by the police in North Little Rock, perhaps one of our readers in that area can provide that information. Anybody who can advise Fredrick, can write to him: at 107 Mission Rd., North Little Rock, AR 72118.

Speaking of frequencies, a frequency-directory publisher provided us with some copies of a listing of about 200 interesting national-use scanner-band frequencies, plus some 170 shortwave-communications "ute" frequencies (military, maritime, aero, emergency, etc.). When we offered them here a year or so ago, they went fast. We have another (limited) supply and can again offer them while they last. If you want one, send a self-addressed, stamped, long envelope for us to mail it to you. Ask for the "Frequency Log" from: Scanner Scene, **Popular Electronics,** 500-B Bi-County Blvd., Farmingdale, NY 11735. It's a nifty listing of all kinds of good stuff—you know what I mean!

A Fair Trade-in? Steven Hochstelter, Nappanee, IN, reports the death of his trusty old *Bearcat 250*. Uniden told him that because the unit was manufactured more than eight years ago, replacement parts were no longer available and the set couldn't be fixed. They did, however, offer him a cash value trade-in against a new Uniden Bearcat scanner. Steve asked us if it's true that the BC-250 can't be repaired, or if they're just trying to sell him a new unit.

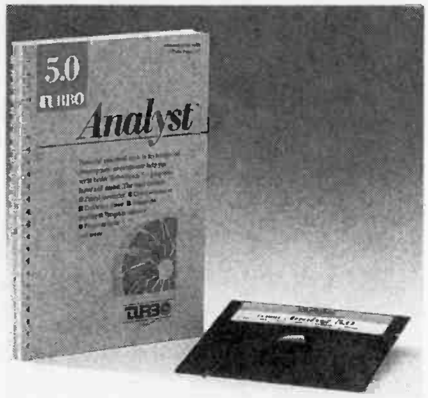
We have been asked those questions many times, since that is Uniden's standard reply to inquiries about repairing old scanners. Take my word for it, they *don't* stock most of the vital innards for very old scanners (and the BC-250 is definitely long in the tooth!). The trade-in is a sincere attempt to accommodate Bearcat users and to get them scanning again with modern equipment that can still be serviced. With zillions of vintage Bearcats in operation, lots of the old ones are slipping into retirement age now. I always advise taking Uniden up on their offer. The trade-in allowance is almost a 50% discount for turning in a unit that can no longer be repaired. Can't beat that deal!

We always welcome your questions, suggestions, frequency information, and whatever. Let's hear from you! ■

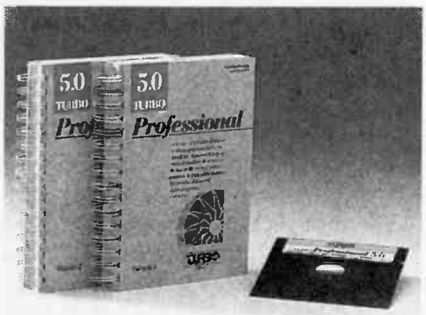
COMPUTER BITS

(Continued from page 87)

- Compare the contents of two directories and list the differences between them.
- Efficiently display a graphic picture of directory structure.



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



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

Contest Rules. The object of the contest is to write the best utility program of 100 lines or fewer (including blank lines and comments). The program must be written in version 4 or 5 of Turbo Pascal, and must use only routines and units contained within the language itself. Short assembly-language routines are permitted, but the bulk of the code must be in Pascal.

Each contest entry must consist of the following: a short description of what the program does and how to use it; a legible printout of it; a copy of the program and the source file on disk; your name and address, and day and night phone numbers.

You can enter more than one program; each must be sent separately. Employees and relatives of the publisher are not eligible. Address entries to: Turbo Contest, Gernsback Publications, 500-B Bi-County Blvd., Farmingdale, NY 11735. All entries must be received by October 31st, 1989; the winner will be announced and the best programs published in the February 1990 issue of **Popular Electronics.**

There will be one winner; selection criteria include overall utility and elegance. I will be the sole judge. The prizes to be awarded are:

A 12-MHz XT-size 80286 motherboard, part no. MCT-M286-12, from JDR Microdevices (110 Knowles Drive, Los Gatos, CA 95030. 800-538-5000), retail value: $300.

Three libraries of Turbo Pascal software from TurboPower Software (P.O. Box 66747, 4444 Scotts Valley Drive, Scotts Valley, CA 95066. 408-438-8608), including Turbo Professional ($125), more than 500 routines you can include in your own Turbo programs; Turbo Analyst ($100), to help you analyze the efficiency of your programs; and the B-Tree Filer ($125), to help you write your own database programs.

Well, there you have it. So get cracking; maybe you'll come up with the winning program. In any case, you will learn how to program in an interesting computer language. Good luck! ■

ELECTRONICS COURSE

(Continued from page 76)

tance range, let's determine the two resistances (forward and reverse) of a single LED. Do not use the seven-segment display for this procedure (but keep it handy as it will be used before the exercise is finished).

If not already done, set the ohmmeter to its highest resistance scale and measure the resistance across the LED. Note the test lead polarity. Now reverse the leads and note the resistance reading with the polarity reversed. Write the information down on a piece of paper.

By noting the polarity of the ohmmeter's test probes during the reverse-resistance test, determine the cathode of the LED. If the LED you were testing was unused, that is the leads were never cut or severely bent out of shape, certain observations you can make about them will probably hold true.

Refer to Fig. 3. Note that the two leads of the LED are unequal in length. The cathode lead (denoted K in Fig. 3) on the LED is shorter than the anode lead. Also, note the flat surface on the bot-

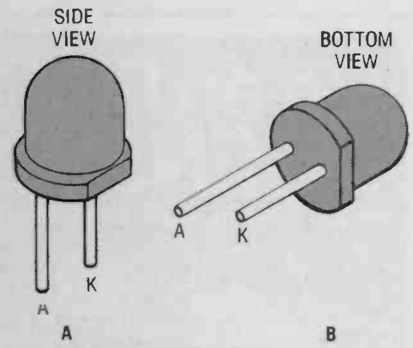


Fig. 3. New or unused LED's can be inspected and the cathode determined without making any tests. The shorter lead (denoted K)—which is also nearest to the flat portion of the LED's lower rim—is the cathode.

tom rim of the LED nearest to the cathode lead. Unfortunately, that is not always the case.

Now that we've determined which lead is the anode (positive lead) and which one is the cathode (negative lead), place the LED—along with a 270-ohm dropping resistor (R1)—into the breadboarded, power-supply circuit as shown in Fig. 1. The LED will serve as a *power-on* indicator for all future projects. Apply power. If the LED did not light, check its polarity. Measure and record the voltage drop (V_f) across the LED when it's lit. Use a DC-voltage range of 0 to 2, 5, or 10 volts. The drop should be around +1.5-volts DC.

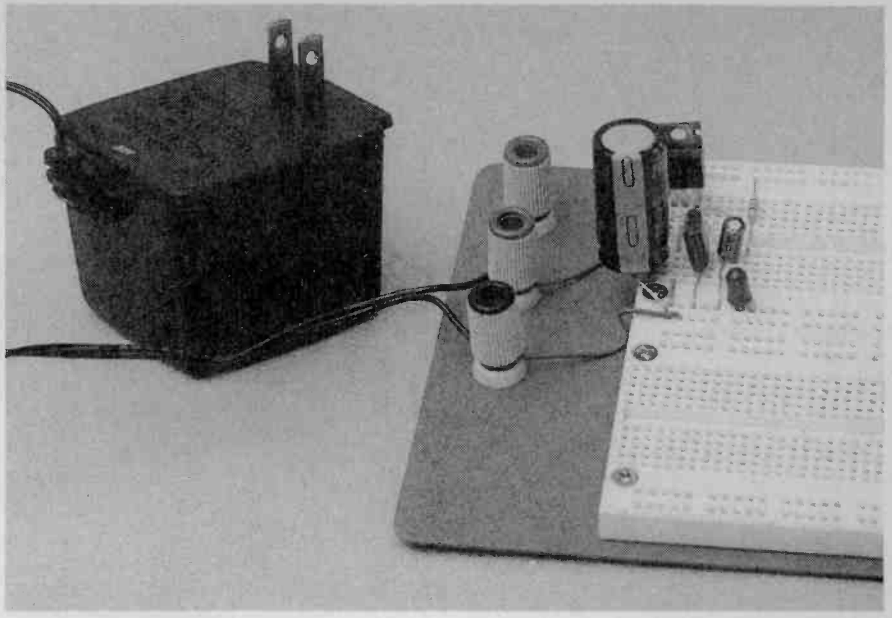
Now make a sketch of your seven-segment display; it should be similar to that shown in Fig. 2A. Draw dots to represent the pins on the display in their proper location.

Insert the seven-segment display onto the solderless breadboard. Use the ohmmeter to determine if the display is a common-cathode or a common-anode type and to identify the common pin or pins. If your VOM cannot supply sufficient current to light the LED's, you can use the power supply on the breadboard.

To use the power supply to determine the type of display, connect a 270-ohm resistor between the V+ terminal of the power supply and one pin of the display unit. Then connect a wire to the ground terminal of the power supply. Touch each unused pin of the display with the grounded lead unit until a segment lights. If none of the segments light, move the V+ connection to another pin on the unit and continue as before. Use the illumination of a segment as a favorable indication.

Once you've gotten one segment to light, move the ground lead to another pin. If another LED lights, you know the display is a common-anode type and the pin receiving V+ is the anode. You can now use the ground lead to determine which pin corresponds to each segment.

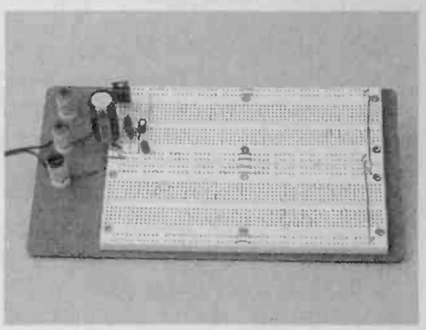
However, if a second LED doesn't light, the display is a common-cathode unit, so you should use the V+ lead to discover the identity of the remaining pins. Keep a record of your findings. After some trial and error, you should be able to diagram which pin lights which segment. Use Fig. 2B as a sample of the possible configuration. ■



Your completed power supply should look similar to this. Note how the leads are carefully routed around components.

PARTS LIST FOR THE LED EXERCISE

LED1—Light-emitting diode
R1—270-ohm, ¼-watt resistor, any precision
Seven-segment LED numeric display, ohmmeter, and No. 22 wire



Connecting the jumpers as shown before the rest of the circuit will be very helpful to you because they set up supply and ground lines for the experiment.

The Digital Electronics Course is reprinted here with the permission of the Electronic Industries Association/Consumer Electronic Group (EIA/CEG). The complete parts kit is available from EIA/CEG. For further information, contact EIA/CEG Product Services Department, 1722 Eye Street, NW, Suite 200, Washington, DC 20006; or call 202/457-4986.

GENERATORS

(Continued from page 64)

wave of frequency *f* without losing some harmonics and reshaping the wave. Figures 7B through 7D show the effect of low-pass filtering on a square wave. In each case the filter cut-off frequency f_c was 5 kHz.

Figure 7A represents the response of the filter to a 100-Hz square wave; it passed undistorted. In Fig. 7B the square-wave frequency is 1 kHz and in Fig. 7C the frequency is 5 kHz. Now watch what happens in Fig. 7D: there the square-wave frequency is 50 kHz, which is above the cut-off frequency. (For 7D, the vertical input attenuator had to be switched to a much more sensitive setting because the signal amplitude drops dramatically.)

Note that the waveshape in Fig. 7D is nearly triangular. Does that suggest an interesting application for the filter? Some triangle-wave generators use a square-wave oscillator as a signal source, heavily low-pass filter the output, and then re-amplify it to produce triangle waves! In some circuits the low-pass filter is disguised as a Miller integrator, but the principle that is at work is the same.

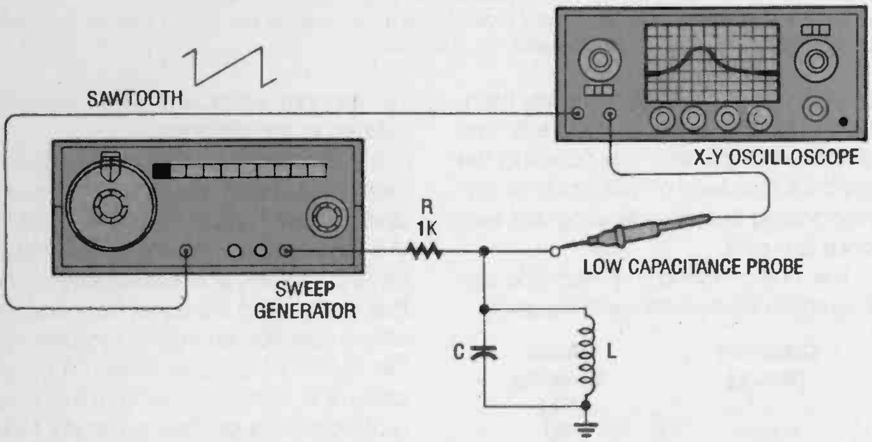


Fig. 8. Sweep features are a must for testing LC tank circuits. With the set-up shown you can determine the tank's frequency response and its center frequency.

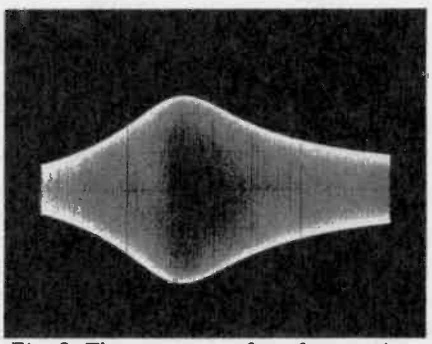


Fig. 9. The output waveform from testing an LC tank circuit without rectification looks like this. Rectifying the output would give you an accurate frequency-response curve of the tank circuit under operation.

Flushing Out Tank Circuits. Almost all sweep function generators will operate at frequencies as high as 100 kHz, while some can operate up to 11 MHz. A large number of low-cost models operate to frequencies of 2 MHz or even 5 MHz. Those are RF frequencies, and LC tank circuits are often used for frequency selection that high up.

Figure 8 shows a frequency generator (in this case an *internally*-swept model) set-up for testing an LC resonant tank circuit. The HI output is applied to the tank circuit, while the sawtooth output of the generator is used to drive the X-input of the X-Y oscilloscope. A resistor between the LC circuit and the signal generator reduces the loading on the circuit by the generator's 600-ohm output impedance. Depending upon the signal level and the sensitivity of the oscilloscope's Y-input, you would need a resistance valve of between 1000 and 100,000 ohms. At low frequencies (under 100 kHz) the Y-input to the oscilloscope should be connected across the tank circuit through a low-capacitance probe.

Figure 9 shows the results of the test when a 50-kHz tank is swept by a 10-kHz to 100-kHz signal. The trace can be improved by rectifying the tank-output signal using a 1N60 (or equivalent) germanium small-signal diode and an RC low-pass filter.

Sweep function generators are now low in cost, yet remain capable enough to give you a lot of functionality that is lacking in non-swept models. Check 'em out. ■

Sweep Function Generator Suppliers

Elenco
616 Wheeling Rd.
Wheeling, IL 60090
CIRCLE 121 ON FREE INFORMATION CARD

Global Specialties
70 Fulton Terrace
POB 1942
New Haven, CT 06509
CIRCLE 122 ON FREE INFORMATION CARD

Hameg Inc.
88-90 Harbor Road
Port Washington, NY 11050
CIRCLE 123 ON FREE INFORMATION CARD

The Heath Company
Benton Harbor, MI 49022
CIRCLE 124 ON FREE INFORMATION CARD

Joseph Electronics
8830 N. Milwaukee Avenue
Niles, IL 60648
CIRCLE 127 ON FREE INFORMATION CARD

Leader Instruments Corporation
380 Oser Avenue
Hauppauge, NY 11788
CIRCLE 126 ON FREE INFORMATION CARD

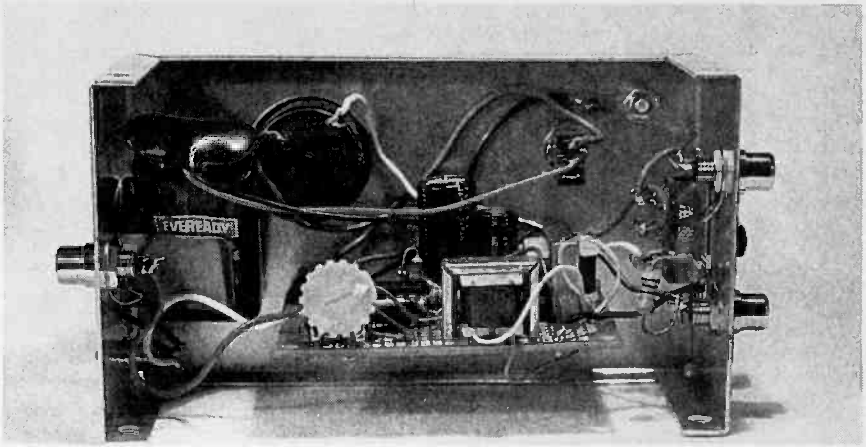
Tektronix, Inc.
POB 500
Beaverton, OR 97075-9959
CIRCLE 127 ON FREE INFORMATION CARD

SFERIC-LEVEL MONITOR

(Continued from page 35)

output jacks (J2 and J3) were mounted at the other end.

The author's prototype was housed in an aluminum enclosure measuring about 2¼ × 3 × 5¼ inches. The meter (M1) and POWER switch S2 are mounted to the front panel of the enclosure. It's also a good idea to label the input and output jacks, as well as the control switches. Before sealing the enclosure, check your work for the usual wiring errors—cold solder joints, solder bridges, misoriented components, etc. Be particularly mindful of the polarized components; diodes, electrolytic capacitors, and the IC.



An interior view of the Sferic Level Monitor just prior to the sealing of its aluminum enclosure. The perfboard assembly, which contains the circuit's major components, is mounted to the enclosure wall with "L" brackets.

Operation. Before doing any serious storm tracking, check the operation of the circuit. That can be accomplished by connecting the circuit to a receiver and tuning to a strong broadcast station. Some experimentation may be required to establish a suitable setting for the radio volume control, but rotating it 25% to 35% of a turn from the off position will probably be satisfactory.

Because of the very long time-constant involved, it may be 1 or 2 minutes before the meter needle deflects much and 6 to 10 minutes before it stabilizes. If it appears that the meter will deflect off scale, turn off the receiver, depress S1 (the DISCHG switch) for 20 to 30 seconds to reduce the meter reading, then lower the volume-control setting of the receiver and try again. Alternatively, you may re-adjust R4. A volume-control setting that gives about 70–80% full-scale deflection after 8 to 10 minutes in this test will probably be suitable for storm monitoring.

The strength of the signal received will depend upon the orientation of the radio's antenna coil—which is greatest when a line between the storm and receiver coincides with the plane of a coil turn. Normally, the antenna coil is oriented so that its windings are in line with the anticipated general direction of the approach of a storm and the receiver is not moved during the monitoring session. Meter readings vs. time or a chart recorder are used to follow the passage of a storm.

To develop some ability to judge storm distance, always use the same setting of the receiver volume control. For several storms, compare your meter readings with NOAA weather bulletins or other sources giving frontal positions at given times. Once you can see flashes and hear thunder, you can estimate distances to the storm by counting the seconds between a flash and the corresponding thunder, allowing five seconds per mile.

The author found the following approximate relationship with his gear:

Distance (miles)	Meter Reading (%)
Local	90
2	74
4	70
8-10	48
12-15	33
25-30	19

The meter readings are in percentage of a full scale. The data was collected for storms of comparable rates of activity. Storms with less frequent flashes give lower readings. Your results will probably not closely agree with the data presented here, but should show a similar trend.

A simplified form of storm tracking can be conducted if one bears in mind that the antenna coil has a bi-directional response. Thus, if maximum signal strength occurs with an east-west orientation of the coil turns, it's not obvious whether the source is east or west, without additional circuitry. In practice, one usually knows the approximate direction of approach so that ambiguity need not deter the amateur observer.

To try such an approach, first align the coil for east-west reception and note the reading after 7 to 10 minutes. Then rotate the receiver and coil 90° and take another reading after a similar interval. Treat the values as two sides of a right triangle to compute a bearing within a given compass quadrant. The hypotenuse gives a measure of signal strength, which should be inversely related to the distance.

The monitor unit may be used at any clear frequency in the broadcast band and has been used with shortwave and VHF (AM) receivers as well. You'll probably find that you can detect storms farther away using the lower frequencies, where greater energy is radiated by the lighting flash. Receivers with coil cores of 3- to 4-inches long or more will probably yield greater sensitivity than miniaturized radios with smaller coils.

The receiver's tuning range can be shifted below the broadcast band to avoid station interference by soldering a 150-pF capacitor across the antenna section and 33 pF across the oscillator section of the tuning capacitors. That should permit tuning over about 300–500 kHz.

The author's monitoring has been conducted in a suburban home of typical wood frame construction with aluminum siding. Performance may be less satisfactory in a building containing much structural steel or surrounded by tall buildings. Remember, the receiver will respond to other sources of electrical noise such as power-line leakage, fluorescent lamps, some motors, and dimmer switches, and even some calculators and computers. However, if you don't hear those sources before connecting the monitor, they should not be a problem.

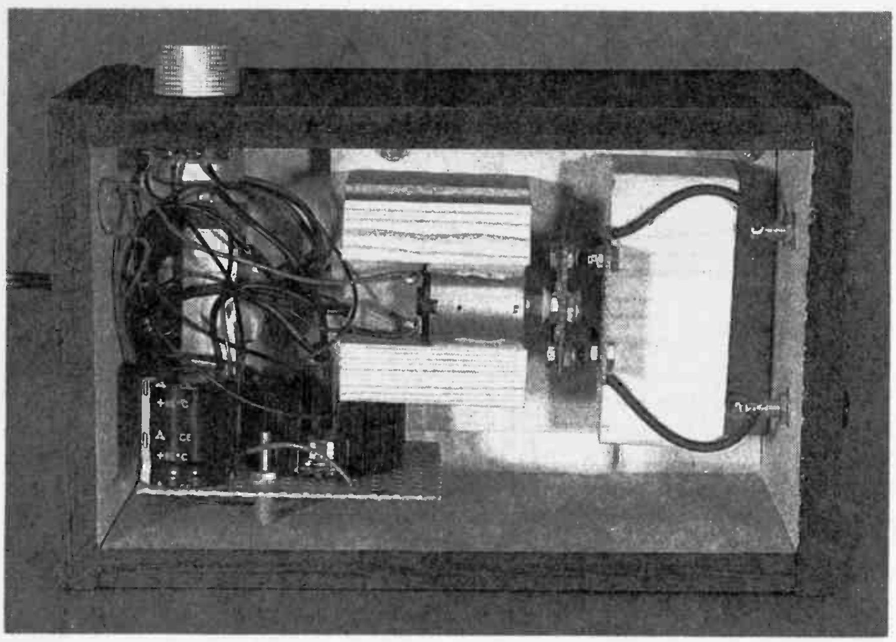
Remember, in view of the risks, leave any work with outdoor antennas and local storms to the professionals. The Sferic-Level Monitor and a simple transistor radio used indoors can generate much interesting information. The Sferic-Level Monitor is no substitute for weather radar, but it is available to hobbyists at an affordable cost! ■

TESLA COIL

(Continued from page 32)

tion. Before mounting T2, make sure that the transformer leads are long enough to connect to the perfboard assembly.

After mounting T2 in the enclosure, mount the perfboard assembly on the enclosure using standoffs, and then complete the wiring between the perfboard assembly and the off-board components. With that done, plug in the line cord and rotate the wiper of R2, making sure that as you do the motor speed increases and decreases. If the circuit does not operate as described, it will be necessary to recheck your work, correct any errors found, and try it again. If everything checks out, the rotary gap is complete.



Here's an inside view of the rotary spark gap; note the tight spacing between the perfboard rotor and the stationary post. The wires coming from the stationary post are connected to J4 and J5, through which the rotary spark gap is connected to the Tesla Coil circuit.

Caution!!! The most important part of using the Tesla Coil is safety. Never tune (adjust the tap on L3) the Tesla Coil when power is applied to the circuit. Use a phenolic plastic box or a wooden box to house the Tesla Coil and the rotary gap—avoid metal enclosures like the plague. In addition, it is recommended that you use one hand *only* while working with high voltage, and wear rubber soled shoes to reduce the potential of shock hazard.

The power transformer, capacitor C1, and coils L3 and L4 must be properly grounded. You must use a 3-conductor AC power cord that is grounded (earth grounded) in the Tesla Coil itself. **Do not** touch the Tesla Coil while it's in operation. However if you want to show-off your creation, a fluorescent lamp may be placed near L4 to demonstrate the ionizing power of the Tesla Coil.

Only use properly rated components. Do not use an overrated power transformer. A 3-kV transformer with a 2-kV AC capacitor is out of the question. An overrated capacitor (for instance, a 6-kV AC unit) is fine in the circuit. Remember the capacitors are AC rated not DC rated.

The rotary gap will work well with this unit, but it may not work well with a larger unit. A larger unit will require that the rotary gap be redesigned. You must also protect your eyes: Do not stare at the stationary or rotary spark gaps; doing so can cause eye damage.

Operating the Tesla Coil. With the unit completely assembled, make sure that all the components are properly installed and oriented. If you are using the stationary gap, start with a gap distance of about a ¼ inch and tune L3 at any point on the third turn from ground. At that point turn the power on; you should get an output at the sphere. Adjust the spark gap for maximum output.

Tune L3 for maximum output, by changing the position of the alligator clip with the power off. Tuning L3 and adjusting the spark gap greatly effects the output of the Tesla Coil. If you place

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ANTIQUE RADIO

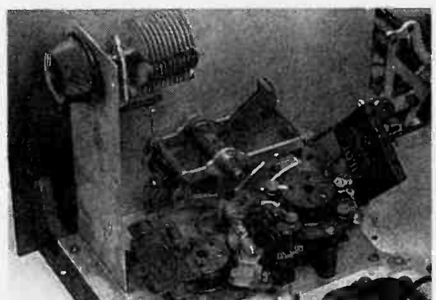
(Continued from page 83)

made a mental note to replace those parts upon reassembly; inadequate bonding could easily reduce the efficiency of the shielding, causing oscillation and instability once the set was placed in operation.

What I Found Out. Checking over the Wasp's circuitry was a little like entering *The Twilight Zone* and being transported back in time. I'd checked out early receivers before without having that experience, primarily because those sets—even the multi-tube ones—had relatively few parts and their wiring was simple enough to be obvious at a glance.

But the Wasp's more complex features, including multi-band coverage, screen-grid amplification, and AC operation, required additional components and greater circuit complexity. I had to concentrate as I worked, so I really got involved. And some of the new components were so similar in function to their more modern counterparts—yet at the same time so oddly different in construction—that the "Twilight Zone" effect was really heightened.

For example, the cathode-bias resistor with its paralleled bypass capacitor (used in the screen-grid amplifier and the two audio stages of the Wasp) is a familiar circuit, found in even the most modern vacuum-tube designs. In more current equipment, those components would be relatively small, mounted right at their associated tube sockets and supported only by their leads. In the Wasp, however, the capacitor and resistor are massive, mounted some distance from their associated tubes, and securely bolted in placed under the chassis.



After opening detector-stage shield can, I found the jerry-rigged capacitor mounted at upper left. Original capacitor is at center, and its stripped-down rotor can be seen just emerging from stator assembly. Extra tube socket is for plug-in coil.

Those assemblies look like they'd be more at home in the electrical system of a battleship than as part of a radio tube's cathode circuit. I'm sure a present-day engineer would never guess their function without tracing the wiring.

Another example I can't resist noting is the resistance-coupling unit (represented by the dashed box on the schematic diagram) between the detector tube and the first audio amplifier. Like the cathode circuit just discussed, the resistance-coupling network is a familiar one, found even in the most recent vacuum-tube circuits. A contemporary engineer would have no trouble identifying it on the schematic, but I'd defy him to spot it on the chassis without tracing the circuit!

Once again, in more modern equipment this network would be made up of relatively small individual components mounted right on the tube sockets and supported only by their leads. But in the Wasp, we have a resistance-coupling "assembly" made of bakelite and incorporating the necessary capacitor and resistors. The latter are glass-enclosed "grid-leak" types held in place above the capacitor by the usual fuse-type clips.

Connections from this assembly to the associated tubes are made via four binding posts labeled "P," "G," "B+," and "F−"—just as if the unit were the audio transformer whose function it superseded. (For example, look at the schematic and check the labeling on the coupling transformer used between the two audio tubes.) The earlier, battery-powered Super-Wasp *had* used a coupling transformer between the detector and first audio stages. But eventually, audio transformers would all but disappear from radio-receiver circuitry, except to couple the plate circuit of the output tube to the loudspeaker voice coil.

My connection-by-connection check revealed no discrepancies between the circuitry of my A.C. Super-Wasp and the schematic published in the 1930 Geloso article. However, I did uncover an odd modification that is going to pose a bit of a problem. Four of the six rotor plates had been removed from the antenna-tuning capacitor, and—in their place—a small additional capacitor (mounted on the shield can for the screen-grid stage) had been wired in parallel with the original unit.

I can only imagine that this was a crude attempt to obtain "bandspread" for the receiver so that the stations would be more spread out on the dial. However, it does add another control to the three already required to tune and adjust the receiver. And it's a control that can only be reached by lifting the cabinet lid.

The schematic calls for the antenna capacitor to be the same size as the tuning capacitor in the screen-grid tube's plate circuit, and the latter has its full capacity of rotor plates. My aim is to remove the jerry-rigged capacitor and return the set to stock specifications. I don't know exactly how I'm going to do that yet, but I have several options in mind. More on the problem in next month's column!

Pilot Experts Wanted. If you have any information on the Pilot Company and/or the Super-Wasp sets, be sure to share your knowledge with us. Following this series of articles, I'll have a roundup of all reader comments. Address your correspondence to *Antique Radio*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

RELAY RACE

(Continued from page 44)

tacts close and energize the coil of the auxiliary relay, which includes an extra holding contact that keeps the auxiliary-relay coil energized and, at the same time, disconnects the heater of the thermal relay.

Now that the heater is disconnected it cools and retracts to its cold position, then whenever power is disconnected from the system, the auxiliary relay opens and the delay circuit is again ready to provide its time delay. That system avoids making and breaking heavy load currents or higher voltages with the light-duty contacts of the thermal relay. In some cases, the auxiliary relay is separate from the thermal relay, but in most cases it is not.

The Slug. Time-delay techniques are numerous and have been used for many decades. One electromagnetic DC technique uses a copper sleeve (called a slug) at the armature end of the coil core under the coil winding. The slug acts as a shorted-turn that delays the build-up of magnetic flux when the coil is energized, and slows the decay of the magnetic field when the coil is de-energized.

That produces delays in both armature pickup and dropout. When the slug is placed on the heel-piece of the core, it delays the dropout. The maximum delays achievable with slugs are about 150 milliseconds on pickup and about 500 milliseconds on dropout.

Brief time delays of a few seconds or less can be achieved with DC relays by adding a resistor-capacitor network (plus a rectifier if the energizing voltage is AC). The resistor and capacitor would be placed in series with one another and connected to the ground and signal lines. The relay coil would be connected across the capacitor. Any incoming control signal will charge the capacitor through the resistor at a rate determined by the component values. When the capacitor's voltage is high enough to trigger the coil, the relay actuates. When the signal voltage is removed, the capacitor discharges through the relay coil, maintaining closure for a few additional seconds.

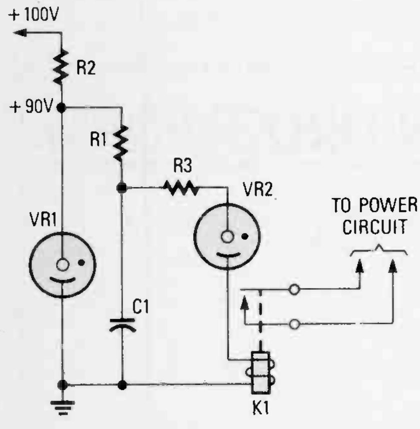


Fig. 11. Charge-operated vacuum-tube devices can be used to sense voltages above a certain level to provide switching control for a relay.

That method is usually used to some extent in motor controls. Of course, more powerful electronic methods have replaced those crude RC networks, and a better example of electronic time-delay relays is the gas-regulator type. Gas-regulator tubes have the ability to keep from conducting until the voltage across the tube has risen to a specific value. At that point, the gas ionizes and becomes conductive. When they are used in an RC-delay network, like that shown in Fig. 11, they provide a means for applying relay-energizing current suddenly at a definite instant after the application of the control voltage.

Since regulator tubes also have the characteristic of maintaining a constant voltage across their terminals (90- to 105-volts DC) after ionization, a second tube (such as VR1 in Fig. 11) is used in some cases to provide a constant operating voltage despite fluctuations in the applied control voltage, thus further improving the accuracy.

Delay relays of that type are still in use, although more recent models use Zener diodes or thryistors in place of the regulator tubes. Zener diodes offer a wide choice of operating voltages, from 2.2 to hundreds of volts.

Purely solid-state, time-delay circuits, like the one shown in Fig. 12, are used for actuating electromechanical relays. The Zener diode, D1, provides a stable DC voltage to the timing network composed of R1 and C1.

The unijunction transistor, Q1, is initially not conducting and C1 charges through R1 and R2. When the voltage at the emitter reaches the trigger potential of the transistor, Q1 conducts. That produces a voltage drop across R3 that triggers SCR1 into conduction, energizing the power-circuit relay, K1. Schemes for achieving precise adjustable time delays for industrial relay control by solid-state techniques are now legion. Each manufacturer will give his own

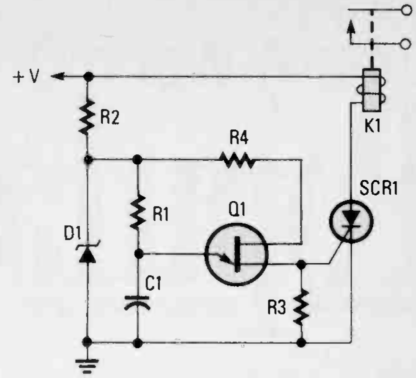


Fig. 12. Solid-state switching devices usually incorporate more circuitry than the examples we've used thus far. This circuit should give you a better feel for the internals of such a device.

schemes, but they all use some form of timing circuit, amplifying network, triggering device, and an on-off switching device.

The reason that relays have survived so long and through so much change in technology is that they have adapted and evolved through the years. They are likely to be with us a long time, that is unless there will be no more high power equipment to control or a new and better way to do it. ■

HAM RADIO

(Continued from page 85)

one of several methods for nulling one lobe of the antenna to produce a unidirectional pattern like that shown in Fig. 3. That pattern is a lot more like the pattern of a unidirectional beam antenna, and thus is a lot less ambiguous than the bidirectional antenna. Use a simple dipole, and you could easily wind up in the wrong county!

For Further Reading. For those readers who want to get more involved in fox hunting, either for fun or professionally, I recommend a book by Joseph D. Moell (K0OV) and Thomas N. Curlee (WB6UZZ), entitled *Transmitter Hunting: Radio Direction Finding Simplified* (TAB Books, Inc., Blue Ridge Summit, PA, 17214; Cat. No. 2701, $17.95).

Next Month. Next month we'll extend the fox hunting theme to a really serious issue—locating and suppressing interference on our bands. There are a lot of signals, both intentional and unintentional, that interfere with amateur-radio operations. If you've ever wondered what that raucous mess near 3,578-kHz in our 80-meter CW band is, "stay tuned" for next month's column! ■

AMAZING AMIGA

(Continued from page 70)

owners, you may wish to wait to upgrade your A500's ROM until the just-around-the-corner 1.4 upgrade is available, as it promises many impressive new features.

Disk Drives. While the A500's internal drive is adequate for many users, you may soon tire of the disk-swapping required by many applications. You should consider adding an external 3.5-inch 800K disk drive.

The Commodore 1010 drive works fine, but it's very boxy-looking and comes with a cable that's much too short to allow the drive to be positioned conveniently. A number of very good third-party drives are available that have low-profile metal cases, and acceptably long connecting cables. Look into external 3.5-inch drives such as the Master-3A (Oceanic America), Pro-Drive (Progressive Peripherals and Software), FS-80A (Future Systems), or CA-880 (California Access). All of them are quiet and reliable, and most of them are considerably less expensive than Commodore's 1010 external drive, and sport a full one-year warranty.

If you require heavy disk access consider adding a hard-disk drive. A hard drive will greatly improve the performance of the A500 with its much greater capacity and speed than a floppy disk. A hard disk will keep you from forever switching disks when using large multitasked software programs.

Several companies offer complete external hard-disk systems for the A500; two that come to mind are the Impact A500-SCSI/HD by Great Valley Products, and the SupraDrive from Supra Corp. Both include an expansion slot that allows further upgrading. Pioneer computing has recently introduced a 44MB hard-disk drive that has a removable cartridge for added flexibility.

Some of the things to look for when shopping for a hard drive and interface include checking out how it connects to the computer, the type of interface used, the drive access time, and drive storage capacity. The drive should also be capable of "auto-booting" the system from a cold start (the 1.3 Kickstart ROM or higher is required for that.)

Modems. Acquiring a modem and a communications program opens up the world of on-line telecommunications to you. Since the Amiga has an RS-232 serial port, most standard external modems will work with it. As a safeguard, though, I'd suggest ordering the modem and cable together from a dealer who specifically supports the Amiga, to ensure full compatibility. These days, it's best to start with a 1200- or 2400-baud modem, rather than a 300-baud unit.

Supra makes an excellent 2400-baud modem that is designed specifically to work with the Amiga. For those who have a Commodore 1670 1200-baud modem that they've been using with their C-64 or C128, LRA Enterprises offers a special hardware adapter that powers the 1670 modem and plugs into the A500's serial port. It's $45.95 plus shipping and is marketed through TNL Enterprises. Another 1670 adapter, the IF-1670 Modem Interface, is sold for $43.95 by Trans-Com.

Video Hardware. There is an incredible variety of video add-on equipment available to support "desktop-video" applications. The most popular is the genlock interface. The genlock synchronizes the Amiga's video signal with the source video to create a single combined video signal that can then be captured on a VCR. A top-line genlock is the SuperGen, offered by Digital Creations. Other, less costly genlocks include the Ami-Gen by Mimetics and the ProGen from Progressive Peripherals and Software.

Another important device is the video digitizer that lets you capture a video image in the computer's memory so that it can be edited with a paint program. A very popular A500 digitizer is Amiga Live!, which captures real-time, full-color images in all Amiga video modes. Combining it with a software product such as InVision (Elan Design) allows you to create truly "wild" special effects.

Other next-generation video hardware include such high-tech electronics as frame grabbers, to capture video images in a fraction of a second; multifunction boards combining the functions of a genlock and a real-time digitizer; and frame-buffer peripherals that reportedly allow you to create super high resolution video images that can display millions of colors. The long-awaited NewTek Video Toaster, is one of the new-breed special effects products now becoming available for the Amiga. (A500 users should be aware that many of the new high performance accessories require the added power and expansion capability of the Amiga 2000 series).

Music Add-Ons. As mentioned, professional musicians will undoubtedly want a MIDI interface. Through MIDI, synthesizers and computers can exchange information, allowing you to create and play sounds and music as never before possible. They are available from Mimetics and others. Go Amigo of Palo Alto CA, offers a complete MIDI system with everything you need to set up your own MIDI studio, including a Yamaha keyboard, MIDI interface, and software, for about $200).

Another peripheral the musician may add to his system is a sound digitizer. Several different digitizers are available, including PerfectSound from SunRize Industries; it digitizes stereo inputs for use with the Amiga's nine-octave, four-voice sound.

Still More Accessories. Because the Amiga can do so many things well, there are many accessories available for it. Since the Amiga suffers from noticeable flicker in the high resolution interlaced mode, several devices are available to reduce the flicker. One is the top-of-the-line ($595) hardware device, FlickerFixer from MicroWay, which doubles the video-output scan rate, requires an expensive multiscanning monitor, and at present it's only available for the Amiga 2000 series. If you're on a budget, the $17.95 Flicker Master (T.S.R. Hutchinson Co.) is a low-cost solution in the form of a polarized mask that fits over your monitor's screen. An ordinary pair of polarized sunglasses can sometimes do the job.

Another handy add-on at $39.95 is the Mouse Master from Practical Solutions. It's a small switchbox that allows you to switch between your mouse and joystick cables, reducing wear on the A500's ports. You may also want to pick up a "mouse pad" from your dealer at the time you purchase your A500; they're usually under $10.

If you have any add-ons besides a single external disk drive and a 1MB internal-memory expander, you should get a huskier power supply. Phoenix Electronics sells a suitable heavy-duty replacement power supply for under $100.

We've only touched the surface of the amazing and expanding world of the Commodore Amiga. Now it's up to you to make your new Amiga "be all it can be." We hope we've helped. ■

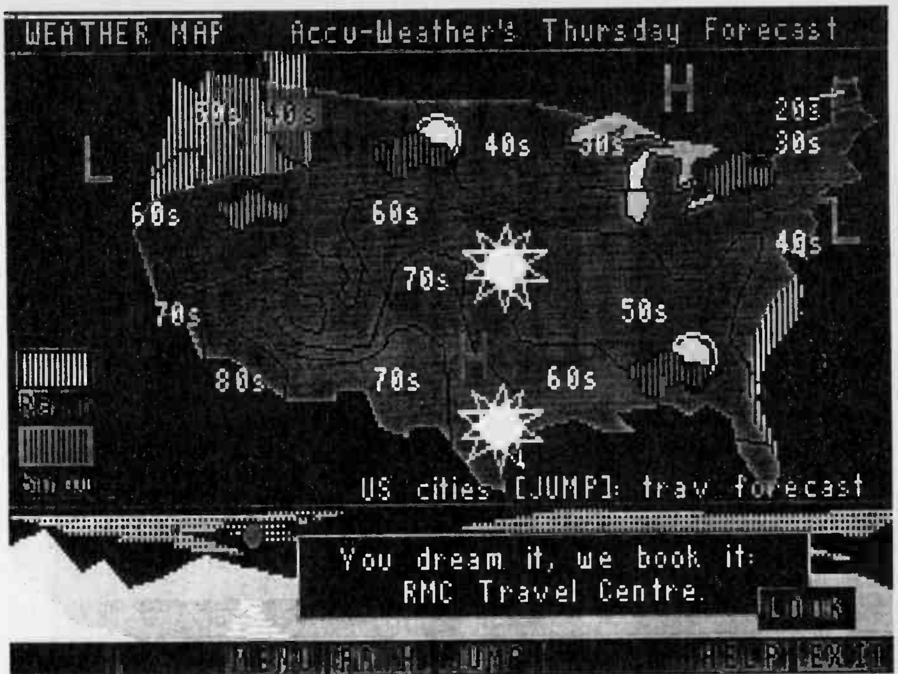
EXPLORING PRODIGY

(Continued from page 79)

"Buildings" lead to Shopping activities indicate the heavy commercial emphasis of Prodigy. To be sure, the company probably has a lot of R&D funding to make up for. But billing Prodigy as an "interactive personal service" is not the same thing as billing it as an "armchair shopping service." Even so, for $10/month, it's worth a look, even if you are a hardened cynic.

Regardless of its faults, Prodigy has enormous potential. Visionaries have for years predicted the widespread use of computer technology in linking the common man to the outside world for everything from home banking to home shopping to home information retrieval. Prodigy is the first commercial product with the potential to equal that vision. It's backed by companies with plenty of smarts in computer technology, marketing, and retail operations. Let's just hope that the desire to recoup an investment and start making a profit doesn't overcome the necessity of providing a truly useful service.

Currently, Prodigy is only available in a few areas of the country (Connecticut, Atlanta, several areas in California, and the Detroit area, as of this past spring), but new areas are being added all the time; Prodigy Services Company expects to have the entire country on-line sometime in 1991. For more information, call 800/822-6922 or write to Prodigy Services Company, 445 Hamilton Avenue, White Plains, NY 10601. ■



With Prodigy, you don't have to sit through a bunch of blathering by your local weatherperson; now you can call up national and local forecasts any time of day or night on your PC. You can also read your horoscope, read advice to the lovelorn, etc.

VIDEO STABILIZER

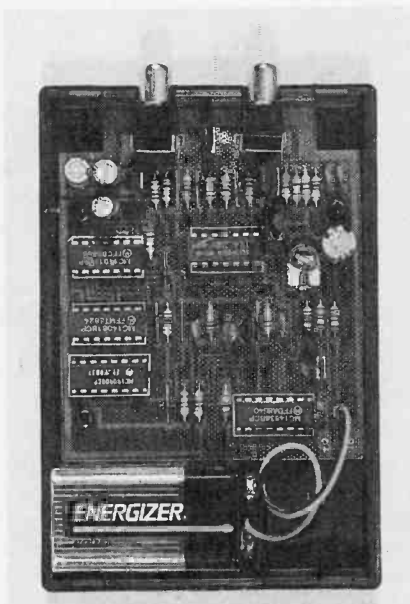
(Continued from page 36)

Stabilizer is intended to stabilize and restore picture quality for private home use only. Do not use the RXII stabilizer to duplicate copyrighted video tapes!

The Trick They Use. To give you an idea of the distance that film makers go to protect their products from copying, here is how a simple sinewave technique works: A 15.75-kHz sinewave is added to the video signal (see Fig. 3). The sinewave is synchronized to the video signal so that its negative peaks occur during some of the video signal's synchronizing pulses. That action places the tops of those sync pulses below the high-point of the video signals. That keeps the TV from detecting the sync pulses and allows it to run wild.

Reduce the amplitude of the disfiguring sinewave, and the pulses can just about drive a TV receiver. That's why you may occasionally see a picture amidst the flashes and color loss. The TV's sync-separator circuit can just about handle the signal.

If you try to copy the tape, the recording losses distort the signal ever so slightly so that the sync pulses will be confused with the video signal upon playback. That's what causes the picture to drift. The RXII stabilizer restores the sync pulses to their proper amplitude in relationship to the video signal. The resulting video-output signal is then watchable.



This inside view of the Digital Video Stabilizer RXII reveals an uncrowded circuit board with five IC's and a handful of other parts. A 9-volt transistor-radio battery powers the project for more than a year, so no on/off switch is required.

Most protection techniques are more sophisticated than the one just described above, but then so is the RXII stabilizer. It does the job and eliminates all forms of copyguard that might disturb your viewing enjoyment.

To obtain the Digital Video Stabilizer RXII, send $49.95 plus $4.00 for shipping and handling to SCO Electronics, 581 West Merrick Road, Valley Stream, NY 11680; Tel. 800/445-9285. They accept Visa or MasterCharge card; Have your card handy when you call. The unit is shipped with a 30-day money-back guarantee, and one-year repair or replace guarantee should the unit fail to operate. ■

TESLA COIL
(Continued from page 95)

a grounded wire near the output sphere, you should get 3- to 4-inch sparks.

If you are using a rotary gap, make sure that the screws on the rotor and the screws on the stationary post are as close as possible. Remember, the speed of the motor effects the output, so adjust the motor speed with the variable power supply.

There should be no arcing anywhere. All arcing must be corrected or you'll burn out the turns in the secondary. If L3 is too close to L4, arcing can occur. You may place a 4-inch OD plexiglass tubing over the secondary coil to help prevent arcing between L3 and L4.

Be aware that corona discharge (a bluish-purple ionization, of the air around the Tesla Coil) can cause breakdown along the secondary coil, and loss of power at the output of the sphere. Proper insulation of L4 will limit corona discharge. You may also notice an output at the top of the secondary coil coming out of the sides. That will take away from the output at the sphere, you could place several layers of tape (Turn off the power first!) around the upper-portion of L4, until the output from the sides of the Tesla Coil is reduced.

In operation, the Tesla Coil emits ozone gas, which in large quantities can be dangerous. So use the Tesla Coil in a well ventilated room, and do not operate it for periods of more than 3 to 5 minutes at a time.

In addition, the Tesla Coil emits a fair amount of *R*adio-*F*requency *I*nterference (RFI). Coils L1 and L2 help to limit the amount of high-voltage kickback introduced to the AC power line, and help to prevent the high voltage kickback form damaging the power transformer. Even with such precautions, RFI will still be generated at the spark gap and the output of the Tesla Coil. RFI will effect both AM radio and television reception. That's why you should not operate your Tesla Coil for more than a few minutes.

The Tesla Coil is an excellent introduction to high-voltage, high-frequency, and tuned circuits. And after building this one, you may wish to build a larger unit. The author does not recommend building a larger unit until you've learned enough about such circuits, and the safety precautions that must be followed when using them. ■

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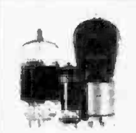

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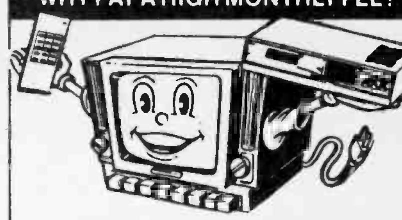

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CIRCUIT CIRCUS

(Continued from page 81)

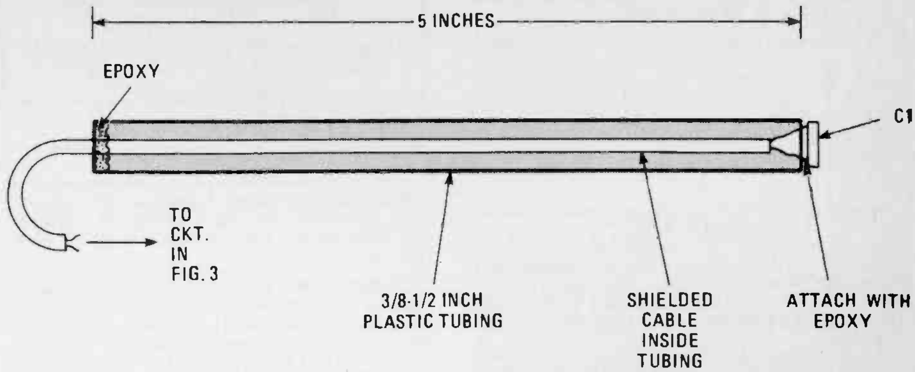

Fig. 4. Shown here are construction details for the probe unit used with the knock-detector circuit.

much time to fully recover and return to a zero reading between input signals. And if the value is too small the meter's needle will not have sufficient time to climb to its peak reading before the voltage across C2 is discharged.

PARTS LIST FOR FIG. 3

U1—LM324 quad op-amp, integrated circuit
D1, D2—1N914 general-purpose, small signal diode
R1, R2—4700-ohm, ¼-watt, 5% resistor
R3, R4, R7—100,000-ohm, ¼-watt, 5% resistor
R5—1000-ohm, ¼-watt, 5% resistor
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A 1-megohm resistor proved to be a good compromise value for R6; but if an intermitant knock ensues, the value can be increased to 10 megohms and the meter will retain the reading for a period of time to make tracing the noise to its source much easier.

The circuit can be built on perfboard and mounted in a small plastic case allowing enough room for the meter, battery, R8, R9, and the OFF/ON switch (S1). Use a socket for the IC. Keep the component leads short and the wiring neat, and with any luck old Murphy will stay far away.

The pick-up probe can be a copy of the one in Fig. 4, or one of your own design. But in any case make sure that C1 can be placed flat against the object being checked to ensure its maximum sensitivity to the shock wave created by the ping or knock. At least a three foot length of shielded cable should be used to connect the probe to the circuit so that it can be maneuvered into hard-to-get places.

Using the instrument is easy. First set the gain control for maximum gain and tap the sensor end of the probe on a hard object and adjust R9 for a full-scale meter reading. Place the probe flat against the object to be checked and note the meter's reading each time the knock occurs and move the probe in the direction that causes the meter's reading to increase. The gain setting may need to be reduced somewhat when the probe is near the source of the knock. ■

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1 Watt Metal Resistor Assortments

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2 Watt Resistor Assortments

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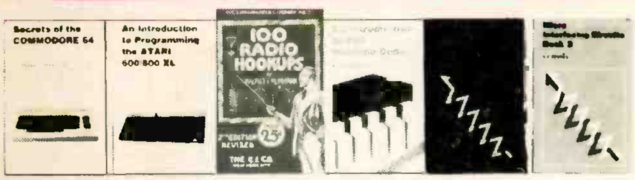

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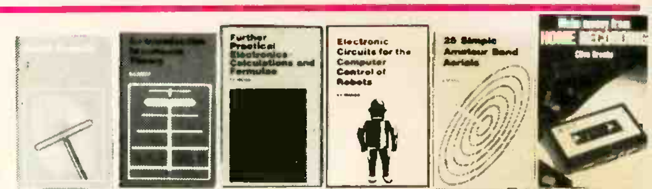

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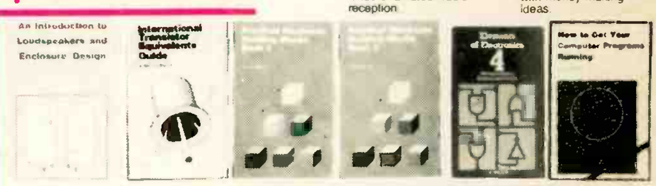

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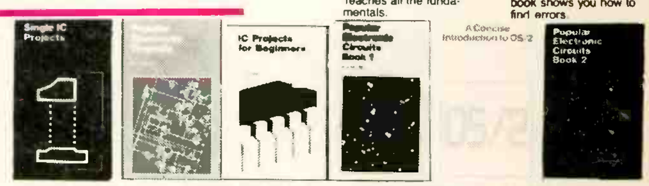

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